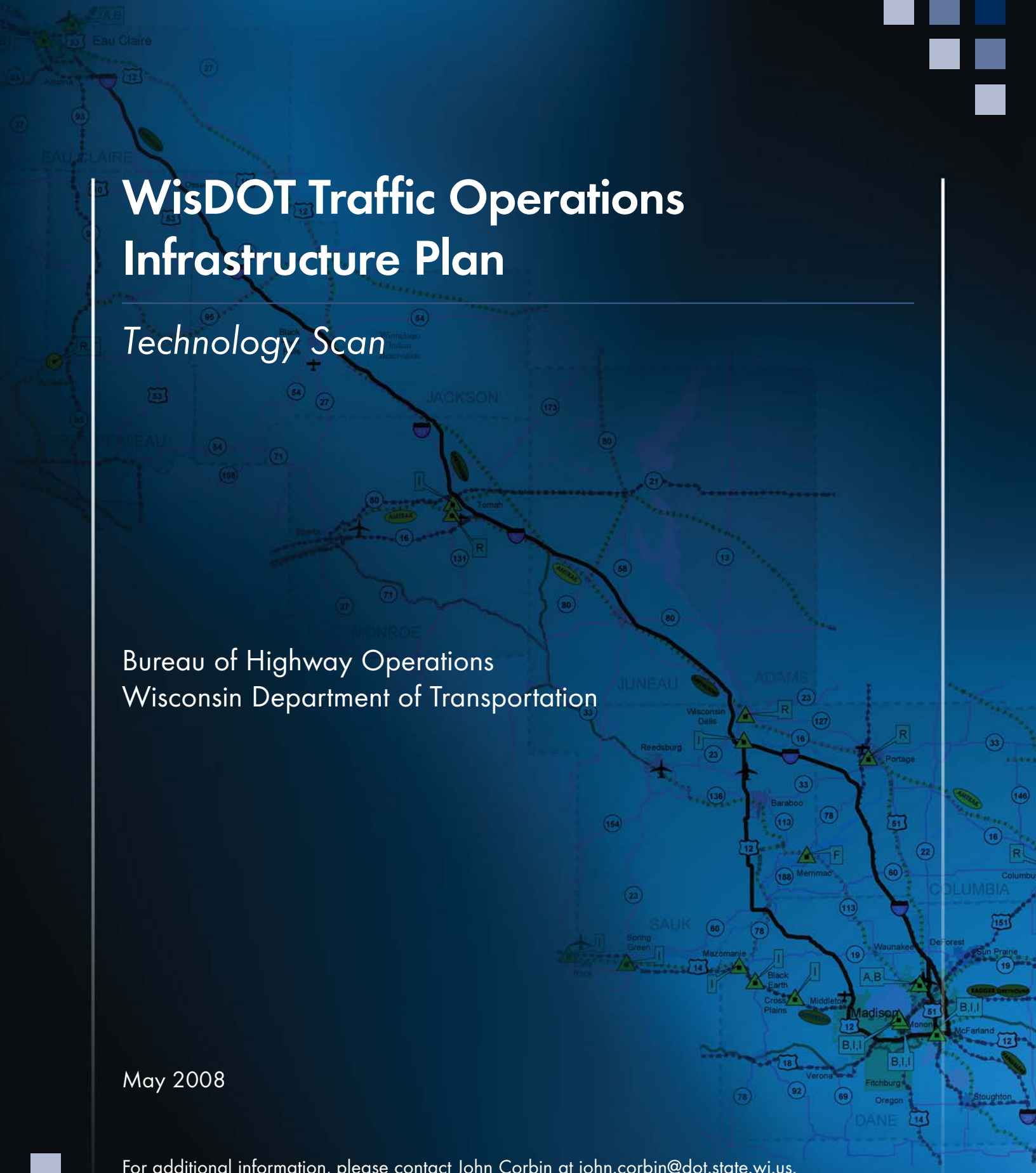
WisDOT Traffic Operations Infrastructure Plan

Technology Scan



Bureau of Highway Operations
Wisconsin Department of Transportation

May 2008

For additional information, please contact John Corbin at john.corbin@dot.state.wi.us.

Wisconsin Department of Transportation Technology Scan – Table of Contents

1) Freeway Management Systems 1
   a) Detection and Classification 1
      i) State of Practice 1
      ii) Available Technologies 1
      iii) Standards 8
      iv) Recommendation 8
      v) Migration Plan 9
      vi) Communications Needs 9
      vii) Software Needs 10
      viii) Cost Summary 10
   b) Surveillance 11
      i) State of Practice 11
      ii) Available Technologies 11
      iii) Specialty Cameras 16
      iv) Other Emerging Technologies 17
      v) Standards 17
      vi) Recommendation 18
      vii) Migration Plan 18
      viii) Communications Needs 18
      ix) Software Needs 18
      x) Cost Summary 19
   c) Ramp Metering 20
      i) State of Practice 20
      ii) Available Technologies 21
      iii) Recommendation 25
      iv) Migration Plan 25
      v) Communications Needs 25
      vi) Software Needs 26
      vii) Cost Summary 27
   d) Ramp Gate Control 28

i) State of Practice 28
ii) Available Technologies 28
iii) Recommendation 32
iv) Migration Plan 32
v) Communications Needs 32
vi) Software Needs 32
vii) Cost Summary 33

2) Arterial Management Systems 34

a) Signal Controllers 34
i) State of Practice 34
ii) Available Technologies 35
iii) Recommendation 39
iv) Migration Plan 40
v) Implementation Strategies 40
vi) Cost Summary 40

b) Cabinets / Foundations 41
i) State of Practice 41
ii) Available Technologies 41
iii) Recommendation 45
iv) Migration Plan 45
v) Implementation Strategies 45
vi) Cost Summary 45

c) Vehicle Detection 46
i) State of Practice 46
ii) Available Technologies 46
iii) Recommendation 48
iv) Migration Plan 48
v) Cost Summary 49

3) Traveler Information 50

a) Permanent DMS 50
i) State of Practice 50
ii) Available Technologies 54
iii) Controller Installation Location 58
iv) NTCIP Compliance 59

v) Enclosure Types 59
vi) Structure Mounting Options 61
vii) Cost Summary 65
viii) Recommendations 66
ix) Migration Plan 67
b) Portable CMS 68
i) State of Practice 68
ii) Available Technologies 69
iii) Message Selection and Communications 69
iv) Cost Summary 72
v) Recommendation 72
vi) Migration Plan 73
c) Web Sites 74
i) State of Practice 74
ii) Available Technologies 75
iii) Recommendation 78
d) Highway Advisory Radio 80
i) State of Practice 80
ii) HAR Technology Scan Results 81
iii) Current WisDOT HAR Messaging Practices 82
iv) Available Technologies 82
v) Cost Summary 85
vi) Recommendation 86
vii) Migration Plan 86
e) 511 Traveler Information System 87
i) State of Practice 87
ii) Common National System Operations Practices 87
iii) Current Status of Wisconsin System 88
iv) Coordination with and Impacts to Traveler Information System 88
v) Cost Summary 89
vi) Recommendation 90
vii) Migration Plan 92
f) In Vehicle Warning and Information Systems 93
i) Vehicle Infrastructure Integration 93

ii) Personal Communications Devices 93
iii) Global Positioning Satellite Navigation Systems 94
g) Site Specific Traveler Information 95
i) Smart Work-Zones 95
ii) Portable HAR 95
iii) Portable Changeable Message Signs 96
iv) Speed Warning Systems 96
h) Weather Hazards Systems 97
i) Road Weather Information Systems 97
ii) Fog Detection/Warning 97
4) STOC Central Software Systems 98
a) Supported STOC Central Software System Modules 98
i) Description of STOC Software Modules 99
b) Supported Freeway Management Technologies 104
i) Traffic Detectors 104
ii) Video Systems 105
iii) Ramp Meter Systems 105
iv) Ramp Gate Systems 106
v) Highway Advisory Radio Systems 106
vi) Dynamic Message Sign Systems 106
vii) Portable Changeable Message Sign Systems 107
viii) Remote Weather Information Systems 108
ix) Smart Work Zone Systems 108
x) Other Information Systems 108
c) Supported Arterial Management Technologies 110
i) Signal Controller Technologies 110
5) Communication Systems and Support Technologies 111
a) ITS Communications Infrastructure Support Systems 111
i) Available Wireless Technologies 111
ii) Available Fixed Line Technologies 127
b) Applicable Technology Environments for ITS Deployments 130
i) Technology Topology Examples 130
c) ITS Communications Information Broadcast Support Systems 132
i) Mobile Wireless Applications 132

ii) Leased Broadband Technologies..... 133

d) Functional Integration..... 137

Appendix A: Signal Controller Summary

Appendix B: Signal Controller Manufacturer Data Sheets

Appendix C: Freeway Management Systems Manufacturer Data Sheets

Appendix D: Table of Acronyms

1) FREEWAY MANAGEMENT SYSTEMS

a) DETECTION AND CLASSIFICATION

i) State of Practice

A variety of applications require the detection of vehicles. This review emphasizes applications that require real time measurement of traffic flow, as is often needed for intelligent transportation systems (ITS). Examples of real time applications include incident detection or travel time estimates along a corridor. These real time systems typically utilize volume, speed and/or occupancy data. Other applications may require different data parameters. For example, signalized intersections require primarily presence detection, and automated traffic recorder stations require mainly volume and classification data parameters. However, as vehicle detection technologies evolve, there are opportunities to share data across these formally disparate applications.

Inductive loop detectors are still the most common method of vehicle detection, but many agencies are experimenting with alternative methods of detecting traffic. These alternative methods include the use of sensors that are non-intrusive to the roadway and, more recently, the use of cellular phone location data to allow phones to serve as mobile probes. The Wisconsin Department of Transportation (WisDOT) is similar to many other transportation agencies in their use of loop detection, supplemented to some degree by alternative methods of detection.

Vehicle detectors can perform a variety of functions. A review of different detection technologies must consider a few basic requirements: they must operate accurately under a variety of traffic and environmental conditions, they must accurately capture vehicle movement in all areas of the detection zone, and they must provide the necessary detection parameters. Other important considerations include cost, ease of maintenance, deployability and ease of integration. These factors will be explored for a variety of detection methods.

ii) Available Technologies

(1) Inductive Loop Detectors

Inductive loop detectors apply a small electric current to a coil of wires and detect the change in inductance caused by the passage of a vehicle. Inductance changes are measured and reported by a loop amplifier (detectors) located in the traffic signal control cabinet. Loop detectors have been in use for over 40 years, making them a mature technology. They are also very accurate and generally reliable, especially when pre-formed loops are installed. The primary drawbacks to loop detectors are the cost to install, especially when multiple lanes need coverage, disruption to traffic during installation and maintenance, and damage to pavement where saw cuts are required.

> **Note: Manufacturer lists presented in this document are not exhaustive. Specific products are provided simply as examples of current applicable technologies.**

Manufacturers

- Manufacturer: Reno A & E
  Sensor(s): Model T-110, T-210, and T-400 series detectors
  Description: The T-110 series detectors are single-channel, shelf mount, DIP switch programmable detectors with Call delay and Call extension. The T-210 series are two-channel and the T-400 series are four-channel. All three are available with relay and solid state outputs.

- Manufacturer: EDI
  Sensor(s): LMD622, LMD604t
  Description: Two channel (LMD622) and four channel (LMD604t) detector cards are compatible with 170/2070 controllers and TS-1 and TS-2 applications. Cards utilize a Deflectometer™ call strength indicator to assist in calibration.

- Manufacturer: Diamond Traffic Products
  Sensor(s): Phoenix RAX, others
  Description: Diamond manufacturers a wide variety of data collection equipment, including road tube counters, piezoelectric detectors and loop detector counters and classifiers. The Phoenix RAX is a shelf mount unit that can accommodate from 4 to 16 loop detector inputs.

- Manufacturer: Global Traffic Technologies (Canoga)
  Sensor(s): Canoga C900 Series Digital Vehicle Detectors
  Description: Two-channel (Model C922) and four channel (Model C924) digital vehicle detectors with delay and extension timing, vehicle counting, vehicle presence, and roadway occupancy functions.

- Manufacturer: Quixote
  Sensor(s): Single-channel to four-channel inductive loop detectors
  Description: single-channel to four-channel inductive loop detectors offering a variety of options such as extend and delay timing, diagnostics, and TS-1 and TS-2 specific.

Reference:

1. *A summary of Vehicle Detection and Surveillance Technologies used in Intelligent Transportation Systems,* Vehicle Detector Clearinghouse, August 31, 2007.

(2) Video Detection

Video sensors use microprocessors to analyze video images captured by a camera. The sensors require careful initial calibration when the detection zones are set up. Video sensors can be cost effective when monitoring large areas because one can offer numerous zones of detection. These sensors have an advantage of offering a variety of traffic parameters, such as speed, volume and queue length. They are also flexible, in that detection zones can be modified easily. Some drawbacks to video detection include their complexity, cost, mounting restrictions and performance in adverse environmental conditions (low light, clouds, wet pavement, wind, etc.). Nighttime detection can be problematic in areas that are not well lighted—a camera will "see"

headlights, but its interpretation of where the vehicle is on the road can be skewed. It is also recommended that detection zones be checked periodically, to make sure the camera has not moved. The general consensus is that video detectors can "see" down the road 10 feet for each foot of mounting height. On some high-speed approaches, this limitation could preclude their use for back detection.

A large number of video detector manufacturers are active in American and international markets. A brief summary of the prominent products available in the U.S. is listed below.

Manufacturers

- Manufacturer: Econolite
  Sensor(s): Autoscope Solo Terra and Autoscope Solo Pro II
  Description: The Solo line of products feature the camera and data processing combined into one housing. The Solo sensors use a combination of pixel tracking and trip line technology to identify vehicles.

- Manufacturer: Iteris, Inc.
  Sensor(s): Vantage RZ4 Camera
  Description: The Vantage detector is most commonly used at signalized intersections, but can also be deployed on highways for data collection and incident detection. The sensor uses a combination of pixel tracking and trip line technology to identify vehicles.

- Manufacturer: PEEK Traffic (Quixote)
  Sensor(s): VideoTrak Plus Model 905 or 910
  Description: The VideoTrak is designed for use at signalized intersections and highways. The 905 processor accepts up to 4 inputs and the 910 accepts up to 8 inputs.

- Manufacturer: Traficon
  Sensor(s): VIP 3D and Traficam
  Description: The Traficon sensors are designed for applications at signalized intersections. The VIP 3D processor card accepts one or two inputs depending on the model selected. The Traficam sensor integrates a CMOS camera with a presence sensor in one housing. Both sensors use a combination of pixel tracking and trip line technology to identify vehicles.

- Manufacturer: Citilog
  Sensor(s): AutoIncident, Traffic Data Collection and Media City
  Description: A French-based manufacturer that makes a suite of video detection products. Their specialty is sensors designed for automated incident detection. Some of their products are designed to work on a PTZ platform. They have deployments on the east coast of the United States.

- Manufacturer: Siemens
  Sensor(s): EagleVision

Description: The EagleVision video detector supports IP communication for remote connectivity. The sensor is designed for detection at signalized intersections and highways.

Reference:
1. *A summary of Vehicle Detection and Surveillance Technologies used in Intelligent Transportation Systems,* Vehicle Detector Clearinghouse, August 31, 2007.

(3) Microwave Sensors

Microwave sensors transmit low-energy microwave radiation at the detection area and analyze the signal reflected back to the sensor. The shift in the reflected signal provides a measure of the vehicle's presence and speed. Advantages of microwave sensors include their simplicity, cost and accuracy. Drawbacks include the difficulty in discerning individual vehicles and their inability to detect vehicles traveling less than 5 mph. Microwave sensors generally offer detection in only one zone. Given their simple setup, microwave sensors are well-suited to short term applications, such as detection during construction.

Manufacturers

- Manufacturer: Xtralis (ASIM)
  Sensor(s): TT 292, MW 232
  Description: The triple technology (TT) sensor incorporates passive infrared, ultrasonic and Doppler microwave technologies to provide a variety of outputs, including volume, speed and classification. The MW 232 is designed for presence detection applications and can be programmed to detect only oncoming traffic, only departing traffic, or traffic in either direction.

- Manufacturer: MS Sedco
  Sensor(s): TC26B, SmartWalk XP, XM or TX
  Description: The TC26B is designed for presence detection at signalized intersections. The sensor detects motion and holds a relay contact closure open until movement is no longer detected. The SmartWalk sensors detect pedestrian and trail users. These sensors only provide presence detection, not vehicle speed or other parameters.

(4) Radar Sensors

Radar sensors are similar to microwave sensors, but are able to detect stationary vehicles and a variety of detection zones through their range-finding ability. Several radar sensors have been developed for traffic applications. Advantages of radar sensors are their multiple detection zones, ease of calibration, and accuracy. Sensors on the market offer self calibration procedures that speed up the process and ensure greater accuracy. Disadvantages include cost and mounting restrictions.

Manufacturers

- Manufacturer: Wavetronix

Sensor(s): SmartSensor, SmartSensor HD, SmartSensor Advance
Description: The SmartSensor and SmartSensor HD are side-fire radar sensors that can detect multiple lanes of traffic. They can record count, speed and length data to their built-in memory or pass data to a centralized traffic management center. The SmartSensor HD has two radar detectors in a "speed-trap" configuration that can detect speed and length with greater accuracy than the SmartSensor. The SmartSensor Advance is forward-firing radar sensor that is designed to be used at signals for dilemma zone and green light extension applications.

- Manufacturer: EIS
  Sensor(s): RTMS X3 and RTMS G4
  Description: The RTMS is a side-fire radar sensor that can detect vehicle presence in multiple zones. The RTMS X3 sensor uses a horn antenna and the G4 has a phased array antenna for greater accuracy. The G4 sensor also has an integrated camera that an operator can use to monitor traffic and for calibration.

- Manufacturer: Quixote
  Sensor(s): trans-Q
  Description: The trans-Q is a battery-operated side-fire traffic classifier. The sensor is designed primarily for portable classification studies and mounts to existing roadside hardware. It collects count, length, and speed data for vehicles in both directions. The trans-Q should be mounted at the level of the vehicles.

(5) Magnetometers

Magnetometers consist of a small coil of wire that measures the change in the earth's magnetic flux that is created when a vehicle passes through a detection zone. Magnetometers can be installed under the roadway through insertion in conduit, in the pavement by core drilling, or affixed to the surface. Recent advances in battery and communication technology have produced products that can be installed in the pavement and communicate wirelessly to a receiver. The battery is estimated to provide approximately 10 years of life under normal operating conditions, after which time a new sensor can be installed and reconfigured.

Manufacturers

- Manufacturer: Global Traffic Technologies (Microloop)
  Sensor(s): Canoga
  Description: The Canoga microloop sensors are installed under the pavement inside a conduit. Installation of the sensors consists of boring conduit under the roadway and inserting "carrier" spacers in the conduit. Microloops and attached cables are inserted into the carriers and then pushed through the conduit. In a nearby traffic cabinet, the microloops are connected to a Canoga card that functions similarly to a loop. The sensor can obtain presence and occupancy. If the sensors are installed in a speed-trap configuration, speed and length can be obtained.

- Manufacturer: Sensys Networks
  Sensor(s): Sensys Wireless Vehicle Detection System

Description: The Sensys Wireless Vehicle Detection System consists of a series of in-pavement magnetometer sensors that wirelessly communicate to a nearby access point. The sensors are battery operated and last about eight years, after which time the entire unit is replaced. The system can detect presence, occupancy and, depending on the sensor configuration, speed and length. The access point can be equipped with a cellular modem for data backhaul and processing.

- Manufacturer: Nu-Metrics (Quixote)
  Sensor(s): Groundhog
  Description: The Groundhog is an in-pavement magnetometer that wirelessly communicates with a controller housed in a nearby RWIS station. The sensor also has an in-pavement temperature sensor, wet/dry detector, and chemical detection. The sensor runs off batteries that need to be periodically replaced. Nu-metrics also makes temporary counters that are affixed directly to the pavement.

(6) Emerging Probe Technologies

A novel approach to traffic detection is to capture data that is constantly being generated by vehicles themselves as they traverse the road network. First, cellular phones can provide valuable mobile probe data due to the high degree of saturation within the vehicle stream. Cell phone carriers need location information in order to route calls and to hand off calls from one cell tower to the next, a point at which location information is known with a higher degree of accuracy. In addition, the approximate location is known for every cell phone that is turned on, not just for phones that are in use. This creates a large database of location information that can be mined for tracking the flow of hundreds of discrete probes across corridors. Cell phone carriers strip away any customer-specific information and then make this information available to third party companies. These companies then apply various algorithms that assign cell location data to specific roadways, remove data outliers, and calculate speed and/or travel time estimates for corridors.

Another approach taps into the automatic vehicle location (AVL) technology used by freight companies to track vehicle fleet movements. AVL systems integrate mobile GPS-based location information with wireless communications. This information can also be used to develop speed and travel time estimates along corridors.

The use of mobile probes for traffic flow measurement has several advantages. They provide a continuous flow of data-rich information without the use of any roadside infrastructure. All system maintenance is handled by the company operating the system. They can provide data across a wide geographic area. Lastly, this information can be analyzed to give traffic condition data for a myriad of corridors and segments.

Disadvantages include cost and data limitations that are inherent to the system. Travel time/speed information requires a minimum number of samples in order to be accurate. Low volume conditions, such as during off-peak periods or in rural areas, can result in poor estimates. There are also privacy concerns with this type of approach. Last, the cost of this data must be weighed against the benefit it provides.

A complete evaluation of cell-probe system efficacy has not yet been completed for any of the commercial offerings available in the US. However, in a white paper published by the Florida DOT in 2007, it was concluded that none of the systems surveyed nation-wide were able to provide data of sufficient accuracy and consistency that it was useful for management decision support. These systems should be monitored as they mature.

Manufacturers

- Manufacturer: Airsage
  Description: Airsage has partnered with a cellular carrier to provide traffic flow measurement across the road network. Their TrafficWiSE technology examines cellular location data to provide real time traffic data. WisDOT has a contract with Airsage to provide mobile data along the I-94 corridor between Milwaukee and Madison.

- Manufacturer: Inrix
  Description: Inrix partners with freight companies to obtain GPS-based flow information from vehicle fleets. While not as numerous as vehicles with cellular phones, the GPS-based data is more accurate. WisDOT has a contract with Inrix to provide location information between Milwaukee and Green Bay.

- Manufacturer: Cellint
  Description: Cellint is an Israeli-based company that has developed a system that does not require cell tower call transfers to identify vehicle locations. The system is designed primarily for incident detection, but other traffic studies, such as origin/destination studies, are also possible. They have deployed systems in Tel Aviv, Sweden, Kansas City, Atlanta and Springfield, Missouri. Deployment costs start at $1,000 per mile.

- Manufacturer: ITIS Traffic Services, Ltd
  Description: ITIS is an Israeli-based company that has deployed nation-wide systems in Israel, England and Belgium. They are also conducting testing in Maryland and Missouri. They utilize the GSM cellular standard that uses “hard handovers” to transfer calls between towers, allowing for accurate location information. By contrast, the CDMA network’s “soft transfer” does not provide as exact location information. In the United States, the only GSM carriers are T-Mobile and AT&T, which up until now have not been willing to share location data with mobile probe providers.

As mentioned above, WisDOT has a contract with Airsage to provide mobile data along the I-94 corridor between Milwaukee and Madison. Another contract with Inrix taps into the freight industry database to provide location information along other corridors.

(7) Integrated Solutions

Along with technologies previously mentioned, recent advances in the market have set a foundation for integrated solutions. Integrated solutions may minimize the amount of devices and software needed; however they are generally more expensive due to the increased functional capability. Depending on the application, these devices may reduce the physical and

communications infrastructure needed to support the system as a single device would be installed at a single location.

Integrated solutions include:

- **RTMS integrated with camera:** this system combines the RTMS radar detector with a simple camera, similar to a web cam. This allows viewing the detection area to check traffic conditions or verify proper sensor aiming.

- **Wavetronix software**: software has been developed to integrate detection control and communication with other ITS applications, such as Dynamic Message Signs (DMS) and Closed Circuit Television (CCTV).

(8) Other Technologies

In addition to the technologies discussed within this document there are detection technologies such as passive infrared, active infrared, ultrasonic and passive acoustic. Since they are not necessarily practical this document does not investigate them in detail.

There are other areas of detection that do not fall into the categories listed above. The first is the use of aerial images in traffic detection applications. Aerial images can be captured in real time with unmanned aerial vehicles (UAVs) that can be flown above traffic corridors of interest. The use of satellite photos is also being explored, although it is currently not possible to receive this information in real time. Thus, only applications that utilize historical data are under consideration.

Another area of detection is the use of video detection for automated license plate readers. These systems can be used for a variety of applications, including origin/destination studies, tollway enforcement, red light running and travel time estimation.

iii) Standards

NTCIP 1209 is a data dictionary standard defining those data elements that may be used for monitoring and controlling transportation sensor system (TSS) devices for detecting and communicating certain traffic parameters. A TSS device can be a loop detector, a video image processing system, or could use other sensing technology. NTCIP 1209 also describes a Zone, Virtual Zone, Sensor, and how zones can be logically grouped together.

NTCIP 1206 (Data Collection and Monitoring Devices) may also be applicable when integration with traditional (i.e., traffic data recorder) systems is needed.

iv) Recommendation

Loop detectors have proven their ability to provide effective vehicle detection. While loop detectors are widely deployed and well understood by maintenance staff, there are several applications that would benefit from other forms of detection:

- **Deploy non-intrusive sensors:** Most non-intrusive sensors can be deployed, calibrated and maintained without disrupting traffic or exposing personnel to live traffic. Multi-zone sensors offer the advantage of covering a wide area from a single location.

- **Add detection to strategically located RWIS stations:** Existing RWIS stations offer a mounting platform, source power and communication infrastructure to support the addition of non-intrusive side fire sensors.

- **Expand mobile probe detection system:** The mobile probe system currently in use by WisDOT should be evaluated for wider deployment.

- **Ongoing research:** The field of traffic detection continues to evolve, with the marketplace continuing to offer new and innovative products. Periodic exploration should be conducted to understand how new advances could be applied.

v) Migration Plan

The following elements are proposed for a migration plan:

- Update the statewide ITS procurement list to accommodate the latest detection technologies,

- Host a manufacturer fair to update staff knowledge on detection technologies and advances in the marketplace.

- Deploy innovative detection systems on pilot projects in order to gage their effectiveness and applicability to WisDOT.

- Sponsor sensor evaluation in side-by-side field tests through WisDOT funds or participation in pooled fund studies.

vi) Communications Needs

In general, communications needs for detection systems are modest, with an emphasis more on reliability than performance. Typical data rates are in the 9600-38400 bits/sec range although this is usually for short bursts of several hundred bytes every 30 seconds to 5 minutes in a polled environment.

For real-time management applications, there are many wireless and hard-wired options available, the most challenging issue usually being data transport back to a management facility. Serial data radios, particularly those that operate in the licensed RF bands offer high reliability over long (up to 20 mile) distances for detector data. If appropriate service is available, many cellular data networks are also viable options. Detection devices may also share communication facilities with other systems, such as CCTV and message signs.

For non real-time applications, (daily or weekly data retrieval) an analog telephone connection may be sufficient. Use of this method is highly dependent on the specific costs associated with installation and service costs at a particular location.

vii) Software Needs

Most manufacturers will supply set-up and data collection software with their devices. This may be satisfactory for planning level data collection, but does not provide an environment where multiple sensor inputs can be used in real-time for management. Most organizations will use either an internally developed software package or a modified version of a product tailored to the specific application. Costs for software development are highly variable, and require specific definition for cost estimation. Use of packages developed by other Departments of Transportation (such as Mn/DOT's IRIS) is also an option, which may provide highly functional software at low initial costs. However, the long term maintenance of such a package should be considered as modification/enhancements would have to be provided internally or through arrangement with the software provider.

viii) Cost Summary

Detection Comparative Costs					
	Capital	**Electrical**	**Communications Needs**	**Maintenance**	**Service**
Inductive Loop Detectors	Low-Med	Low	Low	Low	N/A
Video Detection	High	Low	Med-High	Med	N/A
Microwave Sensors	Low	Low	Low-Med	Low	N/A
Radar Sensors	Med	Low	Med	Low	N/A
Magnetometers	Low-Med	Low	Low-Med	Low	N/A
Emerging Probe Technologies	N/A	N/A	Med-High	N/A	High
Integrated Solutions	Med	Low	Med	Low	N/A
Other					

b) SURVEILLANCE

i) State of Practice

CCTV surveillance has become an important tool for the management of traffic and incidents on a variety of roadways. Unlike vehicle detection systems, CCTV allows for identification of causes of congestion and can provide valuable information to emergency responders.

The last decade has seen a shift from older, analog video management systems to advanced digitally encoded and compressed video. This change has had three major advantages:

1) The infrastructure needed to support camera sites is reduced, since "home runs" of cable are no longer required, along with video multiplexer devices and amplifiers for long distance transmission.

2) Distribution of video is simplified through the use of existing data networks and desktop viewing software.

3) Video can now be stored on multiple input video recorders instead of banks of tape-based recorders. Having video recorded and stored for short periods and easily retrievable can greatly assist accident investigators and others who may need to review incidents.

The advantages of digital video based CCTV systems continue make new applications viable. Smaller, less expensive cameras coupled with advanced video compression techniques allow for installation in more remote areas that may be connected by wireless data systems or other low-bandwidth options.

ii) Available Technologies

(1) Cameras

All CCTV systems are based around a basic electronic camera. These use a small silicon chip to convert incoming light to electronic signals that can be encoded and transmitted. The camera is mated to one of several types of lenses (chosen based on light-gathering properties, zoom ratio, or other factors) and attached to a Pan-Tilt-Zoom (PTZ) mechanism. Outdoor cameras are usually placed into some type of enclosure to protect them from the elements and heated to eliminate condensation inside the enclosure.

Once installed, the video output from the camera (either analog or digital) is transported to a location where it can be viewed and recorded (typically called a "head end"). Where multiple cameras are to be viewed, they can be individually displayed on dedicated monitors or selected for display using a "switch matrix" that can be either a physical device or implemented in software if the video is being transported digitally.

Often video is stored for later review. The Digital Video Recorder (DVR) has become the primary method for doing this, replacing tape based systems. DVRs can have very large storage abilities, provide convenient search tools, and unlike tape, do not experience degradation of video quality over time. Some DVR systems also include basic switch matrix functions, and can simplify video management for smaller (< 32 camera) installations.

Although compression techniques have become very sophisticated, digital video content still requires substantial network bandwidth. In fact, without compression, DVD quality video would require nearly 250 Mbit/sec, exceeding the capacity of all but the fastest networks. In practice, data rates of 1.5 to 6 Mbit/sec produce acceptable, full motion video. These data requirements can be accommodated by most wired Ethernet networks in use today, as well as wireless systems (Wi-Fi – 802.11a/b/g and some cellular data systems).

There are a variety of different camera systems on the market, as well as different encoding/compression options. Examples of camera "systems" (camera, lens, PTZ mount, power supply, etc.) are given below. However, the internal camera electronics in a system may be from a different manufacturer than the system provider. For example a Pelco system may include camera electronics from Hitachi, JVC, Panasonic or even Sony. This relationship will also vary between product lines.

(2) Poles and Camera Lowering System

Several options exist to allow for mounting cameras at the roadside. These are briefly described below:

- **Tip-Down Poles**. These systems use a hinge at the approximate mid-point of the pole and a winch system to permit raising and lowering of the assembly. This arrangement allows for inspection of all camera mounts, wiring and components either from the ground or using a short ladder. Given the height of some poles, care must be taken to ensure that the tip-down area is clear around the pole and that other objects (signs, trees, etc.) do not interfere with the pole.

- **Camera Lowering Systems**. This approach uses a winch and cable system to lower only the actual camera assembly itself to the ground. Lowering systems can be fitted to some existing pole types and allow the work area to be very compact around the pole. Most lowering systems use a disconnect coupling at the top of the pole to allow the camera to lower while leaving power, video and data connections in place.

- **Truss-Style Towers**. Truss or "girder" style towers are commonly used for RWIS systems. They offer a high degree of mounting flexibility for components and usually have lowering systems similar to a tip-down pole. Truss structures will generally be less rigid than other poles, which translate into more camera motion in high wind conditions and may interfere with proper antenna alignment when wireless data systems are used.

- **Extensions**. For locations where there are existing signal or lighting structures, it may be possible to retrofit an extension that provides locations for the signal or light fixtures in addition to a mounting point for a camera system. This approach may be very cost-effective where applicable, providing aesthetic and structural concerns are met.

(3) Enclosures and Mounts

There are two general camera mounting methods - dome and exterior mounts. Dome mounts place the camera and associated PTZ mechanism into a half-sphere enclosure. The camera "hangs" down inside the dome, which has its transparent section pointed downward. The dome has the advantage making the camera and mount removable, allowing for "snap-in" replacements in some cases. Some domes are also compatible with lowering mechanisms, which allow for access to the camera without the need for a lift-truck or tilt-down pole when mounted on poles near the roadside. Domes also have a maintenance advantage in that the shape allows for water and dirt to drain off the bottom of the housing.

The primary disadvantage of the dome is that the upper section can block the view of the camera if a positive tilt angle is needed to view something along the roadway. This characteristic becomes a substantial issue in hilly terrain, where the roadway on a nearby hilltop may be above the mounting height of the camera. Domes that allow the camera to sit low enough to tilt upward are available, but are much larger than typical domes.

Exterior mounts place the camera in a box that is then attached to special PTZ mechanism that allows for tilt-up and tilt-down motion as well as 360-degree pans. This type of mount allows for the maximum freedom of motion of the camera and thus superior fields of view.

Exterior mount cameras have greater maintenance needs, primarily related to keeping the window on the camera enclosure clean. An integrated wiper system keeps the window clear, but requires the periodic change of the wiper blade. The additional moving mechanical parts also pose an increased failure risk.

A sample of different camera and mounting systems is shown in the table below. While not exhaustive, several different approaches to camera system design are included. At one end of the scale is the Sony SSCCD77, which is a very small dome system costing approximately ~$600. The other end of the range is the SpeedDome Ultra, which has an MSRP of $4,268. In all of the cases below, an external digital encoding device must be used. These can range from ~$700 to over $3,000. However the Vicon dome offers an integrated encoder option, which may keep its costs below the others, if used.

In general, the greater costs imply better video quality, superior low light performance and more features.

Comparative Costs						
	Type	**Capital**	**Elect.**	**Comm. Needs**	**Maintenance**	**Service**
Sony SSCCD77	Mini Dome	Low	Low	Low	Low	Low
Pelco Esprit	Exterior	High	Low	Med-High	Med	Low
Vicon SurveyorVFT	Dome	Med	Low	Med-High	Low	Low
American Dynamics SpeedDome Ultra	Dome	High	Low	Med-High	Low	Low

(4) Codecs and Encoders

To transmit video over a packet data network, the analog signals must be captured and converted into a stream of digital data that can be routed as needed and converted back into viewable images. This task relies on devices called Coder/Decoders or Codecs.

A codec consists of an analog video interface, a processor and a network interface (such as Ethernet or T1). Codecs may be stand-alone hardware components or integrated directly into the camera assembly. Integrated solutions are commonly called IP Cameras or Network Cameras.

The stand-alone and integrated approaches each offer advantages in deployment situations. Integrated codecs (IP Cameras) will generally have lower overall cost for the system, are simpler to install, and will work in the same environmental conditions as the camera itself. External codecs allow for "best of breed" selection, upgrades to the system without need for camera replacement and can make troubleshooting and maintenance easier.

If codec hardware is selected properly for the harsh environment in outdoor cabinets, the primary differentiators will be with feature set and compression technologies.

Since codecs are complex network devices, implementation of different features can have major impacts on video quality. Advanced network traffic management protocols (IGMP Multicast, QoS, etc.) affect the efficiency of bandwidth usage and, ultimately, final video quality.

The largest factor in perceived video quality, however, is the method of compression used by the codec. Compression techniques have been available for some time, but in the last 5-10 years made major strides.

The most common method is called MPEG-2, which is used to provide high-quality video on DVD systems. It is most efficient with bit rates from 1.5-8 Mbit/sec and with medium to high resolution images. An earlier version MPEG-1 can still be found, but generally produces lower quality images in exchange for lower bit rates.

More recently, MPEG-4 has become a common standard for distribution of video on Internet platforms. Using sophisticated inter-frame compression algorithms, MPEG-4 can deliver high quality video using 1/2 to 1/5 the bandwidth of MPEG-2 systems. The H.263 standard is also commonly seen in video codecs, but is being replaced by H.264, which is a variant of MPEG-4.

Motion JEPG is another common codec technology. Although it is not as efficient with bandwidth use, it has the advantage of encoding each frame of video as a separate element, which can be useful in security applications where clear rendering of frames is needed.

Codecs designed for high resolution are beginning to be developed, however there are no ruggedized stand-alone products at this time. These include MPEG-4 Part 10 (already in use in some videoconferencing applications) and VC-1, which is used on many HD DVD and Blu-Ray discs.

A short overview of some products available to digitally encode and distribute video is given below. The product mix in this area is evolving very rapidly, and thus the overview table should be used for reference purposes only, and not for product selection without further investigation at the time of purchase. Manufacturers are continually adding, deleting and altering models in their product lines, making listings for reference and planning documents difficult to create in a comprehensive fashion.

	Compression Type	**Extended Temp Range (C)**	**Power over Ethernet**	**Form Factor**
Coretec VCX-2000	MPEG-2	-34 - +74	No	19”/9” 1 U
Coretec VCX-4000	MPEG-4	-34 - +74	No	19”/9” 1 U
iMPath i4000 series	MPEG-2	-34 - +74	No	5” X 7.5” 1U
iMPath i4121	MPEG-2/4	-34 - +74	No	5” X 7.5” 1U
Cornet Mico	MPEG-4	Unknown	Yes	3” X 6” 1U
Cornet iDVO Q264	H.264	Unknown	No	6.3” X 6.1” 1U
DVTel 7401DA	MPEG-4	-30 - +60	No	7.8” X 3.5” 1U

(5) Integrated Solutions

- **CCTV/Detection System:** Using a single CCTV pole, it is possible to integrate the video system with a non-intrusive detection device. This approach reduces the pavement impacts since no disturbance of the system is required and the aesthetic impact since a single site is needed for both functions. “Smart” detectors also eliminate the requirement for a roadside cabinet to house detector input cards for a signal controller.

- **Augmented RWIS System**: RWIS structures are typically truss-style towers with a triangular cross-section. While this type of structure is not rigid enough for large older-style CCTV domes or other enclosures, the smaller systems available today are easily handled by RWIS towers. The “open” nature of the truss tower allows for a great deal of

flexibility in equipment mounting. The flexibility is also valuable in that it allows for easy reconfiguration of the system if needed. This can be a factor when using non-intrusive detectors that are sensitive to their position relative to the roadway or when wireless communications system are used that may require re-orientation of an antenna.

- **Integrated Cabinets:** With equipment becoming smaller and more tolerant of extreme environmental conditions, co-location of ITS components in traditional non-environmentally controlled cabinets is now feasible. CCTV components such as video encoders are now approximately the size of paperback books and require no external heating or cooling. Digital video recorders only slightly larger and able to withstand temperature, vibration and dusty environments are widely available. The current generation of ruggedized networking components is designed with rail-mounting in mind and offer performance equal to their office counterparts. Cabinets that were designed with signal or ramp meter control in mind can now offer a protected enclosure for a wide variety of ITS components.

iii) Specialty Cameras

(1) FLIR

Forward looking infrared (also known as thermal imaging or thermographic) cameras are not dependant on lighting conditions, as they detect differences in temperature rather than reflected light. This ability may allow for improved information in certain incident management situations, detection of occupants and identification of running vehicles.

Since they are based on a different technology than traditional cameras, costs can be substantially higher (2-5 times) than a basic CCTV system. Higher performance cameras (greater sensitivity and higher resolution) generally require active cooling systems for their sensor elements, leading to higher system complexity and greater maintenance costs.

(2) High Resolution/Slow Scan

A new class of surveillance camera is the very high resolution/slow scan device. These are meant to observe very large areas (for example, one side of a football stadium) unattended while providing an image of such high quality that it can be "digitally zoomed" after an incident has occurred (for example, to pick out a single face in a stadium crowd). The large size of each individual frame limits these cameras to very low frame rates, on the order of 1-2 per second. The camera system generally also includes a rotating mirror scanning assembly, which may yield higher maintenance needs.

The specialized nature of these devices drives their higher prices, in the $15,000-$20,000 range.

iv) Other Emerging Technologies

(1) Digital Video Recorders (DVR)

DVRs have become commonplace in the security and home entertainment sectors. These devices typically allow the user to select one or more inputs and a video quality to be recorded at a user-defined quality.

A useful function of some DVR devices is that they can be used as inexpensive management devices for video display. The multiple inputs can be routed to multiple outputs on an ad hoc basis, allowing the DVR to function as a matrix switch for a small TOC with perhaps 24 inputs and 4-8 monitors.

A DVR can also serve as a tool for incident management and training, with all cameras being recorded in a "loop" and only saved for archival purposes when a significant event occurs.

DVRs can be appliance-style devices or large systems, depending on the sophistication and storage needs for a given application.

(2) Video Management Servers

As video is more commonly stored and transported digitally, systems are emerging to take the place of dedicated hardware systems. Specifically, the analog video switch matrix is a device that can be replaced by a management server as video is routed directly from the source to a viewer's desktop or monitor. The management server may also take on the role of a DVR, a security and authentication system for restricting access to video resources and an Internet server distributing video to the public for traveler information purposes.

Several companies offer systems like this, including Cisco, iMPath, Coretec, Pelco, and others. The systems generally will only interoperate with devices from the same manufacturer, so careful assessments of all affected subsystems and components should be undertaken. Costs for systems such as these vary considerably from company to company and with the scale of the system itself.

v) Standards

In general, there are few decisions to be made related to standards used for video management. With exceptions for specific applications, data transport will typically use either TCP/IP or UDP/IP over an Ethernet (802.x) network. Encoding will use one of the codec standards described above (MPEG, H.246, etc.). In the domain of analog video, cameras and monitors will use NTSC standards almost without exception.

Of greater concern is the way in which standards may be implemented by a given manufacturer. Use of subsets or "interpretations" of standards may have an impact on both the functionality of devices and their ability to interoperate with other "standard" devices. Prospective manufacturers should provide this documentation prior to any procurement.

An emerging standard for control of camera functions is the NTCIP 1205 PTZ Protocol. Use of devices following this standard will allow different devices (control joysticks, etc.) with a variety of camera Pan-Tilt-Zoom systems. This may be highly advantageous in situations where a specific camera may be suited to a given application or where manufacturer's products are no longer a desirable solution. Camera systems using this standard should be given consideration to avoid manufacturer lock-in.

vi) Recommendation

The most common, high-efficiency codec available for ruggedized installations at this time is MPEG-4. There are several manufacturers who provide products of this type. MPEG-2 should also be considered as an option, since it is widely used and many products are based around it, and as such can be very mature and reliable. MPEG-2 may be an excellent choice where bandwidth budgets of >2Mbit/sec are attainable.

vii) Migration Plan

The method of use and distribution of video should be carefully considered prior to choosing a long-term solution to digital video management. The number of streams to be simultaneously used at any given location and the capacity of the paths between the camera and user must be calculated and appropriate bandwidth budgets assigned to each portion of the network.

Many manufacturers offer multiple compression methods within their product line. This makes an interoperable system using different codecs feasible. For areas already heavily invested in a given codec, checking with manufacturers for upgrade paths that maintain interoperability with legacy products is strongly recommended.

viii) Communications Needs

Video data is highly bandwidth-intensive and places high demands on network performance. The codec used can greatly affect the required bandwidth, as can the resolution of the video. As a rule of thumb, a real-time, "good" quality image for traffic management will use 1-1.5 Mbit/sec with MPEG-4 encoding, MPEG-2 will require 1.5 -2.5 Mbit/sec.

Beyond the raw bandwidth needed, networks must be properly configured to support management protocols such as IGMP if multi-user video distribution is desired. Without proper network management overall performance can be severely degraded in these applications.

ix) Software Needs

Depending on the manufacturer, software capable of viewing video and controlling camera functions may either be included with the device or available for purchase.

With video encoding done in a standard way, it is also possible to create custom applications to display video within a consolidated management interface.

x) Cost Summary

Costs vary widely for both encoding hardware and viewing software. For a sample, video encoder hardware may be purchased for as little as $700, and can range as high as $4,000. Similarly client software may be free with the purchase of an encoder, or can cost as much as $1,000 per license for some applications.

c) RAMP METERING

i) State of Practice

Freeway ramp metering is implemented in congested urban areas to achieve several objectives: to break up vehicle platoons entering the freeway and to allow vehicles to merge smoothly with mainline traffic, to reduce delays caused by congestion and crashes, to reduce the number of crashes caused by congestion, and to provide more reliable travel times by regulating traffic entering the freeway. The WisDOT ITS Design Manual identifies that ramp metering is the primary system element for addressing recurring freeway congestion. Operators control the rate at which vehicles enter the mainline such that the downstream capacity is not exceeded, thereby allowing the freeway to carry the maximum volume at a uniform speed. The current state of the practice extends beyond the use of ramp metering for freeway traffic management, to interagency coordination between ramp meters and signal systems on crossing arterial roadways and street networks.



Ramp Metering

(1) Theories of Operation

Ramp metering systems currently in use vary widely in terms of their architecture and operation. Some optimize conditions locally and some attempt to perform system-wide optimization. Some ramp metering strategies rely on fixed metering rates based on historical data. Others rely on real-time data or predicted travel demand to adjust metering rates.

Fixed time metering is the simplest form of ramp meter control. It is most attractive in locations where traffic flows are very predictable. The metering rate is predetermined based on historical traffic data. Fixed time metering can help to reduce crashes at merge points. However, it is generally not as effective at regulating traffic flow on the freeway.

For local traffic-responsive operation, the metering rate is dependent on local traffic conditions. Mainline traffic flow data and/or ramp queue detector data is used in an algorithm to select a metering rate. This operation usually uses mainline detection upstream of the merge point as its primary data input. One criticism of this type of operation is that it only reacts to traffic congestion after it has already occurred, although some algorithms try to predict congestion before it occurs.

System-wide traffic-responsive operation seeks to optimize traffic flow for a section of freeway. Often, system is optimized to manage traffic flow through a downstream bottleneck. Typically, mainline and ramp detector data is sent to a central computer, which implements ramp metering strategies across the designated system. This type of operation is effective for managing incidents by altering metering rates on a ramp-by-ramp basis. Additional downstream mainline detection is typically required for this type of operation.

The Minneapolis-St. Paul Metropolitan Area has a system-wide traffic-responsive network, operated by the Minnesota Department of Transportation (Mn/DOT), with over 430 ramp meters. Through the year 2001, the goals of their metering strategy were to maximize bottleneck throughput and improve safety. However, wait times at some ramp meters were excessive according to public opinion. The queues at some ramps often spilled back onto the local streets. This led the State Legislature to direct Mn/DOT to shut off the ramp metering system for a period of time, collect traffic flow and crash data, and compare it to data before the system shutdown. Mn/DOT's data validated ramp metering as a strategy to optimize mainline through-put and improve safety. However, Mn/DOT adjusted metering rates such that maximum wait times were reduced to four minutes on local ramps and two minutes on freeway-to-freeway ramps.

(2) Physical Infrastructure

Ramp metering requires field hardware with special firmware and usually requires hardware and software at a central location. Hardware in the field includes the physical components of the system: ramp and mainline detectors, signal heads and standards/poles, advanced flashing beacons, controllers and cabinets.

If the ramp meter system is tied to a centralized control center, robust communications are needed between the ramp meters and the center. This is particularly true if high bandwidth applications like video feeds are also to be transmitted. At the control center, computers are needed to process data sent by the local controllers in the field. Software processes detector data for the metering algorithms. Software is also needed to allow operators in the control center to remotely monitor and control ramp meter operations.

ii) Available Technologies

(1) Control Equipment

The controller is a device that receives and stores vehicle detector information and operates signals according to internal logic or according to a central supervisory system. The controller processes detector data and controls the ramp meter timing. The controller may provide the following control functions:

- Control ramp meter signal heads
- Store and execute pre-timed metering schedules
- Implement local traffic responsive control algorithms using mainline detector data
- Accept metering rate command signals from the central control system
- Adjust the metering rate or terminate metering to prevent ramp queues from becoming excessive

- Control the advance beacon or blank out sign

Most existing ramp metering systems in the United States utilize standardized controllers. Type 170 or Type 2070 controllers are the most common because of their open architecture and the ability to tailor the software to the localized operational needs. Type 170s is a microprocessor-based device that controls the ramp meter signals using information from the loop detectors. Type 2070s provide similar functions to the type 170s and are more powerful 16-bit microprocessors that provide additional functionality to the older 170s through the use of VME-based (Versa Module Eurocard) expansion slots. The Advanced Traffic/Transportation Controller (ATC) has also been developed to provide an open-architecture hardware and software platform for a wide variety of applications, including ramp metering. The term "open architecture" means that the system includes both public- and private-sector developers that can have modular software cooperatively running on several hardware platforms. Many agencies contract with consultants to develop firmware for their tailored specifications.

A typical WisDOT ramp metering installation consists of a Type 170 controller unit in a Type 334 Cabinet. The controller unit is comprised of the following elements:

- CPU
- Input/output interface
- Unit chassis
- Unit power supply with external power connection
- Unit standby power supply
- Front panel assembly
- Internal system interface
- Connectors C1S, C2S, and T-1
- Communications system interface
- Model 412C program module
- Model 400 modem module



Control Equipment

Additionally, an HOV Programmable Logic Controller (PLC) can be added to the ramp meter processor assembly for 3-lane ramp meters equipped with an HOV lane. The HOV PLC holds the HOV lane signal red until a demand is detected from the demand loop rather than automatically giving a green light indication to the metered HOV lane if a demand is not detected. The WisDOT ITS Design Manual indicates that requirements for ramp metering with model 2070 controllers were under development.

(2) Cabinets

A typical WisDOT ramp metering system utilizes a Type 334 controller cabinet. There are several manufacturers that supply Type 334 cabinets, including McCain, Safetran, Intelight, and Phillips/Sisson Industries, Inc. (PSI). The 334 cabinet is a two-door, base-mounted cabinet that provides power supplies for the various electronic subassemblies such as the controller, detection modules, and external modems mounted throughout the cabinet. It also provides the communications paths between the various devices and monitors their operation. The subassemblies in the controller cabinet attach to a removable Electronic Industries Association (EIA) standard 19-inch equipment rack assembly for ease of maintenance.



Controller Cabinet

The major subsystems that may be installed in a cabinet housing include:

- Controller
- Input assemblies
- Output assemblies
- Power distribution assembly (PDA)
- Fiber-optic splice tray (if required)
- Modular serial and power bus
- Modular power assembly
- Cabinet monitoring system

The placement of the controller cabinet is one of the critical design components that can involve several factors:

- AASHTO Clear Recovery Zone (CRZ) requirements
- Visibility of the stop bar signals from the controller cabinet
- Distance between the controller cabinet and the loop detectors
- Distance between the controller cabinet and the signals on the ramp
- Safety of the cabinet location (should not be placed on the outside of a curve)
- Grades
- Drainage
- Maintenance Accessibility (parking availability for maintenance vehicles)

For maintenance considerations, it is very important that the stop bar signals be visible from the controller cabinet.

(3) Detection

Inductive loops are the most predominant detection method for ramp metering systems. Some agencies saw cut loops into the pavement, while others install preformed loops in non-metallic conduit. Many other non-intrusive detection options exist, such as video, microwave, radar, and magnetometers. These are appropriate for installations in high-speed, high-volume environments where detector maintenance operations would create safety or operational concerns, or where physical constraints make loop detector installation difficult.

There are several uses for detectors at ramp signals, such as, demand, passage, ramp queue, mainline, exit ramp, and entrance ramp without metering. Demand detectors are located in each ramp lane immediately upstream of the stop bar. Passage detectors are placed immediately downstream of the stop bar. Ramp queue detectors are installed near the ramp termini and at intermediate locations as needed to monitor excessive queues that cannot be contained within the queue storage area. These detectors can also serve as count detectors. Mainline detectors are typically located upstream of the entrance ramp gore point and usually have two loops per lane. Exit ramp detectors may be installed for traffic count information.

(4) Emergency Vehicle Preemption (EVP)

While traditionally installed at signalized intersections, EVP systems can be integrated into metered ramps to allow emergency vehicles to quickly pass through ramp meters. Because of the geometry of many ramps, vehicles often cannot move far enough onto the shoulder to allow emergency vehicles to pass. The EVP system overrides the signal timing and accelerates the metering rate to eliminate the queue. After the emergency vehicle is allowed to pass, the ramp meter resumes normal operation.

EVP for ramp meters is implemented similarly to how it is used in traffic signals. The EVP controller is connected to the ramp meter controller to give a local override when necessary. The EVP detector must be placed in a location where only emergency vehicles that enter the ramp will activate the system. Otherwise, errant system activations may result. On a straight ramp, this might involve placing the detector on the same pole as the ramp meter signals so that when the emergency vehicle enters the ramp, it is facing the detector. On other ramps, the EVP detector may need to be placed further up on the ramp such that the emergency vehicle could trigger the preemption when the vehicle enters the ramp.

While EVP at ramp meters could be an effective technique for clearing a queue in the path of an emergency vehicle, an internet search resulted in no examples of a deployment of this type.

(5) Ramp Queue Detection

In most cases, metering rates are determined by the mainline congestion levels. This can lead to long queues on some ramps during the peak hour. Ramp queue detection systems can be used to measure the length of the queue to mitigate this problem. The ramp queue data can help adjust the ramp meter timing to avoid the queue spilling onto local streets and assure that vehicle wait times are not longer than a maximum value.

The most common method of queue detection is a counting method using a conservation model. As vehicles enter the queue they are counted by a vehicle detector. After they pass through the meter, they are counted by a passage vehicle detector. The difference between the count of the entrance detector and passage detector at any given moment is the current inventory of the ramp.

Another method for measuring the queue is a length-based method. This system has several detection zones along the ramp. As the queue develops, the zones become occupied. When the occupancy value of a zone passes a preset threshold, the zone is deemed occupied and the queue length is known. Once the length of the queue is known, the length can be converted to a number of vehicles and the ramp meter timing can be adjusted as in the previous method.

Mn/DOT is experiencing problems with queue estimation on a subset of on-ramps in the Twin Cities Metropolitan Area. Traditional loop detectors have proven inadequate for measuring queue length on ramps that have challenging geometric layouts or are heavily congested. Mn/DOT has selected a ramp to experiment with three different innovative detection technologies. The recommended detection method will then be applied to other problem ramps in the area.

iii) Recommendation

Ramp meters provide benefit by breaking up vehicle platoons and managing demand in areas where freeways are routinely congested in peak periods. In Wisconsin, the Milwaukee and Madison areas, which currently have ramp metering systems, are the primary areas of focus. Other developing areas should contemplate evaluation exercises to determine if ramp metering should be considered in the mid-long term (10+ years).

As for the Milwaukee system of ramp meters, consideration should be given to adding queue loops at the entrances to all ramps that currently do not have them, and adding measures to ramp meter timing to prevent queue spillback onto the crossing arterial roadway. Non-intrusive detectors could be used in lieu of traditional inductive loops to avoid compromising the integrity of the ramp pavement, or if physical conditions preclude the installation of loop detectors.

iv) Migration Plan

Continue migration to 2070 controllers. Complete installation of queue loops on ramps or consider installation of a ramp queue detection system.

v) Communications Needs

Ramp meters, along with detector stations that use the same processing/controller hardware and controlling software, are the most numerous ITS field devices in the current WisDOT system. As previously stated, many ramp meter controllers are Model 170 processor assemblies, which contain internal 1200 baud (bits per second) modems. The ramp meter communication circuits are typically arranged in a multi-dropped configuration, with up to 12 controllers on one channel.

In general telecommunication terms, a channel is a separate path through which signals can flow through copper twisted-pair wires. The existing communication system assigns a channel and drop to each individual field device. Although each channel is capable of carrying 16 drops (device), only 12 drops are initially assigned per channel to allow for increased system reliability and future expansion. Communication between hubs and field processors are regularly polled, and therefore require full time communications. The communication medium selected for ramp meter design is open to any of the communication types described in Chapter 9, Communication System, of the WisDOT ITS Design Manual.

The most common communication medium for ramp metering devices is through copper twisted-pair wires connected via a modem and telephone drop for communications between the controller and a TMC. A telephone bridge can be installed when more than one entrance ramp is to be metered at an interchange. At locations where telephone service is not available or too costly, new communication technologies such as fiber-optic, spread spectrum, cellular, or ethernet communications may be used.

For fiber optic communications, fiber allocation is critical when designing a system. For each individual fiber, the fiber optic system operates as follows for both of these types of devices:

- Data Devices – 2-way data communication, with 2 fibers per data channel allocated across the system. Each channel carries up to 12 drops, with each drop consisting of 1 data device (ramp meter, detector station, etc.)

- Video Devices – 1-way video communication with 2-way data control communication. Each camera (or video sharing) site requires only 1 fiber for video and data communication.

- Other Approaches – It may also be feasible to encapsulate all data (video, signal control, PTZ, etc.) onto an Ethernet network. This would allow all data to be transported over one or two fibers in "daisy chain" arrangement. Implementation of this approach is dependent on specific device compatibility.

Typically, a fiber-optic branch cable will be spliced to the mainline fiber-optic trunk cables and pulled into the ramp meter controller cabinet to a fiber-optic modem that connects directly to the controller.

Many controllers have an internal slot for installation of a modem. Telephone modems have been used. Some have an RS-232 connection that is made to the C2 connector to connect a separate fiber-optic data transceiver. Some have fiber-optic data transceivers that mount internally in the model slot of the controller.

vi) Software Needs

Ramp metering systems utilizing Type 170 or 2070 controllers typically use proprietary firmware that is designed for the specific needs of the system. Examples include BiTransSystems (Arizona DOT), SunGuide (Florida DOT), and Wapiti Micro Systems.

vii) Cost Summary

Installation costs will vary widely with the physical conditions at any given ramp. The table below indicates the costs associated with the active management components of a metering installation.

Ramp Meter Equipment Cabinets (with secondary equipment)	$12,000
Ramp Meter Controller (Type 170)	$2,500
Ramp Meter Controller (Type 2070)	$5,000

d) RAMP GATE CONTROL

i) State of Practice

Currently gated access control for mainline ramps is addressed through a variety of technologies based on operation and budgetary requirements. The majority of the installed base for ramp access control can be categorized as either manual vertical drop or automated vertical drop gates but there are other options.

ii) Available Technologies

(1) Type III Barricade

Type III barricades are generally deployed at low volume, rural freeway on-ramps when weather conditions warrant a closure. When not in use, the type III barricades are often stored on site to be available for future deployment. When a closure is necessary, the type III barricades are moved from their storage location and placed at the entrances of freeway on-ramps. The type III barricade ramp gate is low cost, easy to store and is highly visible to motorists. However, this system must be deployed manually and typically under poor weather conditions which may put workers at risk.



Deployed Type III Barricade Ramp Gate



Stored Type III Barricade Ramp Gate

(2) Manual Vertical Drop Gate

The advantages of manual vertical drop gates are low initial cost, simplicity, little ongoing maintenance, and ease of operation. Two types are generally used. One design incorporates a manual crank that lowers the gate. These can be installed on lighting standards or as self-standing gates. The other gate style requires an operator to lower the gate by moving a counterbalanced weight. This gate has been implemented by the Virginia Department of Transportation to close off ramps for hurricane evacuation.

The only real weakness of this approach is not providing remote control. During the type of event that requires ramp closures, maintenance staff and emergency responders would presumably be the ones called upon to close the ramps when they have other pressing duties.



Virginia DOT Manual Drop Gate



Manual Horizontal Swing Gate

(3) Manual Horizontal Swing Gate

Manual horizontal swing gates are generally deployed at higher volume, urban ramps to control traffic during special events and serious incidents. When not in use, the swing gate is locked in the open position. When a closure is necessary, the swing gates are unlocked and moved into the closed position, where they are locked again. The manual horizontal swing gate is easy to use and is highly visible to motorists. However, this system must be deployed manually, requires a long, flat space for installation, requires two large footings, can be expensive to install, and requires a clear swing space.

(4) Automated Vertical Drop Gate

This type of system is in wide spread use throughout the country for remote access control of ramp gates but also for access control of reversible lanes. It is also the most prevalent means of access control for parking facilities.

This type of gate is generally utilized with a light weight gate arm that provides only a soft deterrent to forced entry. Most vehicles would be able to break through these visual barriers with minimal vehicle damage. This style gate is also available in physical barrier models designed to stop modest sized vehicles.

The provision of remote controlled automated gates would free up key personnel to do their primary jobs during the major events that would warrant the closing of a mainline freeway.

Remote automation requires continuous low bandwidth communications means. This could be fiber, copper wire, radio, or leased Telco lines.

A drawback to this approach is that powered gates are more expensive to install and require more specialized periodic maintenance than manual gates.

The physical barrier type gate is the most expensive to install. Where they can provide significant deterrence to vehicle entry, this type can also be a significant hazard to the traveling public when closed across a typically open high speed ramp. These types of gates are most commonly deployed at low speed facility entrances that open and close daily.

All remote controlled automated gates carry the concern of lowering the gate onto oncoming traffic. The rail industry has addressed this by adding flashers that begin 8 seconds in advance of the gates decent. Facilities often deal with this through a combination of traffic calming measures at the entrances and detectors to keep the gates open while a vehicle is close.

A few states have adopted UL 325 as pedestrian protection code, but even in those that have not it would be prudent to follow its guidelines. This is not a concern on access limited mainlines but it would be a consideration at the top of a ramp.

Powered gates do require electrical service but given their light duty cycle they are also candidates for solar power.

These gates come in many grades of durability, arm length, and deterrence capabilities. They are available from many suppliers targeting the rail crossing, parking facility, and highway markets. Interestingly those specifically designed for highways are the most expensive. See the attached table for gate material purchase cost estimates (not installed).

(5) Automated Horizontal Swing Gate

Horizontal swing gates are typically used to provide a means of achieving a robust physical barrier that is less expensive than their vertical counterparts. They are seldom deployed with lightweight gate arms.

Like the vertical type, these swing gates are most commonly deployed at low speed facility entrances that open and close daily. They also provide a significant deterrence to vehicle entry and can be a significant hazard to the traveling public when closed across a typically open high speed ramp.

Swing gates can be adversely impacted by plow driven snow and are not good candidates near roadways likely to receive high speed snow removal activity.

Remote controlled automated swing gates share the maintenance, communications, power, and code considerations of their vertical counterparts.

Reference:
1. *Traffic Gates.* (December 2000). Wisconsin Department of Transportation Intelligent Transportation Systems Design Manual – Version 2.0.

iii) Recommendation

We recommend either staying with the current manual approach or transitioning to an automated vertical drop gate. The ultimate decision would be based on an assessment of the importance for remote gate control versus its initial and ongoing cost implications.

iv) Migration Plan

Being that WisDOT is currently using manual gates there would be no significant migration concerns to either staying with that approach or moving towards one of the automated systems.

v) Communications Needs

This is dependent on the desired means of control. If local control is preferred there wouldn't be a need for communications. If remote control is required then a low bandwidth data channel would be needed.

vi) Software Needs

This is dependent on the desired means of control. If local control is preferred then gate control could be accomplished through field circuitry and there wouldn't be a need for control software. If remote control is required then a user interface and a means of encoding the control signal would be needed.

vii) Cost Summary

Auto Gate Type	Make	Hy-Security	B & B	B & B	B & B	Safetran	Safetran
	Model	HTG -320-8	VW-4	VW-5	HW-4	EM	S-40-exit
	Operation	Vertical	Vertical	Vertical	Horizontal	Vertical	Vertical
Purchase Price Per Given Arm Length	25’	$8,664	$15,000	$26,000	$14,200	$10,568	$6,022
	30’	N/A	$15,000	$26,000	$14,500	$10,568	$6,022
	35’	$11,904	$15,000	$26,000	$14,800	$10,718	$6,172
	40’	N/A	$15,000	$26,000	$14,900	$10,718	$6,172
	45’	N/A	Spec	$26,000	$15,000	$10,868	$6,350
	50’	N/A	N/A	$26,000	Spec	N/A	N/A
	55’	N/A	N/A	Spec	N/A	N/A	N/A
	60’	N/A	N/A	Spec	N/A	N/A	N/A

Notes:

- Safetran S-40-exit gates have the lowest cost and are able to reach up to 45'
- There is little benefit in using the Safetran EM gates over the S-40-exit gates
- Safetran and railroad style gate runs off 12 volt power (good for standby power, but more maintenance required)
- Manual gates cost significantly less to implement, but consideration should be given to the additional labor required for deployment

2) ARTERIAL MANAGEMENT SYSTEMS

This chapter summarizes the current traffic signal practices of the Wisconsin Department of Transportation and reviews existing and newly developed technologies, not currently deployed by WisDOT, and how they could potentially better provide the functionality that WisDOT staff has indicated they desire. Where new technologies or technology upgrades are considered, one or more equipment options are compared. The chapter concludes with discussions on migration paths for new technologies, ways to maximize benefits when deploying new technologies, and procurement strategies.

The process of evaluating available traffic signal field elements included an on-line survey of eleven state and regional traffic signal operating agencies (ten responded), a literature search on the internet, trade show research, and a review of product literature ("cut sheets") from manufacturers.

a) SIGNAL CONTROLLERS

i) State of Practice

WisDOT typically specifies the National Electrical Manufacturers Association (NEMA) TS 1 standard for traffic signal controllers, but has deployed Type 170 and 2070 controllers for freeway operations. In a few cases WisDOT has used the 2070 controllers for specialized intersection control such as the Integrated Corridor Test Segment (ICTS) in Milwaukee County. Some legacy, non-NEMA controllers are still in use throughout the state. Various cities and counties that operate their own traffic signals mostly specify TS 2 controllers for new installations, but continue to maintain a number of TS 1 legacy controllers. The City of Milwaukee exclusively deploys the 170 controller, having recently completed a citywide replacement of their signal controllers.

The NEMA TS 1 standard has been in use by WisDOT for more than 20 years with only minimal changes. Although NEMA continues to re-ratify the TS 1 standard, they do so only to support legacy control equipment. NEMA recommends the TS 2 (2003) standard in lieu of the TS 1 for all new installations[1].

TS 1 has stood the test of time and been reliable for WisDOT for decades. However, TS 1 represents the past and not the future. TS 1 functionality will not be supported indefinitely by NEMA, and manufacturers and the TS 1 standard limits functionality when the use of advanced intersection, corridor, network and inter-jurisdictional operations are desired.

[1] National Electrical Manufacturers Association. "Traffic Control Systems (Not Recommended for New Designs) TS 1-1989 (R1994, R2000, R2005)." 2007. National Electrical Manufacturers Association. January 1, 2005 http://www.nema.org/stds/TS 1.cfm

ii) Available Technologies

The available technologies discussed were selected based on the desired traffic signal controller ***functionality.*** Because WisDOT has not formally or collectively determined the desired traffic signal controller functionality amongst the various stakeholders at WisDOT, the functionality used in this analysis was based on individual discussions with various WisDOT departments (Electrical Operations, Bureau of Highway Operations, and representatives from the Traffic Operations Center) and a review of the best practices.

On the basis of these discussions, the following functional requirements were identified:

- Ability to operate existing software currently licensed to WisDOT
  - Marc NX™
  - TranSuite™
  - MONITOR
- Multiple modes of coordination
- Ability to co-exist with existing controllers
- National Transportation Communications for ITS Protocol (NTCIP)
- Multiple communications options (including communications to non-WisDOT signal systems)
- Remote access to controller timings
- Data collection
  - Speed
  - Volume
  - Detector Fault
- Alarms/Reports
  - Local Alarm
  - Comm Fault
  - Detector Fault
  - Cycle Log
  - Event Log
  - MMU Fault
- Ability to support multiple Preemption/Priority routines
- Ability to accept greater then 40 detector inputs (for ramp metering)

In addition, the Consultant Team has identified the need to address functionality required by inter-jurisdictional signal system deployments (such as the Integrated Corridor Operations Project's field operational test project on Layton and Howell Avenues in southern Milwaukee County) and potentially other advanced traffic management system software not currently used by WisDOT.

The first step in finding a "market ready" controller(s) that satisfies the identified functional requirements was to group controllers by their standard (e.g. NEMA, 2070, ATC) and then identify individual controller models in each standard grouping. A brief overview of each controller standard is described below; a table summarizing individual controllers and their functionality is included in Appendix A. The study focused on the NEMA TS 2, 2070, and ATC standards. The 170 controller was not considered because it would not co-exist well within the existing NEMA TS 1 environment.

(1) NEMA TS 2 Standard

The TS 2 Standard was first introduced in 1992 and has since been modified/re-ratified in 1998 and 2003. The most recent version of the TS 2 Standard (2003) added National Transportation Communications for ITS Protocol (NTCIP) functionality, which promotes interoperability and interchangeability of ITS devices through the use of open, consensus-based standards. The TS 2 standard was based on the TS 1 standard, which was introduced in 1983 beginning the movement toward standardization. The TS 2 Standard allows for greater expansion and interchangeability between controllers and cabinets over the TS 1 standard. The TS 2 standard simplified cabinet wiring by eliminating the A, B, C connections in lieu of a single serial connection, however both the controller and the cabinet would need to be upgraded to the TS 2 Standard to benefit from simplified wiring.

Two versions of the TS 2 standard were established; the TS 2- Type 1 is the "true" TS 2 controller (i.e., no A, B, C connectors), and TS 2 Type 2 includes the A, B, and C connectors to allow compatibility with TS 1 style cabinets[2]. When a TS 2 controller is installed in a TS 1 cabinet, many of the features of the TS 2 will not be available such as the redundant Malfunction Management Unit (MMU) monitoring, however the TS 2 rack-mount detectors, load switches, flashers and flash relays can be transferred to the TS 1 environment.[3] Additional discussion on controller cabinets is included in the following section.

Compared to the 2070 and ATC controllers (discussed in following sections), the NEMA standard can be more limiting due to preprogrammed software; however, the limitation is not necessarily a negative feature. As long as the desired functionality is obtained with a NEMA standard, then the standardization can result in increased availability of controllers from multiple manufacturers and ease of maintenance.

Manufacturers

There are three primary manufacturers of NEMA TS 2 controllers; Eagle (Siemens), Econolite and Peek (Quixote). Each manufacturer has multiple TS 2 controller models or options to accommodate different functionality, communications requirements, and cabinet styles.

[2] "NEMA Standards Publication TS 2-2003 v02.06, Traffic Controller Assemblies with NTCIP Requirements" National Electrical Manufacturers Association (NEMA). 2003.
[3] *NEMA TS 2 Standards, The "Intelligent Cabinet"*, Econolite 3360 E. La Palma Avenue, Anaheim CA 92816

Identified controllers include:

- Eagle EPAC300 M40 Series
- Eagle EPAC300 M50 Series*
- Econolite ASC/3
- Econolite ASC/2
- Peek LMD 9200

**The Eagle E 50 Series controller exceeds ATC Controller Specification 5.2 when a next generation engine board is specified.*

Because of the large number of NEMA TS 2 controllers deployed throughout the U.S., most, if not all, advanced traffic management system (ATMS) software packages are able to communicate with each of these controllers regardless of their pre-programmed controller software.



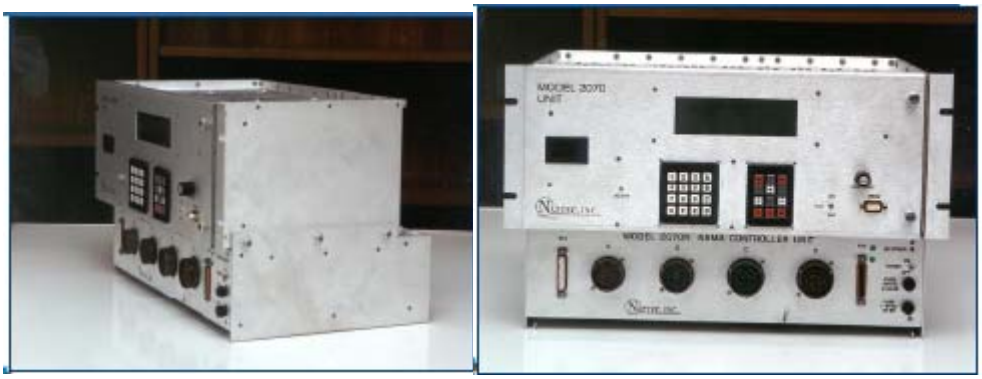
TS 2 Controllers

(2) 2070 (including 2070 ATC)

2070 controllers are based on the "open" platform developed for the 170 controller. The 170 standard was developed by the California Department of Transportation (CalTrans) and New York State DOT (NYDOT) because both agencies wanted to be able to incorporate third-party software into their controllers. The primary difference between the 2070 and the 170 is the operating system. The 2070 operates on an OS/9 operating system that allows for greater functionality, including coordination with NEMA controllers[4].

[4] "ATC 2070 v01.05, Advanced Transportation Controller (ATC) Standard for the Type 2070 Controller." March 29, 2001. American Association of State Highway and Transportation Officials (AASHTO)/Institute of Transportation Engineers (ITE), NEMA, Washington D.C./Rosslyn VA.

Under the 170/2070 platform the hardware and software are separate entities, thus 2070 controllers from various manufacturers can operate any software package written for the 170/2070 controller. 2070 controllers can also operate non-signal related elements for ITS field devices (DMS, ramp meters, HAR Stations) as well as non-traffic related features such as irrigation and lighting systems. 2070 controllers are designed to be rack-mounted; however, 2070 manufacturers have developed a NEMA functionality card and attachment so they can be shelf mounted in a NEMA cabinet.



2070 controller with NEMA compatibility unit

Benefits of the 2070 standard include significant operational flexibility over both the NEMA TS 1 and TS 2 standards. Some WisDOT Regions are already familiar with the 2070 from their freeway management and ITS deployments, potentially simplifying deployment of the 2070 as the statewide traffic signal controller. A disadvantage of the 2070 is the need to purchase NEMA compatibility environment, and the concern that some of the proprietary ATMS systems would not be able to function with the 2070 controller.

Depending on the software and communications options specified, the 2070 typically cost 30% - 50% more than a NEMA TS 2 controller[5]. The additional functionality and additional costs would be needed and could be justified only at selected locations. From a statewide perspective, the benefit/cost ratio would therefore likely be less than 1, meaning that the benefits do not justify the additional costs of using the 2070 as the standard controller.

Manufacturers

The three primary U.S. manufacturers of the 2070 controller are Eagle (Siemens), Econolite and Peek (Quixote). McCain primarily manufactures 170 controllers, thus was not considered. Each of the companies that manufacture 2070 controllers also manufactures NEMA compatibility modules. Eagle and Econolite 2070 controllers come preloaded with controller software with varying levels of functionality.

[5] Phone Conversations with Dan Fuchs, Brown Traffic Control Devices, Volo, IL & Brian Scharles, TAPCO, Elm Grove, WI

(3) ATC

NEMA, the American Association of State Highway and Transportation Officials (AASHTO) developed the ATC specification jointly and the Institute of Transportation Engineers (ITE) to bridge the gap between NEMA and 2070 based controllers. There are several configurations of ATC controllers that allow them to work in most legacy cabinets including NEMA TS 1 style cabinets.

The ATC has similar advantages as the 2070 over the NEMA TS 1 and TS 2 platforms. Similar to the 2070, the ATC can operate multiple systems or ITS field devices from a single controller. The primary difference is the operating system; the ATC uses Linux (primarily used in personal computers) while the 2070 (including the 2070 ATC) operates on an OS/9 platform. Linux was specified over the OS/9 platform because OS/9 requires a specific CPU chip. Because the personal computer marketplace is much smaller than the embedded hardware marketplace, there is a concern that the OS/9 platform will not be supported over the long term[6].

The ATC standard allows for greater software interchangeability than the 2070 and has standardized the controller display, which simplifies programming different software packages. The main disadvantage to an ATC would be technological maturity. The ATC has only been around for just over a year and the number of field deployments is limited. The ATC is priced comparably to the 2070 controller.

Manufacturers

Only Eagle (Siemens) manufactures a true ATC controller using the Linux operating system. The Eagle ATC controller is rack mounted, however, when a shelf-mounted controller is desired, Siemens recommends specifying the EPAC 300 M50 controller with the next generation engine board.

iii) Recommendation

Based on the identified functional requirements, the most appropriate traffic signal control platform would be the NEMA TS-2 Standard (2003), with the option to upgrade ATC functionality. Although the 2070 and ATC controllers could be specified to meet the functional requirements and work within a NEMA cabinet, these controllers are not recommended because of the requirement to purchase additional equipment, the potential for an extended learning process, and their higher cost.

[6] "ATC Version 5.2a Advance Transportation Controller (ATC) Standard, January 24, 2006. American Association of State Highway and Transportation Officials (AASHTO)/Institute of Transportation Engineers (ITE), National Electric Manufacturers Association (NEMA), Washington D.C./Rosslyn VA.

A means to attain a greater cost/benefit ratio with a controller upgrade would be to maximize the utilization of the new features of the controller. Some non-traditional means of increasing benefit with the ATC controller or the next generation card include:

- Control two closely spaced intersections with a single controller
- Control ramp metering or other closely spaced ITS devices with a single controller
- Specify models without a face panel, entry would be conducted via a laptop or handheld device
- Utilize the controller as both a master controller and local control for closed loop systems

Currently only one manufacturer can produce a controller with the desired functionality, Eagle (Siemens) with their EPAC 300 - M50 series controller. The ***cost*** of the M50 controller (shelf mounted) is estimated to be 30% to 40% more than the existing M30 EPAC controllers; however, the actual cost of the controller would be based on the quantity ordered, additional functionality specified, and market conditions. Some of the higher costs may be offset with reduced maintenance (especially if TS 2 or ITS cabinets are specified) and increased functionality, which may permit fewer controllers to be used. The ability to specify the next generation engine board only at locations where additional functionality is required should keep the benefit-to-cost ratio greater than one, indicating that benefits greater than costs are achieved.

Other manufacturers would be able to exceed the requirements of this specification by providing full ATC functionality; however, this is likely to be too costly to be competitive under a competitive bid framework. Depending on the volume of controllers procured as part of the initial bid, a manufacturer may choose to modify one of their controllers to meet the specified requirements.

iv) Migration Plan

Use of the NEMA TS 2 controller specification should begin with the next signal controller purchase.

v) Implementation Strategies

TS 2 controllers can be specified to function in many legacy cabinets as well as all the advanced cabinets discussed in the next section

vi) Cost Summary

As noted in Section iii Recommendations, controller costs can vary based upon quantity purchased and any additional functionality included. A general guide for pricing is approximately $3,000 for a basic TS 2 controller.

b) CABINETS / FOUNDATIONS

The second element of the arterial management systems portion of the technology scan reviewed WisDOT's traffic controller cabinet standard. The cabinet standard ultimately selected is based on the controller selected, features required, and extent that WisDOT wants statewide uniformity for all controller cabinets. The scan focused on cabinet standards in their entirety and not a hybrid between standards. Although technically feasible, for a price manufacturers could manufacture a specialized controller cabinet to the specific requirements developed by WisDOT.

i) State of Practice

WisDOT currently specifies a NEMA TS 1 standard cabinet in a 'P' size, single door cabinet housing. The cabinet rests on a 3.0' x 4.5' foundation with an attached maintenance platform. The cabinet contains one or more shelves that support the controller and communications equipment. Detector cards are rack mounted under the shelves. The controller communicates to other cabinet components via MSA, MSB, and MSC (A, B, & C) connections. A 'D' connection is often specified on the controller for communications purposes.

The TS 1 standard was the first of three cabinet standards developed by NEMA. The others include the TS 2 standard, and the Advanced Traffic Controller ITS Cabinet Standard developed jointly with AASHTO and ITE. On a parallel track, CalTrans/NYDOT led the effort to develop standards to support the rack mounted ITS cabinets for the 170 and 2070 controllers.

Similarly to the controller, WisDOT has not provided fully documented ***functional requirements*** for the controller cabinet for use in this technology scan. Therefore the functionality used in this analysis was based on individual discussions with various WisDOT departments (Electrical Operations, Bureau of Highway Operations, and representatives from the Traffic Operations Center) and a review of the best practices.

- Ability to mount the cabinet on existing 3' x 4.5' foundation*
- Increased serviceability
- Multiple access points
- Police door
- Simplify cabinet wiring with use of NEMA TS 2 or ITS Cabinet designs

**Based on S.D.D. 9 C 6-5 – Concrete Control Cabinet Base, Type 9, Special*

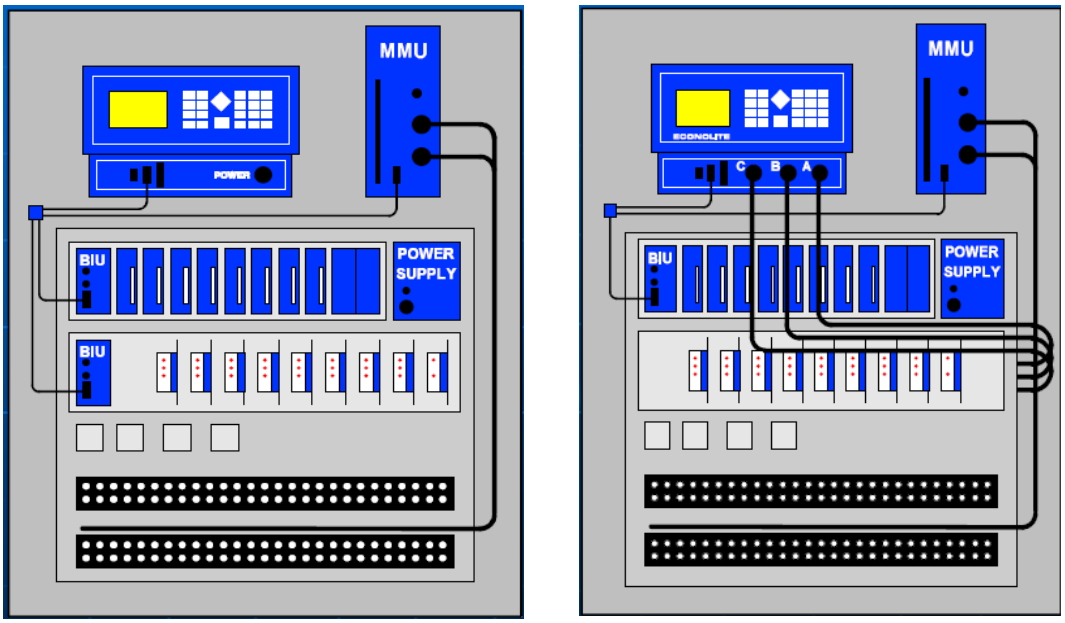
ii) Available Technologies

The first element in selecting a cabinet standard is determining whether to use a rack-mounted cabinet, a shelf-mounted cabinet, or a combination of the two styles. Traffic signal controllers come in both rack-mounted and shelf-mounted versions including the EPAC 300 M50. Thus, the cabinet style decision is not necessarily tied to the selection of the controller. Other controllers such as the 2070 only come in the rack mounted version. 2070s can be installed into a NEMA cabinet with the use of a NEMA compatibility module installed under the 2070 controller.

Currently WisDOT Freeway ITS applications utilize a two-door rack mounted cabinet. Based on discussions with STOC personnel, and discussions in the ramp metering section of this technology scan, the freeway management operators will continue to specify rack mounted cabinets for freeway applications. The decision to use rack mounted cabinets for ITS applications is dictated by the preference of ITS component manufactures to use a rack mounted design. For signal operations any one of the three cabinet styles; NEMA TS 2, ITS and ATC ITS cabinet are possible. A discussion of each follows. Because NEMA no longer recommends the TS 1 standard for new installations, maintaining the TS 1 standard was not considered an option.

(1) TS 2 Standard (Shelf Mounted)

The NEMA TS 2 was introduced in 1992 and updated in 1998 and 2003. As it relates to cabinets, the TS 2 standard greatly improved upon the TS 1 standard by standardizing connections and communications within the cabinet. The TS 2 standard replaces the older military style A, B & C connectors with a serial connection to a SLDC serial bus simplifying wiring, increasing interchangeability between cabinet components, and providing for future cabinet expansion. The cabinet schematics below illustrate both the TS 2 Type 1 and TS 2 Type 2 (TS 1 retrofit) configurations. As shown the Type 2 style retrofit would not be eliminating the A, B & C connectors.



TS 2 Type 1 and TS 2 Type 2 (TS 1 retrofit) Cabinet Wiring Schematics[7]

The greatest operational benefit from the TS 2 standard is realized with both the controller and the cabinet following the same standard. Although TS 2 controllers can be specified to operate in a TS 1 cabinet environment some of the TS 2 functionality, such as the redundant MMU, would be lost.

[7] Shea, Mike; *NEW TS 2 Standard & Technology.* 3360 E. La Palma Avenue, Anaheim CA 92816.

Connections to the power supply and auxiliary functions such as coordination, preemption, time-based control, and flash operations are standardized in the SDLC eliminating the need for the proprietary 'D' connector.[8] TS 2 controllers and cabinets are NTCIP compliant that simplifies coordination with signal systems from other agencies or permitting operation by a third party software platform.

TS 2 cabinets are the same dimensions as their TS 1 counterparts, thus they could be installed on the existing foundations with new modifications. The cabinet chassis and some of the existing hardware could be retooled and reconfigured with TS 2 components limiting the number of components that must be procured to upgrade to the TS 2 standard. The ability to use existing equipment is an excellent reuse of state owned materials and will allow for a greater number of deployments per unit cost compared with selecting a different style of cabinet.

(2) ITS Cabinet (Rack Mounted)

An ITS cabinet standard refers to a rack mounted cabinet based from the Caltrans Specification but does not necessarily mean that the cabinet complies with the ATC ITS cabinet specification.

Rack mounted cabinets were designed to overcome the limitations of shelf mounted cabinets. The use of rack mounted cabinets has increased in recent years due to the incorporation of more ITS devices into controller cabinets. Rack mounting provides:

- Improved cabinet organization,
- Space efficiency
- Increased expandability
- Current ITS standard

Three ITS cabinet types were reviewed: the M-342 (2-door), the M-354 (2-door) and the M-340 (4-door) cabinets. Each of the cabinets is manufactured by Eagle (Siemens). Despite the advantages of a rack mounted cabinet, each of the three cabinets may not be able to be easily mounted on to an existing controller foundation.

During meetings with DOT staff, the initial concern with retrofit cabinets was that they would not fit on the existing concrete base. However, it is not the size of the cabinet or location of the anchor bolts that determine compatibility, but rather the location of the conduits protruding from the foundation. With the M-342 and M-354 cabinets, the opening at the bottom of the cabinet is narrower than a typical spread of conduits. With the M-340 cabinet, the concern is with the center support that extends from the front to the back of the cabinet laying 2" above the bottom of the cabinet. A Siemens representative stated that the bottom crossbar is a structural component and is required, but stated that cabinets could be special ordered to work with existing conditions[9]. Another complication would be the location of the electrical service.

[8] *NEMA TS 2 Standards, The "Intelligent Cabinet"*, Econolite 3360 E. La Palma Avenue, Anaheim CA 92816
[9] Phone conversation with Peter S. Marshall, Senior Associate, Siemens Energy & Automation, Inc. Intelligent Transportation Systems. Salt Lake City, UT.

Typically, the electrical service conduit is set up to align the electrical meter flush to the outside of the cabinet; however, with the change in cabinet dimensions, a nonstandard service connection would be required.

(3) ATC Cabinet (Rack Mounted)

The Advanced Traffic Controller ITS Cabinet (ATC Cabinet) is the cabinet wiring standard that corresponds to the ATC controller standard. This specification was jointly written by AASHTO, ITE and NEMA. The ATC standard builds upon both the NEMA TS 2 standard and Caltrans ITS cabinet standards. The ATC cabinet style is basically the same cabinet as its ITS cabinet counterpart. Thus, it would have the same issues being retrofitted on existing foundations as ITS cabinets. From a controller hardware aspect the ATC standard is with some expansion of the cabinet wiring and communications elements of the ITS cabinet specification.

Due to the recent release of this standard, the standard is not yet widely used and the information is limited to the specification itself. No DOT has adopted this standard as of the end of 2007.

(4) Battery Backup

While not directly related to the cabinet standard selected, the inclusion of battery backup systems will impact the size and style of the cabinet selected. Battery backup systems are increasingly being incorporated into the design of traffic signal cabinets. The advent of LED bulbs has significantly reduced the power consumption of traffic signals, allowing them to be powered by batteries for longer periods of time. Previous attempts to provide battery backup systems stalled because the costs to install the battery backup systems could not be justified by the short time frame that a signal with incandescent bulbs could be powered.

Battery backup systems can add a significant factor of safety to an intersection that experiences power loss. The sizing of the battery backup system relates more to how long an agency wants to operate the signal off the battery rater than the size of the signal. A good starting point would be to operate a signal for 6-8 hours under the normal operation, followed by 24 hours of flash operation. The 30 hours (6+24) allows for traffic to move safely after a massive power outage or during an evacuation. This time also provides a good window of opportunity for a power company to restore power to the signal and for the DOT to reset the program. Flash operation is utilized in lieu of continuing normal signal operation, because flash operation uses less power that means the battery can operate for a longer period of time.

Battery backup systems cost approximately $4,000 each; however additional costs may be incurred due to installing signal heads and expanding or replacing the controller cabinet to accommodate a battery backup system. Battery back-up retrofits typically utilize a piggy back cabinet rather than replacing an entire cabinet. The second cabinet also keeps the battery backup system separated from the rest of the cabinet components minimizing damage should a battery leak. The separate compartment also allows the battery to be accessed without opening the door to the controller cabinet.

iii) Recommendation

Considering the identified functionality, the signal controller recommended, and cost differences with the migration paths of the ITS and ATC cabinet styles, the best fit cabinet would be a NEMA 'D'-size cabinet wired to the NEMA TS 2 standard. This will result in WisDOT maintaining both shelf mounted cabinets for traffic signals and rack mounted cabinets for freeway ITS applications. The costs to modify the approximately 1200 WisDOT signal control cabinets to rack mounted could not be justified by the modest increase in functionality. The cabinet dimensions can remain at the 'P' size cabinet. If a battery back-up system is required a piggy back cabinet can be installed together with the "P" cabinet on the existing foundation or a two-door Super P cabinet can be specified.

WisDOT should not completely eliminate consideration of utilizing rack mounted ITS cabinets for traffic signal applications. Projects that have extensive ITS device deployments, may benefit with the use of rack mounted cabinets. The programming and operation of the rack mounted signal controller would be identical to the shelf mounted version.

iv) Migration Plan

Although TS 2 controllers can be specified to operate within a TS 1 cabinet, the migration should consist of reconfiguring the existing cabinet chassis to the TS 2 standard in conjunction with new controller installations. Upgrading all new deployments to the TS 2 Type 1 standard will eliminate the need to maintain a stock of both TS 2 Type 1 and TS 2 Type 2 controllers. The department may choose to procure a few Type 2 controllers to be used as replacement controllers or in instances where the TS 1 cabinet is fairly new.

v) Implementation

WisDOT will need to rotate in new cabinets in conjunction with the new controller locations during the implementation process. Although the existing cabinet chassis and some of the components in the cabinet can be salvaged under a TS 2 wiring configuration, these changes cannot occur while the cabinet is in service. A temporary controller or a TS 2 retrofit must be installed during the time period that the existing cabinets are being upgraded.

vi) Cost Summary

The table below summarized prices for the technologies discussed in this section. Note that the ITS and ATC cabinets are more recent standards, and that pricing may change greatly as the deployed base for these increases.

TS 2 Standard Cabinet	$18,000
ITS Cabinet (Rack Mount)	$25,000
ATC Cabinet (Rack Mount)	$18,000
Battery Backup System	$4,000 - $7,000

c) VEHICLE DETECTION

The third element of the technology scan examined the available methods and practices for vehicle detection. This review emphasizes detection at signalized intersections, an application that has different performance requirements than other detection applications, such as detector stations (for incident management), or automated traffic recorder stations (for volume and classification studies).

i) State of Practice

The best practices review found widespread use of inductive loop detectors for vehicle detection, making them the predominant method of traffic detection at signalized intersections. However, many of the agencies have experimented with alternative methods of detecting traffic and often use these alternative methods in specific cases. WisDOT is similar to many other transportation agencies in their use of loop detection, supplemented to some degree by alternative methods of detection.

ii) Available Technologies

Vehicle detectors located at signalized intersections have various functions. They can cause the controller to seek an opportunity to provide green time to vehicles stopped on an approach, extend green time for a given approach, or provide dilemma zone protection. All of these functions require the accurate detection of either stationary or moving vehicles. Another key requirement is that the detection be reliable under all traffic and environmental conditions. An additional, and often secondary, function of vehicle detectors is to capture occupancy, volume and speed data. Other important considerations include cost, ease of maintenance, and the ability to deploy and integrate vehicle detectors. These factors will be explored for a variety of detection methods.

(1) Inductive Loop Detectors

Inductive loop detectors apply a small electric current to a coil of wires and detect the change in inductance caused by the passage of a vehicle. Inductance changes are measured and reported by an amplifier (detector card) located in the traffic signal control cabinet. Loop detectors have been in use for over 40 years, making them a mature technology. They are also very accurate and generally reliable, especially when pre-formed loops are installed. The primary drawbacks to loop detectors are the cost to install, especially at large intersections that may require dozens of loop detectors, disruption to traffic during installation and maintenance, damage to pavement when they are installed, and longevity in pavements that are in poor condition.

Manufacturers of loop amplifiers include Reno A & E, EDI, Diamond, Global Traffic Technologies (Canoga), and Quixote.

(2) Video Detection

Video sensors use microprocessors to analyze video images captured by a camera. The sensors require careful initial calibration when the detection zones are set up. Video sensors can be cost effective at larger intersections because one camera per approach is usually sufficient to provide adequate coverage. These sensors have the advantage of offering a variety of traffic parameters, such as speed, volume and queue length. They are also flexible, in that detection zones can be modified easily. Some drawbacks to video detection include its complexity, cost, mounting restrictions and performance in adverse environmental conditions (low light, clouds, wet pavement, wind, etc.). Nighttime detection can be problematic in areas that are not well lighted—a camera will "see" headlights, but its interpretation of where the vehicle is on the road can be skewed. It is also recommended that detection zones be checked periodically, to make sure that the camera has not moved. The general consensus is that video detectors can "see" down the road 10 feet for each foot of mounting height. On some high-speed approaches, this limitation could preclude their use for back detection.

Manufacturers include Econolite (Autoscope), Iteris (Vantage), Peek (VideoTrak), Traficon, and Citilog.

(3) Microwave Sensors

Microwave sensors transmit low-energy microwave radiation at the detection area and analyze the signal reflected back to the sensor. The shift in the reflected signal provides a measure of the vehicle's presence and speed. Advantages of microwave sensors include their simplicity, cost and accuracy. Drawbacks include the difficulty in discerning individual vehicles and their inability to detect vehicles traveling less than 5 mph. Microwave sensors are well-suited to short term applications, such as detection during construction, and to back detection.

Manufacturers of microwave sensors include MS Sedco and Whelen.

(4) Radar Sensors

Radar sensors are similar to microwave sensors, but are able to detect stationary vehicles and to detect a variety of detection zones through their range-finding ability. Several radar sensors have been developed for traffic applications. Advantages of radar sensors are their multiple detection zones, ease of calibration, and accuracy. Disadvantages include cost and mounting restrictions.

Manufacturers of radar sensors include Wavetronix, EIS (RTMS) and Quixote (Trans-Q).

(5) Magnetometers

Magnetometers consist of a small coil of wire that measures the change in the earth's magnetic flux that is created when a vehicle passes through a detection zone. Magnetometers can be installed under the roadway through insertion in conduit, or in the pavement by core drilling. Recent advances in battery and communication technology have produced products that can be installed in the pavement and communicate wirelessly to a receiver. The battery provides approximately 10 years of life, after which time a new sensor can be installed and reconfigured.

Manufacturers include Global Traffic Technologies (Microloop), Sensys Networks, and Nu-Metrics.

Each of the above types of detection has been demonstrated to be effective for use with traffic signals. Other detection technologies that have been used, although not extensively for intersection control, include passive infrared, active infrared, ultrasonic and passive acoustic.

iii) Recommendation

Loop detectors have proven their ability to provide effective vehicle detection in a cost-effective manner. The use of preformed loop detectors has reduced the demand for loop maintenance in the field. While loop detectors are widely deployed and well understood by maintenance staff, there are several applications that would benefit from other forms of detection:

- **Back detection:** The cost to deploy back (call and extend) detection should be examined on a case-by-case basis. In some instances, installation of conduit and lead-in cable may be costly. Another form of detection, such as a microwave or magnetic sensor with wireless communication may be more cost effective.

- **Large intersections:** At intersections that require many detection zones, video detection may be a viable alternative to loop detection from a cost standpoint.

- **Short term applications:** Traffic shifts required during construction can render loop detectors ineffective. Alternative methods, such as microwave detectors and video detection, can offer a cost-effective method of providing interim detection.

- **Exploration:** The technology of traffic detection continues to evolve, with the marketplace continuing to offer new and innovative products. Periodic exploration should be conducted to understand how new advances could be applied

iv) Migration Plan

Migrating to new and innovative detection methods is best accomplished by hands-on experience with the technology. Deploying a test bed to evaluate innovative methods of arterial detection would provide this. The test bed could examine back detection with microwave or magnetic sensors that would communicate wirelessly to the controller. These sensors would be powered by solar and/or battery sources, eliminating the need for hardwire connection. The test bed could also examine the viability of video detection and other methods of detection that would support short term applications, as discussed in the previous section. The test bed would provide practical information on ease of installation, integration issues and maintenance requirements.

Other vehicle detection recommendations developed in the Freeway Management section may be applicable here. They include adding new technologies to the statewide procurement list, hosting a manufacturer fair, and deploying new technologies in pilot projects. Lastly, staying current with the latest trends in technology development is important. This can be done through periodic review of best practices or participation in pooled fund studies.

v) Cost Summary

As in the Freeway Management Systems section's discussions of costs, the breakdown of comparative costs by category is presented below.

Detection Comparative Costs					
	Capital	Electrical	Communications Needs	Maintenance	Service
Inductive Loop Detectors	Low-Med	Low	Low	Low	N/A
Video Detection	High	Low	Med-High	Med	N/A
Microwave Sensors	Low	Low	Low-Med	Low	N/A
Radar Sensors	Med	Low	Med	Low	N/A
Magnetometers	Low-Med	Low	Low-Med	Low	N/A
Emerging Probe Technologies	N/A	N/A	Med-High	N/A	High
Integrated Solutions	Med	Low	Med	Low	N/A

3) TRAVELER INFORMATION

a) PERMANENT DMS

i) State of Practice

(1) Current WisDOT DMS Inventory

WisDOT currently owns, maintains, and operates a variety of permanent DMS installation types and sizes manufactured by one of three manufacturers.

All permanent DMS currently being operated by WisDOT use Light Emitting Diode display technology.

High Speed Facilities
On freeways, expressways, interstates, and high volume high speed state highways, WisDOT has installed full span overhead mounted DMS in two size variations depending on the exact installation site posted speed limit. DMS designed and sized for a three line message of 18-inch high text characters have been used for freeways, interstates, and highways with posted speed limits of 50 mph or higher while DMS designed and sized for a three line message of 14-inch high text characters are used on high volume highway facilities with posted speed limits below 50 mph.

Additionally, there are currently three manufacturer's DMS in use by WisDOT. *Mark IV* signs were procured through a bid project and installed in 1998 and 1999 throughout the Southeast Region, more recent DMS have been manufactured by *Daktronics*, procured through a materials procurement master contract and installed by bid/let construction projects, and most recently *Adaptive Microsystems* was contracted to retrofit and update the oldest signs in Southeast Region to LED display technology with more modern controllers.

There are also currently two ground mounted line matrix DMS in Southeast Region operated for specific special event related information. These signs consist of a combination of fixed message parking information and line matrix DMS used to maintain the parking information in a real time manner. These line matrix DMS were manufactured by *Mark IV*.

Low Speed Facilities
On lower speed roadways, such as arterials and low speed state highways, WisDOT has installed overhead cantilever mounted and side view ground mounted full matrix DMS depending on roadway type and available right of way at specific sites. These arterial DMS have been designed for either a two line message of 10-Inch high text characters or a three line message of 8-inch high text characters depending on when the signs were deployed.

Regarding these message and text size layouts, it is important to remember that since these signs are full matrix, they offer flexibility in the actual text height used. For example, a three line 8-inch high text sign has the capability to display messages with two lines of 12-Inch high text as an alternative to the originally designed maximum message size.

Statewide Inventory

The current statewide operational permanent DMS inventory, separated by region, is included in this section.

Southeast Region DMS Inventory					
Roadway Type	**Size and Layout**	**Mounting Type**	**Manufacturer**	**Approx. Year (s)**	**Qty.**
Interstate / Freeway	3-Lines, 18-Inch	Full-Span Overhead	Mark IV	1998 / 1999	11
Interstate / Freeway	3-Lines, 18-Inch	Full-Span Overhead	Daktronics	2004 / 2006	2
Interstate / Freeway	3-Lines, 18-Inch	Full-Span Overhead	Adaptive Microsystems	2002	10
Interstate / Freeway	2-Lines, 12-Inch	Ground Mounted (Line Matrix)	Mark IV	1999	2
Arterial	3-Lines, 8-Inch	Cantilever Overhead	Mark IV	1999	1
Arterial	3-Lines, 8-Inch	Ground Mounted	Mark IV	1999	2
Arterial	3-Lines, 8-Inch	Cantilever Overhead	Vultron	2001	3
Arterial	3-Lines, 8-Inch	Ground Mounted	Vultron	2001	8
Arterial	3-Lines, 12-Inch	Cantilever Overhead	Adaptive Microsystems	2002	3
Arterial	2-Lines, 10-Inch	Ground Mounted	Daktronics	2006	1
				Southeast Region Subtotal	**43**

Southwest Region DMS Inventory					
Roadway Type	**Size and Layout**	**Mounting Type**	**Manufacturer**	**Approx. Year (s)**	**Qty.**
State Highway	3-Lines, 18-Inch	Full-Span Overhead	Daktronics	2003	1
State Highway	3-Lines, 14-Inch	Full-Span Overhead	Daktronics	2003	1
Arterial	2-Lines, 10-Inch	Cantilever Overhead	Daktronics	2003	4
Arterial	2-Lines, 10-Inch	Ground Mounted	Daktronics	2004	4
				Southwest Region Subtotal	**10**

Northwest Region DMS Inventory					
Roadway Type	**Size and Layout**	**Mounting Type**	**Manufacturer**	**Approx. Year (s)**	**Qty.**
State Highway	2-Lines, 10-Inch	Ground Mounted	Addco	2000	1
State Highway	2-Lines, 10-Inch	Ground Mounted	Addco	2008	3
				Northwest Region Subtotal	**4**

(2) DMS Technology Scan Results

The states surveyed specifically for this project were Idaho, Minnesota, Montana, South Dakota and North Dakota.

The data from this survey are summarized below:

- All subject states use a combination of permanent and portable DMS.
- Permanent DMS are at least partially NTCIP compliant in Minnesota, South Dakota, and North Dakota.
- All agencies polled use DMS control system software that runs NTCIP compliant signs. Montana and North Dakota run software that also controls their legacy non-compliant DMS.
- Idaho and Minnesota have procured DMS through multi-year procurement contracts.
- Montana and South Dakota have procured DMS through stand-alone DMS projects.
- North Dakota has procured DMS as part of corridor based deployment projects.
- In all instances, the respective state has driven the development of DMS standards and operating policies.
- All states have developed standard acceptance tests for DMS.
- All states are currently operating DMS from multiple manufacturers.
- All states use a central control software to operate their DMS.
- Only Minnesota currently has DMS operations linked to other field devices (traffic detectors).

(3) Current WisDOT DMS Messaging Practices

WisDOT DMS messaging policies are defined in the WisDOT DMS Policies and Procedures document maintained by the Statewide Traffic Operations Center. The STOC updates the document as necessary and then trains control room operators in updated practices. It is important to keep these policies and procedures in mind when considering what DMS technologies will be used in the future. The current message policies and procedures described below, taken from the document, are based on the low-resolution LED DMS technology that has been procured most recently, and is the only display technology operated by WisDOT.

1) Text Alignment – Text on all signs should be centered, except for travel times, when justified alignment may be used.

2) Font – All the text should be displayed in capital letters, using only one font size and only one font type.

3) Character Spacing – Proportional spacing should be used as much as possible. Fixed spacing may be used.

4) Graphics, Symbols, and Animation – DMS should not display graphics, symbols, or animation.

5) Standard Terminology – Messages should be designed using standard terminology as defined in the "Message Design Dictionary" stored in the Traveler Information System dictionary. Words not found in the Message Design Dictionary may be used when necessary. New words should be approved and included in the Message Design Dictionary before they are included in the Traveler Information System dictionary.

6) Abbreviations – Abbreviations should be used only when no other formatting or terminology can be used to convey the message. The length of the abbreviation should not exceed two-thirds the length of the word.

7) Message Length Limitations – Messages should generally be no more than 8 words in length (4-8 characters per word) excluding prepositions (to, at, for, etc.).

8) Brightness – Operators should not change the brightness, unless directed by a lead operator. Brightness is auto-adjustable and fluctuates during the day to adapt to natural conditions.

9) Flashing Messages – Flashing messages should only be used for exceptional situations, where the particular DMS supports the function at the direction of a lead operator.

10) Message Phasing – When possible messages should be displayed in one phase. Messages should be displayed in no more than two phases. If two phases are used, each phase should be distinct and understandable.

Minimum message display time should be determined according to posted speeds. To ensure that motorists will be able to read the entire message. A minimum displaying time of 2 seconds per line per phase should be used for speeds of 55 mph. When speeds are below 30 mph, a minimum displaying time of 1 second per line per phase can be used.

Prioritization for information on the Traveler Information System, including the DMS, is as follows:

1) Amber Alert
2) Major Incident (Level 3 or greater)
3) Special Event
4) Construction / Maintenance
5) Travel Times

When no major incident, special event, planned construction activities, or Amber Alert information is being displayed on the DMS, automated Travel Times for pre-defined segments of highway are displayed.

ii) Available Technologies

Earlier in the development of DMS, multiple display technologies were available for deployment. These included rolling drum, flip disk, fiber optic flip disk, and finally LED.

In a flip disk sign, two-sided disks, each mounted on their own individual pivot mechanisms, consisting of one side black and one side colored (usually amber) were manipulated so that the colored side of the disks would spell out the desired message. In many instances, an external light source was also installed to illuminate the messaging surfaces. This system provided relatively good flexibility in creating messages but proved to be very difficult and expensive to maintain as the rotating disk mechanisms needed frequent replacing and the colored side of the disks often faded over time and needed replacement.

A refinement of the flip disk DMS technology was the LED or fiber optic flip disk hybrid. In a flip disk sign, the rotating disks also contained either an LED pixel or a fiber optic strand connected to a light source. This provided an internal illumination source for the signs and eliminated the need for an external light source. It was still a difficult and expensive system to maintain due to the moving parts and fading message surfaces.

Finally, in the late 1990s, Light Emitting Diode technology and manufacturing processes evolved to the point that LEDs became feasible and cost effective for use in manufacturing DMS. Once this happened, LED displays became the dominant technology for DMS. Their low power consumption, long life, and low maintenance needs made them ideal for use in DMS.

Since LEDs became the preferred choice for DMS installations, the practical technological improvements have come in refinements to LED displays. High-resolution amber and high-resolution color DMS are now available at relatively feasible costs. It is not difficult to foresee a time when high-resolution amber or high-resolution color DMS becomes the preferred display technology, but this has not happened yet.

It is also not inconceivable that other developing technologies, such as liquid crystal displays, or plasma displays may someday become viable technologies for DMS but that day is not now, nor will it be in the foreseeable future. Therefore, consistent with the purpose of this document, LED technology and its low and high-resolution, and color display options are the focus of this discussion.

(1) Low-Resolution Full Matrix

Low-Resolution DMS are constructed with a pixel density of approximately 20 pixels per square foot. This provides adequate resolution for clear readable text and some graphics, but does not allow text that closely matches MUTCD text fonts and does not allow for display of more detailed symbols and graphics.

Full Matrix DMS are constructed with pixels across the entire surface of the sign to allow display of text, symbols, and graphics. When compared to line matrix signs, full matrix DMS also provide for enhanced readability and clarity of messages by allowing for variations in font heights and widths as well as variable spacing between characters and lines.

Currently, almost all DMS owned and operated by WisDOT are full matrix signs; however, considering the current WisDOT DMS Messaging Policies of using only one text font and font size, as well as the prohibition against using graphics, symbols, or animation, line matrix signs would be able to display any message allowed within the messaging policy guidelines.



Low-Resolution Full Matrix Message



Low-Resolution Full Matrix WisDOT Message

(2) Line Matrix

Line Matrix DMS were some of the earliest DMS deployed with LED technology. They were originally used when LEDs were first used with DMS as a cost savings effort as they require fewer LED pixels and when they're used within a system of messaging policies and procedures that doesn't take advantage of the additional flexibility provided by full-matrix signs they are equally effective in displaying clear messages.

As LED costs have further been reduced since early LED DMS deployments, line matrix signs have lost a significant amount of their cost advantage and have fallen out of favor for newer deployments. While they are still less expensive to procure compared to full-matrix signs, their lack of flexibility in allowing for future messaging practice changes makes them less desirable for most common deployments. However, they should still be considered for isolated deployments with specific messaging needs that fit the restrictions line matrix signs pose.



Line Matrix Sign

(3) High Resolution DMS

One of the newer innovations in DMS technology is high resolution displays. With a high resolution DMS, the density of pixels in the sign is increased to provide clearer images and text. Of particular interest with high resolution DMS is the ability to use text that more closely matches the MUTCD text fonts and spacing on fixed message signs.

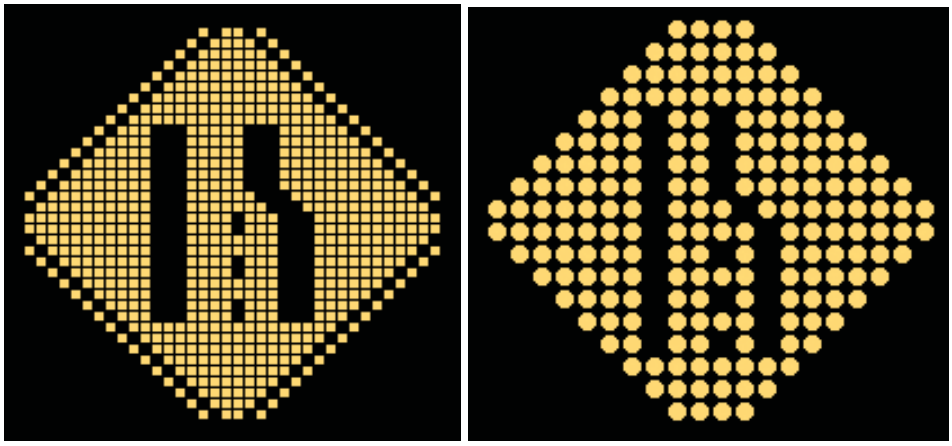
A normal resolution DMS has a pixel density of approximately 20 pixels per square foot of sign surface while a high resolution DMS has a density of approximately 80 pixels per square foot.

Current WisDOT DMS Messaging Policies prohibiting the use of symbols or graphics and using only one font size and type and all capitol letters would not make use of the added features and abilities that high resolution DMS would make available. Consideration of high resolution DMS would need to be made along with consideration of alterations to the current policies.

In addition to the current WisDOT messaging policies prohibiting the use of symbols and graphics, the current version of the sign control module in the central system software does not accommodate the use of symbols and graphics.



High-Resolution Full Matrix Sign



Low and High-Resolution Symbol Display Comparison

(4) Color DMS

High-density color LED DMS would be considered the "top of the line" in DMS display technology. It provides the most flexibility in message creation as well as the clearest graphics and text display and the ability to closely match MUTCD text fonts and spacing. In addition, high-resolution color LED DMS allow the ability to clearly display symbols and graphics, such as a blue, white, and red Interstate Shield in their normal color or colors.

Their relatively high deployment costs dictate that significant consideration be given to whether the DMS will be operated in a manner that makes full use of the added benefits, features, and flexibility that color DMS provide.

Current federal funding requirements limit the funding of color DMS, and that NTCIP 1203 version 1 support only the use of simple graphics and moving chevrons, making incorporation of color DMS and its inherent advantages and features into a central control system more complicated. Version 2 of the standard allows for expanded color and graphics capabilities.



High-Resolution Color Full Matrix Sign

iii) Controller Installation Location

Over the years, reductions in size of DMS controllers and communications gear have made it possible to install the controllers inside the sign enclosures, even with smaller arterial sized signs eliminating the need to install an external cabinet and foundation to house the controller and communications gear. Whether this is desirable should be considered in advance of awarding any procurement contracts for both DMS and controllers, as well as for the communications gear that would be associated with them. This communications gear could include simple serial modems, terminal servers, Ethernet switches, VDSL modems and Ethernet switches, and possibly even fiber optic termination panels. This equipment must be considered so that equipment of a type and size appropriate for a selected DMS controller location is available.

(1) Enclosure Mounted Controller

With the reduction in size of DMS controllers and associated communications equipment it has become possible to install controllers and communications equipment in the DMS enclosure itself, reducing the cost of the installation and reducing the footprint of the installation.

The most significant disadvantage to placing this equipment inside the DMS enclosure is ease of maintenance. As a repair technician would have to enter the sign enclosure to perform even the simplest repairs or controller resets, this could become significant. A compromise for this would be a structure mounted external remote access controller, but installing a housing for this equipment would mitigate some of the cost savings associated with placing the controller in the sign enclosure.

(2) External Cabinet Mounted Controller

Most DMS that have been installed by WisDOT have been installed with the local sign controllers installed in a field cabinet on a concrete base located a distance from the sign. Where field conditions have permitted, the controller and cabinet have been located to allow viewing the sign from the controller and cabinet to make maintenance and troubleshooting easier. The disadvantages to this system are the added cost of a cabinet and concrete foundation and, in some instances, a lack of available right of way for a separate cabinet and foundation.

One alternative to an external mounted controller is to install the local DMS controller in the DMS enclosure itself. This eliminates the need for an additional cabinet and foundation but makes field troubleshooting and some repairs more difficult.

Another alternative is to mount a cabinet for the controller on the DMS structure itself. WisDOT has done this most commonly with arterial DMS where right of way is at a premium and a cleaner design without an external cabinet and foundation is desired.



Arterial DMS with Structure Mounted Cabinet

iv) NTCIP Compliance

The National Transportation Communications for ITS Protocol is set of standards that provides the rules, or standards, and the vocabulary, or objects, necessary to allow traffic control equipment from different manufacturers to operate within the same system. The intent of NTCIP standards is to reduce the need for reliance on specific manufacturers or vendors for system components through the lifespan of the system.

The impact of NTCIP standards compliance is particularly significant when discussing DMS due to their inherent need for interoperability with a central control software / system. Their high deployment and maintenance costs also dictate a need to ensure competitive procurement practices by not becoming dependant on one manufacturer for new signs. Individual manufactures may implement either version 1 or 2 in their products. This may be an important consideration as version 2 offers a greater feature set (color and graphic support) in addition to an updated management information base (MIB).

v) Enclosure Types

There are two primary alternatives for large DMS with capability of displaying messages with text size appropriate for high speed facility applications. These alternatives are to use a walk in enclosure or a front access enclosure.

(1) Walk In Enclosures

With a walk in enclosure, the maintenance technician accesses the DMS components inside the enclosure through a door and completes most maintenance and repair work from within the enclosure itself. Walk in enclosures are only used for large DMS designed for large text sizes. Primarily due to the size of these enclosures necessary to allow for maintenance work to be performed within the enclosure itself, they are more expensive than front access enclosures.

WisDOT has been using walk in enclosures only for large freeway sized DMS.



Walk In DMS Enclosure

(2) Front Access Enclosures

With a front access enclosure, maintenance work is performed from the front of the sign, usually with access through one or more hinged access panels.

WisDOT has been using front access DMS enclosures for all but the largest freeway sized DMS installations.



Outside of Front Access DMS Enclosure

(3) Modular Display Technology

Modular Display Technology DMS, often referred to as "BRICK" signs, use a control and mounting system consisting of multiple rails along the back of the sign. The LED boards, or "BRICKS" signs, snap into place on the rails. The boards are essentially "plug and play" modules that allow for easy maintenance of a sign as well as very lightweight signs that can be mounted on lighter structures.

Modular DMS are low cost and easy to maintain. The most common complaints about these signs pertain to readability and interoperability with legacy control systems.



Modular DMS Technology

vi) Structure Mounting Options

There are a multitude of options available for mounting DMS. Each has its own unique advantages and disadvantages regarding issues such as visibility, installation costs, and ease of future maintenance.

The sections below include brief discussions of many of the available structure mount options for DMS.

(1) Overhead Installations

Cantilever
Typically, WisDOT has used cantilevered overhead mount structures only for arterial DMS. Older installations, and installations requiring a longer horizontal span, have used the truss style cantilever structure shown while newer installations have been using the monotube style structure shown.

Cantilevered DMS structures offer the opportunity to install an overhead DMS, with all the visibility advantages they bring, while taking up a much smaller area of right of way adjacent to the respective roadway as compared to a side view ground mount installation.

The disadvantages to cantilevered structures for DMS are installation costs and difficulty in accessing the signs for future maintenance work. A cantilevered DMS structure and concrete base costs approximately five times the cost of a side view ground mount installation structure and concrete bases. Future maintenance work on an overhead cantilevered DMS will also require access to the front of the sign from a bucket truck and the traffic control and impacts to traffic on the respective roadway that that brings with it.



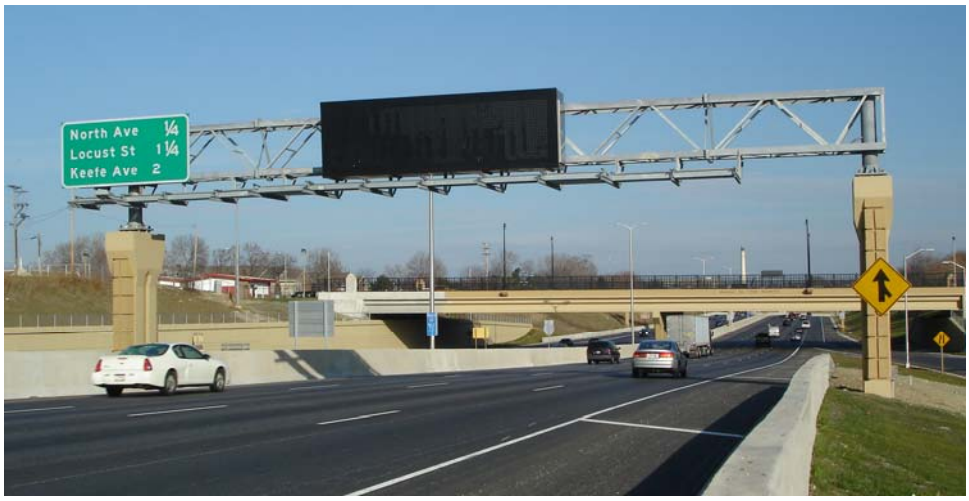
Overhead Cantilever DMS Installations

Full Span
WisDOT has always used full span overhead mount structures for DMS on freeways or other high speed facilities. This installation type provides the best possible visibility for the DMS and practically eliminates the possibility of an obstructed view of the DMS from any point on the respective roadway.

The disadvantages of full span overhead mount structures for DMS are installation cost and the negative impacts the installation has on traffic flow during construction of the structure. Compared to a side mount elevated DMS structure, often referred to as a “butterfly” structure, full span overhead mount structures cost approximately twice as much, although that ratio can

vary significantly depending on site conditions for each type of structure. In addition to the cost of the structure itself, the actual expenditures for traffic control and the general negative impact on traffic during construction will be greater when constructing a full span overhead sign bridge.

Ease of access to the DMS for maintenance is not significantly different for an overhead full span structure mount when compared to a butterfly structure.



Overhead Full Span DMS Installation

(2) Ground Mount Installations

Side View
WisDOT has used ground mounted side view structures for arterial DMS in locations with sufficient right of way space for the installation as well as for combined fixed-dynamic message signs on freeways.

Side view ground mount DMS installations are cost effective and easy to maintain where right of way space and other geometric considerations allow. Consideration must be given to the possibility of motorists missing messages provided on the signs due to the view being potentially obstructed by large vehicles.

Overhead View
While WisDOT has never used a butterfly style structure for a DMS installation, it is a popular mounting style option throughout the country and offers significant cost savings when compared to a full span overhead structure. Butterfly structures and concrete bases for DMS cost approximately half of what a full span overhead structure costs, are much simpler to construct, and can be constructed with less impact to traffic. These structures also offer advantages during roadway construction projects. Typically, butterfly structures are placed at the side of the roadway and do not have a median footing like full span overhead sign bridges. Thus, they are much more likely to be in a location that will not restrict future roadway design and construction projects. This allows them to be used during the important traffic conditions created by a

roadway construction project. Due to their single support, butterfly structures can also be located in the median of a divided highway when considered desirable due to limited right of way or other constraints.



Ground Mount Side View and Overhead DMS

(3) National Preferences

A survey conducted of designers across the country generated the following information regarding preferred DMS structure mounting styles.

National Structural Mounting Preferences	
State or Agency	**Preferred Mounting**
Missouri DOT	Butterfly Structure
Michigan DOT	Butterfly Structure
Nebraska DOR	Full Span Overhead
Iowa DOT	Full Span Overhead
Maine Turnpike Authority	Full Span Overhead
Maine DOT	Butterfly Structure
Florida DOT	Cantilever Overhead
Hillsborough County Florida	Butterfly Structure
Texas DOT	Butterfly Structure
Virginia DOT	Full Span Overhead
Washington State DOT	Full Span Overhead
Connecticut DOT	Cantilever Overhead
Maryland DOT	Full Span Overhead
Louisiana DOT	Butterfly Structure
Ohio DOT	Full Span Overhead
Kansas DOT	Full Span Overhead
Indiana DOT	Full Span Overhead

Current National DMS Display Technology Preferences	
State or Agency	Current Preferred Display
Missouri DOT	Full Matrix Low-Resolution Amber LED
Michigan DOT	Full Matrix Low-Resolution Amber LED
New Jersey Turnpike	Full Matrix High-Resolution Color LED[10]
Garden State Pkwy. (NJ)	Full Matrix High-Resolution Color LED[11]
Arizona DOT	Line-Matrix Low-Resolution Amber LED
Colorado DOT	Line-Matrix Low-Resolution Amber LED
Florida DOT	Full Matrix Low-Resolution Amber LED
Iowa DOT	Full Matrix Low-Resolution Amber LED
New York State DOT	Full Matrix Low-Resolution Amber LED
Texas DOT	Line-Matrix Low-Resolution Amber LED
Virginia DOT	Full Matrix Low-Resolution Amber LED

vii) Cost Summary

(1) Display Technologies

Due to the number of available display technologies and the complications associated with comparing their relative costs, the cost for a DMS and controller from the most recent DMS procurement contract with Daktronics is being used as a baseline with the various alternatives available being presented as a comparative increase or decrease compared to that cost. The signs recently procured, and the costs associated with them below, were for low-resolution full matrix amber LED DMS.

Recent WisDOT DMS Procurement Costs	
DMS Display Size	Unit Price
Full Matrix Walk In Enclosure 3-Lines of 18-Inch High Text	$70,250
Full Matrix Front Access 3-Lines of 14-Inch High Text	$62,750
Full Matrix Front Access 3-Lines of 12-Inch High Text	$46,330
Full Matrix Front Access 2-Lines of 10-Inch High Text	$20,550

[10] No color DMS currently deployed. Large deployment of color DMS is in planning stages.
[11] No color DMS currently deployed. Large deployment of color DMS is in planning stages.

Alternate Technology Cost Differentials	
Alternate Technology	Cost Differential
Line Matrix	- 10%
High Resolution Display	+ 50%
Color Display	+ 100%
Enclosure Mounted Controller	- $5,000
External Cabinet Mounted Controller	+ $5,000
NTCIP Compliance	$0
Walk In Enclosures	+ 10%
Front Access Enclosures	- 10%
Modular Display	- 25%

(2) Structure Mounting Options

As specific site conditions, such as necessary horizontal span or cantilever length, necessary height of vertical member of structure, existence of utilities, and roadway cross section (presence of median barrier) can greatly impact the cost and ease of construction of DMS structures it is most appropriate to compare the structural mounting options in terms of a comparison based on issues to be considered.

Alternate Mounting Options Comparison				
Mounting Option	**Installation Cost**	**Installation Impact on Traffic**	**Visibility**	**Future Maint.**
Overhead Cantilever (Monotube)	Moderate	Low	Very Good	Worst
Overhead Cantilever (Truss w/Catwalk)	High	Low	Very Good	Good
Overhead Full Span	Highest	Highest	Best	Very Good
Ground Mount Side View	Lowest	Lowest	Worst	Best
Ground Mount Overhead	Moderate	Low	Good	Good

viii) Recommendations

As the desirability of different DMS features and technologies are dependant on the manner in which they will be operated over the lifespan of the signs, the selection of new features and technologies must be tied to a review of messaging policies. Considering current WisDOT DMS messaging policies and procedures, specifically the prohibition against using symbols and graphics, the amber low-resolution DMS that have been procured and deployed over approximately the last 10-years continue to be a good match for WisDOT and there is no reason at this time to update them, or the signs to be procured in the foreseeable future.

Our recommendation regarding DMS and display technology is two-fold. First, we recommend that the WisDOT DMS messaging policies and procedures, as well as the DMS being procured, be reviewed and evaluated on a recurring schedule to ensure they stay in touch with current and future operational needs. Second, we recommend that WisDOT continue to procure and deploy DMS similar to those that have been procured and deployed in recent years.

Our recommendation regarding DMS structural mounting systems to be used is to continue using similar mounting as WisDOT has in recent years. Specifically, we recommend continuing to use full-span overhead mountings as the primary structure system for large high speed facility / freeway text sized DMS and either cantilever overhead structures or ground mounted side view structures for arterial signs. This recommendation is due in large part to the fact that the cost savings that may be realized by lower cost structure mounting systems would not likely offset the negative impacts of reduced visibility of the DMS and the lack of consistency in sign locations that using a different structure system would cause.

While full-span overhead sign bridges should continue to be the primary mounting for large high speed facility / freeway text sized DMS, consideration should be given to other structure types in specialized circumstances. For instance, "butterfly" structures offer some distinct advantages over full-span overhead sign bridges in certain situations. In circumstances where physical constraints render the use of full-span overhead sign bridges impractical or deployment during a planned roadway construction project is desired, special consideration should be given to these structures.

We also recommend that WisDOT continue to use external cabinet mounted controller and cabinets. Their ease of future maintenance outweighs the minimal cost savings that would be realized by housing the controller inside the sign enclosure. Our recommendation regarding this stops short of recommending that this be elevated to a policy decision that must be employed universally. This is due to the fact the site specific conditions may dictate that individual signs throughout the state be installed with the controllers in the sign enclosure. The decision regarding controller housing must be considered before selection of a DMS manufacturer for award of any procurement contracts as some manufacturer's controllers may still require a larger external cabinet.

ix) Migration Plan

As the recommendation from this project for DMS procurement is to continue procuring signs similar to as done in recent years, no migration plan is necessary. As new locations desirable for DMS installation are identified and installed, these new sites should consist of signs of similar display technology procured through a single statewide procurement contract and selected manufacturer. This will ensure that new signs continue to be of a similar style to the existing installations and will make future operations and maintenance simpler.

b) PORTABLE CMS

i) State of Practice

(1) Current WisDOT PCMS Inventory

In 2004 and 2005, a statewide inventory was performed as part of the development of a statewide concept of operations for PCMS. The inventory performed at that time found 141 PCMS owned by WisDOT and operated by a combination of WisDOT and the respective counties at which they have been stored and dispatched from. All PCMS were of a single manufacturer, ADDCO, but of multiple display technologies, including line matrix LED, full matrix LED, and LED flip hybrid. As the PCMS messaging policies and procedures, and control system are configured around a 3-line message on a line matrix sign, it does not matter whether the sign is physically a line matrix or full matrix sign.

Communications to the state owned PCMS for central control of the signs is done via dial-up connections via wireless phone connections. The signs can also be controlled locally by manual message selection when necessary.

A project is currently in progress to transition communications to the PCMS from wireless phone links to a state owned wireless communications network on the State Patrol's VHF Radio Network. When fully integrated, this system will improve the reliability of communications to the PCMS, will allow centralized messaging libraries, continuous monitoring of signs and their messages, assist with maintenance records, as well as provide real-time information regarding the sign and battery condition.

In addition to the state owned signs, WisDOT operates PCMS furnished by contractors through let construction projects. These PCMS are specified to be very similar in technology and appearance to the state owned signs and are connected through wireless phones to the STOC control and communications system through contractor provided phones. These contractor owned signs will be incorporated into the new statewide communications system by providing the contractor with the system's interface control unit.

(2) PCMS Technology Scan Results

The states surveyed specifically for this project were Idaho, Minnesota, Montana, South Dakota and North Dakota.

The data from this survey are summarized below:

- All subject states use a combination of permanent and portable DMS.
- Minnesota, Montana, and South Dakota use portable DMS in permanent locations.
- Idaho, Minnesota, and South Dakota have plans in place to rapidly deploy PCMS in the event of a major traffic incident.

(3) Current WisDOT PCMS Messaging and Deployment Practices

WisDOT PCMS messaging policies do not differ from those described and included in the section above regarding permanent DMS messaging policies.

Deployment of the WisDOT owned PCMS is normally done as part of special events traffic management, maintenance activities traffic management, and sometimes incident scene traffic management. Special events and maintenance activities traffic management deployments are handled and planned for in the planning stages for both activities. Deployment for incident scene traffic management is left largely to responders at the incident scene with a general rule of thumb of deploying the signs for significant incidents that are likely to take two or more hours to completely clear.

In addition to using PCMS for temporary short term deployments such as special events, construction / maintenance activities, and incident site traffic management the signs are often used in permanent, or semi-permanent deployments. At some sites identified and used often, permanent hardwire communications links have even been installed for use with PCMS deployments.

ii) Available Technologies

Available technology alternatives for PCMS displays are very similar to the alternatives available for permanent DMS displays. Low-resolution amber line matrix and full matrix PCMS make up the bulk of WisDOT's inventory and are the most common sign types manufactured.

While PCMS could be manufactured with high-resolution amber or color displays, the high cost associated with such a PCMS along with the high risk nature of their deployments make them economically unattractive.

(1) Speed Radar and Speed Warning Message Option

PCMS can be obtained either with a vehicle detector included, or with the ability to connect to a vehicle detector, for the purpose of detecting specific vehicle's speeds. This information can be used to operate the sign as a speed display trailer. WisDOT owned PCMS have the ability to be connected to a vehicle detector and operated in this manner, but none came with the detector pre-installed.

iii) Message Selection and Communications

While display technologies for PCMS have become relatively standard over the years, the opposite is true of available systems to communicate and control the messaging with the signs. Communications media technology is continuing to expand, become mature, and become more reliable. Considering the portable nature of PCMS and the desire to maintain constant communications in a manner similar to permanent DMS, the available systems all have their own inherent advantages and disadvantages. Some of the more common and applicable systems available are described in the following sections.

(1) Manual On-Site Message Selection

The simplest way to control PCMS is to use manual on site message selection. Using this system, staff, either contractor or WisDOT simply drives to the sign location and selects the sign message from a library, or generates a custom message for the sign. Using manual message selection like this is simple, secure, and the message display can be confirmed before the staff leaves the site.

Manual message selection could be an effective system for deployments at which the message is not likely to need to be changed and at which staff is readily on hand. Construction, maintenance, or incident sites could make effective use of manual message selection in many circumstances. It is not a desirable system to use for permanent or semi-permanent PCMS deployments as they would be expected to experience frequent message changes.

The obvious disadvantages to this are the use of expensive staff labor and the time it takes to change the message.

(2) Wireless LAN Hotspots

As the technologies involved in creating and setting up wireless LAN hotspots continues to become more common and less expensive, the technology could be considered for communications to PCMS, and other field devices, particularly at the pre-selected, permanent, or semi-permanent sites near WisDOT owned communications systems.

This system would require the deployment of wireless LAN equipment over a Virtual Private Network at points that would provide access to the PCMS. The difference between this and other wireless links technologies would be simpler deployments once the equipment is installed. Using systems like spread spectrum radio links or other wireless Ethernet links may require additional equipment adjustments with each deployment, whereas wireless LAN equipment would simply connect to the network when it is deployed and powered up.

The disadvantages to this system are that it is only feasible at sites near the permanent WisDOT communications network, and that any sign to be used with the system must be pre-equipped with communications gear appropriate for the connection. This would mean that signs may have to be equipped with two sets of communications gear so that they would work with the LAN system and an alternate system for deployments away from the pre-equipped sites near the WisDOT communications network.

(3) Wireless / Cellular Phones

Currently, all WisDOT owned PCMS can be communicated with over analog dial-up wireless / cellular phones. The signs can be controlled over the wireless / cellular phones through the central software at the STOC, by PCs with copies the central sign control software, or by PCs with the sign manufacturer’s proprietary control software.

The biggest advantage to this is that it provides a simple and cost effective system to communicate with the signs at any site within the wireless / cellular phone provider's coverage area.

The disadvantages experienced with this system have been related to sign deployments in areas of the state that are not within the provider's coverage area. This normally occurs in more rural areas of the state.

A further disadvantage of this system is that in the near future, wireless / cellular providers will be discontinuing their analog cellular services. Continuation of this system will require purchasing all new wireless digital phones for each WisDOT owned signs.

(4) Spread Spectrum Radio Links

900 MHz Spread Spectrum Radio (SSR) links have a long history of use for low speed communications, such as needed for permanent DMS, PCMS, and data collection sites. They are robust communications links that, when used at the short distances they're often used at for ITS, tolerate weather conditions, changes in antenna placement and orientation, and even lack of perfect line of sight.

Use of SSR links for PCMS communications would be an easily deployable system for sites near the permanent WisDOT owned communications system. PCMS deployment would be easiest with the end of the link connected to the permanent communications system pre-deployed, but as long as the equipment near the deployment site has the capacity available, and staff is available at the STOC to assist with configuration, the SSR link could be established entirely at the time of deployment.

The only significant disadvantage to using SSR for PCMS communications is that it could only be used within the range of the SSR from the permanent WisDOT communications system.

(5) Statewide Communications and VHF Radio Network

WisDOT is currently in the early phases of deploying a PCMS communications system that will use a combination of the Wisconsin Statewide Communications Network and the State Patrol's wireless VHF communications system. The combination of the Statewide Communications network and State Patrol VHF system will provide near total coverage of the state and greatly exceed the coverage that any private wireless / cellular provides in Wisconsin.

This system is being contracted for deployment, support, and web-server hosting with JamLogic. The JamLogic Application Server (JAS) will manage security, user profiles, map-based GPS location of PCMS inventory, maintenance information, remote control, PCMS automation, message libraries, and user permissions. The JAS translates PCMS data into web page interfaces. It also communicates with the PCMS through their controller interface in each sign. The system can also read external XML feed sources such as Amber Alerts, travel times, and weather alerts, then prioritize these sources according to user-defined parameters, then create and deliver PCMS messages and e-mail alerts based on these automated services.

When fully deployed and operational, this system will provide continuous communications with all WisDOT owned PCMS. This continuous communications will be used not only to select and deploy messages on the PCMS, but also to do the following additional functions:

- Maintain a chronological history of logins to the system.
- Maintain a GPS map of every PCMS in the system.
- Host centralized message libraries for the PCMS system.
- Historical data and graphs of battery and solar voltages.
- E-mail alerts when voltages dip below pre-defined thresholds.

(6) Hardwired Telephone Connections

For obvious reasons, hardwired telephone communications connections are only feasible for permanent PCMS deployments, or for at pre-defined sites that have had telephone connections arranged for and deployed ahead of time. These hardwired telephone connections have an advantage in terms of reliability when compared to wireless / cellular connections but also carry a significantly higher cost for installation.

iv) Cost Summary

The JamLogic system currently being deployed has the following costs associated with it:

- $2,200 per radio at each PCMS X 160 PCMS Statewide = $350,000
- $1,000,000 for initial deployment of system and 5 years of web hosting and support

The total anticipated cost for the initial 5 years of functionality for the JamLogic system is $1,350,000. After this initial period, the system is expected to cost approximately $50,000 per year for ongoing web hosting and support.

v) Recommendation

Our recommendation for PCMS procurement is to continue with technology similar to that which has been procured and deployed in recent years. For a communications system for PCMS, our recommendation for the immediate future is to continue the JamLogic system currently being deployed.

Further, as there is a perception that maintenance standards, for both preventative and remedial, for PCMS vary significantly across the State due to the fact that it is performed by individual counties at the State's expense, it is recommended that a more standardized maintenance program be developed. This standardized maintenance program may consist of a State managed maintenance contract, State staff performed maintenance, tighter monitoring of maintenance activities performed by the counties' staff, or even some combination of these methods. There should also be a standardized procurement contract or contracts established for easier procurement of common technical spare parts such as batteries, solar panels, solar charging

controllers, LED boards, and others. Contracts for non-technical parts such as wheels, bearings, winches, hitch parts, and others would also help create more uniform maintenance standards.

As the JamLogic system will also provide valuable data on frequency of usage for the PCMS, expansion, contraction, and/or reallocation of the PCMS inventory should be evaluated regularly.

vi) Migration Plan

There is no new migration plan needed for PCMS or PCMS communications in the immediate term. As the JamLogic system is still in the early stages of deployment it will need to be evaluated as it comes closer to full deployment and ultimately when it is fully deployed. The evaluation should consider coverage area and the presence of any coverage gaps in Wisconsin. The PCMS tracking that will be put in place with this system will also make the initiation of an improved maintenance program and standardized parts procurement contracts easier and more effective.

c) WEB SITES

i) State of Practice

As transportation agencies move toward greater integration and distribution of their traveler data, and the public demands a greater ability to personalize the way they receive information, multiple information service providers are increasingly relied upon to integrate and display data that can include: traffic congestion, incident alerts, traffic images, construction advisories, weather, public event advisories, parking information, multimodal trip plans, alternative routes, and current and historic drive times. Additionally, the integration of commercial services, such as reservation and payment systems, are becoming an expectation with Web-based media.

This traveler information marketplace is rapidly evolving, including a focus on a variety of Web-based and wireless/mobile services. Companies are expanding market share with mergers and partnerships, working to better integrate mapping and information services, and find the most commercially viable model. Recent examples include:

- The partnership among Maptuit, Navteq and Westwood One
- Nokia's acquisition of Navteq
- TomTom's acquisition of TeleAtlas

From a development standpoint, Web technologies continue to change rapidly and offer many options for displaying traffic and related traveler information. Significant changes over the past several years that impact the provision of traveler information include the following:

- Release of robust Internet mapping APIs (Application Programming Interfaces)
- Use of XML and RSS feeds to share information
- Improvement of image and browser capabilities in mobile devices
- Improved integration of traffic information from disparate sources
- Further traffic data formatting standardization for mass distribution

Additionally, further attention to the user experience, through better user interfaces and the integration of data into a seamless user experience, has helped increase the effectiveness of communicating traffic data on the Web, although there is much room for improvement.

The following web site examples provide a snapshot of the current state of integration and personalization of traveler information data, primarily within a DOT and transportation agency context:

- General site and map links
  - www.511.org
  - http://mynav.georgianavigator.com/www/
  - http://www.ncdot.org/traffictravel/
  - http://www.tripcheck.com/Pages/RCMap.asp?mainNav=RoadConditions&curRegion=1
  - http://www.chart.state.md.us/default.asp
  - http://traffic.houstontranstar.org/layers/
  - www.511virginia.org/
  - http://www.ntta.org/AboutUs/Traffic?tabid=speed

- Pre-trip planning
  - http://www.trips123.com/trip_planner/default.asp
  - http://www.tripcheck.com/rtp-to/cityCounty/cityCountySearch.aspx
  - http://traffic.511.org/his_traffic_text.asp (based upon historical drive time data)
  - http://www.transportdirect.com/TransportDirect/en/JourneyPlanning/JourneyPlannerInput.aspx (multimodal)
  - http://tripsweb.rtachicago.com/ (multimodal)

- Travel times
  - http://traffic.511.org/traffic_map.asp?drivingtimes=1 (interactive map control)

- Mobile devices
  - http://traffic.houstontranstar.org/mobileinfo/mobileinfo_maps.html
  - http://mynav.georgianavigator.com/www/services.jsp

- Personalization
  - http://www.traffic.com/
  - http://mynav.georgianavigator.com/www/registerUser
  - http://www.iltrafficalert.com/ (email registration)
  - http://www.tripcheck.com/Pages/CCentry.asp (cameras)
  - http://www.google.com/ig/adde?moduleurl=http%3A//www.myganav.com/www/google/gadget_map.jsp
  - http://www.myflorida511.com/MYFL511/MYFL511

- Traffic cameras
  - http://www.wsdot.wa.gov/traffic/seattle/
  - http://mynav.georgianavigator.com/www/cam
  - http://www.smartsunguide.com/Map.aspx

ii) Available Technologies

The following review focuses on development options for the map-based distribution of traveler information, as this is the area that has seen the most significant change in recent years.

(1) Mapping Applications

Three core technology routes exist for developing and integrating traffic data into a map interface: A) the customization of available commercial API mapping technologies; B) the customization of licensed GIS technologies; and C) development of proprietary applications built with standard Web development tools.

Similar capabilities can be developed among the options. Considerations must include the expected lifespan for the site/tool, development and maintenance budget expectations, level of up-time required, existing technologies that can feed data to the Web interface and support the production environment, and the level of accuracy, usability, integration and timeliness required.

A) Customization of commercial API mapping technologies, such as:

- Yahoo Maps
- Google Maps
- Google Mobile
- Google Earth
- MS Virtual Earth

This category of tools provides the benefit of leveraging third-party investment in user-friendly interfaces/controls and ongoing refinements, and the significant capability to customize. Additionally, these technologies may be leveraged to provide additional related traveler information, such as hotels, places of interest, etc. However, the manufacturers have no contractual obligation to create tools fit for a purpose and may alter code or discontinue product delivery with little advanced warning to developers and organizations using the products.

Examples include:

- http://maps.modot.mo.gov/travelerinformation/TravelerInformation.aspx
- http://www.illinoisvirtualtollway.com/Default.aspx
- http://www.smartsunguide.com/Map.aspx

System requirements for this solution are minimal, including a Web server and minimal software requirements depending upon the selected API.

B) The use and customization of mainstream GIS technologies and Web-based, server products from the four main manufacturers: ESRI, Intergraph, Autodesk and Bentley. These products include:

- ESRI ArcGIS Server
- ESRI ArcIMS
- ESRI ArcGIS Server - Mobile
- ESRI StreetMap Mobile SDK
- Intergraph GeoMedia
- Autodesk MapGuide

With GIS technology, an organization's existing GIS environment may be leveraged to build and continue refining a traveler information mapping tool. This may offer an opportunity for efficiencies and for easier future integration with other business data within the organization. Additionally, an organization truly owns and manages the data and interfaces involved.

However, hardware and software licensing costs can be significant, and although user performance and interface usability has improved, generally it is not to the level of the commercial API products that specifically target a mass market audience. The positives and negatives can be balanced through creative solutions of integration, such as the Illinois Tollway's Virtual Tollway (listed earlier), which uses both the Yahoo API and ArcIMS (ESRI) technologies.

Other examples include:

- http://dashboard.virginiadot.org/operations.aspx
- http://www.gettingaroundillinois.com/default.aspx?ql=const

System requirements for this solution may vary, from a single server to multiple servers. A distributed architecture is recommended for performance and maintenance, typically consisting of separate database and application servers. The requirements for the GIS software must be adhered to and may require additional software to run the applications and software.

C) Development from the ground up of proprietary technologies allows for complete flexibility to support the organization's brand, meet unique project requirements, go beyond the capability of existing software, and potentially to best integrate information from multiple sources. However, up-front costs can be significant, and ongoing development costs to improve the tools must be considered.

WisDOT's Marquette Interchange Project site (mchange.org), for example, was designed to seamlessly integrate a variety of information sources (consisting of manually and automatically updated traveler information). Three highly customized components were:

- Toolbar alert, offering quick access to personalized traveler information relayed via the Internet and displayed in a desktop application

- Traffic information map, which illustrates closures according to actual roadway geometry changes tied to the closure database

- Routing map, which provides routing directions based upon a closure schedule

Each of these components included functionality, GUI elements, and content administration tools not available through off-the-shelf tools at the time.

Examples include:

- www.mchange.org
- http://ctabustracker.com/bustime/home.jsp
- http://www.nextbus.com/predictor/publicMap.shtml?a=portsc

It should be noted that all mapping technologies provide Web accessibility challenges, requiring the provision of alternate text versions of map content.

(2) Data Sharing

RSS is an increasingly popular format for sharing traffic-related information for a range of uses and devices. An **RSS** (Really Simple Syndication) file contains brief text and links formatted in XML (eXtensible Markup Language). **GeoRSS** (Geographically Encoded Objects for RSS) files include location information encoded into RSS feeds.

Although custom XML generation and coding for data display is typically required, these methods of distributing information allow for the efficient sharing, aggregating and mapping of traffic and related traveler information on the Web. Additionally, RSS information can be easily incorporated into other Web sites, expanding its reach. The process will continue to improve as we see further standardization of travel information data attributes within the industry standard XML format.

Video formats are evolving as well, but many agencies continue to publish still images (industry standard is .jpg) to the Web rather than video clips or streaming video (leading formats include: .wmv, .mov, .flv, .mp4, .3gp). This primarily is driven by cost and performance issues versus the value to the end users (e.g., users can receive larger, clearer still images at reasonable intervals instead of smaller, lower quality video clips that also take longer to load). Wireless network providers are currently targeting mobile video users; this investment should shift the Web video landscape over the next few years.

Examples include:

- http://www.illinoisvirtualtollway.com/RSS.aspx
- http://myganav.com/www/services.jsp

iii) Recommendation

Web technologies continue to evolve rapidly, so it is crucial that any Web site implementation can respond and accommodate that progress in a cost-effective manner. Although the market can change rapidly, it is expected that in the near future the major providers of the commercial API mapping tools will continue to refine their products and provide them via a similar business model used today. This model will continue to allow for the leveraging of robust "off-the-shelf" functionality with the flexibility to customize for unique requirements and branding, as well as an opportunity to incorporate supplemental traveler information as it becomes available. Additionally, XML/RSS data format standards will evolve but are an industry standard expected to continue in the near term.

Back-end equipment and resources for hosting and ongoing maintenance can be scaled relatively easily to accommodate these types of Web applications that effectively use caching techniques and Web services to communicate data. Plan for a target architecture based on the applications being hosted, then monitor and scale as needed. The applications with more robust requirements need to be developed to take advantage of the distributed architecture. This will improve scalability, usability, manageability, and reliability of the system.

Any recommendations for a traveler information Web site approach should be provided in context with the ongoing 511 rollout in Wisconsin. In addition to the potential efficiencies of leveraging information and resources, 511 provides the opportunity to integrate all traveler information under a common brand while reaping the benefit of national initiatives and advertising.

Although not technology specific, driving user traffic to the site and its services the first time and then for repeat visits is critical to a successful Web site implementation. In addition to the technology components, it is recommended that a focus is placed on content planning, design

and usability testing; this is an area where many sites fall short of their potential to reach the largest audience with the best information. Additionally, browser-based content administration tools integrated to allow for real-time manual updates to portions of the Web site in a manner that appears to the external user to be seamless with the automated updates, will help to improve the administrative and end user experience.

Historically, the Web has reinvented itself every 3-5 years. From the standpoint of geographically based services, such as traveler information, the marketplace is set to make a rapid shift within the next few years based upon factors including the extreme growth of GPS usage, greater targeting of mobile users for products and services, rapid expansion of wireless networks, and information provider integration directed toward meeting consumer needs. This movement should lead to significant near-term improvements in delivering traveler information to the public whenever and wherever they are. Certainly, a review of major information service providers and their integrated products and services would be prudent for long-term traveler information Web site planning.

In the near-term, the use of commonly accepted Internet development tools and methodologies without dramatic up-front investment in proprietary tools can provide a future proofing to the extent possible, offer the flexibility to accommodate research and development on future initiatives such as VII, and offer the potential to integrate with existing business/GIS systems for enterprise data delivered via Intranet, Extranet or Internet. An exception is where specialty or custom tools are required to meet distinct user needs and/or to augment other Web applications.

In summary, the public wants real-time, comprehensive, integrated, user-friendly and personalized access to traveler information when and where they want it. Web applications should provide:

- Consistent up-time
- Comprehensive information
- Integrated interface
- Real-time results
- Ability to customize to user preferences
- Ability to access from multiple locations

And most importantly, an ability to accommodate future technology and methodology changes in the most cost-efficient and timely way.

d) HIGHWAY ADVISORY RADIO

Highway Advisory Radio provides travelers with information through the radios their vehicles and is the oldest traveler information system in use today with the first systems deployed in the 1940s. Most commonly, information is relayed to highway users through the AM radio receiver in their vehicles. Upstream of the HAR signal, users are instructed to tune their vehicle radios to a specific frequency via roadside or overhead signs. During periods when the HAR message is of particular importance attention is brought to the frequency signs with flasher signals.

While evaluations have shown that travelers are unlikely to switch off their music or other entertainment to listen to traffic information reports, those who do tune in express high levels of satisfaction. HAR can be an effective tool for providing timely traffic and travel condition information to the public, provided users can be persuaded to tune in.

HAR has various advantages and disadvantages. It's most important advantage is that it can reach more travelers, and potential travelers, than DMS. While DMS's reach only motorists who have already chosen their transportation mode at a particular point on the roadway, and can only convey a short message, HAR has the advantage of being able to communicate with any persons in their broadcast range and can provide much more detailed information. Its primary disadvantages are that it is restricted to low power, which often leads to poor signal quality (since it is affected by many outside forces such as weather), and it requires the driver to take an action (i.e., turn on the radio or change the station or both).

i) State of Practice

(1) Current WisDOT HAR System Inventory

WisDOT currently owns, maintains, and operates permanent HAR transmitters covering three areas of the state with varying sized coverage areas. The following table summarizes the permanent HAR transmitter systems and their coverage areas.

Statewide Permanent HAR Transmitter Systems			
System Type	**Location**	**Freq.**	**Area of Coverage**
Licensed AM HAR (Synced)	Milw. Co.	1610	I-94 E/W (WIS 83 to MQIC)
	Milw. Co.	1610	I-94 N/S (MQIC to Ryan Rd)
	Oz. Co	1610	I-43 N/S (WIS 60 to MQIC)
	Wauk. Co.	1610	US 45 N/S (Lannon Rd to Zoo Int)
	Milw. Co.	1610	I-894 (Zoo Int to Mitchell Int)
	Wauk. Co.	1610	I-43 N/S (WIS 164 to Hale Int)
	Wauk. Co.	1610	I-94 E/W (WIS 83 to County F)[12]
Licensed AM HAR	Ken. Co	1610	I-94 N/S (WIS 50 to WIS 142)
Licensed AM HAR	Eau Claire Co.	530 AM	I-94 E/W (Mile Post 6 to W. of MN/WI State Line)

The permanent transmitter systems in Milwaukee, Ozaukee, and Waukesha Counties also have the optional transmitter synchronization systems so that the transmitters' overlapping coverage areas are phase synchronized to minimize co-channel interference among HAR stations. This provides a large seamless coverage area with no coverage gaps created by overlapping transmitter signals interfering with each other and garbling the audio. These synchronized transmitters provide nearly complete coverage throughout the urban area in Southeastern Wisconsin in Milwaukee, Waukesha, and Ozaukee Counties.

In addition to the permanent HAR transmitters described above, WisDOT maintains a statewide license for transmission at 1620 AM. WisDOT owns and operates 4 portable HAR units at 1620 AM, normally for significant planned special events. Temporary signs are also deployed to alert motorists of the information available on the portable transmitters when they are deployed and put into use.

ii) HAR Technology Scan Results

This section will include a discussion of the results of the completed technology scan survey regarding messaging practices and policies.

This section will also include a discussion of current HAR messaging practices and policies in other states we have experience with.

[12] Planned for deployment in summer of 2008 (coverage is estimated)

iii) Current WisDOT HAR Messaging Practices

When important information related to a major incident, special event, planned construction activities, or Amber alert is being broadcast on the HAR system, flashing beacons on HAR information signs are activated to make traveler's aware of the availability of important information on the HAR station.



HAR Flasher and Sign Assembly

Prioritization for information on the Traveler Information System (TIS), including the HAR system, is as follows:

1) Amber Alert
2) Major Incident (Level 3 or greater)
3) Special Event
4) Construction / Maintenance
5) Travel Times

When no major incident, special event, planned construction activities, or Amber Alert information is being transmitted on the HAR system, automated Travel Times for pre-defined segments of highway are broadcast.

iv) Available Technologies

There are many different systems available for use today in disseminating traffic information to motorists through their vehicle's radio. These range from agency owned and operated licensed roadside transmitters with 5 mile transmission radii to relying on commercial over-the-air broadcasters to localized low power transmitters with 1,500-foot transmission radii.

(1) Licensed AM Transmitters

The most common HAR application in use today is licensed 10-Watt AM transmitters. Typically, they have a broadcast radius in the range of 3–5 miles depending on topography, atmospheric conditions, and the time of day.

The relatively recent development of transmitter synchronization systems has significantly improved the effectiveness of licensed AM HAR systems by allowing full coverage deployments without signal loss and garbled messages in areas with overlapping transmitter signals.

(2) Transmitter Synchronization Systems

In the mid-1990s a system for phase synchronizing radio transmitter signals was developed and made available, either as a retrofit to existing transmitter sites or as an optional feature on new transmitter sites. Prior to this development, individual transmitter sites had to be power-adjusted to not overlap with the transmission areas of adjacent sites. This was a time consuming process and left gaps in the coverage area between transmitter sites.

The development of the phase synchronizing system allowed coverage areas to be overlapped without signal interference, making it possible to minimize co-channel interference among HAR stations, increasing broadcast quality and coverage. The only significant downside to using a transmission synchronizing system is the loss of the ability to use different messages on each transmitter. With a synchronized system, all synchronized transmitters must transmit the same message making the HAR system an area information system as opposed to a localized specific route system.

(3) Unlicensed Low Power AM Transmitters

Low-power unlicensed HAR has been developed as a means of tightly controlling the broadcast zone and thereby limiting interference from adjacent zones. Low power HAR differs from the previously discussed licensed HAR in that its broadcast radius (per transmitter) is generally limited to 500 feet to 1500 feet. By FCC regulation, each transmitter is limited to a maximum 0.1 watt power input to the final frequency stage, and the total length of the transmission line, antenna, and ground lead can not exceed 3 meters. While this limits its broadcast range significantly, it also provides for a reasonably well-defined area of influence, which, through an inter-connection and synchronizing process, permits upwards of 100 transmitters to be coordinated into larger and well-defined coverage saturation zones.

By using this concept, a series of zones operating on the same frequency, may be established to provide unique site-specific messages. Low-power HAR may also broadcast over any available AM radio frequency without the need to obtain additional FCC licensing approval. Though the ability to install a system without FCC approval provides great flexibility in installing a system quickly, there is no guarantee that once installed it will not be interfered with by a future more powerful transmission.

Another potential problem with this system is that the relatively low signal strength must compete with a variety of obstacles, including overpowering commercial broadcasts, signal skip (particularly at night), and poor signal propagation. These difficulties can be overcome by saturating an area (zone) with multiple transmitters and synchronizing their broadcasts but this concept is relatively new and expensive as it requires multiple transmitters.

(4) Low Power FM Transmitters

Typically, HAR has been implemented using 10-watt AM transmitters. This is because, beginning in 1977, it was the only technology permitted by the FCC for traveler information. As such, this technology implementation has also proven to be the most effective. Other means involve very-low power AM transmission, where multiple transmitters are spaced closely together to form a large area of coverage. This application, however, has not proven very successful. As late as 2000, the FCC ruled to allow the use of low-power FM transmission for TIS. This technology has limited application to-date.

(5) Commercial Radio

Free Over-The-Air

Free over-the-air commercial radio has proven to be a good means of providing travelers with traffic information from both an in-vehicle perspective and a pre-trip perspective. The public has learned to depend upon the media to provide them with "almost" real-time traffic information. Traffic and roadway condition reports have become standard programming items on many commercial radio stations. Commercial radio has the best potential of reaching the greatest number of commuters, since almost all of them have radios (and listen to them) in their vehicles.

The primary disadvantages of depending on commercial radio relate to the accuracy of the information, the level of detail provided, and the lack of control over timing of updates as traffic reports often are transmitted only when normal scheduling permits. Most major metropolitan areas have stations that report traffic every 10 minutes; but the available time is limited, meaning that only the worst situations are reported and with little detail provided. Moreover, with stations that provide less of an emphasis to traffic reports, there is likely to be considerable time delays between when an incident occurs and when it is reported.

Many transportation agencies have made efforts to improve coordination and cooperation between themselves and the media traffic reporters. Some agencies allow private traffic reporting organizations to place personnel in traffic management centers to obtain current information on traffic conditions and expected responses in an accurate and timely manner. Others means of working with the media include proving the media with real time data feeds, congestion maps, and video feeds.

WisDOT currently provides real time data feeds, congestion maps, and video feeds to a number of media outlets in Wisconsin.

Subscription Satellite Transmission

Subscription satellite radio transmissions, such as Sirius and XM, offer some significant advantages regarding traffic information dissemination through free over-the-air commercial radio broadcasts. Both subscription services provide extensive traffic information on traffic and weather combined stations focused on major metropolitan areas within their base subscription packages. They both offer additional premium services to deliver traffic information to properly equipped GPS mapping units.

While these services can provide detailed and timely traffic information to subscribers anywhere they have their satellite receivers, the services currently only cover the largest subscription markets. Sirius provides 10 dedicated traffic and weather stations for each of 10 markets and XM offers 20 dedicated traffic and weather stations for each of 20 markets.

The other downside of satellite subscription radio as a significant disseminator of traffic information is its relatively low market penetration compared to free over-the-air radio. At the end of 2006 there were approximately 9 million subscribers in total to both service providers[13]. Considering that free over-the-air radio enjoys almost complete market penetration to the 200 million licensed drivers in the United States and that satellite radio provides no traffic information in their base packages for most of the country, this means that well under 5% of the driving population has access to satellite radio provided traffic information.

Even when considering projections that by 2020 there will be approximately 35 million subscriptions[14] in total to satellite radio, this will still not represent a significant portion of the driving population.

v) Cost Summary

Costs for a full deployment of HAR system can vary significantly, primarily depending on coverage area desired, but also depending on features desired. Planning level cost comparisons can be done among the systems described above. Approximate costs associated with the systems are included below:

- Licensed AM = $20,000 to $25,000 per transmitter site depending on site conditions
- Transmission Synchronization = additional $3,500 per transmitter site
- Unlicensed AM = $500 per transmitter site15
- Portable AM = $30,000 to $35,000 per unit depending on options
- Low Power FM = $500 per transmitter site
- Commercial Radio = Costs of network links normally born by radio station

[13] Digital Media Growth Projections - Updated 01/24/2007 by Bridge Ratings, LLC
[14] Digital Media Growth Projections - Updated 01/24/2007 by Bridge Ratings, LLC
[15] Note that the number of sites to provide adequate coverage and transmission saturation can be up to 100.

vi) Recommendation

Even when considering the plethora of new technologies and systems available for disseminating traveler information, the radio will continue to be a cost effective tool due to its availability to almost all travelers.

Our recommendation is to continue to disseminate traveler information over the radio in much the same way it has been since the first HAR transmitters were deployed and the first data connections were provided to private media outlets.

Data and video connections to media outlets should be maintained and enhanced as technology improves to allow the media to provide the best, most accurate, and most current traffic information possible. These connections should also be provided to satellite radio providers when they provide traffic or traffic / weather stations covering Wisconsin markets.

Existing licensed AM transmitters should be maintained and the system expanded to provide coverage statewide as the rest of the ITS system, such as vehicle detection systems and video surveillance systems are deployed in those areas.

vii) Migration Plan

As the recommendation from this project for HAR systems and data connections is to continue to maintain and expand the system in a manner similar to as done recently, no migration plan is necessary. HAR systems and transmitters should be considered along with all ITS and traveler information tools. As the effectiveness of traveler information systems such as HAR depends greatly on the deployment of traffic data and surveillance equipment deployments, HAR should be deployed along with other systems as ITS expands throughout the state.

e) 511 TRAVELER INFORMATION SYSTEM

Simply put, a "511" Traveler Information System deploys a telephone based traveler information dissemination system whereby users must dial only the three digits 5 – 1 – 1, which serve as a short cut to the full ten-digit telephone number. The normally automated system then asks the user to input necessary information to get to the specific area, corridor, or roadway for which information is desired. Some systems have been deployed nationally with live operators answering calls.

i) State of Practice

To provide consistency and simplicity in telephone-based traveler information, in 1999 the U.S. Department of Transportation petitioned the Federal Communications Commission to designate a three-digit telephone number for traveler information nationwide. In response, the FCC designated "511" as the national traveler information number.

In petitioning the FCC for the "511" system, USDOT had to demonstrate the need and benefits for such a system. The USDOT identified the following:

- Over 300 telephone traveler information systems in the U.S. could benefit from one such number.
- Demonstrated value of traveler information services to the public.
- 72% call volume increase N11 vs. easy 7-digit number.
- 10-digit dialing makes numbers harder to remember.
- Area code expansion making 7-digit numbers less plausible

ii) Common National System Operations Practices

To reduce the potential for service confusion and inconsistency, the 511 Deployment Coalition offers other guidelines for implementing 511 services. The guidelines include:

- Content guidelines that focus on defining the information that should be provided by a basic 511 service. The guidelines recommend that every 511 system deployed in the United States provide at minimum the basic content as defined in the document. It is this basic content that callers will associate with the core of 511. A summary of some possible optional content categories also is provided.

- Consistency guidelines that address steps that implementers can take increase the degree of uniformity and consistency of 511 service across the country. The consistency guidelines cover 15 separate issues, such as user interface, and time stamping of information.

iii) Current Status of Wisconsin System

In Wisconsin, a planning study for the deployment of 511 was completed in 2005 with preliminary engineering continuing through spring of 2007. A request for proposals was released in Spring of 2007 with a full system deployed by Fall of 2008.

The Wisconsin Department of Transportation issued a request for proposals on April 16, 2007 with proposals due June 8, 2007. The selection process is concluded and LogicTree Corp. has been selected to deploy the initial system, and provide web hosting services and support for four years beyond initial deployment.

(1) Preliminary WisDOT 511 Messaging Practices

At this point in the deployment of the initial 511 system, no messaging practices and policies have been developed. It is expected that the prioritization of messages will closely parallel the prioritization as described for DMS and HAR messages. The main difference between DMS and HAR messaging compared to messaging through a 511 system is that the 511 system will allow including all messages and the prioritization would be used to determine the order of messages as opposed to what messages will be disseminated.

Although both the 511 system and the HAR system are audible information delivery systems, it is not anticipated that the messages on the HAR system will be re-broadcast on the 511 system.

iv) Coordination with and Impacts to Traveler Information System

The detail of information able to be consistently distributed through a 511 system will exceed that of all other TIS with the exception of HAR. While both HAR and 511 systems are audible systems that have the information to provide traveler information focused on the area the traveler is interested in, the 511 system goes one step beyond that and can focus on the exact route the traveler is interested in, provided that the operating agency monitors the route for traffic congestion and/or incident information.

It is easy to see significant benefits to a fully functional 511 system for dissemination of traffic information. It can be everything needed for traffic information:

- Detailed;
- Route specific;
- Timely;
- On demand;
- Effective for in-vehicle use;
- Effective for pre-trip use;

It appears to have such potential that the question must be asked of what its impacts will be to the remaining TIS, particularly DMS and HAR. Its most significant shortcomings are that it takes an active decision by motorists to use 511 to seek out traveler information as opposed to passively delivering the information with no action by motorists, and that cell-phone ownership in the United States is still not nearly total.

As 511 takes an active decision to seek out traveler information, it will not be able to reach a majority of motorists in any area or route. When compared to passive dissemination systems like DMS, a 511 system will never reach as many travelers on a deployed route as a DMS will.

In 2007, approximately 80 percent of the US population owned cell phones. While this may seem like a significant majority, it leaves 20% of the population unable to use a 511 system in their vehicles, as opposed to a HAR system for which as close to 100% of the population as can be expected has a radio in their vehicle.

Considering the shortcomings, particularly the portion of the population without cell phones, a 511 telephone traveler information service is likely to remain one of a handful of useful traveler information tools available to make a fully functional traveler information system. It is not likely to become a replacement for other traveler information tools for the foreseeable future.

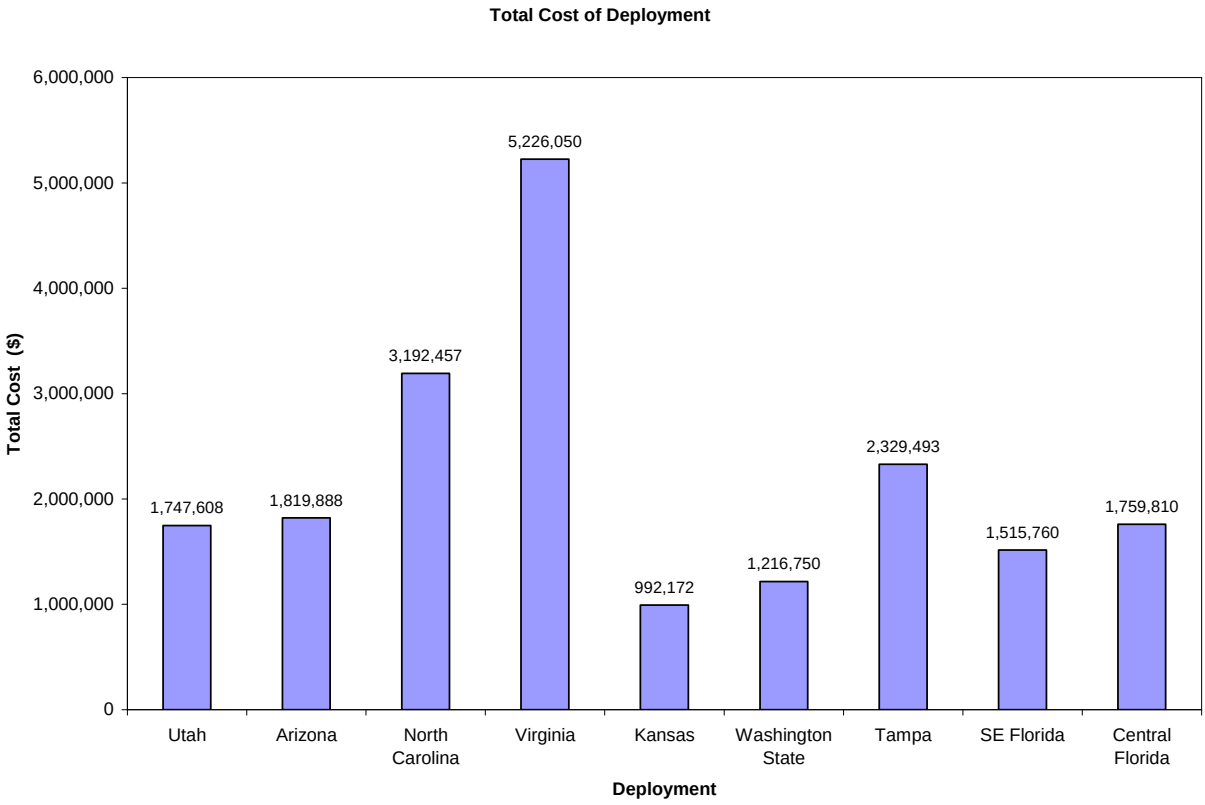
v) Cost Summary

The initial deployment for the 511 system in Wisconsin is contracted for $1.5 Million for initial system deployment and four years of service beyond the initial deployment. This funding level will provide a simple system with no value-added features that are common in other 511 systems nationally.

511 also magnifies the impact of previously deployed ITS infrastructure, such as traffic detection and video monitoring systems, and provides valuable benefits to the traveling public. The State of California estimated a return on investment of $100 in benefits for every $1 invested in comprehensive statewide traveler information over the next 20 years by utilizing the data generated in other infrastructure operations[16]. In that study, California travelers were shown to benefit through substantial savings in travel time and vehicle operating costs by using traveler information.

To address the most basic question of how much it typically costs to deploy and operate a 511 system, an analysis of the total costs by site based on time frames and types of systems (statewide vs. metropolitan) was performed by the 511 Deployment Coalition. The following figure provides a summary of the total costs for six statewide systems and three metropolitan systems. The total costs varied from $1 million to $5.2 million, although a majority of the systems were less than $2 million. The variance in costs is largely dependant on the features included in the system. As mentioned earlier, the total costs per site include the sum of planning and design costs, implementation costs, and annual O&M cost.

[16] *The Value of Deploying 511*; Published May 2004 by the 511 Deployment Coalition



511 Deployment Costs by Agency[17]

vi) Recommendation

Our recommendation regarding the Wisconsin 511 system is to deploy the initial basic system as currently planned and maintain the 511 Work Group that is leading the initial deployment to continue to evaluate the value added features for incorporation into the system as additional funding becomes available.

The value added features that should be considered in the future, in order of priority, follow[18]:

- Construction activity information. This includes functionality in the operator interface capable of accommodating construction information customized for individual projects. The content provided through this functionality would be in addition to the regular lane closure or restriction information provided.

[17] *511 Deployment Costs: A Case Study*; Published by the 511 Deployment Coalition, November 2006
[18] Wisconsin Department of Transportation Request for Proposals for 511 Traveler Information Services; Issues April 16, 2007

- Enhanced road weather reporting. This would include the use of atmospheric forecast data available through the National Weather Service National Gridded Forecast database, applied to road segments of no more than 10 miles. Preferably, this would include integrating segment-specific road weather forecasts that include not only forecasts of atmospheric conditions, but near-term predictions of road conditions on segments as short as 1 mile, including icy condition or visibility warnings.

- Website integration. There is enormous potential to deliver far more traveler information content than is possible via a telephone system. There are currently several places online where travelers must go for information – many of which are provided by WisDOT – but they lack integration among them. The new Wisconsin 511 website would become the first place travelers should look for information.

- Automated integration with roadside communication devices. During emergency alerts such as AMBER or evacuations, information provided through the 511 system would also appear on HAR, VMS, and/or the PCMS system. This equipment statewide is controlled via the STOC.

- Freight and CVO services. This item would provide services including the following:

    - Integration with the oversize-overweight permitting system to provide real-time updates on incidents, closures, or restrictions that may affect those permit holders;

    - Long-term parking information, such as that available at waysides throughout Wisconsin. This information would become real-time as detection and communication with those facilities comes online.

    - Routing services and updated lane closure information for freight operators. The main source for this would be the Wisconsin Lane Closure System, currently under development.

- Additional travel time information. This service would provide improved travel time reporting. In addition to general congestion information, travelers would have the option of selecting key segments to hear current travel times.

- Route guidance based on current travel conditions. This service would present users with suggested routes to minimize travel time.

- Internet content furnished for mobile devices. For example, a sub domain of the 511 website with key traveler information content formatted for mobile devices.

- Push or subscription technology to provide alerts to email or mobile devices.

- Tourism and roadside services. This service would add functionality for tourism and roadside services information, including wayside information, trip planning services, and tourist information or connections to tourist services.

- Customer feedback. Provide a voice mailbox for the phone system and an email or online form for the internet system. Travelers would have an option to leave a message with comments, feedback, or traffic equipment malfunctions.

- Live traffic video. This would include providing streaming video on the 511 website, with necessary server and re-broadcast capabilities to accommodate that without affecting load on WisDOT systems.

- Interoperability. This service would provide better interoperability with neighboring systems, e.g., shared data access, attended call transfers, versus no transfers or blind transfers.

- Additional detection and coverage. The initial 511 system will only cover freeways and major expressways, and the amount of information available on that system varies widely beyond the major metropolitan areas. Additional instrumentation throughout the state would provide more consistent and reliable information to the traveling public.

vii) Migration Plan

There is no migration plan currently necessary for a 511 system in addition to the initial deployment plan being followed. With an expected initial completion date of November 2008, the effectiveness of the project should be evaluated and monitored with further system expansion of the value added features and systems described above considered as additional funding becomes available.

f) IN VEHICLE WARNING AND INFORMATION SYSTEMS

i) Vehicle Infrastructure Integration

Vehicle Infrastructure Integration is an initiative fostering research and applications development for a series of technologies directly linking road vehicles to their physical surroundings. The foremost goal of the VII initiative is to improve road safety. The initiative draws on several disciplines, including transport engineering, electrical engineering, automotive engineering, and computer science. VII specifically covers road transport although similar technologies are in place or under development for other modes of transport. Planes, for example, use ground-based beacons for automated guidance, allowing the autopilot to fly the plane without human intervention. In highway engineering, improving the safety of a roadway can diminish overall efficiency. VII targets improvements in both safety and efficiency.

The impacts of VII on traveler information systems could be dramatic when fully deployed with substantial market penetration for the in-vehicle components of the system. VII could provide real-time information on dangerous road conditions, both from the perspective of known sub-standard design conditions and developing road conditions such as slick pavement or even pot-holes. This detailed real-time information can be obtained and developed by a VII system by interacting with roadside information transmitters and by interacting with other vehicles' systems in the immediate area.

The in-vehicle VII systems would interact with, and display information on, practically any communications devices through developing communications systems such as Bluetooth.

It is important to note and remember that VII is still in the technology testing phases and will not be rolled out in a widespread deployment for years.

ii) Personal Communications Devices

With the growing market penetration of personal communications devices, particularly Personal Data Assistants and Smart Phones, and the ability of these devices to operate as parts of a system connected by developing technologies such as Bluetooth, there are more ways than ever before to reach large numbers of people directly in real-time.

Private companies such as *Traffic.com* and *Trafficcast* will send e-mail messages or automated phone calls to subscribers to their services. Subscribers have the ability to define the city and route they are interested in and schedule updates through the day and set thresholds for additional updates on traffic congestion during incidents. This service is often free to subscribers.

Systems like this are very useful to motorists, particularly from a pre-trip perspective as updates can be scheduled for normal trip departure times, making route or mode selection easier.

iii) Global Positioning Satellite Navigation Systems

The newest and best hand-held and vehicle mounted GPS systems with road map data provide real-time traffic information and will make alternate route suggestions when traffic congestion warrants.

This feature can also be retrofitted onto many older GPS units with the installation of an FM traffic receiver. FM traffic receivers receive silent data transmitted over FM radio transmission, but because it is a silent signal, it does not interfere with a vehicles radio.

Traffic data can also be provided to the GPS unit through a receiver for a pay subscription service such as XM Radio, Sirius Radio, or MSN Direct. These systems usually provide additional features, such as local gas prices, and details, such as congestion maps, travel speeds, and incident locations.

g) SITE SPECIFIC TRAVELER INFORMATION

i) Smart Work-Zones

A smart work zone is a road construction zone in which technology is employed to increase safety and provide information. Smart work zones often use radar detectors or other easy to deploy sensors to detect and predict congestion to properly manage traffic and provide accurate delay and closure information to travelers. Usually, this information is disseminated through a PCMS, but other systems such as portable HAR units can also be used.

A good example of appropriate use of a Smart Work Zone system would be in a "dynamic merge" scenario. In such a scenario, vehicles approaching a lane closure would be directed to use all available lanes during periods of congestion when speeds are low. When congestion is low and speeds are high, motorists would be directed to merge early or are left to use their own judgment. Such a system is usually deployed in addition to traditional static messaging.

ii) Portable HAR

Portable systems installed on trailers can be of value in providing timely dissemination of information to motorists during short-term deviations from normal highway conditions. This is particularly true in areas where there is limited or no normal coverage or the permanent transmitter site has failed. These systems can be solar powered, generator powered, or battery powered. Portable mobile systems can be set up at decision points where a route guidance system directs motorists to an alternate route, in combination with other work zone traffic control, and as part of a Smart Work Zone. Temporary signing must also be deployed with portable HAR units to inform motorists of the information available on the HAR frequency.



Portable Solar Powered HAR and Trailer

iii) Portable Changeable Message Signs

PCMS are probably the most often deployed traveler information tool used for site specific information dissemination. They are deployed with all significant maintenance and construction activities; they are deployed for traffic management at significant incident scenes; they have been deployed as part of alternate route guidance; and they have been deployed for long periods of time warning motorists of existing known sub-standard and dangerous highway segments.

iv) Speed Warning Systems

Speed Warning Systems have been deployed in Wisconsin at several locations of known existing locations of dangerous curves. Similar functioning systems have been deployed throughout the country. They can be deployed with a focus on vehicle speeds to trigger when vehicles, or specific sized vehicles, exceed pre-set thresholds. The system relays a warning to the motorist that they are traveling too fast for the upcoming roadway segment.

Similar systems can also be constructed to monitor roadway conditions for wet, icy, or other slipper conditions at sites known to be problematic in this manner.



Speed Warning System Signing

h) WEATHER HAZARDS SYSTEMS

i) Road Weather Information Systems

Road Weather Information Systems are comprised of environmental sensors in the field measuring atmospheric, pavement, and/or water level conditions. RWIS can be used for either real-time information dissemination through practically any traveler information system tool described in this document. They can also be used for real-time snow and ice removal dispatch, annual budget planning for snow and ice removal, as well as for use in conjunction with a variable speed limit system.

ii) Fog Detection / Warning

Visibility distance is reduced by fog and heavy precipitation, as well as wind-blown snow, dust and smoke. Low visibility conditions have lead to some of the worst crashes in the nation, and in Wisconsin.

Most fog detection systems use a technique called forward scatter. Using this technique, atmospheric visibility is measured by determining the amount of light scattered by particles (smoke, dust, haze, fog, rain, & snow) in the air that passes through the sample volume. This information can then be used to trigger warning signs, or variable speed limit systems.



Fog Warning Sign and Variable Speed Limit Sign

4) STOC CENTRAL SOFTWARE SYSTEMS

The Statewide Traffic Operations Center (STOC) monitors and controls freeway and arterial infrastructure and assets used in the response and management of incidents, construction, and maintenance activities. Operated by the Wisconsin Department of Transportation and located in Milwaukee, Wisconsin the STOC is responsible for operational administration of transportation resources located locally, regionally, and on a statewide level. In an effort to track, monitor, and respond to events that could adversely impact mobility, safety, and the environment the STOC has deployed a comprehensive set of software systems each responsible for different facets of the overall system. These systems are deployed as separate "modules" and also referenced collectively as "TransSuite".

The STOC software system handles a multitude of tasks both automated and manual in nature. Automated tasks range from simple data collection from field devices to the more complex algorithmic processes used to generate predictive travel conditions. Examples of these types of tasks would be collecting data from ramp meters and calculating and displaying travel time estimates on dynamic message boards. Manual tasks require monitoring and interaction from trained operators who perform actions necessary to alert, inform, and coordinate activities with partner agencies and the general public. Examples of these types of task can be seen in the deployment of system wide amber alerts or road closure announcements through the Highway Advisor Radio network. Overall the different modules that make up the STOC software system are specifically designed to handle these and other various tasks.

a) SUPPORTED STOC CENTRAL SOFTWARE SYSTEM MODULES

The majority of the STOC Central Software can be broken down into nine separate modules. Each module is a separate software system that can be operated independently of other modules. However, several feature sets are shared between modules to allow quick access and transfer of operational control. A good example of this would be the ATMS Map, which allows "click through" to other modules from the overall system map to the DMS, HAR, and CCTV control applications.

The nine modules that make up the STOC Central Software System include:

- Traveler Information System (TIS)
- Video Control Subsystem (VCS)
- Incident Management System (IMS)
- Scenario Manager (SM)
- Advanced Traffic Management System Map (ATMS-Map)
- Advanced Traffic Management System Explorer (ATMS-Explorer)
- Freeway Management System (FMS)
- Construction Management System (CMS)
- Traffic Control System (TCS)

Missing from the list is the Central Communications Server (CCS), which handles all the data being sent and received by different ITS devices in the field, the STOC, and other partner centers. The CCS module provides the means by which information and tasks are handled by the other modules listed. However, there is very little operator or management interaction with this module outside of periodic maintenance. Although it performs the most vital function in the central software system it largely operates in the background and is rather transparent to most other system activities. Thus it will not be discussed in any detail herein.

i) Description of STOC Software Modules

Each of the nine central software modules perform tasks associated with the active or passive monitoring or control of ITS equipment deployed by the STOC. Each module performs different functions that are meant to assist trained operators in their responsibilities while making the task performed easier to manage and accomplish.

The following provides a general overview of each module, its function, and a short-list of existing features.

(1) Traveler Information System (TIS)

The TIS module is a heavily utilized piece of software and vital to the STOC when it comes to the delivery of traveler information. The TIS system controls the overhead dynamic message boards, smaller portables, and can do so manually or is automated when directed by the modules scheduler application. The TIS supports NTCIP signs and several proprietary sign types as well as signs of varying types and sizes. It has a library that stores message sets so frequently used messages do not need to be reentered and it boasts the ability to deploy “plan sets” which allow for the quick deployment of a message(s) to multiple signs at the same time. Features of the TIS module are as follows:

- DMS inventory management
- HAR inventory management
- PCMS inventory management
- Create, edit, store, manage multiple messages
- WYSIWYG viewer, includes multiphase support
- Supports NTCIP signs
- Supports several proprietary signs
- Spell check and word lock out feature
- Automated scheduler
- Response plan sets
- Hierarchical control management, for multi-jurisdictional control of devices
- Supports FMS algorithmic display of travel time and speed message sets
- Supports equipment control through web-based or workstation client

(2) Video Control Subsystem (VCS)

Although not integrated directly into the STOC the VCS module is an IP based camera and video switch control application that has been deployed in other regions of the country. The VCS has basic support for pan, tilt, and zoom and supports many advanced operations depending on the camera type being controlled. The module is meant to handle a center's video collection, display, and control functions. Features of the VCS module are as follows:

- Supports NTCIP camera control
- Supports video switch control
- Displays video on the operator and partner agency workstations
- Integrates with IP-based decoders
- Supports PTZ camera control
- Multi-monitor display capability
- Video recording and playback functions
- Works with multiplexers (Quad+)
- Supports still image capture for website or archive operations
- Supports multicast functions
- Supports camera control lock out by priority

(3) Incident Management System (IMS)

The IMS module is a database application designed to track location, duration, severity, date and time of incidents that happen within the operational boundaries of the STOC. It supports both manual entry of incident information from trained staff members and automatic entry generated from 911 partner agencies. Its primary purpose is to record the types of incidents and track responses so historical analysis can be performed and/or to assist in the recreation of an incident response for purposes of training or improving performance measures. Features of the IMS module are as follows:

- Planned event management and tracking
- Unplanned incident management and response tracking
- Automatic 911 incident generation
- Supports archiving of STOC operator actions in response to incidents and events
- Geo-codes incident locations to support historical analysis of roadway segments
- Generates logs of actions taken by multiple entities for the same incident or event
- Generates standard reports for performance measurements
- Links entries to overall system map for easy recognition of ITS field assets in proximity to incident location

(4) Scenario Manager (SM)

One of the biggest challenges facing traffic operations agencies across the country comes in the form of generating consistent responses to unplanned events. Level of training, experience, familiarization with the region and ITS field assets, are all examples of factors that lead to

inconsistent operator responses to incidents of similar nature. To overcome these inconsistencies the SM module provides an operator a "blueprint" response they can use to help them when dealing with frequently occurring scenarios. The blueprint is meant as a checklist that helps the operator determine the level of response and the recommended actions to take when dealing with a selected scenario. Features of the SM module are as follows:

- Stores pre-configured response plans for frequent incidents
- Plans consist of actions, contacts, and attachments to use when an incident type matches pre-established criteria (Location, Incident Type, Severity, Lane, and Impact)
- Automates the link between incidents and available response plans
- Tracks devices being used and compares to recommended plan
- Provides instructions to operator working on plan
- Instructions support detailing actions such as appropriate DMS messages, CCTV Presets, and ramp metering rates
- Contact information including email, voice, fax, etc. is provided for outside support

(5) Advanced Traffic Management System Map (ATMS-Map)

The most visible module in use at the STOC, the ATMS-Map provides a system wide overview of ITS device locations as well as color-coded traffic congestion conditions for a region. For all devices displayed on the map additional detailed information is provided in the form of color icons indicating device status as well as mouse over functions that support additional detailed display information such as location, current action, planned action, and direction. The maps use colored links representing segments of a roadway to display traffic volume, speed, or occupancy conditions and to highlight where roadway thresholds are not being reached, thus alerting operation staff to potential issues that require attention or further investigations. Features of the ATMS-Map module are as follows:

- Geographic platform for display of deployed ITS field assets
- Can utilize ESRI shape file format
- Supports pan, zoom, and detail filtering
- Supports the ability to save or bookmark a view for quick future reference
- Supports dynamic layers
- Current dynamic layers deployed at the STOC include
    - Incidents and planned events
    - Traffic conditions
    - CCTV
    - DMS
    - PCMS
    - Traffic Detectors
    - RWIS
    - Ramp meters
    - Signal systems
    - Construction Zones
    - HAR

(6) Advanced Traffic Management System Explorer (ATMS-Explorer)

ATMS-Explorer is a user-defined workspace that allows for the display of ATMS-Map dynamic layers in a multitude of different forms. For example the ATMS-Map may display all the ramp meters within a system but they are likely to be spread out and it would be hard for an operator to take an inventory of what each ramp meter is doing visually using the Map module alone. With the ATMS-Explorer module all ramp meters could be placed into a blank page that preserves their color status, icon, and mouse over information. Thus a complete systems worth of equipment that is spread over a map could be condensed into a more compact workspace for easier visual reference. More elaborate designs are possible as ATMS-Explorer also supports background images and provides basic drawing tools. Features of the ATMS-Explorer module are as follows:

- Supports display of dynamic layer information outside of the ATMS-Map module
- Supports user-defined workspace that can be customized for different needs
- Supports background images
- Supports multiple different dynamic layers in the same workspace
- Workspaces can be saved for quick reference and published for others to utilize
- Basic drawing tools are supported

(7) Freeway Management System (FMS)

The FMS module is the workhorse of the STOC central software system. It's designed to collect data from detection sites, smooth that data, and perform analysis that will be used to generate incident detection, travel time estimates, ramp meter adjustments, delay calculations, and assign volume, speed and occupancy (VSO) values to congestion links on the ATMS-Map. FMS handles the data, performs the calculations, and ultimately provides the numerical information that supports many of the STOC field devices. Features of the FMS module are as follows:

- Supports detection information collected from a variety of system detectors
- Supports the display of VSO assigned to Links for ATMS Map
- Supports estimated "Travel Times" calculations, used by DMS and HAR
- Supports estimated "Speed Warning" calculations used by work zone PCMS
- Supports estimated "Queue Message" Warnings
- Supports estimated "Delay Time" Warnings
- Supports automatic incident detection, using historical thresholds
- Supports ramp metering and metering adjustments based on mainline VSO

(8) Construction Management System (CMS)

One of the more recent modules to be added to the STOC is the CMS. For large construction projects the number, shape, size, and location of "competing" information sources being displayed along a route can be difficult to coordinate. Not only is it difficult to track down messages being displayed through different PCMS but also who owns and operates each signboard in a work zone. With sign technology readily adapting the NTCIP standard and

wireless communication methods and coverage improving it is now possible to remotely monitor and manage the different sign resources in a work zone from a single location. Thus for large or mega projects a more complete and accurate picture of the information being displayed to drivers can be obtained. The purpose behind the CMS is to track the different sign resources in a work zone, their location, to visually show an operator the information being displayed by each, and contact information for each sign so coherent and relevant information is provided to the traveling public. Though not currently used for such a purpose the CMS ultimately could be used by the STOC to trigger a systematic response plan that could tap into the construction PCMS network to relay severe incident or emergency information such as in the case of an evacuation or severe weather, which would take precedent over other messages. Features of the CMS module are as follows:

- Web based client interface
- Supports display of construction project id, project manager, timeframe, and project boundaries
- Supports contact information for each work zone PCMS
- Supports association of existing ITS field elements to a work zone
- Supports remote visual display of PCMS messages
- Supports management of PCMS plans, message libraries, and FMS integration (effectively turning PCMS into smart work zone elements)

(9) Traffic Control System (TCS)

TCS provides the STOC and its partner agencies with the capability to remotely monitor and control arterial ITS assets, primarily signal controllers. The TCS module shows existing signal controller plans running at each site, the current phase that the controller is in, and cycle and offset information. The module allows for remotely changing signal plans to accommodate emergency conditions as well as the ability to use localized system detectors for traffic responsive operations. The ability to modify existing plans and upload them to a controller's memory is also available, thus eliminating the need for sent resources out in the field to perform a similar function. Features of the TCS module are as follows:

- Supports remote access and control of signal controllers running NTCIP
- Supports remote monitoring of signal operations
- Supports dynamic controller plan changes based on localized traffic conditions
- Allow for the manual controller plan changes for emergency operations
- Central storage of controller database information
- Allows for the remote upload and download of new controller information
- Extensive privilege system that allows for multiple jurisdictions use

b) SUPPORTED FREEWAY MANAGEMENT TECHNOLOGIES

The STOC has gone through a great deal of growth and development during the past decade. This growth and development has also been seen in the software and technologies that the central software now supports. The following section looks more closely at the current devices and technologies supported by the central software, specifically those meant to support freeway management operations.

i) Traffic Detectors

The STOC central software currently supports several different types of traffic detectors. The type of detectors supported range from simple inductive loops to more complex video motion capture methods. Below is a list of traffic detector types and corresponding products supported by the existing STOC central software.

(1) Inductive Loop

- Supports preformed inductive loops technologies
- Supports field formed inductive loops technologies
- TransCore 170 firmware, distributed by TransCore

(2) Video Detection

- Supports Autoscope® video detection systems, distributed by Econolite™

(3) Microwave

- Remote Traffic Microwave Sensor (RTMS) manufactured by Electronic Integrated Systems, Inc.

(4) Radar

- Wavetronix Smart Sensor® manufactured by Wavetronix LLC

(5) Vehicle Probes

- Supports XML system feeds from AirSage
- Supports XML system feeds from Inrix®

(6) NTCIP Standard Support

- 1207 - NTCIP Object Definitions for Ramp Meter Control (RMC)
- 1209 - NTCIP Object Definitions for Transportation Sensor Systems (TSS)

ii) Video Systems

Video systems supported by software applications developed as part of the "TransSuite" package included communication and support to monitor and control video switches, cameras, and decoder technologies. Below is a list of video systems supported by TransSuite.

(1) Traffic Camera Control

Various camera models from the following manufactures:

- Cohu
- Phillips
- Vicon
- Pelco

(2) Video Encoder Decoders

Various Mpeg-2 and -4 equipment from the following manufactures:

- IMPath Networks
- Teleste Systems
- Vbrick Video Networks

(3) Video Switch

- Javelin Systems

(4) NTCIP Standard Support

- 1205 - NTCIP Objects for CCTV Camera Control

iii) Ramp Meter Systems

Technologies in this category center on supporting the firmware that monitors and controls the various field devices that make up a ramp meter subsystem. This firmware is typically installed on 170 or 2070 field controllers, which are tied back to the STOC central software. The following are ramp meter firmware packages that are supported by the STOC central software.

(1) 170 Controller Systems

- 170 TransCore Ramp Metering Control and Support Firmware

(2) 2070 Controller Systems

- McCain (formerly BiTrans 2070)

- Siemens

(3) NTCIP Standard Support

- 1207 - NTCIP Object Definitions for Ramp Meter Control (RMC)

iv) Ramp Gate Systems

Remote Ramp Gate technologies are an emerging field of devices deployed at locations where there is a future need to restrict access to freeway corridors when conditions make it hazardous to allow additional vehicles onto the traffic system. Automated ramp gates allow a single trained operator to remotely activate and monitor one or several sites allowing for a quicker and more uniform response with lesser need to tie up human resources and assets. The STOC central software supports the following ramp gate technologies.

(1) Remote Operated Ramp Closure

- ThomTech Design Inc.

v) Highway Advisory Radio Systems

Highway advisory radio systems allow for the transmitting of information over select AM airwaves to localized pockets along a transportation network. In the past HAR systems deployed by the STOC were analog but have recently been updated to support digital text to voice messages that can be augmented with calculated travel time data generated by the central software FMS module. Thus STOC operators using the central software can now schedule text messages that are converted to digital voice and transmitted over to field devices that then distribute the notices. The field devices that the central software supports to deliver the message to travelers include the following.

(1) HAR Systems

- ISS AP55, manufactured by Information Station Specialists
- HIS DR2000 Server, manufactured by Quixote

vi) Dynamic Message Sign Systems

Dynamic message signs relay important information to motorists along their travel path. DMS are intended to alert motorists of adverse conditions, congestion, special events, construction, and public safety notices (i.e. amber alert). They are relied on to assist the motorist in making real time choices about route and destination. The signs referenced herein are considered to be the largest of the message boards in the STOC inventory and are found frequently along the freeway and major arterials. The DMS currently supported by the STOC central software include.

(1) Propriety Based Signs

Support for various sizes and models made by the following manufactures:

- ADDCO
- Skyline

(2) NTCIP Based Signs

Support for various sizes and models by manufacturers using the NTCIP protocol:

- Skyline
- ADDCO
- Adaptive
- MarkIV
- Vultron
- Daktronics
- Wanco
- McCain

(3) NTCIP Standard Support

- 1203 - NTCIP Object Definitions for Dynamic Message Signs (DMS)

vii) Portable Changeable Message Sign Systems

Smaller and mobile versions of DMS, PCMS boards are frequently used where temporary messages and alerts need to be directed at motorists traveling through an impacted location or corridor. The message area is limited, however, they serve a vital function during special events, construction, maintenance, and weather related activities. The STOC central software supports talking directly to PCMS or using wireless technology to link to these field units. The PCMS currently supported by the STOC central software include.

(1) Propriety Based Signs

Support for various models made by the following manufactures:

- ADDCO
- Display Solutions

(2) NTCIP Based Signs

Support for various models by manufacturers using the NTCIP protocol:

- ADDCO

- Any NTCIP compliant PCMS

(3) NTCIP Standard Support

Although referenced as PCMS in Wisconsin the signboards utilize the same NTCIP protocol as the DMS.

- 1203 - NTCIP Object Definitions for Dynamic Message Signs (DMS)

viii) Remote Weather Information Systems

RWIS stations are used to monitor, record, and report changing atmospheric conditions that could impact travel and public safety. These stations are localized and frequently used to make "up to the moment" decisions on weather related maintenance such as snow removal and salting operations in the winter months. The information is intended to help customize maintenance activities to reduce wasteful resource demands. Currently the STOC central software supports the display of information being collected at RWIS locations through the region. The following existing RWIS stations supported by the STOC central software include the following.

(1) Weather Reporting and Monitoring

- Surface Systems, Inc RWIS stations
- Environmental Sensor Stations, manufactured by Campbell Scientific
- Vaisala Weather Monitoring Stations

ix) Smart Work Zone Systems

Currently the central software does not support any propriety based Smart Work Zone systems. However the central software does have the capability of using existing supported technologies to offer and support various Smart Work Zone functions. Using portable or stationary detection sites along with PCMS units connected to the FMS module at the STOC allows for the display of dynamic messages that alert drivers approaching a construction zone of severe speed reduction, queue locations, and estimate time to clear the corridor. By using existing supported technologies the STOC has the capability to expand, reduce, or even reallocate field equipment between work zones to meet demands without the need to purchase additional equipment or train operators on new software systems.

x) Other Information Systems

Currently the STOC supports several "stand alone" systems that are not directly tied to the central software system. These standalone systems were deployed to address specific problems, special needs, or to evaluate technologies for future use. Although the following systems are not tied directly to the STOC it is important to note that the software is capable of being modified to integrate these systems if such a desire was made by the Department. The following is a list of other technologies and devices the STOC has deployed but has not integrated into the central software system.

(1) Other Information Systems

- Dynamic Trailblazers
- Brick Systems
- Anti-Rollover Systems
- Over height Warning Systems

c) SUPPORTED ARTERIAL MANAGEMENT TECHNOLOGIES

Although not extensively utilized by the STOC, a small-scale arterial management system has been deployed within its current operational boundaries. As a result the STOC along with other regional signal operations jurisdictions have the ability to remotely monitor and control local street assets that can be used to support the freeway infrastructure or respond to localized "off freeway" incidents and events. The following section looks at the current devices and technologies supported by the central software, specifically those meant to support arterial management operations.

i) Signal Controller Technologies

Technologies in this category center on supporting the firmware that monitors and controls the various signal controllers that make up an integrated smart corridor. The firmware is typically installed on signal controllers supporting proprietary or NTCIP protocols, which are used to link operations in the field with monitor and control operations back at the STOC through the central software. The following are firmware and signal controller manufacturers that are supported by the STOC central software.

(1) NTCIP Based Controllers

Various controller manufacturers are supported:

- Econolite ASC/2
- Econolite ASC/3
- Eagle M40 series
- Eagle M50 series

(2) Propriety Based Controllers

- 170E controller, W4IKS Wapiti actuated firmware including the JHK protocol
- 170E controller using HC11 firmware
- 170E controller, W9FT Wapiti fixed time firmware including the JHK protocol

5) COMMUNICATION SYSTEMS AND SUPPORT TECHNOLOGIES

a) ITS COMMUNICATIONS INFRASTRUCTURE SUPPORT SYSTEMS

i) Available Wireless Technologies

(1) Unlicensed Spectrum Environments

Spread Spectrum Systems
Spread spectrum radio systems have been used in commercial applications since 1985 when the FCC (Federal Communications Commission) designated three specific frequency bands (902-928 MHz, 2400-2483.5 MHz, and 5752.5-5850 MHz) for unlicensed radio transmissions in the ISM (Industrial, Scientific, and Medical) frequency bands. By FCC definition, a spread spectrum system is an information bearing communications system in which: (1) Information is conveyed by modulation of a carrier by some conventional means, (2) the bandwidth is deliberately widened by means of a spreading function over that which would be needed to transmit the information alone. Unlicensed spread spectrum products must meet FCC spread spectrum regulations (FCC 47 CFR Parts 2, 15, and 90).

The modulation technology used for spread spectrum systems is the same for all unlicensed frequency bands. Spread spectrum systems make use of pseudorandom code generators. This code is referred to as pseudorandom noise code (PN code) and is used to determine the frequency spectrum that the output signal will occupy and it determines and controls the spreading pattern of the system. There are two popular methods for modulating signals in spread spectrum radios used for commercial applications (1) frequency hopping, and (2) direct sequencing. Frequency hopping spreads its signals by hopping the narrow band signal as a function of time. Direct sequencing spreads its signal by expanding the signal over a broad portion of the radio band. Some spread spectrum radio designs use a combination of these two methods (called a hybrid spread spectrum system).

Spread spectrum systems are typically set up in point-to-point and point-to-multipoint configurations for ITS communication systems. A point-to-point radio system provides a link connecting two end-points and provides a fixed bandwidth on a permanent basis. A point-to-point link is usually equipped with two high-gain antennas and two radios (transmitter and receiver). A point-to-multipoint radio system has a radio/ omni-directional antenna combination at a hub that communicates simultaneously with many other radio/ fixed antenna combinations. The antenna at a hub location of a point-to-multipoint radio system usually provides very broad coverage, whereas the antenna at the subscriber location is usually directional (towards the hub).

In the past 10 years, unlicensed spread spectrum radio systems have been used for ITS applications, particularly wireless communication links. The use of spread spectrum radio has several advantages. This technology has a much greater immunity to noise and interference compared to conventional radio transmissions. Another advantage of spread spectrum systems is the signal security. Spread spectrum systems spread the signal over a wide bandwidth to hide the transmitted signal as close to the background noise as possible. This makes the communication difficult to find in the frequency spectrum. The signal cannot be easily tracked and is more difficult to jam.

One of the main disadvantages of unlicensed spread spectrum radio systems is that anyone using FCC approved spread spectrum products may use the frequency bands for communication systems. Although spread spectrum radios have a greater immunity to noise and interference, several spread spectrum communication systems in the same area using the same frequency band can cause signals to interfere with each other. Recently licensed frequency bands have been allocated that can be used for public safety spread spectrum applications, such as the 4.9 GHz frequency band, in recognition that unlicensed communication systems can cause unwanted interference.

- 900 MHz Spread Spectrum Radio Characteristics
    - The frequency band 902-928 MHz is used for low bandwidth (4 Mbps) and long distance (up to 20 miles) spread spectrum applications.
    - The 900 MHz radios have the general characteristic of allowing non line of sight transmission over radio paths that may be partially obscured. The 900 MHz radio paths can bend, reflect, and project around buildings better than 2.4 GHz and 5.8 GHz radio paths. This makes them useful for communication to the sites where buildings and trees can make line of sight antenna placement difficult.

- 2.4 GHz Spread Spectrum Radio Characteristics
    - The frequency band 2400-2483.5 is used for medium bandwidth (10 Mbps) and short distance (up to 3 miles) line of sight spread spectrum applications.
    - Used for commercial indoor or outdoor wireless networks and also for outdoor fixed communication links.
    - A variety of wireless technology systems operate in this band including Bluetooth and Wi-Fi.
    - This band can deliver high-speed data over ranges of three miles or more when there is sufficient line of sight.
    - High level of service in this band is difficult due to the interference from many competitive systems, less energy output, and the narrow spectrum available.

- 5.8 GHz Spread Spectrum Radio Characteristics
    - The frequency band 5752.5-5850 MHz is used for high bandwidth (108 Mbps) and short distance (up to 3 miles) line of sight spread spectrum applications.
    - Used for indoor or outdoor wireless networks and also for outdoor fixed communication links.
    - A variety of technology systems operate in this band including Wi-Fi and WiMAX.
    - This band can deliver high-speed data over ranges of three miles or more when there is sufficient line of sight.
    - Service in this band is better than 2.4 GHz because the wider band allows for more data throughput and more channel space.

Manufacturers

- Manufacturer: Alvarion
  Frequency Bands: 900 MHz, 2.4 GHz, and 5.8 GHz
  Product: BreezeACCESS
  Description: The radios have a throughput of 3 Mbps for 900 MHz and 2.4 GHz models. The 5.8 GHz models have a throughput of 54 Mbps. The radios can be configured for point to point and point to multipoint applications.

- Manufacturer: ENCOM
  Frequency Bands: 900 MHz, 2.4 GHz, and 5.8 GHz
  Product: COMMPAK Broadband
  Description: The radios have a throughput of 108 Mbps for 5.8 GHz and 2.4 GHz models. The 900 MHz models have a throughput of 54 Mbps. The radios can be configured for point to point and point to multipoint applications.

- Manufacturer: Trango Systems, Inc.
  Frequency Bands: 900 MHz, 2.4 GHz, and 5.8 GHz
  Product: trangobroadband
  Description: The radios have a throughput of 10 Mbps for 5.8 GHz and 5 Mbps for 2.4 GHz models. The 900 MHz models have a throughput of 3 Mbps. The radios can be configured for point to point and point to multipoint applications.

- Manufacturer: Vecima Networks
  Frequency Bands: 900 MHz and 5.8 GHz
  Product: WaveRider
  Description: The radios have a throughput of 108 Mbps for 5.8 GHz and 13.5 Mbps for 900 MHz models. The radios can be configured for point to point and point to multipoint applications.

- Manufacturer: Proxim
  Frequency Bands: 2.4 GHz and 5.8 GHz
  Product: Tsunami QuickBridge
  Description: The radios have a throughput of 54 Mbps for 5.8 GHz and 2.4 GHz models. The radios can be configured for point to point and point to multipoint applications.

- Manufacturer: Motorola
  Frequency Bands: 900 MHz, 2.4 GHz, and 5.8 GHz
  Product: Canopy
  Description: The radios have a throughput of 14 Mbps for 5.8 GHz and 2.4 GHz models. The 900 MHz models have a throughput of 4 Mbps. The radios can be configured for point to point and point to multipoint applications.

- Manufacturer: Solectek
  Frequency Bands: 5.8 GHz
  Product: SkyWay 7000 Series
  Description: The radios have a throughput of 108 Mbps for the 5.8 GHz models. The radios can be configured for point to point and point to multipoint applications.

- Manufacturer: Redline Communications
  Frequency Bands: 5.8 GHz
  Product: RedCONNEX Series
  Description: The radios have a throughput of 90 Mbps for the 5.8 GHz models. The radios can be configured for point to point and point to multipoint applications.

References:

1. The ABCs of Spread Spectrum; http://sss-mag.com/ss.html
2. Spread Spectrum Systems; http://cbdd.wsu.edu
3. Spread Spectrum Technology; http://www.kmj.com/proxim/pxhist.html
4. Understanding the Benefits of License-free Spread Spectrum Fixed wireless; http://www.adtran.com
5. FCC 47 CFR Parts 2, 15, and 90; http://www.fcc.gov
6. ENCOM; http://www.encomwireless.com
7. Redline Communications; http://www.redlinecommunications.com
8. Trango Systems Inc; http://www.trangobroadband.com
9. Alvarion; http://www.alvarion.com
10. Motorola; http://motorola.canopywireless.com
11. Solectek; http://www.solectek.com
12. Vecima Networks; http://www.vecima.com
13. Proxim; http://www.proxim.com

Free Space Optics (FSO) Technology

Free Space Optics is a line of sight point-to-point telecommunication technology that uses invisible beams of light propagating in free space to provide optical bandwidth connections that can send and receive voice video and data information. The optical link is typically an infrared laser light. The technology is touted as having the speed of fiber with the flexibility of wireless.

One of the main advantages of FSO is the high speed at which data can be transferred. Commercially operated FSO systems offer data throughput in the range of 100 Mbps to 1.25 Gbps. Future technology advances in wavelength division multiplexing will allow for transmission speeds of 10 Gbps. Another advantage of FSO technology is that it is immune to radio frequency interference and saturation.

The disadvantages of FSO include dependence on clear line of sight and clear atmospheric conditions. The laser light between the transmitter and receiver must be free of physical obstruction. Fog and precipitation (rain or snow) can cause absorption and scattering that disrupts the signal. For this reason the technology is best utilized in very dry climates. The distance that FSO can transmit is usually one mile or less, which is significantly less distance than spread spectrum systems.

Manufacturers

- Manufacturer: Canon Canobeam
  Product: Models DT-110, DT-120, and DT-130
  Description: The DT series of FSO transmitter and receivers can transmit from 100 Mbps to 1250 Mbps over a distance of 1640 to 6560 feet. This series is the fourth generation of real time active aligned models with IP management.

- Manufacturer: Lightpointe
  Product: Models FL (100, 155, G) and FSA (155, 622, G)
  Description: FSO transmitter and receivers can transmit from 100 Mbps to 1250 Mbps over a distance of 1640 to 6560 feet. The FSA series are active aligned models with IP management.

- Manufacturer: Laserbit
  Product: Models PICO (II, Plus, Giga), PINTO (Plus, Giga), PRONTO (Giga)
  Description: FSO transmitter and receivers can transmit from 100 Mbps to 1250 Mbps over a distance of 650 to 3937 feet.

- Manufacturer: fSona
  Product: Models 155 (E, S, M), 622 (S, M), 1250 (E, S, M)
  Description: FSO transmitter and receivers can transmit from 100 Mbps to 1250 Mbps over a distance of 2625 to 5250 feet. This series uses 1550 nm lasers that require heating and cooling.

- Manufacturer: MRV
  Product: Models TereScope (700, 702, 811, 940, 1000, 4000, 5000)
  Description: The TS series of FSO transmitter and receivers can transmit from 100 Mbps to 1250 Mbps over a distance of 785 to 8530 feet.

- Manufacturer: Solectek
  Product: Model SkyWay FSO-100E
  Description: The FSO transmitter and receiver can transmit 200 Mbps over a distance of 330 feet.

References:

1. What is Free Space Optics (FSO)?; http://freespaceoptics.org
2. Free Space Optics; http://freespaceoptic.com
3. Free Space Optics (FSO): An Introduction; http://free-space-optics.org
4. Free Space Optics; http:/en.wikipedia.org/wiki/Free_Space_Optics
5. MRV; http://mrv.com
6. Lightpointe; http://www.lightpointe.com
7. Solectek; http://www.solectek.com
8. Canon Canobeam; http://www.usa.canon.com/html/industrial_canobeam/canobeam/
9. Laserbit; http://www.laserbitcommunications.com/
10. fSona; http://www.fsona.com/

Ultra Wideband (UWB) Technology

Ultra Wideband is a radio technology that is used for short-range (10 to 30 feet) high bandwidth (480 Mbps) communications by using a larger portion of the radio spectrum (3.1 to 10.6 GHz) and very low energy levels. UWB was traditionally accepted as a pulse radio, but the FCC now defines UWB in terms of a transmission from an antenna for which the emitted signal bandwidth exceeds the lesser of 500 MHz or 20% of the center frequency.

One advantage of UWB communications is that it transmits in a way that does not interfere largely with other more traditional "narrow band" and continuous carrier waves in the same frequency band. Initial concerns that UWB would interfere with existing GPS systems delayed the approval of UWB. After testing UWB, bandwidth ranges were selected to ensure any existing systems that use radio frequencies would not be affected. With these conditions met, the FCC allowed the use of UWB for commercial applications in 2003. Another advantage is that UWB uses less energy than other short-range wireless technologies. Devices that connect to the UWB wireless network will not require as much power to operate.

The disadvantages of UWB are the short transmission range (30 feet max) and the current lack of a unified standard. Both UWB Forum and WiMedia Alliance have ISO-published radio platform standards for high-speed ultra wideband wireless connectivity. The UWB Standards group disbanded in 2006, so the marketplace will decide which technology will become the future de facto standard.

The current developments in UWB have been focused on creating high-speed wireless applications in conjunction with Bluetooth and USB next generation applications. UWB is ideally suited for low power, short range (10 feet to 30 feet), high bandwidth (480 Mbps and beyond), wireless personal area networks (WPAN).

Comparison Chart: UWB, Wi-Fi, Bluetooth			
	UWB	**Wi-Fi IEEE802.11a/b/g/n**	**Bluetooth 2.0 + EDR**
Band	3.1 GHz to 10.6 GHz	2.4 GHz or 5 GHz	2.4 GHz
Data Rate (Distance)	480 Mbps (10 ft), 110 Mbps (30 ft)	300 Mbps (300 ft)	3 Mbps (3 ft-300 ft)
Modulation	MB-OFDM	DSSS, DBPSK, DQPSK, CCK, OFDM	GFSK

References:

1. Ultrawideband Tutorials; http://www.palowireless.com/uwb/tutorials.asp
2. Ultra-wideband has Competitive Edge on Traditional Applications; http://electronics.his.com/news/frost-uwb-competitive.htm
3. Ultrawideband in the News; http://sss-mag.com/uwb.html
4. Ultra-Wideband (UWB) Technology; http://www.intel.com
5. WiMedia; www.wimedia.org
6. Ultra-wideband; http://en.wikipedia.org/Ultra-wideband
7. http://www.fcc.gov

Fixed and Mobile WiMAX Technology

WiMAX (Worldwide Interoperability for Microwave Access) is a telecommunications technology that provides wireless data over long distances. It is based on the IEEE 802.16 standard, which is also called WirelessMAN. WiMAX certification allows manufacturers with 802.16 products to sell their equipment as WiMAX certified, thus ensuring a level of interoperability in the marketplace. The primary unlicensed frequency bands available for WiMAX are 2.4 GHz and 5.8 GHz. The practical bandwidth for a 6-mile range is 10 Mbps, but shorter-range installations can achieve a 75 Mbps data rate.

The are currently two standards for WiMAX deployments, 802.16-2004 (Fixed WiMAX) and 802.16-2005 (Mobile WiMAX). Fixed WiMAX is typically used for "last mile" broadband access. Mobile WiMAX can be used for fixed services, but is primarily used for nomadic broadband connectivity.

The reach and bandwidth of WiMAX make it ideal for the following applications:

- Connecting Wi-Fi hotspots
- Wireless last mile broadband access alternative (instead of Cable Modems and DSL)
- Provide high-speed data and telecommunication services over a large range
- Provide nomadic connectivity
- Increase bandwidth for data intensive applications

The advantages of WiMAX include:

- A single station can serve hundreds of users.
- Endpoints can be installed far faster than wired connections.
- Data rates as high as 280 Mb/s and distances up to 30 miles are possible.
- Users can operate mobile within three to five miles of a base station at up to 75 Mb/s.
- No Federal Communications Commission (FCC) licensing is required for its use.
- It is a worldwide standard and same frequency equipment should work together.

The disadvantages of WiMAX include:

- Line of site is required for connections five miles or further.
- Rain and weather can disrupt the service.
- Other wireless equipment in the vicinity can interfere with WiMAX.
- Multiple frequencies will be used to deploy WiMAX.
- WiMAX is a power intensive technology and requires strong electrical support.
- Realities of WiMAX data rates are more like 75 Mbps.

Manufacturers

- Manufacturer: Sprint-Nextel
  Product: Xohm
  Description: Sprint Nextel has invested money to test mobile WiMAX networks in Chicago, Baltimore, and Washington D.C. The typical data rates are 2-4 Mbps download and 1-2 Mbps upload.

- Manufacturer: Alvarion
  Product: BreezeMAX
  Description: Alvarion has products for fixed and mobile WiMAX.

- Manufacturer: Redline Communications
  Product: RedMAX
  Description: Redline has products for mobile WiMAX. The data rate for its RedMAX product is 18 Mbps at 7 MHz.

- Manufacturer: ADC
  Product: Flexwave (WMX 100, 105, and 120)
  Description: ADC has products for fixed and mobile WiMAX.

- Manufacturer: Proxim
  Product: Tsunami MP.16 3500
  Description: The Tsunami products are for fixed WiMAX. The data rates range from 2.8 Mbps to 25.4 Mbps.

References:

1. WiMAX Deployment Considerations for Fixed Wireless Access in the 2.5 GHz and 3.5 GHz Licensed Bands; http://www.wimaxforum.org
2. Don't Forget Fixed WiMax, Ed Sutherland; http://www.wi-fiplanet.com
3. Redline Communications; http://www.redlinecommunications.com
4. Alvarion; http://www.alvarion.com
5. Proxim; http://www.proxim.com
6. ADC; http://www.adc.com/
7. Sprint; http://www.sprint.com/index.html
8. WiMAX; http://en.wikipedia.org/wiki/WiMAX
9. WiMax holds promise to help narrow digital divide; http://www.wimaxxed.com/wimax_reports/20060224/wimax_holds_pro.html
10. Sprint Sets Stage for 2008 Xohm WiMAX Launch with Service, Device and Advertising Agency Agreements; http://newsreleases.sprint.com/

Wi-Fi Technologies

Wi-Fi is a wireless technology based on the IEEE 802.11 standard that is primarily used to access the Internet. Wi-Fi enabled devices can connect to the Internet when within the range of a wireless network access point (called a "hotspot") connected to the Internet. Access points can be as small as a single room or as large as many square miles covered by overlapping access points. Wi-Fi operates in the 2.4 GHz (802.11 b/g/n) and 5 GHz (802.11a) frequency bands.

The maximum data rate for 802.11a/g is 54 Mbps and the maximum data rate for 802.11b is 11 Mbps. A recent addition to the standard is 802.11n that allows for 300 Mbps data rates and is backwards compatible with 802.11b/g products.

The advantages of Wi-Fi include:

- No Federal Communications Commission (FCC) licensing is required for its use.
- It is a worldwide standard and same frequency equipment should work together.
- Local area networks can be created without cables.
- Products are extensively available on the market.
- Prices for products are low.
- Wi-Fi allows connectivity in peer-to-peer mode (wireless ad-hoc network) that enables devices to connect directly with each other.
- Wi-Fi has also enabled the use and set up of mesh networks.
- Encryption protocols are available to protect the network.

The disadvantages of Wi-Fi include:

- Other wireless equipment in the vicinity can interfere with Wi-Fi and degrade the performance.
- The power consumption is fairly high.
- Wi-Fi networks have a limited range (120 feet indoors, 300 feet outdoors).
- Some of the encryption protocols are vulnerable to hackers.
- Range varies with the frequency band used. Wi-Fi in the 2.4 GHz frequency block has a slightly better range than Wi-Fi in the 5GHz frequency block.

  Manufacturers

- Manufacturer: D-Link
  Product: DIR-615, DIR-655 (802.11 b/g/n)
  Description: D-Link produces wireless routers for 802.11 a/b/g/n standards. Several models and options are available.

- Manufacturer: Linksys
  Product: WRT 150N, WRT 160N, WRT 300N (802.11 b/g/n)
  Description: Linksys produces wireless routers for 802.11 a/b/g/n standards. Several models and options are available.

- Manufacturer: Netgear
  Product: WNDR 3300, WNDR 3500 (802.11 b/g/n)
  Description: Netgear produces wireless routers for 802.11 a/b/g/n standards. Several models and options are available.

References:

1. Wi-Fi Technology: Future Market Challenges and Opportunities; http://www.scipub.org/fulltext/jcs/jcs2113-18.pdf
2. Wi-Fi; http://en.wikipedia.org/wiki/Wi-Fi
3. Broadband Wireless Wi-Fi: http://www.bwif.org/broadband_wireless_wifi.html
4. Linksys; http://www.linksys.com
5. Netgear; http://www.netgear.com/
6. D-Link; http://www.dlink.com/

(2) Licensed Spectrum Environments

4.9 GHz Spread Spectrum

With the same capabilities as the 2.4 GHz and 5.8 GHz spread spectrum systems, the frequency band 4940-4990 MHz is a licensed frequency band available for use by public safety agencies. The qualifications for the 4.9 GHz license are similar to the qualifications for the 700 MHz license. The license covers all government entities, private companies sponsored by a government entity (such as private ambulance services) and any organization with critical infrastructure (power companies, pipelines, etc.). A general 4.9 GHz license gives an agency the right to use the entire 4940-4990 MHz frequency band. The band may be used for any terrestrial based radio transmission including data, voice, and video. Aeronautical use and commercial use of the band is prohibited.

Point-to-point and multipoint operations are permitted. All multipoint and temporary (less than 1 year) point-to-point links are primary uses of the band. Permanent point-to-point links are secondary uses and require separate site licenses.

One disadvantage is that multiple agencies may receive licenses within the same geographic area. Potential interference can be prevented or eliminated by affected licensees working together on a technical solution. Point-to-point links with good directional antennas should be resistant to interference. Where interference cannot be eliminated by technical or operational modifications, primary users take precedence over secondary users.

Manufacturers

- Manufacturer: ENCOM
  Product: COMMPAK Broadband 4.9 GHz
  Description: The radios can transmit 6 Mbps to 108 Mbps up to a distance of 20 miles. This radio features E-OFDM wireless modulation, dynamic frequency selection, and is 802.11a compliant. This system can operate in a point-to-point, point to multipoint, or MESH architecture.

- Manufacturer: Alvarion
  Product: BreezeACCESS 4900
  Description: The radios can transmit 6 Mbps to 108 Mbps up to a distance of 20 miles. This radio features E-OFDM wireless modulation, dynamic frequency selection, and is 802.11a compliant. This system can operate in a point-to-point, point to multipoint, or MESH architecture.

- Manufacturer: Vecima Networks
  Product: Waverider NCL4900 Series
  Description: The radios can transmit 6 Mbps to 108 Mbps up to a distance of 20 miles. This radio features E-OFDM wireless modulation, dynamic frequency selection, and is 802.11a compliant. This system can operate in a point-to-point, point to multipoint, or MESH architecture.

- Manufacturer: Proxim
  Product: Tsunami QuickBridge
  Description: The radios can transmit 6 Mbps to 54 Mbps up to a distance of 20 miles. This radio features E-OFDM wireless modulation, dynamic frequency selection, and is 802.11a compliant. This system can operate in a point-to-point, point to multipoint, or MESH architecture.

- Manufacturer: Solectek
  Product: SkyWay 4000 Series
  Description: The radios can transmit up to 54 Mbps for a distance of 20 miles. This radio features E-OFDM wireless modulation, dynamic frequency selection, and is 802.11a compliant. This system can operate in a point-to-point, point to multipoint, or MESH architecture.

- Manufacturer: Redline Communications
  Product: RedCONNEX 4.9 GHz AN-80i Series
  Description: The radios can transmit up to 90 Mbps for a distance of 20 miles. This radio features E-OFDM wireless modulation, dynamic frequency selection, and is 802.11a compliant. This system can operate in a point-to-point, point to multipoint, or MESH architecture.

- Manufacturer: Trango Systems, Inc.
  Product: Atlas 4900 Series
  Description: The radios can transmit up to 90 Mbps for a distance of 20 miles. This radio features E-OFDM wireless modulation, dynamic frequency selection, and is 802.11a compliant. This system can operate in a point-to-point, point to multipoint, or MESH architecture.

References:

1. ENCOM; http://www.encomwireless.com
2. Redline Communications; http://www.redlinecommunications.com
3. Trango Systems Inc; http://www.trangobroadband.com
4. Alvarion; http://www.alvarion.com
5. Solectek; http://www.solectek.com
6. Vecima Networks; http://www.vecima.com
7. Proxim; http://www.proxim.com
8. 4.9 GHz Report & Order Synopsis:
   http://www.apcointl.org/frequency/4.9GHZplansynopsis.htm

9. FCC Designates 4.9 GHZ Band for Use in Support of Public Safety and Proposes Licensing and Service Rules;
   http://www.fcc.gov/Bureaus/Wireless/News_Releases/2002/nrwl0202.html

2G Mobile Data Services

2G stands for second-generation wireless digital telephone technology. It uses digital signaling to connect radio towers to the rest of the telephone system. 2G services are frequently referred to as Personal Communications Service (PCS) and are used primarily for voice communications. 2G networks are being replaced with 2.5G and 3G networks as carriers continue to upgrade their systems.

The 2G standards currently used in the United States are: GSM (Global System for Mobile Communications), CDMA (Code Division Multiple Access), and iDEN (Integrated Digital Enhanced Network). T-Mobile and AT&T/Cingular use GSM technology while Verizon Wireless, U.S. Cellular, Sprint/Nextel, and Alltel use CDMA technology. The only company that uses iDEN technology is Sprint for its Nextel direct connect phone service.

- GPRS (2.5G)
  GPRS is a packet based wireless communication service available only to Global System for Mobile Communications (GSM) mobile phones subscribers. 2G mobile data services combined with General Packet Radio Service (GPRS) technology is labeled as a 2.5G mobile data service. GPRS can be used for services such as Wireless Application Protocol (WAP) access, Short Message Service (SMS), Multimedia Messaging Service (MMS), and for Internet communication services such as email and web access. The maximum data rate for phones enabled with GPRS technology is 115 kbps. Both T-Mobile and AT&T/Cingular offer GPRS connectivity.

- EDGE (2.75G)
  Enhanced Data rates for GSM Evolution (EDGE) is a digital mobile phone technology that significantly increases data transmission rates for GSM mobile phone subscribers. EDGE is classified as the unofficial standard 2.75G, due to its slower network speed than 3G networks. EDGE can be used for any packet switched high-speed data applications such as video services and Internet connections. The maximum data rate for phones enabled with EDGE technology is 384 kbps, which is three times the capacity of GPRS.

  Existing GPRS base stations can be upgraded to provide EDGE technology to subscribers. Mobile terminal hardware and software upgrades are also required to decode/encode the new modulation and coding schemes and carry the higher user data rates to implement new services. Both T-Mobile and AT&T/Cingular offer EDGE connectivity.

- CDMA One
  CDMA One, also written cdmaOne, refers to the original ITU IS-95 (CDMA) wireless interface protocol that was first standardized in 1993. CDMA One provides services including cellular, PCS, and fixed wireless. Today, there are two versions of IS-95, called IS-95A and IS-95B. The IS-95A protocol uses a 1.25-MHz carrier, operates in radio-frequency bands at either 800 MHz or 1.9 GHz, and supports data speeds of up to

14.4 kbps. IS-95B can support data speeds of up to 64 kbps by bundling up to eight channels. CDMA One is being replaced with CDMA 2000 3G technology. Verizon Wireless, U.S. Cellular, Sprint/Nextel, and Alltel offer CDMA One connectivity.

References:

1. GPRS (General Packet Radio Service), HSCSD & EDGE; http://www.mobile-phones-uk.org.uk/gprs.htm
2. Differentiating the Gs in Cellular Networks; http://www.phoneplusmag.com/articles/825/71h241551435767.html
3. 3G Provides Mobile Broad Band; http://www.qualcomm.com/common/documents/white_papers/3G_ProvidesMobileBroadband.pdf
4. http://www.qualcomm.com/
5. 2G - 3G Cellular Wireless Data Transport Terminology; http://www.arcelect.com/2G-3G_Cellular_Wireless.htm
6. Cingular EDGE; http://www.pcmag.com/article2/0,1759,1770749,00.asp
7. 2G cdmaOne; http://www.cdg.org/technology/2g.asp
8. 3G Data Matrix; http://www.ctlcorp.com/wireless/v2/3g_data_matrix.aspx?hdr=WirelessData
9. EDGE: http://en.wikipedia.org/wiki/Enhanced_Data_Rates_for_GSM_Evolution
10. GPRS; http://en.wikipedia.org/wiki/General_Packet_Radio_Service

3G Mobile Data Services

3G stands for the third generation of mobile phone standards and technology. 3G technologies offer mobile phone users a wider range of more advanced services. 3G networks are wide area cellular telephone networks that evolved to incorporate high-speed Internet access and video services. 3G Services provide better quality voice and high-speed data, support for packet applications, and high-speed access to the Internet.

- High Speed Packet Access (HSPA) (3.5G)
  High Speed Packet Access (HSPA) is a 3G high-speed digital data service provided by cellular carriers that use the GSM technology, including AT&T /Cingular and T-Mobile. HSPA is a collection of mobile telephony protocols that extend and improve the performance of existing UMTS protocols. Two standards, HSDPA and HSUPA (3.5G networks), have been established and a further standard, HSOPA, is being proposed.

  The two existing standards (HSDPA and HSUPA) provide increased bandwidth by using improved modulation schemes and by refining the protocols by which handsets and base stations communicate. Existing commercial HSDPA networks support downlink speeds of 3.6 Mbps and 7.2 Mbps. HSUPA provides improved up-link performance of up to 5.76 Mbps. HSOPA is currently under development, but the projected maximum transfer rates are 100 Mbps for downlink and 50 Mbps for uplink.

- Evolution Data Optimized (EVDO)
  Evolution-Data Optimized (EVDO) is a telecommunications standard for the wireless transmission of data through radio signals. EVDO is typically used for broadband Internet access. It uses multiplexing techniques including Code division multiple access

(CDMA) as well as Time division multiple access (TDMA) to maximize both individual user's throughput and the overall system throughput. It is standardized as part of the CDMA2000 family of standards and has been adopted by CDMA networks such as Verizon Wireless, U.S. Cellular, Sprint/Nextel, and Alltel.
EVDO was designed as the next generation of the CDMA2000 (IS-2000) standard that can support high data rates and be deployed along side a wireless carrier's voice services. An EVDO channel has a bandwidth of 1.25 MHz, the same bandwidth size that IS-95A (IS-95) and IS-2000 (1xRTT) use. EVDO provides access to mobile devices with speeds of up to 2.4 Mbps (download)/153 kbps (upload) with Rev. 0 and up to 3.1 Mbps (download)/1.8 Mbps (upload) with Rev. A.

- Universal Mobile Telecommunications System-TDD (UMTS-TDD)
  UMTS-TDD is a mobile data network standard built upon the UMTS 3G cellular mobile phone standard, using a TD-CDMA interface that utilizes Time Division Duplexing (TDD) to duplex spectrum between the uplink and downlink. UMTS-TDD is used to provide Internet access in markets similar to those in which Mobile WiMAX can be deployed. UTMS-TDD supports data rates of 40 Mbps to 70 Mbps at speeds of up to 80 miles per hour. UMTS-TDD tends to be allocated frequency intended for mobile/wireless Internet services rather than use bandwidth on existing cellular frequencies. This is because TDD duplexing is not normally allowed on cellular, PCS/PCN, and 3G frequencies. TDD technologies open up the usage of leftover unpaired spectrum. In several countries the 2500-2690 MHz band (also known as MMDS in the USA) have been used for UMTS-TDD deployments.

CDMA 2000

CDMA2000 is a hybrid technology of mobile telecommunications standards that uses CDMA technology to provide high-speed digital services to CDMA mobile phone users. CDMA2000 1xRTT, the core CDMA2000 wireless air interface standard, is also known as 1x, 1xRTT, and IS-2000. CDMA2000 is considered a 2.5G technology in 1xRTT and a 3G technology in EVDO. CDMA2000 can support mobile data communications at speeds ranging from 144 Kbps to 2 Mbps.

The CDMA2000 standards are a direct successor to 2G CDMA, IS-95 (cdmaOne). It is defined to operate in multiple spectrum bands (450 MHz, 700 MHz, 800 MHz, 900 MHz, 1700 MHz, 1800 MHz, 1900 MHz, and 2100 MHz). CDMA2000 introduces enhancements such as such as Orthogonal Frequency Division Multiplexing (OFDM and OFDMA), advanced control and signaling mechanisms, improved interference management techniques, end-to-end Quality of Service (QoS), and new antenna techniques such as Multiple Inputs Multiple Outputs (MIMO) and Space Division Multiple Access (SDMA). CDMA2000 family of standards and has been adopted by CDMA networks such as Verizon Wireless, U.S. Cellular, Sprint/Nextel, and Alltel.

References:
1. High Speed Packed Access: http://en.wikipedia.org/wiki/High-Speed_Packet_Access
2. HSPA- Mobile Broadband Today; http://hspa.gsmworld.com/about-hspa/default.asp
3. What is HSUPA?; http://3gweek.net/index.php/what-is-hsupa
4. Evolution-Data Optimized; http://en.wikipedia.org/wiki/Evdo
5. What is EVDO; http://www.evdoinfo.com/content/view/37/61/

6. What is EVDO; http://www.wisegeek.com/what-is-evdo.htm
7. Technology Delivers High Data Rates; http://www.networkworld.com/news/tech/2006/030606-umts-td-cdma.html
8. UMTS Alliance; http://www.umtstdd.org/index.html
9. Differentiating the Gs in Cellular Networks; http://www.phoneplusmag.com/articles/825/71h241551435767.html
10. 3G CDMA 2000; http://www.cdg.org/technology/3g.asp
11. CDMA 2000; http://en.wikipedia.org/wiki/CDMA2000
12. CDMA 2000; http://www.umtsworld.com/technology/cdma2000.htm

4G Mobile Data Services

4G stands for Fourth-Generation Communications System, and is a term used to describe the next step in wireless communications. 4G will be a fully IP-based integrated system that unites fixed wireless, wireline and mobility together, making for a seamless shroud of connectivity. The devices using the 4G network will figure out which access network to use, and users simply will go from home to the office and everywhere in-between, never losing their data connections. Data rates will be higher than previous generations, providing between 100 Mbps and 1 Gbps speeds both indoors and outdoors.

- Ultra Mobile Broadband (UMB)
  UMB (Ultra Mobile Broadband) is the brand name to describe the CDMA2000 mobile phone standard for next generation 4G applications and requirements. The system is based upon Internet (TCP/IP) networking technologies running over a next generation radio system, with the ability to support peak download speeds as high as 280 Mbps. UMB is an evolutionary upgrade within the CDMA200 family and supports handoffs with CDMA technologies including the existing CDMA2000 1X and 1xEV-DO systems. The UMB standardization is expected to be completed soon, with commercial availability in 2009.

  The CDMA Development Group (CDG) has developed an outline of key features of UMB which include:

  - Multiple radio and advanced antenna techniques
    - Sophisticated control and signaling mechanisms (minimized) combine the best aspects of CDMA, TDM, OFDM, and OFDMA into a single air interface
    - Multiple Input Multiple Output (MIMO), Spatial Division Multiple Access (SDMA) and beamforming antenna techniques
    - Improved interference management techniques
  - Ultra-high mobile broadband peak data rates
    - Up to 288 Mbps peak data rate on forward link
    - Up to 75 Mbps peak data rate on reverse link
  - Ultra-low network latency
    - An average of 16 msec (32-byte, RTT) end-to-end network latency
  - Enhanced VoIP capacity and user experience
    - Up to 1000 simultaneous VoIP users (20 MHz FDD allocations)

- Scalable IP-based flat or hierarchical architecture
  - Greater service deployment flexibility, improved performance, and lower cost of ownership
- Flexible spectrum allocations
  - Scalable, non-contiguous and dynamic channel (bandwidth) allocations
  - Support for incremental bandwidth allocations from 1.25 MHz to 20 MHz
  - Support of multi-carrier operations
- Optimized power consumption

- Mobile WiMAX Sprint Nextel
  Sprint Nextel has developed and deployed a fourth generation (4G) nationwide broadband mobile network called Xohm in Chicago, Baltimore, and Washington D.C. The 4G wireless broadband network uses the mobile WiMAX (Worldwide Interoperability for Microwave Access) IEEE 802.16e-2005 technology standard.

  The Sprint Nextel 4G mobility network uses the company's extensive 2.5 GHz spectrum holdings, which cover 85 percent of the households in the top 100 U.S. markets - the most of any wireless carrier in any single spectrum band. To access that network, Sprint Nextel has been working with Intel, Motorola and Samsung to incorporate WiMAX technology for advanced wireless communications and help make chipsets widely available for new consumer electronics devices.

  The company's deployment plans target a launch of the advanced wireless broadband services in trial markets in 2008, with plans to deploy a network that reaches as many as 100 million people in 2009. The network will offer between 2 Mbps to 4 Mbps data rates to customers. Sprint Nextel plans to expand mobile WiMAX network coverage thereafter.

References:

1. Differentiating the Gs in Cellular Networks; http://www.phoneplusmag.com/articles/825/71h241551435767.html
2. 4G wireless broadband will use many technologies; http://searchtelecom.techtarget.com
3. 4G Mobile; http://www1.alcatellucent.com/doctypes/articlepaperlibrary/html/ATR2005Q2/ATR2005Q2A15_EN.jhtml?tcmID=tcm:172-262211635
4. IEEE 802.20 Working Group on Mobile Broadband Wireless Access; http://www.ieee802.org/20/Contribs/C802.20-05-68r1.pdf
5. Ultra Mobile Broadband; http://en.wikipedia.org/wiki/Ultra_Mobile_Broadband
6. Ultra Mobile Broadband; http://www.cdg.org/technology/3g_umb.asp
7. Ultra Mobile Broadband Selected to Describe Next Major Advancement in Mobile Communications; http://www.primenewswire.com/newsroom/news.html?d=109733
8. UMB and WiMAX Technical Comparison; www.qualcomm.com/common/documents/white_papers/UMB_WiMAX.pdf
9. Sprint Sets Stage for 2008 Xohm WiMAX Launch with Service, Device and Advertising Agency Agreements; http://newsreleases.sprint.com/

ii) Available Fixed Line Technologies

(1) Advanced Fiber Technologies

Polarization Maintaining Optical Fiber
In fiber optics, the definition of a polarization-maintaining optical fiber (PMF or PM fiber) is an optical fiber in which the polarization planes of light waves launched into the fiber are maintained during propagation with little or no cross coupling of optical power between the polarization modes.

Two different designs of polarization-maintaining optical fiber are used in the commercial market. Panda Fiber uses round and symmetric rods on either side of the core to induce polarization and is named for the literal resemblance to the face of a panda bear when looking at the fiber's cross section. For Bow-tie fiber, the stress applying parts act like opposing wedges to generate the optimum stress distribution in the fiber and is named for the literal resemblance to a bow-tie when looking at the fiber's cross section. The practical difference between the two fibers is merely the shape of their stress members.

Polarization-maintaining optical fibers are used in special applications where the polarization state cannot be allowed to drift, such as in fiber lasers, fiber interferometry and quantum key distribution. They are also commonly used in telecommunications for the connection between a source laser and a modulator, since the modulator requires polarized light as input. PM fiber is typically used for short distances because the fiber is expensive and has higher attenuation than single mode fiber.

References:
1. Polarization-maintaining optical fiber; http://en.wikipedia.org/wiki/Polarization-maintaining_optical_fiber
2. Polarization Maintaining Cable Assemblies; http://www.timbercon.com/Polarization-Maintaining-Cables/index.html
3. Bowtie PM Fiber; http://www.fibercore.com/
4. Fujikura Panda PM Fiber; http://www.fujikura.co.uk/pdf/fibre_optics_panda_fibre_presentation.pdf
5. Polarization-maintaining fibers; http://www.rp-photonics.com/polarization_maintaining_fibers.html
6. Definition, PM Optical Fiber; http://132.163.64.205/fs-1037/dir-028/_4057.htm

Plastic Optical Fiber
POF (Plastic Optical Fiber) products are large diameter assemblies constructed of acrylic and fluorinated polymers, for the core and cladding respectively. Similar to traditional glass fiber, POF transmits light/data through the core of the fiber. POF assemblies have a core size, in some cases, 100x that of glass fiber. The increased core diameter allows 96% of the core to transmit signal from point-to-point, making it an ideal material for very high bandwidth/signal transmission over very short distances.

Plastic fiber optic assemblies possess special characteristics that make this product an ideal solution for applications which traditional glass fiber products are not well suited. For applications requiring a very tight bend radius, plastic optical fiber products can generally bend to 25 mm with no excessive attenuation. Plastic fiber can be easily bent and connected to additional lines, making it useful in hard-to-reach buildings. For visible light laser applications, plastic optical fiber assemblies can transmit the signal such that it is visible to the human eye, making the user aware of its attachment to an active laser and allowing them to avoid associated dangers. Plastic optical fiber products also have a very wide tolerance for scratching and contamination from the field. This tolerance allows the product to perform at acceptable level despite some compromise in physical condition.

Plastic optical fiber isn't as fast as traditional glass, but its 2.5 Gbps transfer speed still represents an improvement beyond copper wire connections. Verizon (FiOS) and AT&T (U-Verse) may use this technology in the future to run fiber directly into the home of each subscriber. Plastic optical fiber is cheaper than the glass fiber Verizon is currently using and provides more bandwidth than the copper wire AT&T is currently using.

References:

1. Luceat VIDA 300; http://www.pofto.com/
2. New plastic optical fiber could solve the "last mile" conundrum; http://arstechnica.com/news.ars/post/20071127-korean-researchers-demonstrate-plastic-optical-fiber.html
3. Plastic Optical Fiber; http://en.wikipedia.org/wiki/Plastic_optical_fiber
4. Plasict Optical Fiber; http://www.timbercon.com/Plastic-Optical-Fiber/
5. About Plastic Optic Fiber; http://www.toray.co.jp/english/raytela/whatspof/wha_a001.html
6. Basics of Plastic Optic Fiber; http://www.pofeska.com/pofeskae/tece/whatspofe/whatspofe.htm

Low Loss Fiber Technologies

Corning has designed a new single-mode optical fiber with its proprietary ultra-low-loss technology. The fiber features specifications for low attenuation and low polarization mode dispersion, enabling both greater system reach and longer span lengths in long haul and regional terrestrial networks. The fiber, which is fully compatible with the installed base of single-mode fibers (G.652), has the lowest loss of any terrestrial-grade fiber, with maximum attenuation available between 0.17 dB/km and 0.18 dB/km at 1550 nm. Combined, these features provide spare network margin that can be leveraged to extend network span lengths, skip amplification sites, upgrade to faster bit rates, add network components for improved flexibility, or lengthen the distance between regenerators.

References:

1. Corning(R) Ultra-low-Loss Optical Fiber Technology with Nortel's Optical Equipment; http://www.pcb007.com/anm/templates/article.aspx?articleid=15377&zoneid=53&v=
2. SMF-28® ULL Optical Fiber with Corning® Ultra-Low-Loss Technology; http://www.corning.com/opticalfiber/products__applications/products/smf_28_ULL.aspx

(2) Communication Protocol Advancements

Multiprotocol over ATM

Multiprotocol over ATM (MPOA) is an ATM Forum specification for overlaying layer three network routing protocols like IP over an ATM switched network environment. It allows organizations to take advantage of the bandwidth and scalability of ATM while retaining legacy LANs, the ability to create VLANs (virtual LANs), and the ability to route between those VLANs. Multi-Protocol over ATM (MPOA) is being considered by the communication industry as an important short-cut technology that provides an efficient transfer of inter-subnet unicast data in a LANE environment. MPOA was initially considered to carry backbone traffic in the enterprise or campus networks. However, congestion in the public Internet provokes many to consider MPOA as a solution for the carrier or service provider networks as well.

References:

1. MPOA; http://www.linktionary.com/m/mpoa.html
2. MPOA: Multi-Protocol Over ATM; http://www.javvin.com/protocolMPOA.html
3. Multiprotocol over ATM (MPOA); http://www.cs.wustl.edu/~jain/atm/atm_mpoa.htm
4. MPOA: Multi-Protocol Over ATM; http://www.netcraftsmen.net/welcher/papers/mpoa.htm

b) APPLICABLE TECHNOLOGY ENVIRONMENTS FOR ITS DEPLOYMENTS

i) Technology Topology Examples

(1) Ring Coverage

A ring network is a network topology in which each node connects to exactly two other nodes, forming a circular pathway for signals. Data travels from node to node, with each node handling every packet.

Because a ring topology provides only one pathway between any two nodes, ring networks may be disrupted by the failure of a single link. A node failure or cable break might isolate every node attached to the ring. FDDI networks overcome this vulnerability by sending data on a clockwise and a counterclockwise ring: in the event of a break data is wrapped back onto the complementary ring before it reaches the end of the cable, maintaining a path to every node along the resulting "C-Ring". 802.5 networks — also known as IBM Token Ring networks — avoid the weakness of a ring topology altogether. They actually use a star topology at the physical layer and a Multistation Access Unit to imitate a ring at the datalink layer. Many ring networks add a "counter-rotating ring" to form a redundant topology. Such "dual ring" networks include Spatial Reuse Protocol, fiber distributed data interface, and Resilient Packet Ring.

Full Mesh Coverage
Mesh networking is a way to route data, voice and instructions between nodes. It allows for continuous connections and reconfiguration around broken or blocked paths by “hopping” from node to node until the destination is reached. A mesh network whose nodes are all connected to each other is a fully connected network. Mesh networks differ from other networks in that the component parts can all connect to each other via multiple hops, and they generally are not mobile. Mesh networks can be seen as one type of ad hoc network. Mobile ad-hoc networking (MANet), and mesh networking are therefore closely related, but mobile ad hoc networks also have to deal with the problems introduced by the mobility of the nodes.

Mesh networks are self-healing: the network can still operate even when a node breaks down or a connection goes bad. As a result, a very reliable network is formed. This concept is applicable to wireless networks, wired networks, and software interaction.

Partial Mesh Coverage
With partial mesh coverage, some nodes are organized in a full mesh scheme but others are only connected to one or two in the network. Partial mesh topology is commonly found in peripheral networks connected to a full meshed backbone. It is less expensive to implement and yields less redundancy than full mesh topology.

Hub and Spoke (Star) Coverage
Star networks are one of the most common computer network topologies. In its simplest form, a star network consists of one central switch, hub or computer, which acts as a conduit to transmit messages. If the central node is passive, the originating node must be able to tolerate the reception of an echo of its own transmission, delayed by the two-way transmission time (i.e., to

and from the central node) plus any delay generated in the central node. An active star network has an active central node that usually has the means to prevent echo-related problems.

The star topology reduces the chance of network failure by connecting all of the systems to a central node. When applied to a bus-based network, this central hub rebroadcasts all transmissions received from any peripheral node to all peripheral nodes on the network, sometimes including the originating node. All peripheral nodes may thus communicate with all others by transmitting to, and receiving from, the central node only. The failure of a transmission line linking any peripheral node to the central node will result in the isolation of that peripheral node from all others, but the rest of the systems will be unaffected.

References:

1. Network Topologies; http://compnetworking.about.com/od/networkdesign/a/topologies.htm
2. Network Topology; http://en.wikipedia.org/wiki/Network_topologies
3. Network Topology; http://uva.ulb.ac.be/cit_courseware/networks/

c) ITS COMMUNICATIONS INFORMATION BROADCAST SUPPORT SYSTEMS

i) Mobile Wireless Applications

(1) Wireless Application Protocol (WAP)

Wireless application protocol is an application environment and set of communication protocols for wireless devices designed to enable technology-independent access to the Internet and advanced telephony services. WAP offers the ability to deliver an unlimited range of mobile value-added services to subscribers—independent of their network, bearer, and terminal. Subscribers can access the same information from a pocket-sized device or desktop computer.

WAP is a global standard that was founded in 1997 by the WAP Forum (Ericsson, Nokia, Motorola, and Unwired Planet). The purpose of the forum is to define industry-wide specifications for developing applications over wireless communications networks. The WAP specifications define a set of protocols in application, session, transaction, security, and transport layers, which enable operators, manufacturers, and applications providers to meet the challenges in advanced wireless service differentiation and fast/flexible service creation. There are now over one hundred members representing terminal and infrastructure manufacturers, operators, carriers, service providers, software houses, content providers, and companies developing services and applications for mobile devices.

<u>References:</u>

1. Wireless Application Protocol (WAP); http://www.iec.org/online/tutorials/wap/index.html
2. WAP Forum; http://www.openmobilealliance.org/tech/affiliates/wap/wapindex.html
3. Wireless Application Protocol: http://en.wikipedia.org/wiki/Wireless_Application_Protocol

(2) iMobile Application Environment:

iMobile is an enterprise platform to that allows resource limited mobile devices to communicate with each other and to securely access services. iMobile receives messages and commands from devices, accesses internet services and information on behalf of the mobile user, and then relay messages or internet content back to the sending devices or other devices according to their device profiles.

Many devices can communicate with iMobile through various protocols and access networks.

- GSM/TDMA phones can communicate with iMobile through an SMS driver hosted on iMobile.
- CDPD devices can use WAP to access iMobile through the Internet.
- Email devices such as Blackberry can use the standard email protocols (SMTP) on the CDPD network or a two-way paging network to communicate with iMobile.

- Users on PC devices and some PDA's can use AOL instant messenger (AIM) to talk with an AIM client hosted on iMobile.
- It is also possible to communicate with iMobile directly via the telnet interface.

References:

1. iMobile: An Agent based Platform for Mobile Services; http://www10.org/cdrom/posters/1120.pdf
2. iMobile EE- An Enterprise Mobile Service Platform; http://www.research.att.com/~trevor/papers/imobile-ee.pdf

(3) Smart Phone Environments

A smart phone is a mobile phone that incorporates a PDA (Personal Digital Assistant) and has advanced capabilities so the phone can function as a mobile phone and handheld computer. A smart phone runs complete operating system software and provides digital voice service. The most common operating system (OS) environments used in smart phones include: Symbian OS from Symbian Ltd., Linux operating system, Windows Mobile from Microsoft, RIM BlackBerry operating system, Palm OS developed by PalmSource, and OS X from Apple Inc.

Smart phones take advantage of second and half generation (2.5G) and third generation (3G) high-speed mobile service networks. User services available for smart phones include e-mail, text messaging, instant messaging (IM), pager, Internet access, MP3 player, voice recognition, still camera, video camera, GPS receiver, TV or video player, and organizer.

References:

1. Smartphone; http://en.wikipedia.org/wiki/Smartphone
2. What is a Smartphone; http://www.oreillynet.com/pub/a/wireless/2005/08/23/whatissmartphone.html

ii) Leased Broadband Technologies

Broadband is often called high-speed Internet, because it usually has a high rate of data transmission. Any connection to the customer of 256 kbps (0.256 Mbps) or more is considered broadband Internet. The FCC definition of broadband is 200 kbps (0.2 Mbps) in one direction, and advanced broadband is at least 200 kbps in both directions.

The most common leased broadband technologies are digital subscriber line (DSL) and cable modems. Fiber-optic communication, while only recently being used in fiber to the premises (FTTP), is enabling additional broadband Internet access by making transmission of information over larger distances much more cost-effective than copper wire technology.

(1) Digital Subscriber Line (DSL)

Digital Subscriber Line (DSL) is a technology that provides digital data transmission over the wires of a local telephone network. The download speed of consumer DSL services ranges from 512 kbps to 24,000 kbps, depending on DSL technology, line conditions and service level implemented. Typically, upload speed is lower than download speed for Asymmetric Digital Subscriber Line (ADSL) and equal to download speed for Symmetric Digital Subscriber Line (SDSL). The customer end of the connection consists of a Terminal Adaptor or in layman's terms "DSL modem." This converts data from the digital signals used by computers into a voltage signal of a suitable frequency range that is then applied to the phone line. DSL typically works by dividing the frequencies used in a single phone line into two primary “bands”. The ISP data is carried over the high frequency band (25 kHz and above) and the voice is carried over the lower frequency band (4 kHz and below). Most local telephone companies can provide this service.

(2) Cable Modem

A cable modem is a type of modem that provides access to a data signal sent over the cable television infrastructure. Cable modems are primarily used to deliver broadband Internet access in the form of cable Internet, taking advantage of unused bandwidth on a cable television network. With the advent of Voice over IP telephony, cable modems can also be used to provide telephone service. In network topology, a cable modem is a network bridge that conforms to IEEE 802.1D for Ethernet networking (with some modifications). The cable modem bridges Ethernet frames between a customer LAN and the coax cable network. In some systems, coaxial cable is the only medium used for distributing signals in the network. In other systems, fiber-optic cable goes from the cable company to different neighborhoods or areas. Then the fiber is terminated and the signals move onto coaxial cable for distribution to individual houses.

(3) Verizon FiOS

FiOS (Fiber Optic Service) is a fiber to the premises (FTTP) telecommunications service, presently offered in some areas of the United States by Verizon, including some large metropolitan areas. Verizon has attracted consumer and media attention in the area of broadband Internet access as the first major U.S. carrier to offer such a service. In their rapidly expanding coverage areas, FiOS provides telephone, Internet and digital video services to the subscriber's premises. Some areas do not have service due to franchise agreements, and some can only receive the Internet access, also due to franchising. FiOS packages offer up to 30 Mbps downloads and 5 Mbps uploads.

Verizon FiOS products are delivered over the FTTP (fiber to the premises) network using passive optical network (PON) technology. Voice, video, and data travel over three wavelengths in the infrared spectrum. To serve a home, a single-mode optical fiber extends from an optical line terminal (OLT) at a FiOS central office or head end out to the neighborhoods where an optical splitter fans out the same signal on up to 32 fibers- thus serving up to 32 subscribers. At the subscriber's home, an optical network terminal (ONT) transfers data onto the corresponding copper wiring for phone, video and Internet access.

(4) High Speed T-1 Data Line

These are highly-regulated communication services traditionally intended for businesses that are managed through Public Service Commissions (PSCs) in each state, must be fully defined in PSC tariff documents, and have management rules dating back to the early 1980s which still refer to teletypes as potential connection devices. T-1 services have very strict and rigid service requirements which drive up the provider's maintenance costs and may require them to have a technician on standby 24 hours a day to repair the line if it malfunctions. In comparison, ISDN and DSL are not regulated by the PSCs at all.

Due to the expensive and regulated nature of T-1 lines, they are normally installed under the provisions of a written agreement, the contract term being typically one to three years. However, there are usually few restrictions to an end-user's use of a T-1, uptime and bandwidth speed may be guaranteed (1.5 Mb), quality of service may be supported, and blocks of static IP addresses are commonly included.

(5) Satellite Internet

This employs a satellite in geostationary orbit to relay data from the satellite company to each customer. Satellite Internet is usually among the most expensive ways of gaining broadband Internet access, but in rural areas it may only compete with cellular broadband. However, costs have been coming down in recent years to the point that it is becoming more competitive with other high-speed options.

Satellite Internet also has a high latency problem caused by the signal having to travel 35,000 km (22,000 miles) out into space to the satellite and back to Earth again. The signal delay can be as much as 500 milliseconds to 900 milliseconds. These delays are more than tolerable for just basic email access and web browsing and in most cases are barely noticeable.

Most satellite Internet providers have a FAP (Fair Access Policy). Perhaps one of the largest cons against satellite Internet, these policies usually limit a user's throughput to dial-up speeds after a certain "invisible wall" is hit (usually around 200 MB a day). This FAP usually lasts for 24 hours after the wall is hit, and a user's throughput is restored to whatever tier they paid for. This makes bandwidth-intensive activities nearly impossible to complete in a reasonable amount of time.

<u>References:</u>

1. Broadband; http://en.wikipedia.org/wiki/Broadband
2. Digital Subscriber Line: http://en.wikipedia.org/wiki/DSL
3. Digital Subscriber Line; http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/adsl.htm
4. How DSL Works: http://www.howstuffworks.com/dsl.htm
5. http://www.dslforum.org/
6. Digital Subscriber Line Tutorials: http://www.iec.org/online/tutorials/dslam/
7. Cable Modem; http://en.wikipedia.org/wiki/Cable_modem

8. Cable Modem Primer; http://www.cable-modem.net/tt/primer.html
9. How Cable Modems Work; http://computer.howstuffworks.com/cable-modem.htm
10. What is a cable modem?; http://searchsecurity.techtarget.com/sDefinition/0,,sid14_gci211726,00.html
11. Verizon FiOS; http://www22.verizon.com/content/ConsumerFios
12. T-carrier; http://en.wikipedia.org/wiki/T-carrier#T1
13. How Does a T1 Line Work; http://computer.howstuffworks.com/question372.htm
14. Satellite Internet Service; http://www.high-speed-internet-access-guide.com/satellite/
15. Satellite Internet Access; http://en.wikipedia.org/wiki/Satellite_Internet_access
16. Satellite Internet Explained In Plain English: Latency; http://www.vsat-systems.com/satellite-internet-explained/latency.html

d) FUNCTIONAL INTEGRATION

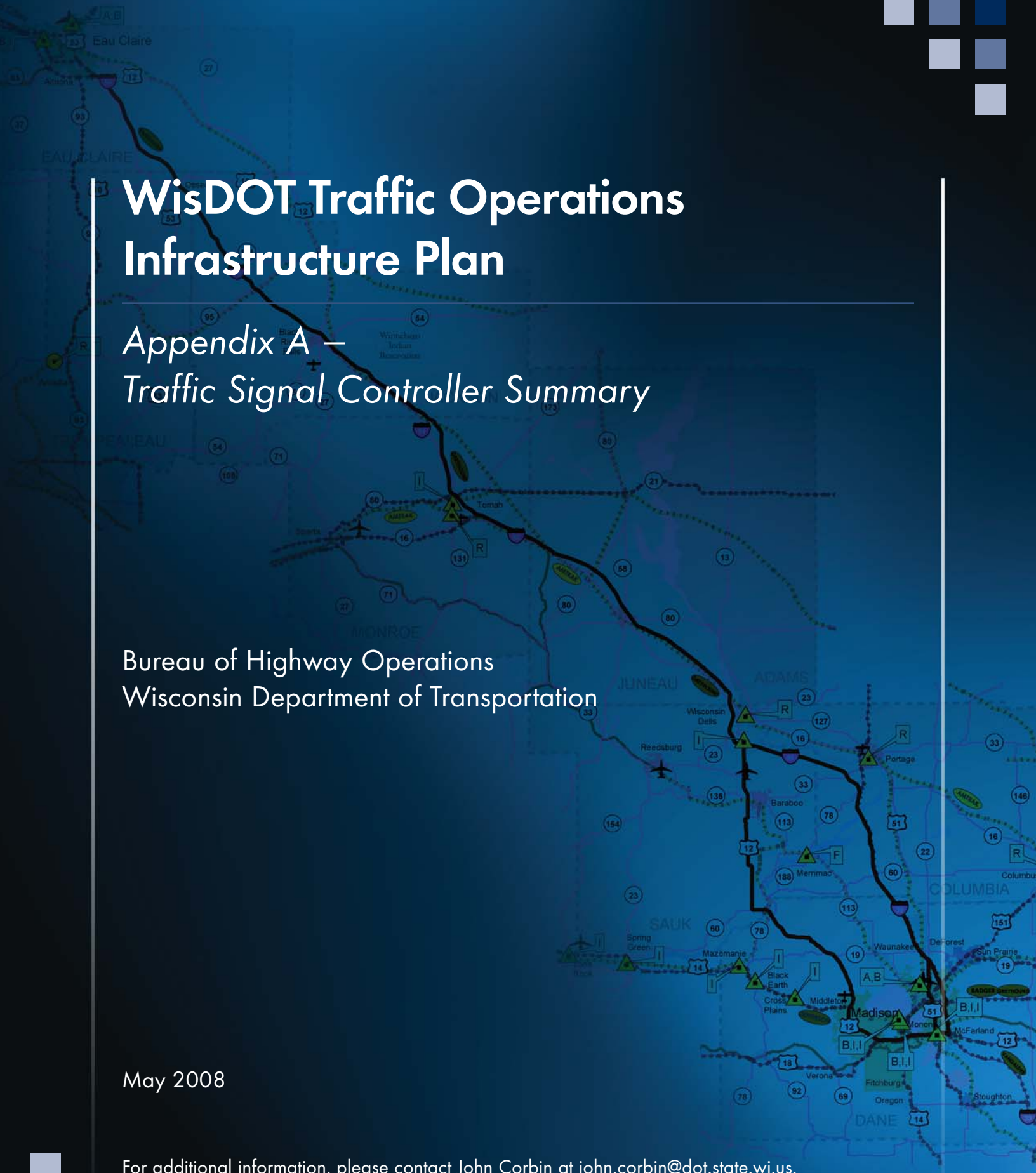
- **Communications Integration:** With the wide adoption of TCP/IP and Ethernet standards as the most common method of data communication, a number of opportunities have been created to share data paths for ITS deployment. Different devices such as traffic controllers, message signs, detectors, and CCTV systems can now share a single, common link for all of their data needs. In the past, these may have required complex multi-drop serial arrangements or even individual connection methods for each device. Now multiple occurrences of each device can share a single pair of fiber optic or copper wires for all of their needs.

  Many manufacturers have begun including Ethernet interfaces on their equipment, but for legacy devices, products exist that allow for easy conversion from serial communications.

- **Networked Applications:** As devices standardize on Ethernet for their communications, it becomes possible to disseminate the data more widely without large capital investments in new infrastructure. The ability to route ITS data in the same manner as any other, allows the general purpose networks built by many agencies to support deployments on a regional, statewide or even national level. A properly implemented CCTV system can support local incident management, regional traffic management, 911 providers and emergency operations center management, all with a single connection to the field device and proper network integration.

WisDOT Traffic Operations Infrastructure Plan

Appendix A – Traffic Signal Controller Summary



Bureau of Highway Operations
Wisconsin Department of Transportation

May 2008

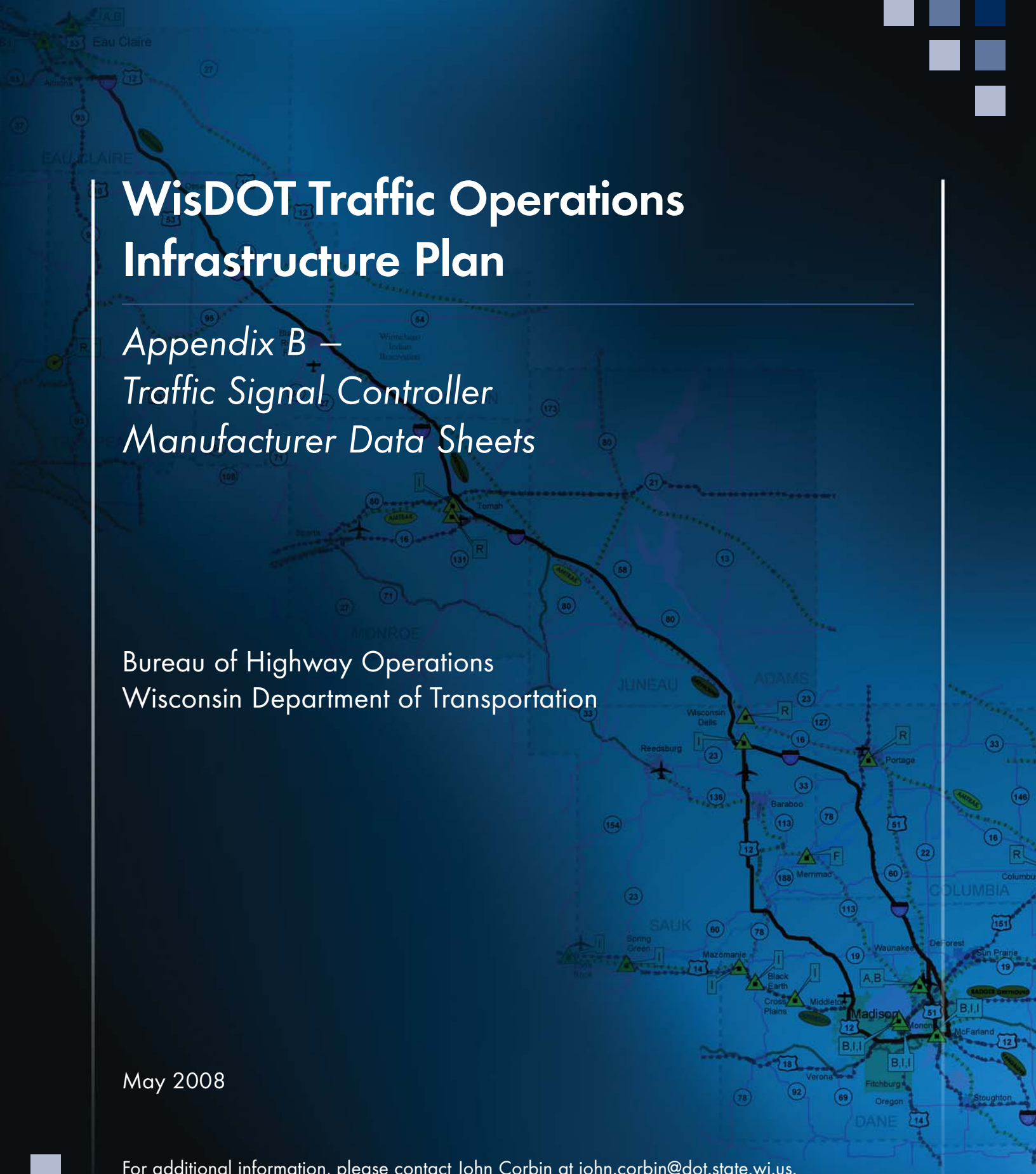
For additional information, please contact John Corbin at john.corbin@dot.state.wi.us.

Traffic Signal Summary

	Model	Controller Standard Compliance				Cabinet Compatibility					Controller					Coordination			TBC	LCD	Detector Inputs	Preemption	Priority	Data Key	Flash Memory Range	Operating System	Power Consumption Ave./Max	Comments
		NEMA TS1 (1989)	NEMA TS2 (1998)	ATC2070 v. 1.05 (2001)	ATC 5.26 (2006)	NEMA TS-1	NEMA TS-2	170	332	ITS	Dimensions (H x W x D)	Mounting	Rings	Vehicle Phases	Overlap	# Plans	Responsive	Adaptive	# Plans								
Existing Cooktek	M30	X				X					9" x 15" x 8"	Shelf	2	8	8	4	No	No	4	NA	40	Yes	No	No	NA	NA	-	
NEMA Based – Eagle/Siemens (EPAC Family)	M40	Yes	Yes	No	No	Yes	Yes	No		No	9" x 15" x 8"	Shelf	4	16	16	6	No	Yes	250	8 lines x 40 characters per line	80	Yes	Yes			NA	15	
NEMA Based – Eagle/Siemens (EPAC Family)	M50	Yes	Yes	No	No	Yes	Yes	No		Optional	7" x 15.5" x 9.5"	Shelf	4	16	16	6	No	Yes	250	8 lines x 40 characters per line	80	Yes	Yes	Optional	8 MB	NA	25/120	Ability to run other ITS applications. Agency only needs to purchase the number of front panels as it has technicians (+ spares)
NEMA Based – Econolite (ASC Family)	ASC/2	Yes	Yes	No	Optional	N/A	N/A	No		No	10.25" x 15.25" x 9"	Shelf	2		16	16				16 lines x 40 characters per line	64/16				1 MB		NA	
NEMA Based – Econolite (ASC Family)	ASC/3	No	Yes	No	Yes	N/A	N/A	No		No	10.25" x 15.25" x 9"	Shelf	4		16	120			200	16 lines x 40 characters per line	64/16	Optional					-	Firmware stored in flash memory
NEMA Based – Peek/Quixote	3000E	Yes	Yes	No	No	Yes	Yes	No	No	Yes	10.86" x 13.7" x 8.84"	Shelf	4	16	16				220	8 lines x 40 characters per line	64/32	Yes					-	
2070 Based – Eagle/ Siemens	2070	Optional	Optional	Yes	Yes	Optional	Optional	Optional		Optional	7" x 19" x 10.25" PLUS 4" x 17" x 10.25" (NEMA Module)	Rack (Shelf Optional)	Function of Software Selected							8 lines x 40 characters per line		Function of Software		Yes	8 MB	Microware OS-9	25/120	NEMA card and attachment required
2070 Based – Econolite	ATC 2070	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	10.25" x 15.25" x 9"	Rack	Function of Software Selected							8 lines x 40 characters per line		Function of Software		Yes		Microware OS-9	-	
2070 Based – Quixote	2070 Lite	No	No	Yes	No	Yes	Yes	Yes	No	No	10.5" x 17" 14"	Rack	Function of Software Selected							8 lines x 40 characters per line		Function of Software		Yes		Microware OS-9	115	
ATC Based – Eagle/ Siemens	ATCnx	Yes	Yes	Yes	Yes		Yes			Yes	7" x 19" x 9"	Rack	Function of Software Selected							Removable/ Interchangeable		Function of Software				Linux OS 9 Other 3rd Party Options Available	25/120	
ATC Based – Quixote (Peek)	IQATC	Optional	Optional	Yes	Yes	Yes	Yes	No		Yes	8" x 10" x 10"	Shelf	Function of Software Selected							Yes					8 MB		-	

WisDOT Traffic Operations Infrastructure Plan

Appendix B – Traffic Signal Controller Manufacturer Data Sheets



Bureau of Highway Operations
Wisconsin Department of Transportation

May 2008

For additional information, please contact John Corbin at john.corbin@dot.state.wi.us.

SIEMENS

EAGLE EPAC M40 NEMA Controller

Hardware Features

- Exceeds NEMA TS-1 and TS-2 standards for traffic controllers
- Front Panel multi-line alphanumeric backlit display for all operational parameters and states
- Fully prompted, menu driven programmability
- EEPROM technology is used to retain all timing and control parameters even during power outages. No batteries are required for retention of traffic parameters.

Coordination Modes

- Permissive Mode
- Yield Mode
- Permissive Yield Mode
- Permissive Omit Mode
- Sequential Omit Mode
- Full Actuated Mode

Adaptive Traffic Control

- 16 Vehicle Phases
- 16 Pedestrian Phases
- 4 Timing Rings
- 16 Overlaps
- 80 Detectors
- Adaptive Maximum Routines
- Adaptive Protected/Permissive Routines
- Coordination Virtual Split Routine

Time Base Control

- 250 Events
- 99 Day Programs
- 10 Week Programs

Preemption/Priority

- 6 Preempt Routines
- 6 Priority Routines

Other Features

- Diagnostics & Staus Displays
- Reports

The EAGLE EPAC M40 Series Controller Unit is a fully actuated controller unit with a full complement of operational, programming, and diagnostics capabilities. The M40 Series Controller Unit EXCEEDS both NEMA TS 1-1989 and TS 2-2003 Actuated Controller Unit Standards.

The M40 Series Controller Unit has an LCD alphanumeric backlit display (8-line - 40 char/line). Programming is easy and error free using English Language Menus. Within a menu, each parameter can be viewed and a cursor moved to that parameter for changes. Related parameters are visible simultaneously, making verification an easy matter. The screen provides both programming area identification and editing prompts.



EAGLE EPAC M42 TS-2, Type 2 Controller
w/ Fiber Modem (optional)

Hardware Design

The M40 Series Controller Unit is designed for efficient operation and ease of maintenance. The chassis is of metal and is designed for easy access to the boards for testing without disassembly.

To insure the accuracy of traffic control parameters, even during power outages, EEPROM technology is used to retain all timing and control parameters. No batteries are required for retention of traffic parameters. Event logging and Time Base clock utilize RAM memory for those functions with battery support.

Intelligent Transportation Systems

A Look at the EAGLE EPAC M40 Series Controller...

TS-2 Type 1 and 2 Features

TS-2, Type 1 Actuated Controller Unit is a performance oriented controller unit using a high speed data channel between all major components within the Terminal and Facilities.

TS-2, Type 2 Actuated Controller Unit includes all the features of the Type 1 and adds the following:

1. MSA, MSB, and MSC connectors for data exchange with the Terminals & Facilities. This provides a degree of downward compatibility with NEMA TS-1 counterparts.
2. 37 pin "D" connector for backward compatibility with TS-1 counterpart.

TS-2 Advantages

Controller assemblies with TS-2 Detector Racks provide increased capability, consume less power, and provide additional diagnostic data to the Controller Unit via the SDLC port. The Controller Unit can take corrective action much earlier than one based on internal diagnostics.

Controller assemblies with TS-2 Monitors provide additional diagnostic data to the Controller Unit via the SDLC port.

Six Modes of Coordination

Permissive Mode provides non-actuated coord phase, vehicle and pedestrian, with permissive windows opened phase by phase to the non-coord phases.

Yield Mode provides non-actuated coord phase, vehicle and pedestrian, with a single permissive window for all non-coord phases.

Permissive Yield Mode provides for actuated coord phase, vehicle and pedestrian, with permissive windows opened phase by phase to the non-coord phases. Additionally, the coord phase vehicle may extend its green time at the beginning of the first permissive window.

Permissive Omit Mode provides operation similar to the Permissive Yield Mode, except that the coord phase, once terminated, is prevented from occurring prior to the end of the last permissive.

Sequential Omit Mode provides operation similar to the Permissive Yield Mode, except the permissive is a phase by phase sliding window (only one phase in a ring will be allowed service at any time).

Full Actuated Mode provides operation similar to the Permissive Yield Mode, except that any phase may be serviced and reserviced in the standard sequence following the first permissive and through the last permissive.

Security

The M40 Series Controller Unit provides for a user specified security code entry before data may be altered. This security code entry is not required to view any parameters. The M40 Series Controller Unit can also disable security code requirements for perpetual access.

Adaptive Traffic Control

Simple or highly complex control including:

- 16 Vehicle Phases
- 16 Pedestrian Phases
- 4 Timing Rings
- 16 Overlaps
- 80 Detectors

Adaptive Maximum Routines which are enabled via Time Base, offer three separate Step values to cause the running maximum to increase or decrease smoothly based on current traffic conditions. Separate Dynamic Maximum parameters are available for each Step value.

Adaptive Protected / Permissive Routines measure the volume of Left Turn vehicle traffic and available gap windows in the conflicting Through-Vehicle traffic to determine whether the Left Turn should operate protected or permissive.

Coordination Virtual Split Routine provides for actuated coord phase vehicle and pedestrian modes. This control provides for a period of time of each cycle which is distributed to the Coord Phase(s) or non-coord phases, based on Coord Phase vehicle traffic activity.

Coordination Adaptive Split Routines which are enabled via Time Base adjust split times smoothly based on current traffic conditions.

Time Base Control

Internal Time Base Control is a highly flexible routine operating within the M40 Series Controller Unit. Included are:

- 250 Events for the control of Pattern Selection, Free, Flash, Dimming, Detector Diagnostic Parameters, System Detector Logging, 3 Auxiliary Functions, 8 Special Functions, 16 Traffic Functions
- 99 Day Programs
- 10 Week Programs

Preemption/Priority

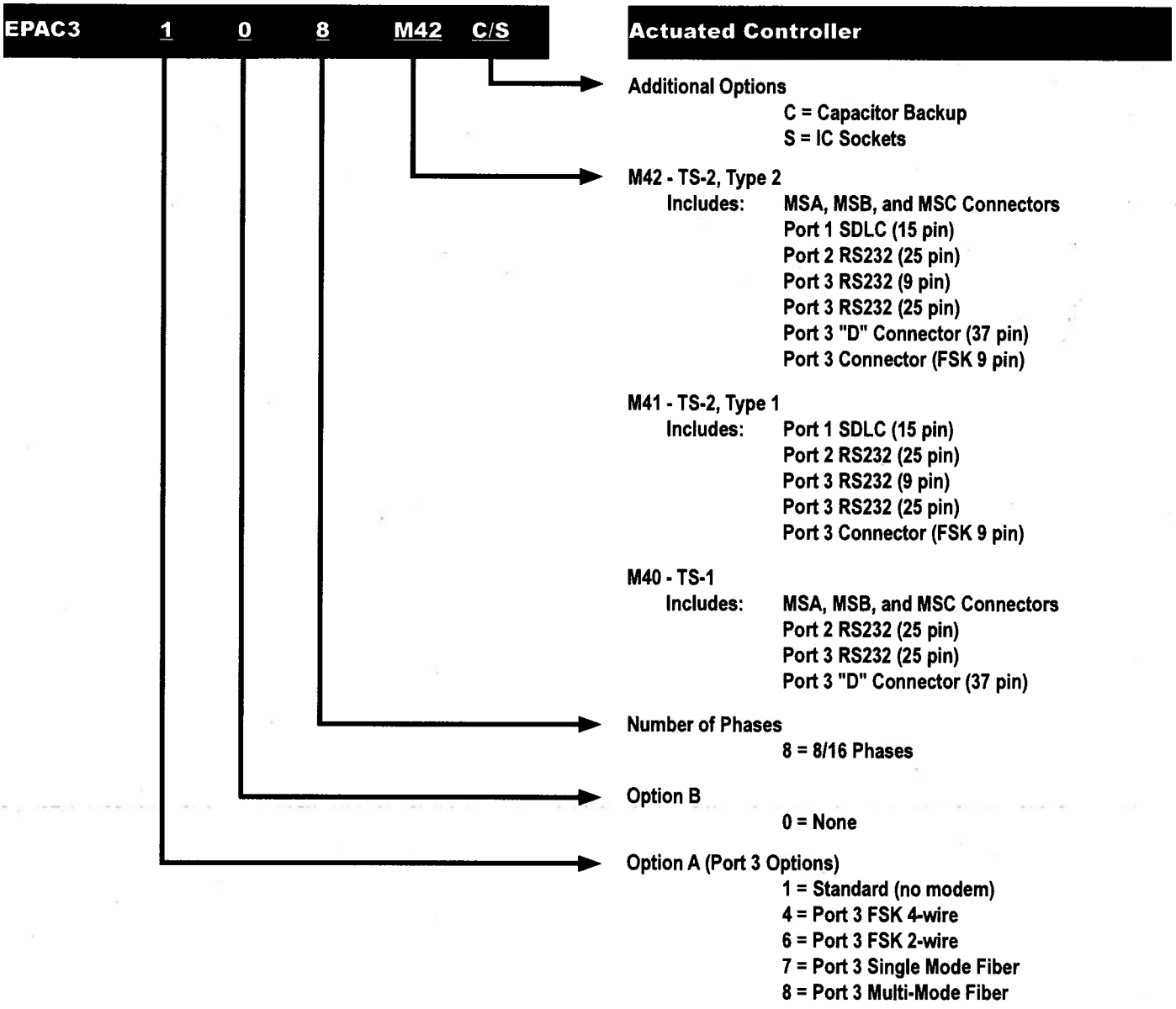
Internal Preemption is a highly flexible routine operating within the M40 Series Controller Unit. Included are:

- 6 Preempt Routines providing complete signal control
- 6 Priority Routines providing complete phase control and in-sync return to coordination

Preempt activity can be monitored on a Preempt Status display which denotes:

- Preempt In Control, Interval Timing, & Interval Countdown
- Individual Preempt Status & Timing
- Individual Priority Status & Timing

Ordering Matrix





EAGLE EPAC M41 TS-2, Type 1 Controller

Reports

The M40 Series Controller Unit provides extensive reporting capability. Each report entry includes the Date and Time of occurrence.

- Local Alarm Log, stores up to 120 events
- Comm Fault Log, stores up to 60 events
- Detector Fault Log, stores up to 60 events
- System Detector Log, stores up to 96 events
- MOE Log, stores up to 24 events
- Speed Log, stores up to 24 events
- Volume Count Log, stores up to 72 events
- Cycle MOE Log, stores up to 60 events
- MMU Fault Log, stores up to 10 events

Diagnostics & Status Displays

A resident diagnostic program is standard in the M40 Series Controller Unit. In addition to the extensive displays to aid in intersection setup, monitoring, and operation, the resident diagnostic program enhances the maintenance and troubleshooting of the controller assembly.

- Monitor Compatibility Diagnostics
- Monitor Field Status Diagnostics
- Cycling Diagnostics
- Detector Diagnostics
- Port 1 Message Display
- Port 2 Comm Status Display
- Port 3 Comm Status Display
- Hardware I/O Status Display
- MMU Status Display

SPECIFICATIONS

Physical Dimensions

229mm H x 381mm W x 203mm D
9" H x 15" W x 8" D

Power Consumption

25 Watts (typical) · 120 Watts (max)
89 to 135 VAC · 57 to 63 Hz

Weight

6 kg (typical)
14 lbs. (typical)

Temperature

-34°C to +74°C
-30° F to +165° F

For more advanced future features and/or more information on Siemens hardware products call (512) 837-8310 or call your local dealer (see website for the dealer in your area).

Siemens reserves the right to alter any of the Company's products or published technical data relating thereto at any time without notice.

Siemens Energy & Automation, Inc.
Business Unit Intelligent Transportation Systems

8004 Cameron Road
Austin, TX 78754
Ph: (512) 837-8310
Fax: (512) 837-0196
http://www.itssiemens.com

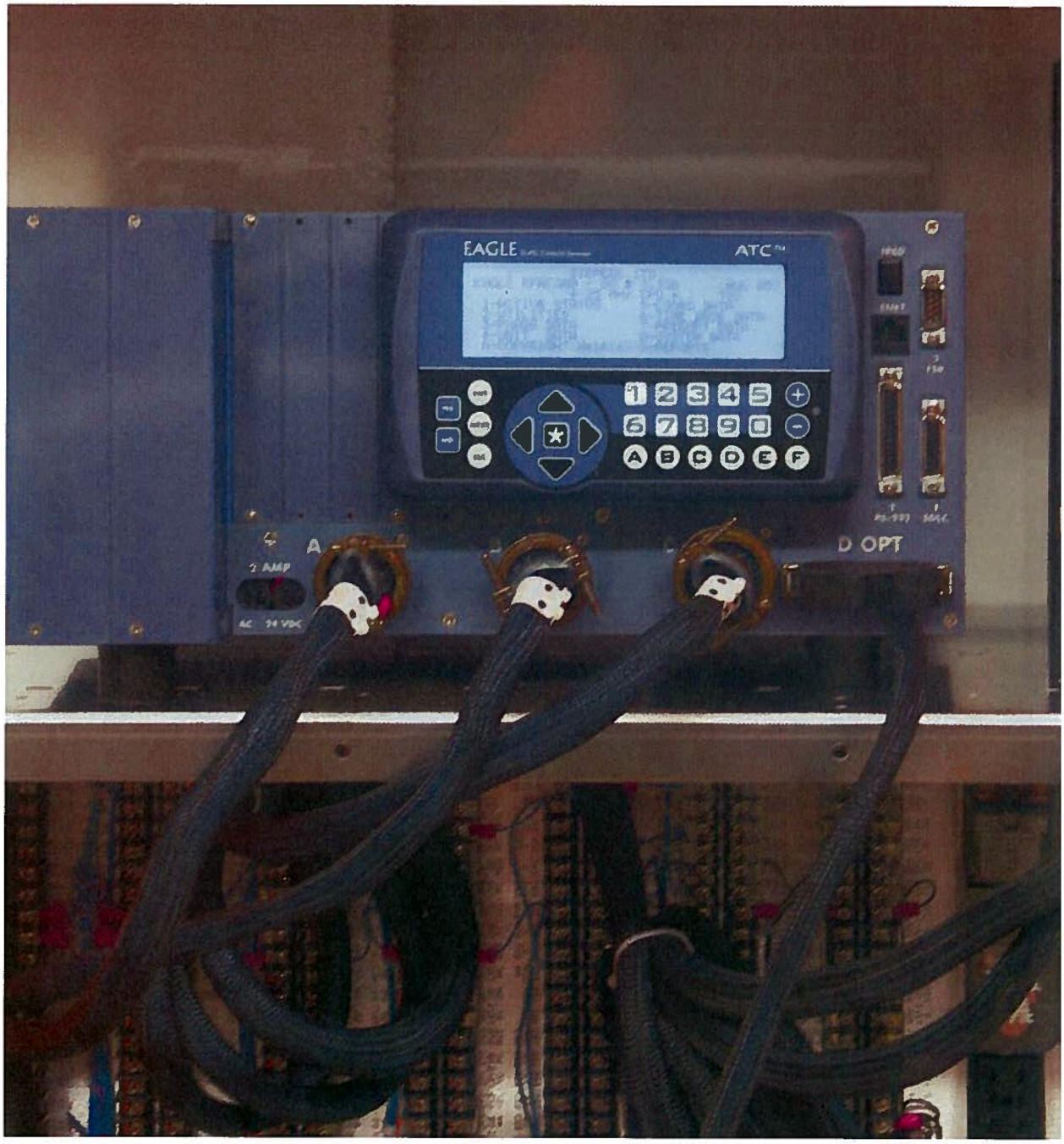
SIEMENS











EAGLE EPAC® M50 Series Controller

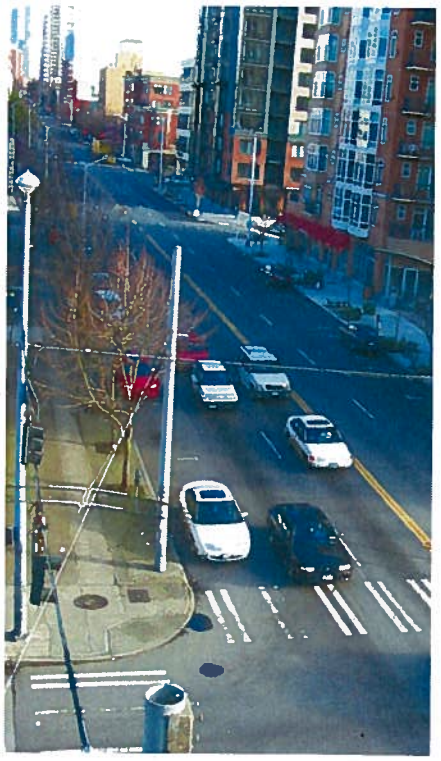
A trendsetter since its introduction, the M50 Series provides state-of-the-art features and functionality, including SEPAC®, *NextPhase®*, and SafeSuite® local controller software.

www.itssiemens.com

SIEMENS



The optional next generation engine board, along with SafeSuite, allows the M50 Series to run multiple transportation software applications simultaneously.



The EAGLE EPAC M50 Series NEMA controller is an innovative, fully actuated controller unit with a full compliment of operational, programming, and diagnostic capabilities.

The M50 Series consists of the M51, M52, M53, and ATCnx® models. The M50 ATCnx includes the NEMA/AASHTO/ITE next generation engine board, which is available as an option for the other M50 models. The M50 can be loaded with SEPAC, *NextPhase*, SeMARC®, and/or SafeSuite (SafeSuite requires next generation engine board) – providing all the features of that particular proven software package.

The M50 series supports a variety of cabinet styles, including NEMA TS-1, TS-2 Type 1, and TS-2 Type 2; CALTRANS 332, 336, 340, 342, and 356; and NEMA/AASHTO/ITE 340, 342 and 356 ITS.

The M50 series meets and exceeds a number of industry standards and specifications.

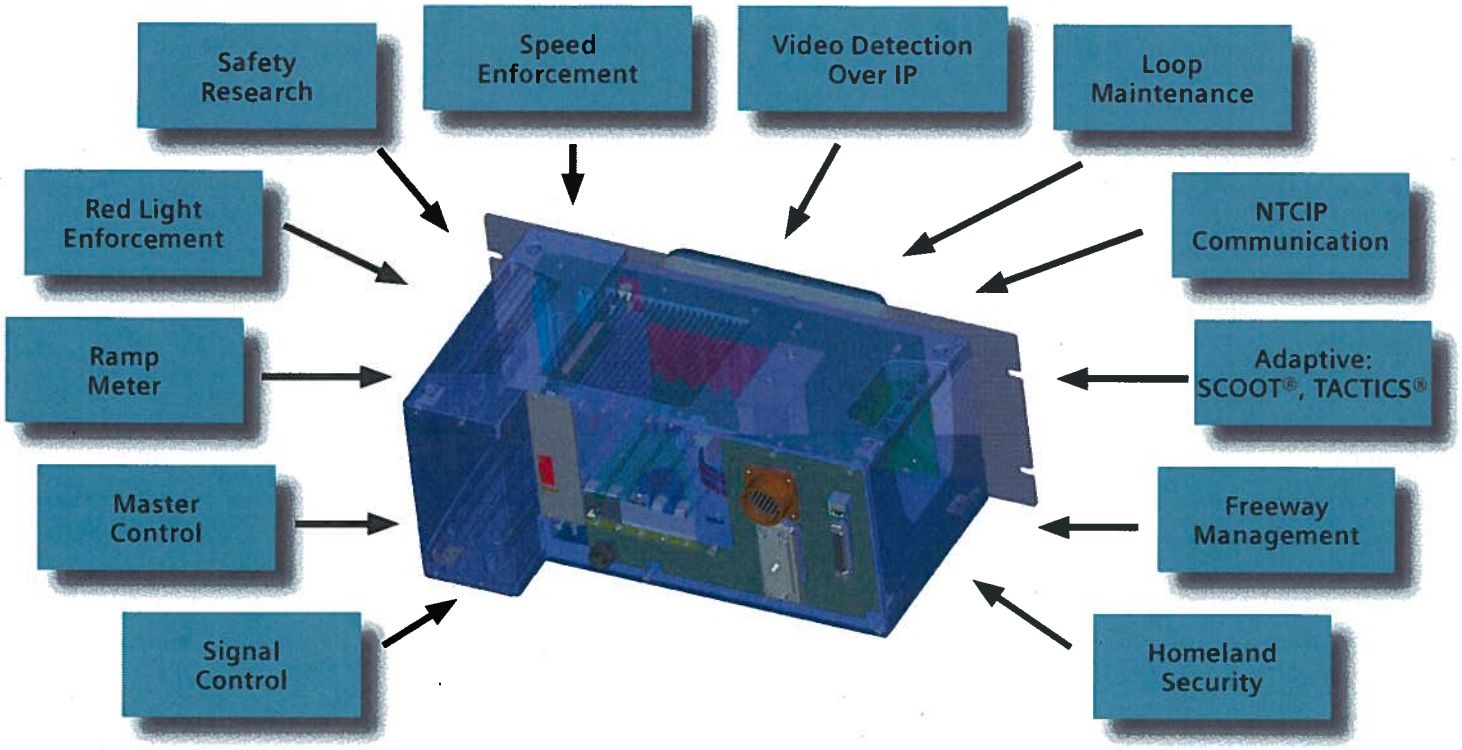
- Exceeds NEMA TS 1-1989 Standard for Actuated Controller Unit;
- Exceeds NEMA TS 2-1998 Standard for Actuated Controller Unit;
- Exceeds NEMA TS 2 -2003 Standard for Traffic Controller Assemblies with NTCIP Requirements;
- Exceeds NEMA/AASHTO/ITE Rev 5.2 Standard for Advanced Transportation Controller (with next generation engine board);
- M50 ATCnx is compatible with 2070 ATC (physical dimensions, cabinet connectors, modems, software) –
  - CALTRANS TEES 2002;
  - NEMA/AASHTO/ITE 2070 ATC.

The M50 series has many advanced functionalities beyond the normal NEMA standards.

- High impact polycarbonate case – makes it lighter than other NEMA controllers;
- External Infrared port for communication with laptops and PDAs;
- Built-in external 10 Base-T Ethernet port – with configurable IP;
- 8MB of flash memory – eliminates need for EPROM chips;
- Industry standard 3-U expansion slots;
- Standard ATC Modem options;
- Optional Datakey® module allows timing data to be easily carried from controller to controller;
- Removable hand-held front panel display that can snap to the front of the unit or connect via a cable – makes it convenient to program the M50.

In addition to the standard M50 features, the ATCnx offers new capabilities and enhancements in hardware design and communications.

- Meets ITE Next-Generation ATC standard;
- Increased support for IP-enabled intersection technology;
- Rack-mounted design, with back-of-cabinet wiring and access;
- USB port on front of controller - supports USB memory stick;
- Built-in Datakey access;
- ITS Cabinet connectors for SB1/SB2;
- Adapts to 15-pin NEMA TS-2 Port 1;
- Optional C1S and C11S connectors for 332 Cabinet;
- Two (2) separate 100-Base T Ethernet links, each with a 2-port hub – connect to IP-enabled intersection devices and the central network through back-of-cabinet wiring, accessing both via laptop or PDA through the front-of-controller connections, all without unplugging anything.



The next generation engine board, standard on the ATCnx and available as an option for the other M50 models, provides advanced functionality and software support.

- Faster, more powerful engine board – at least an order of magnitude faster than the 2070 ATC engine board – with substantial increase in flash memory drive and RAM;
- Runs both Linux and OS-9 operating systems, providing more options for third-party development;
- Preloaded with the SafeSuite software package, which includes *NextPhase*, SEPAC, SeMARC, NTCIP, Monitor, Enforce, and more, making it a comprehensive intersection control and monitoring system;
- Can run multiple-concurrent transportation software applications, offering true multitasking traffic control.

The M50 controller's removable front panel is an alphanumeric backlit LCD display unit with 8-lines and 40 characters per line.

Programming is easy and error free using English Language Menus. Within a menu, each parameter can be viewed and a cursor moved to that parameter for changes. Related parameters are visible simultaneously, making verification an easy matter. The screen provides both programming area identification and editing prompts.

The display unit connects to the controller via a dedicated C60 port.

The removable front panel works with all M50 models, as well as Siemens' next generation Central Business District Cabinet [CBD]. Because they are portable and work with all M50 controllers, a agency only needs as many front panels as it has field technicians (plus a few spares). This provides agencies a cost savings on installations of M50s and CBDs.

The M50 Series Controller Unit is designed for efficient operation and ease of maintenance.

The chassis is made of injection molded, high impact polycarbonate and is designed for easy access to the boards for testing without disassembly. A molded handle makes the lightweight controller easy to carry. The ATCnx features a metal face-plate for rack-mounting.

Adjustable rubber feet (except on ATCnx) along the front allow users to change the angle of the display and create more or less space around the controller. Grounding metal feet (except ATCnx) in the rear stabilize the controller. The controller is convection-cooled via vents along the sides and/or back of the controller.

NEMA TS-2 controllers provide performance and diagnostic enhancements over TS-1 controllers.

TS-2, Type 1 and Type 2 controllers use high speed data channels between all major components within the terminal and facilities. In addition, Type 2 controllers provides backward compatibility with TS-1 controllers through MSA, MSB and MSC connectors, as well as a 37-pin "D" connector.

Controller assemblies with TS-2 detector racks provide increased capability, consume less power, and provide additional diagnostic data to the controller via the SDLC port, allowing the controller to take corrective action much earlier than one based on internal diagnostics.

Physical Dimensions – M51, M52, M53
7" H x 15.5" W x 9.5" D
(177 mm H x 394 mm W x 241 mm D)

Physical Dimensions – ATCnx
7" H x 19" W x 9.5" D
(177 mm H x 483 mm W x 241 mm D)

Weight
8 lbs. / 4 kg (typical)

Power Consumption
25 Watts (typical) • 120 Watts (max)
89 to 135 VAC • 57 to 63 Hz

Temperature
-30° F to +165° F
(-34° C to +74° C)

For more advanced future features and/or more information on Siemens hardware products call (512) 837-8310 or call your local dealer (see website for the dealer in your area).

Siemens reserves the right to alter any of the Company's products or published technical data relating thereto at any time without notice.

Datakey is a registered trademark of Datakey Electronics, Inc. EAGLE, EPAC, SEPAC, *NextPhase*, SafeSuite, ATCnx, SeMARC, and TACTICS are registered trademarkes of Siemens Energy & Automation, Inc., Business Unit Intelligent Transportations Systems. SCOOT is a registered trademark of Siemens Traffic Controls Limited and Siemens Energy & Automation, Inc., Business Unit Intelligent Transportations Systems. The Tux image is © Copyright 1997 Larry Ewing (lewing@isc.tamu.edu).

Siemens Energy & Automation, Inc.
Business Unit Intelligent Transportation Systems
8004 Cameron Road, Austin, TX 78754
Ph: (512) 837-8310 • Fax: (512) 837-0196



www.itssiemens.com

ECONOLITE
Solutions that Move the World®

ASC/2S Series NEMA TS2 Actuated Controllers



The ASC/2S combines the ASC/2's familiar software, data module, and telemetry with new hardware for greater reliability and lower cost of ownership.

Description

In 1992 the ASC/2 Series was the first NEMA TS2 Type-1 or Type-2 controller offered to the marketplace. In 1998, the industry standard was raised once more with the introduction of the next member of the ASC/2 family - the ASC/2S.

The ASC/2S provides all of the features of the ASC/2 family of controllers with an updated hardware design that allows the ASC/2S to serve as a platform for future traffic management applications. This includes being NTCIP compliant and compatible with all Econolite systems.

The ASC/2S is designed using the latest in surface mount technology. This offers the end user a controller that is more reliable, easier to maintain, and less costly than earlier generation controllers. The ASC/2S, utilizes the same software, plus telemetry and data modules of the field-proven ASC/2 family of controllers.

The majority of the electronic components of the ASC/2S are contained on one easy to replace module. All software in the ASC/2S is stored in flash EPROMs. This allows quick and easy software updates in the field without changing PROMs. ASC/2S software is easily updated using either a laptop computer or optional software installation module (SIM). A complete software update can be accomplished in minutes.

The ASC/2S uses the industries largest LCD display module (16 line x 40 character alphanumeric) module to simplify the user interface. This display provides improved viewing in all lighting conditions. In addition, an optional display heater is available to enhance display performance in environments with extended periods of below 0° F.

Controller Models

The ASC/2S is available in two models. All models share a common enclosure, power supply, data, telemetry, and processor/input/output modules:

- ASC/2S-1000: TS2 Type-1
- ASC/2S-2100: TS2 Type-2/TS1

Features

- Exceeds NEMA TS2 and TS1 requirements
- NTCIP compliant (optional)
- Advanced Transit Signal Priority (TSP) functions (optional)
- Surface-mount technology provides increased reliability
- Flash EPROM simplifies software installation
- Optional 1 MB memory for custom applications
- Windows-based remote user interface program (optional)
- Rechargeable lithium battery eliminates disposal problems
- 16 x 40 LCD display with automated contrast adjustment
- Optional display heater for extended periods below 0° F
- Enhanced electrostatic discharge and line transient protection
- Multi-system protocol support

ASC/2S-1000: TS2 Type-1

The first version, the ASC/2S-1000 meets and exceeds the requirements of the NEMA TS2 Type-1 Standard. Its interface controls all inputs and outputs over a high-speed RS-485 serial bus (Port 1) with digital addressing to simplify cabinet wiring. This bus is also interfaced directly to a TS2 Malfunction Management Unit (MMU) for enhanced malfunction monitoring.

ASC/2S-2100: TS2 Type-2/ TS1

The second version of the ASC/2S family, the ASC/2S-2100, provides all of the capabilities of the previous two models, plus I/O expansion for compatibility with Econolite's ASC-8000 controller. This adds an I/O expansion "D" connector and a 25-pin telemetry connector which match those of the ASC-8000. This allows the ASC/2S-2100 to be used as a replacement for an ASC-8000 or other TS1 controller.

Control features

- 12 phases, 8 concurrent groups, 2 timing rings
- All standard NEMA TS1 and TS2 timing functions
- Up to 16 overlaps can be created
- 12 pedestrian phases
- Exclusive pedestrian operation
- Pedestrian overlaps
- Soft recall
- Phase re-service
- Dynamic max operation

Coordinator features

- 64 coordination patterns, each with its own cycle, offset, and split set
- Three interconnect methods: Plan, TS2, standard
- Offset and split entries are available in percent or in seconds
- Automatic permissive periods
- Fixed or floating force-off

Preemptor features

- 6 priority and 4 bus preemption sequences
- Optional TSP control

Time-of-day features

- Separate control for NIC® (non-interconnected coordination and Time-of-Day (TOD) functions
- 16 day programs
- 10 week programs
- Year program with 53 weeks
- 36 holiday programs, fixed or floating
- 200 NIC program steps
- 100 TOD program steps

Status display features

- Keyboard selection of detailed dynamic status displays for each of the main controller unit functions, including: controller, coordinator, preemptor, NIC/TOD, detectors, and MMU

Detector features

- 64 vehicle detectors
- 16 system or speed detectors
- 9 detector types
- Detectors individually assignable to phase and functions
- Lock/non-lock function by detector

Logging features

- Separate buffers for detector logging, detector failures, controller events, and MMU events
- Logged data can be viewed on front panel, retrieved via RS-232 terminal port, or transferred via telemetry

Telemetry features

- Compatible with KMC-10,000 or ASC/2M-1000 zone masters
- 1200 bps FSK 2/4 wire telemetry or 1200-19,200 bps RS-232 telemetry
- RS-232 modem port
- Multi-protocol support

Available Option Models

- ASC/2S-1000 TS2 Type-1
- ASC/2S-2100 TS2 Type-2

Telemetry

- 1200 bps FSK 2/4 wire
- RS-232 1200 - 19.2K bps

Protocols

- ECPIP (Standard)
- AB3418 (Standard)
- AB3418+ (Optional)
- NTCIP (Optional)
- Protocol 90™ (Optional)

Other Features

- Display Heater
- Overlap Card & Connector
- Shelf-mounted

© 2007 Econolite Control Products, Inc. All rights reserved. Econolite Control Products, Inc. reserves the right to change or update these specifications at any time without prior notification

3360 E. La Palma, Anaheim, CA 92806-2856
Tel: (714) 630-3700 • Fax: (714) 630-6349
E-mail: sales@econolite.com
www.econolite.com
38205E0607-3

ISO 9001 REGISTERED

ECONOLITE
Solutions that Move the World®

ECONOLITE

Solutions that Move the World®

ASC/3 Series NEMA TS2/NTCIP Actuated Controllers



The ASC/3 combines the requirements of NEMA TS2 and NTCIP, along with new hardware and the familiar software features of the ASC/2, allowing a lower cost of ownership and expanded adaptability for developing traffic strategies.

Description

The ASC/3 is the latest in a series of Advanced System Controllers offered by Econolite. It builds on the proven software, design flexibility, and unique feature set of the popular ASC/2 family of controllers.

The ASC/3 has been developed to fully comply with NEMA TS2 requirements. In addition, the design, manufacturing, and testing of the ASC/3 have used processes controlled by the latest ISO quality standards.

The ASC/3 provides an updated hardware design that allows it to serve as the traffic control platform for present and future traffic management environments. This includes NEMA TS2 and NTCIP compliance and compatibility with all existing Econolite systems.

The ASC/3 was designed using the latest electronics technology, which offers the user a controller that is more reliable, easier to maintain, and interchangeable with older TS1 and TS2 controllers while continuing to offer a competitive price.

All firmware in the ASC/3 is stored in flash memory. This allows for quick and easy software updates in the field without changing hardware. The ASC/3 firmware is easily updated in the background while the intersection remains in operation. Once updated, the controller only needs to be power cycled to allow the new firmware to take control. The majority of the electronic components of the ASC/3 are contained in one easy-to-replace module.

The ASC/3 uses the largest LCD display module (16 lines x 40 characters) in the industry to simplify the user interface. This display provides improved viewing in all lighting conditions. In addition, an optional display heater is available that enhances the display performance in temperatures below 0° F (-18° C).

Controller Models

The ASC/3 is available in two models. Both share a common enclosure, power supply, processor, keyboard, display and optional data key telemetry and Ethernet modules.

- ASC/3-1000: Dedicated to the TS2 Type-1 environment
- ASC/3-2100: Can operate in any TS1/TS2 Type-1 and TS2 Type-2 environment

(Optional ASC/3 SL [Slim Line] Series chassis available for both models)

Features

- Exceeds NEMA TS2 requirements
- State-of-the-art manufacturing and design for reliability, maintainability, and cost-effectiveness
- Designed, manufactured, and tested in an ISO-certified environment
- Windows-based remote user interface (optional)
- Advanced controller, coordinator, and preemptor features
- Optional Data Key Module
- Optional Ethernet support for 10/100 Base T networks
- Optional Transit Signal Priority (TSP) software module
- Optional Intersection Monitor (IM) software module
- 16 x 40 LCD display with adjustable contrast
- Enhanced transient and environmental protection
- Protocol support for ECPIP, NTCIP, and AB3418
- Software support for *icons*™, **Aries®**, and any NTCIP 1202, level 2-compliant applications
- Software and upgrades can be easily downloaded via laptop or PDA
- User-programmable default database
- Database and logs uploadable via laptop or PDA
- Data key backup and restore capabilities

ASC/3-1000: NEMA TS2 / Type-1

The ASC/3-1000 meets and exceeds all the requirements of the NEMA TS2 Type-1 Standard. Its interface controls all inputs and outputs over a high-speed RS-485 serial bus (Port 1) with digital addressing that simplifies cabinet wiring. This bus also interfaces directly to a TS2 Malfunction Management Unit (MMU) for enhanced intersection monitoring.

ASC/3-2100: NEMA TS2 Type-2 / TS1

The ASC/3-2100 meets and exceeds all the requirements of the NEMA TS2 Type-2 Standard. It also provides downward compatibility to the Econolite KMC-8000, ASC-8000, ASC/2-2100 and ASC/2S-2100 controllers as well as other NEMA TS1 controllers.

An optional 25-pin telemetry connector matches the KMC-8000 and ASC-8000. This allows the ASC/3-2100 to be used as a direct replacement for these older controllers.

Control features

- 16 phases, 8 configurable concurrent groups in 4 timing rings
- All standard NEMA TS1, TS2 and NTCIP functions
- 16 timed vehicle overlaps
- 16 pedestrian phases that can be configured as pedestrian overlaps
- Exclusive pedestrian operation
- Soft vehicle recall
- Conditional service
- Dynamic max operation
- Bike minimum green, second walk and pedestrian clear times, plus a walk and pedestrian clearance maximum
- Advanced walk
- Pedestrian clear protect
- Red maximum
- Vehicle extension 2
- Guaranteed minimum green, walk, ped clear, yellow, red, red revert and overlap green
- Redundant monitoring of the MMU status to enhance intersection monitoring
- 4 timing plans selectable on TOD or coordination plan basis or for one cycle following preemption
- Powerful logic processor

Coordinator features

- 120 coordination patterns, each with its own cycle, offsets and split plan selection
- 120 split plans, each with its own coordinated phases, vehicle and pedestrian recall and phase omits
- Offset and split entries displayed in percent or seconds
- Automatic permissive periods
- Fixed or floating force-off
- Crossing arterial coordination
- Quick-sync feature

Preemptor features

- Ten preemption sequences. Each may be configured as priority, first-come-first-serve, or bus preemption operation
- ECPI interlock to provide added monitoring safety

Time Base features

- 200 schedule programs, configurable for any combination of months, days of the week, and days of the month
- 36 fixed or floating exception day programs that override the day plan event on a specific day
- 50 day plan events that can use any of the 100 action plans
- 100 action plans that can be used by any of the 50 day plans

Status display feature

- Keyboard selection of detailed dynamic status displays for each of the main controller unit functions including: controller, coordinator, preemptor, time base, detectors, and MMU

Detector features

- 64 vehicle detectors
- 16 system or speed detectors
- Unique detector types and operation
- Individually assignable to phase and functions
- Lock/non-lock function by detector
- 4 detector plans
- 4 detector diagnostics plans
- Logging of volume and/or occupancy assignable by detector
- 4 pedestrian diagnostic plans

Logging features

- Separate buffers for detector activity, detector failures, controller events, and MMU events
- Logged data can be viewed on front panel, retrieved via RS-232 terminal port, or transferred via telemetry to a traffic management center

Telemetry features

- Can be configured to be compatible with KMC-10,000 or ASC/2M-1000 zone masters and *icons* or **Aries** systems
- 1200/9.6K bps FSK 2/4 wire telemetry module (optional)
- Multiple RS-232 1200-115.2 Kbps serial ports
- Multi-protocol support: ECPIP (Standard), AB3418 (Standard), NTCIP (Standard)

© 2007 Econolite Control Products, Inc. All rights reserved. Econolite Control Products, Inc. reserves the right to change or update these specifications at any time without prior notification

3360 E. La Palma, Anaheim, CA 92806-2856
Tel: (714) 630-3700 • Fax: (714) 630-6349
E-mail: sales@econolite.com
www.econolite.com
38203E0607-3

ISO 9001

ECONOLITE
Solutions that Move the World®



3000E™ Series
NEMA TRAFFIC SIGNAL CONTROLLERS

TRAFFIC CONTROL

The 3000E Series is one of a global range of Traffic Signal Controllers developed by Peek Traffic to meet the differing demands of governments, traffic authorities and vehicle users world-wide.

The 3000E Traffic Signal Controller is designed specifically to meet US NEMA standards and is an enhanced version of the Peek 3000 Series Advanced NEMA Traffic Controller. The proven software of the current 3000 series controller has been improved with a new user interface and complimented by a new front panel layout. The rugged enclosure design facilitates easy access to all components from the front of the controller resulting in simpler maintenance and adaptation to ITS applications.

The 3000E utilizes the proven Motorola 68302 32-bit processor with extended memory for data logging. An efficient power supply and the use of surface mount technology and HCMOS logic provides added quality and improved reliability.

Available in a variety of configurations exceeding both NEMA TSI and TS2 standards, the 3000E unit offers extensive customized D module configurations that are directly compatible with legacy Peek Transyt / TCT and other vendors' D modules.

In the TS2 Type 1 configuration, the 3000E controls all inputs and outputs through the Port 1 high speed EIA-485. In the Type 2 TS1 / TS2 standard, the unit includes the features of the Type 1 unit plus the TS1 standard MSA, MSB, MSC connectors, and various D modules, for downward compatibility with NEMA TS1 cabinet facilities. Both models also provide a Port 2 EIA-232 terminal and a Port 3 telemetry interface capable of supporting protocols for various systems.



FEATURES

- Enhanced functionality and user interface.
- 8 row x 40 column character display.
- Smart keyboard with user customized menu.
- Extensive context sensitive help screens.
- NEMA TSI and TS2 standards compliant.
- NTCIP compliant.
- 16 vehicle and pedestrian phases.
- 16 vehicle and pedestrian overlaps.
- 4 rings and 8 barriers.





Quixote Traffic Corporation

WWW.QUIXTRAFFIC.COM

ADDITIONAL FEATURES

Characteristic	Description
Built-in special capabilities	Multiple sequences including double clearance overlaps, not ped and exclusive ped overlaps, 4 timing plan sets, dynamic third max for each phase, extensive copy and diagnostics utilities.
Pedestrian override	Allows over timing of phases due to peds, without skipping or short timing other phases during coordination.
Cycle-based measure of effectiveness	Provides data on volume, speed and green utilization of phases.
Automatic full-time diagnostics	Power On Self Test (POST) diagnostics to verify microprocessor, memory, and programming. Continuous automatic diagnostics to verify essential elements of controller operation. Dynamic testing of memory and processor. Logging of controller, BIU, MMU failures and detector inputs with descriptive error routines for each test.
Systems compatibility	Optional modem for hardwire communications, capable of operating in existing Bell 202 systems at 1200 baud and/or private line metallic systems at 9600 baud. Compatible with Smartways, CLMATS, MATS, NTCIP, and many UTCS systems.
Super twist LCD display	320 character (8 row - 40 column) adjustable contrast and timed backlight that automatically illuminates when any key is pressed. The LCD also supports 64 - 240 pixels for graphics.
Smart keyboard	Audible (selectable) and tactile feedback, group copy, context sensitive help and a user customized menu to eliminate unnecessary menu items.
Printer, computer remote control	EIA-232 (Port 2) Data Terminal Equipment (DTE) port for printer, unit to unit data transfer, upload and download with personal computer, dial-up modem, and radio.
Backups	Controller databases can be backed up to optional non-volatile EEPROM Cards.

SPECIFICATIONS

Characteristic	Description
Control	16 vehicle and pedestrian phases. 16 vehicle and pedestrian overlaps. Programmable 4 rings and 8 barriers. Steering of outputs.
Coordination	120 patterns, 24 cycles, 5 offsets/cycle, 24 splits, automatic permissives, 3 offset seeking modes, offsets to beginning or end of artery green, multi-arterial capability, fixed and floating force-offs, alternate timing plans by COS, split entries in seconds or percent. Auto calculation routines. Adaptive split selections.
Preemption	6 Preempt inputs with programmable priority.
Detectors	Assignable ped call inputs. 32/64 vehicle detector inputs with switching, stretch, delay and stop bar detector Lock/non-lock function by phase and input.
Calendar scheduler	99 year clock with 220 events, 20 base weeks, 32 day plans, 50 exception days, 255 circuit functions by TOD, programmable Daylight Savings Time, time clock reset input.
Dimensions	10.86H x 13.7W x 8.84D inches. (275.5H x 349.74W x 224.34D mm)
Weight	12.6 lb. (5.72 Kg)
Temperatures	-30°F to +165°F (-34°C to +74°C)
Options	▸ NEMA overlap program card. ▸ Supercap backed RAM. ▸ Various modularized D connectors. ▸ Hardwire interconnect. ▸ Port 3 communications options: - Integral fiber optic interface (MM 850nm). - Integral DSP modem (1200 / 9600 baud). - Auxiliary EIA-232 (1200-19,200 baud).

Quixote Traffic Corporation



WWW.QUIXTRAFFIC.COM

PEEK TRAFFIC

2511 Corporate Way • Palmetto, FL 34221
Tel: (941) 845-1200 • Fax: (941) 365-0837
Toll Free: 1-866-260-7335 • www.peek-traffic.com

Please contact Peek Traffic for customer inquiries about any of the company's Traffic Control, Data Collection, Enforcement, Detection, or Tolling products. To learn how Peek Traffic is making the world a safer place to travel, visit the Peek Traffic web site at http:\\www.peek-traffic.com.

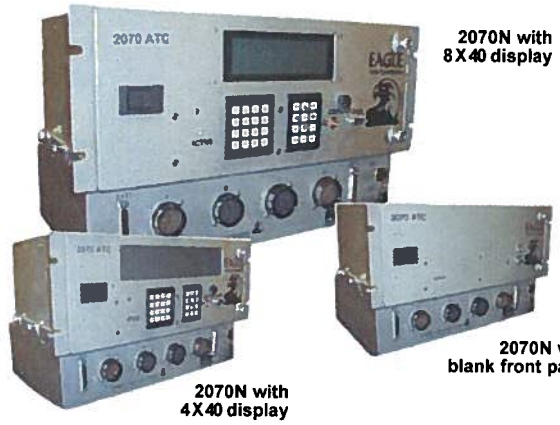
The information contained in this publication is presented for informational purposes only, and while every effort has been made to ensure its accuracy, the information is not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. No license is granted by implication or otherwise to any of Peek Traffic's intellectual property. Peek Traffic reserves the right to alter or revise any of its products or published technical data relating thereto at any time without notice.

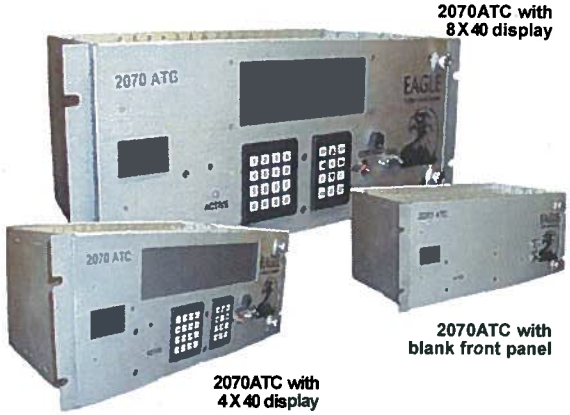
Copyright © 2004 Peek Traffic, A Quixote Company. All rights reserved. Printed in the United States.

SIEMENS

EAGLE 2070 ATC SERIES
2070 CONTROLLER

2070 Advanced Transportation Controller Units are advanced ruggedized field processors and communication systems configurable for a variety of traffic management applications. The controllers are modular in design and permit compatibility with 170, 170E, 2070 ATC, and NEMA specified equipment. The EAGLE-built 2070 ATC controllers meet and exceed Caltrans' Qualified Products List [QPL] and the Joint AASHTO/ITE/NEMA Advanced Transportation Controller Standard Specification.





SPECIFICATIONS

Physical Dimensions		Temperature	Power Consumption	Weight
2070ATC Unit	*NEMA Interface Module*			
177mm H x 260mm D x 483mm L 7" H x 10.25" D x 19" L	101mm H x 260mm D x 432mm L 4" H x 10.25" D x 17" L	-37°C to +74°C -34.6° F to +165° F	25 Watts (typical) 120 Watts (maximum)	2070ATC <11 kg/<25 lb 2070N <14 kg/<31 lb

Highlights

- Approved by Caltrans - Latest QPL
- Open Architecture insures compatibility with off-the-shelf products
- VME Hardware (VME chassis not included on the "lite" version)
  - -Standard VME interface modules from multiple vendors
  - -Standard OS-9™ Operating System
  - -Standard software modules from multiple sources
- Added VME boards and software extensions upgrade system easily
- 2 slots available for choice of dual serial, FSK, and fiber optic, EIA232 or 485 modems
- Multitasking - each 2070ATC unit can control multiple applications
- Multiprocessing - each 2070ATC unit can accommodate multiple CPUs
- High speed serial communications to CPU
- Designed and built for unattended operation in harsh environments
- Built-in 10 Base-T Ethernet with IP address on 2070-1B (2070L models)

Models Available

2070V
Mates to 170 style cabinets, 5-slot VME Cage Assembly, 4-line display

2070L
Mates to 170 style cabinets, Ethernet, 8-line display

2070LC
Mates to ITS cabinets, Ethernet, 8-line display

2070LN1
Mates to TS-1 or TS-2 Type 2 cabinets, Ethernet, 8-line display

2070VN1
Mates to TS-1 or TS-2 Type 2 cabinets, 5-slot VME Cage, 8-line display

2070VN2
Mates to TS-2 Type 1 cabinet, 5-slot VME Cage, 8-line display

2070LN2
Mates to TS-2 Type 1 cabinet, Ethernet, 8-line display

Numerous other configurations available — contact your dealer.

Traffic Application Software

SE-PAC - Proven Siemens ITS local controller software
SE-MARC - Proven Siemens ITS master controller software
NextPhase - Proven Siemens ITS local controller software
Other - Diagnostic Acceptance Test Software

Siemens ITS
Siemens Energy & Automation, Inc.
Business Unit Intelligent Transportation Systems

8004 Cameron Road · Austin, TX 78754
Ph: (512) 837-8310 · Fax: (512) 837-0196
http://www.itssiemens.com

A Look at the 2070 Advanced Transportation Controller...

Unit Hardware Features

- Metal housing, serial motherboard, single 96 pin DIN connectors for all plug-in boards (2070ATC)
- Three Front Panel options:
  2070-3A — 4 lines, 40 char/line backlighted Liquid-Crystal Display (LCD) (Each character 5mm wide x 10.44mm high) Two keypads on panel for programming
  2070-3B — 8 lines, 40 char/line backlighted Liquid-Crystal Display (LCD) (Each character 2.65mm wide x 4.24mm high) Two keypads on panel for programming
  2070-3C — No display, No keypad, No bell Programming via PC terminal C60 port

Operating System Features

- Standard Microware OS-9™ Multi-tasking and DOS-like commands
- Embedded real time kernel
- Sequential character file manager (SCFMAN)
- Sequential protocol file manager (SPFMAN)
- Pipe file manager (PIPEMAN)
- Random block file manager (RBFMAN)
- "C" input/output library
- Embedded Software Utilities:
  Flash drive, RAM drive, Timer library, Error logger, Validation suite for self-testing, Modem tester

Field I/O Module Features

2070-2A for Type 170 cabinet wiring
2070-2B for NEMA TS-2 Type 2 & ITS cabinets
2070-2N for NEMA TS-2 Type 1 cabinet

Common Features
- 614 Kbaud data rate to CPU
- SDLC compatible communication with CPU module
- Connector for external EIA-485 port

2070-2A Additional Features
- Motorola 68302 microprocessor, 25 Mhz
- Optically isolated - provides protection from lightning and surges
- Socket EPROM firmware for operational software
- Parallel I/O Ports - 64 bits each input and 64 output

2070-2N Additional Features
- 120 VAC outlet (accommodates 2070-4 line cord)
- Built-in CPU and memory emulates the 2070-8 NEMA Base (less additional inputs and outputs)

CPU Features (2070-1A & 2070-1B)

Common Features
- Motorola 68360 microprocessor, 25 Mhz
- 4 MB of DRAM (minimum)
- 512 KB supercap backed SRAM
- 8 MB of Flash memory
- Data Key
- Real Time Clock

2070-1A CPU
- 2 printed circuit boards:
  -Standard VME 3U size board (MCU) with OS-9™
  -Transition board plugs into serial motherboard bus

2070-1B "single-board" CPU
- 1 MB supercap backed SRAM
- RJ45 Ethernet Communications on Face Plate
- Standard TCP/IP protocols
- DB-25 EIA485 Serial Communications

Power Supply Features (2070-4)

- 10 amp
- Industrial-grade 100 watt quadruple output supply
- Internal safety circuitry senses and measures
- Efficient 50 Khz switching regulator
- Supercap storage system for memory backup without batteries

VME Cage Assembly

(2070-5A for 2070-1A CPU, not available for "lite" version)

- VME standard P1 bus, 3U high cage
- 5 Slots - 1 for CPU, 4 vacant slots for expandability (not included on "lite" version)
- Multiple CPUs can be used and data shared between the CPUs

Miscellaneous 2070ATC Features

- Access to serial ports under application software control
- Power supply module independent, self contained
- Input protection
- +5 VDC standby power using capacitor backup
- Safety circuitry monitors line voltage and output

Communication Modules Options

The two leftmost slots on the motherboard (from the back of the Model 2070ATC unit) are available for dual communications modules.

2070-6 Asynchronous Communications

2070-6A Module Features

- 300 to 1200 baud rate
- 2 channels to voice-grade telephone lines for data transmission
- Frequency Shift Keying (FSK) modulation
- Model 170 "Audio in" and "Audio out" configured connectors
- Face plate C2S and C20S connectors for FSK lines
- Face plate switches to select/enable 2 or 4 wire
- Face plate LED lamp for transmit and receive, and carrier detect for each modem
- Transmission Line: Type 3002, Voice grade, Unconditioned
- Tx output signal level: 0 to -8 dB
- Receiver input sensitivity: 0 to -40 dB
- Converts EIA-485 from the motherboard to telephone lines
- Dual channel
- Half or full duplex selectable

2070-6B Module Features

- Same as above, but with 0 to 9600 baud rate over a limited distance

2070-6D Module Features

- 2 channels to fiber optic lines for data transmission
- 1300 nM fiber optic single mode signal modulation
- Converts EIA-485 from the motherboard to fiber optic cables
- Front panel TxD and RxD fiber connector
- Separate TxD and RxD fiber connector that acts as a repeater for fiber ring
- Face plate LED lamp for transmit and receive on each modem
- Face plate type ST connectors to the fiber data and repeater fibers
- Transmission Line: Plastic or glass fiber cable, type depends on distance required.
- Dual EIA-232 and Dual EIA-485
- 0-614,400 baud

2070-7 Serial Communications Modules

Two Comm

- Two communication ports for connection to local serial devices, i.e. printers, terminals, personal computers, serial modems
- Face plate LED lamp for transmit and receive for each modem

2070-7

- Conforms to EIA-232 specifications for external modem
- 0-38,400 baud
- 9-pin "D" connector

2070-7A

- Conforms to EIA-232 specifications for direct connect
- 0-38,400 baud
- 9 Pin "D" connector
- Optical Isolation

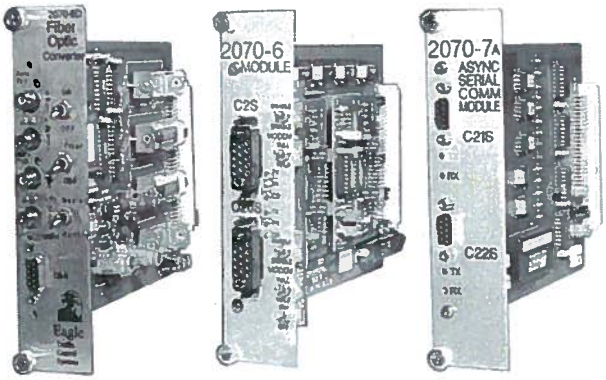
2070-7B

- Conforms to EIA-485 specifications for twisted pair
- 0-614,400 baud
- 15 pin "D" connector
- Optical Isolation

Other Communications Modules

- VME Ethernet adapter, OS-9™ drivers (requires 2070-1A)
- VME EIA-232 adapter, 8 channels (requires 2070-1A)

A few of the available communications modules



Fiber Connect **FSK Connect** **EIA Connect**

2070N NEMA (2070-8)
Compatibility Module Option - TS1 & TS2 Type 2

Compatibility with NEMA TS-1 and TS-2 Type 2 standard equipment is via the installation of the NEMA module (2070-8) and the SDLC compatible communication module (2070-2B). The 2070-8 module is mounted to the bottom of the 2070ATC unit, and is connected to the 2070-2B module via cable.

2070-8 Module Features

- NEMA specified "A," "B," and "C" connectors with 80 bits of input and 96 bits of output
- 63 pin "D" Connector
- C12 Cable to connect to 2070-2B
- Fault/Voltage Monitor Circuitry
- Internal Motorola 68302 microprocessor 25 Mhz
- Watchdog Circuit
- Parallel I/O Ports — 118 NEMA inputs, 102 NEMA outputs for NEMA TS1 and TS2 Type 2
- EIA-485 differential transmission for noise immunity
- 614 Kbaud data rate to CPU
- Secure SDLC Protocol
- Separate Power Supply
  - +24 VDC for External Logic
  - Input Protection
  - DC Voltage tolerance +/- 3%
  - LED DC Power Indicator
  - Incoming VAC Fuse Protection
- Two DB-25S Connectors
  - EIA-232 serial channel to 68302 processor (Ext 1)
  - 2 modem and 2- EIA-232 (Ext 2)
- Circuitry optically isolated
- 2070N Back Cover (optional, not required)

2070N NEMA (2070-2N)
Compatibility Module Option - TS2 Type 1

Compatibility with NEMA TS2 Type 1 standard equipment is via the installation of the NEMA module (2070-2N) that communicates to the standard NEMA BIU.

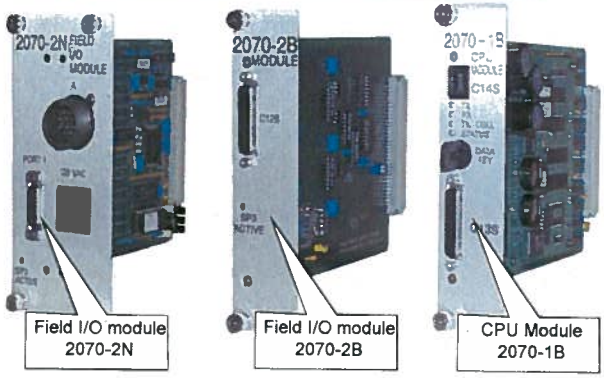
2070-2N Module Features

- NEMA Port 1 "D" connector (15 pin)
- NEMA TS-2 Type 1 "A" connector
- 153.6 SDLC Communications to BIU
- 120 VAC outlet for 2070 line cord

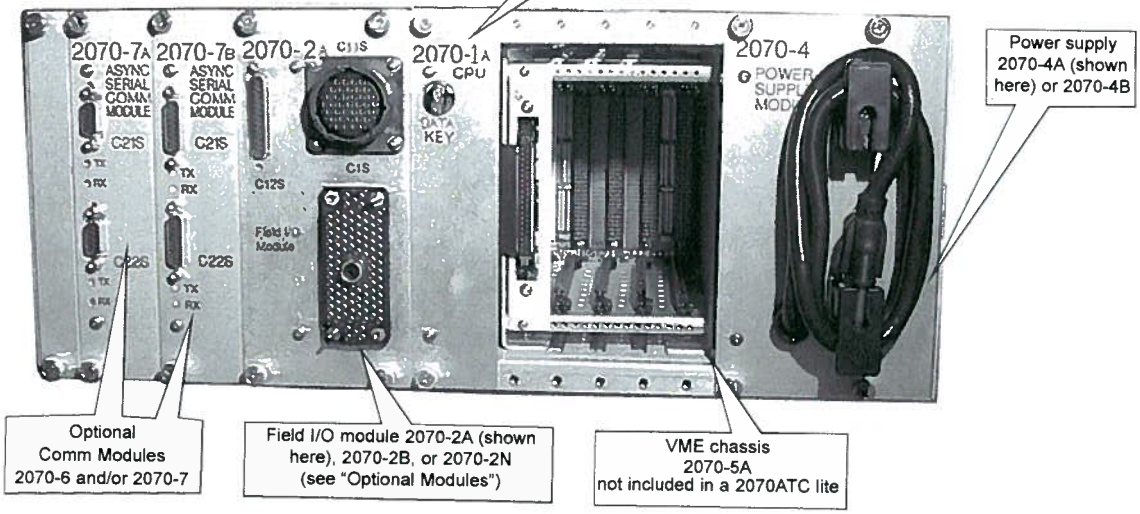
2070ATC Lite Option

- No VME chassis (Upgrade to a standard 2070V by adding the VME chassis)
- Requires a mounting bracket (2070-5B) for the 2070-1A MCU card

Optional Modules



2070 ATC Back View



Siemens ITS
Siemens Energy & Automation, Inc.
Business Unit Intelligent Transportation Systems

8004 Cameron Road · Austin, TX 78754
Ph: (512) 837-8310 · Fax: (512) 837-0196
http://www.itssiemens.com

ECONOLITE
Solutions that Move the World®

Model ATC2070 Controller Advanced Transportation Controller Series



Combines the flexibility of open architecture hardware with the power and performance of Econolite's 2070 software packages

Description

The Econolite Model ATC2070 Controllers are designed to meet the CALTRANS TEES specifications. This design allows the Econolite Model ATC2070 to be easily configured to fit all 2070, 170, 170E, and NEMA TS1 and TS2 Type-1 and Type-2 applications. While the hardware meets or exceeds industry standard traffic controller specifications, the extensive controller software base is supported through open architecture and a standard OS-9 multi-tasking operating system. The ATC2070 may be installed with one of Econolite's highly capable ASC/2070, ASC/3-2070, or **OASIS™** software packages (the culmination of Econolite's 70+ year background in the application of traffic control techniques) or any industry-available 2070 software which meets current CALTRANS TEES 2002 (errata 2) specifications.

The base Model ATC2070 unit employs the preferred "lite" serial backplane and chassis, along with an exceptional 8 x 40 LCD display. The "lite" chassis also supports its own CPU module (2070-1B) and one of three optional I/O modules - standard 170 cabinet interface (2070-2A) or NEMA cabinet interfaces (2070-2B or 2070-2N).

NEMA TS1 compatibility is achieved by the bolt-on addition of a 2070-8 NEMA Interface Module (chassis). The NEMA Interface Module will support all TS1 and TS2 Type-2 applications. In addition, a wide variety of communications modules are available to configure communications for all media (serial/FSK/Ethernet) or standards (AB3418/NTCIP/proprietary). The Econolite ATC2070 Controller series meets all applicable NEMA TS1 and TS2 standards as well as CALTRANS 2002 TEES (errata 2) specifications and joint AASHTO/ITE/NEMA ATC standards.

Features

- Open architecture design
  - OS-9 Operating System
  - Motorola 68360 Microprocessor, 25 MHz
  - Real-time multi-tasking
  - Meets CALTRANS TEES 2002 (errata 2) specifications
- Metal housing compatible with Type 170 chassis
  - Compatible with 170 or NEMA cabinets
  - Interchangeable with NEMA TS1 & TS2 controllers
- Flexible communications options
  - Ethernet interface capability
  - High-speed serial communications

Special Features

- Supports ASC/2070, ASC/3-2070, or **OASIS** software, or any Model 2070 specified software
- All-metal housing
- Single 96-pin DIN connectors for all plug-in board modules
- Synchronous Data Link Control (SDLC) communications across controller bus, between all modules
  - 614 Kbps data rate CPU to field I/O modules
- Single board design/serial motherboard
  - 8 MB DRAM/8 MB FLASH/+800kb "supercap" backed SRAM (30-day return)
  - Embedded software utilities: Flash drive, RAM drive, and timer library
- I/O modules use Motorola 68302 microprocessor (2070-2A and 2070-8)
  - Multiple-configuration parallel I/O ports
- Direct access to serial ports under application software control
  - Asynchronous, Synchronous, Hardwire (FSK), and Fiber-optic communications options
  - Built-in Ethernet port on CPU
- Independent, self-contained power supplies - I/O protection
  - Optical isolation provides protection from lightning and surges
  - Safety circuitry monitors line voltage and output
- Backup power supplied by capacitors - no batteries
  - +VDC standby power using capacitor backup
- 8 line x 40 char/line backlit Liquid-Crystal Display (LCD)

Controller Models

- The Model ATC2070 is available in two basic configurations:
  - Model ATC2070L for 170, 170E, and 2070 facilities & ATC2070L for TS2 Type-1 cabinets or other serial bus applications
  - Model ATC2070LN - for NEMA TS1 & TS2 Type-2 facilities

There are a significant number of module options to custom tailor either of the above models to customer-specific needs.

Power

- 115 VAC, 60 Hz, 25-120 W

Weight

- Model 2070L: 25 lb (11 kg)
- Model 2070LN: 31 lb (14 kg)

Temperature

- -34.6°F to +165°F (-37°C to +74°C)

Dimensions

- Model 2070L only:
  - 19 in. L x 10.25 in. D x 7 in. H (483 mm L x 260 mm D x 177 mm H)
- NEMA interface module only:
  - 17 in. L x 10.25 in. D x 4 in. H (432 mm L x 260 mm D x 101 mm H)

© 2007 Econolite Control Products, Inc. All rights reserved. Econolite Control Products, Inc. reserves the right to change or update these specifications at any time without prior notification

3360 E. La Palma, Anaheim, CA 92806-2856
Tel: (714) 630-3700 • Fax: (714) 630-6349
E-mail: sales@econolite.com
www.econolite.com
38201E0607-4

ISO 9001

ECONOLITE
Solutions that Move the World®



MODEL 2070 LITE
ADVANCED TRANSPORTATION CONTROLLER

OVERVIEW

The 2070 Lite controller from Quixote Traffic Corporation is a configurable field processor and communications system for traffic management applications such as adaptive intersection control, field master, integrated corridor management and other applications requiring field processing.

The 2070 Lite retrofits into industry standard cabinets. It's design is based upon Caltrans and NY DOT 170 traffic cabinet standards.

FEATURES AND BENEFITS

- 170 or NEMA cabinet compatibility.
- Open architecture.
- Flexible system implementation.
- Powerful and expandable.
- Designed to industry standard traffic controller specifications.

OPEN SYSTEMS ARCHITECTURE

Hardware

- Caltrans/NY DOT 170 cabinet digital interfaces (2070).
- 32-Bit microprocessor.
- 8 Lines by 40 characters LCD display with backlight.
- Modular 115-Watt power supply (with surge protection).
- Flexible communications options (e.g., serial twisted pair 202 modem, fiber, etc.).

Software

- Supports OS-9 and other real-time operating systems.
- Supports third-party software available for intersection control, communications, and other applications.

Standards

- Designed based on industry standard traffic controller specifications.



Quixote Traffic Corporation



WWW.QUIXTRAFFIC.COM

RUGGED ENVIRONMENTAL SPECIFICATIONS

- Operating range of -40°to +85°C (-40°to +185°F) for system modules.
- High-reliability, low-wattage design.
- Designed to limit EMI emissions.

COMMUNICATIONS MODULE

The 2070 Lite also has two general purpose serial channels that can be configured for EIA-232, -422, -485, and other electrical interfaces. The standard electrical interface is configured for EIA-232. Contact Quixote Traffic Corporation for additional requirements.

SOFTWARE

The 2070 includes a license for OS-9, an industry standard real-time operating system that may or may not be used in the end application. Application software is not an integral part of the 2070 controllers. Instead, application software is available from an extensive list of third-party software company suppliers, integrators, and DOTs.

MAINTENANCE AND RELIABILITY

The 2070 consist of replaceable modules, so the units are easy to maintain. Software upgrades are performed by serial downloads, eliminating the need to handle electronic components, which is one of the primary causes of system failures. Each module within the controllers is built using modern, low-wattage, high-quality components that meet or exceed IPC quality standards.

SPECIFICATIONS

System Level

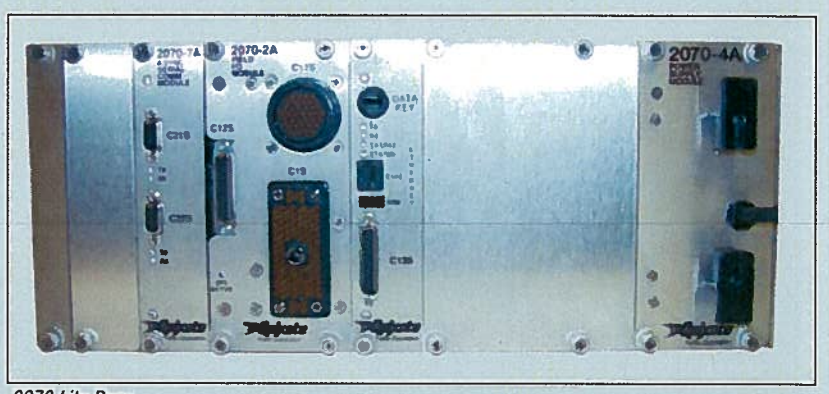
Temperature	▸ Ambient Operating	-34° to +74°C
	▸ Storage	-45° to +85°C
Relative humidity	95% max., noncondensing (4.4-43.3°C)	
Strength, shock	Max. 10G in orthogonal axis.	
Strength, vibration	5-30 Hz up to 0.5G in orthogonal axis.	
Height x Width x Depth	10.5" x 17" x 14"	

Front Panel

Display	8 lines by 40 characters.
Keypads	4 x 4 Hex and 3 x 4.

Power Supply

Wattage	115
Voltage	89-135 VAC applied line range.
Frequency, operating	57-63 Hz
Outputs	▸ +5 VDC @ 10A, +12 VDC @ 0.5A,
	▸ -12 VDC @ 0.5A, +12 VDC (isolated) at 1A



2070 Lite Rear



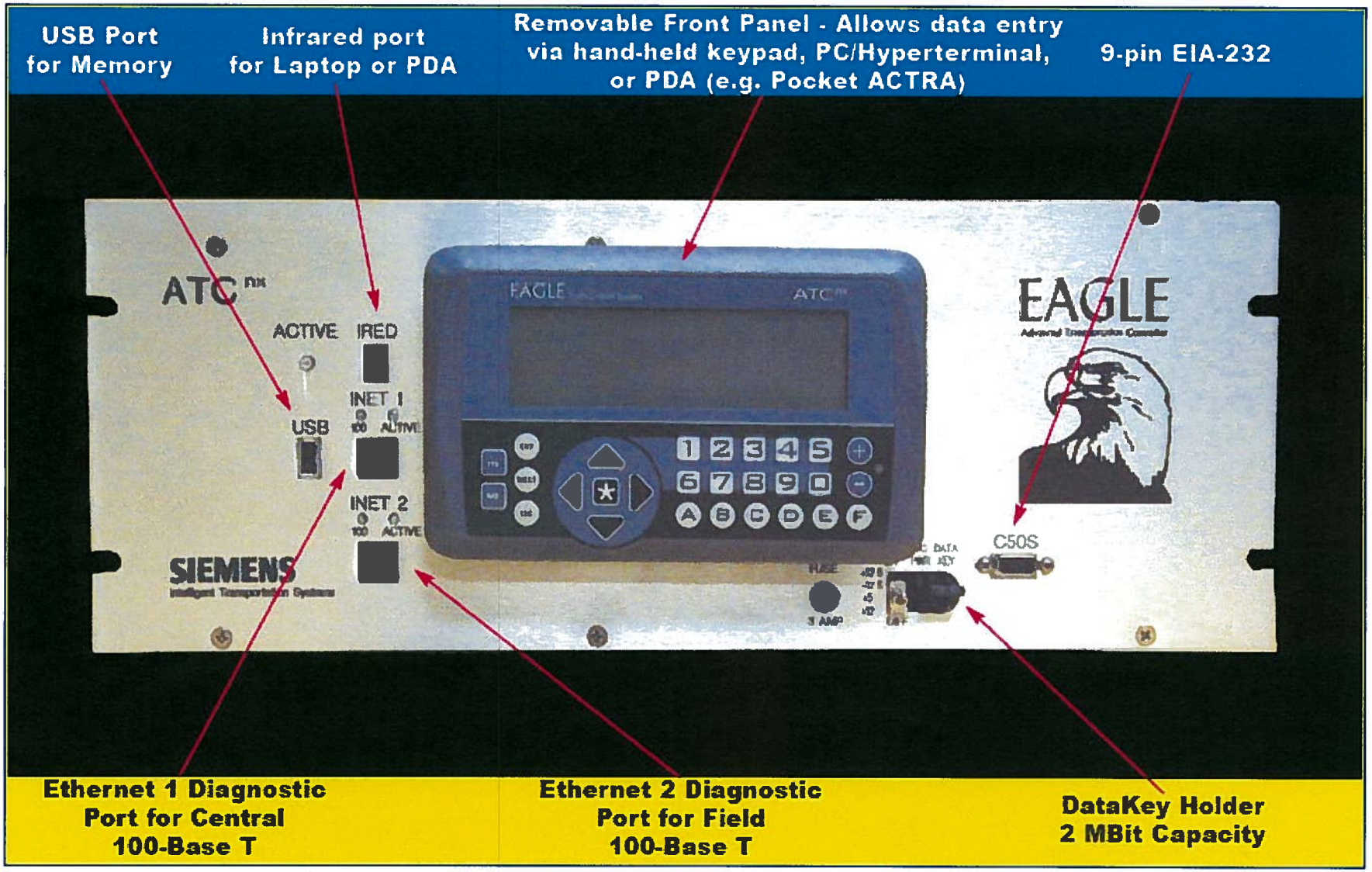
Quixote Traffic Corporation

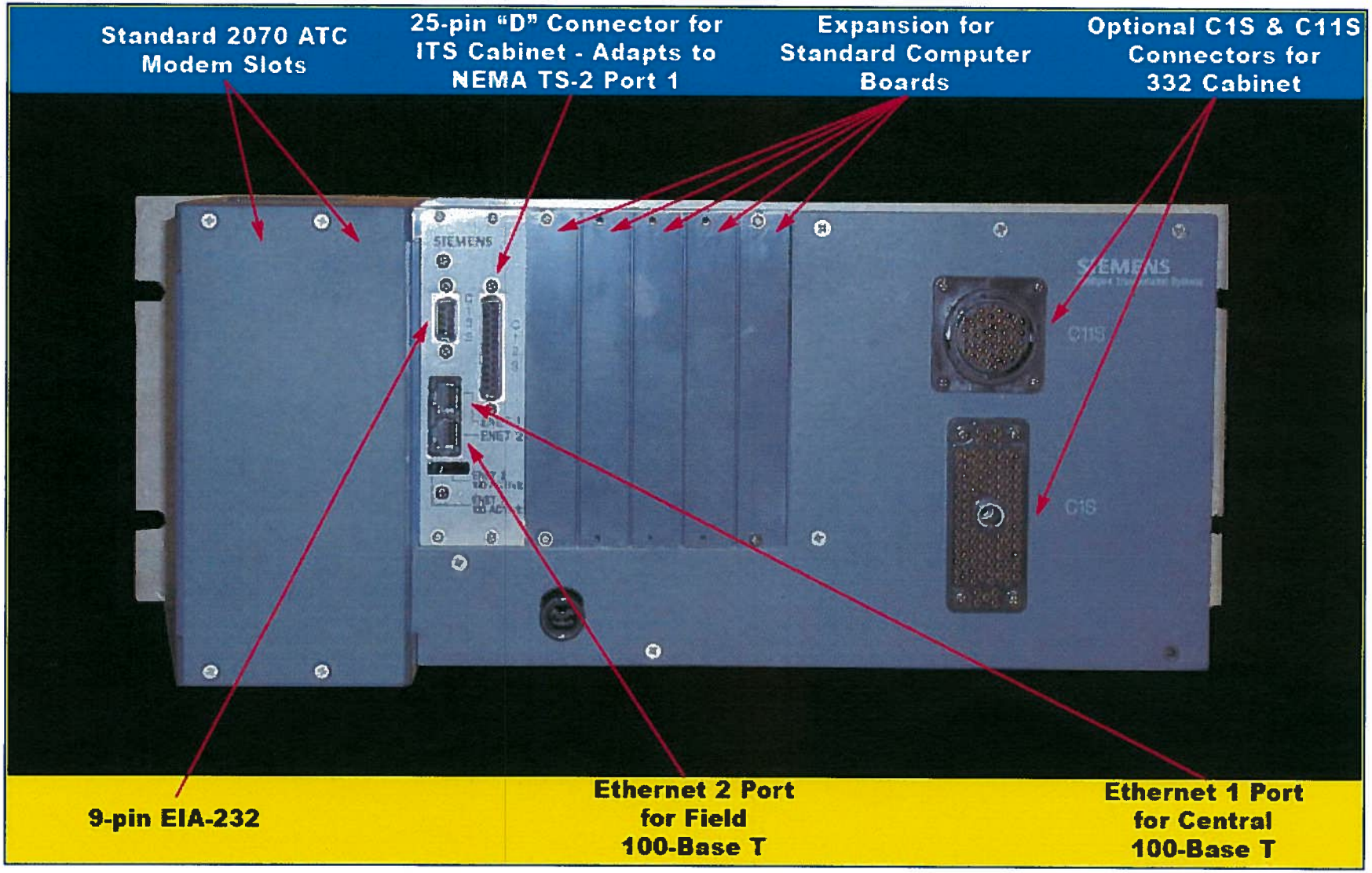
WWW.QUIXTRAFFIC.COM

ISO 9001: 2000 Certified Manufacturer

9603 John Street • Santa Fe Springs, CA 90670
Tel: (562) 923-9600 • Fax: (562) 923-7555
Toll Free: 1-800-733-7872

Specifications are subject to change without notice to reflect improvements and upgrades.


USB Port
for Memory
Infrared port
for Laptop or PDA
Removable Front Panel - Allows data entry
via hand-held keypad, PC/Hyperterminal,
or PDA (e.g. Pocket ACTRA)
9-pin EIA-232
ATC
ACTIVE
IRED
USB
INET 1
INET 2
SIEMENS
EAGLE
C50S
Ethernet 1 Diagnostic
Port for Central
100-Base T
Ethernet 2 Diagnostic
Port for Field
100-Base T
DataKey Holder
2 MBit Capacity


Standard 2070 ATC Modem Slots
25-pin "D" Connector for ITS Cabinet - Adapts to NEMA TS-2 Port 1
Expansion for Standard Computer Boards
Optional C1S & C11S Connectors for 332 Cabinet
9-pin EIA-232
Ethernet 2 Port for Field 100-Base T
Ethernet 1 Port for Central 100-Base T

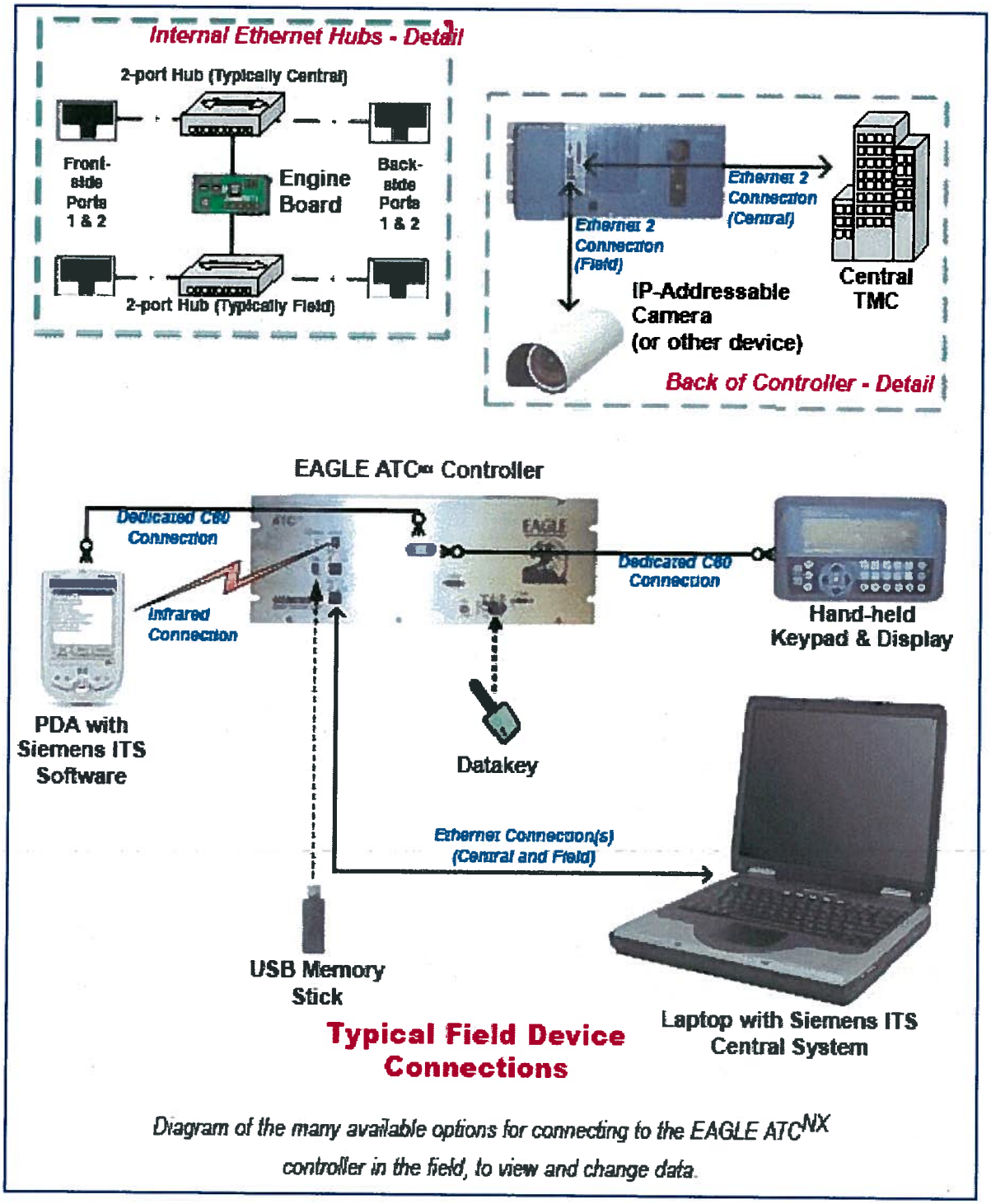


Diagram of the many available options for connecting to the EAGLE ATC^{NX} controller in the field, to view and change data.

Advanced New Hardware Features

Meets ITS Next-Generation ATC standard

Increased support for IP-enabled intersection technology

Faster, more powerful engine board - at least an order of magnitude faster than the 2070 ATC engine board, with substantial increase in flash memory drive and RAM

Rack-mounted design, with back-of-cabinet wiring and access

USB port on front of controller - supports USB memory stick

Two (2) separate 100 Base-T Ethernet links, each with a 2-port hub - connect to IP-enabled intersection devices and the central network through back-of-cabinet wiring, and access both on a laptop or PDA through front-of-network connections, all without unplugging anything.

Fusion Technology

Meets and exceeds NEMA TS-1 1989 and TS-2 2003 Actuated Controller Unit Standards (Paragraph 3.2.1). Also software compatible with CALTRANS 2002 TEES 2070 ATC - 2070 ATC and NEMA technology in one package

Runs both Linux and OS-9 operating systems - more options for third-party development

Runs the SafeSuite software package, including NextPhase, SEPAC, SeMARC, NTCIP, and more - a comprehensive intersection control and monitoring system

Runs multiple-concurrent transportation software applications - multitasking traffic control

Proven NEMA and ATC Capabilities

Removable front panel multi-line alpha-numeric backlit display, interchangable with other ATCnx controllers, as well as EAGLE EPAC M50 controllers and EAGLE Low-Power CBD cabinets

Flash memory is used to retain all timing and control parameters - no replacement of EPROMs necessary

Injection molded, high-impact polycarbonate case makes the EAGLE ATCnx controller much lighter than other ATC and NEMA controllers

Infrared port for communicating with laptops and PDAs

ITS Cabinet connectors for SB1 and SB2

Adapts to 15-pin NEMA TS-2 Port 1

Optional C1S and C11S connectors for 332 Cabinet

Physical Dimensions

177mm H x 483mm W x 241mm D

7" H x 19 " W x 9.5 " D

Temperature

-34°C to +74°C

30°F to 165°F

Power Requirements

Voltage

89 to 135 VAC

Frequency

57 to 63 Hz

Consumption

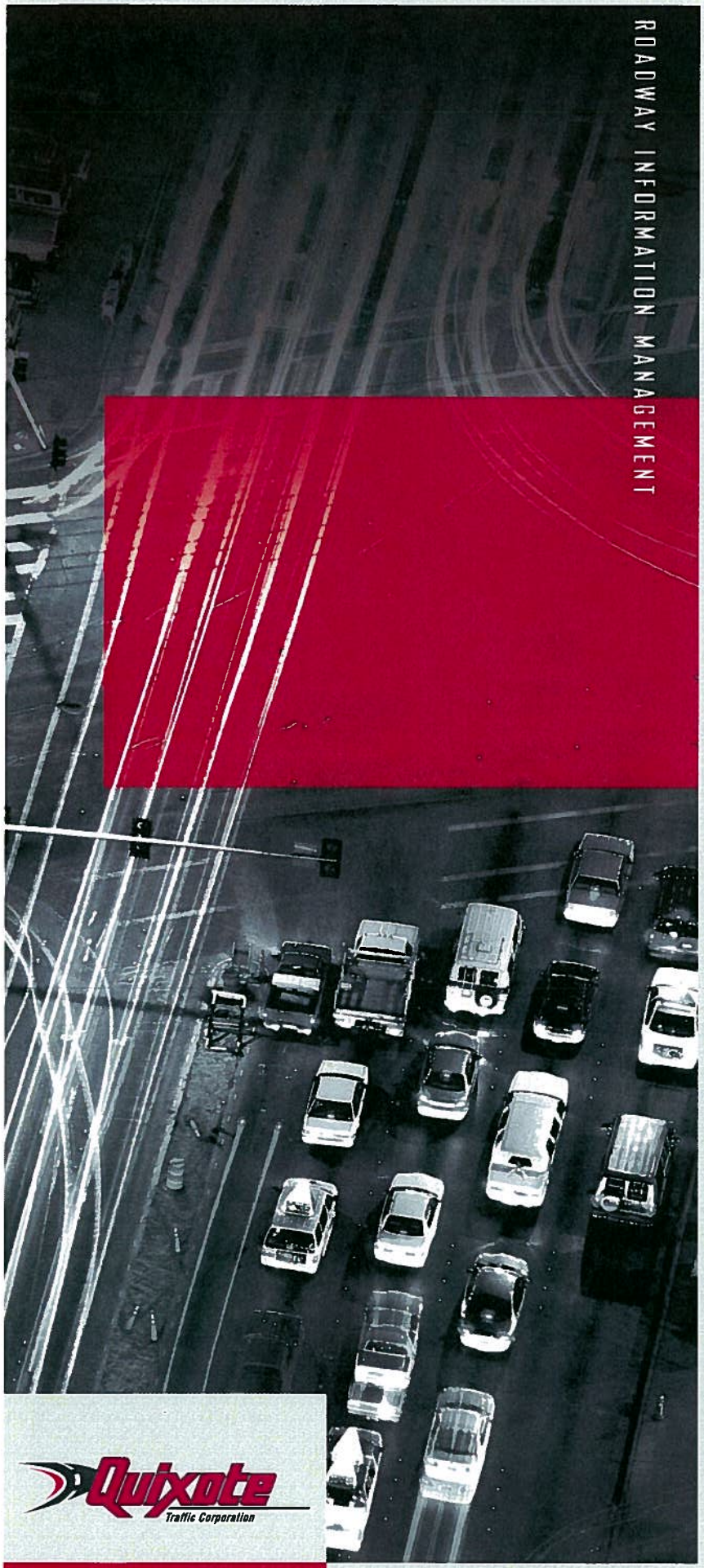
25 watts (typical)

120 watts (max)

Weight

8 lbs.

4 kg



IQ ATC

ADVANCED TRAFFIC CONTROLLER

MODEL 3000-PC-CBD
MODEL 3000-PC-TS2/2

OVERVIEW

The IQ ATC™ from Quixote Traffic Corporation is the next generation in advanced transportation control. It utilizes the latest in advanced embedded technology to provide the reliable and flexible operation required in today's advanced traffic control operations. The IQ ATC's innovative features, such as memory management control, allow for implementation of process isolation to ensure operational integrity. And, it works with IQCentral™.

Using an X86-based hardware platform and Real Time Operating System makes the IQ ATC extremely flexible, allowing for rapid software implementation and modification. Application software upgrades are made extremely easy using the high speed Ethernet port.

With these advanced features housed in a remarkably compact unit, the IQ ATC from Quixote Traffic Corporation sets a new benchmark for performance and versatility.

AVAILABLE MODELS

- CBD Model available for applications with space limitations
- NEMA TS2 Type 1 and Type 2 Models available for a wide range of applications



IQ ATC - CBD Model

IQ ATC - TS2 Model

Quixote Traffic Corporation

WWW.QUIXTRAFFIC.COM

INTELLIGENCE FROM QUIXOTE

FEATURES

- X86-based hardware platform with floating point and 8KB cache
- QNX Real Time Operating with memory management for process isolation.
- Compliant with NTCIP 1201, 1202
- 2070 compatible modem slot with full modem flow control support.
- 100MHz clock speed
- LCD display for status and diagnostics
- High speed USB port (optional)
- Infrared port (optional)

SPECIFICATIONS

Dimensions:	▸ 3000-PC-CBD- 8"H x10"Wx10"D (203 x 254 x 254mm)
	▸ 3000-PC-TS2- 8"H x 13"Wx10"D (203x330x254mm)
Weight:	▸ 13.2 pounds (6.0 kg) ....CBD
	▸ 12.8 pounds (5.8 kg) TS2
Power requirements	▸ 95 to 135VAC
	▸ 60Hz ± 3 Hz
	▸ 25 VA nominal
Enviroment:	▸ -35°F to + 165°F
	▸ -37°C to + 74°C
	▸ 0-95% relative humidity
Memory:	▸ 8MB Flash memory
	▸ 32MB SDRAM
	▸ 256KB SRAM
NTCIP compliant	The traffic application software is NTCIP software compliant ensuring easy integration into any NTCIP or ITS traffic control system. The IQ ATC also interfaces with IQ Central,™ Quixote Traffic Corporation's new central control system. Interfaces to both legacy PEEK & USTC controllers as well as NTCIP compliant devices.

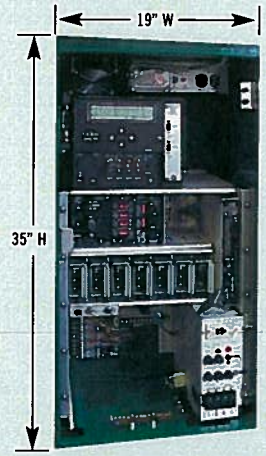
SPECIFICATIONS

Computer Interfacing	Intersections configuration is made easy with the available laptop computer interface software, allowing for prior configuration and rapid download in the field. Or, downoad from an NTCIP compliant central system. Store the configuration on a portable "flash drive" and download in the field in seconds!
Communications	Communication connectivity is easily achieved with multiple communication options available.

- 6 serial ports; SDLC support on 2 ports, RS 485 support on 1 port (jumper selectable)
- 10/100 BaseT Ethernet
- 2070 compatible modem slot with full modem control support.
- High speed USB port (optional)
- Infrared port (optional)

These options allows for interfacing to numerous communicatioins infrastructures including:

- Existing 1200 baud twisted pair
- High speed serial (RS232) up to 115kbps
- Fiber-optic modems
- Wireless systems
- LAN/WAN applications



3000-PC-CBD installed in ASTC-6 Pole-mounted cabinet (door removed).

Quixote Traffic Corporation



WWW.QUIXTRAFFIC.COM

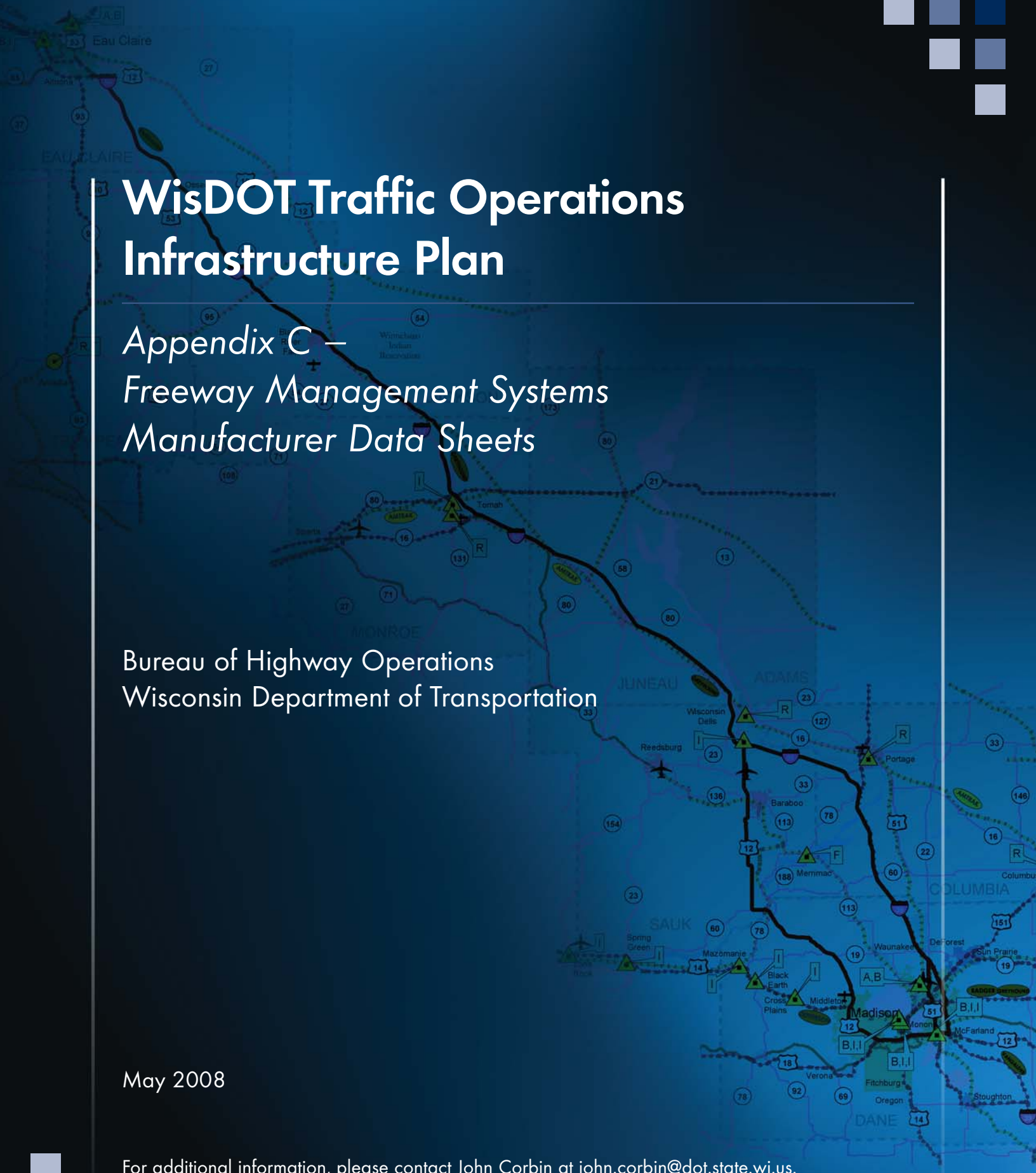
ISO 9001: 2000 Certified Manufacturer

9603 John Street • Santa Fe Springs, CA 90670
Tel: (562) 923-9600 • Fax: (562) 923-7555
Toll Free: 1-800-733-7872

Specifications are subject to change without notice to reflect improvement and upgrades.

WisDOT Traffic Operations Infrastructure Plan

Appendix C – Freeway Management Systems Manufacturer Data Sheets



Bureau of Highway Operations
Wisconsin Department of Transportation

May 2008

For additional information, please contact John Corbin at john.corbin@dot.state.wi.us.

T-110 SERIES

SINGLE CHANNEL SHELF MOUNT DETECTOR

Engineering Excellence!



- Meets and exceeds NEMA TS 1 specification.
- Six front panel DIP switches provide:
  - Seven levels of sensitivity plus off.
  - Presence or Pulse mode.
  - Four loop frequencies.
- Loop Fail Event Monitor remembers and indicates intermittent and current loop failures.
- Detector is self tuning and provides complete environmental tracking.
- Dual color, high intensity LED:
  - Green indicates detect.
  - Red indicates loop fail.
- Complete built-in detector integrity test.
- Space provided on front panel to label detector.
- Audible detect signal (buzzer) facilitates loop and/or detector troubleshooting.
- Call Delay and Call Extension timing.

With Audible Detect Signal

Ordering Information:

Model T-110-R	Single channel detector with Relay outputs, Call Delay and Call Extension.
Model T-110-SS	Single channel detector with Solid State outputs, Call Delay and Call Extension.

Overview:

The Model T-110 series is designed to meet or exceed NEMA Standards TS 1-1989. Model T-110 detectors are single channel, shelf mount type loop detectors with Delay and Extension timing. Detect and loop fail indications are provided via a dual color, high intensity LED. Available with both Relay and Solid State outputs, the Model T-110 series offers advanced single channel detection capabilities in a compact package.

Reno A & E
4655 Aircenter Circle • Reno, Nevada • 89502 • USA
Tel: (775) 826-2020 • Fax: (775) 826-9191 • E-mail: sales@renoae.com • Internet: www.renoae.com

ISO 9001 REGISTERED

Manufactured under Patent # s 5,936,551 and 6,281,809. - Other Patents Pending.

T-110 SERIES SPECIFICATION

This is a Performance Specification. It is not intended to be used as Operating Instructions.

Loop Frequency: Four (4) DIP switch selectable loop frequencies (normally in the range of 20 to 100 kilohertz) that are a function of the actual loop / lead-in network.

Sensitivity: Seven (7) sensitivity levels (plus off) are available. The eight settings are selectable using three (3) front panel mounted DIP switches. Each of the seven sensitivity levels are binary encoded from 1 to 7 (lowest to highest sensitivity). A setting of 0 turns the detector off. The sensitivity level selected determines the percentage of negative inductance change of the loop circuit required for a CALL output signal. See ***SENSITIVITY, -ΔL/L, & RESPONSE TIME*** table.

Presence / Pulse Mode: The detector can be set to operate in one of two modes by means of a front panel mounted DIP switch.

Presence Mode: Call hold time is a minimum of four minutes regardless of vehicle size, and is typically one to three hours for an automobile or truck.

Pulse Mode: A pulse of 125 ±10 milliseconds duration is generated for each vehicle entering the loop detection zone. Each vehicle detected is instantly tuned out if it remains in the loop detection zone longer than two seconds. This feature allows detection of vehicles subsequently entering the detection zone. After each vehicle leaves the loop detection zone, the detector resumes full detection sensitivity within one second. Changing the setting of the Presence / Pulse Mode switch will RESET the detector.

Call Delay: Call Delay is adjustable from 0 to 63 seconds in one-second steps by means of six (6) front panel mounted DIP switches. Call Delay time starts counting down when a vehicle first enters the loop detection zone. If the Delay feature is activated, the output will only be turned on after the selected delay time has passed with a vehicle continuously present in the loop detection area. If a vehicle leaves the loop detection area during the delay interval, detection is aborted and the next vehicle to enter the loop detection area will initiate a new full delay interval. The detector indicates that a vehicle is being detected but that the output is being delayed by flashing the Detect / Fail LED (green) at four Hz with a 50% duty cycle.

Call Extension: Call Extension is adjustable from 0 to 15.75 seconds in 0.25-second steps by means of six (6) front panel mounted DIP switches. Call Extension time starts counting down when the last vehicle leaves the loop detection zone. In the event a vehicle enters the loop detection zone before the extension time expires, the detector will return to the detect state (regardless of the setting of the delay timer) and the extension timer will be reset. When the last vehicle leaves the loop detection zone, full Extension time is reestablished and the detector begins counting down again. The detector will indicate that the extension interval is currently timing by flashing the Detect / Fail LED (green) at 16 Hz with a 50% duty cycle.

Audible Detect Signal: A front panel mounted push button is used to enable an audible detect signal that is emitted any time the detection zone is occupied.

Detect / Fail Indicator: The detector has a super bright, high intensity, dual color (Red / Green) LED that indicates a Call output and/or the status of any current or prior loop fault condition. A continuous ON (green) state indicates a CALL output. A continuous ON (red) state indicates that a current open loop failure condition or an inductance change condition of greater than +25% condition exists. A one Hz (red) flash rate indicates that a current shorted loop failure condition or an inductance change condition of greater than -25% condition exists. A flash rate of three 50 millisecond (red) pulses indicates a prior loop failure condition. A flash rate of three 50 millisecond (red) pulses followed by a 750 millisecond (green) pulse indicates a prior loop failure condition and a current CALL output (detect state). If the audible detect signal is activated, any detect indication that would normally be displayed as green will be displayed as orange.

Loop Fail (Event) Monitor: If the total inductance of the loop input network goes out of the range specified for the detector, or rapidly changes by more than ±25%, the detector will immediately enter the Fail-Safe mode of operation. Fail-Safe operation generates a continuous call output in Presence or Pulse mode. The Detect / Fail LED will provide an indication of the type of loop failure (see Detect / Fail Indicator, above) and will continue to do so as long as the loop fault exists. If the loop self-heals, the detector will resume operation in a normal manner, but the Detect / Fail LED will begin to flash at a rate of three flashes per second (red) as a means of indicating a prior Loop Fail condition. The FAIL LED will continue its indication of a prior loop failure until the detector is reset or power is removed.

Loop Inductance Range: 20 to 2000 microhenries with a Q factor of 5 or greater.

Loop Feeder Length: Up to 5000 feet (1500m) maximum with proper feeder cable and appropriate loops.

Loop Input: Transformer isolated. The minimum capacitance added by the detector is 0.068 microfarad.

Lightning Protection: The detector can tolerate, without damage, a 10 microfarad capacitor charged to 2,000 volts being discharged directly into the loop input terminals, or a 10 microfarad capacitor charged to 2,000 volts being discharged between either loop terminal and earth (chassis) ground.

Detector Reset: Changing the position of any DIP switch (except the Frequency switches or Call Delay / Call Extension switches) will reset the detector. Pressing the front panel mounted reset switch will reset the detector. Reapplication of power after a power loss will also cause the detector to reset. After changing a Frequency selection switch (DIP switches 1 & 2), the detector will require a reset.

Phase Green Inputs: Also known as Delay Inhibit inputs. Meets or exceeds NEMA TS 1 requirements. The application of an ON state voltage (75 to 130 VAC) to the Phase Green Input pin (Pin J) will cause the detector's delay timer to abort its delay timing function.

Solid State Outputs: Optically isolated. 30 VDC max. collector (drain) to emitter (source). 100 mA max. saturation current. 2 VDC max. transistor saturation voltage. The output is protected with a 33-volt Zener diode connected between the collector (drain) and emitter (source).

Relay Outputs: The relay contacts are rated for 6 Amps max., 150 VDC max., and 180 Watts max. switched power.

Response Time: The response time of the detector is 33 ± 12 milliseconds regardless of the sensitivity level setting. See ***SENSITIVITY, -ΔL/L, & RESPONSE TIME*** table.

Self Tuning: The detector automatically self tunes and is operational within two seconds after application of power or after being reset. Full sensitivity and hold time requires 30 seconds of operation.

Environmental & Tracking: The detector is fully self-compensating for environmental changes and loop drift over the full temperature range and the entire loop inductance range.

Grounded Loop Operation: The loop isolation transformer allows operation with poor quality loops (which may include one short to ground at a single point).

Detect Outputs: A detection output (CALL) is indicated by a closed relay contact (Relay output) or a conducting state (Solid State output). The detector output defaults to a CALL state for any loop failure condition or upon loss of power.

Test Mode: A PCB mounted jumper enables Test Mode. Test Mode provides a means of verifying proper operation of the detector's controls and indicators (switches and LEDs). The detector's loop oscillator circuit is also checked to verify the correct frequency in each of the four frequency settings. The frequency portion of testing requires that the detector be connected to a 100 microhenry loop; if other inductance values are used, the frequency test results will be invalid.

Weight: 19 oz (538.7 gm).

Size: 4.70 inches (11.94 cm) high x 2.25 inches (5.72 cm) wide x 5.30 inches (13.46 cm) deep (excluding connector). Connector adds .675 inches (1.71 cm) to depth measurement.

Operating Temperature: -40ºF to +180ºF (-40ºC to +82ºC).

Circuit Board: Printed circuit boards are 0.062 inch thick FR4 material with 2 oz. copper on both sides and plated through holes. Circuit boards and components are conformal coated with polyurethane.

Connector: MS 3102A-18-1P 10 pin male. See ***PIN ASSIGNMENTS*** table.

Power: 89 to 135 VAC, 50/60 Hz, 6 Watts max.

TABLES

SENSITIVITY, -ΔL/L, & RESPONSE TIME:

Sensitivity Setting	0	1	2	3	4	5	6*	7
-ΔL/L	OFF	0.64%	0.32%	0.16%	0.08%	0.04%	0.02%	0.01%
Response Time (ms)	N/A	33 ±12	33 ±12	33 ±12	33 ±12	33 ±12	33 ±12	33 ±12

* Denotes factory default.

Note: Changing a sensitivity switch will RESET the detector.

PIN ASSIGNMENTS:

Pin	Function (Relay Outputs)	Function (Solid State Outputs)
A	Power, Neutral, 120 VAC	Power, Neutral, 120 VAC
B	Output, Relay Common	Output, Emitter (Source)
C	Power, Line, 120 VAC	Power, Line, 120 VAC
D	Loop Input	Loop Input
E	Loop Input	Loop Input
F	Output, Relay Normally Open	Output, Collector (Drain)
G	Output, Relay Normally Closed	No Connection
H	Chassis Ground	Chassis Ground
I	No Connection	No Connection
J	Phase Green Input	Phase Green Input

FACTORY DEFAULT SETTINGS:

Switch	Function	Setting	Factory Default
1	Frequency	0	OFF
2			OFF
3	Presence / Pulse	Presence	ON
4	Sensitivity	6	OFF
5			ON
6			ON

T-210 SERIES

TWO CHANNEL SHELF MOUNT DETECTOR

Engineering Excellence!



- Meets and exceeds NEMA TS 1 specification.
- Six front panel DIP switches for each channel provide:
  - Seven levels of sensitivity plus off.
  - Presence or Pulse mode.
  - Four loop frequencies.
- Loops are sequentially scanned to eliminate crosstalk.
- Loop Fail Event Monitor remembers and indicates intermittent and current loop failures.
- Detector is self tuning and provides complete environmental tracking.
- Dual color, high intensity LEDs:
  - Green indicates detect.
  - Red indicates loop fail.
- Complete built-in detector integrity test.
- Space provided on front panel to label each channel.
- Audible detect signal (buzzer) facilitates loop and/or detector troubleshooting.
- Call Delay and Call Extension timing.

With Audible Detect Signal

Ordering Information:

Model T-210-R Two channel detector with Relay outputs, Call Delay and Call Extension.
Model T-210-SS Two channel detector with Solid State outputs, Call Delay and Call Extension.

Overview:

The Model T-210 series is designed to meet or exceed NEMA Standards TS 1-1989. Model T-210 Detectors are two channel, shelf mount type loop detectors with Delay and Extension timing. Individual channel detect and loop fail indications are provided via two dual color, high intensity LEDs. Available with both Relay and Solid State outputs, the Model T-210 series offers advanced multiple channel detection capabilities in a compact package.

Reno A & E
4655 Aircenter Circle • Reno, Nevada • 89502 • USA
Tel: (775) 826-2020 • Fax: (775) 826-9191 • E-mail: sales@renoae.com • Internet: www.renoae.com

ISO 9001 REGISTERED

Manufactured under Patent #'s 5,936,551 and 6,281,809. - Other Patents Pending.

T-210 SERIES SPECIFICATION

This is a Performance Specification. It is not intended to be used as Operating Instructions.

Loop Frequency: Each channel has four (4) DIP switch selectable loop frequencies (normally in the range of 20 to 100 kilohertz) that are a function of the actual loop / lead-in network.

Sensitivity: Seven (7) sensitivity levels (plus off) are available for each channel. The eight settings are selectable using three (3) front panel mounted DIP switches. Each of the seven sensitivity levels are binary encoded from 1 to 7 (lowest to highest sensitivity). A setting of 0 turns the channel off. The sensitivity level selected determines the percentage of negative inductance change of the loop circuit required for a CALL output signal. See ***SENSITIVITY, -ΔL/L, & RESPONSE TIME*** table.

Presence / Pulse Mode: Each channel can be independently set to operate in one of two modes by means of front panel mounted DIP switches.

Presence Mode: Call hold time is a minimum of four minutes regardless of vehicle size, and is typically one to three hours for an automobile or truck.

Pulse Mode: A pulse of 125 ±10 milliseconds duration is generated for each vehicle entering the loop detection zone. Each vehicle detected is instantly tuned out if it remains in the loop detection zone longer than two seconds. This feature allows detection of vehicles subsequently entering the detection zone. After each vehicle leaves the loop detection zone, the channel resumes full detection sensitivity within one second. Changing the setting of the Presence / Pulse Mode switch will RESET the channel.

Call Delay: Each channel's Call Delay is adjustable from 0 to 63 seconds in one-second steps by means of six (6) front panel mounted DIP switches. Call Delay time starts counting down when a vehicle first enters the loop detection zone. If the Delay feature is activated, the output will only be turned on after the selected delay time has passed with a vehicle continuously present in the loop detection area. If a vehicle leaves the loop detection area during the delay interval, detection is aborted and the next vehicle to enter the loop detection area will initiate a new full delay interval. The detector indicates that a vehicle is being detected but that the outputs are being delayed by flashing the channel's Detect / Fail LED (green) at four Hz with a 50% duty cycle.

Call Extension: Each channel's Call Extension is adjustable from 0 to 15.75 seconds in ¼-second steps by means of six (6) front panel mounted DIP switches. Call Extension time starts counting down when the last vehicle leaves the loop detection zone. In the event a vehicle enters the loop detection zone before the extension time expires, the detector will return to the detect state (regardless of the setting of the delay timer) and the extension timer will be reset. When the last vehicle leaves the loop detection zone, full Extension time is reestablished and the detector begins counting down again. The detector will indicate that the extension interval is currently timing by flashing the channel's Detect / Fail LED (green) at 16 Hz with a 50% duty cycle.

Audible Detect Signal: A front panel mounted push button is used to enable an audible detect signal that is emitted any time a given channel's detection zone is occupied.

Detect / Fail Indicator: Each channel has a super bright, high intensity, dual color (Red / Green) LED that indicates a Call output and/or the status of any current or prior loop fault condition for that channel. A continuous ON (green) state indicates a CALL output. A continuous ON (red) state indicates that a current open loop failure condition or an inductance change condition of greater than +25% condition exists. This indication is also generates a CALL output. A one Hz (red) flash rate indicates that a current shorted loop failure condition or an inductance change condition of greater than -25% condition exists. This indication is also generates a CALL output. A flash rate of three 50 millisecond (red) pulses indicates a prior loop failure condition. A flash rate of three 50 millisecond (red) pulses followed by a 750 millisecond (green) pulse indicates a prior loop failure condition and a current CALL output (detect state). If the audible detect signal is activated, any detect indication that would normally be displayed as green will be displayed as orange.

Loop Fail (Event) Monitor: If the total inductance of a channel's loop input network goes out of the range specified for the detector, or rapidly changes by more than ±25%, the affected channel will immediately enter the Fail-Safe mode of operation. Fail-Safe operation generates a continuous call output in Presence or Pulse mode. The channel's Detect / Fail LED will provide an indication of the type of loop failure (see Detect / Fail Indicator, above) and will continue to do so as long as the loop fault exists. If the loop self-heals, the channel will resume operation in a normal manner, but the Detect / Fail LED of the channel will begin to flash at a rate of three flashes per second (red) as a means of indicating a prior Loop Fail condition. The Detect / Fail LED will continue its indication of a prior loop failure until the detector channel is reset, the detector is reset, or power is removed.

Loop Inductance Range: 20 to 2000 microhenries with a Q factor of 5 or greater.

Loop Feeder Length: Up to 5000 feet (1500m) maximum with proper feeder cable and appropriate loops.

Loop Input: Transformer isolated. The minimum capacitance added by the detector is 0.068 microfarad.

Scanning: The loop(s) connected to each detector channel are activated alternately to minimize crosstalk between adjacent loops connected to the same detector.

Lightning Protection: The detector can tolerate, without damage, a 10 microfarad capacitor charged to 2,000 volts being discharged directly into the loop input terminals, or a 10 microfarad capacitor charged to 2,000 volts being discharged between either loop terminal and earth (chassis) ground.

Detector Reset: Changing the position of either channel's DIP switches (except the Frequency switches or Call Delay / Call Extension switches) will reset that detector channel. Pressing the front panel mounted reset switch will reset the detector. Reapplication of power after a power loss will also cause the detector to reset. After changing either channel's Frequency selection switches (DIP switches 1 & 2), the channel will require a reset.

Phase Green Inputs: Also known as Delay Inhibit inputs. Meets or exceeds NEMA TS 1 requirements. The application of an ON state voltage (75 to 130 VAC) to the Phase Green Input pin (Pin J) of the Channel 1 or Channel 2 connector will cause that channel's delay timer to abort its delay timing function.

Solid State Outputs: Optically isolated. 30 VDC max. collector (drain) to emitter (source). 100 mA max. saturation current. 2 VDC max. transistor saturation voltage. The output is protected with a 33-volt Zener diode connected between the collector (drain) and emitter (source).

Relay Outputs: The relay contacts are rated for 6 Amps max., 150 VDC max., and 180 Watts max. switched power.

Response Time: The response time of any channel is 65 ± 25 milliseconds regardless of the sensitivity level setting. See ***SENSITIVITY, - ΔL/L, & RESPONSE TIME*** table.

Self Tuning: The detector automatically self tunes and is operational within two seconds after application of power or after being reset. Full sensitivity and hold time requires 30 seconds of operation.

Environmental & Tracking: The detector is fully self-compensating for environmental changes and loop drift over the full temperature range and the entire loop inductance range.

Grounded Loop Operation: The loop isolation transformer allows operation with poor quality loops (which may include one short to ground at a single point).

Detect Outputs: A detection output (CALL) is indicated by a closed relay contact (Relay output) or a conducting state (Solid State output). A channel's output defaults to a CALL state for any loop failure condition on that channel or upon loss of power.

Test Mode: A PCB mounted jumper enables Test Mode. Test Mode provides a means of verifying proper operation of the detector's controls and indicators (switches and LEDs). Each channel's loop oscillator circuit is also checked to verify the correct frequency in each of the four frequency settings. The frequency portion of testing requires that each channel be connected to a 100 microhenry loop; if other inductance values are used, the frequency test results will be invalid.

Weight: 27 oz (765.5 gm).

Size: 6.45 inches (16.38 cm) high x 2.50 inches (6.35 cm) wide x 6.35 inches (16.13 cm) deep (excluding connector). Connector adds .675 inches (1.71 cm) to depth measurement.

Operating Temperature: -40ºF to +180ºF (-40ºC to +82ºC).

Circuit Board: Printed circuit boards are 0.062 inch thick FR4 material with 2 oz. copper on both sides and plated through holes. Circuit boards and components are conformal coated with polyurethane.

Connectors: Two (2) MS 3102A-18-1P 10 pin male. See ***PIN ASSIGNMENTS*** table.

Power: 89 to 135 VAC, 50/60 Hz, 6 Watts max.

TABLES

SENSITIVITY, -ΔL/L, & RESPONSE TIME:

Sensitivity Setting	0	1	2	3	4	5	6*	7
-ΔL/L	OFF	0.64%	0.32%	0.16%	0.08%	0.04%	0.02%	0.01%
Response Time (ms)	N/A	65 ±25	65 ±25	65 ±25	65 ±25	65 ±25	65 ±25	65 ±25

* Denotes factory default.

Note: Changing a channel's sensitivity switch will RESET the channel.

PIN ASSIGNMENTS:

Channel 1 Connector

Pin	Function (Relay Outputs)	Function (Solid State Outputs)
A	Power, Neutral, 120 VAC	Power, Neutral, 120 VAC
B	Channel 1 Output, Relay Common	Channel 1 Output, Emitter (Source)
C	Power, Line, 120 VAC	Power, Line, 120 VAC
D	Channel 1 Loop Input	Channel 1 Loop Input
E	Channel 1 Loop Input	Channel 1 Loop Input
F	Channel 1 Output, Relay Normally Open	Channel 1 Output, Collector (Drain)
G	Channel 1 Output, Relay Normally Closed	No Connection
H	Chassis Ground	Chassis Ground
I	No Connection	No Connection
J	Channel 1 Phase Green Input	Channel 1 Phase Green Input

Channel 2 Connector

Pin	Function (Relay Outputs)	Function (Solid State Outputs)
A	No Connection	No Connection
B	Channel 2 Output, Relay Common	Channel 2 Output, Emitter (Source)
C	No Connection	No Connection
D	Channel 2 Loop Input	Channel 2 Loop Input
E	Channel 2 Loop Input	Channel 2 Loop Input
F	Channel 2 Output, Relay Normally Open	Channel 2 Output, Collector (Drain)
G	Channel 2 Output, Relay Normally Closed	No Connection
H	Chassis Ground	Chassis Ground
I	No Connection	No Connection
J	Channel 2 Phase Green Input	Channel 2 Phase Green Input

FACTORY DEFAULT SETTINGS:

Switch	Function	Setting	Factory Default
1	Frequency	0	OFF
2			OFF
3	Presence / Pulse	Presence	ON
4	Sensitivity	6	OFF
5			ON
6			ON

T-400 SERIES

FOUR CHANNEL SHELF MOUNT DETECTOR

Engineering Excellence!



- Meets and exceeds NEMA TS 1 specification.
- Six front panel DIP switches for each channel provide:
  - Seven levels of sensitivity plus off.
  - Presence or Pulse mode.
  - Four loop frequencies.
- Loops are sequentially scanned to eliminate crosstalk.
- Loop Fail Event Monitor remembers and indicates intermittent and current loop failures.
- Detector is self tuning and provides complete environmental tracking.
- Dual color, high intensity LEDs:
  - Green indicates detect.
  - Red indicates loop fail.
- Complete built-in detector integrity test.
- Space provided on front panel to label each channel.
- Audible detect signal (buzzer) facilitates loop and/or detector troubleshooting.

With Audible Detect Signal

Ordering Information:

Model T-400-R Four channel detector with Relay outputs.
Model T-400-SS Four channel detector with Solid State outputs.

Overview:

The Model T-400 series is designed to meet or exceed NEMA Standards TS 1-1989. Model T-400 detectors are four channel, shelf mount type loop detectors. Individual channel detect and loop fail indications are provided via four dual color, high intensity LEDs. Available with both Relay and Solid State outputs, the Model T-400 series offers advanced multiple channel detection capabilities in a compact package.

Reno A & E
4655 Aircenter Circle • Reno, Nevada • 89502 • USA
Tel: (775) 826-2020 • Fax: (775) 826-9191 • E-mail: sales@renoae.com • Internet: www.renoae.com

ISO 9001 REGISTERED

Manufactured under Patent #'s 5,936,551 and 6,281,809. - Other Patents Pending.

T-400 SERIES SPECIFICATION

This is a Performance Specification. It is not intended to be used as Operating Instructions.

Loop Frequency: Each channel has four (4) DIP switch selectable loop frequencies (normally in the range of 20 to 100 kilohertz) that are a function of the actual loop / lead-in network.

Sensitivity: Seven (7) sensitivity levels (plus off) are available for each channel. The eight settings are selectable using three (3) front panel mounted DIP switches. Each of the seven sensitivity levels are binary encoded from 1 to 7 (lowest to highest sensitivity). A setting of 0 turns the channel off. The sensitivity level selected determines the percentage of negative inductance change of the loop circuit required for a CALL output signal. See ***SENSITIVITY, -ΔL/L, & RESPONSE TIME*** table.

Presence / Pulse Mode: Each channel can be independently set to operate in one of two modes by means of front panel mounted DIP switches.

Presence Mode: Call hold time is a minimum of four minutes regardless of vehicle size, and is typically one to three hours for an automobile or truck.

Pulse Mode: A pulse of 125 ±10 milliseconds duration is generated for each vehicle entering the loop detection zone. Each vehicle detected is instantly tuned out if it remains in the loop detection zone longer than two seconds. This feature allows detection of vehicles subsequently entering the detection zone. After each vehicle leaves the loop detection zone, the channel resumes full detection sensitivity within one second. Changing the setting of the Presence / Pulse Mode switch will RESET the channel.

Audible Detect Signal: A front panel mounted push button is used to enable an audible detect signal that is emitted any time a given channel's detection zone is occupied.

Detect / Fail Indicator: Each channel has a super bright, high intensity, dual color (Red / Green) LED that indicates a Call output and/or the status of any current or prior loop fault condition for that channel. A continuous ON (green) state indicates a CALL output. A continuous ON (red) state indicates that a current open loop failure condition or an inductance change condition of greater than +25% condition exists. This indication is also generates a CALL output. A one Hz (red) flash rate indicates that a current shorted loop failure condition or an inductance change condition of greater than -25% condition exists. This indication is also generates a CALL output. A flash rate of three 50 millisecond (red) pulses indicates a prior loop failure condition. A flash rate of three 50 millisecond (red) pulses followed by a 750 millisecond (green) pulse indicates a prior loop failure condition and a current CALL output (detect state). If the audible detect signal is activated, any detect indication that would normally be displayed as green will be displayed as orange.

Loop Fail (Event) Monitor: If the total inductance of a channel's loop input network goes out of the range specified for the detector, or rapidly changes by more than ±25%, the affected channel will immediately enter the programmed Fail-Safe mode of operation. Fail-Safe operation generates a continuous call output in the Presence or Pulse mode. The channel's Detect / Fail LED will provide an indication of the type of loop failure (see Detect / Fail Indicator, above) and will continue to do so as long as the loop fault exists. If the loop self-heals, the channel will resume operation in a normal manner, but the Detect / Fail LED of the channel will begin to flash at a rate of three flashes per second (red) as a means of indicating a prior Loop Fail condition. The Detect / Fail LED will continue its indication of a prior loop failure until the detector channel is reset, the detector is reset, or power is removed.

Loop Inductance Range: 20 to 2000 microhenries with a Q factor of 5 or greater.

Loop Feeder Length: Up to 5000 feet (1500m) maximum with proper feeder cable and appropriate loops.

Loop Input: Transformer isolated. The minimum capacitance added by the detector is 0.068 microfarad.

Scanning: The loop(s) connected to each detector channel are activated alternately to minimize crosstalk between adjacent loops connected to the same detector.

Lightning Protection: The detector can tolerate, without damage, a 10 microfarad capacitor charged to 2,000 volts being discharged directly into the loop input terminals, or a 10 microfarad capacitor charged to 2,000 volts being discharged between either loop terminal and earth (chassis) ground.

Detector Reset: Changing the position of any channel's DIP switches (except the Frequency switches) will reset that detector channel. Pressing the front panel mounted reset switch will reset the detector. Reapplication of power after a power loss will also cause the detector to reset. After changing any channel's Frequency selection switches (DIP switches 1 & 2), the channel will require a reset.

Solid State Outputs: Optically isolated. 30 VDC max. collector (drain) to emitter (source). 100 mA max. saturation current. 2 VDC max. transistor saturation voltage. The output is protected with a 33-volt Zener diode connected between the collector (drain) and emitter (source).

Relay Outputs: The relay contacts are rated for 6 Amps max., 150 VDC max., and 180 Watts max. switched power.

Response Time: The response time of any channel is 120 ± 40 milliseconds regardless of the sensitivity level setting. See ***SENSITIVITY, -ΔL/L, & RESPONSE TIME*** table.

Self Tuning: The detector automatically self tunes and is operational within two seconds after application of power or after being reset. Full sensitivity and hold time requires 30 seconds of operation.

Environmental & Tracking: The detector is fully self-compensating for environmental changes and loop drift over the full temperature range and the entire loop inductance range.

Grounded Loop Operation: The loop isolation transformer allows operation with poor quality loops (which may include one short to ground at a single point).

Detect Outputs: A detection output (CALL) is indicated by a closed relay contact (Relay output) or a conducting state (Solid State output). A channel's output defaults to a CALL state for any loop failure condition on that channel or upon loss of power.

Test Mode: A PCB mounted jumper enables Test Mode. Test Mode provides a means of verifying proper operation of the detector's controls and indicators (switches and LEDs). Each channel's loop oscillator circuit is also checked to verify the correct frequency in each of the four frequency settings. The frequency portion of testing requires that each channel be connected to a 100 microhenry loop; if other inductance values are used, the frequency test results will be invalid.

Weight: 34 oz (963.9 gm).

Size: 6.45 inches (16.38 cm) high x 2.50 inches (6.35 cm) wide x 6.35 inches (16.13 cm) deep (excluding connector). Connector adds .675 inches (1.71 cm) to depth measurement.

Operating Temperature: -40ºF to +180ºF (-40ºC to +82ºC).

Circuit Board: Printed circuit boards are 0.062 inch thick FR4 material with 2 oz. copper on both sides and plated through holes. Circuit boards and components are conformal coated with polyurethane.

Connector: MS 3102A-22-14P 19 pin male. See ***PIN ASSIGNMENTS*** table.

Power: 89 to 135 VAC, 50/60 Hz, 6 Watts max.

TABLES

SENSITIVITY, -ΔL/L, & RESPONSE TIME:

Sensitivity Setting	0	1	2	3	4	5	6*	7
-ΔL/L	OFF	0.64%	0.32%	0.16%	0.08%	0.04%	0.02%	0.01%
Response Time (ms)	N/A	120 ±40	120 ±40	120 ±40	120 ±40	120 ±40	120 ±40	120 ±40

* Denotes factory default.

Note: Changing a channel's sensitivity switch will RESET the channel.

PIN ASSIGNMENTS:

Pin	Function (Relay Outputs)	Function (Solid State Outputs)
A	Power, Neutral, 120 VAC	Power, Neutral, 120 VAC
B	Channel 4 Output, Relay Common	Channel 4 Output, Emitter (Source)
C	Power, Line, 120 VAC	Power, Line, 120 VAC
D	Channel 1 Loop Input	Channel 1 Loop Input
E	Channel 1 Loop Input	Channel 1 Loop Input
F	Channel 2 Loop Input	Channel 2 Loop Input
G	Channel 2 Loop Input	Channel 2 Loop Input
H	Chassis Ground	Chassis Ground
J	Channel 3 Loop Input	Channel 3 Loop Input
K	Channel 3 Loop Input	Channel 3 Loop Input
L	Channel 4 Loop Input	Channel 4 Loop Input
M	Channel 4 Loop Input	Channel 4 Loop Input
N	Channel 1 Output, Relay Normally Open	Channel 1 Output, Collector (Drain)
P	Channel 1 Output, Relay Common	Channel 1 Output, Emitter (Source)
R	Channel 2 Output, Relay Common	Channel 2 Output, Emitter (Source)
S	Channel 2 Output, Relay Normally Open	Channel 2 Output, Collector (Drain)
T	Channel 3 Output, Relay Common	Channel 3 Output, Emitter (Source)
U	Channel 3 Output, Relay Normally Open	Channel 3 Output, Collector (Drain)
V	Channel 4 Output, Relay Normally Open	Channel 4 Output, Collector (Drain)

FACTORY DEFAULT SETTINGS:

Switch	Function	Setting	Factory Default
1	Frequency	0	OFF
2			OFF
3	Presence / Pulse	Presence	ON
4	Sensitivity	6	OFF
5			ON
6			ON

DEFLECTOMETER™



LMD622

DEFLECTOMETER™ SERIES

TWO CHANNEL NEMA TS-2 TYPE A LOOP MONITOR™

Built-in DEFLECTOMETER™ Technology Provides Users With:

- ☑ **Call Strength Indicator for Optimum Sensitivity Programming**
- ☑ **One step / One vehicle dynamic Sensitivity programming**
- ☑ **Frequency Meter for immediate analysis of loop frequency, avoiding loop cross-talk problems**
- ☑ **Push Button Programming**

Why guess when you can know **your detector is optimally programmed and performing for all vehicles classes!**

ENHANCED FEATURES

DEFLECTOMETER Call Strength Indictor: The *Call Strength Indicator* provides the technician with a simple one-step method for accurately setting the optimum level of sensitivity that ensures accurate vehicle detection of all vehicles, including motorcycles and high-bed trucks. *NO MORE GUESSING!*

When a medium size vehicle is over the roadway loop, a DEFLECTOMETER™ Call Strength value of "5" assures that the optimum sensitivity has been achieved. You can adjust the DEFLECTOMETER™ reading *DYNAMICALLY* without moving the vehicle by using the front panel UP or DOWN sensitivity buttons. *IT DOES NOT GET ANY EASIER THAN THIS!*

Frequency Meter: The built-in *Frequency Meter* reports the operating frequency of the loop network. Ensuring that adjacent loops are separated by at least 5 KHz will avoid crosstalk problems and future service calls.

Output CALL Test Mode: The Output Call Test Mode provides a straight forward way to test that the Controller Unit is receiving an active output from the detector. This eliminates the need for cabinet test switches and associated wiring. A huge time saving feature during system set-up and trouble-shooting.

Rugged Handle Assembly: The rugged handle assembly is made of GE LEXAN™, which is a super durable polycarbonate resin. The design of this assembly strengthens and protects the whole PCB assembly much better than conventional face plates. The temperature stability of critical components is improved with the more encompassing enclosure. Quick reference instructions are conveniently attached directly on the side of the unit, eliminating the need for cards.

Advanced Loop Diagnostics: The Fault (FLT) indicator displays the type of fault: Short, Open or 25% change of inductance. The Fault Monitor will report and store three types of loop faults; Open Loops, Shorted Loops, and 25% sudden changes in inductance. Each type of fault is indicated by a unique sequence of flashes allowing the user to diagnose loop failures at a glance.

Options: Relay Outputs, Model LMD622R

STANDARD FEATURES

- ☑ **Automatic Tuning**
- ☑ **Lightning & Surge Protection**
- ☑ **Four (4) Frequency Levels**
- ☑ **Fail Safe Output Configuration**
- ☑ **Separate Color-Coded LED indicators**
- ☑ **Wide Loop Inductance Range: 20 to 2500 microHenries.**

EBERLE DESIGN INC.
3819 East La Salle Street
Phoenix, AZ 85040 USA
www.EDItraffic.com
Tel (480) 968-6407
Fax (602) 437-1996

DEFLECTOMETER and Loop Monitor are trademarks of Eberle Design Inc. LEXAN Resin is a trademark of General Electric

LMD622 DEFLECTOMETER™ SERIES TWO CHANNEL INDUCTIVE LOOP VEHICLE DETECTOR
SPECIFICATIONS

General Characteristics

Controls: Front panel push buttons allow the user to set the Sensitivity Level, Operational mode, and nominal Frequency independently on each channel.

Setting Sensitivity - Front Panel Push Buttons

The DEFLECTOMETER™ (front panel 7-segment LED) aids in setting the DETECTOR quickly and easily to the most optimum sensitivity level to ensure the trouble-free detection of all vehicles, including motorcycles and high bed vehicles. For typical vehicles (mid-size vehicle / small pick up) utilizing properly installed roadway loops, a Call Strength of 5 displayed on the DEFLECTOMETER™ during the DETECT output period indicates an optimum sensitivity setting. For high profile vehicles (commercial trucks, 4x4's, etc…), a Call Strength value of 4 will be optimum. For low profile vehicles (sports cars, etc…), a Call Strength value of 6 will be optimum.

Adjusting sensitivity using the DEFLECTOMETER™ (recommended):

The DEFLECTOMETER™ should read zero (0) with no vehicle over the roadway loop. When a typical mid-sized vehicle is completely in the detection zone (DET indicator On), the Call Strength value should be adjusted up or down until the DEFLECTOMETER™ displays the desired optimum value of 5 (or 4 or 6 as described above).

If a typical vehicle located over the roadway loop causes the Call Strength "7" to be displayed on the DEFLECTOMETER™, the sensitivity should be decreased two levels. This can be done by pressing the front panel SENS⬇ button two times to achieve the Call Strength value of 5.

If a typical vehicle located over the roadway loop causes the number "2" to be displayed on the DEFLECTOMETER™, the sensitivity should be increased three levels. This can be done by pressing the front panel SENS⬆ button three times to achieve the Call Strength value of 5.

NOTE: THE DEFLECTOMETER™ CALL STRENGTH DYNAMICALLY UPDATES AFTER EACH SENSITIVITY LEVEL CHANGE, ALLOWING YOU TO CHANGE SENSITIVITY SETTINGS WHILE A VEHICLE REMAINS IN THE LOOP DETECTION ZONE.

Adjusting sensitivity without using the DEFLECTOMETER™ (manually setting sensitivity):

The DETECTOR offers 9 levels of sensitivity (1 to 9). Level 9 is the highest sensitivity. Sensitivity Level can be manually set to any desired value by pressing the front panel SENS buttons (⬆ or⬇) when a vehicle is NOT over the roadway loop (DET indicator Off). The first time a SENS button (⬆ or⬇) is pressed, the current Sensitivity Level is displayed on the DEFLECTOMETER™ for 3 seconds. If either SENS button (⬆ or⬇) is pressed again before the 3 second period ends, the Sensitivity Level will increase (SENS ⬆) or decrease (SENS ⬇). The new Sensitivity Level value will be displayed on the DEFLECTOMETER™ display for 3 seconds. The factory default Sensitivity setting is level 6.

Sensitivity	ΔL / L	Sensitivity	ΔL / L
9	0.01%	4	0.32%
8	0.02%	3	0.64%
7	0.04%	2	1.28%
6	**0.08%**	1	2.56%
5	0.16%	-	-

Loop Frequency / Loop Frequency Display: One of four frequency settings may be selected via the front panel FREQ push button to alleviate interference which may occur when loops connected to different detectors are located adjacent to one another. To help prevent or diagnose crosstalk problems, the loop frequency is displayed on the front panel DEFLECTOMETER™. The current loop frequency is displayed after pressing the FREQ button to display the current Frequency Level. The frequency is shown in KHz with a "-" symbol displayed both before and after the numeric digits shown on the DEFLECTOMETER™.

For example, after pressing the FREQ button once the display sequence might show:

"3" ⇨ "-" ⇨ "2" ⇨ "7" ⇨ "-"

This sequence would indicate Frequency Level "3" and a loop reference frequency of 27 KHz. Detectors on adjacent loops should all be separated by at least 5 KHz.

Loop Fault Monitoring: The Detector continuously checks the integrity of the loop. The system is able to detect shorted or open circuit loops, or sudden changes in inductance exceeding 25% of the nominal inductance. If a fault is detected, the OUT and FLT indicators continuously emit a sequence of flashes. Additionally, the DEFLECTOMETER™ displays the letter "F" indicating a current loop fault. Each type of fault is identified by a unique flash sequence:

Flash Sequence	Fault
1 flash	Open Circuit Loop.
2 flashes	Shorted Circuit Loop.
3 flashes	25% excessive change in inductance.

If the Open or Shorted fault condition self heals, the DET indicator and DEFLECTOMETER™ will return to normal operation. The FLT indicator will continue to flash with the sequence signifying the type of fault that was last detected. In the case of the excessive inductance change fault, the unit will retune to the new inductance after a period of two seconds and continue operation. The fault condition will be indicated by the flash sequence of the FLT indicator.

Operational Modes

Presence: For each channel, a Presence output mode may be selected from the front panel MODE push button. If presence mode is selected then a choice of short **(S)** or long **(L)** can be selected. Short Presence is defined as 30 minutes and Long Presence is defined as 120 minutes.

Pulse: For each channel, a Pulse output mode **(P)** may be selected from the front panel MODE push button. In Pulse mode, a 125 ms ± 25ms width pulse will be output for each vehicle entering the loop.

Call: For each channel, a continuous CALL output **(C)** may be selected from the front panel MODE push button which will simulate the presence of a vehicle. This mode is used for testing the CALL output of a channel.

Channel Off: For each channel, the Channel Off **(-)** may be selected from the front panel Mode push button. This option turns OFF the channel and disables the oscillator. An additional option allows the Status Output to be turned ON while the channel is OFF.

Status Outputs:

Each channel includes a separate output which is used to transmit operational status information to a Bus Interface Unit (BIU). Fault information is transmitted by means of pulse-width modulation. Pulse widths shown are +10ms.

Status	Status Output Condition
Normal operation / No fault	Continuous ON (low)
Watchdog fail / Power Supply fail	Continuous OFF (high)
Open circuit loop	50ms OFF, 50ms ON
Short circuit loop	100ms OFF, 50ms ON
25% change in inductance	150ms OFF, 50ms ON

Specifications:

DC Supply Voltage: Minimum ..... 10.8 Vdc
Maximum ..... 28.8 Vdc

DC Supply Current: Maximum ..... 100 mA

Optically Isolated Outputs: True (low, 50 mA) ..... Less than 1.5 Vdc
Maximum Current ..... 100 mA

Outputs are fail-safe such that a Detector with no power will provide the True (low) Call state.

Relay Outputs: AC Contact Rating ..... 5A @ 120 Vac
DC Contact Rating ..... 5A @ 30 Vdc

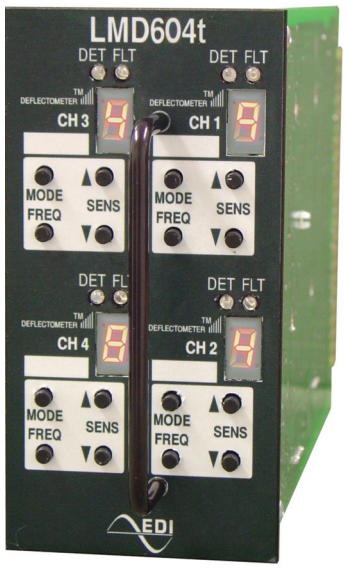
Environmental: Operating Temperature Range: -30ºF to 165ºF (-34ºC to 74ºC)

Mechanical: International Card 4.500"H (114.30mm) x 6.875"D (174.63mm) x 1.14"W (28.96mm), excluding handle, with 44 pin double sided edge connector.

Pin Assignment:

PIN	FUNCTION	PIN	FUNCTION
A	Logic Ground	**1**	Reserved
B	DC Supply	**2**	Reserved
C	External Reset	**3**	Reserved
D	Ch 1 Loop Input	**4**	Ch 1 Redundant Loop Input
E	Ch 1 Loop Input	**5**	Ch 1 Redundant Loop Input
F	Ch 1 Output (+)	**6**	Reserved
H	Ch 1 Output (-)	**7**	Ch 1 Status Output
J	Ch 2 Loop Input	**8**	Ch 2 Redundant Loop Input
K	Ch 2 Loop Input	**9**	Ch 2 Redundant Loop Input
L	Chassis Ground	**10**	Reserved
M	Reserved	**11**	Reserved
N	Reserved	**12**	Reserved
P	Reserved	**13**	Reserved
R	Reserved	**14**	Reserved
S	Reserved	**15**	Reserved
T	Reserved	**16**	Reserved
U	Reserved	**17**	Reserved
V	Reserved	**18**	Reserved
W	Ch 2 Output (+)	**19**	Reserved
X	Ch 2 Output (-)	**20**	Ch 2 Status Output
Y	Reserved	**21**	Reserved
Z	Reserved	**22**	Reserved

DEFLECTOMETER™



LMD604t

DEFLECTOMETER™ SERIES

FOUR CHANNEL NEMA TS-1 LOOP MONITOR™

Built-in DEFLECTOMETER™ Technology Provides Users With:

- ☑ **Call Strength Indicator for Optimum Sensitivity Programming**
- ☑ **Frequency Meter for immediate analysis of loop frequency, avoiding loop cross-talk problems**
- ☑ **Push Button Programming**

Why guess when you can know **your detector is optimally programmed and performing for all vehicle classes!**

ENHANCED FEATURES

DEFLECTOMETER Call Strength Indictor: The *Call Strength Indicator* provides the technician with a simple one-step method for accurately setting the optimum level of sensitivity that ensures accurate vehicle detection of all vehicles, including motorcycles and high-bed trucks. *NO MORE GUESSING!*

When a medium size vehicle is over the roadway loop, a DEFLECTOMETER™ Call Strength value of "5" assures that the optimum sensitivity has been achieved. You can adjust the DEFLECTOMETER™ reading *DYNAMICALLY* without moving the vehicle by using the front panel UP or DOWN sensitivity buttons. *IT DOES NOT GET ANY EASIER THAN THIS!*

Frequency Meter: The built-in *Frequency Meter* reports the operating frequency of the loop network. Ensuring that adjacent loops are separated by at least 5 KHz will avoid crosstalk problems and future service calls.

Delay and Extension Timing: Delay and Extension Timing is provided for all four channels via PCB mounted DIP switches

Output CALL Test Mode: The Output Call Test Mode provides a straight forward way to test that the Controller Unit is receiving an active output from the detector. This eliminates the need for cabinet test switches and associated wiring. A huge time saving feature during system set-up and trouble-shooting.

Advanced Loop Diagnostics: The Fault (FLT) indicator displays the type of fault: Short, Open or 25% change of inductance. The Fault Monitor will report and store three types of loop faults; Open Loops, Shorted Loops, and 25% sudden changes in inductance. Each type of fault is indicated by a unique sequence of flashes allowing the user to diagnose loop failures at a glance.

STANDARD FEATURES

- ☑ **Delay & Extension Timing on All Four Channels**
- ☑ **Automatic Tuning**
- ☑ **Lightning & Surge Protection**
- ☑ **Four (4) Frequency Levels**
- ☑ **Separate Color Coded LED indicators**
- ☑ **Wide Loop Inductance Range: 20 to 2500 micro Henries.**

EBERLE DESIGN INC.

3819 East La Salle Street
Phoenix, AZ 85040 USA
www.EDItraffic.com

Tel (480) 968-6407
Fax (602) 437-1996

Designed, Manufactured and Tested in the United States of America
DEFLECTOMETER and Loop Monitor are trademarks of Eberle Design Inc.

ISO 9001:2000 Registered

LMD604t DEFLECTOMETER™ SERIES FOUR CHANNEL INDUCTIVE LOOP VEHICLE DETECTOR
SPECIFICATIONS

General Characteristics

Controls: Front panel push buttons allow the user to set the Sensitivity Level, Operational mode, and nominal Frequency independently on each channel. PCB mounted DIP switches allow the user to set the Delay and Extension timers.

Setting Sensitivity - Front Panel Push Buttons

The DEFLECTOMETER™ (front panel 7-segment LED) aids in setting the DETECTOR quickly and easily to the most optimum sensitivity level to ensure the trouble-free detection of all vehicles, including motorcycles and high bed vehicles. For typical vehicles (mid-size vehicle / small pick up) utilizing properly installed roadway loops, a Call Strength of 5 displayed on the DEFLECTOMETER™ during the DETECT output period indicates an optimum sensitivity setting. For high profile vehicles (commercial trucks, 4x4's, etc…), a Call Strength value of 4 will be optimum. For low profile vehicles (sports cars, etc…), a Call Strength value of 6 will be optimum.

Adjusting sensitivity using the DEFLECTOMETER™ (recommended):

The DEFLECTOMETER™ should read zero (0) with no vehicle over the roadway loop. When a typical mid-sized vehicle is completely in the detection zone (DET indicator On), the Call Strength value should be adjusted up or down until the DEFLECTOMETER™ displays the desired optimum value of 5 (or 4 or 6 as described above).

If a typical vehicle located over the roadway loop causes the Call Strength "7" to be displayed on the DEFLECTOMETER™, the sensitivity should be decreased two levels. This can be done by pressing the front panel SENS⬇ button two times to achieve the Call Strength value of 5.

If a typical vehicle located over the roadway loop causes the number "2" to be displayed on the DEFLECTOMETER™, the sensitivity should be increased three levels. This can be done by pressing the front panel SENS⬆ button three times to achieve the Call Strength value of 5.

NOTE: THE DEFLECTOMETER™ CALL STRENGTH DYNAMICALLY UPDATES AFTER EACH SENSITIVITY LEVEL CHANGE, ALLOWING YOU TO CHANGE SENSITIVITY SETTINGS WHILE A VEHICLE REMAINS IN THE LOOP DETECTION ZONE.

Adjusting sensitivity without using the DEFLECTOMETER™ (manually setting sensitivity):

The DETECTOR offers 9 levels of sensitivity (1 to 9). Level 9 is the highest sensitivity. Sensitivity Level can be manually set to any desired value by pressing the front panel SENS buttons (⬆ or⬇) when a vehicle is NOT over the roadway loop (DET indicator Off). The first time a SENS button (⬆ or⬇) is pressed, the current Sensitivity Level is displayed on the DEFLECTOMETER™ for 3 seconds. If either SENS button (⬆ or⬇) is pressed again before the 3 second period ends, the Sensitivity Level will increase (SENS ⬆) or decrease (SENS ⬇). The new Sensitivity Level value will be displayed on the DEFLECTOMETER™ display for 3 seconds. The factory default Sensitivity setting is level 6.

Sensitivity	ΔL / L	Sensitivity	ΔL / L
9	0.01%	4	0.32%
8	0.02%	3	0.64%
7	0.04%	2	1.28%
6	**0.08%**	1	2.56%
5	0.16%	-	-

Loop Frequency / Loop Frequency Display: One of four frequency settings may be selected via the front panel FREQ push button to alleviate interference which may occur when loops connected to different detectors are located adjacent to one another. To help prevent or diagnose crosstalk problems, the loop frequency is displayed on the front panel DEFLECTOMETER™. The current loop frequency is displayed after pressing the FREQ button to display the current Frequency Level. The frequency is shown in KHz with a "-" symbol displayed both before and after the numeric digits shown on the DEFLECTOMETER™.

For example, after pressing the FREQ button once the display sequence might show:

"3" ⇨ "-" ⇨ "2" ⇨ "7" ⇨ "-"

This sequence would indicate Frequency Level "3" and a loop reference frequency of 27 KHz. Detectors on adjacent loops should all be separated by at least 5 KHz.

Loop Fault Monitoring: The Detector continuously checks the integrity of the loop. The system is able to detect shorted or open circuit loops, or sudden changes in inductance exceeding 25% of the nominal inductance. If a fault is detected, the OUT and FLT indicators continuously emit a sequence of flashes. Additionally, the DEFLECTOMETER™ displays the letter "F" indicating a current loop fault. Each type of fault is identified by a unique flash sequence:

Flash Sequence	Fault
1 flash	Open Circuit Loop.
2 flashes	Shorted Circuit Loop.
3 flashes	25% excessive change in inductance.

If the Open or Shorted fault condition self heals, the DET indicator and DEFLECTOMETER™ will return to normal operation. The FLT indicator will continue to flash with the sequence signifying the type of fault that was last detected. In the case of the excessive inductance change fault, the unit will retune to the new inductance after a period of two seconds and continue operation. The fault condition will be indicated by the flash sequence of the FLT indicator.

Operational Modes

Presence: For each channel, a Presence output mode may be selected from the front panel MODE push button. If presence mode is selected then a choice of short **(S)** or long **(L)** can be selected. Short Presence is defined as 30 minutes and Long Presence is defined as 120 minutes.

Pulse: For each channel, a Pulse output mode **(P)** may be selected from the front panel MODE push button. In Pulse mode, a 125 ms ± 25ms width pulse will be output for each vehicle entering the loop.

Call: For each channel, a continuous CALL output **(C)** may be selected from the front panel MODE push button which will simulate the presence of a vehicle. This mode is used for testing the CALL output of a channel.

Channel Off: For each channel, the Channel Off **(-)** may be selected from the front panel Mode push button. This option turns OFF the channel and disables the oscillator. An additional option allows the Status Output to be turned ON while the channel is OFF.

Selectable Options:

Call Delay Timer for Presence & Pulse Modes: For each channel, a delay time of 1 to 63 seconds may be selected by setting the appropriate PCB mounted DIP switches to the ON position. Call Delay time starts counting down when a vehicle enters the loop detection area. During the Delay time the DET indicator will flash two times per second and the DEFLECTOMETER™ will display the letter "d". Delay time can be overridden by a True (low) signal at the Timer Control input.

Call Extension Timer for Presence Mode: For each channel, an extend time of 0.25 to 15.75 seconds can be set via the EXTEND DIP switches. The numeric sum of the switches in the On position is equal to the Extend time. Two modes are provided:

Extend Always (default): Call Extend time starts counting down when the last vehicle clears the loop detection zone. During the Extend time the DET indicator will flash four times per second and the DEFLECTOMETER will display the letter "E". Any vehicle entering the loop detection zone during the Extend time period causes the Extend timer to be reset and the output maintained. The Timer Control input has no effect on this mode.

Extend on Green (EOG)

Call Extend time starts counting down when the last vehicle clears the loop detection zone if the Timer Control input is True (low). During the Extend time the DET indicator will flash four times per second and the DEFLECTOMETER will display the letter "E". Any vehicle entering the loop detection zone during the Extend time period causes the Extend timer to be reset and the output maintained.

The Extend on Green mode is enabled by a factory installed jumper located at E6 on the pcb. Consult the factory for details.

Timer Control Inputs: Timer Control inputs are provided for each channel to modify the operation of the Delay and Extension functions. The application of a True (low) state voltage will inhibit the Delay timing function and/or enable the Extend timing function. Timer Control inputs are primarily provided for downward compatibility.

Pin Assignment:

PIN	FUNCTIONS	PIN	FUNCTIONS
A	Logic Ground	**1**	Ch 1 Timer Control Input
B	DC Supply	**2**	Ch 2 Timer Control Input
C	Ext. Reset	**3**	Ch 3 Timer Control Input
D	Ch 1 Loop Input	**4**	Ch 1 Redundant Loop Input
E	Ch 1 Loop Input	**5**	Ch 1 Redundant Loop Input
F	Ch 1 Output (+)	**6**	Reserved
H	Ch 1 Output (-)	**7**	Reserved
J	Ch 2 Loop Input	**8**	Ch 2 Redundant Loop Input
K	Ch 2 Loop Input	**9**	Ch 2 Redundant Loop Input
L	Chassis Ground	**10**	Ch 4 Timer Control Input
M	Reserved	**11**	Reserved
N	Reserved	**12**	Reserved
P	Ch 3 Loop Input	**13**	Ch 3 Redundant Loop Input
R	Ch 3 Loop Input	**14**	Ch 3 Redundant Loop Input
S	Ch 3 Output (+)	**15**	Reserved
T	Ch 3 Output (-)	**16**	Reserved
U	Ch 4 Loop Input	**17**	Ch 4 Redundant Loop Input
V	Ch 4 Loop Input	**18**	Ch 4 Redundant Loop Input
W	Ch 2 Output (+)	**19**	Reserved
X	Ch 2 Output (-)	**20**	Reserved
Y	Ch 4 Output (+)	**21**	Reserved
Z	Ch 4 Output (-)	**22**	Reserved

DC Supply Voltage: Minimum ..... 10.8 Vdc
Maximum ..... 28.8 Vdc

DC Supply Current: Maximum ..... 100 mA

DC Timer Control Inputs: True (low) ..... Less than 8 Vdc
False (high) ..... Greater than 16 Vdc

Optical Isolated Outputs: True (low, 50 mA) ..... Less than 1.5 Vdc
Maximum Current ..... 100 mA

Environmental: Operating Temperature Range: -30ºF to 165ºF (-34ºC to 74ºC)

Mechanical: International Card with 44 pin double sided edge connector

Height ..... 4.5" (114.3mm)
Width ..... 2.34" (59.4mm)
Depth (excluding handle) ..... 6.875" (174.6mm)

PHOENIX Rax

RACK MOUNT VEHICLE CLASSIFIER AND DATA RECORDER



THE RAX CAN BE POWERED BY A SOLAR PANEL

The Phoenix Rax is a 19" rack mounted unit that is designed for permanent installation in a cabinet in the field. The circuitry and functionality are identical to the standard Phoenix. All circuit boards plug into the back plane of the rack mount case allowing quick exchange for trouble shooting, upgrading or adding functions.

The Rax is designed to allow new features such as weigh-in-motion to be added as they become available. Terminal strips on the back of the back plane allow connection of necessary harnesses and cables. The Phoenix Rax comes standard with a four line x 20 character backlit display.

The Phoenix Rax has its own built-in 120VAC 40 watt power supply. Alternatively it can be powered by a solar panel. If you are connecting to a telephone for data retrieval we recommend using our 14.4 or 28.8 Cascade modem that draws only 170 micro amps (0.000170 amps) when awaiting a phone call and is hardened for lightning.

Sensors

- *Four to 16 multiplexing presence loop detectors (30 to 500 microhenrys, auto tuning, auto sensitivity adjustment).*
- *Four or eight remote contact closures or open collector to ground external inputs.*
- *Four or eight piezo electric or piezo resistive sensor inputs (sensitivity adjustable from keyboard or via telemetry).*
- *Interfaces to all brands of standard piezos or resistive sensors.*
- *Two or four road tube air switches (32 counts per second).*

Possible sensor arrangements per lane for speed and axle classifying are:

- *Two axle sensors.*
- *Two presence sensors..*
- *Two axle sensors and one presence sensor.*
- *Two presence sensors and one axle sensor*



Features

- *Count one to sixteen lanes*
  Count methods include direction, lane subtraction and normal.
- *Classify one to eight lanes*
- *Record interval lengths of one minute to 24 hours*
  Counter can be programmed to change the length of record interval five times during the day. This allows for closer inspection of rush hour traffic patterns.
- *Two modes of count (1 to 16 lane)*
  ***Time interval count mode** – the traditional method of time interval counting using the field unit to collect and sort count data by user-selectable time intervals traffic counts. Count methods using two axle sensors per lane (road tube or piezo) include direction and lane subtraction.*
  ***Time Stamped Sensor Event** – another method of collecting traffic count data where the field unit stores in its memory sensor accuations with a time stamp accurate to 1/10695 of a second. This recorded sensor data is later fed into your PC computer that uses it to produce the reports you select for any type of data.*
- *Three modes of classification (1 to 8 lane)*
  ***Binning** – User can define 30 speed, 30 axle, 30 headway and 30 gap bins. Default FHWA 13 bin scheme F, European scheme or your custom scheme on special order. Matrix classification: speed by axle, speed by length.*
  ***Individual Vehicle Records (Raw)** – In this mode, classifier stores in memory for each vehicle, time of passage to 1/100 second, speed to 1/100 mph or kph, number of axles, and spacing between axles.*
  Sample printout:

LANE	TIME	SPEED	AXLE SPACING
1	15:10:30.1	48.6 KPH	2 axle 10.2
1	15:10:32.4	57.3 KPH	3 axle 8.7 13.1
1	15:11:14.7	55.7 KPH	5 axle 14.5 4.3 29.7 4.3

  ***Time Stamped Sensor Event** – A method of collecting traffic data where the field unit stores in its memory sensor accuations with a time stamp accurate to 1/10695 of a second. The recorded sensor data is later fed into your office PC computer that processes it into speed, axle, count or binned data.*
- *Memory*
  The Phoenix Rax comes standard with 68K of counter memory. Memory can be expanded internally in 128K increments up to 960K. 960K of extra memory will enable the Rax to store vehicle-by-vehicle (raw data) files for about 105,000 vehicles. Memory can be expanded beyond 960K by plugging in an optional (PCMCIA) TAM card with from 256K to 16 megs of memory.
- *16-key watertight keyboard*
  Complete alphabet and numbers read on a four line, 80 character, backlit liquid crystal display.

DIAMOND TRAFFIC PRODUCTS

P.O. Box 1455, Oakridge, OR 97463. (541)782-3903 fax: (541)782-2053

www.diamondtraffic.com
e-mail: diamondtrf@aol.com

Data Recovery

TAM Credit Card Memory

We offer 256K to 16 meg flash credit card Take Away Memory as an option for the Phoenix Rax. An optional TAM card receptacle can be installed on the face panel. The PCMCIA TAM card can retrieve data files or be left in the unit as primary extended memory.

Portable Data Retriever

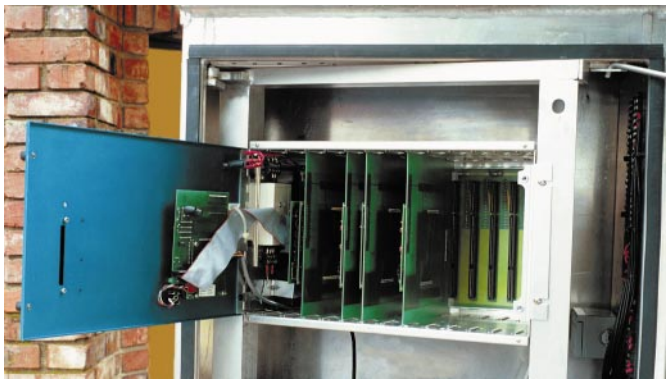
Soon to be available willl be our new all solid state electronic unit called the Data Hog. The device, about the size of two packs of cigarettes, will have serial data retrieval ability. Data storage capacity will be 2 to 128 megabytes in flash memory.

Modem Telemetry

Our new **TrafModem** *telemetry software for Windows is available for use on your P.C. or laptop to control 1 to 4 modems at once for automatic telemetry data retrieval of permanent site equipment.*

Serial Interface to PC, Laptop or Palmtop

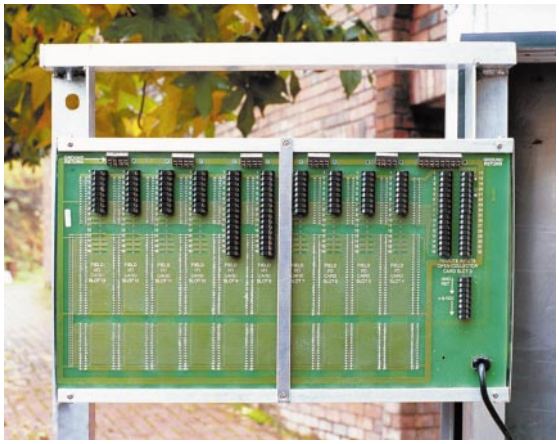
RS232 serial cable connects the counter to a laptop, palmtop, or 100% IBM compatible computer. The Phoenix data files may be retrieved using TrafMan software or your own software and computer systems. Our open architecture command codes are published in TrafMan help screens.



Circuit boards plug into the back plane of the rack mount case allowing easy upgrades and exchanges.

TrafMan

TrafMan is our PC programming, communications and data recovery software. TrafMan will run on IBM PC or compatible computers and is available for the Pegasus, Unicorn, Phoenix, Phoenix Rax, TT-2001, TT-501 and TT-74. TrafMan includes XMODEM downloading, on-line help, disk file directory, DOS shell, plus much more. TrafMan software allows the user to edit, merge, factor, analyze, print, etc. (See TrafMan brochure for more complete description.)



Terminal strips on the back allow connection of necessary harnesses and cables.

Incident Detection and Call Back:



As a firmware programmable option, the Phoenix Rax offers ***automatic call back*** *for traffic incident and sensor failure detection. The Phoenix Rax can be programmed to call your central computer and report the failure of any of its traffic sensors. It can also be programmed to report when the average speed per lane or group of lanes drops below an initial predetermined trip speed, and calls a second time if the average falls below a second trip speed. The Phoenix Rax can also be programmed to activate a warning sign or message board for one specific type of vehicle, or if one or more types of vehicles exceed a selected speed. Other automated procedures can be custom written to your needs - such as temperature, wind speed, etc.*

Phoenix Rax Specifications

Sensor Inputs:
- 4 air switches (road tube) 32 counts/second, 5-100+ mph (7-150km)
- Up to 16 presence loop detectors (30-500 microhenry)
- Up to 8 piezo electric sensors
- Up to 8 piezo resistive sensors
- Up to 8 remote switch closures or open collector to ground

Lane Sensor Configuration: (count only) (1-16 lanes)
- One or two axle sensors for directional, subtractive or normal counts
- One or two loops for normal or directional counts

Lane Sensor Configuration: classification
- loop-loop, loop-axle-loop, axle-axle, axle-loop-axle

Memory:
- 68K internally expandable to 964K
- Externally expandable with TAM to 16 meg

Programming:
- From counter keyboard and display
- From IBM-compatible computer
- Remotely with a telephone modem
- With TAM

Recording Time Intervals:
- Can have from 1-5 different intervals selectable from 1-1440 minutes in any 24 hour period

Count Mode Selection:
- Normal
- Subtractive
- Directional

Classification Binning Mode: (1-8 lanes)
- FHWA Scheme “F” default, or the user may define up to 30 each of speed, axle, length, gap and headway bins. Default to European binning scheme available. Optional custom user schemes available.

Individual Vehicle Records Mode:
- Stores in memory a record of each vehicle to 1/100th of a second
- The record contains lane number, time of day, speed, number of axles, axle spacing and type of vehicle

Time Stamped Sensor Mode:
- Stores each sensor activation by internal crystal clock in memory to 1/10695 of a second

Study Start Selections:
- Immediately
- At midnight
- At a specified date and time

Study Stop Selections:
- Never
- 24 hours after start
- At a specified date and time

Lane Test and Monitoring:
- All lanes can be monitored, sensor activation tested, and configurations, spacing and IDs verified without interference of data collections. This can be accomplished either from the display or via telemetry.

Data Collection:
- Through a telephone modem
- With an IBM-compatible computer
- With our Rover, Palmtop, Laptop
- With a TAM

Files:
- Up to 99 individual site files can be stored in memory. At your option the files can be rolled over or the classifier can stop when memory is full.

File Delete Options:
- Files can be rolled over and first in will be deleted manually or automatic deletion at retrieval or deleted by groups or ranges.

Measurements:
- Metric speed and distance measurements or Imperial (US).

Date format:
- Selectable to give MM/DD/YY, DD-MM-YY or YY-MM-DD

Keyboard:
- Complete alpha/numeric with punctuations from standard 16 key keyboard
- A no-keyboard version is available which is controlled by your computer

Display:
- 4-line, 80 character, alpha/numeric backlit LCD display

Power Supply:
- 100 to 240 VAC fused power supply provides 3.3 amps at 12VDC.

Auto Restart:
- If unit shuts down due to loss of power, the auto restart will bring the Rax back on line when battery voltage reaches 6.4 volts.

Telemetry:
- Telemetry ready with the addition of an internal or external modem.

Construction:
- 1/16" (1.5mm) thick welded and anodized aluminum, with modular plug-in CMOS electronic circuit boards

Climatic Operating Range:
- -40°F (-40°C) to 165°F (72°C)
- 0-95% non-condensing relative humidity

FIFO Sensor Inputs:
- A FIFO (first in, first out) buffer is on all sensor inputs. This helps eliminate sensor misses due to simultaneous activation.

Sensor Miss Errors:
- Sensor miss errors in binned or per vehicle modes can be:
  - Monitored and stored in file
  - Monitored but not stored
  - Not displayed or stored

Dimensions:
- 17" wide x 10 3/4" tall x 12" deep (43.18 cm x 27.305 cm x 34.38 cm)

DIAMOND TRAFFIC PRODUCTS

P.O.Box 1455, Oakridge, OR 97463
(541) 782-3903 FAX: (541) 782-2053

www.diamondtraffic.com
e-mail: diamondtrf@aol.com

Global Traffic Technologies

Canoga™ Traffic Sensing System

Canoga™ C922 and C924 Vehicle Detectors

Matched Components of the Canoga™ Traffic Sensing System **October 2007**

Description

Canoga™ C922 and C924 Vehicle Detectors measure vehicle presence, count and roadway occupancy with industry-leading accuracy and reliability through superior inductive vehicle detection. Canoga C922 is a two-channel vehicle detector and the Canoga C924 is a four-channel vehicle detector. Both are designed to meet U.S. control cabinet rack standards. They are configured using Canoga™ C900 Configuration Software. Through the Canoga C900-CS, users are able to easily change a detector's configuration, view binning data, monitor traffic real-time (including speed and length), and view detector status. Canoga C922 and C924 allow remote access through serial ports on the front of the detector and on the back panel connector.

Operating Characteristics

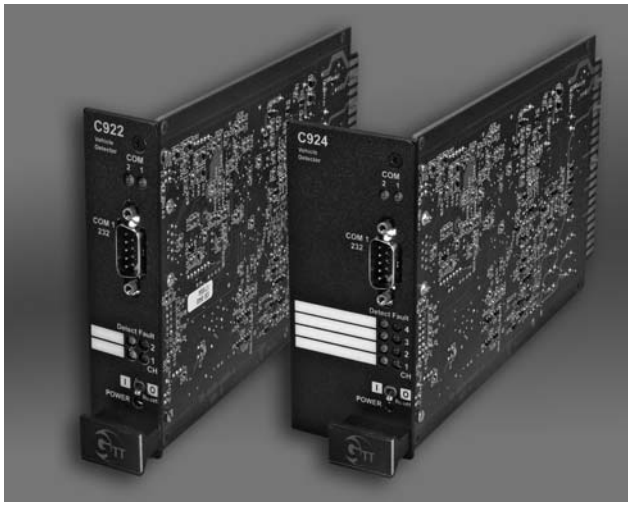
Canoga C922 and C924 have built-in protection against lightning-induced and other transients. User-programmed settings and vehicle detector–gathered data are stored in non-volatile memory.

Communication

Two independent serial ports are available for local and remote communications:

- Front panel TIA232 (RS232) port
- Back panel transmit/receive pin connectors for multi-drop TIA485 (RS485) communication

Canoga C900-CS uses the ports for local or remote configuration of the detector and for disturbance identification, to monitor and retrieve real-time activity, and to access data logging and binning information.



Canoga™ C922 Vehicle Detector and
Canoga™ C924 Vehicle Detector

Tuning Range

20 to 2,500 microhenries.

Sensitivity Setting

Sixteen sensitivity settings are available per channel:

- Eight "pulse" mode sensitivities, or
- Seven "presence" mode sensitivities, or
- "Off" mode

Frequency Setting

Four frequency settings per channel.

Matched Components of the Canoga™ Traffic Sensing System

Sensitivity, Threshold and Typical Response Time Values

Sensitivity Level	Threshold in Nanohenries	Typical Loop System Response Time
C	1024	<5 milliseconds
1	512	<6 milliseconds
2	256	<6 milliseconds
3	128	<8 milliseconds
4	64	<12 milliseconds
5	32	<20 milliseconds
6	16	<34 milliseconds
7	8	<64 milliseconds

Remote Reset Input

Input allows an external reset of the detector. When input voltage on pin C is pulled below 6 VDC for ≥ 17 milliseconds, the detector resets all active channels and establishes a new reference for each "On" loop within four seconds.

Power On/Off Switch (Reset Switch)

Allows the unit to be disabled or reset while still in the card rack.

Internal Loop Diagnostics

Records and stores type of loop fault and time of occurrence.

Channel by Channel Programmability

All vehicle detection parameters are programmable separately for each channel. This includes the sensitivity, background adapt rate, recovery method, wash delay time and wash adapt rate.

Status Output

Status output "on" when channel is okay.

Switch Output

Opto-isolated darlington pair switch outputs.

Detect and Fault LED Indicators

Green Detect LED indicators display channel output status and output timing.

- "On" during detection indicates that a vehicle is being detected
- "Flash" indicates that timing is active during delay or extension (with timing option) or direction detection
- Continuous "on" indicates fault condition exists

Red Fault LED indicators display coded messages of current or historical fault status and failure type.

- One long and one short pulse indicates a current open loop
- One long and two short pulses indicate a current shorted loop
- One long and three short pulses indicate current excess inductance change (ΔL≥25%)
- A 5-second long pulse followed by the flash code for a fault indicates historical fault status

Power LED

- Indicates power is applied to the unit

Comm Port Activity LEDs

- Rapidly flashing LED indicates data transmission
- COM 1 LED indicates front port communication
- COM 2 LED indicates rear port communication
- A 1-Hz flash by either LED indicates synchronization faults

Environmental

Temperature: -29° F (-34° C) to +165° F (+74° C)
Humidity: 5% to 95% (non-condensing)
Electrical: 10.8 VDC to 37.8 VDC
≤50 milliamperes/channel at 24 VDC
110 milliamperes/unit typical at 12 VDC
55 milliamperes/unit typical at 24 VDC

Physical Dimensions

Net Weight: (C922) 4.2 oz. (181 g)
(C924) 7.8 oz. (220 g)
Width: (C922) 1.13 in. (2.87 cm)
(C924) 1.91 in. (4.86 cm)
Height PC board: 4.5 in. (11.43 cm)
Face plate: 4.5 in. (11.43 cm)
Depth: 7.1 in. plus .55 in. for handle
(18 cm plus 1.4 cm for handle)

Canoga™ C900 Configuration Software

Canoga™ C900 Configuration Software is a matched component of the Canoga™ Vehicle Detection System. The configuration software can be run on both PCs and handheld devices. It uses communication ports to access Canoga™ C922 and C924 Vehicle Detectors to read and change configuration settings, for disturbance or fault identification and verification, to monitor real-time activity, and to retrieve binned traffic data.

Configuration of Canoga C922 and C924

Canoga C900-CS is used to completely configure Canoga C922 and C924 using the TIA232 serial port. The following parameters can be programmed per channel:

- Sensitivity/mode and operating frequency
- Delay or extend time
- Adapt parameters per channel: background adapt rate, recovery method, wash delay time, wash adapt rate
- Traffic sensor parameters
- Long loop counting parameters
- Directional vehicle detection parameters
- Detect LED, call output, fault LED and status output can be forced "on" or "off"
- Configure channel for traffic count and occupancy data selection

Canoga C900-CS is also used to set all other detector parameters:

- Field modem parameters
- Programmable address and password of detector
- Front and rear communication ports
- Synchronization mode
- Vehicle count period
- State of outputs for fault conditions
- Three types of noise filtering
- Pulse rephase time
- Configure schedule for traffic count and occupancy data collection

Applications

Real-time Activity Monitoring

The real-time activity monitoring application allows a traffic engineer to monitor detector activity in real-time from a remote location. The following parameters can be monitored: loop measurements (loop status, loop inductance, loop frequency, reference frequency), last fault or disturbance (type, time and date of occurrence), last vehicle (inductance change, duration of detection, and time and date of detection) and count (vehicle count, directional count and period remaining).

Traffic Data Binning

Traffic data binning retrieves the binned data collected in the vehicle detector memory. Binned vehicle count and occupancy can be viewed by date and time for each channel. Since overall memory is limited in size, setting the end time to "indefinite" or too far into the future will eventually fill the memory of the detector. In this case, the first data collected will be replaced by new data. If longer binning duration is required, the Canoga™ 848 Memory Module is available as an option to increase the memory size.

The table below illustrates the binning duration depending on the indicated binning interval.

	Binning Interval	Onboard Memory	Memory Module
Two Channel	1 Minute	42 Hours	180 Hours
	15 Minutes	26 Days	112 Days
Four Channel	1 Minute	21 Hours	90 Hours
	15 Minutes	13 Days	56 Days

Real-time Vehicle Logging

Canoga C900-CS receives data from the vehicle detector serial port and displays the information in real-time. Users may select which channel to log and can enter location-specific descriptions. The following parameters are displayed in real-time calculated by Canoga C900-CS: vehicle speed, detection duration, loop duration and vehicle length. The real-time data may be stored in a file on a disk or printed for later analysis.

Directional Vehicle Travel Detection

Canoga C900-CS can configure Canoga C922 and C924 for detection of vehicle travel direction. Two overlapping inductive loops are connected to either channels 1 and 2 (Canoga C922 or C924) or 3 and 4 (Canoga C924 only). The travel direction of a vehicle is identified by the directional vehicle count and the directional call in either the first or second channel of the channel pair, depending on the channel chosen for direction detection.

Long Loop Counting

Canoga C900-CS can be used to remotely retrieve long loop counting information from Canoga C922 and C924.

Canoga™ C922 and C924 Vehicle Detector Options

Canoga™ 848 Memory Module

The Canoga™ 848 Memory Module is an optional accessory for Canoga™ C922 and C924 Vehicle Detectors and expands the memory used for traffic data binning. This module increases the standard available binning memory from 16KB to 64KB.

Canoga™ 832 Communication Module

The Canoga™ 832 Communication Module changes the rear TIA485 port to a TIA232 port. The Canoga 832 module cannot be used when a Canoga 848 module is installed, and vice versa.

Canoga™ C922 AND C924 Vehicle Detector Board Edge Connector Terminations

Pin	Function	C922	C924	Pin	Function	C922	C924
A	Common of +24VDC	•	•	1	Synchronize Conductor 1	•	•
B	+24VDC (+10.8VDC to 38VDC)	•	•	2	Synchronize Conductor 2	•	•
C	RESET External	•	•	3	NC		
D	Channel 1 Loop Input A	•	•	4	Channel 1 Redundant Loop Input A	•	•
E	Channel 1 Loop Input B	•	•	5	Channel 1 Redundant Loop Input B	•	•
F	Channel 1 Switch Output (C)	•	•	6	NC		
H	Channel 1 Switch Output (E)	•	•	7	Channel 1 Disturbance Signal (OC)	•	•
J	Channel 2 Loop Input A	•	•	8	Channel 2 Redundant Loop Input A	•	•
K	Channel 2 Loop Input B	•	•	9	Channel 2 Redundant Loop Input B	•	•
L	PE (Protective Earth)	•	•	10	NC		
M	NC			11	NC		
N	NC			12	NC		
P	Channel 3 Loop Input A		•	13	Channel 3 Redundant Loop Input A		•
R	Channel 3 Loop Input B		•	14	Channel 3 Redundant Loop Input B		•
S	Channel 3 Switch Output (C)		•	15	NC		
T	Channel 3 Switch Output (E)		•	16	Channel 3 Disturbance Signal (OC)		•
U	Channel 4 Loop Input A		•	17	Channel 4 Redundant Loop Input A		•
V	Channel 4 Loop Input B		•	18	Redundant Loop Input B		•
W	Channel 2 Switch Output (C)	•	•	19	EIA-485-A [RS-232 TX (M832 Option)]	•	•
X	Channel 2 Switch Output (E)	•	•	20	Channel 2EIA Disturbance Signal (OC)	•	•
Y	Channel 4 Switch Output (C)		•	21	EIA-485-B [RS-232 RX (M832 Option)]	•	•
Z	Channel 4 Switch Output (E)		•	22	Channel 4 EIA Disturbance Signal (OC)		•
	Shaded means this model has no connection to this pin.						

(E): Emitter of Opto-coupler (C): Collector of Opto-coupler (OC): Open Collector/Open Drain NC = No Connection
Pins 1 through 22 are on the top (component) side and pins A through Z are on the back (solder side).
Polarization keys are located at three positions: between B/2 and C/3, between M/11 and N/12, between E/5 and F/6.

Important Notice to Purchaser:

EXCEPT FOR THE LIMITED WARRANTIES SET FORTH IN THIS DOCUMENT, GLOBAL TRAFFIC TECHNOLOGIES (GTT) MAKES NO OTHER WARRANTIES AND EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE.

GTT will, at its sole option, repair, replace or refund the purchase price of Canoga™ Traffic Sensing System components or Canoga™ Vehicle Detectors described herein found to be defective in materials or manufacture within seven (7) years from the date of shipment from GTT. This warranty shall not apply to Canoga traffic sensing system components or Canoga vehicle detectors which have been (1) repaired or modified by persons not authorized by GTT; (2) subjected to misuse, neglect or accident; (3) damaged by extreme atmospheric or weather conditions; or (4) subjected to events or use outside the normal or anticipated course.

IN NO EVENT SHALL GTT BE LIABLE FOR ANY INJURY (INCLUDING, WITHOUT LIMITATION, PERSONAL INJURY), DEATH, LOSS, OR DAMAGE (INCLUDING, WITHOUT LIMITATION, PROPERTY DAMAGE), WHETHER DIRECT, INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR OTHERWISE, ARISING OUT OF THE USE OR INABILITY TO USE, REPAIR OR FAILURE TO REPAIR, ANY GTT PRODUCT, REGARDLESS OF THE LEGAL THEORY ASSERTED. THE REMEDIES SET FORTH IN THIS DOCUMENT ARE EXCLUSIVE.

Global Traffic Technologies

Global Traffic Technologies, LLC
7800 Third Street North
St. Paul, Minnesota 55128-5441
1-800-258-4610
651-789-7333
www.gtt.com

Global Traffic Technologies Canada, Inc.
157 Adelaide Street West
Suite 448
Toronto, ON M5H 4E7
Canada
1-800-258-4610

Canoga is a trademark of Global Traffic Technologies, LLC.
3M and Scotchcast are trademarks of 3M. Used under license in Canada.
Please recycle. Printed in U.S.A.
© Global Traffic Technologies, LLC 2007
All rights reserved.

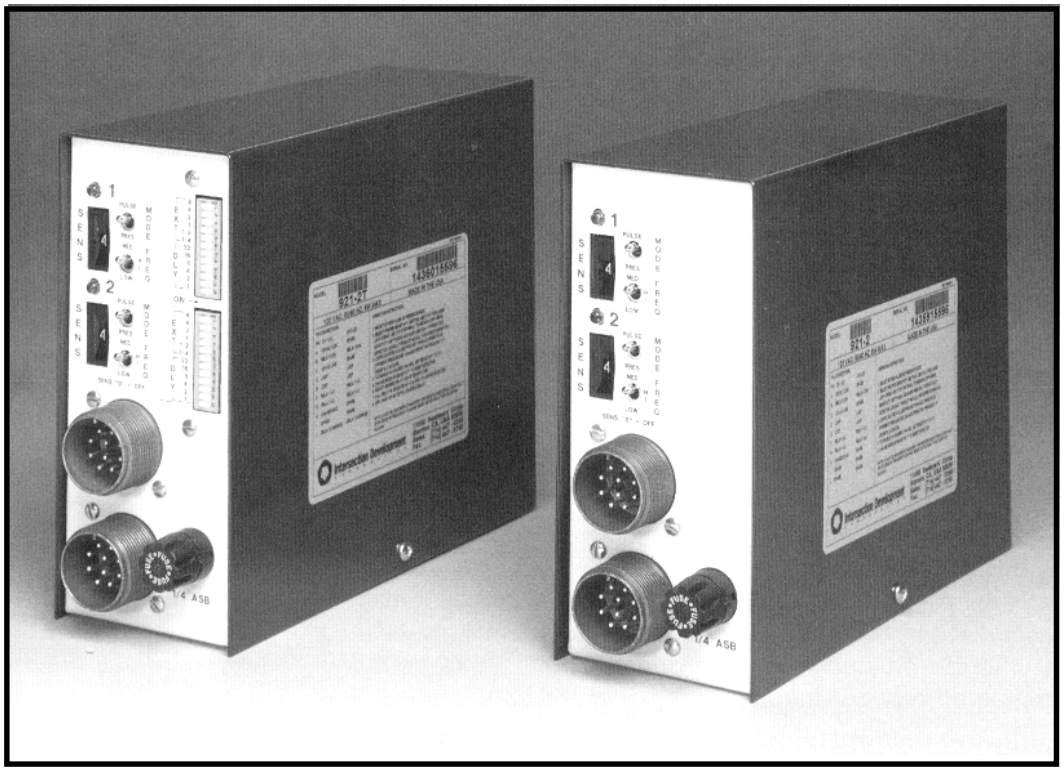
75-0301-3183-5 (A)

U.S. Traffic Corporation

Manufacturers & System Engineers

Models
921-2
921-2SS
921-2T
921-2TSS

Two Channel Digital Inductive Loop Vehicle Detectors



Features & Benefits

- **Two detector channels in a single unit**
- **The Winky-Blink™ loop monitor remembers and indicates intermittent and failed loops**
- **If intermittent or failed loops self-heal, the detector will resume normal operation without requiring a manual reset**
- **Thumbwheel switches for sensitivity settings**
- **Nine levels of sensitivity per channel**
- **Gold contact toggle switches on front panel for frequency and mode selections, increase long term reliability**
- **Three loop frequencies per channel**
- **Two selectable modes per channel:**
  - **√ Pulse**
  - **√ Presence**
- **Self-tuning and complete environmental tracking**
- **Complete low power CMOS digital design**
- **Transformer isolation for loops**
- **High intensity LED DETECT indicator**

<u>Additional Features & Benefits for Models 921-2T and 921-2TSS</u>

- **Digital delay and extension timers for each channel:**
  - **√ Delay time range is 0 to 63 seconds with 1 second steps**
  - **√ Delay is indicated by the LED flashing at 4 Hz**
  - **√ Delay inhibit control is available on pin J**
  - **√ Extension time range is 0 to 15.75 seconds in 0.25 second steps**
  - **√ Extension is indicated by the LED flashing at 16 Hz**

iDC Detector Systems ®

TRAFFIC CONTROL SYSTEMS SECTION NEMA MEMBER

Winky-Blink and Detector Systems are registered trademarks of U.S. Traffic Corporation.

▼ Specifications

Self-Tuning: The detector automatically tunes itself and is fully operational within one second after application of power or after being reset. 30 seconds is required before full presence time is possible.

Environmental and Drift Tracking: The detector is fully self-compensating for environmental changes and component drift over the full temperature range and the entire loop inductance range.

Loop Inductance Range: 20 to 2500 microhenries with Q factor of 5 or greater.

Loop Feeder Length: Up to 5,000 feet (1500 m) maximum with proper feeder cable and appropriate loops.

Loop Frequency: Three frequencies (normally in the range of 20 to 50 kilohertz) are switch selectable for each channel. The detector should be manually reset following a manual change in loop frequency.

Loop Input: Transformer isolated.

Reset: The detector channels are reset automatically by changing the sensitivity switch or the mode switch, or by applying or interrupting power.

Grounded Loop Operation: The loop isolation transformer allows operation with poor quality loops (which may include one short to ground at a single point).

Lightning Protection: The detector can tolerate, without damage, a 10 microfarad capacitor charged to 2,000 volts being discharged directly into the loop input terminals, or a 10 microfarad capacitor charged to 2,000 volts being discharged between either loop terminal and earth ground.

Faulty/Intermittent Loop Monitor: If the total inductance of the detector input network goes out of the range specified for the detector or suddenly changes more than 25%, the detector will immediately generate a failsafe continuous output (CALL) in either presence mode or pulse mode, and the front panel LED will begin repeating bursts of three blinks, the Winky-Blink™ mode. This failsafe condition will continue until the inductance returns to its previous value at which time the detector output will automatically resume normal operation. However, the red DETECT LED will continue in the Winky-Blink™ mode until the detector is manually reset or a power interruption occurs. This feature helps identify intermittent loop problems not present during troubleshooting. (The detector input network consists of the loop or loops plus the feeder [lead-in or home run] cable up to the connector on the detector.)

Sensitivity: Vehicle detection results from a sufficient negative change in loop inductance ($-\Delta L/L$). Nine detection sensitivity levels, plus OFF are switch selectable per channel. (Note that the detector is reset automatically whenever the sensitivity level is changed.)

Sensitivity	$-\Delta L/L$	Sensitivity	$-\Delta L/L$
Level 9	0.0025%	Level 4	0.08%
Level 8	0.005%	Level 3	0.16%
Level 7	0.01%	Level 2	0.32%
Level 6	0.02%	Level 1	0.64%
Level 5	0.04%	Level 0	OFF

Mode: Two modes of operation are determined by the front panel Mode switch:

- PRESENCE: Is a presence mode with a hold time of four minutes minimum (regardless of vehicle size) and typically 60 to 90 minutes for a car.
- PULSE: Is a pulse mode with a pulse of 125±25 ms. duration generated for each vehicle detected. Each detected vehicle is instantly tuned out if it remains in the loop detection zone longer than two seconds. This enables detection of subsequent vehicles entering the detection zone.

Detect Indicator: High intensity red light emitting diode (LED) indicates output status of channel:

- NORMAL CALL: Indicator is steadily on after the call delay time has expired and while a vehicle is still being detected.
- FAILED OR OUT-OF-RANGE LOOP: Indicator emits the Winky-Blink™ signal of three 50 ms "blinks" 50 ms apart once per second. Note: If the loop frequency is manually changed, the Winky-Blink™ signal may appear if the detector is not then manually reset.

Response Timing: The table below lists typical response times for solid state output (Models 921-2SS and 921-2TSS) only. Response time for relay output (921-2 and 921-2T) is 100 milliseconds, regardless of sensitivity setting.

Sensitivity	Response Time*	Sensitivity	Response Time*
Levels 1, 2, 3	2 milliseconds	Level 7	32 milliseconds
Level 4	4 milliseconds	Level 8	64 milliseconds
Level 5	8 milliseconds	Level 9	128 milliseconds
Level 6	16 milliseconds		

Output Conditions Table:

921-2 & 921-2T	POWER OK				POWER OUT
	Loop Normal		Loop Failed		
	Car	No Car	Car	No Car	
Output (Presence)	D	E	D	D	D
Output (Pulse)	MD	E	E	E	D

KEY: E = Relay energized; D = Relay de-energized; MD = Relay momentarily de-energized.

Output Conditions Table:

921-2SS & 921-2TSS	POWER OK				POWER OUT
	Loop Normal		Loop Failed		
	Car	No Car	Car	No Car	
Output (Presence)	S	O	S	S	O
Output (Pulse)	MS	O	S	S	O

KEY: S = Transistor Saturated (VCE < 1.2 V); O = Transistor off; MS = Transistor momentarily saturated (pulse).

Relay Ratings: The relay contacts are rated for: 3 A max, 150 VDC max, 300 VAC max, and 100 watts max switched power.

Solid State Output Ratings: Optically coupled transistors: 40 VDC maximum collector to emitter; 50 mA maximum collector current. The transistor saturation level is 1.2 VDC maximum. The output transistor is protected with a 47 volt zener diode connected between the emitter and collector.

Winky-Blink is a registered trademark of Intersection Development Corporation.

Power: 90 to 135 VAC, 50/60 Hz, 6 watts max

Operating Temperature: -40° F to +180° F (-40° C to +82° C)

Size: 6.5" H x 7.65" D x 3.0" W (16.5 x 19.4 x 7.7 cm) excluding switches and connector

Weight: 1 lb 15 oz (678 gm)

Internal Circuitry Isolation: All internal electronic circuitry is isolated from all external circuitry. Power is isolated by means of the power transformer. The loops are isolated by means of the loop isolation transformers. The outputs are isolated by means of the output relays or solid state opto-couplers.

Maintenance Provisions: The detector is constructed so that all components can be easily accessed on both sides of the printed circuit board without removing the board from the enclosure.

Ruggedized Construction: The enclosure is aluminum with a durable fused polyester coating. Printed circuit boards are made with double sided 2 oz./square foot cooper and plated through holes. Circuit boards are conformally coated for environmental protection.

Connectors/Pin Assignments (J1 & J2): MS3102A-18-1P

PIN	Model 921-2	
	J1 Connector	J2 Connector
A	120 VAC Neutral	Spare
B	Relay #1 (COM.)	Relay #2 (COM.)
C	120 VAC Line	Spare
D	Loop	Loop
E	Loop	Loop
F	Relay #1 (N.O.)	Relay #2 (N.O.)
G	Relay #1 (N.C.)	Relay #2 (N.C.)
H	Chassis Ground	Spare
I	Spare	Spare
J	Spare	Spare

PIN	Model 921-2SS	
	J1 Connector	J2 Connector
A	120 VAC Neutral	Spare
B	Output #1 (Emitter)	Output #2 (Emitter)
C	120 VAC Line	Spare
D	Loop	Loop
E	Loop	Loop
F	Output #1 (Collector)	Output #2 (Collector)
G	Spare	Spare
H	Chassis Ground	Spare
I	Spare	Spare
J	Spare	Spare

NOTES: The N.O. and N.C. contacts are shown with power applied, loop(s) connected, and no vehicles present.

Recommended harness (not included): Two Model 801A.

Connectors/Pin Assignments (J1 & J2): MS3102A-18-1P

PIN	Model 921-2T	
	J1 Connector	J2 Connector
A	120 VAC Neutral	Spare
B	Relay #1 (COM.)	Relay #2 (COM.)
C	120 VAC Line	Spare
D	Loop	Loop
E	Loop	Loop
F	Relay #1 (N.O.)	Relay #2 (N.O.)
G	Relay #1 (N.C.)	Relay #2 (N.C.)
H	Chassis Ground	Spare
I	Spare	Spare
J	Call Delay Inhibit (120 VAC)	Call Delay Inhibit (120 VAC)

PIN	Model 921-2TSS	
	J1 Connector	J2 Connector
A	120 VAC Neutral	Spare
B	Output #1 (Emitter)	Output #2 (Emitter)
C	120 VAC Line	Spare
D	Loop	Loop
E	Loop	Loop
F	Output #1 (Collector)	Output #2 (Collector)
G	Spare	Spare
H	Chassis Ground	Spare
I	Spare	Spare
J	Call Delay Inhibit (120 VAC)	Call Delay Inhibit (120 VAC)

NOTES: The N.O. and N.C. contacts are shown with power applied, loop(s) connected, and no vehicles present.

Recommended harness (not included): Two Model 801A.

Additional Specifications for Models 921-2T, 921-2TSS

Call Delay Time: The DELAY selection switch on the main circuit board permits Output calls to be delayed from 0 to 63 seconds in one second steps. Timing is digitally derived from the 50/60 Hz power.

Call Delay Inhibit: The call delay timer is inhibited when 120 VAC line is applied to the call delay inhibit input, pin J (with 120 VAC Neutral connected to pin A). Pin J is optically isolated from internal circuitry.

Call Extension Time: The EXTEND selection switch on the main circuit board permits Output calls to be extended from 0 to 15.75 seconds in 0.25 second steps. Full call extension is added to the end of every vehicle detection regardless of vehicle spacing. Timing is digitally derived from the 50/60 Hz power. (A jumper on the circuit board can be moved so call extension will be activated only when 120 VAC Line is applied to pin J. Note that the operation of Call Delay Inhibit is not affected by changing the jumper, i.e. application of 120 VAC Line to pin J inhibits the call delay timer regardless of the jumper position.)

Detect Indicator: High intensity and red light emitting diode (LED) indicates output status of channel:

- DELAY PERIOD: Indicator flashes at 4 Hz with 50% duty cycle if a vehicle is being detected but the call delay time has not expired.
- NORMAL CALL: Indicator is steadily on after the call delay time has expired but while a vehicle is still being detected.
- EXTEND PERIOD: Indicator flashes at 16 Hz with a 50% duty cycle after the vehicle is no longer detected but the extend time has not expired.
- FAILED OR OUT-OF-RANGE LOOP: Indicator emits the Winky-Blink™ signal of three 50 ms "blinks" 50 ms apart once per second. Note: If the loop frequency is manually changed, the Winky-Blink™ signal may appear if the detector is not then reset.

U.S. Traffic Corporation
Manufacturers & System Engineers
9603 John Street • Santa Fe Springs, CA 90670
Tel: (562) 923-9600 • Fax: (562) 923-7555
Toll Free: 1-800-733-7872 • www.idc-traffic.com

Specifications are subject to change without notice to reflect improvements and upgrades.

222N-TS2 GP7 Two Channel Detector Modules





- Exceeds all NEMA TS-1 and TS-2 Standards
- Excellent noise filtering
- Four frequency settings to eliminate crosstalk
- Pulse or presence modes per channel
- Sensitivity boost to hold small and high vehicles
- Event LED indicates present and historical loop faults
- Seven sensitivity levels per channel
- Sequentially scanned loops

The 222N-TS2 GP7 allows the user to optimize the detector's performance parameters for the most demanding detector application intersection control. For any application, the 222N-TS2 GP7 will identify loop events such as open loops, shorted loops or loops with excessive inductance changes. The event LED, using special flash rates, identifies the condition of loop fault, whether present or historical. This is the standard operation for intersection control where reliability is the major concern.

Designed especially for intersection control where cross-talk must be eliminated, the 222N-TS2 GP7 gives the user four different front panel selectable frequencies. In addition the 222N-TS2 GP7 is a scanning detector further reducing the possibility of cross-talk between two loops connected to the same detector.

Fast, predictable and consistent response times facilitate accurate speed and occupancy measurements. This level of performance is increasingly important for IVHS applications. Simple set-up is also a key feature of the 222N-TS2 GP7. Front panel frequency, sensitivity and mode switches allow the user to simply plug the unit in, adjust switches to desired positions and walk away.

Specifications

Characteristic	Description
Frequence	Tuning range for a nominal loop inductance with a Q-factor >4 & <12 F1F2 mode: 46 to 2400 µH nominal F0F2 mode: 38 to 1700 µH nominal F1F0 mode: 26 to 1200 µH nominal F0F0 mode: 18 to 700 µH nominal
Sensitivity	Seven levels of sensitivity can be selected by DIL switch. Settings 7 through 0 are as follows: 7 1+2+4 = 0.01% 6 0+2+4 = 0.02% 5 1+0+4 = 0.04% 4 0+0+4 = 0.08% 3 1+2+0 = 0.16% 2 0+2+0 = 0.32% 1 1+0+0 = 0.64% 0 0+0+0 = Channel Off All sensitivity settings, except the highest, activate a Sensitivity Boost. The detection threshold falls by 50% after detection is established to improve detection of high bed vehicles.
Operating Modes	Two modes of operation are available via a mode selection switch, Pulse (PLS) and Presence (PR).
Presence	Presence times of 16, 60, 120 minutes or permanent are available by setting the on board switch. Optional: any presence time value can be set from 1 to 127 minutes in 1 second increments.
Pulse	In pulse mode, a momentary output 125 ± 20ms (optional 250ms ± 30ms) is provided on vehicle entry. If the vehicle remains in the loop, a 2 second pulse paralysis time is provided before additional vehicles are detected.
Detect LED	**In detect:** High intensity Red LED lights for the duration of presence/ pulse setting in parallel with the channel output. **In fault:** Operates in parallel with the channel output.
Fault LED	**In open circuit loop fault:** LED flashes at 16Hz for 2 seconds and ON continuously for 2 seconds during current fault. Once the fault clears, the LED flashes continuously at 16Hz until reset. **In short circuit loop fault:** Pattern is the same as above except at 4Hz. **In loop drift fault:** Pattern is the same as above except at 1Hz. NOTE: Detector must be reset for historical fault condition to be cleared from memory.
Ambient Tracking	Asymmetrical tracking is used when the detector is quiescent.

Characteristic	Description
Power Requirements	10.8 to 30 VDC. Maximum permissible RMS ripple = 700 millivolt.
Outputs	SolidState Optically isolated NPN Transistor V_{ce}, ON voltage +1.2 VDC @ 50mA This output conducts a maximum of 500 µA in the OFF state at a collector-emitter voltage of +40VDC
Failsafe Output	A DETECT Output is given when the detector power supply fails. (Failsafe is default)
Input Supply Current	For each Detector Module: Nominal Current, normal operation = 60mA Maximum, with shorted loop-inputs = 90mA
Inductance Range	18 to 2400 µH, automatically tuned
Lightning Protection	Exceeds NEMA and Caltrans
Temperature Range	-40°F to +176°F (-40°C to +80°C)
Dimensions	4.5" H × 6.875" D × 1.1" W

Response Times

With the following sensitivity settings:

Channel X	Other Channel	Response Times
.01 to .02%	.01 to .02%	35 ms +/- 4 ms
.04 to .16%	.04 & above	20 ms +/-2ms
.16 & above	.04 & above	5 ms +/- 1 ms*

*Value shown is in 'Fast Response' mode, times vary according to Traffic setting. See manual.

Connections

22 pin card edge connector, mates with Cinch Jones 50-44A-30M

Pin	Function	Pin	Function
A	DC common (-)	N	Not used
B	DC 24V (+)	P	Not used
C	Reset	R	Not used
D	Ch.1Loopinput	S	Not used
E	Ch.1Loopinput	T	Not used
F	Ch.1outputcollector(+)	U	Not used
H	Ch.1outputemitter(-)	V	Not used
J	Ch.2loopinput	W	Ch. 2 output collector (+)
K	Ch.2loopinput	X	Ch. 2 output emitter (-)
L	Chassis ground	Y	Not used
M	Not used	Z	Not used
1	Not used	12	Not used
2	Not used	13	Not used
3	Not used	14	Not used
4	Not used	15	Not used
5	Not used	16	Not used
6	Not used	17	Not used
7	Channel 1 Status Output	18	Not used
8	Not used	19	Not used
9	Not used	20	Channel 2 StatusOutput
10	Not used	21	Not used
11	Not used	22	Not used

NEMAdetectorsmaynotbecompatiblewith170rackconfigurations.

Other available detection products

These other detection products are also available from Peek Traffic:

224N-TS2	Four channel NEMA	p/n 82-1336-02
224NT-TS2	Extend/Delay Timing	p/n 82-1336-01
222N-TS2	NEMA TS-2	p/n 82-1339-01
222NT-TS2	NEMA TS-2, Timing	p/n 82-1341-01
222N	NEMA TS-1	p/n 82-1339-02

Making the World a Safer Place to Travel

http://www.peek-traffic.com

Please contact Peek Traffic Corporation for customer inquiries about any of the company's Control, Data Collection, Enforcement, Detection, Signals, Tolling, or Systems products. To learn how Peek Traffic is making the world a safer place to travel, visit the Peek Traffic web site at http://www.peek-traffic.com.

The information contained in this publication is presented for informational purposes only, and while every effort has been made to ensure its accuracy, the information is not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. No license is granted by implication or otherwise to any of Peek Traffic's intellectual property. Peek Traffic reserves the right to alter or revise any of its products or published technical data relating thereto at any time without notice.

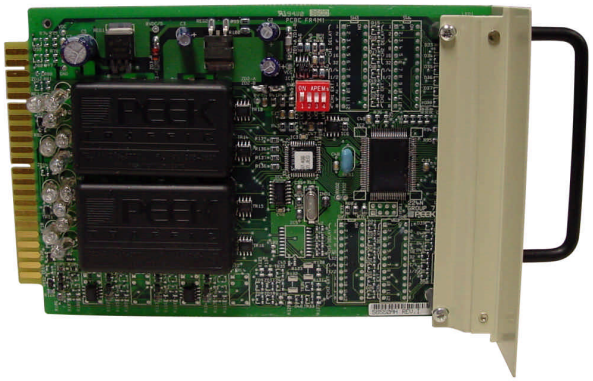
Copyright © 2004 Peek Traffic Corporation, A Quixote Company. All rights reserved. Printed in the United States.

Peek Traffic Corporation
A Quixote Company
2511 Corporate Way
Palmetto, Florida 34221
phone: (941) 845-1200
toll free in the US: 1 (866) 260-7335
fax: 1 (941) 365-0837

224N-TS2 GP7

Four Channel Detector Module





Fast, predictable and consistent response times facilitate accurate speed and occupancy measurements. This level of performance is increasingly important for IVHS applications.

Simple set-up is also a key feature of the 224N-TS2 GP7. Front panel frequency, sensitivity and mode switches allow the user to simply plug the unit in, adjust switches to the desired positions, and walk away.

Peek's 224N-TS2 GP7 allows you to optimize the detector's performance parameters for the most demanding detector application — intersection control. For any application, the 224N-TS2 GP7 identifies loop events such as open loops, shorted loops or loops with excessive inductance changes. The event LED, using special flash rates, identifies the condition of loop fault, whether present or historical. This is the standard operation for intersection control where reliability is the major concern.

Designed especially for intersection control where crosstalk must be eliminated, the 224N-TS2 GP7 provides four different front panel selectable frequencies. In addition, the 224N-TS2 GP7 also functions as a scanning detector, further reducing the possibility of crosstalk between two loops connected to the same detector.

Features

- Exceeds all NEMA TS-1 and TS-2 standards
- Excellent noise filtering
- Four frequency settings to eliminate crosstalk
- Pulse or presence modes per channel
- Sensitivity boost to hold small and high vehicles
- Fault LED to indicate present and historical loop faults
- Seven sensitivity levels per channel
- Sequentially scanned loops
- Quick, simple set-up

Specifications

Characteristic	Description
Frequence	Tuning range for a nominal loop inductance with a Q-factor >4 & <12 F1F2 mode: 46 to 2400 µH nominal F0F2 mode: 38 to 1700 µH nominal F1F0 mode: 26 to 1200 µH nominal F0F0 mode: 18 to 700 µH nominal
Sensitivity	Seven levels of sensitivity can be selected by DIL switch. Settings 7 through 0 are: 7 1+2+4 = 0.01% 6 0+2+4 = 0.02% 5 1+0+4 = 0.04% 4 0+0+4 = 0.08% 3 1+2+0 = 0.16% 2 0+2+0 = 0.32% 1 1+0+0 = 0.64% 0 0+0+0 = Channel Off All sensitivity settings, except the highest, activate a Sensitivity Boost. The detection threshold falls by 50% after detection is established to improve detection of high bed vehicles.
Operating Modes	Two modes of operation are available via a mode selection switch, Pulse (PLS) and Presence (PR).
Presence	Presence times of 16, 60, 120 minutes or permanent are available by setting the on board switch. Optional: any presence time value can be set from 1 to 127 minutes in 1 second increments.
Pulse	In pulse mode, a momentary output 125 ± 20ms (optional 250ms ± 30ms) is provided on vehicle entry. If the vehicle remains in the loop, a 2 second pulse paralysis time is provided before additional vehicles are detected.
Detect LED	**In detect:** High intensity Red LED lights for the duration of presence/ pulse setting in parallel with the channel output. **In fault:** Operates in parallel with the channel output.
Fault LED	**In open circuit loop fault:** LED flashes at 16Hz for 2 seconds and ON continuously for 2 seconds during current fault. Once the fault clears, the LED flashes continuously at 16Hz until reset. **In short circuit loop fault:** Pattern is the same as above except at 4Hz. **In loop drift fault:** Pattern is the same as above except at 1Hz. NOTE: Detector must be reset for historical fault condition to be cleared from memory.
Ambient Tracking	Asymmetrical tracking is used when the detector is quiescent.

Characteristic	Description
Power Requirements	10.8 to 30 VDC. Maximum permissible RMS ripple = 700 millivolt.
Outputs	SolidState optically-isolated NPN Transistor V_{ce}, ON voltage ≤+1.2 VDC @ 50mA This output conducts a maximum of 500 µA in the OFF state at a collector-emitter voltage of +40VDC
Failsafe Output	A DETECT Output is given when the detector power supply fails. (Failsafe is default)
Input Supply Current	For each Detector Module: Nominal Current, normal operation = 80mA Maximum, with shorted loop-inputs = 100mA
Inductance Range	18 to 2400 µH, automatically tuned
Lightning Protection	Exceeds NEMA and Caltrans
Temperature Range	-40°F to +176°F (-40°C to +80°C)
Dimensions	4.5" H × 6.875" D × 2.2" W

Response Times

With the following sensitivity settings:

Channel X	Other Channel	Response Times
.01 to .02%	.01 to .02%	35 ms ± 4 ms
.04 to .16%	.04 & above	20 ms ± 2ms
.16 & above	.04 & above	5 ms ± 1 ms*

*Value shown is in 'Fast Response' mode, times vary according to Traffic setting. See manual.

Connections

22 pin card edge connector, mates with Cinch Jones 50-44A-30M

Pin	Function	Pin	Function
A	DC common (-)	N	Not used
B	DC 24V (+)	P	Channel 3 loop input
C	Reset	R	Channel 3 loop input
D	Ch.1loopinput	S	Ch. 3 output collector (+)
E	Ch.1loopinput	T	Ch. 3 output emitter (-)
F	Ch.1outputcollector(+)	U	Channel 4 loop input
H	Ch.1outputemitter(-)	V	Channel 4 loop input
J	Ch.2loopinput	W	Ch. 2 output collector (+)
K	Ch.2loopinput	X	Ch. 2 output emitter (-)
L	Chassis ground	Y	Ch. 4 output collector (+)
M	Not used	Z	Ch. 4 output emitter (-)
1	Not used	12	Not used
2	Not used	13	Not used
3	Not used	14	Not used
4	Not used	15	Not used
5	Not used	16	Channel 3 StatusOutput
6	Not used	17	Not used
7	Channel 1 Status Output	18	Not used
8	Not used	19	Not used
9	Not used	20	Channel 2 StatusOutput
10	Not used	21	Not used
11	Not used	22	Channel 4 StatusOutput

NEMA detectors may not be compatible with 170 rack configurations.

Other available detection products

These other detection products are also available from Peek Traffic:

222N	Two channel NEMA TS-1	p/n 82-1339-02
222N-TS2	Two channel NEMA TS-2	p/n 82-1339-01
222NT-TS2	Two channel NEMA TS-2, w/ Timing	p/n 82-1341-01
224N-TS2	Four channel NEMA TS-2	p/n 82-1336-02
224NT-TS2	As above, w/ Extend/Delay Timing	p/n 82-1336-01

Making the World a Safer Place to Travel

http://www.peek-traffic.com

Please contact Peek Traffic Corporation for customer inquiries about any of the company's Traffic Control, Data Collection, Enforcement, Detection, or Tolling products. To learn how Peek Traffic is making the world a safer place to travel, visit the Peek Traffic web site at http://www.peek-traffic.com.

The information contained in this publication is presented for informational purposes only, and while every effort has been made to ensure its accuracy, the information is not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. No license is granted by implication or otherwise to any of Peek Traffic's intellectual property. Peek Traffic reserves the right to alter or revise any of its products or published technical data relating thereto at any time without notice.

Copyright © 2004 Peek Traffic Corporation, A Quixote Company. All rights reserved. Printed in the United States.

Peek Traffic Corporation
A Quixote Company
2511 Corporate Way
Palmetto, Florida 34221
phone: (941) 845-1200
toll free in the US: 1 (866) 260-7335
fax: 1 (941) 365-0837

ECONOLITE
Solutions that Move the World®

Autoscope Solo® *Terra*™ Vehicle Detection System



Autoscope Solo *Terra* is a cost-effective video detection and surveillance system with easy installation and minimal maintenance.

Description

The **Autoscope Solo *Terra*** sensor is a color video detection and surveillance system that quickly installs with "three wires only," reduces maintenance with ClearVision faceplate coating, and offers user-convenient ***Terra Technology***. The **Solo *Terra*** sensor provides timely, high-quality traffic information required for today's sophisticated transportation systems.

Terra Technology uses IP-based addressing with a unique Ethernet MAC address. It combines state-of-the-art advances in digital image signal processing, broadband communications, and System-on-Chip (SoC) processors to add versatility and boost performance.

EasyLink connectivity means simple installation into the traffic cabinet and integration into an agency's IP-based communications network. A standard CAT-5 cable connects ***Terra Technology*** products into a network providing access to video, traffic data, and the **Autoscope Solo *Terra*** vehicle detection system. The reusable EasyLock connector simplifies the task of pulling "three wires only" either up or down the pole without splicing and no coaxial cable is required. Zoom configuration is conducted at the cabinet.

Terra Technology provides MPEG-4 streaming video via the **Autoscope**® Video Player or any standard digital video player such as QuickTime. Depending on the available network bandwidth, viewing rates vary from 5 fps to 30 fps. In the traffic cabinet, the ***Terra*** Access Point (TAP) also provides full-motion video output to an analog video monitor. The TAP, using ***Terra Technology***, interfaces between the video detection unit and the cabinet.

Terra Technology allows simple Internet browser interface with common Internet browsers in addition to implementing safe and secure password-protected access over the internet. The embedded web server capability is a convenience to users, enabling access to streaming video, configuration editing, and system monitoring via the Internet.

Terra Technology employs an **Autoscope *Terra*** dual-core processor with sophisticated image processing and Advanced RISC Machine (ARM) general-purpose processing in a small SoC package for low power consumption. Multi-threaded software processes video images in real-time to detect traffic, extract data, identify incidents, and transmit detector outputs, while simultaneously streaming full-motion MPEG-4 video. The ClearVision faceplate coating helps keep the faceplate clean, even when missing routine maintenance.

Benefits

- Cost-effective solutions for traffic management
- Field-proven accuracy and reliability
- Easy to install and configure
- Flexible design meets a variety of detection and surveillance applications
- Superior to other detection systems in value and performance

Features

- EasyLink connectivity for IP-addressable broadband communications
- Web server interface for easy setup
- Streaming digital MPEG-4 video output
- User-definable password protection
- Vehicle detection, traffic data measurement, speed, and incident detection
- Integrated color camera, zoom lens, and dual-core processor for advanced image processing
- Direct real-time iris and shutter speed control
- Fail-safe detector outputs with the **Autoscope** TAP
- Non-volatile memory data storage
- High energy transient protection
- Technologically advanced faceplate heater and ClearVision faceplate coating
- Local language support

Setup & Operation

The **Autoscope Solo** *Terra* unit makes it easier than ever to set up and customize to meet application requirements. The **Autoscope** Configuration **Wizard**® quickly sets up intersection or highway incident detection applications. Simple mouse of keyboard operations allow custom positioning for virtual detectors per field-of-view. Detection zones provide traffic count, presence, speed, and incident detection alarms. Incident types include freeway congestion, stopped vehicles, wrong direction vehicles, slow-moving vehicles, debris, pedestrians, or other customized alarms. Real-time polling or stored data include volume, occupancy, five vehicle classes by length, density, and other traffic data for selected periods or by phase.

Detector outputs can be assigned to interface with NEMA TS1/TS2, Type 170/179 and 2070 ATC controller via the optional **Autoscope** *Terra* Access Point (TAP). Traffic data is quickly integrated into proprietary software applications with the optional **Autoscope** Software Developer's Kit (SDK). Extensive Boolean Logic capabilities provide flexibility in detector layouts to help validate an event or incident alarm.

Applications

- Traffic incident management for highways, tunnels, and bridges
- Junction control
- Traffic data collection
- Work-zone safety and traffic control
- Traveler information systems
- Journey time (travel time)
- Remote video surveillance

Power

- 15W
- 110/220 VAC 50/60 Hz

Video

- Digital streaming MPEG-4 video output

Lens

- 22x Continuous focus lens
- Standard configuration:
  - Horizontal: 2.3° to 48°
  - Vertical: 1.8° to 37°
  - Focal Length: 0.16 in. to 3.46 in. (4 mm to 88 mm)
- Optional wide-angle configuration:
  - Horizontal: 4° to 74°
  - Vertical: 3° to 59°
  - Focal Length: 0.09 in. to 2.08 in. (2.4 mm to 52.8 mm)

Camera

- CCD ¼ in. diam. (4.5 mm)
- Horizontal resolution: NTSC > 470 TVL
- Sensitivity (at lens, full video, AGC off, 1/60 sec) 2.0 lux (color)
- Signal-to-noise > 50 dB
- Synchronization: Crystal lock

Effective Pixels

- NTSC: 380K (768 x 494)
- PAL: 440K (752 x 582)

Housing & Sunshield

- Image sensor and processor sealed in a water-proof and dust-tight NEMA-4 housing (IP 66)
- Thermostatically controlled faceplate heater
- Adjustable weather and sunshield with drip guard
- Low-power thermostatically-controlled ITO faceplate heater
- Hydrophilic faceplate coating
- Weatherproof rear connector (IDC rapid termination industrial connector)

Communications

- EasyLink (broadband communications (up to 5 MB/sec) with RJ-45 connection from required ***Terra*** Interface Panel (TIP)

Environmental

- -29°F to +140°F (-34°C to +60°C)
- Up to 100% relative humidity per MIL-E-5400T paragraph 4.3.24.4

Dimensions and Weight

Overall H x W x L (with sunshield and bracket):

- 8 in. x 4.3 in. x 21.3 in. (20 cm x 12 cm x 54 cm)
- 6.6 lb (3.0 kg)
- Mounting: Standard camera bracket tilt-top provided

Options

- Standard or wide-angle zoom lens
- Paint color

Warranty

- Two-year warranty
- Extended warranty package to five years

Regulatory

- CE EN 55022, EN 61000-6-1, EN 60950
- FCC Part 15, Class A

Product Support

Product support and training by team of factory-trained **Autoscope** technical support specialists

© 2007 Econolite Control Products, Inc. All rights reserved. Econolite Control Products, Inc. reserves the right to change or update these specifications at any time without prior notification.

3360 E. La Palma, Anaheim, CA 92806-2856
Tel: (714) 630-3700 • Fax: (714) 630-6349
E-mail: sales@econolite.com
www.econolite.com
38113E0407-4

ISO 9001 REGISTERED

ECONOLITE
Solutions that Move the World®

ECONOLITE
Solutions that Move the World®

Autoscope Solo® Pro II Machine Vision Processor (MVP)



An integrated color camera, zoom lens, and MVP featuring exceptional performance and simple setup via Autoscope Configuration Wizard®

Description

The **Autoscope Solo** Pro II MVP sensor offers field-proven reliability and the flexibility to meet greater detection objectives. Its features increase the effectiveness of the world's first integrated wide-area video detection system for traffic management professionals everywhere.

The Solo Pro II sensor compliments the advanced **Autoscope®** product suite and system architecture. This product is ideal for freeway, intersection, bridge, tunnel, railroad, traffic-monitoring, and incident prevention applications. With the **Autoscope** Software Developer's Kit (SDK), a programmer can easily create new client applications for display, incident alarms, and traffic parameter databases.

The **Autoscope Solo** Pro II sensor provides an economic alternative to loops and other detection technologies. Twisted-pair wiring to the Solo Pro II sensor is faster and easier to install than higher-cost coaxial cables. Remote connections as simple as a phone line or wireless radio can bring compressed video and data back to a traffic management center.

Benefits

- Simplicity with **Autoscope** Configuration **Wizard** and SmartMouse™/Mouse & Monitor
- Superior value when compared to other detection systems
- Flexibility in application
- Reliable detection performance
- Ease of installation and cost-effective maintenance
- Native language support
- Streaming video with actuations

Features

- Integrated color camera, zoom lens, and MVP in one housing
- 22x zoom lens and color imager
- Direct real-time iris and shutter speed control
- Unique and private IP address for Solo network
- Rugged, environmentally-sealed enclosure
- Technologically advanced faceplate heater
- Low power consumption
- Microprocessor technology for reliable long-life performance
- Optical or electrical fail-safe mode sends outputs to traffic controller
- Optional five-year extended warranty package

Setup & Operation

Simple mouse or keyboard operations allow positioning for virtual detectors in the field of view. Detector layouts can be customized to match specific detection objectives for each site. Any performance monitoring or modifications can be conducted on-site or remotely, via phone lines, twisted pair copper, fiber, or wireless communications infrastructures.

Detection zones include count, presence, and incident detection. Real-time polling, dial-up, or stored traffic data include: volume, occupancy, speed, density, and headway, as well as five vehicle classifications determined by time intervals from 1 second to 60 minutes. Extensive Boolean Logic capabilities provide flexibility in detector layouts and can help validate an event or incident alarm.

Autoscope Solo Pro II now features the **Autoscope** Configuration **Wizard** for simplified set-up and configuration of common intersection applications.

Power
- 24 VAC, 50/60 Hz
- 10 to 28 VDC
- 15 W max

Weight
- 6.6 lb (3.0 kg)

Imaging Device
- 22x continuous-focus zoom
- Horizontal: 4° to 74°
- Vertical: 3° to 59°
- Focal Length: 2.4 mm to 52.8 mm
- ¼ in. CCD (4.5 mm diam.)

Video Formats Supported
- RS170
- NTSC
- CCIR
- PAL

Resolution
- NTSC: ≥470 TVL Horizontal / 400 TVL Vertical
- PAL: ≥460 TVL Horizontal / 550 TVL Vertical

Effective Pixels
- NTSC: 380K (768 x 494)
- PAL: 440K (752 x 582)

Synchronization
- Crystal lock

Sensitivity at Lens
- Full video
- AGC off
- 2.0 lux

Signal to Noise Ratio
- ≥50 dB

Ambient Temperature Limits
- -29°F to +140°F (-34°C to +60°C)

Humidity Limits
- Up to 100% relative humidity
- Non-condensing

Interface
- MS 14-18P Connector
- 24 VAC or VDC (15 W)
- RS-485 supervisor communication
- RS-485 detector communication
- Differential color video

Housing & Sunshield
- Image sensor and MVP sealed in waterproof and dust-tight enclosure
- Low-power technologically advanced faceplate heater
- Adjustable weather and sunshield drip guard

Dimensions
- Mounting: Standard camera bracket tilt-top provided
- Housing enclosure: 3.5 in. diam., 15.5 in. L (8.89 cm diam., 39.37 cm L)
- Weather sunshield: 21.3 in. L (54.1 cm L)
- 8 in. H x 4.75 in. W x 21.3 in. L (20 cm H x 12 cm W x 54 cm L) with sunshield and bracket

Options
- Analog video output
- DC model for solar or other DC applications
- Sealed or pressurized enclosure
- Paint color

Warranty
- Two-year warranty
- Extended warranty available (five-year warranty package)

Product Support
Product support and training by team of factory-trained **Autoscope** technical support specialists

© 2007 Econolite Control Products, Inc. All rights reserved. Econolite Control Products, Inc. reserves the right to change or update these specifications at any time without prior notification

3360 E. La Palma, Anaheim, CA 92806-2856
Tel: (714) 630-3700 • Fax: (714) 630-6349
E-mail: sales@econolite.com
www.econolite.com
38111E0607-3

ISO 9001 REGISTERED

ECONOLITE
Solutions that Move the World®



Vantage® RZ4 Camera

[Optimized for traffic video detection]



The Vantage® Camera offers the best all-round performance for the capture of vehicles in a variety of lighting and weather conditions. Most video detection systems require a clean and stable video signal to function correctly. In contrast to other CCTV type cameras, the Vantage camera delivers a constant and regulated video signal that is easily processed by the Vantage video detection systems.

The camera assembly is sealed in a weather-resistant enclosure specifically designed for outdoor use. To prevent sun glare and to protect the housing from the weather elements, the camera is fitted with a moveable sunshield to allow the camera to be pointed in any direction. The sunshield also extends beyond the front of the camera housing to protect the housing glass from rain and the formation of icicles that could hinder the view of the camera.

The camera housing incorporates an adjustable mounting bracket that allows the camera to be positioned correctly. The mounting bracket is pre-drilled for easy attachment to a variety of poles and other street fixtures simplifying installation and set up.

The camera is virtually maintenance-free with no active moving parts. To prevent the build up of condensation and ice on the lens glass, the camera housing is fitted with a heater that ensures a clear view at all times.

The Vantage Camera has been optimized for use in outdoor conditions specifically for the viewing of traffic flows at the intersection, on the highway, on bridges or in tunnels. The camera's image is normally adjusted to view up to 4 or 5 lanes of traffic. Other uses for video detection include: Ramp Metering, Pedestrian Detection, Red Light Enforcement as well as Bicycle Detection. It all depends upon where and how you position the Vantage Camera.

Installation and Configuration

The Vantage camera has been designed to simplify and reduce the time needed to install and configure the unit on a pole or other fixture. The camera housing is supplied sealed from the factory with two connectors on the rear edge. Water-tight plugs are easily assembled on site to ensure rapid connection and long term use. Once the camera is mounted using the supplied camera bracket, the camera needs to be focused and zoomed to achieve the correct field of view. This is performed using the Vantage Lens Adjustment Module (LAM) as illustrated on this information sheet. The LAM must be used to access the camera controls which are secured within the camera housing thus maintaining the watertight seal.

Features

- Camera
  - Color or monochrome image sensors available
  - Latest CCD Sensing element and DSP technology
  - Electronic shutter and auto iris lens
  - Auto focus with manual override
- Camera Housing
  - Sealed housing to IP67 specification
  - Integrated adjustable sunshield
  - Auto-sensing power supply – 115/240 VAC 50/60 Hz
  - Internal heater with proportional power control
  - Integrated mounting bracket
  - Separate connectors for power and video
- Options
  - DC power for solar or battery applications
  - 2.4Ghz wireless operation
  - Junction Box adapter for field terminations

ITERIS® *Innovation for better mobility*

Roadway Sensors

Benefits

- Optimized for outdoor traffic situations that aids video detection
- Integrated mounting brackets reduce installation and setup time
- Connectors located on back faceplate simplifies cable connection
- Proportional power-controlled internal heater prevents ice and condensation resulting in improved video detection performance in adverse weather conditions.

Typical Applications

- Intersection flow control
- Ramp metering
- Traffic data collection
- Bicycle detection
- Traveler information system input
- Temporary and construction zone vehicle detection replacement
- Moving or wrong way motion detection
- Automatic Incident Detection (AID) in tunnels and on bridges

Vantage Family Products

- Machine Vision Processor modules
- Input and Output Extension modules
- Communications modules
- Video detector rack systems

The camera produces color or monochrome images of roadway scenes for detection of vehicle traffic. Camera is mounted tilted down 20°, or more, below horizontal to avoid direct view of sun or horizon.

Vantage LAM Option

The LAM (Lens Adjustment Module) is an easy-to-use hand held device that allows field adjustment of the camera settings. The unit is available in NTSC or PAL format, and can be used with or without a monitor.



Technical Specifications

Imager	768 x 494 effective pixels
	470 TV lines minimum
	Automatic white balance
	>50 dB S/N ratio
	.1 lux capable
Lens	Focal length and focus adjustable through connector at rear of housing for a horizontal field of view ranging from 5.4° wide to 50.7° wide
Connections	BNC connector for video at rear of housing.
	Power connector for line power, DC input, neutral, and safety ground at rear of housing.
Physical	
Weight	5.7 pounds (2.6 Kg), including camera, lens, housing, sunshield, and mounting bracket
Dimensions	17" (43.2cm) long x 5" (12.7cm) diameter (without mounting bracket)
Environment	
Temperature	–31° F to +140° F (–35° C to +60° C)
Humidity	0% to 100%
Vibration	0.5G, 3 axes, 5-30 Hz
Power	
Standard	115/230 VAC (45W max.) 50/60 Hz
Option	12V DC (30W max.)

ITERIS® Innovation for better mobility

TÜV ESSEN ISO 9001

Information furnished by Iteris is believed to be accurate and reliable. However, Iteris does not warranty the accuracy, completeness, or fitness for use of any of the information furnished. No license is granted by implication or otherwise under any intellectual property. Specifications subject to change without notice.



VideoTrak® PLUS

VEHICLE DETECTION, COUNTING, INTERSECTION ACTUATION & CLASSIFICATION

DETECTION

VideoTrak is the intelligent choice for cost-effective and accurate above ground vehicle detection and traffic data collection. With its patented digital image processing algorithms, VideoTrak provides an inexpensive and unobtrusive means to accomplish both fully actuated vehicle detection for intersection control and traffic surveillance.

PROVEN DIGITAL IMAGING ALGORITHMS

The multi-resolution processor provides efficient analysis of real-time video input in order to identify traffic conditions, adapt to various environments, monitor for adequate image quality, and verify proper camera operation.

Patented tracking-based algorithms provide superior detection, while specialized shadow filtering, image stabilization, and automatic field-of-view gain algorithms minimize false detections and missed calls.

SCALABLE MODULAR DESIGN

- Remote or onsite display of the traffic scene provides visual verification of detection accuracy.
- Available in two models, which support up to 4 or 8 cameras - with as many as 32 detection zones per camera - providing up to 128 or 256 detection zones, depending on model.



STANDARDS COMPLIANCE

- Video Processing Module supports RS-170, NTSC, CCIR or PAL format CCD cameras.
- Detection features are compatible with NEMA TS-1/TS-2, Type 170/179, Type 2070 and ATC controllers.
- Counting and classification data retrieval supported via ATMS Real-time Protocol.
- NEMA, FCC and CE compliant.

APPLICATIONS

VideoTrak's breadth of features is designed to serve the needs of transportation engineers across the globe.

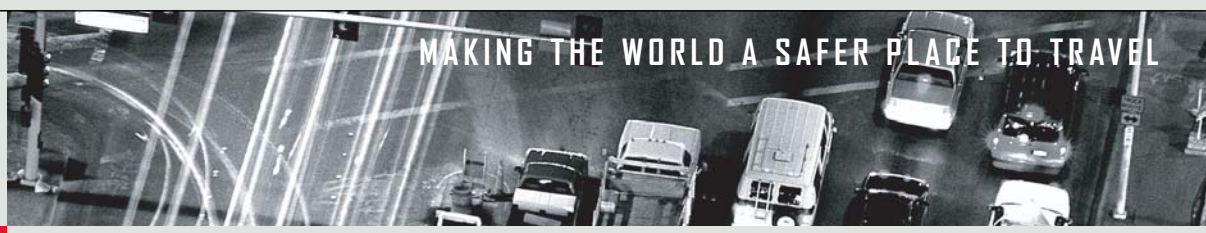
- Complete intersection detection.
- Highway detection/management.
- Highway ramp control.
- Tunnel stopped-vehicle detection.
- Vehicle counting/classification.
- Automatic incident detection.
- Collection of traffic statistics.

HOW IT WORKS

Video cameras are mounted in accordance with a Peek site survey to optimize camera locations. Positioned on a signal pole or mounted on a traffic signal mast arm or any other stable structure, cameras require only power and video connections.

For each camera, the user defines the area of detection (Zone). Each zone can be configured as either a normal or incident detection zone. A normal zone provides standard presence detection, which can be programmed to operate any output, either directly or conditionally. An incident zone is used to detect particular traffic conditions or events. Typically, incident detections are forwarded to ATMS systems for instant recognition.

Standard notebook/laptop computers may be used for detection zone setup and viewing of detector actuations within the traffic scene.



Quixote Traffic Corporation

WWW.QUIXTRAFFIC.COM

STATISTICS

Regardless of the zone type, user-configured statistics may be collected and stored in user-selected intervals (10 seconds to 60 minutes) for each vehicle passing over a zone.

- Number of vehicles (volume/counts).
- Average speed (mph/kph).
- Lane occupancy (% time lane is occupied).
- Density (volume/speed).
- Headway (avg. in seconds).
- Delay (avg. delay in seconds).
- Queue length (foot/meters).
- Vehicle length (avg. in ft/meters).

NORMAL DETECTION

Normal detection zones can be set up using one of many conditional attributes, including delay and extend, as well as these other attributes:

- Detect always.
- Detect only if phase is (green/red)/is not (green/red).
- Detect only if zone X has no occluding vehicles.
- Detect always, but only accumulate statistics if the phase is red/yellow/green.



INCIDENT DETECTION FEATURES

Automatic incident detection features that may be captured include:

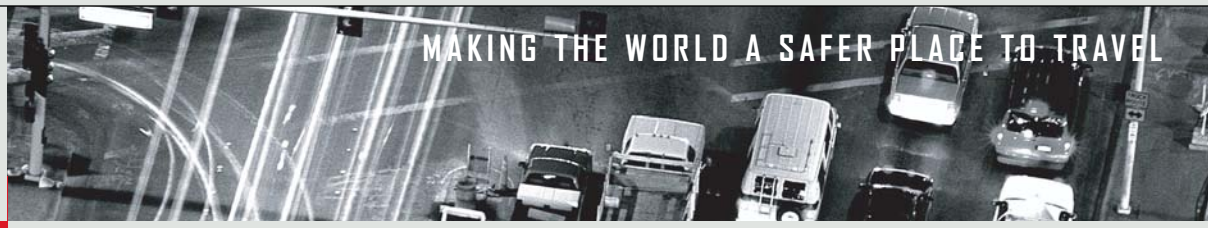
- Vehicle presence for “n” duration.
- Vehicle speed (less than/more than speed).
- Wrong way detection.
- Queue length exceeded.
- Delay exceeded.
- Occupancy exceeded.
- Length exceeded.
- Red light traffic runners.
- Vehicle stopped for “n” seconds.

ATMS COMPATIBLE

VideoTrak can act as a data collection outstation and provide larger traffic management systems with real-time traffic data via an Advanced Transportation Management System (ATMS) communications protocol. The ATMS package provides developers a mechanism to poll VideoTrak for current statistical and status information that can then be used for a myriad of functions such as Adaptive Traffic Control, Incident Detection, Tunnel Management, etc.

SPECIFICATIONS

Characteristic	Description
Height	6.5” (165 mm).
Depth	10.75” with handle (275 mm).
Width	▸ Model 905 Plus: 10.72” (272 mm). ▸ Model 910 Plus: 13” (331 mm).
Card size	3U.
Bus interface	3U VME (J1 Connector).
Voltage	▸ 120 VAC / 60 Hz or ▸ 240 VAC / 50 Hz
Temperature range	-29°F to +165°F (-34°C to +74°C)
Humidity	0% to 95% non-condensing.



Quixote Traffic Corporation

WWW.QUIXTRAFFIC.COM

PEEK TRAFFIC

2511 Corporate Way • Palmetto, FL 34221
Tel: (941) 845-1200 • Fax: (941) 365-0837
Toll Free: 1-866-260-7335 • www.peek-traffic.com

Please contact Peek Traffic for customer inquiries about any of the company’s Traffic Control, Data Collection, Enforcement, Detection, or Tolling products. To learn how Peek Traffic is making the world a safer place to travel, visit the Peek Traffic web site at http:\\www.peek-traffic.com.

The information contained in this publication is presented for informational purposes only, and while every effort has been made to ensure its accuracy, the information is not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. No license is granted by implication or otherwise to any of Peek Traffic’s intellectual property. Peek Traffic reserves the right to alter or revise any of its products or published technical data relating thereto at any time without notice.

Copyright © 2004 Peek Traffic, A Quixote Company. All rights reserved. Printed in the United States.

TECHNICAL SPECIFICATIONS

Sensor (incl. Mounting Bracket)

General info	
Materials:	• Housing: ○ Camera & detector integrated in one housing ○ Front Shell (= detection part): painted semi sphere of Polycarbonate ○ Mid Section: central piece of Fibre Reinforced Polyamide ○ Back Shell (= connection part): painted semi sphere of Polycarbonate ○ Waterproof to IP67 • Mounting Bracket: ○ mounting Device: U-Profile 18cm (7in) of Fibre Reinforced Polyamide ○ Clamps for TrafiCam®: 2 tube clamps of Fibre Reinforced Polyamide ○ Clamps for mounting device: 2 tube clamps of Fibre Reinforced Polyamide ○ Connection TrafiCam® - Mounting Device: Tube 25cm (10in) of Aluminium • Both housing and mounting bracket are weatherproof (UV-resistant)
Mass:	• 600g (1.32lb), incl. mounting bracket and excl. cable
Height:	• Height x Width x Depth (max. dimensions, incl. mounting bracket) ○ Vertically mounted: 45cm x 16cm x 10cm (17.7in x 6.3in x 4in) ○ Horizontally mounted: 41cm x 18cm x 10cm (16.1in x 7.1in x 4in)
Diameter:	Diameter: 10cm (4in)
Temperature:	Temperature Range -34C to +80C (-29F to 176F)
Humidity:	Humidity 95% non-condensing

Camera details	
Camera Type:	• Black & White • CMOS • 1/3" • Resolution 640x480 pixels
Lens Types:	• Wide Angle: ○ Focal Distance = 3,0 mm ○ Field of View: Horizontal: 95, Vertical: 65, Corner to corner: 103 • Narrow Angle: ○ Focal Distance = 8,0 mm ○ Field of View: Horizontal: 32, Vertical: 22, Corner to corner: 39

Detector details
• Connectors present for connection with 4 wires (power supply and communications) and 9 wires (power supply, communications and outputs) • RS485 connection between sensor and interface for communications • Red LED to indicate detection

Power Supply, Outputs & Communications:
• Input Power 12-26VAC/DC (excl. wireless) • Current Consumption < 85mA @ 12VDC and < 50mA @ 24VDC (excl. wireless)

- Power Consumption ≤ 1,2W (excl. wireless)
- 4 opto-isolated MOSFET outputs: Pmax = 300mW / Imax = 50mA
- RS485 for configuring and verifying

Regulatory issues:

- EMC: CE directive 89/336/EEC; product standard EN55022 class A
- FCC: FCC part 15 class A
- Shock & vibration NEMA II specs

‹‹ **back** ^ **top**



INTELLIGENT VIDEO DETECTION SOLUTIONS

The only Video Detection System without configuration

Automatic Incident Detection

Advanced Video Surveillance

VisioPaD

VisioPaD is a **safety** and **security system** that provides an automatic and **real time detection** of **traffic incidents.**

- No configuration required
- Automatic and dynamic calibration
- Adapts to **P**an-**T**ilt-**Z**oom & fixed cameras
- No preset position
- Field proven technology
- Compatible with **IP** and analog **CCTV** Systems
- Integrated pre & post incident video recording
- Digital video recording

Video detection uses **image processing** algorithms to extract pertinent information from standard video-surveillance camera images.

VisioPaD main feature is to detect stopped vehicles on any fixed or **PTZ** camera **without** the hassle of **configuration**.

Especially developed for **Automatic Incident Detection** and **Advanced Video Surveillance** on highways, expressways, bridges and tunnels, VisioPaD is designed to be efficiently integrated into any traffic management system.

The high reliability of the VisioPaD system allows a **fully automatic surveillance**.

VisioPaD significantly increases the efficiency of Traffic Monitoring and raises the performance of your Video Surveillance System.

citilog



VisioPad equipment is exclusively assembled from **standard industrial components** (PC, boards, frame grabbers, etc…) thus insuring **duration**, **reliability** and **evolution** of products at minimal cost.
VisioPad processes analog video as well as IP encoded video streams.

Dimensions (mm)	482 x 177 x 450
Weight	15 kg
Input voltage	110 - 240 VAC
Maximum power consuption	250 W / 0 - 25 °C
Processor	INTEL X86 Architecture
Hard disk	120 Gb
Memory	512 Mb
Video input	8 video inputs (PAL/NTSC or IP)



A user friendly system

VisioPad works without **setup** or **calibration**. Just plug in existing video signals: **VisioPad is ready to detect**.
It automatically adjusts to:

- Camera shifts
- Change of video feed
- All weather conditions
- All traffic conditions

VisioPad features **user friendly interfaces** designed with and for Traffic Operators.

VisioPad requires **no fine tuning, no maintenance**.



VisioPad uses standard video cameras, colour or B&W, fixed or Pan-Tilt-Zoom.
The monitored area covers up to 600 meters.
All directions and traffic lanes visible in the image are analysed.
VisioPad integrates in a safe, easy and efficient manner into your supervision and traffic management system thanks to an architecture using standard communication protocols.

Transmission modes	Twisted pairs, Radio, Fibre-optics
Connections	Open collector, Serial (RS 232, RS 485, …)
	Network (ADSL, Ethernet, ATM, …)
Communication protocols	TCP/IP (OPC, LCR, …), Serial (Modbus, …)



Incident video sequences

The **database of digital video sequences** associated to each incident is a true account of incidents occurring on the road network.
These sequences are immediately accessible for the operator and available for later review and analysis of recurring events.

- **No setup and no calibration**
- **Standard communication protocols**
- **Standard industrial components**
- **Works on standard video cameras fixed or PTZ**
- **High performances = safety**
- **Detection time < 20s**
- **Integrated pre & post incident video recording**
- **Digital video recording**

The high reliability of the VisioPaD system allows a fully automatic surveillance

Europe
64, rue du Dessous des Berges
75013 Paris - France
Tel: +33 1 53 94 53 95
Fax: +33 1 53 94 53 99
citilog@citilog.com

North America
355 W. Lancaster avenue - Building E
Haverford, PA 19041, U.S.A.
Tel: +1 215 609 4945
Fax: +1 484 873 2292
citilogusa@citilog.com

Asia-Pacific
35/F, Central Plaza
18 Harbour Road, Wanchai, Hong Kong
Tel: +852 2593 1500
Fax: +852 2593 1222
citilog@citilog.com

Siemens provides leading-edge traffic technology for the fast-paced Intelligent Transportation Systems world. Whether providing local controllers, video detectors, controller firmware, central systems, system analysis, design, integration, or consulting services, Siemens brings innovative and reliable solutions to customers. Siemens has a long history of quality and innovation in transportation control and management.

Coupled with proven products and development experience, as well as highly regarded consulting services, we form the world's foremost traffic control and transportation management company. Siemens is very active in the development of new industry standards, and we have helped to form positive industry standards and develop new "state-of-the-art" products, including the NTCIP C2C protocol and the Advanced Traffic Controller Specification.

The information contained in this document is subject to change without notice. Siemens reserves the right to make changes and improvements to its products and assumes no responsibility for making these modifications on any equipment previously sold.

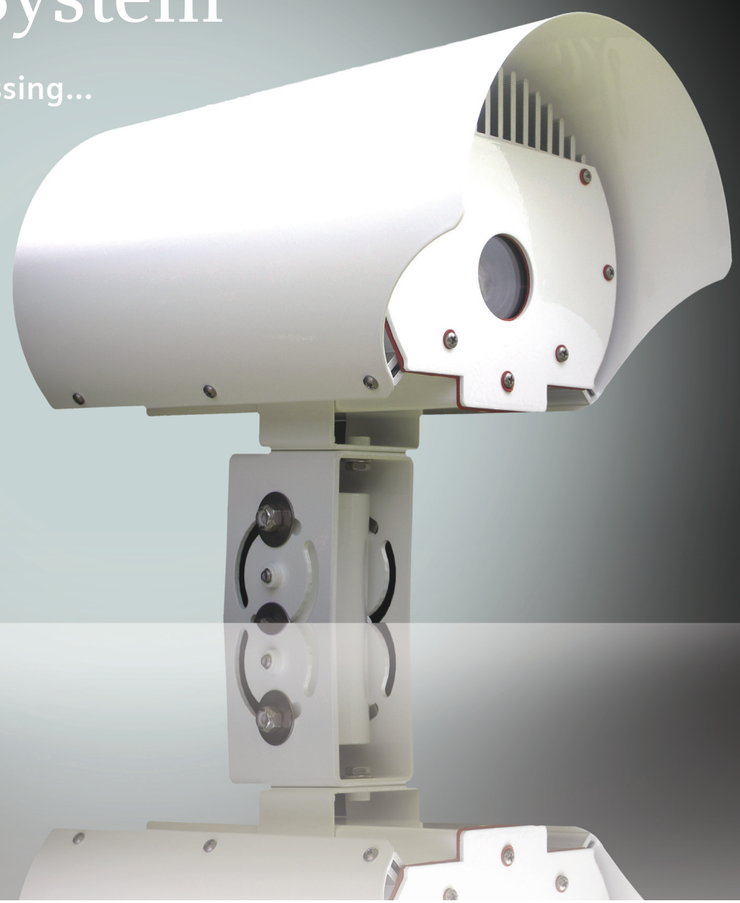
© Copyright 2007
Siemens Energy & Automation, Inc.

Siemens Energy & Automation, Inc.
Intelligent Transportation Systems
8004 Cameron Road.
Austin, TX 78754
Telephone: 512.837-8310
Fax: 512.837.0196

www.itssiemens.com

EagleVision Video Detection System

See what you've been missing...



www.itssiemens.com

SIEMENS

Convenience has never been so smart...



Accurate and reliable vehicle detection is the cornerstone of smooth traffic operation.

Video Detection Systems available on the market today often require cumbersome, costly, and tedious installation with challenging setup and configuration. These systems demand a direct focus of the camera on the target area leaving no room for error. The isolation of detector zones within the target area can sometimes take hours of minute adjustments to the camera position while in the field. Siemens new EagleVision Video Detection system eliminates the hassle of these traditional setup methods. Simply mount the camera, aim the lens in the general target area, and connect the camera to the cabinet through a single cable. No further calibration of the camera angle is necessary.

Fine tuning of the detection area is done remotely via a computer interface, allowing you to isolate and focus on a specific section of the viewing area as desired. Even if the detection zones change, or require future adjustments, return visits to the physical location of the camera are no longer needed. Merely draw the new detection zone on the image, wait a few moments for the camera to learn the new settings automatically, and the EagleVision Video Detection system identifies the updated vehicle detection area.

The EagleVision Ethernet solution eliminates the need for bulky detector racks by connecting directly to an M50 or 2070 controller with a 1B card. When direct Ethernet connections are not available, or a different style controller is in use, the 10-pin wires connect directly to the Detector Input Panel. Detectors have the option of being configured for presence, count, or an enhanced directionality detection.

Remote Access via Ethernet or LAN

Each camera is connected to the cabinet or controller via a standard CAT-5 Ethernet cable. Authorized users can connect remotely to the camera from anywhere in the world where Internet access is available. A technician traveling in Tulsa, OK can easily maintain his cameras in Anaheim, CA over a secured internet connection, or from the comfort of his office, never having to enter into the field to access data or reconfigure any number of units. Whether it's a software or firmware upgrade, EagleVision offers the convenience of access remotely via the Ethernet or a LAN connection. With the EagleVision user interface you can view the camera image, configure detector zones, and monitor camera detection activity with a laptop, PC or other internet capable device.

Easy to Program

The EagleVision user interface is a Java based program featuring easy to use menus and intuitive graphic icon buttons. Cameras are up and running in three simple steps: launch the program, add the camera IP address, and draw the zones.

One Man System

Ethernet ready, advanced targeting methods, simplified user-interface, intuitive design, sophisticated detection algorithms eliminating false detection... EagleVision is truly a one-man capable solution to vehicle detection systems. Whether your needs are as basic as managing a single intersection in a rural district, or as complicated as controlling the challenges of rush-hour traffic, EagleVision saves time and resources that other detection systems demand. Vehicle detection has never been clearer.

Advanced Technology

Video Detection has long been seen as a convenient, albeit less accurate alternative to traditional loop detectors. Sacrificing even a nominal amount of accuracy can sometimes lead to major traffic problems. EagleVision's sophisticated technology takes advantage of a superior algorithm providing the convenience of video detection with accuracy. These advancements offer solutions to false detection, missed calls, and ghost reflections that have long beleaguered previous Video Detection systems. Lower installation and maintenance costs with accuracy of traditional loop detectors makes EagleVision Video Detection system the leader in detector technology. EagleVision utilizes color video and an intelligent system that will learn the behavior of the selected zone, adjusting for shadow or other anomalies associated with a detection environment. Accuracy in vehicle detection is paramount to the steady flow and ebb of traffic in a real-time situation. The EagleVision camera is capable of eight detector zones, with eight outputs making it a single solution to any intersection's complex needs. Traditional detectors cannot be viewed for potential failure or maintenance requirements; with EagleVision, your intersection check-up is just a mouse click away.

With EagleVision, your intersection check-up is just a mouse click away.

See what you've been missing...





It's nice in the central heat and air office.

Weather forecast claimed a 20 percent chance of showers. It's pouring down outside. The lion in your stomach reminds you once again you missed breakfast. One eye is on the chewy brownie snack staring at you from the vending machine down the hall. You spot the smiling new intern as he brews a new French Roast blend coffee. The aroma drifts through the office, over cubicles, through walls, sending a silent message to your nervous system that you need a wake-up call.

But that will all have to wait.

Construction finished at 3 a.m. and 4 intersections that used to be 2 lanes are now 4. 6 intersections downtown are reduced to a single lane for that city festival this week. Dispatch called and two of the bucket trucks are going in for service for a broken starter and a dead battery. That leaves just one. Rush hour starts in 2 hours. Your boss is making his monthly inspection at 9 a.m. The field tech is out with the flu and it's the first day of school.

Relax. You've got EagleVision.

It's the same for municipalities everywhere. It doesn't matter the size, the budget, the man power... we are all facing the same dilemmas each day. It is time to do more with less. You need to stay on the cutting edge of technology and the high end of traffic control to keep drivers happy, but do it with less money, less time, and fewer resources. You want to work smarter, not harder. Problems that keep our traffic moving are solved by people, everyday.

Convenience anywhere, anytime.

You open the web, talk to your cameras. A few clicks from within the confines of a warm and dry office and all of the intersections are configured with the new detectors zones. Already the system begins to learn and the torrential downpour won't bother them one bit. A few moments later and the system has learned, adapts. Central is notified to map the new detectors and you've got time for another cup of coffee before rush hour even begins to set in. The intern brings you a cup of the French blend. The field tech called back: he needs a few more days. You smile.

EagleVision.

Siemens designs the tools to help you get the job done. At Siemens we've worked harder, so you can work smarter, and still enjoy that brownie and a cup of coffee. Nobody is going to be late for school today. Not on your watch. Now about that brownie...

EagleVision

See what you've been missing...

EagleVision Video Detection System

Intelligent Transportation Systems

SIEMENS

EagleVision, by Siemens.

Features
- Eight detector zones
- Eight detector outputs
- IP Communications
- Color video
- Streaming video
- Java GUI
- OS Independent

The Camera
- Linux OS
- Lumenera Camera
- Low Power Consumption
- 24 VDC @ <13w
- Power PC processor

One Man System
- Ethernet ready
- Advanced Targeting system
- Simplified user-interface
- Intuitive Design

Advanced **Technology**
- Sophisticated detection algorithms
- TS1 cabinet ready with no additional hardware required
- Vehicle detection comparable to traditional loop detectors

Program Features
- Advanced logic configuration features for experienced users
- Turn-key style solution for novice users
- Java interface

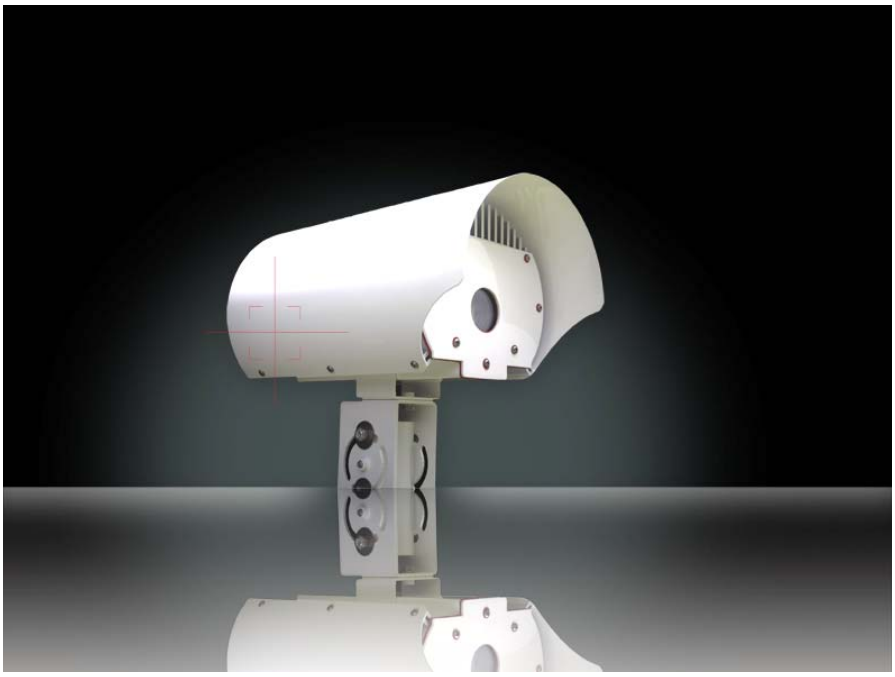
Backwards compatible
- NEMA hardware rated
- Older cabinets, controllers and communications compatible
- Seamless integration with current intersection configuration

Convenient Setup
- General viewing area can be isolated into specific zones for precise targeting
- Single CAT-5 cable connection
- Remote adjustment access via Internet
- Quick re-zone editing ability on any Java enabled device remotely

Hardware solution
- Plug and Play capable connection directly to a M50 or 2070 controller with a 1B card
- Direct 10-pin wires eliminate need for detector racks
- Option to connect directly to the Detector Input Panel

EagleVision saves time and resources that other detection systems demand. See what you've been missing.

The new EagleVision video detection camera offers state-of-the-art technology that will ensure reliability and functionality to intersection vehicle progression. EagleVision is the optimal answer for vehicle detection, smooth traffic operation, and a low-cost solution requiring no additional hardware or manpower to install. It is truly a 'one-man' system for all vehicle detection needs.



For more advanced future features and/or more information on Siemens hardware products call (512) 837-8310 or call your local dealer (see website for the dealer in your area).Siemens reserves the right to alter any of the Company's products or published technical data relating thereto at any time without notice.

© Copyright 2007
Siemens Energy & Automation, Inc.
Business Unit Intelligent Transportation Systems
8004 Cameron Road, Austin, TX 78754
Ph: (512) 837-8310 • Fax: (512) 837-0196

www.siemens.com

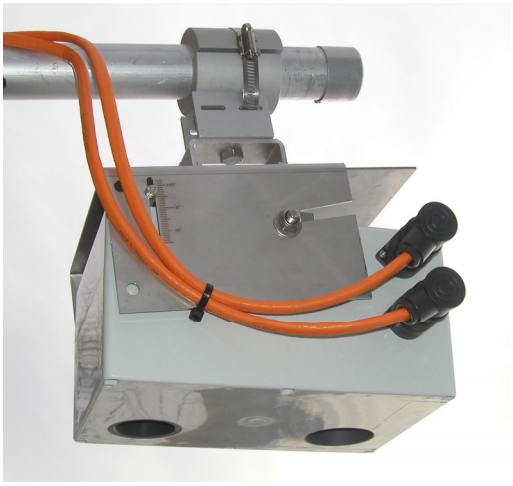
xtralis

ASIM

Triple Technology Model TT 292

Non-Intrusive Combination Detector for Lane Selective Traffic Data

ASIM tri-tech detectors use a combination of Doppler Radar, Ultrasound and Passive Infrared in a single unit. Individual vehicle speed, class, time gap and occupancy time are available via RS 485 – in all traffic situations and all weathers, day and night.



How do ASIM Tri-Tech Detectors Work?

ASIM combination detectors measure the speed of each vehicle by means of the Doppler shift of the reflected microwave frequency. The ultrasonic part scans the vehicle's height profile as it passes under the detector. The PIR channels provide lane selective information and trigger the ultrasonic measurement.
In power save mode, the PIR activates the radar too.

The ASIM combination detector Model TT 292 is easily mounted on gantries or other overhead structures above the lane to be observed, or alternatively on a pole on the side of the lane. Superior performance and reliability are standard thanks to:

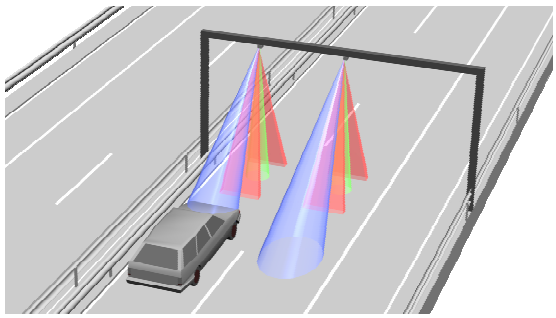
- Three independent detection technologies in a single unit
- Redundant digital signal processing (DSP) with adaptive parameters
- Full temperature compensation

Applications

ASIM combination detectors are ideal for a variety of traffic data acquisition and traffic control applications where inductive loops have been used in the past:

- Vehicle classification
- Counting of all kinds of vehicles
- Individual vehicle speed
- True presence and queue detection
- Occupancy and headway / time gap measurement

Field of View



Picture shows a typical two lane installation (2 detectors)

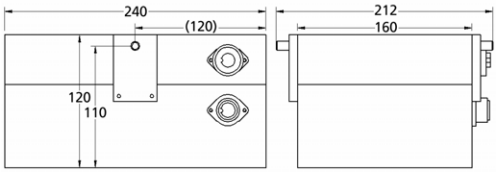
Product Highlights

- **Low Power Consumption**
  100 mA or less at 12 V DC in continuous operation, less in power save mode
- **Detection of Standing Vehicles**
- **Detection of Wrong-Way Drivers**
- **Suitable for Alternating Traffic**
  Remote switching of measuring direction for use in situations with alternating traffic
- **Triple Technology Detection**
  Three independent physical detection principles in a single unit
- **Low Cost per Monitored Lane**
  Cutting edge Swiss manufacturing and precision engineering result in a highly reliable, cost effective product
- **–40 to +70°C (–40 to +158°F) Operating Temperature**
  Optimal performance in all weather conditions
- **Remote Configuration and Setup**
  Dedicated Windows installation program
- **Mounting Height Adjustment**
  Self calibration within the recommended height above the lane
- **Standardized Vehicle Classification**
  2 classes according German TLS

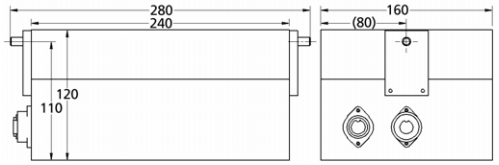
The Americas +1 781 740 2223 • **Asia** +852 2297 2438 • **Australia and New Zealand** +61 3 9936 7000
Continental Europe +41 55 285 99 99 • **UK and the Middle East** +44 1442 242 330 • **www.xtralis.com**
09/2007

Mechanical Dimensions

L & R Versions



Q Version



Accessories

IF 485B & Software



Mounting Accessories

Mounting hardware and cable connectors are **not** part of the delivery. Information regarding the available accessories depending on the mounting and operation mode according to the separate list.

Technical Specifications

Mechanical	
Dimensions	see drawing
Case Material	Polycarbonate, light grey
Mounting Points	M8, stainless steel V4A
Weight	app. 1'800 g (3.95 lbs)
Microwave	
Doppler Radar	K-Band 24.05 … 24.25 GHz
Ultrasound	
Frequency	50 kHz
Pulse Frequency	10 … 30 Hz
Infrared	
Sensors	Dual channel dynamic
Spectral Response	8 … 14 µm
Electrical	
Supply Voltage	10.5 … 30 V DC
Power Consumption	max. 110 mA @ 12 V DC typ. 25 mA in standby
Output (Data Transfer)	RS 485 Bus. 9600, 8, e, 1
Turn-on Time	typ. 20 s from power on
Accuracy	
Counting	typ. ± 3%
Speed	typ. ± 3% (> 100 km/h) typ. ± 3km/h (≤ 100 km/h)
Classification	Vehicle types according TLS The specifications refer to free traffic flow, detector operated in Frontfire mode
Environmental	
Operating Temperature	–40°C to +70°C (–40 to +158°F)
Humidity	95 % RH max.
Sealing	IP 64 splash proof

Standard Model

- **TT 292** MW, US & PIR (2 Classes)

Ordering Information

T T 2 9 2 – X X 3 – Y Y

Detector Type
2 Classes **2**

Supply Voltage
10.5 ... 30 V DC **3**

Outputs
RS 485 Bus **5**

Colour
Grey **3**

Mounting
Longitudinal standard **L**
Perpendicular **Q**
Longitudinal reverse **R**

Protocol
Standard **0**

Important:
Data is based on samples and believed to be representative.
Design and specification changes reserved without prior notice.
For more specific information on the products, their installation and application please refer to the installation manual or contact the manufacturer.

The Americas +1 781 740 2223 • **Asia** +852 2297 2438 • **Australia and New Zealand** +61 3 9936 7000
Continental Europe +41 55 285 99 99 • **UK and the Middle East** +44 1442 242 330 • **www.xtralis.com**
09/2007

MW 231 & MW 232

Doppler Radar Vehicle Detectors



ASIM K-Band (24 GHz) Doppler Radar traffic detectors of the MW 230 Series are designed for detection vehicles moving into or through their field of view in short to medium range.
The digital output of the detector is activated as long as objects within the field of view are moving. When the movement stops the output will reset.
Correct alignment of the detector and a stable mounting structure are mandatory for optimal performance.

How do ASIM MW – Detectors Work?

The standard model **MW 231** reacts **only to approaching traffic**, moving faster than the low speed threshold of 4 km/h (2.5 mph).

The multi-functional model **MW 232** has a number of DIP-switches enabling additional user-selectable functions:

- Direction discrimination: Detector reacts only to approaching traffic or both directions.
- Minimum speed threshold: 4 km/h or 8 km/h (2.5 / 5 mph)
- Timer function: Automatically activates the output to simulate the arrival of a vehicle if the MW 232 has not changed state for a period of 2.5 minutes.

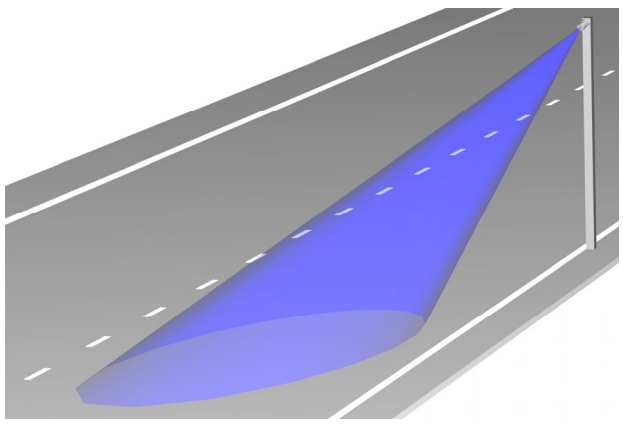
The detector can be mounted overhead or on a pole on the side of the road. The recommended mounting height is within the range of 1 to 5 m (3 to 16 ft).

Applications

ASIM Doppler radar vehicle detectors are ideal for a variety of traffic control applications:

- Direction dependent vehicle detection
- Request of green phase
- Extension of green phase

Field of View

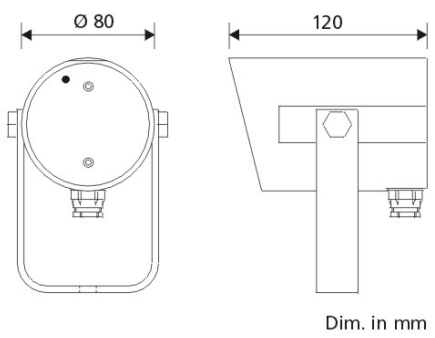


Product Highlights

- **Easy Installation and Maintenance**
  The supplied standard mounting bracket allows an easy und stable mounting for all common applications.
- **Front – LED to signal the activated Output**
  To easily check the alignment and functionality of the detector.
- **Small and Rugged Housing**
  The splash proof, rugged housing of anodised aluminium protects the detector in the harshest environmental conditions.
- **-40 to +70°C (-40 to +158°F) Operating Temperature**
- **Low Power Consumption**
  100 mA or less at 12 V DC in continuous operation
- **Typical Detection Range of 45 m (150 ft)**

The Americas +1 781 740 2223 • **Asia** +852 2297 2438 • **Australia and New Zealand** +61 3 9936 7000
Continental Europe +41 55 285 99 99 • **UK and the Middle East** +44 1442 242 330 • **www.xtralis.com**
09/2007

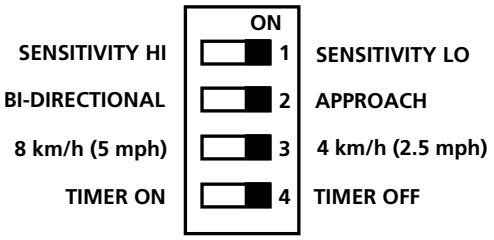
Mechanical Dimensions



Dim. in mm

MW 232 DIP-Switches

The operating modes and other functions of the vehicle detector MW 232 can be selected with DIP-switches. The DIP-switches are accessible behind the screw on the back of the housing.



Electrical Connections

The models MW 231 and MW 232 are supplied with 2.5 m (8 ft) pigtail, without a plug.

Brown	V+ Supply
White	V– Ground
Yellow	C Relay
Grey	NO Relay
Green	NC Relay

Relay is shown for detector in operation, output not active.

Technical Specifications

Mechanical	
Dimensions	see mechanical dimensions
Case Material	aluminium anodised
Weight	ca. 820 g (1.8 lbs)
Microwave	
Doppler Radar	K-Band 24 GHz
Detection Range	typ. 45 m (150 ft)
Low Speed Threshold	MW 231: 4 km/h (2.5 mph) MW 232: 4 / 8 km/h (2.5 / 5 mph) (selectable via DIP-switch)
Turn-on / Turn-off Delay Time	0.25 s / 0.5 s
EMC Specification	ETS300.339
FCC Identifier	R2DMW23X
Electrical	
Supply Voltage	10.5 … 30 V DC / 24 V AC
Power Consumption	typ. 90 mA @ 12 V DC or 45 mA @ 24 V AC/DC
Output *Relay SPDT*	250 V AC / 2 A / 60 W
Turn-on Time	typ. 1 s from power on
Function Indication	red LED on the case front
Environmental	
Operating Temperature	–40°C to +70°C (-40 to +158°F)
Humidity	95 % RH max.
Sealing	IP 64 splash proof

Ordering Information

M W 2 3 X – X X 9

Detector Type
Standard **1**
Multi-functional **2**

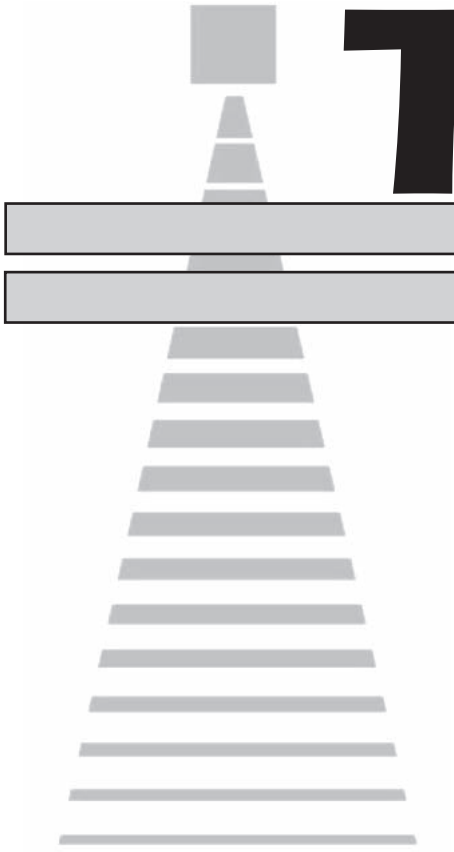
Supply Voltage
10.5 ... 30 V DC / 24 V AC **8**

Output
Relay SPDT **1**

Important:
Data is based on samples and believed to be representative.
Design and specification changes reserved without prior notice.
For more specific information on the products, their installation and application please contact the manufacturer.

TC26-B

MICROWAVE VEHICLE MOTION SENSOR





- ADJUSTABLE RANGE
  (up to 200' for cars, 350' for trucks)
- DIRECTIONAL SCANNING
  (select approach-only or depart-only motion)
- SEALED HOUSING
- EXTERNAL ADJUSTMENT PANEL & CONNECTOR
  (no need to open the housing during installation)
- EXTERNAL INDICATOR LEDs
  (eases drive test confirmation)
- LOW POWER—IDEAL FOR SOLAR APPLICATIONS
  (uses 1/5 the power of inductive loops)
- COVERS SINGLE OR MULTIPLE LANES
- INSTALLS EASILY ABOVE GROUND

The TC26-B is a microwave motion sensor that will identify a vehicle moving in its detection pattern and then trigger the operation of a traffic controller. By utilizing microwave technology, this device provides accurate and consistent vehicle detection that is not affected by temperature, humidity, color or background variations.

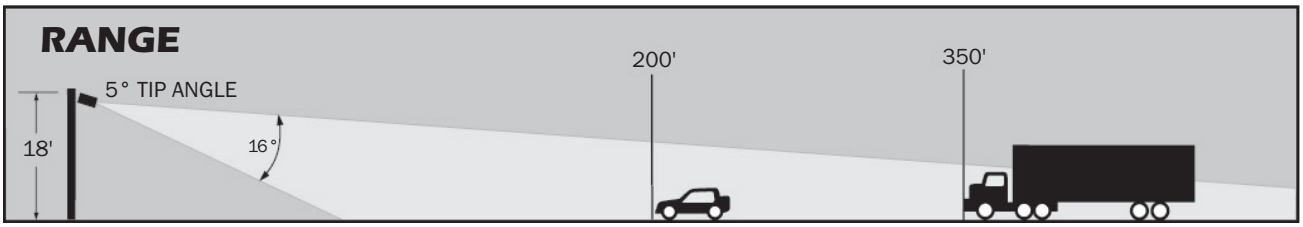
The TC26-B easily mounts above ground, requires no pavement cuts and can be installed with minimal traffic disruption. All parameters are adjusted via external controls located on the back panel. The housing is factory sealed with an external wiring harness or an optional quick-connect cable eliminating the need to open the sensor during installation.

Once mounted, the installer simply connects the cable, makes the necessary adjustments, aims the sensor at the desired detection area and applies power. It's that simple!

MS SEDCO

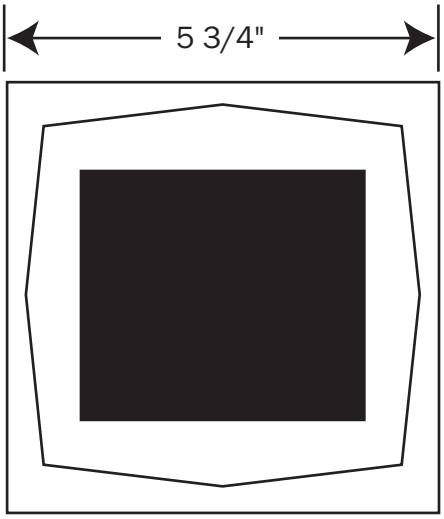
SENSORS & SWITCHES

TECHNICAL DATA

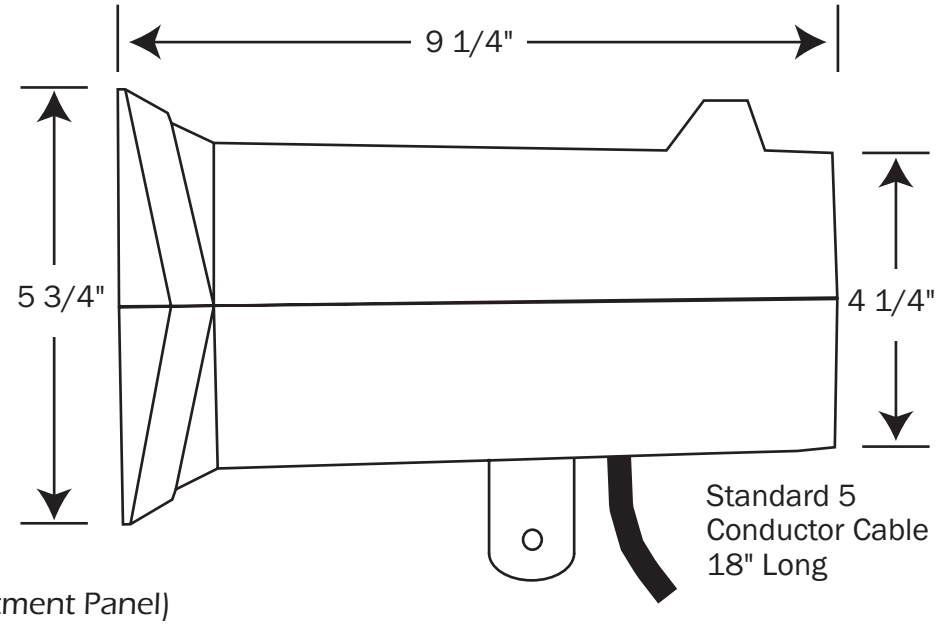


Range shown at maximum - not drawn to scale

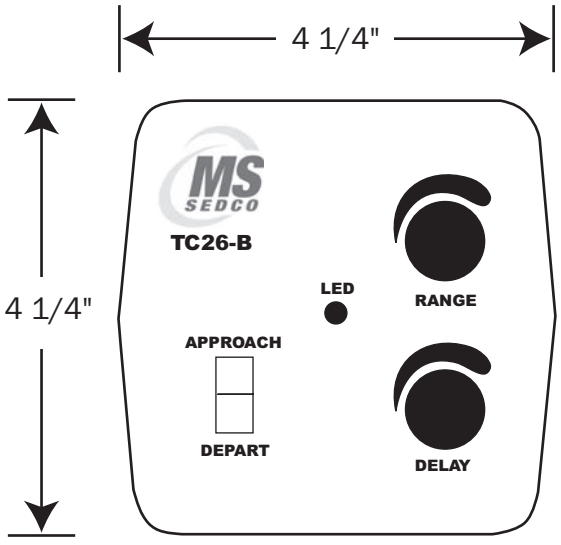
FRONT VIEW



SIDE VIEW



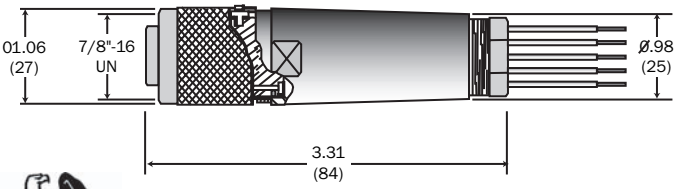
REAR VIEW (External Adjustment Panel)



SPECIFICATIONS

Model Number	TC26-B
Operating Frequency	10.525 gHz (X-band)
Detection Method	Microprocessor analyzed doppler-microwave
Detection Pattern (maximum)	200' long x 50' wide (cars) 350' long x 75' wide (trucks)
Detection Mode	Directional motion
Detection Hold-Time	Continuous with motion
Response Time	0.250 seconds
Time Delay	Adjustable 0.250 - 5.0 seconds
Power Requirements	12 to 24 V AC or DC
Current Draw	75mA max. @ 24V DC
Power Consumption	1.8 Watts max. @ 24V DC
Relay Output	Form C, rated at 3 Amps @ 24V DC
Wiring Harness	18 gauge 5 conductor cable (standard) 18 gauge 5 conductor quick release (optional)
Mounting Bracket	Predrilled & slotted (band or lag-bolt mount)
Enclosure/Finish	Gray powder coated aluminum
Operating Temperature	-35°F to 165°F (-37°C to 75°C)
Shipping Weight	Approx. 5 lbs.
Physical Dimensions	9.25"L x 5.5"W x 5.5"H 23.5 cm L x 14.0 cm W x 14.0 cm H

OPTIONAL QUICK RELEASE



MADE IN U.S.A.

MS SEDCO
SENSORS & SWITCHES
8701 Castle Park Drive • Indianapolis, Indiana 46256
Phone: (800) 842-2545 / (317) 842-2545
Fax: (800) 849-3387 / (317) 849-3387

Wavetronix
SmartSensor HD™
Model 125

High-definition, true ten-lane detection delivers consistently accurate data for traffic monitoring systems, even in slow or stopped traffic.



Advantages:

EASY TO USE
- Patented auto-configuration process for PC and Pocket PC®
- Easiest to install and operate
- Integrates with Wavetronix Click!™ products

ACCURATE
- Patented Digital Wave Radar II™ technology
- Detects and reports up to ten lanes of traffic
- Reports the speed and classification of individual vehicles
- Works over barriers, guardrails, medians and gores
- Accurately detects lane-changing vehicles

RELIABLE
- Requires no "tweaking" or "tuning"
- All-weather, all-condition performance
- Flash memory protects data storage
- Automated manufacturing process

EASY TO MAINTAIN
- Remote accessible for easy management
- Flash upgradeable
- No performance variance due to temperature

The Wavetronix SmartSensor HD uses the latest technology to collect consistently accurate traffic data in high definition. **Patented Digital Wave Radar II™** measures traffic volume, individual vehicle speed, average speed, 85th percentile speed, average headway, average gap, lane occupancy, vehicle classification and presence. Operating at five times the bandwidth, SmartSensor HD has **five times the resolution** of the original SmartSensor, a **detection range of 250 feet** and the ability to detect up to **10 lanes** of traffic simultaneously.

SmartSensor HD offers many high performance advantages:

1. More precise control of radar signal and noise enables greater range and detection accuracy.
2. Five times resolution in range for greater accuracy.
3. Improved detection performance even with slow or stopped traffic.
4. Dual radar design for more accurate speed measurements.



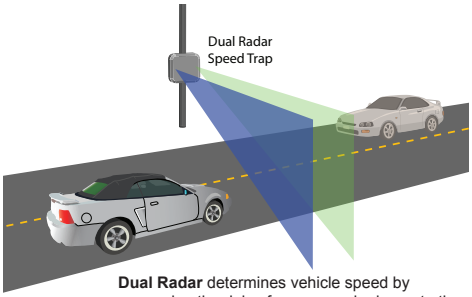
SmartSensor HD's unique **Dual Radar** design is incredibly accurate, providing individual vehicle speeds to within four miles per hour as well as more precise vehicle classifications. Digital Wave Radar II reduces "spillover"; works over barriers, guardrails, medians and gores; and accurately detects partially occluded vehicles. Armed with high definition radar, SmartSensor HD sees all vehicles in its field of view, and not just those in pre-defined zones.

These **vehicle-based detections** help raise the performance bar for SmartSensor HD. Sensor configuration is made even easier because configuration no longer affects detection, only the reporting of vehicles. SmartSensor HD's vehicle-based detection even sees lane-changing vehicles that are often missed, or counted twice, by other radar sensors and other technologies.

SmartSensor HD is easy to install and includes a pointing assistant for precise alignment. Like all SmartSensors, SmartSensor HD's patented auto-configuration process is quick and simple. **HD Manager™** detects lanes by observing traffic flow, and immediately provides visual confirmation of a successful configuration. This unique auto-configuration and operation software has been developed especially for Pocket PC® handheld devices and laptops.

After installation, SmartSensor HD requires little or no on-site maintenance. Traffic data and configuration settings are stored in Flash memory, so the sensor can be remotely reconfigured for optimal performance. And SmartSensor HD is manufactured using a modern, automated process, with surface-mounted components and integrated antennas that provide consistent production and performance.

SmartSensor HD integrates seamlessly with existing legacy systems and is **reverse compatible** with the original SmartSensor. Dual communication ports enable SmartSensor HD to integrate with different systems simultaneously, and flexible connectivity options make it possible to directly retrofit SmartSensor HD into any existing radar deployment. This, combined with high definition radar and consistent accuracy, makes SmartSensor HD the most accurate, most cost effective traffic monitoring solution.



Dual Radar determines vehicle speed by measuring the delay from one radar beam to the next. This also determines vehicle direction.

380 South Technology Court
Lindon, UT 84042 USA
tel: (801) 764-0277 fax: (801) 764-0208
email: sales@wavetronix.com
www.wavetronix.com

WAVETRONIX™

Copyright © 2006 by Wavetronix LLC. All rights reserved. SmartSensor HD, HD Manager, Digital Wave Radar II and associated logos are trademarks of Wavetronix LLC.
SmartSensor is protected by U.S. Patent Nos. 6,556,916 and 6,693,557. Other U.S. and international patents are pending.

SmartSensor HD™ Model 125 Specifications

SmartSensor HD is a 24 GHz Frequency Modulated Continuous Wave (FMCW) radar. It rapidly configures using its patented lane configuration software, and it is uniquely suited for long term ITS and arterial monitoring applications with its network connectivity and its ability to be remotely configured and upgraded.

Measured Quantities:	Volume, speed, 85th percentile speed, average headway, average gap, occupancy, classification and presence
Detection Zones:	Up to 10 traffic lanes simultaneously
Detection Range:	6 to 250 ft (1.8 m to 76.2 m)
Zone Resolution	1 foot (0.3 m)
Time Resolution	2 msec
Elevation 3 dB beamwidth:	65°
Azimuth 3 dB beamwidth:	7°
Operating frequency	24.0 to 24.25 GHz (K-band)
Communications	RS-232 and RS-485 connection
Power	8.0 watts @ 9-28 VDC
Ambient operating temperature:	-40°C to 75°C
Humidity:	Up to 95% RH
Shock:	10 g 10ms half sine wave
Physical dimensions (HxWxD):	13.2 in x 10.6 in x 3.3 in (33.5 cm x 27 cm x 8.3 cm)
Weight	less than 5 lbs. (2.27 kg)

Full specifications available upon request.

SmartSensor HD is fully compatible with all Wavetronix products:

- *SmartSensor Advance™, the industry's only auto-configuring radar device that manages dilemma zones and efficiently controls intersections.*
- *Wavetronix DataCollector™, the data management solution that easily integrates into any ATMS environment.*
- *Wavetronix Click!™ products: Simple connectivity solutions for contact closure, power and surge protection, data conversion and wireless & Ethernet communications.*

SMART SENSOR iQ HD™



Wavetronix SmartSensor HD™

The industry's only patented auto-calibrating, auto-configuring high-definition traffic sensor.

Represented by:

EIS – RTMS

Area Coverage

The RTMS field of view covers the area defined by:

Elevation angle:	45 degrees
Azimuth:	15 degrees
Range:	3 to 60 metres (10 - 200 feet)

Measurement Resolution

Detection Zones:	Up to 8 zones
Range (Increment):	2 metres (7 feet)
Zone Width:	2 to 7 metres (7 - 20 feet)
Time Events:	10 mSec

Interface

- ☑ Single MS crimp multi-pin connector provides power and output signals
- ☑ 9 isolated contact pairs rated for 100mA at 350 Volts AC for presence indication
- ☑ Isolated serial RS-232 or RS-485 data bus provides measurement data in point-to-point or polled multi-drop configurations.
- ☑ Optional RF modems or TCP/IP interfaces.
- ☑ Optional dual-loop speed-trap emulation interface

Mechanical

The unit is encased in a rugged water-tight NEMA 4X polycarbonate box. It is mounted on a universal bracket, enabling securing of unit to poles, tilting in both axes and quick locking.

Size:	16 x 24 x 12 cm (6 x 9 x5 inches)
Weight:	2.2 kg (5 lbs)

Power Requirements

- ☑ 12 - 24 Volt AC or DC @ 4.5W; 115 VAC option
- ☑ Surge Protection: IEC 1000-4-5/EN 61000-4-5
- ☑ Power management option
- ☑ Over voltage and brownout shutdown protection

Reliability

- ☑ MTBF (Mean Time Between Failures) designed for 90,000 hours (10 years)

Maintainability

- ☑ Shop repairable
- ☑ Self-test diagnostic software
- ☑ 15 minute replacement time
- ☑ Field level firmware upgrade

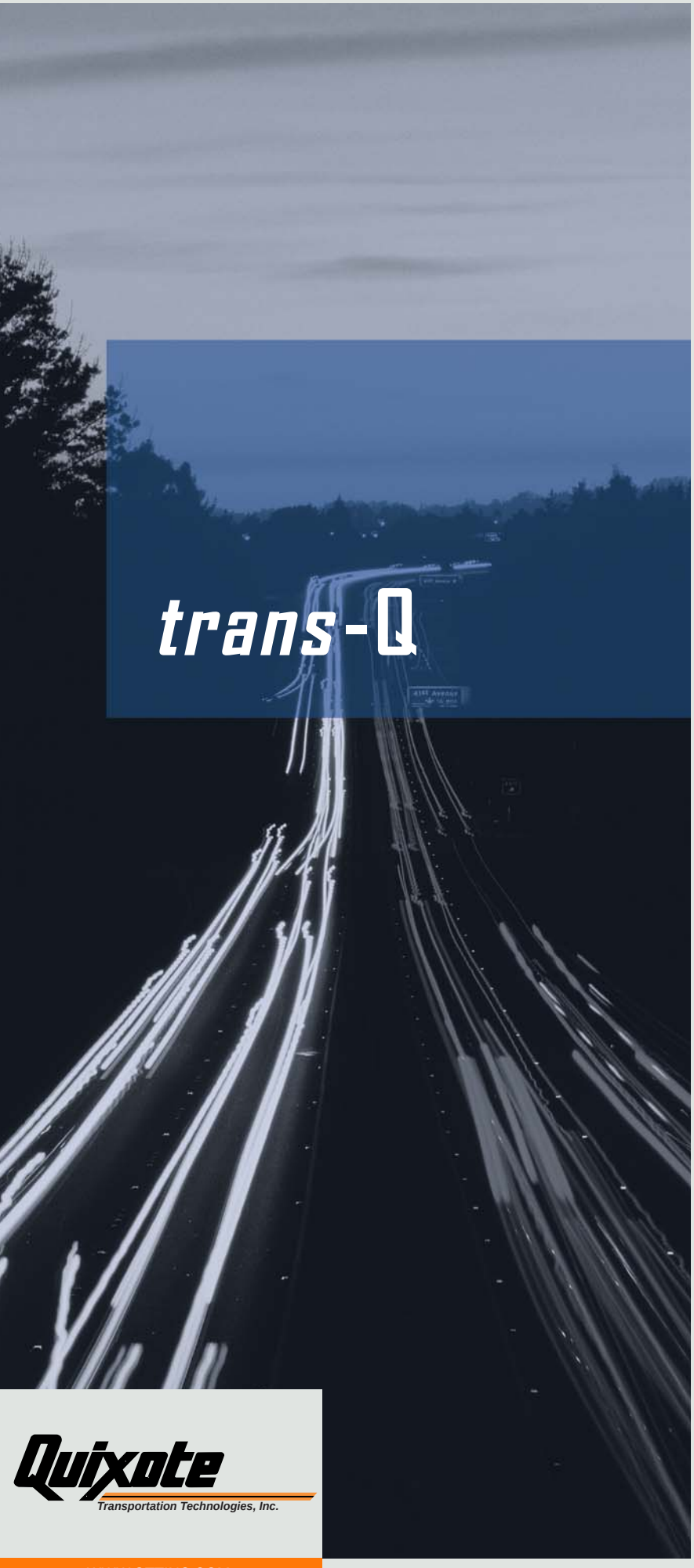
Environmental Conditions

Temperature Range:	-37° to + 74°C
Humidity:	to 95% RH
Vibration:	2g up to 200 Hz
Shock:	5 g 10mSec half sine wave

- ☑ Winds up to 160 Km/h (100 MPH) will not degrade performance
- ☑ Precipitation (rain or snow): up to 100mm/h

EMI and licensing

- ☑ Meets US FCC Rule part 15 Class A for unlicensed operation
- ☑ CE certified



trans-Q
NON-INTRUSIVE RADAR CLASSIFIER

OVERVIEW

The *trans*-Q radar traffic classifier meets the increasing demand for a reliable, non-intrusive traffic measuring device. Daily traffic volumes continue to increase making it more difficult and dangerous than ever to install traffic sensors in the roadway or on top of the road surface. The *trans*-Q gives traffic engineers a solution for these problems.

The *trans*-Q is easy to set-up on the roadside with a PDA (Palm) and does not disturb traffic flow. The sensor detects all passing vehicles in two directions, obtaining their length, speed and classification. Data is easily retrieved with either a PDA (Palm) or wireless connection (GPRS or Bluetooth).

BENEFITS

- Non-intrusive technology allows you to analyze traffic without sensors in the roadway
- Easy roadside installation with pole-mounted set-up
- Does not disturb traffic flow
- Reduces safety risk to workers because there is no maintenance of embedded roadway sensors
- 12 Volt battery can be recharged in as little as eight hours



***trans*-Q Traffic Sensor**

Quixote
Transportation Technologies, Inc.

WWW.QTTINC.COM

FEATURES

- Non-intrusive radar classifier that provides high resolution speed, count, and length classification
- Two lane detection - two direction capability
- Speed range of 2-130 mph (3-199 kmh)
- Radar range up to 98.4 feet (30 meters)
- Memory up to 1.6 million vehicles
- Rechargeable battery
- Solar power option
- Easy set-up using either a PDA (Palm) or wireless connection (GPRS or Bluetooth)

ADVANTAGES

- No influence on speed behavior because there are no visible road sensors
- Does not require tubes, loops, chains. Cost of tubes over a lifetime of counter can be expensive.
- No cutting into pavement, which reduces installation cost and increases pavement life
- Only one sensor necessary to monitor two lane/two direction traffic



SPECIFICATIONS

Model Number	PTQ-200
Sensor	Microwave 24, 125 GHz Power output 5 mW
Speed Range	2 - 130 mph (3 - 199 km/h)
Length Range	3 - 75 feet (1 - 25 meters)
Directions	Two direction detection
Radar Range	Up to 98.4 feet (30 meters)
Installation Height/Distance	Up to 30.8 feet (10 meters)
Power	Battery rechargeable 12 V 18 Ah internal Optional main/solar power
Battery Life	Average 10-12 days at -20ºC to 60ºC
Battery Charging	External battery charger Charging time typically 8 hours
Weight	27.5 lbs including battery (12.5 kg) 8.8 lbs without battery (4 kg)
Operating Temperature	-22ºF to 176ºF (-30ºC to 80ºC)
Dimensions	11.8 x 13.7 x 5.9 inches (300 x 350 x 150 mm)
Housing Material	PVC and aluminum
Computed Values	English or metric
Data Prog/ Read Rate	9600 baud RS-232
Real-Time Clock	Year, Month, Day, Hour, Minute, Second Direction, Length
Data Storage Memory	Up to 1.6 million vehicles
Verification	Serial on/off data at 9600 baud
Set-up and Data Retrieval	Palm PDA (RS-232, Bluetooth, GPRS)

DISTRIBUTED BY:

Quixote Transportation Technologies, Inc.

WWW.QTTINC.COM

nu-metrics®

Quixote Transportation Technologies, Inc.
518 University Drive • Uniontown, Pennsylvania 15401
Tel: (724) 438-8750 • Fax: (724) 438-8769
Toll Free: (800) 346-2025
www.qttinc.com

Global Traffic Technologies

Canoga™ Traffic Sensing System

Canoga™ 702 Non-invasive Microloop™ Sensors

A Matched Component of the Canoga™ Traffic Sensing System **October 2007**

Description

Canoga™ 702 Non-invasive Microloop™ Sensors are a matched component of the Canoga™ Traffic Sensing System. These traffic sensors provide a unique alternative to other vehicle detection systems when connected to a suitably configured Canoga™ Traffic Monitoring Card or a Canoga™ C900 Series Vehicle Detector.

The Canoga 702 Microloop is a transducer that converts changes in the vertical component of the earth's magnetic field to changes in inductance. Vehicles containing vertical components of ferromagnetic material "focus" the earth's field, increasing the magnetic field at the sensor when vehicles move over the sensor. Changes in inductance can be sensed by a Canoga traffic monitoring card or Canoga C900 series vehicle detector suitably configured for the Canoga 702 Microloop.

The Canoga 702 Microloop sensor's small size permits its easy insertion into a 3-inch (7.6 cm) plastic conduit installed 18–24 inches (46–61 cm) below the road surface. Installing the sensors in a conduit leaves the road surface intact, bypasses the effects of poor pavement conditions and inclement weather, and virtually eliminates maintenance and service requirements.

Features

Canoga 702 Microloop offers superior value compared with other vehicle detection technology. It effectively replaces inductive loops for freeway, counting and intersection applications. When connected to Canoga traffic monitoring cards, Canoga 702 Microloop provides accurate, real-time mean speed, count and occupancy data, and vehicle speed and length classification. When performance and life cycle cost are important, Canoga 702 Microloop provides an industry leading advantage.



Canoga™ 702 Non-invasive Microloop™ Sensor

Superior Value

- Lower life cycle costs.
- No maintenance. Underground, protected from weather and traffic, highly durable Canoga 702 Microloop requires no maintenance.
- Lower service costs. Repair is virtually eliminated. Buried sensors and cables are not affected by environmental factors, pavement deterioration or other mechanical stresses. Sensors can be replaced from the roadside without affecting traffic.
- Lower pavement repair and maintenance costs; the road surface is not damaged.
- Better installation and efficiency; traffic lanes are not closed for long periods of time.
- Better road repair efficiency; resurfacing and surface repairs can occur without affecting detection performance.

Flexibility

The Canoga™ 702 Non-invasive Microloop™ Sensors can be easily repositioned or readjusted to improve vehicle sensing accuracy or to reflect changing traffic characteristics in permanent installations or work zones.

Easy to Install

Conventional, horizontal directional drilling techniques or open trenching are used for installation of the conduit.

Small Size

Canoga 702 Microloop sensors fit into specially designed carriers. Carriers can be inserted in less than an hour into a 3-inch (7.6 cm) Schedule 80 conduit installed 18–24 inches (46–61 cm) below the road surface.

Accurate

Canoga 702 Microloop sensors connected to a suitably configured Canoga™ Traffic Monitoring Card or Canoga™ C900 Series Vehicle Detector provide accurate and highly reliable measurements.

- Closely spaced vehicles can be resolved and adjacent lane vehicles rejected.
- Accurate detection is achieved in every lane and under all environmental conditions, unfazed by rain, snow, wind or fog.

Operating Parameters

- **Earth's Vertical Magnetic Field:** 0.2–0.8 oersted.
- **Inductance (Red to Green Wires):** 50–63 microhenries per sensor plus a nominal 16.5 microhenries per 100 feet (30 m) of lead-in cable.
- **DC Resistance (Red to Green Wires):** 1.2–1.8 ohm per sensor plus a nominal 3.04 ohm per 100 feet (30 m) of lead-in cable.
- **Transducer Gain (Sensitivity):** Typically 5.0 nH per millioersted per sensor at 0.4 oersted ambient vertical field intensity.
- **Canoga 702 Microloop Assemblies:** Available in single, double or triple sensor assemblies with standard sensor separations and connected in series to a lead-in cable which may be up to 1,000 feet (305 m) in length.
- **Home-run Cable:** Canoga™ 30003 Home-run Cable is used to connect lead-in cable to the cabinet. The combined length of home-run cable and lead-in cable may be as long as 2,500 feet (762 m).
- **Maximum Number of Sensors per Channel:** Up to three sensors are recommended per channel.
- **Microloop Peak-to-Peak Drive Current with Canoga Traffic Monitoring Cards or Canoga C900 Series Cards:** The cards must provide between 14 and 80 milliAmp$_{p\text{-}p}$.

Installation

Canoga 702 Microloop sensors are designed to be inserted into a 3-inch (7.6 cm) non-ferrous Schedule 80 conduit.

Conduit is installed 21 ± 3 inches (53.3 ± 7.6 cm) below the road surface using horizontal directional drilling or open trenching techniques.

See Canoga 702 Microloop installation instructions for more information.

Wiring

Multiple Canoga 702 Microloop sets can be wired in series to accommodate different applications. Two independent sensor sets can be connected to a single Canoga 30003. For reliable operation, all splices must be soldered, insulated and waterproofed. See Canoga 702 Microloop installation instructions for detailed wiring instructions.

Environmental

- **Temperature:** -30° F to +165° F (-34° C to +74° C).
- **Relative Humidity:** 100% (including submersion in solutions of chemicals typical of roadway runoff).

Physical Characteristics

- **Sensor:** Cylindrical, 2.25 inches (5.7 cm) high, fitting a .8125 inch (2 cm) hole in the carrier.
- **Lead-in Cable:** Polyurethane-jacketed cable with two PVC insulated AWG #22 conductors. Overall diameter 0.19 inches (0.48 cm).
- **Color:** Black sensor body and black jacketed lead-in cable with red and green insulated wires.

Related Products or Accessories

Canoga™ 702 Non-invasive Microloop™ Sensor Carriers hold Canoga 702 Microloop sensors in a fixed, vertical position as they are inserted into the previously installed, 3-inch (7.6 cm) conduit. The carriers' interlocking mechanism maintains the alignment of the sensors within ± 20° from vertical.

— Physical characteristics of the carrier: 12 inches (30.5 cm) long PVC sensor carrier with an outer diameter of 2.6 inches (6.6 cm).

Canoga™ 702 Non-invasive Microloop™ Sensor Installation Kit is required for each conduit

\(one kit per conduit). The kit contains all of the parts necessary to insert and remove the sensors, to label sensor cables and to close off the conduit ends.

— Physical characteristics of the end cap carrier: PVC tubing 13 inches (33 cm) long and 2.6 inches (6.6 cm) in diameter. The end cap carrier is the first piece to be inserted into the conduit. It has an attached rope that permits removal of the installed Canoga 702 Microloop assembly.

Consult the installation instructions to install the conduit and Canoga 702 Microloop sensors using Canoga 702 Microloop carriers.

3M™ Scotchcast™ 3832 Buried Service Wire Splice Installation Kit is recommended for splicing the lead-in cable with the home-run cable. This wire splice installation kit ensures a reliable connection in the environments encountered by the Canoga 702 Microloop.

Canoga™ 942 or 944 Traffic Monitoring Card for monitoring vehicle speeds, count and occupancy, and for classification of vehicle speeds and lengths.

Canoga™ C922 or C924 Vehicle Detectors for detection of vehicle presence and for traffic count applications.

Canoga™ 30003 Home-run Cable is recommended for all home-runs, especially those exceeding 500 feet.



Canoga™ 702 Non-invasive Microloop™ Sensor Carriers



Canoga™ 702 Non-invasive Microloop™ Sensor Installation Kit

Important Notice to Purchaser:

EXCEPT FOR THE LIMITED WARRANTIES SET FORTH IN THIS DOCUMENT, GLOBAL TRAFFIC TECHNOLOGIES (GTT) MAKES NO OTHER WARRANTIES AND EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY AS TO MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE.

GTT will, at its sole option, repair, replace or refund the purchase price of Canoga™ Traffic Sensing System components or Canoga™ Vehicle Detectors described herein found to be defective in materials or manufacture within seven (7) years from the date of shipment from GTT. This warranty shall not apply to Canoga traffic sensing system components or Canoga vehicle detectors which have been (1) repaired or modified by persons not authorized by GTT; (2) subjected to misuse, neglect or accident; (3) damaged by extreme atmospheric or weather conditions; or (4) subjected to events or use outside the normal or anticipated course.

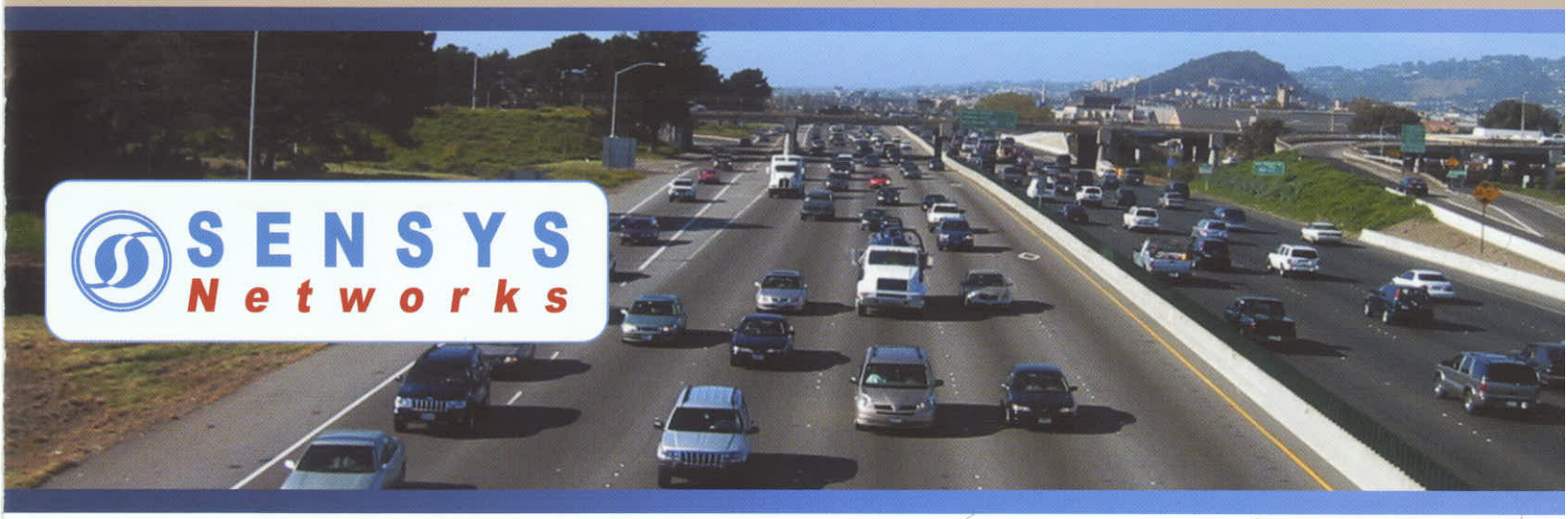
IN NO EVENT SHALL GTT BE LIABLE FOR ANY INJURY (INCLUDING, WITHOUT LIMITATION, PERSONAL INJURY), DEATH, LOSS, OR DAMAGE (INCLUDING, WITHOUT LIMITATION, PROPERTY DAMAGE), WHETHER DIRECT, INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL OR OTHERWISE, ARISING OUT OF THE USE OR INABILITY TO USE, REPAIR OR FAILURE TO REPAIR, ANY GTT PRODUCT, REGARDLESS OF THE LEGAL THEORY ASSERTED. THE REMEDIES SET FORTH IN THIS DOCUMENT ARE EXCLUSIVE.

Global Traffic Technologies

Global Traffic Technologies, LLC
7800 Third Street North
St. Paul, Minnesota 55128-5441
1-800-258-4610

Global Traffic Technologies Canada, Inc.
157 Adelaide Street West
Suite 448
Toronto, ON M5H 4E7
Canada
1-800-258-4610

Canoga and Microloop are trademarks of Global Traffic Technologies, LLC.
3M and Scotchcast are trademarks of 3M. Used under license in Canada.
All rights reserved. Printed in U.S.A.
© Global Traffic Technologies, LLC 2007
75-0301-3689-1 (A)



WIRELESS SENSOR NETWORKS FOR THE TRANSPORTATION INDUSTRY

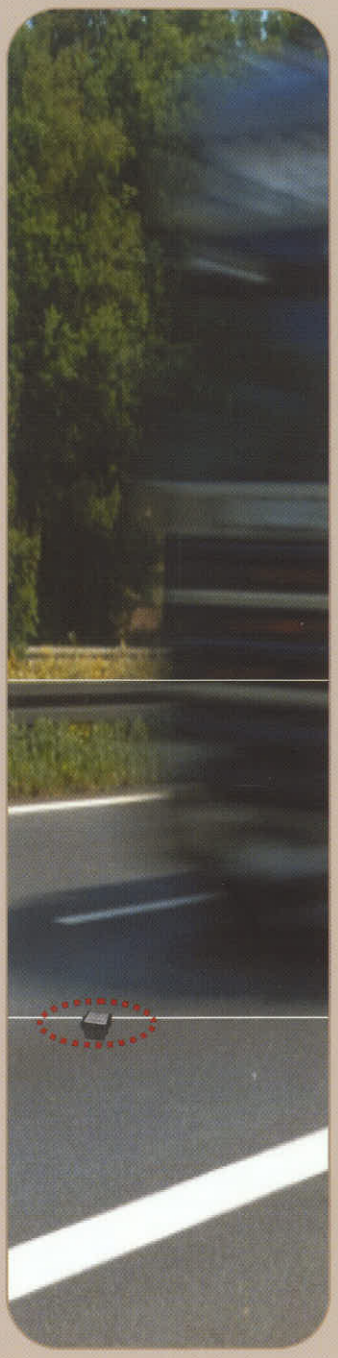
Sensys Networks, Inc.
2560 Ninth Street, Suite 211
Berkeley, CA 94710

Tel: (510) 548-4620
info@sensysnetworks.com
www.sensysnetworks.com

ADVANCES IN WIRELESS SENSOR NETWORKS DELIVER A NEW ERA FOR VEHICLE DETECTION

Sensys Networks products bring an unprecedented level of performance and simplicity to the growing need for traffic monitoring on freeways and arterials and traffic signal controls at intersections. A leader in ultra low-power wireless sensor networking, Sensys Networks has developed the **VDS240** family of vehicle detection products. Wireless sensor networking is a breakthrough technology that combines sophisticated networking software with highly integrated radio and sensor chips to enable sensing applications on a scale - and at a cost- unthinkable until now.

With the **VDS240**, it is now possible to deploy vehicle detection at a much higher density and at a fraction of the initial installation and maintenance costs of currently prevalent technologies such as inductive loops, video cameras, and radar.



A WIRELESS ALTERNATIVE TO INDUCTIVE LOOPS

A VDS240 system can be used in all applications where loops are deployed and in applications where loops are either impractical or too expensive. With the VDS240 system, no more trenching is required to install sensors for advance detection at traffic signals or for queue length measurement at freeway ramps. Without wires in the pavement that break, repair and maintenance costs are dramatically reduced.

In a **VDS240** installation, inductive loops are replaced by small, hardened, VSN240 wireless sensors that are placed in a 2" deep cored hole. Typical installation time is less than 15 minutes. A surface mount version of the VSN240 sensor is also available for lower speed applications such as parking lots and structures. The wireless sensors are battery operated lasting 10 years in the pavement.

The **VDS240** system provides highly accurate individual vehicle presence, speed, and length measurements as well as average counts, speeds, and occupancy over selectable time intervals. In side by side tests the VDS240 demonstrates performance comparable to the best inductive loop systems.

TOWARDS PERVASIVE DETECTION

With its ease of installation, lower initial and maintenance costs, the **VDS240** will enable traffic monitoring on a much larger scale than is economically feasible with existing technologies. The **VDS240** will enable pervasive detection in support of accurate traffic management operations and timely traveler information systems. The **VDS240** will help increase traffic safety, alleviate congestion on roads and freeways, and in turn, decrease commute and travel times for everyone.

(Source PeMS)



VDS240 VEHICLE DETECTION SYSTEM COMPONENTS

VDS240 installation is comprised of the following components:

- VSN240 in-pavement wireless vehicle sensors at locations where detection is desired.
- AP240 access point that is mounted on the side of the road and relays the sensor node data to the local controller or – the Traffic Management Center (TMC).
- Optional: RP240 repeaters that are used to extend the radius of coverage of the access point.

VSN240 WIRELESS SENSOR NODE

The **VSN240** wireless sensors are magnetic sensing devices that are available in two types of hardened casings:

The **VSN240-f** is a flush mount sensor that is mounted in a 2" cored hole in the pavement. It has a 10 year battery life.

The **VSN240-s** is a surface-mount sensor in a hardened casing similar in shape and size to the raised pavement markers that are ubiquitous on many roads worldwide, and are glued to the pavement. It has a 7-year battery life.

The **VSN240** has a built-in magneto-resistive sensor that measures changes in the Earth's magnetic field caused by the presence or passage of vehicles in the proximity of the sensor node. A low-power radio in the VSN240 transmits time-stamped detection events to an access point on the side of the road.

By placing two or more **VSN240** sensors in a lane, accurate individual vehicle speeds, direction of travel, and queue lengths can be measured and reported.



VSN240-f
(flush mount)



VSN240-s
(surface mount)

AP240 ACCESS POINT

The **AP240 Access Point** is a lightweight unit that can be mounted on a pole, sign, or traffic signal. The AP240 collects the detection data from all the sensor nodes that are assigned to it and relays this data to either the TMC or to a standard roadside controller, depending on the application.

The high-end **AP240-E** has a powerful host processor running Linux and supports a host of communication interfaces including GPRS/CDMA cellular data, Ethernet, and RS-485.

The **AP240-S** is a streamlined access point that is ideal in applications where the VDS240 interfaces directly to a controller or host PC.



AP240

RP240 REPEATER

The **RP240** Repeater is a standalone battery powered device that extends the radius of coverage of a VDS240 installation by 1000ft. Batteries last two years.

For example, the deployment of mid-block detection is much simplified by the installation of an RP240 at the location where the detection is desired. The RP240 will then relay the data from the sensor nodes in the pavement at the selected mid-block detection to the AP240 located at the traffic signal.

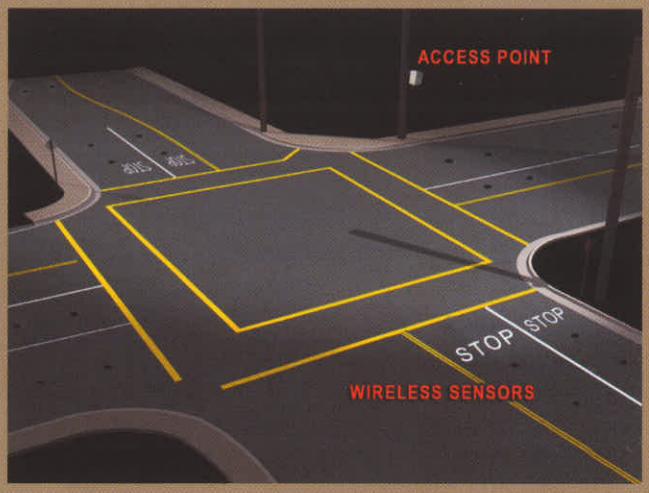


RP240

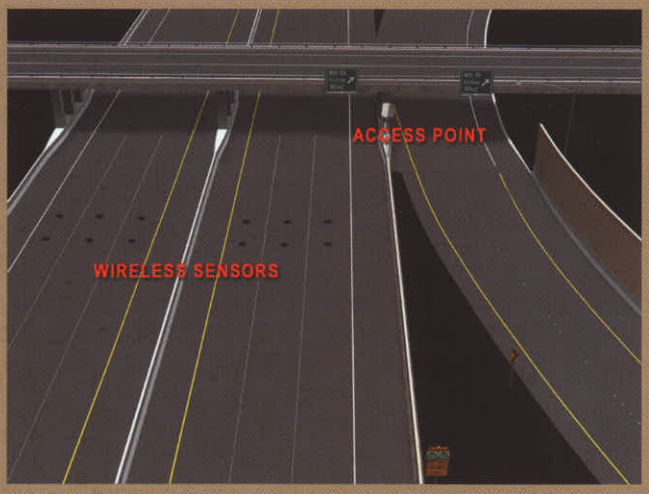
A WIDE RANGE OF APPLICATIONS

VDS240 deployment includes intersections, parking and freeways applications:

At intersections, the VDS240 measures presence, speed, counts, and queues as far upstream as desired.



On freeways, the VDS240 measures counts, occupancy, speed, headway, and vehicle length. The system is connected to the local controller or TMC.



In parking structures, the VDS240 provides individual presence for parking spaces or counts at the entry and exit points of a zone. The system is connected to a parking guidance system or a real-time traveler information service.



Brochure designed by www.bonnevilleconsulting.com

© Copyright Sensys Networks, Inc. All Rights Reserved 2006

VDS240 for Advance Detection

The New Technology Standard for Advance Detection

In pavement wireless vehicle sensors provide reliable and accurate vehicle detection for advanced applications.



The use of advance detection in the transportation industry is accelerating. Advance detection is used to improve the safety and efficiency of traffic intersections. Safety applications including traffic calming, green light extension and collision avoidance require detection and speed measurements several hundreds of feet before an intersection. Traffic flow efficiency can be achieved by measuring vehicle counts and lane occupancy in advance of the intersection and by relaying this information to a traffic control system.

Sensys Networks' VDS240 detection system is an ideal vehicle sensor for advance detection applications. Using small wireless sensors that are placed in the pavement, the VDS240 offers a direct replacement for inductive loops without the expense and prolonged lane closures associated with the installation and maintenance of loops. With its unique wireless technology, the VDS240 can be quickly installed with minimal impact to roadways and the motoring public.

The VSN240-f is designed to be installed flush with the pavement surface in a small 4" diameter, 2" deep cored hole in the roadway. The VSN240-f can be deployed in all weather climates and roadways. The VSN240-f sensor has undergone rigorous field testing and has a battery life expectancy of 10 years.

- Easy to install and eliminates expensive saw cuts & trenching
- Installed exactly where detection is required
- Communicates wirelessly
- Detects vehicles in all weather conditions
- Detection precisely terminates when vehicle is no longer over the sensor
- Reliable & precise detection
- Requires minimal training
- Interfaces directly to standard detector racks in 170/2070 and NEMA TS-1 & TS-2 cabinets
- VSN240-f designed to last 10 years under demanding conditions



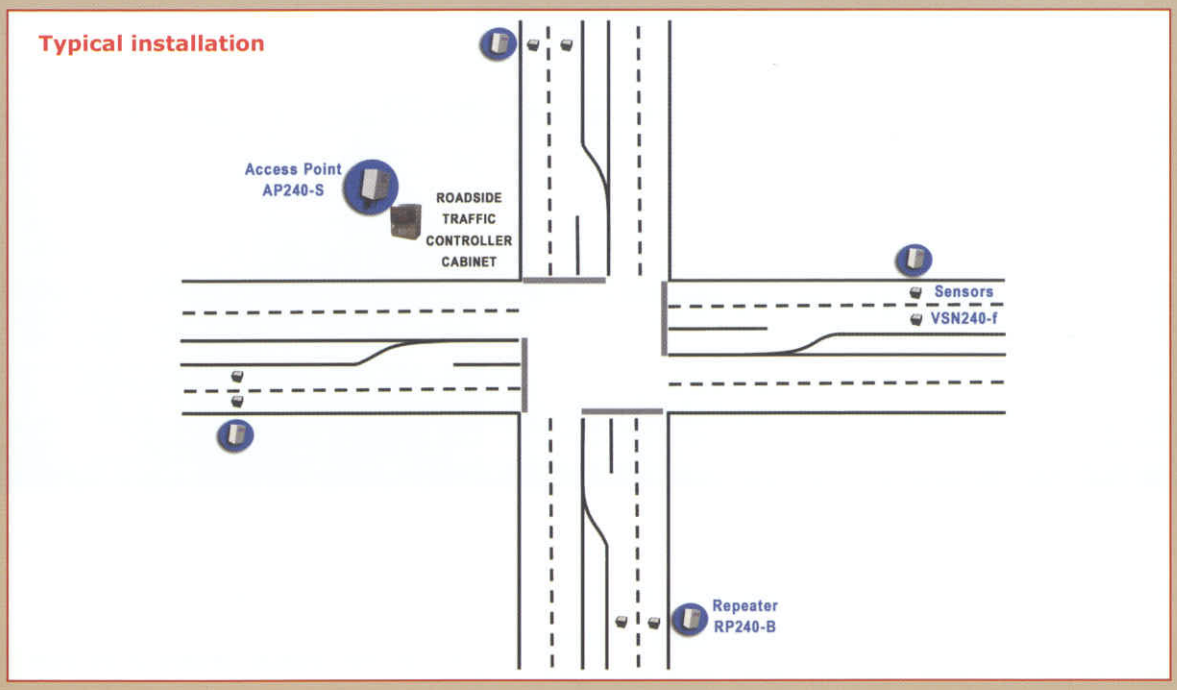
See back for detailed product specifications —>

WIRELESS SENSOR NETWORKS FOR THE TRANSPORTATION INDUSTRY

APPLICATION SPECIFICATION

SENSYS Networks

Typical installation



Typical Advance Detection Installation:

Designing and implementing an advance detection system using Sensys Networks' VDS240 system is simple.

The detection sensor (VSN240-f) is installed in the middle of the lane at the position where detection is desired. If multiple lanes of detection are required, additional sensors can be placed in each lane.

At the cabinet, an Access Point (AP240-S) is installed. The AP240-S can communicate with up to 8 sensors located within its communication range. The AP240-S communicates detection information to the AI Controller Interface card, which mounts directly into the input file or detector rack. The AI card provides 4 detector outputs. If additional detector outputs are required, an optional CI card provides an additional 4 outputs.

The information on this data sheet is subject to change without notice.

If the distance from the sensor to the AP240-S exceeds the maximum communication range (see table below), the use of a repeater (RP240-B) will be required. The RP240-B is a battery or solar powered unit which is placed within the communication range of the sensor(s).

The RP240-B then re-transmits the detection information to the AP240-S located up to 1,000 feet away. The AP240-S has an effective "field of view" of approximately 180°. If the VSN240 sensor(s) or RP240-B repeaters are located outside of this range, an additional AP240-S may be required.

AP240-S Height	Range from Sensor to AP240-S
8ft (4m)	50-75ft (15-25m)
16ft (6m)	75-125ft (25-35m)
24ft (8m)	100-150ft (30-50m)

© Copyright Sensys Networks, Inc. All Rights Reserved 2006

TO ORDER OR FOR MORE INFORMATION

Sensys Networks, Inc.
2560 Ninth Street, Suite 211
Berkeley, CA 94710
Tel: (510) 548.4620
info@sensysnetworks.com
www.sensysnetworks.com

Local Dealer Information

WIRELESS SENSOR NETWORKS FOR THE TRANSPORTATION INDUSTRY

AP240-E ACCESS POINT

VDS240 Wireless Vehicle Detection System

- IP-Based Access Point
- Built-in Ethernet, RS-485, GPRS or CDMA Backhaul Options
- Linux-Based Host Processor
- Software for Permanent Count Stations, Classification & Parking Guidance
- Interfaces to Standard 170, Nema TS-1 and TS-2 controllers
- Installs in Minutes and Requires No Calibration



The Sensys Networks AP240-E is an IP-based access point for the VDS240 family of wireless sensor vehicle detection products. It offers a rich set of features that simplify installation, traffic monitoring, and data reporting. The AP240-E contains a host processor and a number of communications interfaces, including a radio transceiver to the VSN240 in-pavement wireless sensors, an Ethernet port, 2 serial ports, and options for GPRS/CDMA and GPS radios.

The AP240-E communicates with VSN240 sensors using the Sensys NanoPower (SNP) Protocol, an advanced wireless communications protocol designed to minimize power consumption, and extend battery life, in wireless sensors. The AP240-E supports a single SNP radio, operating in the 2.4GHz ISM band, based on the IEEE 802.15.4 standard.



The AP240-E can manage and communicate with a large number of VSN240 sensors. Time-stamped vehicle detection events from each sensor can be relayed in real-time by the AP240-E to a remote server over one of the backhaul options. Alternatively, events can be aggregated and analyzed locally on the AP240-E and the resulting statistics can be formatted and transmitted to any IP device or stored locally for later retrieval.

The AP240-E can activate contact closures to interface to standard traffic controllers such as the 170, Nema TS-1 and TS-2. Sensys Networks provides standard form factor interface cards for connecting an AP240-E to the controller input file shelves. The AP240-E is connected to these interface cards via an RS-485 cable.

The AP240-E has a powerful host processor running Linux®, which allows sophisticated user applications to run directly in the AP240-E. An API to the Sensys NanoPower Protocol is TCP-based, allowing software development to take place at an external workstation, and then optionally ported to the host processor.

The AP240-E is typically mounted at a height of 10 ft or more on an existing pole, sign, or traffic signal. Its quick installation is straightforward, requiring no precise measurements or calibration.

The AP240-E is DC-powered and can support input voltages from 9V to 24V, or from 36V to 58V allowing solar or line powering with battery backup, or standard POE powering.

See back for detailed product specifications —>

PRODUCT SPECIFICATIONS

SENSYS Networks

Host Processor
- 66MHz 5272 Coldfire processor
- 4MB of Flash memory
- 16MB of DRAM

SNP-based wireless interface to the VSN240 sensors
- Conforms to Sensys SNP
- IEEE 802.15.4 Standard Compliant
- Distance from AP240-E to sensors: 100ft to 200ft, depending on AP240-E antenna height and terrain.
- Operates in any one of 16 5MHz channels in the 2.4 – 2.48 GHz ISM band.

Ethernet Interface
- 10/100 BaseT
- IP address via DHCP or static
- IP67 RJ45 bulkhead connector
- Proprietary Power Over Ethernet (12V to 24V)
- Standard Power Over Ethernet (36V to 60V)

Serial Port A Interface
- GPRS or CDMA 1xRTT modem (optional)
- Up to 115.2kbps RS232C

Serial Port B Interface
- GPS (optional)
- External via IP67 RJ45 bulkhead connector (optional)
- Up to 115,200kbps RS232C or RS485
- Proprietary Power over Serial Port (optional)

TCP/IP Support
- Protocols supported: telnet, ftp, http, ppp, pptp
- Tunneling to VPN allows connection to AP240-E without a static address
- Encryption over Tunnel (optional)

Powering
- 9VDC to 24VDC or 36V to 60V input
- 1 W to 1.5 W depending on options.
- POE injector with 110VAC to 240VAC 50Hz-60Hz DC supply (optional)
- Solar power panel (12V, 10W with battery back-up) (Optional)

LINUX® is a registered trademark of Linus Torvalds.
PeMS® is a registered trademark of Berkeley Transportation Systems, Inc.
The information on this data sheet is subject to change without notice

Environmental
- NEMA 4X / IP 67 Enclosure, 6 x 5 x 2.5"
- Temperature: -40F to +176F (-40C to +80C)

SNP-TCP/IP Gateway
- Supports TCP streams to applications
- Transparent access to sensor data
- Multiple applications can ask for SNP packets based on packet type
- Can supply synchronization to applications

Software Download
- Can store download image locally in host
- Can download new software to one or more sensor simultaneously

Software Applications

SNAP-STAT:
- Computes counts, speed, occupancy, vehicle length, & other statistics per lane over various intervals
- Real-time individual vehicle speed, length and inter-vehicle time gaps
- Data can be pulled via telnet/ftp or pushed via PeMs® Interface
- On-board storage eliminates dropped data

SNAP-COUNT:
- Accurate directional count for parking facilities
- Provides event time-stamp, lane id, direction of travel, and duration of vehicle presence over sensing area

SNAP-EVENT:
- IP port to access event data
- SNAP-C:
- Interfaces to contact closure interface cards

Third-Party Custom Applications
- Can be developed over IP (Ethernet or GPRS) then ported to AP240-E
- Forward and backward compatible IP interface
- Messaging-based protocol
- Message buffering during network down-time
- C API available

© Copyright Sensys Networks, Inc. All Rights Reserved 2005

TO ORDER OR FOR MORE INFORMATION

Sensys Networks, Inc.
2560 Ninth Street, Suite 211
Berkeley, CA 94710
Tel: (510) 548.4620
info@sensysnetworks.com
www.sensysnetworks.com

Local Dealer Information

WIRELESS SENSOR NETWORKS FOR THE TRANSPORTATION INDUSTRY

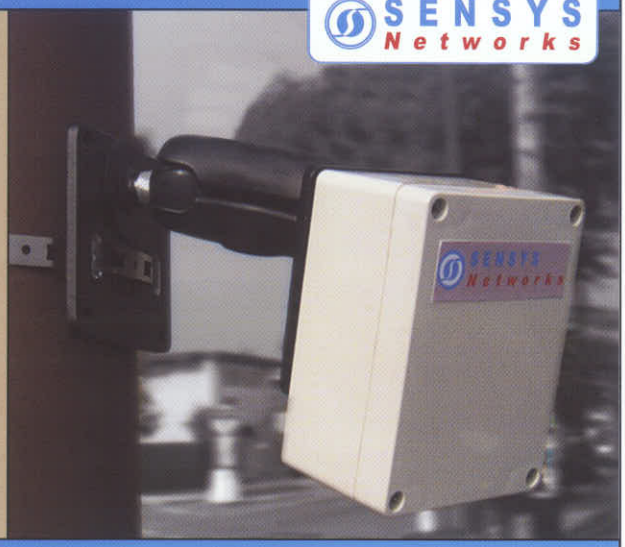
RP240-B REPEATER

VDS240 Wireless Vehicle Detection System

Extends The Range of AP240 Access Point by up to 1000ft

Stand-Alone Battery Operated Device Requires No-Cabling

Can Repeat Up to 10 VSN240 Wireless Sensors

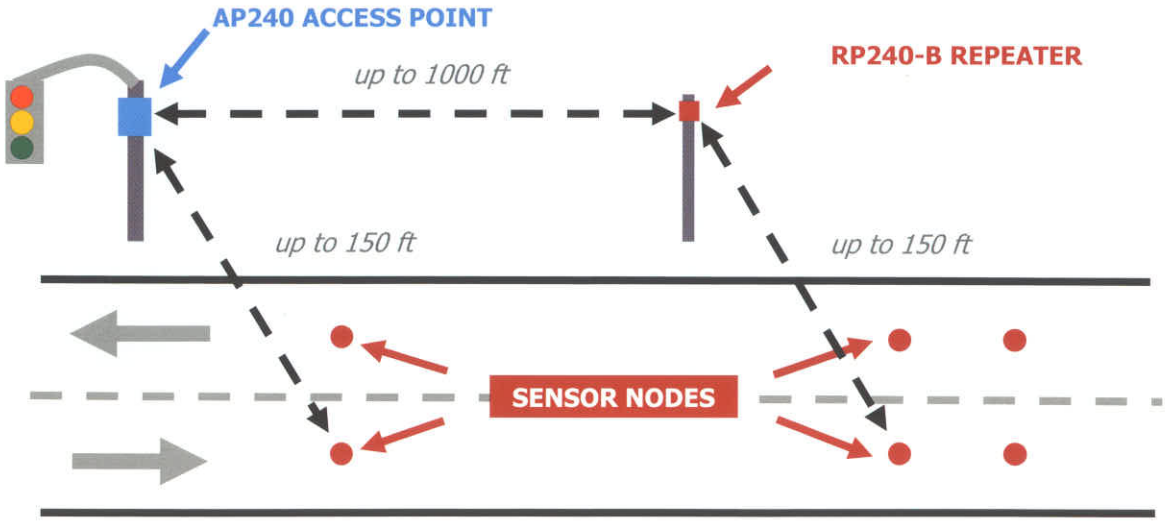


The Sensys Networks **RP240-B** is a stand-alone battery operated repeater that extends the range of a VDS240 Wireless Vehicle Detection System by up to 1,000 ft.

As shown in the picture below an **RP240-B** is deployed in conjunction with an AP240 access point when the desired location of the wireless sensors is beyond the 150ft range of the AP240.

Multiple **RP240-B** can be used with a single access point. In an advance detection application each intersection approach might require its own RP240-B repeater talking back to a single AP240 at the traffic signal.

An **RP240-B** can be added to an existing installation without requiring any changes to the installed equipment or any application software.



See back for detailed product specifications —>

PRODUCT SPECIFICATIONS

SENSYS Networks

SNP-Based wireless interface to the VSN240 sensors and AP240

- Conforms with Sensys SNP
- IEEE 802.15.4 Standard Compliant
- Distance from RP240-B to sensors: 75 to 150ft depending on RP240-B height and terrain
- Distance from RP240-B to AP240: Up to 1,000ft depending on height of AP240 and RP240-B, and terrain
- Operates in any one of 16 5MHz channels in the 2.4-2.48GHz ISM band

Capacity and Latency

- Can repeat up to 80 time-slots per second
- Latency of 4msec
- Can handle 10 sensors in a typical application

Powering

- Replaceable custom battery pack
- Battery life of 2-years under typical use

Environmental

- NEMA 4X/IP 67 Enclosure – Dimensions
- Temperature: -40F to 176F (-40C to +80C)

The information on this data sheet is subject to change without notice

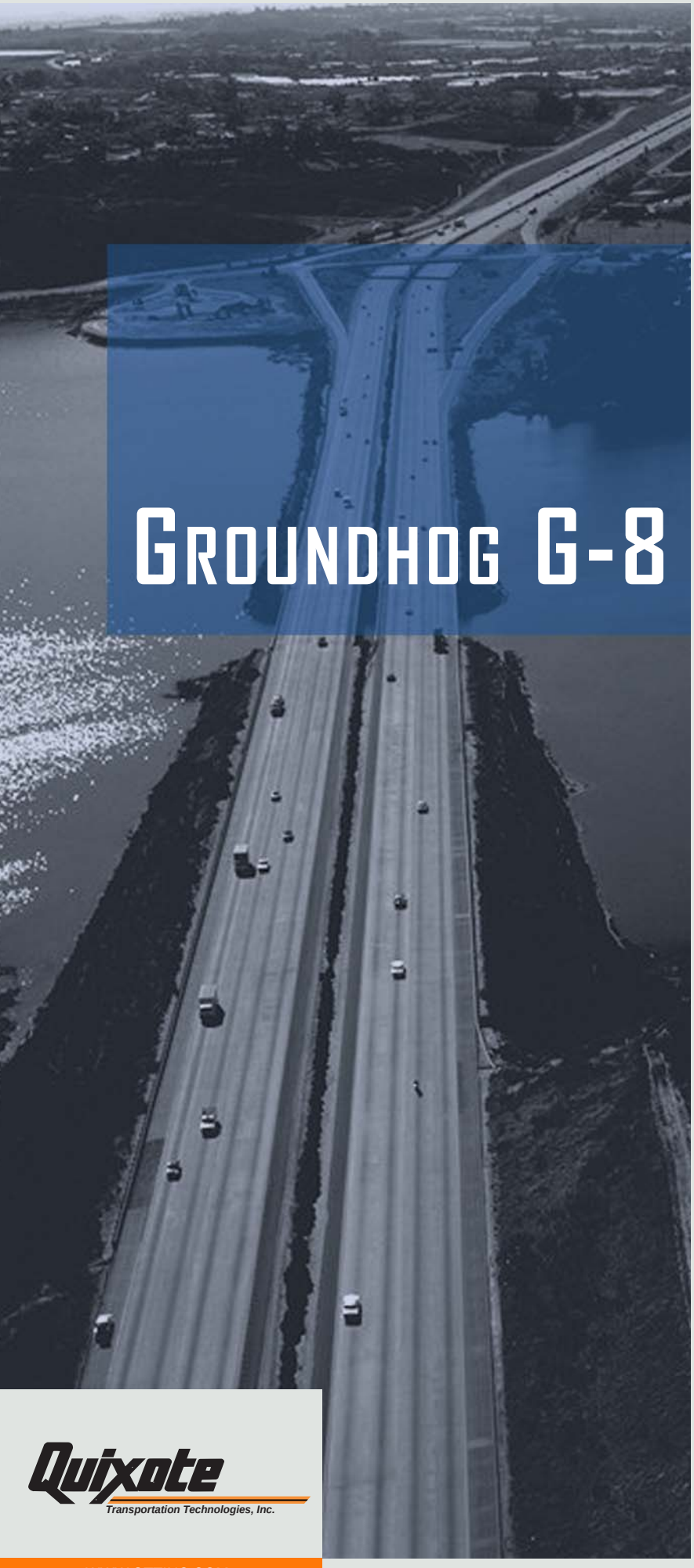
© Copyright Sensys Networks, Inc. All Rights Reserved 2006

TO ORDER OR FOR MORE INFORMATION

Sensys Networks, Inc.
2560 Ninth Street, Suite 211
Berkeley, CA 94710
Tel: (510) 548.4620
info@sensysnetworks.com
www.sensysnetworks.com

Local Dealer Information

WIRELESS SENSOR NETWORKS FOR THE TRANSPORTATION INDUSTRY



GROUNDHOG® G-8
WIRELESS TRAFFIC ANALYZER

OVERVIEW

The Groundhog G-8 is a wireless, permanent traffic analyzer that collects data without any external sensors, loops or tubes. The Groundhog is a self-contained, in-pavement sensor that utilizes Vehicle Magnetic Imaging Technology to detect vehicle count, speed and classification.

The Groundhog reports wirelessly to a site controller alongside the roadway or a road weather station and features an easily removable lid, which allows for quick extraction of sensor components during road maintenance or sensor maintenance.

The Groundhog provides accurate and essential data necessary for effective traffic analysis, control and management. When used with Nu-Metrics Wireless Data Management (WDM) software, historical data can easily be presented in the form of reports, charts and graphs.

FEATURES

- Provides vehicle count, speed and classification
- Detects roadway surface temperature and roadway wet / dry condition
- Wireless data transfer
- Easy-to-use WDM software
- Typical battery life 2 to 4 years
- Lower maintenance cost than traditional inductive loops

APPLICATIONS

- Highways and city streets and with free-flow conditions
- Parking lots, garages and shopping centers with free-flow conditions
- Bridges and toll booths
- Construction areas
- Airports, stadiums and casinos
- Military bases and border crossings
- Easily incorporates into incident management systems such as low visibility warnings, vehicle-in-median warnings, and variable message sign notifications
- Compatible with SSI Road Weather Information Systems (RWIS) and QTT IntelliZone® AdvanceWarn™ systems



Groundhog Permanent Traffic Analyzer

Quixote
Transportation Technologies, Inc.

WWW.QTTINC.COM

GROUNDHOG G-8 MODELS

Model CS - Traffic Only

- Monitors traffic only for focused studies
- Monitors traffic at a specific location
- Compatible with SSI road weather stations

Model Wx - Weather and Traffic

- Monitors traffic and weather data for enhanced studies
- Helps determine the effects weather is having on traffic
- Compatible with SSI road weather stations

Model ETP - External Temperature Probe

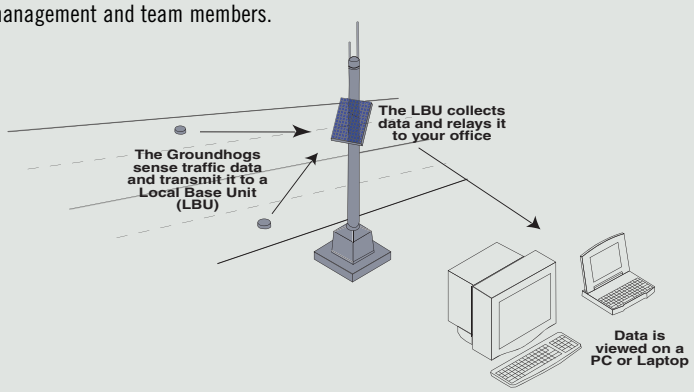
- External temperature sensor provides reading away from canister, resulting in greater accuracy
- Provides a wet/dry pavement condition reading
- Compatible with SSI road weather stations



Groundhog with External Temperature Probe

PERMANENT COUNT STATION (PCS) APPLICATION

The Groundhog is frequently used in the Permanent Count Station (PCS) application. This system utilizes a network of wireless Groundhog sensors, which transmit data to a Local Base Unit (LBU) positioned alongside the roadway. The LBU relays the information to your computer for review. The system provides accurate data for traffic analysis, control and management. Additionally, with the use of WDM software, the data can be easily compiled and displayed for management and team members.



Quixote Transportation Technologies, Inc.

WWW.QTTINC.COM

nu-metrics®

SPECIFICATIONS (BASED ON STANDARD MODEL)

Canister

Dimensions	6.0 in (diameter) x 3.25 in (height) (152.4 mm x 82.6 mm)
Weight	1 lb (454 g)
Wall Thickness	0.6 in (15.2 mm)
Core Drill Size	6.5 in (165.1 mm)
Material	Molybdenum Disulfide filled nylon thermoplastic
Density	0.0473 lb/in^3
Lid / Housing	10 tpi 3.25 in (82.5 mm) bolt circle, 0.25 in (6.4 mm) diameter pins Double-grooved, silicon o-ring construction
Operating Temperature	-40ºF to +185ºF (-40ºC to +85ºC)
Humidity	0 to 100%
Chemical Exposure	Sodium chloride (NaCl), calcium chloride ($CaCl_2$), calcium magnesium acetate (CMA), magnesium chloride ($MgCl_2$), potassium acetate (KAc), etc.

Electrical

Operating Voltage	3.0 V
Protocol	CEBUS EIA 600
Battery Type	Lithium thionyl chloride (-40ºC to +85ºC)
Battery Configuration	Heat-sealed, 4 D cell arrangement, 72 Ah capacity
Battery Life	Up to 5 years (typically 2 - 4 years, varying with AADT* and polling interval)

Transmitter

Frequency	Frequency hopping: ISM 902 - 928 MHz or ISM 2.4000 - 2.4835 GHz
Transfer Rate	10,000 bps
Output Power	100 mW for ISM 902 - 928 MHz 50 mW for ISM 2.4000 - 2.4835 GHz
Distance from Groundhog to LBU	300 ft (91.4 m) max

Traffic

Vehicle Count	Binned, speed, length, daily and AADT*
Vehicle Speed	Binned; custom up to 12 bins
Vehicle Length	Binned; custom up to 6 bins
Polling Intervals	5 - 120 minutes
Occupancy	0 to 100%

Weather

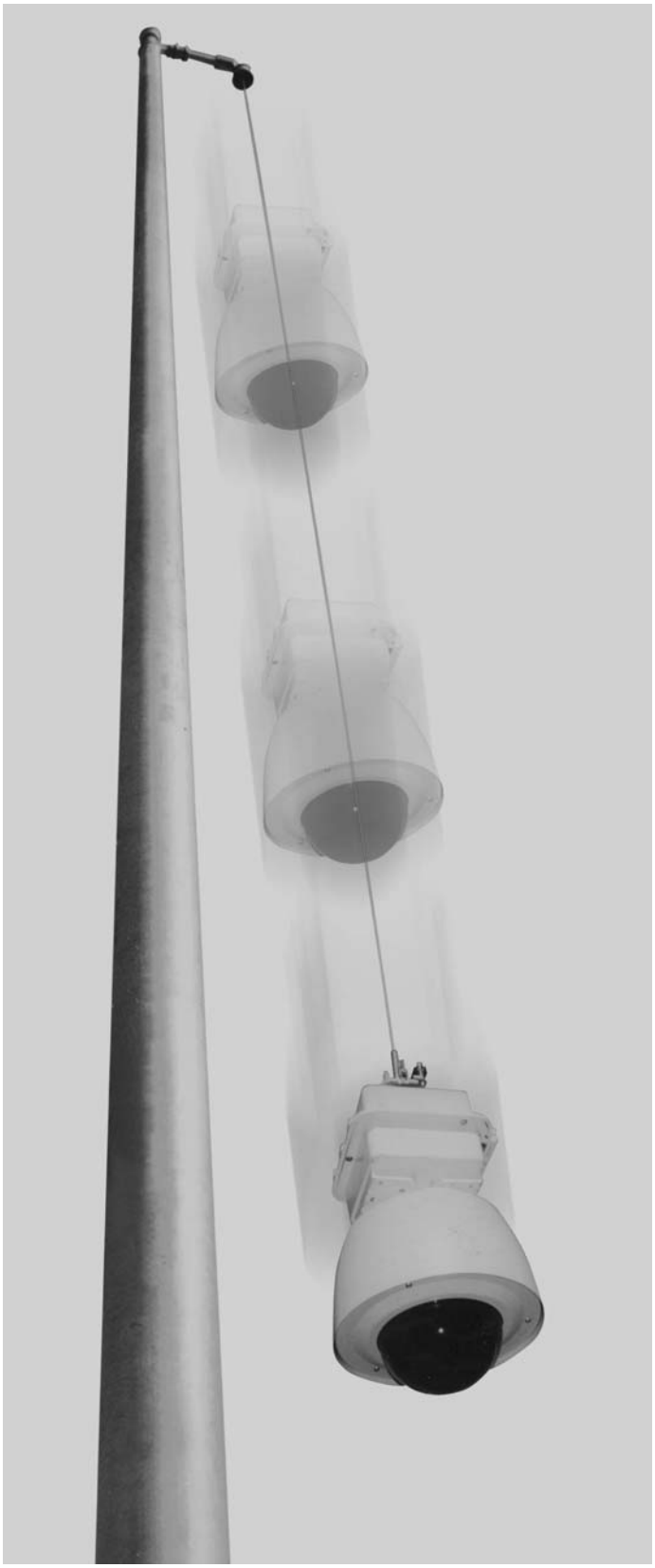
Chemical Index	0 to 100% (passive detection)
Road Surface Temperature	Fast-response thermistor type
Operating Temperature Range	-67ºF to +185ºF (-55ºC to +85ºC)
Road Condition	Wet / dry

*AADT denotes Average Annual Daily Total

DISTRIBUTED BY:

Quixote Transportation Technologies, Inc.
518 University Drive • Uniontown, Pennsylvania 15401
Tel: (724) 438-8750 • Fax: (724) 438-8769
Toll Free: (800) 346-2025
www.qttinc.com

CAMERA LOWERING SYSTEMS



Camera Lowering Systems experience in lowering systems dates back to 1967. Their engineering and marketing and marketing know how has been a major force in the industry starting with their pioneering efforts in the development of the first raising and lowering High Mast system in the United States.

Realizing the need for this type of maintenance, they have perfected new lowering systems for indoor and outdoor applications at reduced cost; at the same time keeping the system simple and safer for maintenance people to operate.

Camera Lowering Systems lowering devices offer three major features:

♦ Safety ♦ Simplicity ♦ Value

New lowering systems offer fast, safe and easy maintenance of cameras and other devices in high or inaccessible areas. All servicing is done at ground level. Hazardous and time consuming high lift truck maintenance is eliminated. The efficiency of the higher mounting height need not present a problem in servicing the equipment.

The use of higher mounting height results in fewer cameras and poles. This results in reduced installation costs and less power usage. These savings offset the cost of the lowering system. Cameras and other devices are lowered individually eliminating the need to lower massive lowering units that are complicated, expensive and heavy.

CAMERA LOWERING SYSTEMS

HOW IT WORKS

The heart of every camera lowering system is the **DISCONNECT UNIT.** Specially designed mechanical components assure precise alignment and positioning of the camera each time it is returned to its operating position after the camera has been serviced. A multi-contact connector intrinsically handles all the functions of the camera including power supply and video signal. Mechanical components, together with the connector, provide every **DISCONNECT UNIT** with the features required for operating surveillance cameras at the highest level available for lowering systems.

DISCONNECT UNIT

Precision cast high strength stainless steel guide post.

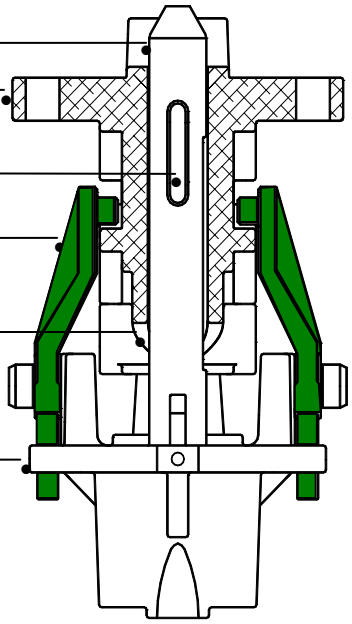
High strength cast aluminum upper fixed portion of disconnect unit with specially designed tracking guide system and support notches.

Precision cast-in-place stainless steel heavy duty alignment key.

Precision cast stainless steel support arms. Shown with the support pins secure in the '**L**' notches of the tracking guide.

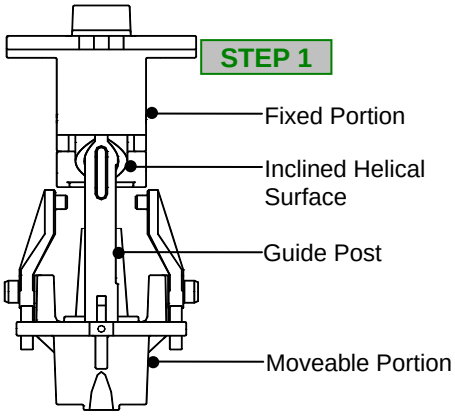
Inclined helical guide surface. Engineered to provide smooth and precise interlocking between the tracking guide and the guide post.

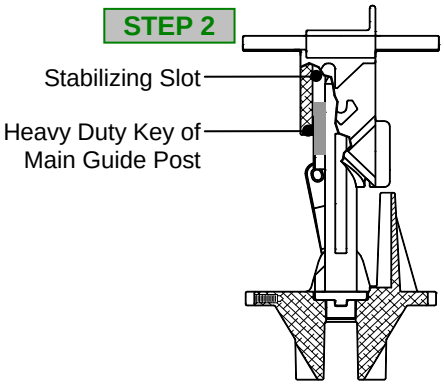
High strength cast aluminum lower moveable portion of disconnect unit.

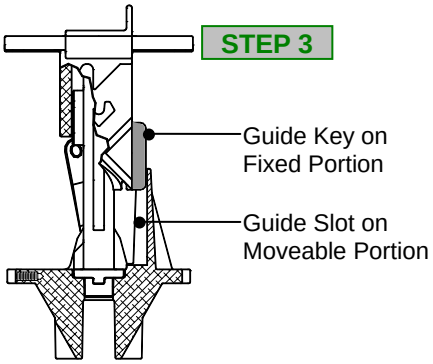


Pivoting Support Arms — Twin supports (highlighted), precision cast in stainless steel, toggle as they move through a tracking guide to their final locked position. Once locked, they assure a balanced load without relying on cable tension, motor gearing, or braking devices.

3-Way Stabilizing Guides — Prior to connector engagement, there are three stepped alignment and stabilizing guides integrated into the *Disconnect Unit.* STEP 1: A cast stainless steel guide post initially aligns the moveable portion with the upper fixed portion. With the aid of an inclined helical surface, the *Disconnect Unit* rotates into its preset position. STEP 2: A heavy duty key on the main guide post enters a stabilizing slot to stop rotation and align the support arms and connector. STEP 3: Offset at 180° to the main guide post key, a second key and slot engage to finalize alignment and stabilize the *Disconnect Unit* immediately before the pins and sockets of the connector engage.



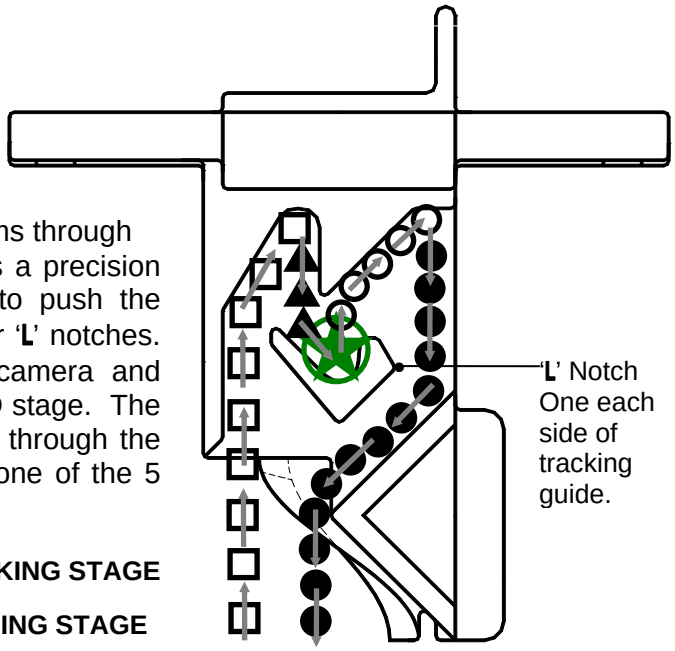




CAMERA LOWERING SYSTEMS

THE 5 OPERATING STAGES OF THE DISCONNECT UNIT

When lowering or raising a surveillance camera, there are 5 basic steps, or stages that the *Disconnect Unit* goes through.

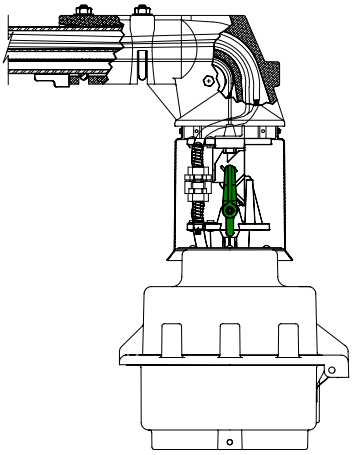


The principal part responsible for moving the support arms through the 5 stages, is the **TRACKING GUIDE.** This guide is a precision cast series of angular surfaces strategically located to push the support arms in the required direction toward the center '**L**' notches. The two **L** Notches support the entire load of the camera and components when the support arms are in the **LOCKED** stage. The drawing at right shows the path the support arms take through the tracking guide. Each shape of dot shown represents one of the 5 stages.

RAISING STAGE **LOCKED STAGE** **UNLOCKING STAGE**

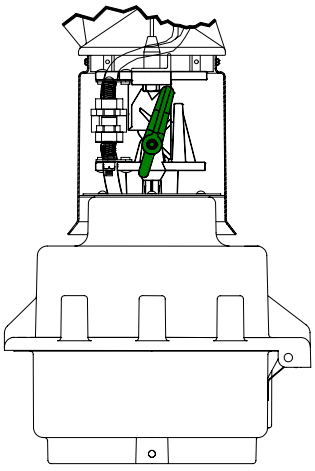
LOCKING STAGE **LOWERING STAGE**

1 LOCKED



The first and most important stage is ***LOCKED***. Generally, all aspects of the operation of the *Disconnect Unit* will begin and end in the locked stage. In the locked position, the twin support arms hold all the weight of the surveillance camera. There is no tension on the the operating cable, no locking of gears, and no pressure on braking devices to hold the camera secure in its operating position. The electrical and signal contacts are fully engaged and fully insulated and all camera functions are operational when the *Disconnect Unit* is LOCKED.

2 UNLOCKING

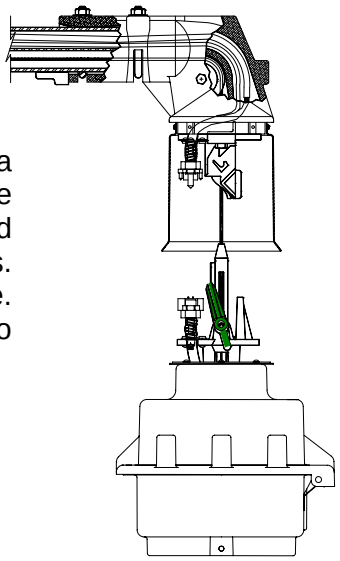


The second stage is ***UNLOCKING.*** Before lowering the camera, the *Disconnect Unit* must first be raised approximately 3/4 inch. During the slight raising operation, the support arms will be pushed to one side by the tracking guide to clear the support notches. Springs inside both halves of the connector compress as the *Disconnect Unit* is raised. Electrical and signal contacts are still engaged during this stage. Each *Disconnect Unit* has a built-in positive stop that, when reached, is an indication to the operator to begin lowering the camera. Every time the *Disconnect Unit* is raised from the 'locked' position, the support arms will move and unlock the *Disconnect Unit.*

CAMERA LOWERING SYSTEMS

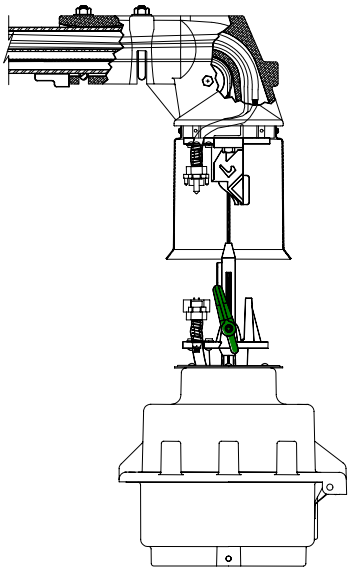
THE 5 OPERATING STAGES OF THE DISCONNECT UNIT

● LOWERING



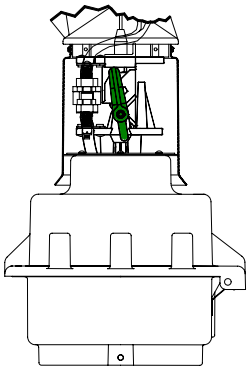
With the *Disconnect Unit* unlocked, ***LOWERING*** is the next stage. As the camera is lowered, the bottom portion of the *Disconnect Unit* begins to separate from the tracking guide and the top portion of the *Disconnect Unit*. Next, the electrical and signal connector disconnects followed by the coming apart of all stabilizing guides. All the weight of the camera and equipment now hangs from the control cable. There are no live electrical contacts to contend with as the camera is lowered to the desired height above the ground for maintenance.
Cleaning and repair work can be accomplished at ground level.

□ RAISING



After maintenance to the camera, ***RAISING*** is the forth of the operating stages. During this part, the camera and moveable portion of the *Disconnect Unit* are raised to the top. As the camera slowly approaches the upper portion of the *Disconnect Unit*, the control cable initially pre-positions the main guide post in the center hole of the tracking guide. With continued raising, the guide post centers itself in the tracking guide and rotates into its original orientation as the guide post's cast-in-place key follows the inclined helical surface of the tracking guide. Sustained raising of the camera will engage the next stabilizing key and guide slot of the *Disconnect Unit* as the support arms toggle through the tracking guide. Electrical and signal pins and sockets of the connector engage as the last step before the lower moveable portion of the *Disconnect Unit* reaches the very top. There is still tension on the control cable at this time and the camera is operational. Because there is still tension on the control cable and the *Disconnect Unit* is not locked in place, the system must ***never*** be left in the **RAISING** stage. Proceed to the final stage: **LOCKING.**

▲ LOCKING



The final phase of the 5 operating stages is **LOCKING.** During this stage, the camera must be lowered approximately 3/4 inch so that the support arms of the lower portion of the *Disconnect Unit* move toward the center '**L**' notches of the tracking guide. Springs within the socket half of the connector that were compressed during the final part of the raising stage are now extending and exerting force on the pin half of the connector to assure complete isolation and insulation of the contacts. After the slight lowering operation, the support arms are secured in the '**L**' notches. The *Disconnect Unit* is now in the **LOCKED** stage. The operating stages 1 through 5 may now be repeated over and over again with the camera returning to its original operating position each time. The operating stages of the *Disconnect Unit* must always begin and end with the *Disconnect Unit* in the **LOCKED** position.

SONY



SSC-CD Series

Fixed Mini-dome Cameras

www.sony.com/security

Reproducing Extremely Clear and Detailed Images, Sony Analog Mini-dome Cameras are Ideal for use in Commercial and Industrial Locations Such as Airports, Schools, Offices, and Many More!

Sony introduces a new line of fixed mini-dome cameras. All of these cameras employ highly sensitive imagers that produce amazingly clear and detailed images in a number of security and surveillance monitoring applications. For easy setup, they incorporate the Sony patented Ball-Joint Lens Mount mechanism, which provides quick and easy adjustment of the camera's viewing angle during installation.

The SSC-CD77/CD77P and SSC-CD75/CD75P are vandal-resistant mini-domes designed for either indoor or outdoor use. The SSC-CD77/CD77P camera incorporates the latest 1/3-type CCD with SuperExwave™ technology, which provides superb sensitivity. Designed for 24x7 operation, it also incorporates a Day/Night function that can produce detailed images even in zero lx*1 lighting conditions. The SSC-CD75/CD75P utilizes a 1/3-type Super HAD CCD™ to deliver high-quality color images and is perfect for security applications that do not require a day/night capability.

The SSC-CD49/CD49P and the SSC-CD45/CD45P are compact and discreet dome cameras designed for indoor security and surveillance monitoring applications. The SSC-CD49/CD49P camera incorporates unique Sony DynaView™ technology to provide a wide dynamic range when viewing high-contrast scenes with severe backlighting, such as a window or an entrance to a building.

Feature rich and flexible, this line of mini-dome cameras offers a wide variety of options to choose from. Each camera has a unique feature set, which allows users to choose exactly the right camera for their solution requirements.

*1 Zero lx means the absence of visible light to the naked eye. IR illuminators are required to operate at zero lx.

FEATURES AT A GLANCE

	SSC-CD77/CD77P	SSC-CD75/CD75P	SSC-CD49/CD49P	SSC-CD45/CD45P
				
CCD Imager	1/3-type CCD With Super Exwave Technology	1/3-type Super HAD CCD	1/3-type CCD With Dynaview Technology	1/3-type Super HAD CCD
Horizontal Resolution (TV lines)	540	540	480	540
Ruggedized Design (Vandal- and Weather-Resistant)	○	○	–	–
Wall- or Ceiling-Mountable	○	○	○	○
3.6x Zoom, Auto-Iris Vari-Focal Lens	○	○	○	○
Sony Patented Ball-Joint Lens Mount	○	○	○	○
Day/Night Function	○	–	–	–
Wide Dynamic Range With DynaView	–	–	○	–
Backlight Compensation	○	○	○	○
Auto Tracing White Balance (ATW)/ATW pro	○	○	○	○

FEATURES

Superb Picture Quality

SuperExwave Technology

SSC-CD77/CD77P

The SSC-CD77/CD77P incorporates an advanced 1/3-type CCD with SuperExwave technology that achieves extremely high sensitivity levels. This CCD imager provides a minimum illumination of 0.6 lx in color and 0.06 lx in B/W at F1.3, enabling the camera to capture clear and detailed images even under low light conditions.

Wide Dynamic Range With DynaView Technology

SSC-CD49/CD49P

The SSC-CD49/CD49P incorporates DynaView technology, which dramatically improves the camera's dynamic range by 128 times when compared to conventional cameras. This results in clear image reproduction, even in extreme high-contrast environments. The camera captures the same image twice – first with a normal shutter speed, and then with a high shutter speed. The dark areas captured at normal shutter speed and the bright areas captured at high shutter speed are then combined into one image using an advanced DSP LSI. Additionally, as these high-contrast scenes may have different lighting conditions, two white balance circuits are employed – one for normal shutter speed and the other for high shutter speed. This advanced technique reproduces high-contrast images with proper color.



DynaView Technology

Super HAD™ CCD

SSC-CD75/CD75P SSC-CD45/CD45P

The SSC-CD75/CD75P and SSC-CD45/45P incorporate a 1/3-type Super HAD CCD that delivers high sensitivity levels and high picture quality for a number of monitoring applications. The minimum illumination of these cameras is 0.9 lx at F1.3.

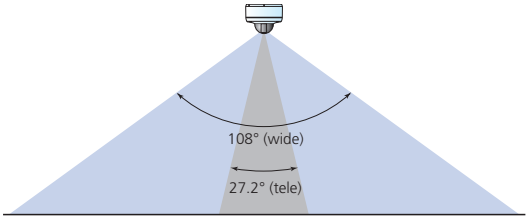
High Horizontal Resolution

SSC-CD77/CD77P SSC-CD75/CD75P SSC-CD45/CD45P

The high-quality CCD imager of the SSC-CD77/CD77P/CD75/CD75P/CD45/CD45P, in combination with the camera's state-of-the-art DSP technology, produces a high horizontal resolution of 540 TV lines for amazingly clear and detailed images.

Powerful 3.6x Zoom, Vari-focal Lens

These cameras come equipped with a 3.6x zoom, vari-focal lens that covers an extremely wide range of viewing angles from 100.8° (wide-angle) to 27.2° (telephoto). This feature provides installation flexibility for a number of different applications and locations.



Flexible and Easy Installation

Wall- or Ceiling-mountable/Easy Viewing-angle Adjustment

These cameras can be easily wall- or ceiling-mounted*2, for installation flexibility. Also, in addition to the BNC video output on the rear of the camera, a secondary video output (RCA phono jack) is provided on the front of the camera. This allows installers to monitor images during installation for accurate and quick adjustment of the focus and viewing-angle.

*2 Supplied bracket is required when the SSC-CD77/CD77P is wall- or ceiling-mounted.



Ceiling Surface Mount
(SSC-CD45)



Ceiling Flush Mount
(SSC-CD45/ YT-ICB45
Ceiling Mount Bracket)

Ball-Joint Lens Mount Technology

With the Sony patented Ball-Joint Lens Mount mechanism incorporated into the vari-focal lens of these cameras, the lens can be rotated freely in any direction. Unlike conventional cameras, it takes only one action to pan, tilt and rotate the imager/lens, allowing for quick and easy adjustment of the camera's viewing angle during installation.



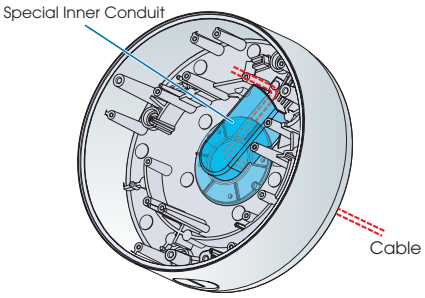
Sony Patented Ball-Joint Lens Mount

Ruggedized Design

SSC-CD77/CD77P SSC-CD75/CD75P

The vandal-resistant SSC-CD77/CD77P and SSC-CD75/CD75P cameras are housed in a heavy-duty, aluminum die-cast enclosure with an impact-resistant polycarbonate dome. The camera complies with the IP66[*3] standard, and offers additional water resistance by using a special inner conduit for the camera cables. For cold-weather outdoor applications, the optional YT-HU75 Heater Unit is available. This allows the camera to be used in severe temperatures as low as -40 °C (-40 °F).

[*3] Ingress Protection (IP) standard is a system for numerically classifying the degree of protection provided by enclosures of electrical equipment against solid objects and liquids. IP66 means there is no ingress of dust and the equipment is protected against powerful water jets.



Water-resistant Design (SSC-CD77/CD75 inside)

Operational Flexibility

Day/Night Function

SSC-CD77/CD77P

The SNC-CD77/CD77P camera can switch from day mode (color) to night mode (B/W) by replacing its infrared-cut filter with a clear filter. Based on user presets, the camera can toggle between day mode and night mode when triggered by an external sensor, or automatically in response to surrounding light conditions. The camera can simultaneously switch to night mode and provide a trigger for near-IR illuminators via its external control port, allowing it to operate even in zero lx[*4] conditions.

[*4] Zero lx means the absence of visible light to the naked eye. IR illuminators are required to operate at zero lx.

Other Convenient Features

Backlight Compensation (BLC)

SSC-CD77/CD77P SSC-CD75/CD75P SSC-CD45/CD45P

Unwanted backlight can often cast a shadow in front of the subject of an image, making it appear dark to the camera. The BLC function incorporated in the SSC-CD77/CD77P/CD75/CD75P/CD45/CD45P cameras automatically compensates for such conditions, making the subject more visible.

Automatic Gain Control (AGC)

These cameras are equipped with an advanced AGC function. This automatically boosts the camera gain up to 24 dB, allowing operators monitoring the image to distinguish the subject more easily in low light conditions.

Auto Tracing White Balance (ATW)/ATW Pro

ATW is a feature that automatically adjusts the camera's white balance to adapt to changing light conditions. With ATW, these cameras can compensate for a color temperature range of between 2,000 K and 10,000 K, allowing for operation under a variety of lighting conditions, including common outdoor light sources such as high pressure sodium vapor lamp. When operating under natural light, incandescent lamps, or fluorescent light sources, ATW Pro – which compensates for a color temperature range of between 2,500 K and 6,000 K – is ideal for reproducing color images closer to what we see with our eyes.

AC Line Lock/Internal Line Lock

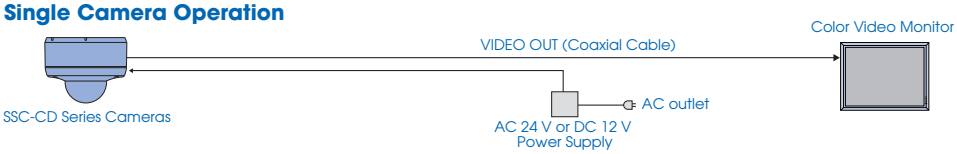
These cameras feature both an AC line lock and an internal line lock for synchronization. The AC line lock is ideal in multi-camera operations, as it synchronizes all cameras connected to the same power line. This helps to prevent the video from rolling vertically when switching between cameras. The vertical phase can be adjusted by ±90 degrees.

Flexible Power Operation

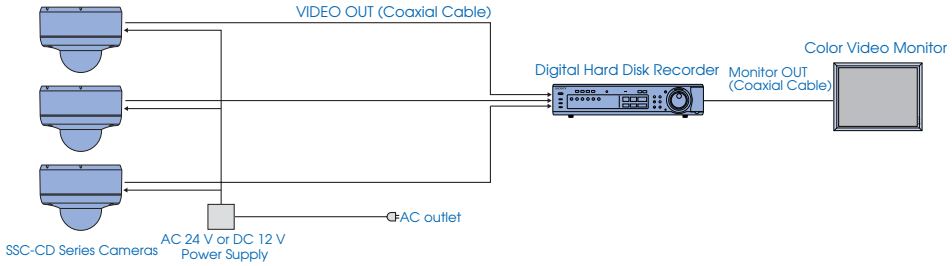
These cameras offer a choice of two types of power: 24 V AC or 12 V DC. The camera automatically adapts to whichever power source is used, making installation fast and effective.

SYSTEM CONFIGURATIONS

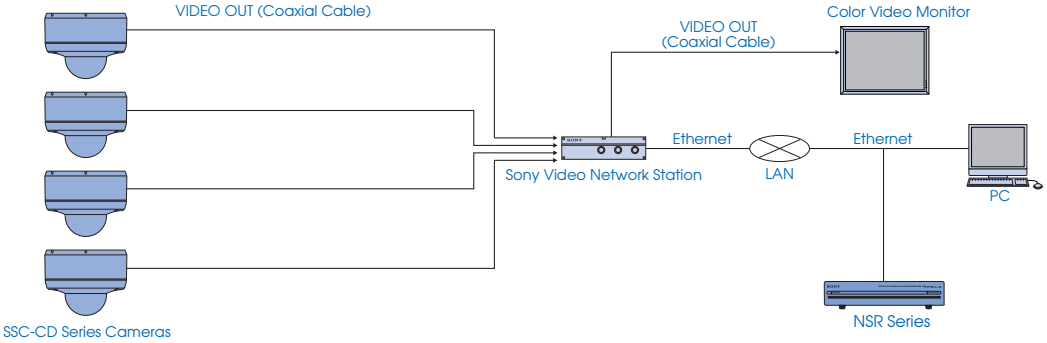
Single Camera Operation



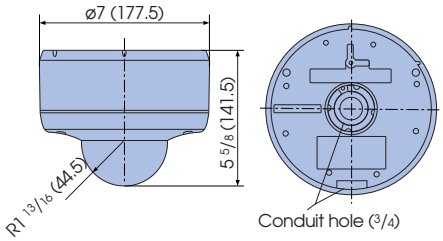
Multiple Camera Operation



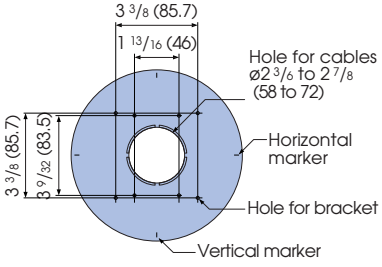
Multiple Camera Operation over LAN



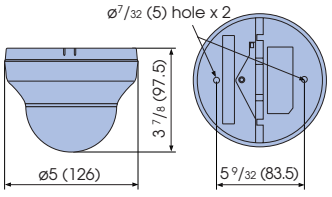
DIMENSIONS



SSC-CD77/CD77P
SSC-CD75/CD75P



Template



SSC-CD49/CD49P
SSC-CD45/CD45P

Unit: inches (mm)

OPTIONAL ACCESSORIES



YT-ICB45
In-Ceiling Mount Bracket



YT-HU75 Heater Unit

SSC-CD77/CD77P

SSC-CD75/CD75P

SPECIFICATIONS

	SSC-CD77	SSC-CD77P	SSC-CD75	SSC-CD75P
Camera				
Image device	1/3-type CCD with SuperExwave Technology		1/3-type CCD with Super HAD Technology	
Number of effective pixels (H x V)	380,000 (768 x 494)	440,000 (752 x 582)	380,000 (768 x 494)	440,000 (752 x 582)
Gain control	ON/OFF			
White balance mode	ATW/ATW Pro			
Lens type	Auto iris vari-focal lens			
Zoom ratio	3.6x optical zoom (1.5x digital zoom)			
Horizontal viewing angle	100.8° to 27.7°			
Focal length	f=2.8 to 10.0 mm			
Backlight compensation	ON/OFF			
Day/Night function	Auto/External control		–	
Analog video output	BNC x1, 1.0 Vp-p, 75 Ω, RCA x 1			
Signal system	NTSC (Composite)	PAL (Composite)	NTSC (Composite)	PAL (Composite)
Sync system	AC Line Lock/Internal Lock			
Horizontal resolution	540 TV lines			
S/N ratio	more than 50 dB (AGC ON/Weight ON)			
Min. illumination	Color: 0.6 lx (50IRE, F1.3, AGC ON) B&W: 0.06 lx (50IRE, F1.3, AGC ON)		0.9 lx (50IRE, F1.3, AGC ON)	
General				
Weight	approx. 3 lb 11 oz (1.75 kg)			
Dimensions (Ø x H)	approx. 7 x 5 5/8 inches (177 x 141 mm)			
Power requirements	AC24V/DC12V			
Power consumption	4 W max. (16 W with heater option)			
Operating temperature	-4 to 122 °F (-20 to 50 °C) -40 to 122 °F (-40 to 50 °C) w/heater unit			
Storage temperature	-40 to 140 °F (-40 to 60 °C)			
Supplied accessories				
	Bracket, Template, Torx wrench, M4 screws (4), Wire rope, M4 shoulder screw, Operation instructions			

	SSC-CD49	SSC-CD49P	SSC-CD45	SSC-CD45P
Camera				
Image device	1/3-type CCD with DynaView technology		1/3-type CCD with Super HAD Technology	
Number of effective pixels (H x V)	380,000 (768 x 494)	440,000 (752 x 582)	380,000 (768 x 494)	440,000 (752 x 582)
Gain control	ON/OFF			
White balance mode	ATW/ATW Pro			
Lens type	Auto iris vari-focal lens			
Zoom ratio	3.6x optical zoom (1.5x digital zoom)			
Horizontal viewing angle	100.8° to 27.7°			
Focal length	f=2.8 to 10.0 mm			
Backlight compensation	DynaView ON/OFF		ON/OFF	
Analog video output	BNC x1, 1.0 Vp-p, 75 Ω, RCA x 1			
Signal system	NTSC (Composite)	PAL (Composite)	NTSC (Composite)	PAL (Composite)
Sync system	AC Line Lock/Internal Lock			
Horizontal resolution	480 TV lines		540 TV lines	
S/N ratio	more than 50 dB (AGC ON/Weight ON)			
Min. illumination	Color: 0.7 lx (50IRE, F1.3, AGC ON)		0.9 lx (50IRE, F1.3, AGC ON)	
General				
Weight	approx. 15 lb (440 g)			
Dimensions (Ø x H)	approx. 5 x 3 7/8 inches (126 x 97 mm)			
Power requirements	AC24V/DC12V			
Power consumption	4.2 W max.		4.0 W max.	
Operating temperature	-4 to 122 °F (-20 to 50 °C)			
Storage temperature	-40 to 140 °F (-40 to 60 °C)			
Supplied accessories				
	Template, Wire rope, M4 shoulder screw, Operation instructions			

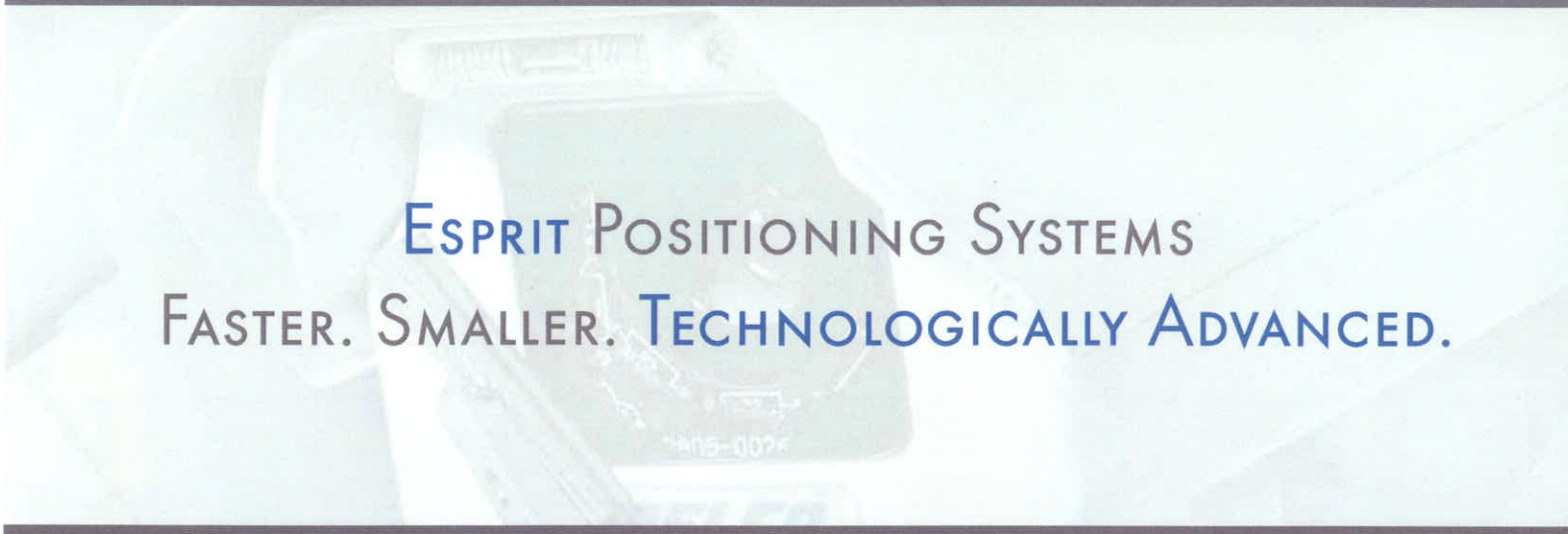
SONY

Sony Electronics Inc.
One Sony Drive
Park Ridge, NJ 07656
www.sony.com/security

© 2007 Sony Electronics Inc. All rights reserved.
Reproduction in whole or in part without written permission is prohibited.
Features and specifications are subject to change without notice.
All non-metric weights and measurements are approximate.
Some images in this brochure are simulated.
Sony, SuperExwave, Super HAD, and DynaView are trademarks of Sony.
All other trademarks are the property of their respective owners.

S-A3001
MK10393V1

Printed in U.S.A. 4/07



Esprit Positioning Systems
Faster. Smaller. Technologically Advanced.

With the Esprit Positioning System, Pelco engineers have brought together the very best in enclosure design, pan-and-tilt mechanics and receiver technologies. This completely integrated package offers responsive, high-speed positioning capabilities, outstanding weather protection and a level of aesthetics and ease-of-installation that remains unmatched in the industry.

Esprit has become the positioning system of choice for surveying roadways, airport runways, train yards, shipyards and most any other outdoor video security application.

Highlights

- Integrated Multi-Protocol Receiver/Driver within Pan-and-Tilt Housing
- Operational in 90 MPH Wind Conditions; Able to withstand wind velocity up to 130 MPH
- Complete Feed-through System, No Exposed Cabling
- 360-Degree Operation
- Pan Speed of 100 Degrees-Per-Second to Presets
- Tilt Range of +33° to –83° from Horizontal
- Digital Position Feedback and On-Screen Display
- Operates in temperatures ranging from -50° to 120°F
- Two-Year Warranty
- IP66 Rating
- NEMA-4X Certification

The Industry's Leading Positioning System



Pelco Esprit

The Pelco Esprit is a high-performance, remote-positioning system featuring an integrated camera and lens, pan-and-tilt unit and a multi-protocol receiver. Designed and built for continuous duty, Esprit offers the most dynamic movement capabilities available along with load-bearing and wind-resistant capabilities that allow it to remain completely operational in 90 mile-per-hour-wind conditions.

Esprit can accelerate and decelerate more smoothly, more responsively and more accurately than any other pan-and-tilt system available. Thanks to an ultra-slow, ultra-smooth "creep mode" speed of 0.1 degree per second, Esprit is perfect for tracking almost any object at any speed at almost any distance.

Complete Environmental Protection

The Esprit Series Positioning System comes standard with industry-leading features such as heater, window defroster, sun shroud and thermal insulation blanket, enabling your unit to operate in temperature conditions ranging from as low as –50° F to over 120° F. And in the event of a power failure during an ice storm, the entire unit can de-ice itself and become operational in just two hours after regaining power at a temperature as low as 13° F.

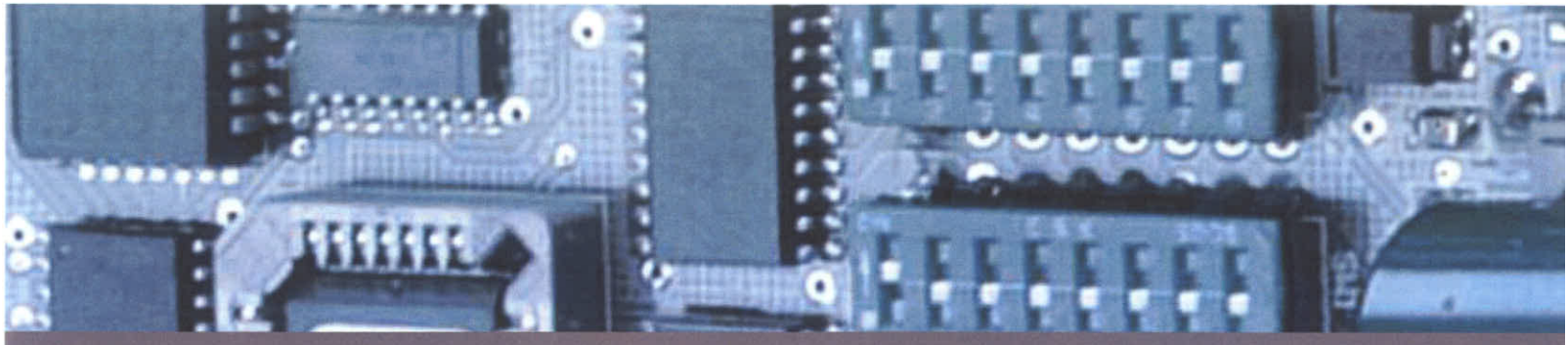
Esprit systems are pre-wired for power input, video and control, with all wiring connections made at the base of the unit. Constructed of cast aluminum and boasting an IP66 rating and NEMA-4X certification, Esprit has been designed and built to deliver the results you demand for years to come.



Integrated Optics Package

Your Esprit is available with an Integrated Optics Package option that includes an auto-focus camera and lens module with programmable features such as white balance and sharpness control. A choice of three distinct cameras is available:

- 24X Optical Zoom, 10X Digital, Color 0.005 Lux, B-W 0.0005 Lux, 520 TVL (NTSC/PAL)
- 22X Optical Zoom, 10X Digital, LowLight Color 0.02 Lux, 470 TVL (460 TVL PAL)
- 16X Optical Zoom, 10X Digital, LowLight Color 0.5 Lux, 470 TVL (460 TVL PAL)



Digital Position and On-Screen Feedback



On-screen position feedback displays the camera's directional orientation and zoom position. Esprit also can accept RS-422 data commands send it to exact azimuth, elevation and zoom positions or report its current position.

The Pelco Remote Data Port



A first-of-its-kind interface, the Remote Data Port can be installed anywhere along the video data lines. Such "bottom-of-the-pole" access provides an unprecedented level of control to verify camera settings and video output without ever needing a lane closure or lift truck.

Day/Night Capabilities



Esprit's Integrated Optics Package (IOP) features a Day/Night option along with theadded capability of LowLight viewing. With Pelco's LowLight Technologies, Esprit Day/Night units now have light sensitivity of an amazing 0.005 Lux in color mode and 0.0005 Lux in B&W Mode.

IOC Pressurized Optics



For the ultimate protection of your optics investment, Pelco offers the Pressurized Integrated Optics Cartridge (IOC). Internal pressurization eliminates internal condensation and corrosion. Sensors in the cartridge send an "Alert" message if changes in pressure, temperature or humidity are beyond acceptable limits.

Optional Window Wiper



Esprit's optional Integrated Window Wiper system features programmable delay, programmable shut-off and high reliability.

TXB Series Translator Boards



The TXB Translator Interface enables Esprit to be used with a variety of competitive control systems. Protocol translation is achieved by means of translator boards that install directly to the interface connector. Protected by the pan/tilt enclosure, they provide seamless operation without the need for additional hardware. NTCIP compatible interface for traffic applications is also available.



The Esprit Positioning System

Esprit has become the industry's standard by which all other pan-and-tilt positioning systems are measured. Ready to go, right out of the box, Esprit systems are easy to install, with no exposed cables, no wiring harnesses to fabricate or connectors to seal or secure.

Simplified Mounting

Three system-mounting options are available. The standard Esprit wall mount arm can be used with most any reliable vertical mounting surface, or an adapter plate can be used for pole- and corner-mount applications. Parapet or pedestal mount adapters are also available.



Choose the Esprit Enclosure that Fits Your Application

Pelco offers a wide range of options that makes the Esprit positioning system the most versatile available. From installing your own camera and lens combination, to ordering the system with a completely installed state-of-the-art pressurized optics package, Esprit offers nothing less than premium performance, and 100-percent customer satisfaction.

High-Performance IOP and Optional Wiper



The ES30C and ES31C not only combine a receiver, pan and tilt, and enclosure in a single, easy-to-install system, they also include an Integrated Optics Package (IOP). The IOP contains an auto-focus camera, lens module with programmable features including onscreen programming and onscreen direction indicators.

Pressurized IOC and Optional Wiper



Pelco's ES30PC/ES31PC Esprit Positioning System is optimally designed to protect camera optics and electronics from moisture and airborne contaminants. The system features a receiver, pan and tilt, enclosure, and a pressurized Integrated Optics Cartridge (IOC).

The ES30PC/ES31PC system's IOC packages an auto focus camera, lens, heater, and sensors in a small, self-contained, sealed unit. Dry nitrogen pressurized to 10 PSIG protects the environment inside the cartridge, eliminating internal condensation and corrosion. Sensors strategically placed in the cartridge send an "Alert" message if changes in pressure, temperature, or humidity are beyond factory set acceptable limits. The sensors also allow for instant on-screen display of temperature, pressure, and dew point.

ImagePak Camera and Lens



The Esprit ImagePak system combines the innovative design of the standard system with a factory-installed camera and lens package of your choice. Choose from a variety of standard or high-resolution, color or monochrome, and LowLight DSP camera and lens combinations. ImagePak saves time and money, and greatly reduces installation errors.

Esprit ES3012 Series



Pelco's Esprit ES3012 Series Integrated Positioning System integrates a pan and tilt, enclosure, and receiver into one compact system that is easy to install. On-screen, user-friendly menus also make the system easy to program and operate.

The standard system does not include the camera and lens components. It is designed to accept any 24 VAC camera and lens combination up to 3.45" W x 3.17" H x 12.10" L (8.76 x 8.05 x 30.73 cm).



Pelco Worldwide Headquarters

3500 Pelco Way

Clovis, California 93612 USA

800/289-9100

800/289-9150 Fax

559/292-1981 International

559/348-1120 International Fax

PELCO.COM

Worldwide Locations:

Australia

Canada

Finland

France

Germany

Italy

Macau

Russia

Singapore

South Africa

Spain

Sweden

The Netherlands

United Arab Emirates

United Kingdom

United States

Pelco, the Pelco logos and Coaxitron are either trademarks or federally registered trademarks of Pelco.

Windows is a registered trademark of Microsoft Corporation.

©2006 Pelco.

C265-11/06

VICON NET
Powered by
IP Video Solutions

SurveyorVFT

IP Camera Dome Series



- **State-of-the-art IP Camera Dome transmits high quality video across the network for remote viewing and recording**
- **Powered by ViconNet version 3 software**
- **Maximum video transmission rate of 30 fps (25 fps PAL) at 720 x 488 pixels (4 CIF) (864 x 586 PAL)**
- **Uses optimized proprietary compression based on MPEG4 that maximizes data size and picture quality**
- **Indoor/outdoor, vandal-resistant and pressurized options**
- **Can be remotely configured from Kollector Elite recorders and ViconNet NVR workstations**

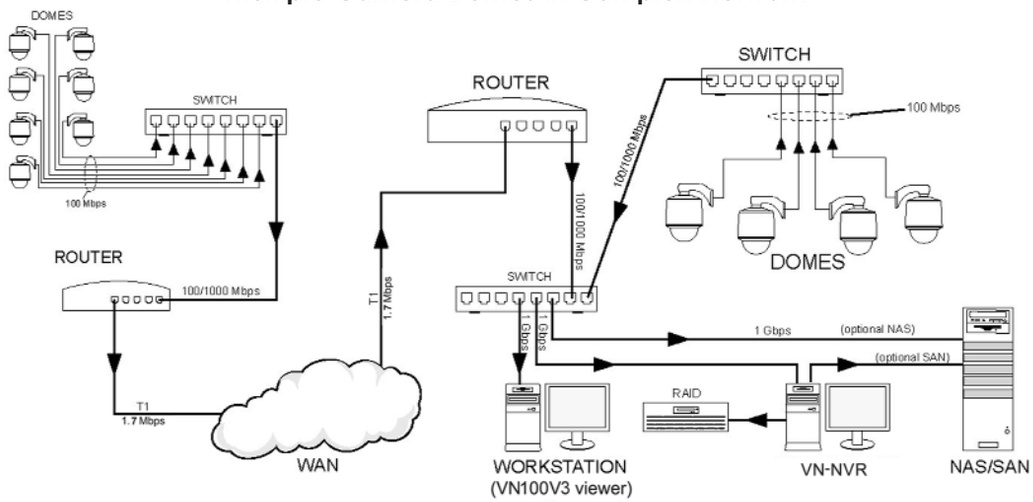
The SurveyorVFT IP Camera Dome is a powerful IP video source for a complete digital video management system based on ViconNet. It is fully compatible all ViconNet systems and is remotely managed and controlled from ViconNet NVRs and Kollector Elite recorders. It can deliver up to 30 fps at a nominal bandwidth of 1.7 Mbps at Q5 (360 x 244 pixels).

A pre-installed 100 Mbps LAN interface board allows direct plug-in to a system network switch. Images received from the IP dome can be displayed, recorded or archived like any other ViconNet video and audio component using the ViconNet management platform.

The ViconNet dome utilizes an MD5 type video authentication algorithm which is based on a 128- bit message used to identify data integrity. Viewing authenticated video can be configured from the software. In addition, video from the SurveyorVFT supports museum search, motion detection, alarm reporting, macros and alarm configuration.

SurveyorVFT IP Camera Dome System is a compact, lightweight and intelligent security device comprised of a camera, pan/tilt drive, receiver and CPU-based electronics all in an attractive and covert enclosure. It is available in a variety of indoor and outdoor versions and can be configured with a variety of camera and lower dome types.

Multiple Camera Domes in Complex Network



- Number of cameras - Multiple on multiple sites
- Network bandwith - Each switch to its limit (as shown above), constrained only by the WAN (T1 @ 1.7 Mbps)
- Storage method - Local workstation hard drive, SCSI attached RAID or NAS/SAN storage
- In the basic configuration, workstation recording capability is approximately 25 cameras

World Headquarters
Hauppauge, New York
631-952-CCTV (2288)
800-645-9116

European Headquarters
Fareham, PO 15 5TX
United Kingdom
+44 (0) 1489 566300

Brussels Office
Zaventem
Belgium
+32 (2) 712 8780

Hong Kong Office
Shatin
New Territories
852-2145-7118

VICON

Model Descriptions

Model Series	Product Code	Nominal Bandwidth (Mbps)	Video Transmission Rate (fps)	Capture Resolution	Total Zoom	Housing Types
22X Cost-Effective Color	8741-25/26, 8742-25/26, 8743-25/26	1.7 per video stream (max 10 streams per dome)	1 channel @ 30 fps max.	480 horizontal TV lines max @ 720 x 488 (4 CIF) pixels	264X	Indoor, Outdoor, Ceiling, Pendant, Maximum Security
22X ExView™ Color	8701-25/26, 8704-25/26, 8707-25/26	1.7 per video stream (max 10 streams per dome)	1 channel @ 30 fps max.	480 horizontal TV lines max @ 720 x 488 (4 CIF) pixels	264X	Indoor, Outdoor, Ceiling, Pendant, Pressurized, Maximum Security
23X Day/Night with Wide Dynamic Range	8701-25/26, 8705-25/26, 8708-25/26	1.7 per video stream (max 10 streams per dome)	1 channel @ 30 fps max.	480 horizontal TV lines max @ 720 x 488 (4 CIF) pixels	276X	Indoor, Outdoor, Ceiling, Pendant, Pressurized, Maximum Security
35X Day/Night with Wide Dynamic Range amd Image Stabilization	9102-25/26	1.7 per video stream (max 10 streams per dome)	1 channel @ 30 fps max.	480 horizontal TV lines max @ 720 x 488 (4 CIF) pixels	420X	Outdoor, Pendant, Pressurized, Maximum Security,

Technical Information

ELECTRICAL

Drive Type:	Electrical motorized pan and tilt with electronic control.
Camera Types:	Color or day/night (NTSC/PAL); variety of zoom and features.
Input Voltage:	18-32 VAC.
Max. Current (@ 24 VAC):	Indoor: 1.4 A. Outdoor: 2.3 A.
Power Consumption:	Indoor: 34 W. Outdoor: 54 W.

VICONNET (IP)

Communication Hardware:	ViconNet Digital Video Management System.
LAN Interface:	100 MBPS, TCP/IP Unicast.
Number of Channels:	1, over LAN connection.
Video Quality:	ViconNet software quality 1-4, selectable on a 4-position bar with 2 compression level settings.

OPERATIONAL

Video Pan View:	360º.
Video Tilt View:	-2.5º to 92.5º.
Pan Speed:	Variable, 0.1 to 360º/sec (120º/sec in 22X).
Autopan Speed:	Variable, 0.1 to 42º/sec.
Tilt Speed:	Variable, 0.1 to 150º/sec (90º/sec in 22X).
Zoom/Focus Speed:	Less than 1.8 sec end to end.
Sectoring:	16 max, programmable.
Presets:	79, programmable.

SOFTWARE

Network Setup:	Standard network protocol type using IP addressing scheme and separate PC application software.
Site Authorization:	Camera dome can be setup using remote recorder or workstation.
Macro Create & Edit:	System macros can configured to use the dome's video.
Alarm Setup:	Can be triggered on video motion detection and loss.
Authentication:	Can be set to view the symbol A on displayed video.
Picture Quality and FPS Priority:	Can prioritize recorded picture quality and video FPS.

MECHANICAL

Dimensions:	Indoor Ceiling Diameter: 7.1 in. (180 mm). Height: 9.7 in. (246 mm). Indoor Pendant Diameter: 8.0 in. (203 mm). Height: 10.0 in. (254 mm). Outdoor Pendant Diameter: 9.0 in. (228 mm). Height: 10.3 in. (262 mm). Lower Dome Diameter: 5.9 in. (150 mm).

ENVIRONMENTAL

Operating Temperature:	Indoor: 32 to 132ºF (0 to 55ºC). Outdoor: -29 to 165ºF (-34 to 14ºC).
IP Rating:	Outdoor: IP66. Indoor Pendant: IP52. In-Ceiling: IP51

Vicon and its logo are registered trademarks of Vicon Industries Inc. Copyright© 2006 Vicon Industries Inc. All rights reserved. Vicon part number 8015-5094-00-02
Product specification subject to change without notice.

AMERICAN DYNAMICS™

DATA SHEET



SpeedDome® Ultra 8

Programmable Dome Camera

Features that make a difference:

- Two powerful series (22x and 35x optical zoom) let you choose the dome that's right for your application
- Powerful 35x optical zoom (ADSDU835) features 540 TVL and other advanced features for superior images
- Store presets and patterns within the base to eliminate reprogramming
- No fans ensure quiet operation and superior reliability
- Integrated Unshielded Twisted Pair (UTP) simplifies wiring and installation
- Covert design eliminates the need for an external bubble
- Innovative I/O base design simplifies installation
- Continuous autofocus provides the clearest images during full range of motion
- Dome usage statistics provide important information on how a dome is utilized
- Up to 8 privacy zones give you the flexibility to protect confidential areas or respect personnel privacy
- Advanced on-screen display with titles provides the detail you need to know exactly what you're looking at
- Supports SensorNet, RS-422, AD-UTC, Manchester and select manufacturers protocols[1]
- Supports NTCIP protocol, designed specifically for the transportation market
- 35x series offers Day/Night, Digital Slow Shutter (DSS) and Wide Dynamic Range (WDR) functionality to provide the flexibility to monitor any type of environment
- 35x series offers Electronic Image Stabilization (EIS) to reduce image blurriness when the mounted camera experiences movement

SpeedDome Ultra 8 (35x series)

The 35x series offers the highest performance with 540TVL, 35x optical zoom, WDR, day/night, DSS and EIS. The day/night and DSS features allow you to clearly see images in scenes as dim as 0.00041 lux. EIS reduces the vibration so the image can be viewed properly. This feature is especially useful when the dome is installed in places that subject it to shaking or moving, such as a pole next to a highway. These features combine to make the SpeedDome Ultra 8 series an ideal solution for outdoor applications requiring high resolution images whether up close, far away or for indoor applications requiring the best picture possible, such as in casinos or retail establishments.

SpeedDome Ultra 8 (22x series)

The 22x series delivers excellent color images in scenes as dim as .02 lux. Zoom ability consists of 22x optical and 11x digital zoom for 242x total zoom. Like the 35x series, the 22x offers advanced programmable features including DSS, automatic home position, dome usage statistics, privacy zones, advanced on-screen text, and freeze frame on presets to conserve digital recorder hard drive space. This series is well-suited for indoor applications requiring clarity, color and detail in well lit or low light conditions.

(1) Compatibility with other manufacturers is based upon known current protocols and controllers at time of test. However, compatibility may be affected if other manufacturers make changes to their products.

tyco / Fire & Security

features

Superior Video Images

SpeedDome Ultra 8 features powerful zoom capabilities with either 420x total zoom (35x optical zoom with 12x digital magnifier) or 242x total zoom (22x optical zoom with 11x digital magnifier).

The 35x series includes some of the industry's most powerful features including the innovative WDR capability which compensates for very bright and dark conditions within the same scene without losing image clarity. For low light applications, a removable infrared (IR) cut filter provides effective viewing in lighting conditions as low as .00041 lux in black and white mode.

The 35x series also includes the innovative EIS feature which reduces the effect vibration has so an image can be viewed properly. This feature is especially useful when the dome is installed in places that subject it to shaking or moving, such as a pole next to a highway.

Both the 22x and 35x series allow you to further compensate for low lighting conditions using DSS technology that allows the CCD imager to accumulate more light. Additional image adjustments include automatic gain control (AGC) and white balance.

Advanced Control and Positioning

SpeedDome Ultra 8 supports up to 96 preset positions[2] with user-defined titles and 16 preset sequences with a 10 minute dwell time for the ultimate in viewing flexibility. Sixteen patterns are supported and a preprogrammed default spiral pan pattern ("apple peel") covers the entire viewing area. Each pattern, which can be up to 10 minutes long, can store up to 99 PTZ commands. Using the Freeze Frame feature before moving to a preset minimizes hard drive usage when video is digitally recorded.

Alarms can be processed internally by the dome, externally by the controller or by both the dome and the controller. Each of the dome's alarm inputs can automatically call a preset or run a pattern when the alarm is activated.

To ensure key areas of a facility are continually monitored, an inactive or unattended dome can be configured to return to "home position" after it performs a pre-defined preset, sequence or pattern. When the dome tilts to its lower limits, an innovative automatic proportional flip feature automatically turns the dome 180°. Alternatively, you can manually flip the dome from the keyboard.

To protect sensitive areas, you can program up to 8 privacy zones of different sizes. These privacy zones automatically change size proportionally when zooming in or out.

Zoom adjusted programming (ZAP) automatically adjusts pan and tilt speeds in proportion to zoom position, even at maximum magnification.

In addition to SensorNet, Manchester, AD-UTC, NTCIP, SensorNet, and RS-422 protocols, the dome can be controlled via other select manufacturers' protocols[3] such as Pelco® P and Coaxitron, Panasonic® UTC and Vicon® RS-422, making it a perfect choice for customers wanting to replace older PTZs.

Powerful On-Screen Display

SpeedDome Ultra 8 generates helpful on-screen text including dome, preset, pattern, alarm and area names as well as direction indicators. These indicators show the direction the dome is currently pointing and the direction in which it is moving. For example, you can assign up to sixteen areas of various sizes to identify boundaries within different areas. In addition, the direction indicators display the dome's azimuth (degree of tilt).

On-screen text also indicates zoom, focus and iris status. All information is user-definable and can be turned on or off. When on, you can set the text to appear solid or translucent white, and with or without black outline which makes it easy to ensure the text is always visible, but doesn't block important parts of the image.

On-screen text supports six languages: English, French, Italian, Spanish, German and Portuguese.

Powerful Configuration and Maintenance

A convenient DirectSet feature provides fast access to all of your most frequently used dome features when used with a suitably equipped controller[4]. To ensure the integrity of your security settings, password protection prevents unauthorized use of the on-screen menus.

The following daisy chain configurations of control wiring are supported:

- RS-422: 10 domes over a maximum distance of 1 km (3000 ft) on two 22 AWG shielded twisted pairs (STP)
- For SensorNet: 32 devices over a maximum distance of 1 km (3000 ft) on one 22 AWG UTP
- For Manchester: 3 domes over a maximum distance of 1500 m (5000 ft) on one 18 AWG STP
- For AD-UTC: Maximum distance per dome is 700 m (2300 ft) on 20 AWG RG59U cable. (Note-This distance is for AD-UTC data only. See cable manufacturer's specifications for video capabilities).

Sensing of 50/60 Hz lines is automatic and does not require manual adjustment. The fully isolated power supply helps eliminate ground loops. Surge protection is provided for video, code, alarms and power connections.

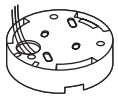
(2) Controller dependent, see Preset Table for details.
(3) Compatibility with other manufacturers is based upon known current protocols and controllers at time of test. However, compatibility may be affected if other manufacturers make changes to their products.
(4) A Matrix keyboard or a controller from which users can call DirectSet commands.

To ensure you have ample time to schedule maintenance, the dome maintains statistics on how long it has been on, duration of pan/tilt/zoom movements, number of presets selected and other usage information.

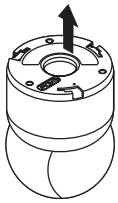
In the event that a camera needs to be changed, the new SpeedDome Ultra 8 I/O base now retains preset and pattern information so a user does not have to spend time reprogramming.

Ease of Installation

The dome incorporates an innovative twist lock release from the mounting base for easy installation and servicing. Power, communication and video cables (or composite cable) are connected at one time to an I/O PC board in the mounting base so the assembly is simply twist-locked onto the base. Service and maintenance are easy and can be accomplished without a ladder or lift via the installation/removal tool. The I/O board mounting base supports four alarm inputs and four alarm outputs (indoor only) as well as power and communication LEDs.



Mounting base with Integral I/O Board



Housing with Eyeball Assembly

Model Numbers

Housing /Eyeball Assembly without Mounting Base

ADSDU835N. . . . . .35x NTSC (black camera body)
ADSDU835WN . . . . . .35x NTSC (white camera body)
ADSDU835P. . . . . .35x PAL (black camera body)
ADSDU835WP . . . . . .35x PAL (white camera body)
ADSDU822N. . . . . .22x NTSC (black camera body)
ADSDU822WN . . . . . .22x NTSC (white camera body)
ADSDU822P. . . . . .22x PAL (black camera body)
ADSDU822WP . . . . . .22x PAL (white camera body)

Mounting Base without Housing/Eyeball Assembly

ADSDUIOB . . . . . .I/O Board Base (black base)
ADSDUIOBW . . . . . .I/O Board Base (white base)

Housing/Eyeball Assembly with Mounting Base

ADSDU835ION. . . . . .35x NTSC (black assembly and base)
ADSDU835WION . . . .35x NTSC (white assembly and base)
ADSDU835IOP . . . . . .35x PAL (black assembly and base)
ADSDU835WIOP . . . .35x PAL (white assembly and base)
ADSDU822ION. . . . . .22x NTSC (black assembly and base)
ADSDU822WION . . . .22x NTSC (white assembly and base)
ADSDU822IOP . . . . . .22x PAL (black assembly and base)
ADSDU822WIOP . . . .22x PAL (white assembly and base)

Options

Optional Bubbles for RHIUTH Top Hat Mount

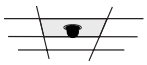
RUCLR . . . . . .Clear Bubble (f0)
RUSLV . . . . . .Silver Bubble (f2.0)
RUSMK. . . . . .Smoked Bubble
RUGLD . . . . . .Gold Bubble (f2.0)

Bubble Specifications

Bubble diameter . . . . .176 mm (6.93 in)
Bubble depth . . . . . .86.5 mm (3.4 in)
Bubble weight. . . . . .0.13 kg (4.4 oz) with trim ring

Dome Kit Model Numbers and What's Included

SpeedDome Ultra 8 domes can be ordered as pre-configured kits. A kit includes a camera module, base, mount and housing. Bubbles may be included as noted. Refer to the following chart for a description of the models included with each Dome Kit.

			35x Series Kits		22x Series Kits	
Mount or Housing Type		Kit Includes	NTSC	PAL	NTSC	PAL
	Indoor hard ceiling w/ no bubble	SpeedDome Ultra 8, RHIUTH and RHIUHC	ADSDU835IHN	ADSDU835IHP	ADSDU822IHN	ADSDU822IHP
	w/ smoked bubble	includes above and RUSMK	ADSDU835IHSN	ADSDU835IHSP	ADSDU822IHSN	ADSDU822IHSP
	Indoor 2' x 2' drop ceiling w/ no bubble	SpeedDome Ultra 8 and RHIU2X2M	ADSDU835I2X2N	ADSDU835I2X2P	ADSDU822I2X2N	ADSDU822I2X2P
	w/ smoked bubble	includes above and RUSMK	ADSDU835I2X2SN	ADSDU835I2X2SP	ADSDU822I2X2SN	ADSDU822I2X2SP
	Outdoor housing	SpeedDome Ultra 8 and ADSDUHOC	ADSDU835OPCN	ADSDU835OPCP	ADSDU822OPCN	ADSDU822OPCP
	Outdoor housing w/ long wall mount and end cap assembly	includes above and RHOLW	ADSDU835OPCWN	ADSDU835OPCWP	ADSDU822OPCWN	ADSDU822OPCWP

Number of Presets

Controller or Matrix Switcher	Protocol	Number of Presets
ADTT16E	SensorNet / RS-422*	96 /4
MegaPower LT	AD-UTC / SensorNet	96 /96
MegaPower 48 Plus	SensorNet / Manchester / RS-422	96 /64 /96
MegaPower 3200	Manchester** / RS-422***	64 /60
Intellex Digital Video Management Systems	SensorNet***** / RS-422****	96 /96
EDVR	RS-422 (Simplex)	10
Third Party interfaces	RS-485/RS-422	96

*Using SensorNet to RS-422 converter (model number RCSN422)
**Using Manchester code distributor (model number AD2091)
***Using RS-422 code distributor (model number AD2083-02C)
****Requires USB to RS-422 adaptor
*****Using USB CCTV Control Module (Model number ADACSNET)

AMERICAN DYNAMICS™

SPECIFICATIONS

	35x Series	22x Series
Camera		
Horizontal Resolution	540 lines	470 lines
Imager	Interline transfer 1/4-inch CCD array	Interline transfer 1/4-inch CCD array
Scanning System	2:1 interface	2:1 interface
Wide Dynamic Range, EIS, Day/Night	Yes	No
Video Output	1.0 Vp-p, 75 composite	1.0 Vp-p, 75 composite
tS/N Ratio	>50 dB (tyical)	>50 dB (tyical)
Minimum Illumination (20IRE, AGC)	0.24 lux (Color); 0.028 lux (Color with 1/4 sec open shutter) 0.021 lux (B/W IR Mode); 0.00041 lux (B/W IR Mode with 1/2 sec open shutter	0.3 lux (Color) 0.02 lux (Color with 1/4 sec open shutter)
White Balance	Through the Lens (TTL) Automatic Tracing White Balance (ATW)	Through the Lens (TTL) Automatic Tracing White Balance (ATW)
NTSC (PAL)		
Effective Pixels (H x V)	768 x 494 (752 x 582)	768 x 494 (752 x 582)
Scanning (lines/fields/frames)	525 /60 /30 (625 /50 /25)	525 /60 /30 (625 /50 /25)
Horizontal (kHz)	15.734 (15.625)	15.734 (15.625)
Vertical (Hz)	59.9 (50)	59.9 (50)
Shutter Speed (Auto/Manual)	1/2 - 1/30,000 (1/1.5 - 1/30,000)	1/2 - 1/30,000 (1/1.5 - 1/30,000)
Lens		
Aperture (Aspherical Design)	f1.4	f1.6
Focal Length	3.4 to 119 mm	4 to 88 mm
Wide Angle (field of view)	3.4 mm/55.8 (H) x 41.8 (V)	4 mm/47.0 (H) x 35.2 (V)
Telephoto (field of view)	119 mm/1.7 (H) x 1.3 (V)	88 mm/4.0 (H) x 3.0 (V)
Total/Optical/Digital Zoom	420x/35x/12x	242x/22x/11x

Common Specifications for SpeedDome Ultra 8

Operational	
Manual Pan/Tilt	0.25°-100° per second (based on zoom position)
Preset Pan/Tilt Speed	360° per second, maximum (Pan) and 220° per second, maximum (Tilt)
Pan Travel	360° continuous
Tilt Travel	110°
Pan/Tilt Accuracy	± 0.5°
Zoom/Focus Accuracy	± 0.5%
Programmable Patters/ Sequences/Areas/Privacy Zones	16/16/16/8
Direction Indicators	Yes
Auto Synchronizations	Line-Locked with Remote V-phase adjustment or Internal with Built-in sync generator
Address Range RS-422/RS-485 Manchester SensorNet AD-UTC	 1–99 1–64 1–255 Based on number of inputs
Alarm Inputs with I/O Board (indoor only)	4 dry contacts/3.5 mA sink
Alarm Outputs with I/O Board (indoor only)	3 open collector drivers at 12 VDC, 40mA
Menu Languages	English, French, German, Italian, Spanish, Portuguese
Electrical	
Input Voltage	18 to 30 VAC, 50/60 Hz Class 2 LPS
Design Tolerance	16 to 36 VAC, 50/60 Hz
Power	11 watts
Power On In-Rush Current	1.5 amps
Allowable Drop-Out	100 µsec
Surge Protection Video SensorNet/Manchester RS-422/RS-485 Alarm Input/Aux Outputs Power Line	 Low-capacitance Zener suppressor of 6.5 V, 1500 watts Isolation transformer coupled, 2000 Vrms; PTC resettable fuse protects transformer; 9.8V/1A, 500 watts, 8/20 µsec impulse; 10kA impulse rated gas tube TVS rated at 9.8V/1A, 500 watts, 8/20 µsec impulse TVS rated at 9.8V/1A, 500 watts, 8/20 µsec impulse TVS rated at 60 V, 250 A, 1.5 joules, 8/20 µsec impulse

Mechanical	
Height (includes base)	205 mm (8.0 in)
Diameter	120 mm (4.7 in)
Housing & Eyeball Weight	1.09 kg (2.40 lbs)
Base (with I/O Board) Weight	0.16 kg (0.35 lbs)
Environmental	
Operating Temperature	-10° to 50°C (14° to 122°F)
Humidity	0 to 95% RH (noncondensing)
Storage Temperature	-20° to 65°C (-4° to 149°F)
Regulatory VP SDU	
Emissions	FCC: 47 CFR Part 15 Subpart B Class A CE: EN55022 Class B CE: EN61000-3-2; 3-3 AS/NZS 3548, Class A CISPR22 ICES-003
Immunity	CE: EN50130-4
Safety	UL 1950 CSA 22.2 No. 950 EN60950-1 IEC60950-1

Product offerings and specifications are subject to change without notice. Actual products may vary from photos. Not all products include all features. Availability varies by region; contact your sales representative. Certain product names mentioned herein may be trade names and/or registered trademarks of other companies.

© 2007 Sensormatic Electronics Corporation. All rights reserved. AD0056-DS-200701-R01-LT-EN

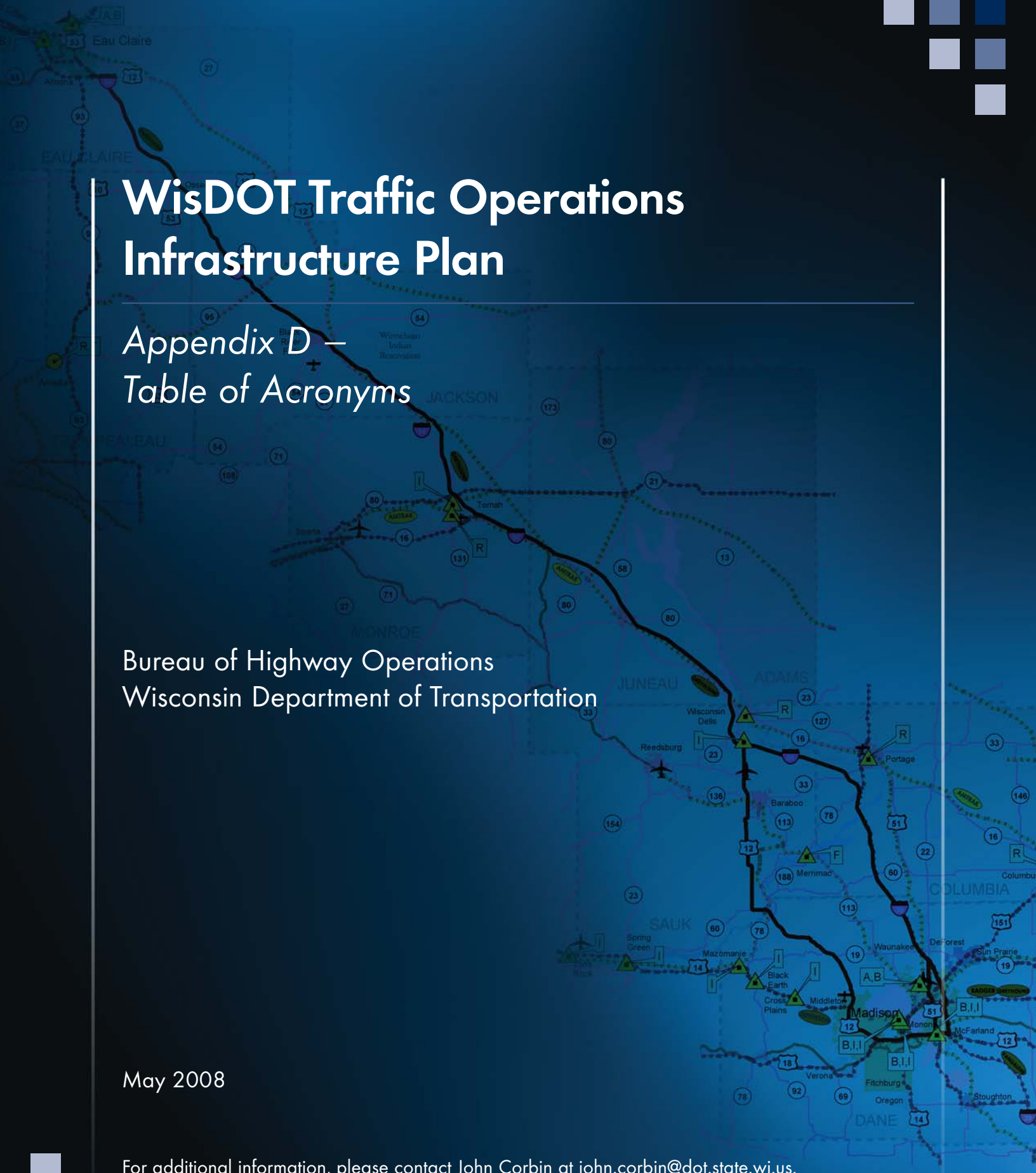
www.americandynamics.net

RoHS 2002/95/EC

tyco / Fire & Security

WisDOT Traffic Operations Infrastructure Plan

Appendix D –
Table of Acronyms



Bureau of Highway Operations
Wisconsin Department of Transportation

May 2008

For additional information, please contact John Corbin at john.corbin@dot.state.wi.us.

AASHTO	American Association of State Highway and Transportation Officials
AM	Amplitude Modulation
AMBER	American Missing Broadcast Emergency Response
API	Application Programming Interface
ATC	Advanced Traffic/Transportation Controller
ATMS	Advanced Traffic Management System
ATMS-Map	Advanced Traffic Management System Map
ATMS-Explorer	Advanced Traffic Management System Explorer
CalTrans	California Department of Transportation
CCTV	Closed Circuit Television
CMS	Changeable Message Sign
CMS	Construction Management System
CVO	Commercial Vehicle Operations
DMS	Dynamic Message Sign
DOT	Department of Transportation
DVD	Digital Video Disc or Digital Versatile Disc
DVR	Digital Video Recorder
EVP	Emergency Vehicle Preemption
FCC	Federal Communications Commission
FLIR	Forward Looking Infrared
FM	Frequency Modulation
FMS	Freeway Management System
FSO	Free Space Optics
GeoRSS	Geographically Encoded Objects for RSS
GIS	Geographic Information System
GPS	Global Positioning System
HAR	Highway Advisory Radio
HD	High Definition
ICTS	Integrated Corridor Test Segment
IMS	Incident Management System
IP	Internet Protocol
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
JAS	JamLogic Application Server
LAN	Local Area Network
LED	Light Emitting Diode
Mn/DOT	Minnesota Department of Transportation
MSRP	Manufacturer's Suggested Retail Price
MUTCD	Manual on Uniform Traffic Control Devices
NEMA	National Electrical Manufacturers Association
NTCIP	National Transportation Communications for ITS Protocol
NTSC	National Television System Committee
NYDOT	New York State Department of Transportation
PC	Personal Computer
PCMS	Portable Changeable Message Sign
PLC	Programmable Logic Controller

PTZ	Pan-Tilt-Zoom
RSS	Really Simple Syndication
RWIS	Road Weather Information System
SM	Scenario Manager
SSR	Spread Spectrum Radio
STOC	Statewide Traffic Operations Center
TCP/IP	Transmission Control Protocol/Internet Protocol
TCS	Traffic Control System
TIS	Traveler Information System
TMC	Traffic Management Center
TSS	Transportation Sensor System
UAV	Unmanned Aerial Vehicle
UDP/IP	User Datagram Protocol/Internet Protocol
USDOT	United States Department of Transportation
UWB	Ultra-Wideband
VCS	Video Control Subsystem
VME	Versa Module Eurocard
VMS	Variable Message Sign
VHF	Very High Frequency
WAP	Wireless Application Protocol
Wi-Fi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access
WisDOT	Wisconsin Department of Transportation
XML	eXtensible Markup Language