Mobile ITS hotspot trailers, an evolving technology

Presented By

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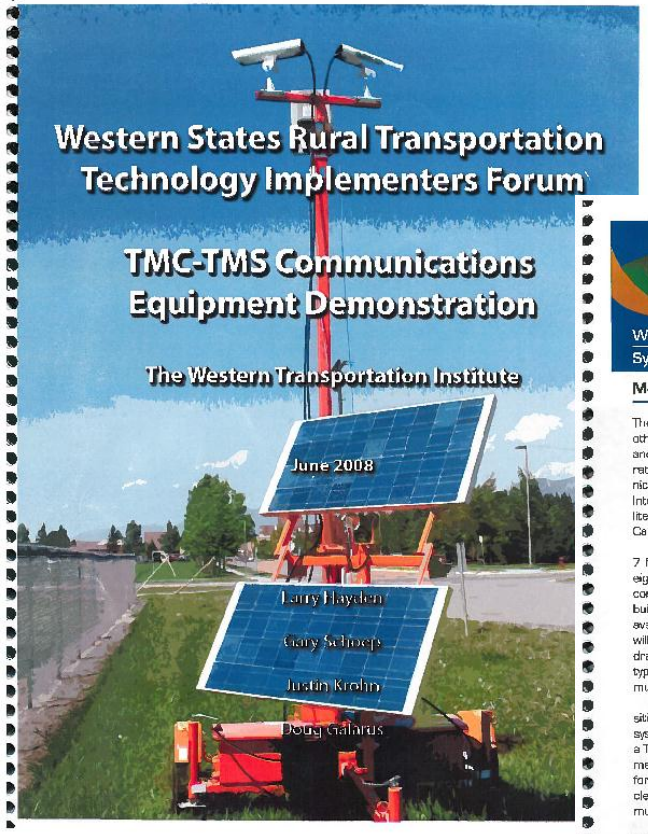
Traffic Operations Division

Nevada Department of Transportation

Mobile ITS hotspot trailers an evolving technology

- How a product discovered during this conference has made its way into NDOT's fleet
- How the "ITS Hotspot Trailers" were procured
- What makes up a Trailer
- The Evolution process
- What's new
- Live Demonstration

How a product discovered during this conference has made its way into NDOT's fleet



Western Transportation Institute
Systems Engineering Prototyping and Fabrication Laboratory

Mobile Traffic Monitor System Data Sheet

The Mobile Traffic Monitor System allows sensors and other ITS equipment to be deployed anywhere-anytime and be monitored remotely from the WTI TRAIL Laboratory. The system consists of trailers with communications equipment and a connection to the Internet. Internet connectivity is provided by Hughesnet satellite service, broadband cellular (EV-DO or 1xRTT) or a Canopy connection to the MSU campus network.

The trailer is approximately 11 feet long and 7 foot wide and has onboard power from a bank of eight 10B Ah batteries, solar panels, and a charge controller for remote deployment power source. A built in battery charger for "on grid" charging is also available in the cabinet. The fully charged battery bank will provide over 200 hours of power at a 50 watt draw without solar charging. (Fifty watts will power a typical CCTV, video server, router, and wireless communication system.)

The mast is 16 feet tall when in the vertical position and can be extended to 35 feet with the winch system. Cameras and/or a radio may be mounted on a T-cap which is bolted to the top of the mast. A radio may be mounted to the bottom section of the mast for simplicity or installed on the T-cap for achieving a clear "line of sight" over nearby obstructions for communications.

The Cohu camera outputs video by Ethernet in MPEG4 format. An optional Axis video encoder may be installed to send NTSC video over the IP based communication networks. The cabinet also houses a router which provides Ethernet connections, troubleshooting and WiFi capabilities for the IP based equipment. A microwave traffic counter can also be easily added to the system. An inverter provides 120VAC power for the system.

Solar power allows traffic sensors to be deployed anywhere-anytime needed.

Features:

- Configurable for Multiple Sensors
  - Cohu IP PTZ Color Camera
  - Autoscope AIS/Pro/Pro II
  - RTMS X3 (June 08)
- Multiple Wireless Communication Systems
  - Wireless LAN connectivity
    - Canopy (AP on campus for WAN connectivity)
    - WiMax
    - WiF (mobile hotspot)
    - WTI MeshBox (single 2.4 GHz OLSR radio)
  - WAN/Internet connectivity
    - Satellite
    - Broadband Cellular
- Adjustable Mast Height (16' to 35')
- Onboard 840 AH Battery Power
- 250 Watt Solar Charging Power

www.wti.montana.edu • 406.994.6114

Systems Engineering Prototyping and Fabrication Laboratory

Specifications:

Item	Manufacturer	Model
Trailer	CMJC Signal	Peri-Scope Jr (35' mast)
Batteries	Concorde Battery Corp.	Sun Xtender PVX-1080T
Solar Panels	Generic	120 Watt/panel
Solar Controller	BZ Products	MPPT250
Inverter	EXELTECH	XP250
Battery Charger	IOTA Engineering	DLS55
Cameras	Cohu	3945 IP Dome
	Ecrolite	Autoscope AIS/RackVision
Radios	Motorola	Canopy - 900 MHz
	Proxim	Tsunemi MP.11 5054-R
Cellular Modem	Sierra Wireless	Airlink Raven X
Router	LinkSys	WRT54GL
Serial to Ethernet Converter	Comtrol	DeviceMaster RTS 1-Port
Video Encoder	Axis Communications	Axis 241S
Microwave Sensor	EIS	RTMS

Mobile system can be deployed quickly and easily.

Trailer performing queue detection for traffic management before a campus sports event.

Funded by the University Transportation Centers Program of the Office of Research, Development and Technology Research & Innovative Technology Administration U.S. Department of Transportation and the MSU Civil Engineering Department. Ahmed AlKaisy.

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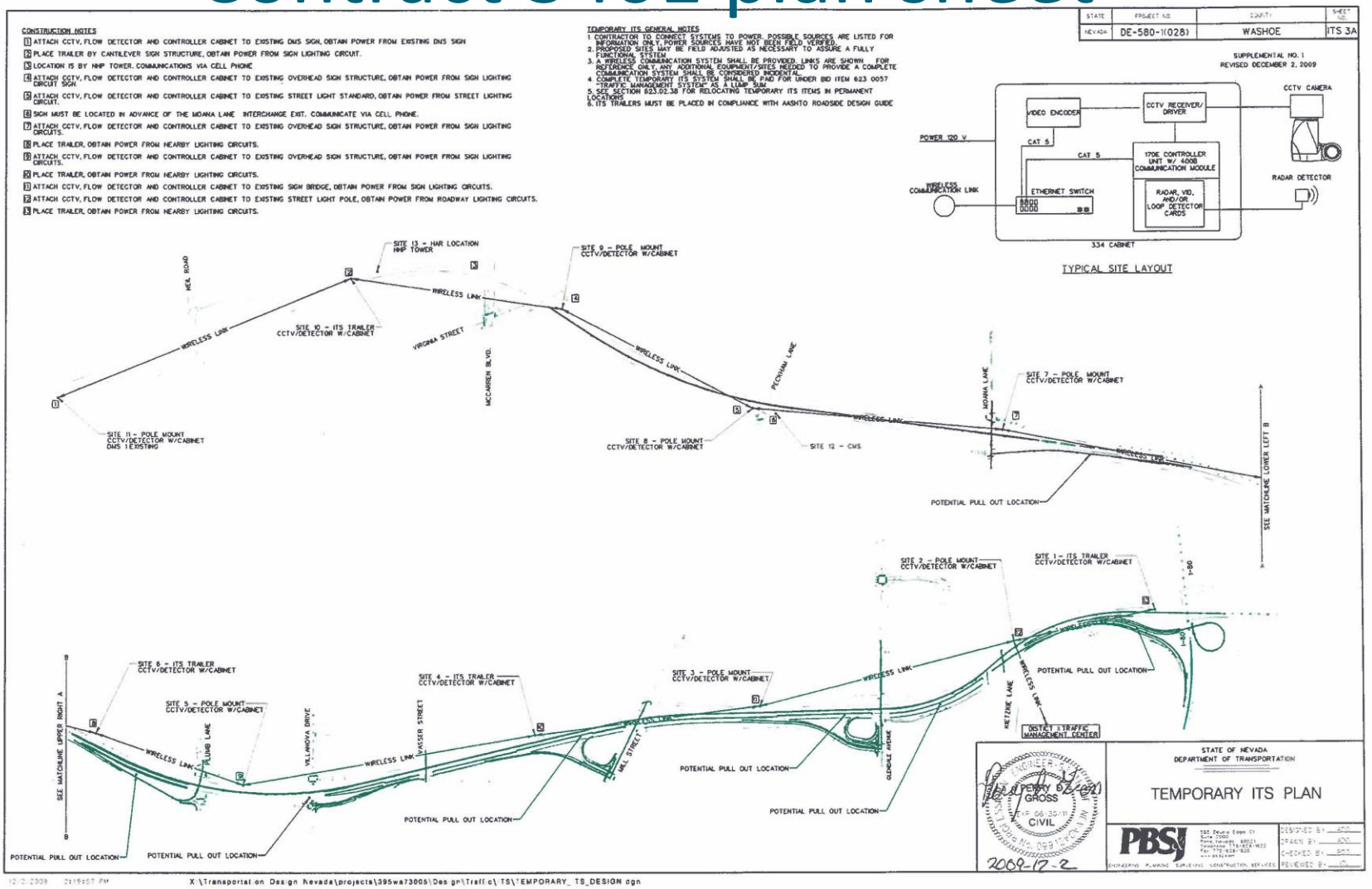
How a product discovered during this conference has made its way into NDOT's fleet

- After seeing the demonstration of WTI-MSU communications trailer in 2008, desired to use a similar trailer for "Work zone ITS"
- Seeing how a mobile platform could benefit the Department, we looked for opportunities to develop, purchase and deploy a mobile ITS hot spot trailer.
- The first opportunity came in 2009, on NDOT contract 3401, a major widening project on a high volume freeway in the heart of Reno. The traffic management plan would require a roadway with no shoulders and narrowed lanes in order to complete the widening contract. A Workzone ITS program became the solution to mitigate the affects on the motoring public.

How a product discovered during this conference has made its way into NDOT's fleet

- Portions of this workzone ITS project needed to be flexible and portable. Mobile hotspot trailers offered the Department the solution we were seeking.
- Being a last minute addition to the contract gave us approximately 2 weeks to develop a plan that was both constructible and flexible enough to not hinder construction of this contract and a second contract in the area.
- System had to be up and running before the general contractor could begin their work

Contract 3401 plan sheet



Contract 3401 Specifications

- The mobile hot spot trailers were included as part of a lump sum bid item for the complete workzone ITS system on a roadway widening project
- The ITS workzone required 11 ITS sites of which 4 sites were required to be on a mobile platform, these trailers were the end result of that requirement.
- The complete system had to be compatible with the Departments Central System Software.
- This included the CCTV camera system including the Video encoder
- This included the Flow detector system including the Wavetronix HD detector and 170E controller, *at the time of deployment a 170E controller was required in order operate on the system*
- Mobile units were required so they could be adjusted in the field as needed because of construction
- The units were turned over to the department at the conclusion of the construction project.

As used in contract 3401

- On AC power
- Solar panels and batteries removed to prevent theft
- Used Solectek Skyway Excel series radios for communications
- Easily relocated and adjusted

Cost of the trailers*

As ordered

Trailer	$18,000
Cabinet	$ 7,000
Camera	$ 4,000
Wavetronix HD	$ 6,000
Layer 2 switch	$ 2,500
Modem	$ 500
Misc	$ 4,000
Total	**$42,000**

Current configuration

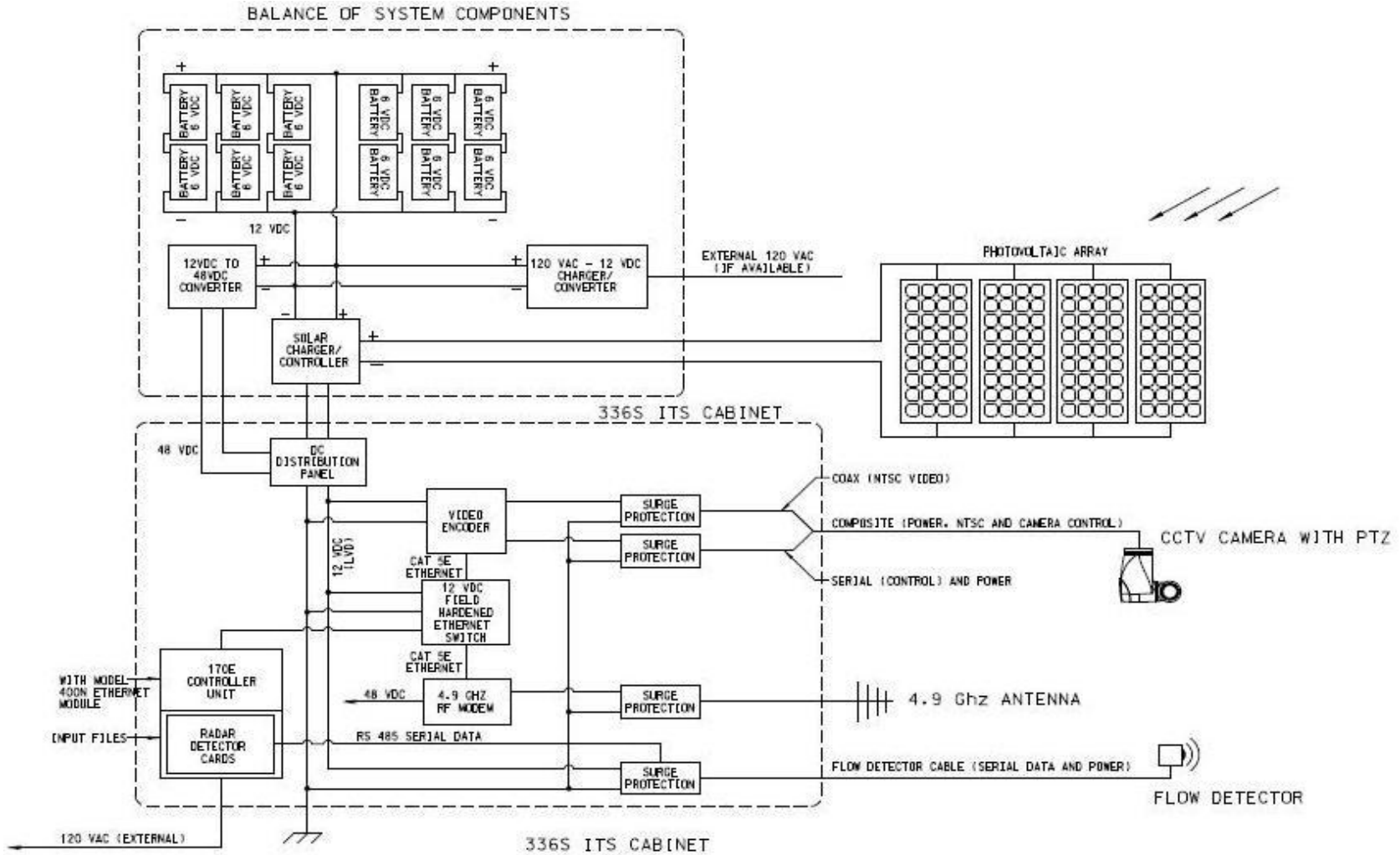
Trailer	$18,000
Cabinet (no 170E)	$ 5,000
Camera	$ 4,000
Wavetronix V	$ 3,000
Cell modem/router	$ 1,000
Misc	$ 4,000
Total	**$35,000**

*All costs are an approximate cost, actual cost included using them on a construction project for 18 months

Details on the “ITS Hotspot Trailers” As originally supplied

- “TRAFCON” TC2 PEP Series Trailer with 30’ mast
  - Manual mast with 360 degree rotation
  - Solar and Battery plant by trailer manufacture
- 336S controller cabinet
  - 170E Controller
- “Cohu” 3960 series camera
  - Factory modified to operate on 12vDC
  - Heater modified to better operate on solar
  - “Teleste” MPC-E1 Video Encoder
- “Wavetronix” 120 Flow Detector
- “Ruggedcom” RS900 series Switch
- Standard dial-up modem (Never installed)
- 4.9 GHz data radio

Block Diagram of Original Design



ITS MOBILE HOT SPOT BLOCK DIAGRAM
ORIGINAL CONFIGURATION

“TRAFCON”
TC2 PEP Series Portable Equipment Platform

- 30’ Equipment Mast
- (4) 123 Watt solar panels
- (12) 6 volt Deep Cycle Batteries
- 30 Watt solar controller
- 75 watt AC battery charger
- Battery Storage boxes

“Trafcon” Equipment Platform

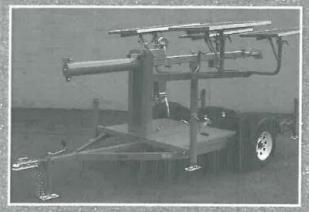
623 0057 -TMS
Portable trailer

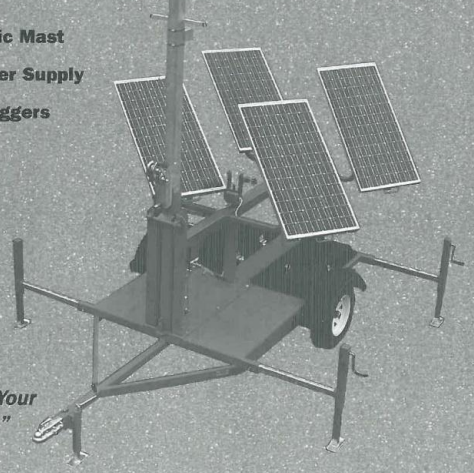
TRAFCON

TC2 PEP SERIES

Portable Equipment Platform, Solar Powered

- Galvanized Steel Mast
- 30 ft - 40 ft Masts
- Solar/Battery Power
- Adjustable Solar Array
- 360° Mast Rotation
- Trailer Mounted
- Manual or Electric Mast
- Customized Power Supply
- Extendable Outriggers





“We Custom Manufacture to Your Specifications”

TRAFCON INDUSTRIES INC.
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TRAFCON

TC2 PEP SERIES

Portable Equipment Platform, Solar Powered

STANDARD SPECIFICATIONS

TRAILER
Length - 14'
Width - 7'
Tongue - A-Frame
Frame - Heavy gauge steel tubing and structural channel
Battery Enclosure - Low density thermoplastic with lockable lid(s)
Fenders - Low density thermoplastic with splash shields
Safety Chains - 24" x 1/4" proof coil plated chain with hooks
Outriggers - (4) Extend 30" each from trailer frame
Leveling Jacks - (5) H.D. screw type jacks
Trailer Hitch - 2" ball or pintle ring
Axle - 2,000 lb. capacity
Springs - 3 leaf, double eye
Tires - 14" automotive type
Track Width - 71"
Weight - 1,400 lbs. to 1,800 lbs. (depending on specifications)
Paint - Safety Orange, Custom colors available

PEDESTAL
Pedestal - H.D. 6" diameter receiver tube
Tilt - 90° tilt and lock via 1,000 lb. manual winch
Rotation - 360° manual rotation

MAST
Height - 31' standard (extensions up to 40' available)
Material - H.D. Galvanized steel tubing
Segments - (3) at 10' each
Raise/Lower - 1,000 lb. manual winch (1,500 lb. electric winch available)

SOLAR CHARGING SYSTEM
- 50w-440w solar array available
- Solid state charge controller
- Low voltage disconnect
- Tilt and Rotatable solar panels

POWER SUPPLY/BATTERY
Batteries - 2 to 12 GC-2 deep cycle 6v available
Voltage - 12 VDC output
AC Charge - 30 Amp to 75 Amp chargers available

TRAFCON PRODUCTS DISTRIBUTED BY

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NEVADA DOT

Mobile Platforms Power source

“Safetran” Model 336S controller cabinet

170E Controller
(later removed)

Detector card racks
(later removed)

Power Distribution Assembly
(later removed)

19” Computer rack

Cabinet works well for mounting and storing equipment

“Safetran 336S Controller Cabinet

Safetran

623 0057 - TMS Traffic controller Type 170E Cabinet

Model 336S Cabinet Control System

Features

- Meets all Federal Highway Administration (FHWA) and Caltrans requirements
- Two doors (one front, one rear)
- Mounted on base, side of pole, or top of post
- Three-point locking system
- Suited for intersection controllers and accessories
- Cabinet diagnostic (optional)
- 0.125-inch thick aluminum

Description

The Model 336S cabinet system is a versatile modular design providing control of up to eight vehicle and four pedestrian phases. An optional configuration provides six additional load switch positions for use as overlaps, seven-wire interconnect outputs, or a variety of special function outputs.

The use of standard subassemblies, as defined by Caltrans and FHWA, assures interchangeability between manufacturers. All subassemblies are mounted in a removable 19-inch Electronic Industries Alliance (EIA) rack for ease of maintenance and are fully interchangeable with the Model 332, 336, 333SD, and 332D cabinets. The 336S can be base-mounted using an 8-inch high "M" base adapter. It can also be mounted on the side of the pole or the top of the post.

An ECONOLITE Group Company

Safetran

623 0603 Traffic controller, Type 170E

Model 170E Microcomputer/6800/68HC11

Features

- Multipurpose microcomputer:
  - Traffic control
  - Ramp metering
  - Sign control
  - Sprinkler control
- Meets or exceed the Caltrans requirements
- Accepts two plug-in communication modules
- Designed for ease of maintenance
- Low wattage, removable power supply
- HC11 CPU board option
- M170E board option

Description

The Model 170E Microcomputer is Safetran's most successful family of microcomputers and complies with all applicable Caltrans requirements. The model 170E incorporates the latest concepts in design for operation in hostile environments. The HC11 CPU can replace the 6800 CPU by simply removing the 6800 CPU board and sliding the new Model HC11 CPU into the same slot.

Applications

The Model 170E has been designed to manage virtually all traffic applications, from two-phase intersection control to computerized, networked systems. In addition, with the implementation of various software packages, the Model 170E has found applications in ramp-metering control, matrix sign control, sprinkler control, pump control, and changeable lane control.

Module Design

Mounted on a vertical plane to facilitate heat dissipation, all modules have been designed to increase reliability, reduce maintenance, and lower power consumption. A unique module and chassis design ensures proper positioning of each module. All modules may be extended for maintenance purposes, using extender cards.

An ECONOLITE Group Company

NEVADA DOT

336S Cabinet

A quick look inside the cabinet

Cohu 3960 “Iview” CCTV

Shown here in its travel case

Factory Modified to operate on 12volts DC

Heater modified to so camera could be operate on batteries

Operates on NDOT’s FAST protocol

“Cohu” Iview Model 3960

623 0057 - TMS
CCTV

COHU

3960 Series

i-view™ integrated positioner, camera & control

Striking, yet unobtrusive appearance

DSP technology for highest quality images day and night

Now with electronic image stabilization

8 or 16-point on-screen compass display, plus absolute position in degrees

High speed positioner can be operated inverted

A vertical tilt range greater than standard pan and tilts

Multi-manufacturer protocol control system for system-wide compatibility

i-view™ shown with optional wiper

- General Surveillance & Monitoring
- Traffic Management
- Access Control

www.cohu-cameras.com

i-view™ is fast becoming the new standard in high performance CCTV cameras and, with the addition of progressive new features, offers even more value and imaging advantages. This integrated camera/positioner provides what you can always expect from Cohu Electronics: quality, affordability, and style.

i-view™ has the right options and features to complete an individual site or a whole system.

Compass Setting and Display. Camera direction can be identified in 8 or 16 compass positions, with the ability to set the true north position. Plus, absolute scene position can be displayed in degrees, if desired.

Image stabilization. Two frequency operating modes provide stable, jitter-free video under adverse conditions.

Multi-protocol Control System. You can incorporate quality Cohu cameras into an existing control system from other major manufacturers. Traffic management professionals can install *i-view*™ today for immediate NTCIP 1205 compatibility.

Digital position feedback. Each *i-view*™ site can provide the precise camera and positioner data to system management software.

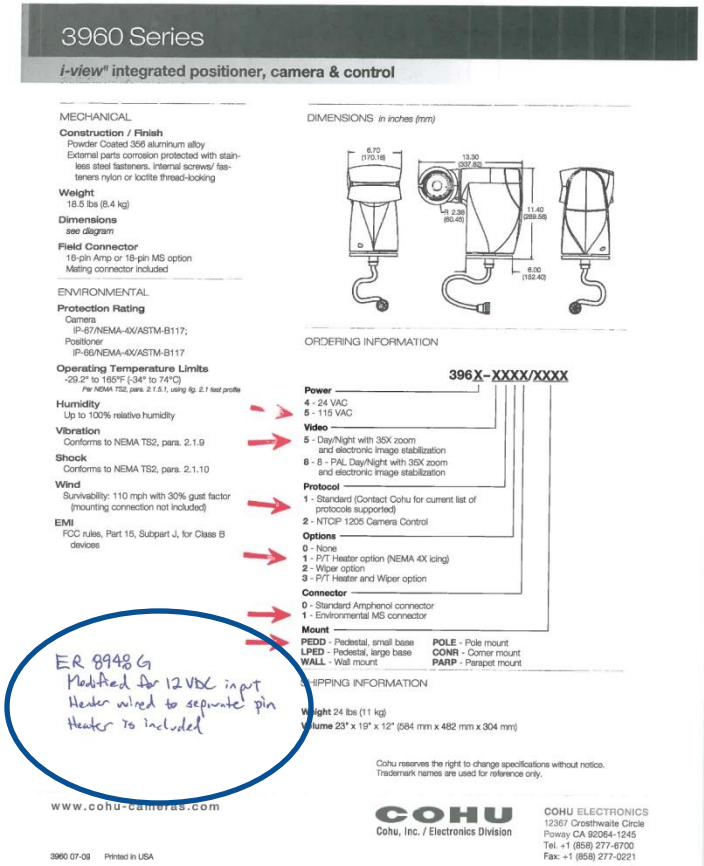
There is a wide range of DSP functions to support the particular camera site, including privacy zones, image manipulation and backlight control.

Higher standards. Cohu designed this next generation camera and positioning system to meet the technical objectives of security professionals.

The *i-view*™ contains a high performance color DSP camera with integrated lens, a built-in camera control receiver, and a pan/tilt mechanism that is both attractive yet unobtrusive. Its sleek design allows for quick and easy mounting, and is unassuming in any installation.

Because it's made by Cohu Electronics, the camera is protected by our legendary IP67 camera enclosure that protects your investment from the damaging effects of water, pollutants and corrosives.

Unlike ordinary sunshields, the *i-view*™ sunshield is pre-positioned and needs no adjustments — reducing installation costs and maximizing performance.



3960 Series

i-view™ integrated positioner, camera & control

MECHANICAL

Construction / Finish
Powder Coated 356 aluminum alloy
External parts corrosion protected with stainless steel fasteners. Internal screws/ fasteners nylon or loctite thread-locking

Weight
18.5 lbs (8.4 kg)

Dimensions
see diagram

Field Connector
18-pin Amp or 18-pin MS option
Mating connector included

ENVIRONMENTAL

Protection Rating
Camera
IP-67/NEMA-4X/ASTM-B117;
Positioner
IP-66/NEMA-4X/ASTM-B117

Operating Temperature Limits
-29.2° to 165°F (-34° to 74°C)
Per NEMA TS2, para. 2.1.5.1, using fig. 2.1 test profile

Humidity
Up to 100% relative humidity

Vibration
Conforms to NEMA TS2, para. 2.1.9

Shock
Conforms to NEMA TS2, para. 2.1.10

Wind
Survivability: 110 mph with 30% gust factor (mounting connection not included)

EMI
FCC rules, Part 15, Subpart J, for Class B devices

DIMENSIONS *in inches (mm)*

6.70 (170.18)
13.30 (337.82)
2.36 (60.45)
11.40 (289.56)
6.00 (152.40)

ORDERING INFORMATION

396X–XXXX/XXXX

Power
4 - 24 VAC
5 - 115 VAC

Video
5 - Day/Night with 35X zoom and electronic image stabilization
8 - PAL Day/Night with 35X zoom and electronic image stabilization

Protocol
1 - Standard (Contact Cohu for current list of protocols supported)
2 - NTCIP 1205 Camera Control

Options
0 - None
1 - P/T Heater option (NEMA 4X icing)
2 - Wiper option
3 - P/T Heater and Wiper option

Connector
0 - Standard Amphenol connector
1 - Environmental MS connector

Mount
PEDD - Pedestal, small base
LPED - Pedestal, large base
WALL - Wall mount
POLE - Pole mount
CONR - Corner mount
PARP - Parapet mount

SHIPPING INFORMATION

Weight 24 lbs (11 kg)
Volume 23" x 19" x 12" (584 mm x 482 mm x 304 mm)

ER 8948 G
Modified for 12 VDC input
Heater wired to separate pin
Heater is included

www.cohu-cameras.com

Cohu reserves the right to change specifications without notice. Trademark names are used for reference only.

COHU
Cohu, Inc. / Electronics Division

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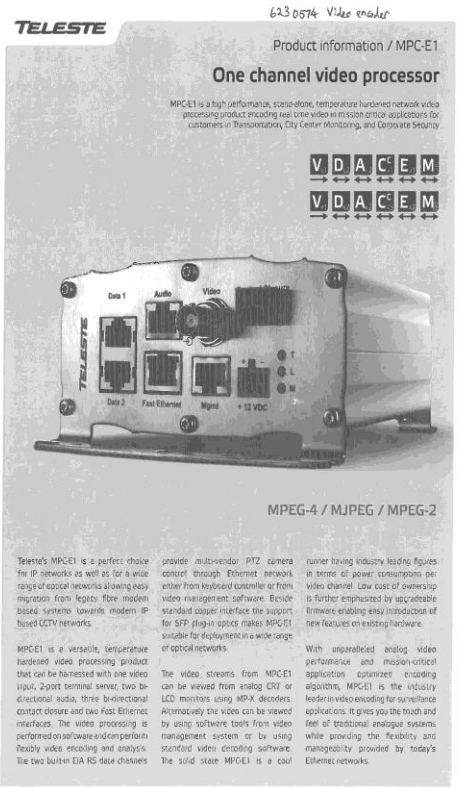
3960 07-09 Printed in USA


COHU

Video Encoder

"TELESTE" MPC-E1
MPEG-4 Format



623 0574 Video encoder

TELESTE

Product information / MPC-E1

One channel video processor

MPC-E1 is a high performance, stand-alone, temperature hardened network video processing product encoding real time video in mission critical applications for customers in Transportation, City Center Monitoring, and Corporate Security.

V.D.A.C.E.M

V.D.A.C.E.M

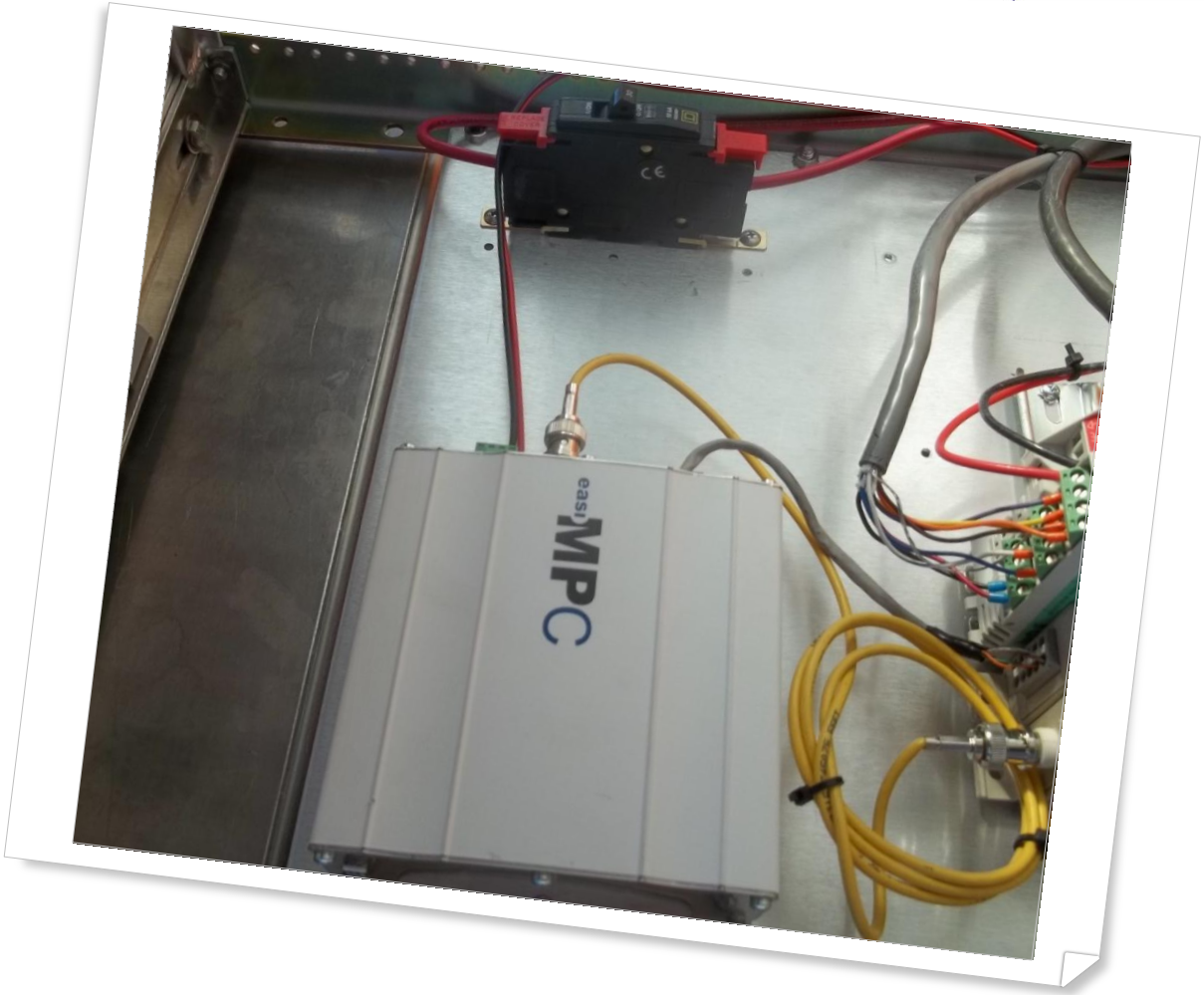
MPEG-4 / MJPEG / MPEG-2

Teleste's MPC-E1 is a perfect choice for IP networks as well as for a wide range of optical networks allowing easy migration from legacy fibre modem based systems towards modern IP based CCTV networks.

MPC-E1 is a versatile, temperature hardened video processing product that can be harnessed with one video input, 2port terminal server, two bi-directional audio, three bi-directional contact closure and two Fast Ethernet interfaces. The video processing is performed on software and can perform flexibly video encoding and analysis. The two built-in EIA RS data channels provide multi-vendor PTZ camera control through Ethernet network either from keyboard controller or from video management software. Beside standard copper interface the support for SFP plug-in optics makes MPC-E1 suitable for deployment in a wide range of optical networks.

The video streams from MPC-E1 can be viewed from analog CRT or LCD monitors using MP-X decoders. Alternatively the video can be viewed by using software tools from video management system or by using standard video decoding software. The solid state MPC-E1 is a cool runner having industry leading figures in terms of power consumptions per video channel. Low cost of ownership is further emphasized by upgradeable firmware enabling easy introduction of new features on existing hardware.

With unparalleled analog video performance and mission-critical application optimized encoding algorithm, MPC-E1 is the industry leader in video encoding for surveillance applications. It gives you the touch and feel of traditional analogue systems while providing the flexibility and manageability provided by today's Ethernet networks.



“Wavetronix” Flow Detector

Wavetronix HD 125
(Later replaced with a Smart sensor V)

System originally required a 170E controller, in order to work on NDOT’s central system software

Later software modifications allow for units to communicate via an IP connection.

Flow Detectors

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.

623 0576
Special detector
with Wavetronix

PRELIMINARY

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
- 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, headway, 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 by other radar sensors.

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 Speed Trap

Dual Radar determines vehicle speed by measuring the delay from one radar beam to the next. This also determines vehicle direction.

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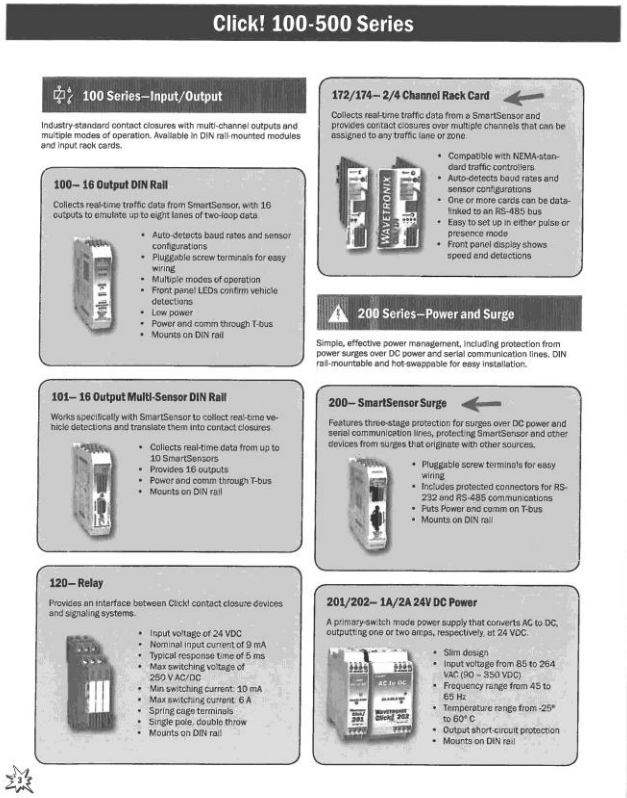
www.wavetronix.com

WAVETRONIX™



Click! 100-500 Series

100 Series—Input/Output

Industry-standard contact closures with multi-channel outputs and multiple modes of operation. Available in DIN rail-mounted modules and input rack cards.

100— 16 Output DIN Rail

Collects real-time traffic data from SmartSensor, with 16 outputs to emulate up to eight lanes of two-loop data

- Auto-detects baud rates and sensor configurations
- Pluggable screw terminals for easy wiring
- Multiple modes of operation
- Front panel LEDs confirm vehicle detections
- Low power
- Power and comm through T-bus
- Mounts on DIN rail

101— 16 Output Multi-Sensor DIN Rail

Works specifically with SmartSensor to collect real-time vehicle detections and translate them into contact closures

- Collects real-time data from up to 10 SmartSensors
- Provides 16 outputs
- Power and comm through T-bus
- Mounts on DIN rail

120— Relay

Provides an interface between Click! contact closure devices and signaling systems.

- Input voltage of 24 VDC
- Nominal input current of 9 mA
- Typical response time of 5 ms
- Max switching voltage of 250 V AC/DC
- Min switching current: 10 mA
- Max switching current: 6 A
- Spring cage terminals
- Single pole, double throw
- Mounts on DIN rail

172/174— 2/4 Channel Rack Card

Collects real-time traffic data from a SmartSensor and provides contact closures over multiple channels that can be assigned to any traffic lane or zone.

- Compatible with NEMA-standard traffic controllers
- Auto-detects baud rates and sensor configurations
- One or more cards can be daisy-linked to an RS-485 bus
- Easy to set up in either pulse or presence mode
- Front panel display shows speed and detections

200 Series—Power and Surge

Simple, effective power management, including protection from power surges over DC power and serial communication lines. DIN rail-mountable and hot-swappable for easy installation.

200— SmartSensor Surge

Features three-stage protection for surges over DC power and serial communication lines, protecting SmartSensor and other devices from surges that originate with other sources.

- Pluggable screw terminals for easy wiring
- Includes protected connectors for RS-232 and RS-485 communications
- Puts Power and comm on T-bus
- Mounts on DIN rail

201/202— 1A/2A 24V DC Power

A primary-switch mode power supply that converts AC to DC, outputting one or two amps, respectively, at 24 VDC.

- Slim design
- Input voltage from 85 to 264 VAC (90 – 350 VDC)
- Frequency range from 45 to 65 Hz
- Temperature range from -25° to 60° C
- Output short-circuit protection
- Mounts on DIN rail

NEVADA DOT

Unit was replaced with

Wavetronix SmartSenso
Model 125

High-definition, true ten-lane detection for traffic monitoring systems, even in s

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
- 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

380 South Technology Court
Lindon, UT 84042 USA
tel: (801) 764-0277 fax: (801) 764-0208
email: sales@wavetronix.com
www.wavetronix.com

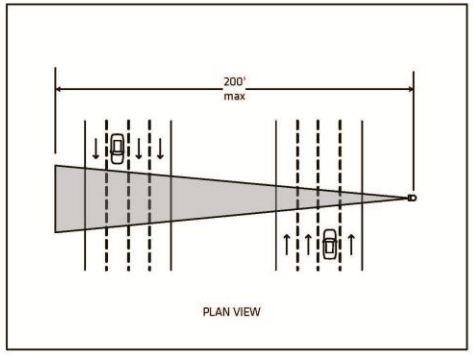
WAVETRONIX SmartSensor V

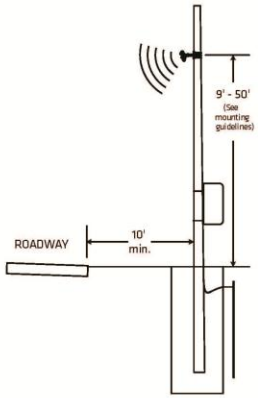
SmartSensor V

The SmartSensor™ V provides true eight-lane detection of vehicle volume, occupancy and speed using patented Digital Wave Radar™. Quick and easy to install, the SmartSensor V is the industry's first auto-configuring and auto-calibrating device.

Features

- Patented automatic configuration process
- Simple "ball park" alignment process
- Easy to install, easy to operate
- Integrates with Wavetronix Click products
- Patented Digital Wave Radar technology
- Works over barriers, medians and center guardrails
- Provides true eight-lane detection with a range of 200 ft. (61 m).
- Operates in side-fire or forward-fire installations
- All-weather and all-condition performance
- Onboard flash memory protects data storage
- Automated manufacturing process
- Remote accessible for easy management
- Flash upgradeable
- No performance variance due to temperature





WX-500-0205

0 Series

72/174— 2/4 Channel Rack Card

llects real-time traffic data from a SmartSensor and ovides contact closures over multiple channels that can be signed to any traffic lane or zone.

- Compatible with NEMA-standard traffic controllers
- Auto-detects baud rates and sensor configurations
- One or more cards can be data-linked to an RS-485 bus
- Easy to set up in either pulse or presence mode
- Front panel display shows speed and detections

200 Series—Power and Surge

, effective power management, including protection from surges over DC power and serial communication lines. DIN ountable and hot-swappable for easy installation.

0— SmartSensor Surge

tures three-stage protection for surges over DC power and ial communication lines, protecting SmartSensor and other ices from surges that originate with other sources.

- Pluggable screw terminals for easy wiring
- Includes protected connectors for RS-232 and RS-485 communications
- Puts Power and comm on T-bus
- Mounts on DIN rail

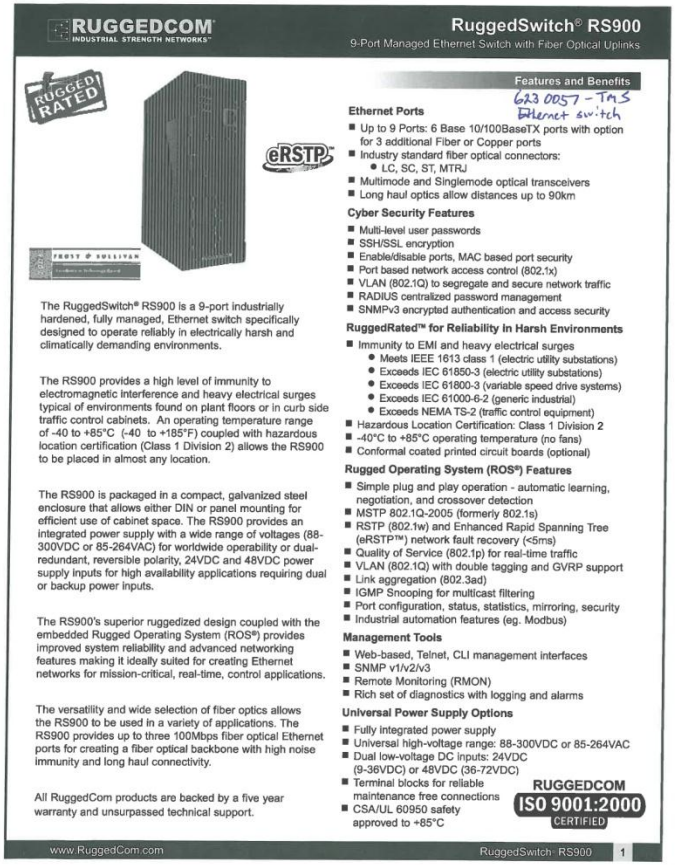
1/202— 1A/2A 24V DC Power

imary-switch mode power supply that converts AC to DC, putting one or two amps, respectively, at 24 VDC.

- Slim design
- Input voltage from 85 to 264 VAC (90 – 350 VDC)
- Frequency range from 45 to 65 Hz
- Temperature range from -25° to 60° C
- Output short-circuit protection
- Mounts on DIN rail

NEVADA DOT

Ethernet Switch



RUGGEDCOM
INDUSTRIAL STRENGTH NETWORKS

RuggedSwitch® RS900
9-Port Managed Ethernet Switch with Fiber Optical Uplinks

RUGGED RATED

eRSTP

FROST & SULLIVAN

The RuggedSwitch® RS900 is a 9-port industrially hardened, fully managed, Ethernet switch specifically designed to operate reliably in electrically harsh and climatically demanding environments.

The RS900 provides a high level of immunity to electromagnetic interference and heavy electrical surges typical of environments found on plant floors or in curb side traffic control cabinets. An operating temperature range of -40 to +85°C (-40 to +185°F) coupled with hazardous location certification (Class 1 Division 2) allows the RS900 to be placed in almost any location.

The RS900 is packaged in a compact, galvanized steel enclosure that allows either DIN or panel mounting for efficient use of cabinet space. The RS900 provides an integrated power supply with a wide range of voltages (88-300VDC or 85-264VAC) for worldwide operability or dual-redundant, reversible polarity, 24VDC and 48VDC power supply inputs for high availability applications requiring dual or backup power inputs.

The RS900's superior ruggedized design coupled with the embedded Rugged Operating System (ROS®) provides improved system reliability and advanced networking features making it ideally suited for creating Ethernet networks for mission-critical, real-time, control applications.

The versatility and wide selection of fiber optics allows the RS900 to be used in a variety of applications. The RS900 provides up to three 100Mbps fiber optical Ethernet ports for creating a fiber optical backbone with high noise immunity and long haul connectivity.

All RuggedCom products are backed by a five year warranty and unsurpassed technical support.

Features and Benefits

623 0057 - TMS Ethernet switch

Ethernet Ports
- Up to 9 Ports: 6 Base 10/100BaseTX ports with option for 3 additional Fiber or Copper ports
- Industry standard fiber optical connectors:
  - LC, SC, ST, MTRJ
- Multimode and Singlemode optical transceivers
- Long haul optics allow distances up to 90km

Cyber Security Features
- Multi-level user passwords
- SSH/SSL encryption
- Enable/disable ports, MAC based port security
- Port based network access control (802.1x)
- VLAN (802.1Q) to segregate and secure network traffic
- RADIUS centralized password management
- SNMPv3 encrypted authentication and access security

RuggedRated™ for Reliability in Harsh Environments
- Immunity to EMI and heavy electrical surges
  - Meets IEEE 1613 class 1 (electric utility substations)
  - Exceeds IEC 61850-3 (electric utility substations)
  - Exceeds IEC 61800-3 (variable speed drive systems)
  - Exceeds IEC 61000-6-2 (generic industrial)
  - Exceeds NEMA TS-2 (traffic control equipment)
- Hazardous Location Certification: Class 1 Division 2
- -40°C to +85°C operating temperature (no fans)
- Conformal coated printed circuit boards (optional)

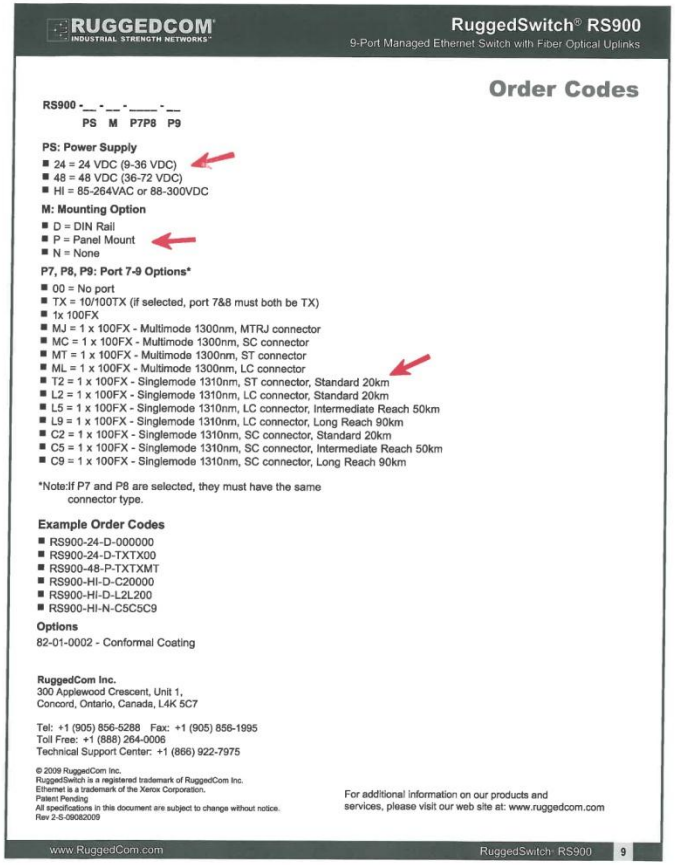
Rugged Operating System (ROS®) Features
- Simple plug and play operation - automatic learning, negotiation, and crossover detection
- MSTP 802.1Q-2005 (formerly 802.1s)
- RSTP (802.1w) and Enhanced Rapid Spanning Tree (eRSTP™) network fault recovery (<5ms)
- Quality of Service (802.1p) for real-time traffic
- VLAN (802.1Q) with double tagging and GVRP support
- Link aggregation (802.3ad)
- IGMP Snooping for multicast filtering
- Port configuration, status, statistics, mirroring, security
- Industrial automation features (eg. Modbus)

Management Tools
- Web-based, Telnet, CLI management interfaces
- SNMP v1/v2/v3
- Remote Monitoring (RMON)
- Rich set of diagnostics with logging and alarms

Universal Power Supply Options
- Fully integrated power supply
- Universal high-voltage range: 88-300VDC or 85-264VAC
- Dual low-voltage DC inputs: 24VDC (9-36VDC) or 48VDC (36-72VDC)
- Terminal blocks for reliable maintenance free connections
- CSA/UL 60950 safety approved to +85°C

RUGGEDCOM ISO 9001:2000 CERTIFIED

www.RuggedCom.com RuggedSwitch RS900 1



RUGGEDCOM
INDUSTRIAL STRENGTH NETWORKS

RuggedSwitch® RS900
9-Port Managed Ethernet Switch with Fiber Optical Uplinks

Order Codes

RS900 -__ - __ - ____ - __
PS M P7P8 P9

PS: Power Supply
- 24 = 24 VDC (9-36 VDC)
- 48 = 48 VDC (36-72 VDC)
- HI = 85-264VAC or 88-300VDC

M: Mounting Option
- D = DIN Rail
- P = Panel Mount
- N = None

P7, P8, P9: Port 7-9 Options*
- 00 = No port
- TX = 10/100TX (if selected, port 7&8 must both be TX)
- 1x 100FX
- MJ = 1 x 100FX - Multimode 1300nm, MTRJ connector
- MC = 1 x 100FX - Multimode 1300nm, SC connector
- MT = 1 x 100FX - Multimode 1300nm, ST connector
- ML = 1 x 100FX - Multimode 1300nm, LC connector
- T2 = 1 x 100FX - Singlemode 1310nm, ST connector, Standard 20km
- L2 = 1 x 100FX - Singlemode 1310nm, LC connector, Standard 20km
- L5 = 1 x 100FX - Singlemode 1310nm, LC connector, Intermediate Reach 50km
- L9 = 1 x 100FX - Singlemode 1310nm, LC connector, Long Reach 90km
- C2 = 1 x 100FX - Singlemode 1310nm, SC connector, Standard 20km
- C5 = 1 x 100FX - Singlemode 1310nm, SC connector, Intermediate Reach 50km
- C9 = 1 x 100FX - Singlemode 1310nm, SC connector, Long Reach 90km

*Note:If P7 and P8 are selected, they must have the same connector type.

Example Order Codes
- RS900-24-D-000000
- RS900-24-D-TXTX00
- RS900-48-P-TXTXMT
- RS900-HI-D-C20000
- RS900-HI-D-L2L200
- RS900-HI-N-C5C5C9

Options
82-01-0002 - Conformal Coating

RuggedCom Inc.
300 Applewood Crescent, Unit 1,
Concord, Ontario, Canada, L4K 5C7

Tel: +1 (905) 856-5288 Fax: +1 (905) 856-1995
Toll Free: +1 (888) 264-0006
Technical Support Center: +1 (866) 922-7975

For additional information on our products and services, please visit our web site at: www.ruggedcom.com

www.RuggedCom.com RuggedSwitch RS900 9

NEVADA DOT

Unit was replaced with

RUGGEDCOM
INDUSTRIAL STRENGTH NETWORKS

RUGGED RATED

eRSTP

The RuggedSwitch® RS900 is a 9-port industrially hardened, fully managed, Ethernet switch specifically designed to operate reliably in electrically harsh and climatically demanding environments.

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The versatility and wide selection of fiber optics allows the RS900 to be used in a variety of applications. The RS900 provides up to three 100Mbps fiber optical Ethen ports for creating a fiber optical backbone with high nois immunity and long haul connectivity.

All RuggedCom products are backed by a five year warranty and unsurpassed technical support.

www.RuggedCom.com

LAN-Cell™ 2

High-Performance 3G Cellular Router + VPN + Firewall

Front view with Card-Guard™ and optional external cellular antenna installed (right side)

The LAN-Cell 2 is a high-performance, rugged, upgradeable, enterprise-grade 3G cellular gateway that allows multiple PC's, laptops, web-cams, PLCs, POS terminals, ATMs and other Ethernet- and WiFi-based devices to simultaneously share a single cellular data account for primary or backup connectivity.

Building on the success of Proxicast's original LAN-Cell Mobile Gateway, the LAN-Cell 2 adds support for the latest 3G high-speed cellular technologies and dramatically expanded routing, security and management features.

The LAN-Cell 2 is the most advanced, secure and flexible 3G cellular router available. The LAN-Cell 2 protects your LAN equipment from Internet threats and gives you control over your cellular data connection in ways no other modem or router can.

Key Features

- **Uses standard 3G PC-Card modems (PCMCIA)** from popular manufacturers
- **Supports EV-DO RevA/Rev0, 1xRTT, HSUPA, HSDPA, UMTS, EDGE & GPRS cards**
- **User accessible PC-Card slot** - easily upgrade modems or change carriers
- **Compact rugged modular metal chassis** with Card-Guard™ and Card-Lock™
- **4 port 10/100 Ethernet LAN switch** with LAN / DMZ / WLAN configurable zones
- **Built-in WiFi** 802.11a/b/g access point
- **10/100 Ethernet WAN port:** DSL, cable or Ethernet for primary or backup
- **RS-232 port** for serial modem backup
- **Auto fail-over between cellular & WAN ports** - user selectable priority
- **IPSec-based VPN client** w/DES, 3DES, AES
- **Stateful Packet Inspection Firewall**
- **Cell-Sentry™ cellular data budgeting system** - manages cellular costs
- **Supports dynamic or static IP addresses** assigned by cellular carriers

RuggedSwitch® RS900
9-Port Managed Ethernet Switch with Fiber Optical Uplinks

Order Codes

Standard 20km
Standard 20km
Intermediate Reach 50km
Long Reach 90km
Standard 20km
Intermediate Reach 50km
Long Reach 90km

For additional information on our products and services, please visit our web site at: www.ruggedcom.com

RuggedSwitch RS900 9

Why the equipment was selected (General)

- The equipment had to work with our current Central System Software.
- Had to work on solar power.
- Procurement had to be open to many venders, but also work as a system.
- Most of the products used are the same as our permanent ITS installations.
- Performance requirements were used because the general contractor would be a roadway contractor, not a system integrator.

Why the equipment was selected (for Communications)

- Communications Equipment as specified
  - Standard Dial-up Modem
  - Wireless comm. In the 4.9Ghz band (used during construction)
- Communication Equipment final configuration
  - Proxicast cellular router/VPN/Firewall (all in one unit)
    - Pros of data cell
      - Ease of use
      - Available on most urban areas and across interstates
    - Cons of cell
      - Coverage not always available, spotty in rural areas and minor highways
  - Can be configured as a Wi-Fi hotspot
  - Proxicast router will allow for wireless radios to be connected if 3G service is not available.
  - Low power consumption
  - Modem is easily configured to work with the Departments firewalls

Solar Calculations

- Solar calculations for original design
  - 170E controller, flow detector not designed to operate on solar, would have made for a large and difficult platform to operate.
  - Designed to operate a CCTV camera, encoder, switch and basic 4.9 Mhz. radio.
- Recalculated with current configuration
  - allowed for operating Flow detector
  - CCTV, Encoder remained the same
  - Allowed for operating via cell modem

Solar Design Current Calculation (Original Design)

Worksheet #1 - Calculate the Loads (for each month or season as required)

Load Description	Quantity	Load Current	Load Voltage	DC Load Power	AC Load Power	Duty Cycle	Duty Cycle	Power Conv Eff	Nominal System Voltage	Amp-Hr Load
		A	Voltage	W	W	Hrs/Day	Days/Wk		V	AH/Day
CCTV Camera COHU	1	2.500	12	30.000		24.0	7	1.00	12	60.00
Video Encoder Teleste	1	0.383	12	4.600		24.0	7	1.00	12	9.20
Ethernet Switch	1	0.667	12	8.000		24.0	7	1.00	12	16.00
4.9 GHz Radio	1	0.400	48	19.200		24.0	7	0.90	12	42.67
Total Load Power				**61.8**	**0**				**Total Amp-Hr Load**	**127.87**

12 VDC to 48 VDC Converter efficiency

*Peak current draw is not used in calculations, but shown for proper sizing of solar controller load connection.

Total DC Load Power	Total AC Load Power	Nom System Voltage	Peak Current Draw	Total Amp-Hr Load	Wire Eff. Factor	Battery Eff. Factor	Corrected Amp-Hr Load
W	W	V	A	AH/Day			AH/Day
49.2	0	12	4.10	127.87	0.99	0.98	**131.80**

Solar Design Current Calculation (Original Design)

Worksheet #2 - Design Current and Array Tilt

System Location	Reno, NV	Latitude	39.50° N	Longitude	119.78° W
Insolation Location	Reno, NV	Latitude	39.50° N	Longitude	119.78° W

	Tilt at Latitude -15°			Tilt at Latitude			Tilt at Latitude +15°		
	Corrected Load	Peak Sun	Design Current	Corrected Load	Peak Sun	Design Current	Corrected Load	Peak Sun	Design Current
Month	AH/Day	Hrs/Day	A	AH/Day	Hrs/Day	A	AH/Day	Hrs/Day	A
Jan	131.80	3.60	36.61	131.80	4.10	32.15	131.80	4.40	29.95
Feb	131.80	4.40	29.95	131.80	4.90	26.90	131.80	5.10	25.84
Mar	131.80	5.50	23.96	131.80	5.70	23.12	131.80	5.60	23.54
Apr	131.80	6.50	20.28	131.80	6.40	20.59	131.80	5.90	22.34
May	131.80	7.10	18.56	131.80	6.60	19.97	131.80	5.80	22.72
Jun	131.80	7.40	17.81	131.80	6.80	19.38	131.80	5.80	22.72
Jul	131.80	7.70	17.12	131.80	7.10	18.56	131.80	6.10	21.61
Aug	131.80	7.40	17.81	131.80	7.10	18.56	131.80	6.40	20.59
Sep	131.80	6.80	19.38	131.80	6.90	19.10	131.80	6.70	19.67
Oct	131.80	5.60	23.54	131.80	6.10	21.61	131.80	6.20	21.26
Nov	131.80	3.90	33.79	131.80	4.40	29.95	131.80	4.60	28.65
Dec	131.80	3.30	39.94	131.80	3.90	33.79	131.80	4.20	31.38

Latitude -15	
Peak Sun	Design Current
Hrs/Day	A
3.30	39.94

Latitude	
Peak Sun	Design Current
Hrs/Day	A
3.90	33.79

Latitude +15	
Peak Sun	Design Current
Hrs/Day	A
4.20	31.38

Lat +15 deg	
Peak Sun	Design Current
Hrs/Day	A
4.20	**31.38**

Solar Battery Storage Calculation (Original Design)

Worksheet #3 - Calculate System Battery Size

Calculate Series Batteries:

Corrected Load	Storage Days	Max Discharge Depth	Derate for Temp.	Req'd Battery Capacity	Capacity of Sel. Battery	Batteries in Parallel
AH/Day	Day			Amp-Hrs	Amp-Hrs	#
131.80	7	0.8	0.9	1281.39	221	6

Nominal System Voltage	Nominal Battery Voltage	Batteries in Series	Batteries in Parallel	Total Batteries
V	V	#	#	#
12	6	2	6	12

Batteries in Parallel	Capacity of Sel. Battery	Req'd Battery Capacity	Max Discharge Depth	Usable Battery Capacity
#	Amp-Hrs	Amp-Hrs		Amp-Hrs
6	221	1326	0.8	1060.8

Make	Trojan		Weight:	59	kg
Model	GC2		C/Weight:	3.75	Ah/kg
Type	AGM		Length:	260	mm
Nom Voltage V	6	Volts	Width:	181	mm
Rated Capacity AH	221	AH	Height:	234	mm
Discharge rate	C/100		Discharge Current:	2.21	A

Solar PV Array Calculation (Original Design)

Worksheet #4 - Calculate System Array Size

Design Current	Module Derate Factor	Derated Design Current	Rated Module Current	Modules in Parallel
A		A	A	#
31.38	0.90	34.87	6.30	6

	Nominal Battery Voltage	Batteries in Series	Charge Voltage	Highest Temp Mod Volt	Modules in Series	Modules in Parallel	Total Modules	Total Area
	V	#	V	#	#	#	#	SQM
1.20	6.00	2	14.40	16.83	1	6	6	0.85

Modules in Series	Rated Module Voltage	Rated Array Voltage	Array Opn Circ Voltage
#	V	V	V
1	17.00	17.00	21.00

Modules in Parallel	Rated Module Current	Rated Array Current	Array Sht Circ Current
#	A	A	A
6	6.30	37.80	39.00

Modules	X	Price	=	Cost	/	Power	=	Cost/Kwh
#						Kwh		
6	X	$500	=	$3,000	/	11,554	=	$0.26

PV Module Specifications		
Make	Siemens	
Model	SM100	
Nom Volts	12.00	V
Length	1307.00	mm
Width	652.00	mm
Weight	11.50	kg
Thickness	5.50	mm
Bypass Diode	Y / N	Y
Pmax	100.00	W
Voc STC	-3.40E-03	V/°C
Vmpp	17.00	V
Voc	21.00	V
at High Temp	16.83	V
Isc STC	4.00E-04	A/°C
Impp	5.90	A
Isc	6.50	A
Impp/area	6.924	A/SQM
Cost	$500	Each
Cost/Watt	$5.00	Per Watt
Area	0.85	SQM
Power	117.35	W/SQM
Efficiency	11.73%	

NEVADA DOT

Solar Design Current Calculation

Worksheet #1 - Calculate the Loads (for each month or season as required)

Load Description	Quantity	Load Current	Load Voltage	DC Load Power	AC Load Power	Duty Cycle	Duty Cycle	Power Conv Eff	Nominal System Voltage	Amp-Hr Load
		A	Voltage	W	W	Hrs/Day	Days/Wk		V	AH/Day
CCTV Camera COHU	1	2.500	12	30.000		24.0	7	1.00	12	60.00
Video Encoder Teleste	1	0.383	12	4.600		24.0	7	1.00	12	9.20
3G Router/Modem	1	0.417	12	5.000		24.0	7	1.00	12	10.00
Flow Detector	1	0.625	12	7.500		24.0	7	1.00	12	15.00
Total Load Power				**47.1**	**0**				**Total Amp-Hr Load**	**94.20**

*Peak current draw is not used in calculations, but shown for proper sizing of solar controller load connection.

Total DC Load Power	Total AC Load Power	Nom System Voltage	Peak Current Draw	Total Amp-Hr Load	Wire Eff. Factor	Battery Eff. Factor	Corrected Amp-Hr Load
W	W	V	A	AH/Day			AH/Day
37.5	0	12	3.13	94.20	0.99	0.98	**97.09**

Solar Design Current Calculation

Worksheet #2 - Design Current and Array Tilt

System Location	Reno, NV	Latitude	39.50° N	Longitude	119.78° W
Insolation Location	Reno, NV	Latitude	39.50° N	Longitude	119.78° W

	Tilt at Latitude -15°			Tilt at Latitude			Tilt at Latitude +15°		
Month	Corrected Load AH/Day	Peak Sun Hrs/Day	Design Current A	Corrected Load AH/Day	Peak Sun Hrs/Day	Design Current A	Corrected Load AH/Day	Peak Sun Hrs/Day	Design Current A
Jan	97.09	3.60	26.97	97.09	4.10	23.68	97.09	4.40	22.07
Feb	97.09	4.40	22.07	97.09	4.90	19.81	97.09	5.10	19.04
Mar	97.09	5.50	17.65	97.09	5.70	17.03	97.09	5.60	17.34
Apr	97.09	6.50	14.94	97.09	6.40	15.17	97.09	5.90	16.46
May	97.09	7.10	13.67	97.09	6.60	14.71	97.09	5.80	16.74
Jun	97.09	7.40	13.12	97.09	6.80	14.28	97.09	5.80	16.74
Jul	97.09	7.70	12.61	97.09	7.10	13.67	97.09	6.10	15.92
Aug	97.09	7.40	13.12	97.09	7.10	13.67	97.09	6.40	15.17
Sep	97.09	6.80	14.28	97.09	6.90	14.07	97.09	6.70	14.49
Oct	97.09	5.60	17.34	97.09	6.10	15.92	97.09	6.20	15.66
Nov	97.09	3.90	24.89	97.09	4.40	22.07	97.09	4.60	21.11
Dec	97.09	3.30	29.42	97.09	3.90	24.89	97.09	4.20	23.12

Latitude -15	
Peak Sun	Design Current
Hrs/Day	A
3.30	29.42

Latitude	
Peak Sun	Design Current
Hrs/Day	A
3.90	24.89

Latitude +15	
Peak Sun	Design Current
Hrs/Day	A
4.20	23.12

Lat +15 deg	
Peak Sun	Design Current
Hrs/Day	A
4.20	**23.12**

Solar Battery Storage Calculation

Worksheet #3 - Calculate System Battery Size

Calculate Series Batteries:

Corrected Load	Storage Days	Max Discharge Depth	Derate for Temp.	Req'd Battery Capacity	Capacity of Sel. Battery	Batteries in Parallel
AH/Day	Day			Amp-Hrs	Amp-Hrs	#
97.09	9	0.8	0.9	1213.63	221	6

Nominal System Voltage	Nominal Battery Voltage	Batteries in Series	Batteries in Parallel	Total Batteries
V	V	#	#	#
12	6	2	6	12

Batteries in Parallel	Capacity of Sel. Battery	Req'd Battery Capacity	Max Discharge Depth	Usable Battery Capacity
#	Amp-Hrs	Amp-Hrs		Amp-Hrs
6	221	1326	0.8	1060.8

Make	Trojan		Weight:	59	kg
Model	GC2		C/Weight:	3.75	Ah/kg
Type	AGM		Length:	260	mm
Nom Voltage V	6	Volts	Width:	181	mm
Rated Capacity AH	221	AH	Height:	234	mm
Discharge rate	C/100		Discharge Current:	2.21	A

Solar PV Array Calculation

Worksheet #4 - Calculate System Array Size

Design Current	Module Derate Factor	Derated Design Current	Rated Module Current	Modules in Parallel
A		A	A	#
23.12	0.90	25.69	6.30	4

	Nominal Battery Voltage	Batteries in Series	Charge Voltage	Highest Temp Mod Volt	Modules in Series	Modules in Parallel	Total Modules	Total Area
	V	#	V	#	#	#	#	SQM
1.20	6.00	2	14.40	16.83	1	4	4	0.85

Modules in Series	Rated Module Voltage	Rated Array Voltage	Array Opn Circ Voltage
#	V	V	V
1	17.00	17.00	21.00

Modules in Parallel	Rated Module Current	Rated Array Current	Array Sht Circ Current
#	A	A	A
4	6.30	25.20	26.00

Modules	X	Price	=	Cost	/	Power	=	Cost/Kwh
#						Kwh		
4	X	$500	=	$2,000	/	8,511	=	$0.23

PV Module Specifications		
Make	Siemens	
Model	SM100	
Nom Volts	12.00	V
Length	1307.00	mm
Width	652.00	mm
Weight	11.50	kg
Thickness	5.50	mm
Bypass Diode	Y / N	Y
Pmax	100.00	W
Voc STC	-3.40E-03	V/°C
Vmpp	17.00	V
Voc	21.00	V
at High Temp	16.83	V
Isc STC	4.00E-04	A/°C
Impp	5.90	A
Isc	6.50	A
Impp/area	6.924	A/SQM
Cost	$500	Each
Cost/Watt	$5.00	Per Watt
Area	0.85	SQM
Power	117.35	W/SQM
Efficiency	11.73%	

NEVADA DOT

Solar Calculations summary

- Original design supplied 7 days of battery storage, but would only allowed for operations of a CCTV camera.
- Platform is limited in size in order to remain easily deployable and reasonable to maintain.
- Updated equipment allows the system to operate for 9 days with little to no sun using the existing solar equipment
- Future enhancements such as a maximum power point tracking controller (MPPT) may allow for a more efficient system
- Enough Amp hours are available to add additional equipment could be added.

The Evolution Process

- As with any technology type system, changes happen.
- We had the 170E controller that was used with the flow detector and corresponding racks removed, the Departments Central System Software has been updated to communicate to the Flow Detector directly via IP using the RTMS protocol.
- We also have an IS Department who had a desire to boost security in the field and required us to install firewalls, This was achieved by adding a 3G modem with a built in router and firewall.

The 170E Controllers were removed

- At the start of the project the Central System Software (CSS) required a 170E controller and NDOT firmware to determine vehicle speed, volume and lane occupancy.
- With some major changes complete to the CSS, we could better utilize the equipment we had. The CSS now uses the RTMS protocol via IP.
- Removing the 170E controller allows for better battery life and less equipment to maintain

Flow Detectors were changed

- The Wavetronix's HD125 units were changed out to the smaller Wavetronix's Smart sensor V
- As part of changing from a contact closure system using a 170E controller and NDOT firmware to using the RTMS protocol via IP caused some issues in how travel times are computed. The units were swapped as part of a test.
- The Wavetronix Smart sensor V was more than adequate for duty on the trailer

New Communications equipment

- A standard dial up modem was originally required in the contract, working with our contractor during the final delivery of the trailers that modem was deleted and a new cell modem was purchased.
- A Proxicast LAN Cell 2 wireless router/VPN/Firewall was selected because of its ability to work with NDOT's newly installed firewall.
- This system also worked as a Layer 2 switch which solved our problem of using the switches on the construction project, deleting a change order to the contract
- System is more power efficient, which is great for solar applications like this.

New Communications equipment

LAN-Cell™ 2

High-Performance
3G Cellular Router +
VPN + Firewall

The LAN-Cell 2 is a high-performance, rugged, upgradeable, enterprise-grade 3G cellular gateway that allows multiple PC's, laptops, web-cams, PLCs, POS terminals, ATMs and other Ethernet- and WiFi-based devices to simultaneously share a single cellular data account for primary or backup connectivity.

Building on the success of Proxicast's original LAN-Cell Mobile Gateway, the LAN-Cell 2 adds support for the latest 3G high-speed cellular technologies and dramatically expanded routing, security and management features.

The LAN-Cell 2 is the most advanced, secure and flexible 3G cellular router available. The LAN-Cell 2 protects your LAN equipment from Internet threats and gives you control over your cellular data connection in ways no other modem or router can.

Key Features

- **Uses standard 3G PC-Card modems (PCMCIA)** from popular manufacturers
- **Supports EV-DO RevA/Rev0, 1xRTT, HSUPA, HSDPA, UMTS, EDGE & GPRS cards**
- **User accessible PC-Card slot** - easily upgrade modems or change carriers
- **Compact rugged modular metal chassis** with Card-Guard™ and Card-Lock™
- **4 port 10/100 Ethernet LAN switch** with LAN / DMZ / WLAN configurable zones
- **Built-in WiFi** 802.11a/b/g access point
- **10/100 Ethernet WAN port:** DSL, cable or Ethernet for primary or backup
- **RS-232 port** for serial modem backup
- **Auto fail-over between cellular & WAN ports** - user selectable priority
- **IPSec-based VPN client** w/DES, 3DES, AES
- **Stateful Packet Inspection Firewall**
- **Cell-Sentry™ cellular data budgeting system** - manages cellular costs
- **Supports dynamic or static IP addresses** assigned by cellular carriers

proxicast®

LAN-Cell™ 2 3G Cellular Gateway

Hardware Specifications

Physical
- Dimensions:
  Main Unit:
  8.66" L x 5.38" D x 1.25" H
  (220mm x 137mm x 32mm)
  With Card-Guard:
  11.25" L x 5.38" D x 1.25" H
  (286mm x 137mm x 32mm)
- Weight: 2.4 lbs (1.09 kg) - with power supply & Card-Guard
- Rugged 19 gauge steel enclosure
- Includes side-attached mounting brackets for mobile and fixed installations

Power
- 12 VDC - 1200 ma max (vehicle & solar power compatible)
- Includes auto switching 120-240 VAC to 12 VDC power supply (global plug kit optional)
- 2.1 mm jack (positive center pin)
- Power consumption: 5W (typical), 8W (max)

Environmental
- Operating Temperature: -22 to 140 F (-30 to 60 C)
- Operating Humidity: 0% to 92% (non-condensing)

I/O Connections
- (4) 10/100 Mbps Ethernet LAN switch ports (auto-negotiate / auto MDI /MDIX)
- (1) 10/100 Mbps Ethernet WAN port (auto-negotiate / auto MDI/MDIX)
- (1) RS-232 (RJ45) serial modem port - 230Kbps max (RJ45 to DB9 cable included)
- (1) RS-232 (RJ45) serial configuration port (RJ45 to DB9 cable included)
- (1) SMA Reverse Polarity Male WiFi 802.11a/b/g antenna connector (antenna included)
- (1) Bulkhead antenna connector hole (external pigtail antenna connector optional)

PC-Card Modems Supported

The LAN-Cell 2 supports a wide-range of 3G PC-Card modems and technologies:
- CDMA: EV-DO Rev A, Rev 0, 1xRTT
- GSM: HSDPA, HSUPA, EDGE, GPRS
- WCDMA: UMTS

See the Proxicast web site for a list of the specific 3G PC-Card modems currently supported. Support for addtional PC-Card modems will be included in free future firmware upgrades.

Wireless LAN
- IEEE 802.11a/b/g compliant access point built-in
- 64/128/152 bit WEP encryption
- MAC Filtering
- IEEE 802.1x (EAP-MD5/TLS/TTLS/PEAP)
- WPA/WPA-PSK/WPA2/WPA2-PSK
- Configurable power output (70mw max)

Software Specifications

Cellular WAN Management
- Auto-failover routing between Ethernet, Cellular and Serial (user selectable routing priority)
- Auto-connect on demand or stay connected 7x24 with "always-on" feature
- ICMP heartbeat (ping continuity) monitor to ensure persistent connections
- Configurable load balancing between WAN interfaces
- MAC address access control list
- Traffic redirect to an external device for high-availability applications
- Bandwidth utilization and bandwidth throttling controls
- Cell-Sentry™ cellular data budgeting system - helps manage cellular costs

Virtual Private Networks
- IPSec-compliant VPN
- 8 Simultaneous VPN connections
- DES, 3DES, AES encryption
- Local User Database or RADIUS server for Extended Authentication
- LAN-Cell initiated/terminated IPSec VPNs and VPN client pass-through
- IPSec NAT Traversal + Keep-alive packet support
- Redundant VPN connection (VPN HA)
- Manual key, IKE and PKI (X.509)
- Wizard based VPN set up
- Interoperable with standard IPSec-based VPN products (e.g. Cisco, SonicWall, Juniper, WatchGuard, NetScreen, etc.)

Firewall
- Stateful Packet Inspection (SPI) firewall
- Packet Filter
- Denial of Service protection
- Attack Alerts & Logs
- Access Control by type of service

Security & Certificates
- Digital Certificates - X.509, PKCS#7 & PKCS#12
- Local & Remote Certificate Authority
- Supports SCEP/CMP with CA & RA auto-enrollment

IP & Routing
- DHCP client & server
- Multi-NAT / SUA / port translation and port-forwarding
- IP Routing: UDP, TCP, ICMP, ARP, RIP V1 and RIP V2
- IP Multicast
- Programmable static routes
- Policy-based routing and traffic shaping
- Application level priority for bandwidth sensitive applications such as VoIP
- Configurable LAN / DMZ / WLAN zones
- IP Alias (3 VLANs)
- Dynamic DNS support (DDNS)

Device Management
- Web-based configuration utility (HTTP or HTTPS)
- Terminal-based configuration utility (telnet or SSH)
- User upgradable firmware via LAN, WAN or serial and over-the air cellular
- FTP/TFTP for firmware upgrade & configuration backup/restore
- SNMP support
- Command line interface for advanced configuration
- Remote management from LAN & WAN
- User selectable IP port assignments for each management utility
- Detailed event logging & packet tracing with Syslog and E-Mail log/alert support

General Product Information

Regulatory Certifications
- EMC: FCC Part 15 Class B, CE-EMC Class B, C-Tick Class B, VCCI Class B
- Safety: CSA International, CE EN60950-1 (UL60950-1, CSA60950-1, EN60950-1, IEC60950-1)
- Green Product, RoHS compliant

Standard Items Included
- LAN-Cell 2 cellular router unit
- Card-Guard modular card protection cover
- 120-240 VAC power supply
- Ethernet cable
- Serial cable
- Console cable
- WiFi antenna
- Mounting hardware
- Cable ties for Card-Lock
- Quick Start Guide
- Documentation & Support CD-ROM
- One year limited warranty

Optional Items - Sold Separately
- PC-Card cellular modem cards
- External cellular antennas and accessories
- PC-Card to "pig-tail" cables
- International power plug kit
- Vehicle power adapter

Your Authorized Proxicast Reseller Is:

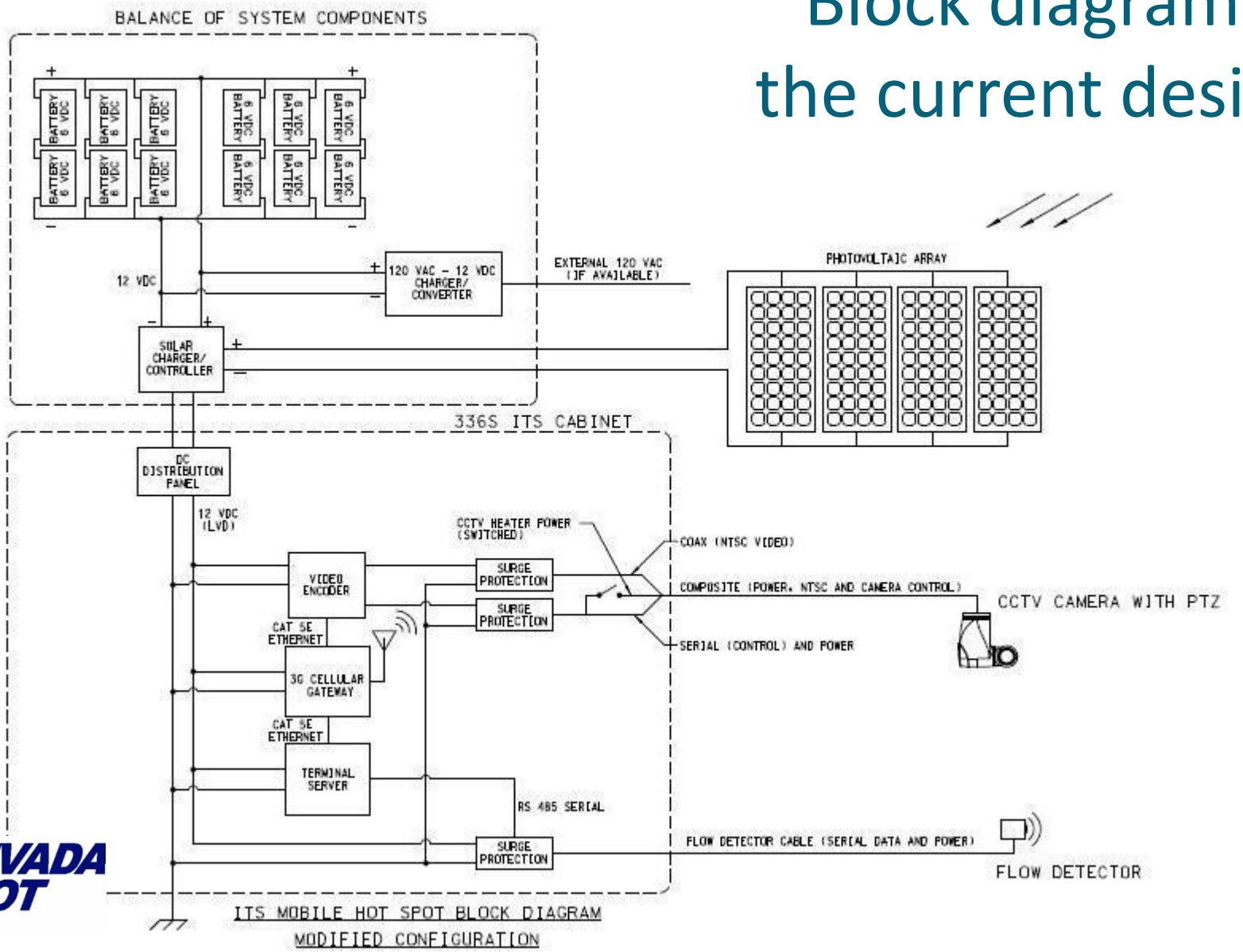
Proxicast, LLC
312 Sunnyfield Drive, Suite 200
Glenshaw, PA 15116-1936 USA

1-877-77PROXI
(1-877-777-7694)
Outside U.S. 1-412-213-2477

www.proxicast.com
Email: sales@proxicast.com

NEVADA DOT

Block diagram of the current design



Details on the “ITS Hotspot Trailers” as currently configured

- “TRAFCON” TC2 PEP Series Trailer with 30’ mast
  - Manual mast with 360 degree rotation
  - Solar and Battery plant by trailer manufacture
- 336S controller cabinet
- “Cohu” 3960 series camera
  - Factory modified to operate on 12vDC
  - Heater modified so camera can operate on solar
  - “Teleste” MPC-E1 Video Encoder
- “Wavetronix” 105V Flow Detector
- “Proxicast cellular router, VPN, firewall

How NDOT plans to use its new Fleet

- Special Events, both urban and rural
  - Burning Man Event
  - NASCAR Race in Las Vegas
- Testing locations for future ITS devices
  - Allows for better placement of future ITS devices
  - Allows for easy adjustment of permanent device
- Rapid deployment to an area of concern (Trouble spots)
  - Verify a problem exists
  - Verify improvements are having the desired effect on the motoring public
- Incident Management
  - For long term incidents like natural disasters
  - Weather related events (advanced planning required)

Lessons Learned

- Communications
  - Would have required cell modem,
  - Having a line of site radio system requires lots of work to redeploy
- Acceptance testing
  - Would require acceptance testing of the final trailers
  - Trailers were required to be delivered to the department after the construction project was complete, no additional testing was required
- Cohu Cameras are very power hungry and not the best fit for a solar platform
  - Would use a camera that is better suited for solar applications
- Better research on available equipment
  - Hard to develop and insert a solid performance specification in short order.

Future Enhancements
4G Proxicast Router/VPN/Firewall

- + 4G will allow for better streaming of Video
- + inexpensive
- + works with our current systems
- - 4G not available in rural areas

Future Enhancements
Axis Camera

- + CCTV camera is more efficient (power usage).
- + inexpensive
- +NDOT's CSS now supports protocol
- Also have fixed cameras
- - not great for night vision

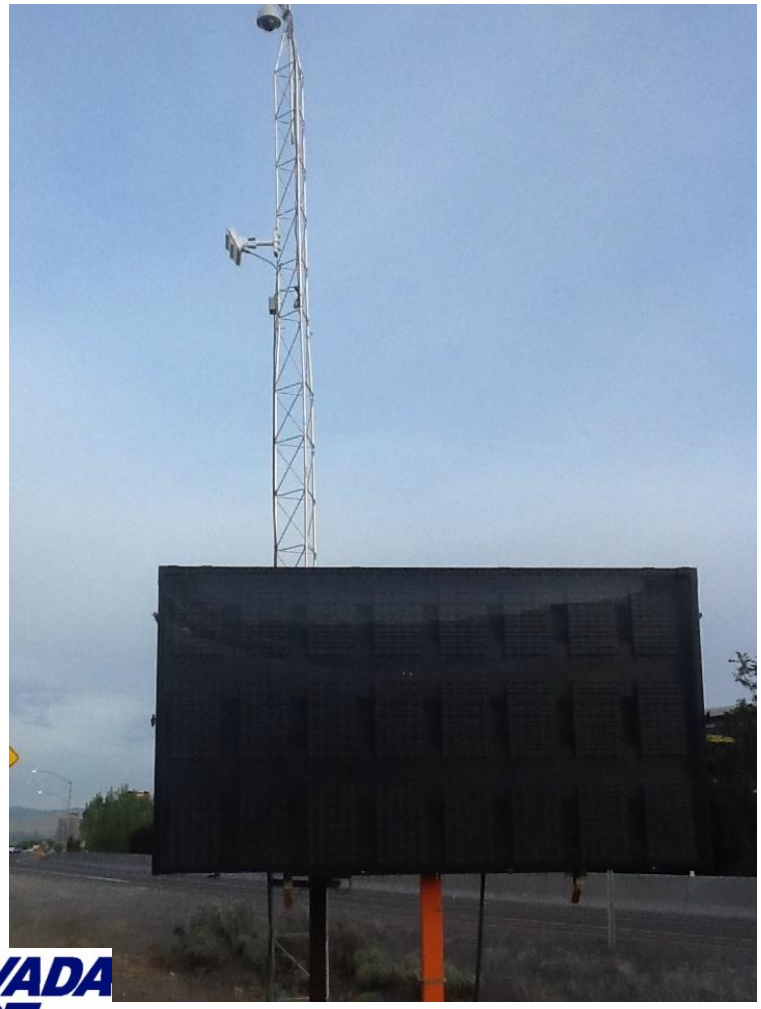
How the Idea of a Mobile ITS platform has evolved in Nevada

- (2) New RWIS/CCTV/Flow detector Trailers powered via Solar panels with battery storage and communicating via a Data Modem (currently 3G)
- (4) New Mobile Hotspot ITS trailers with an LED Changeable Message Sign, 30’ tower, CCTV camera, Flow detector, all powered via Solar panels with Battery storage and communicating via a Data Modem (currently 3G)

Mobile RWIS, CCTV, Flow Detector Sites

Deployed on the new I-580 bridge in Washoe Valley

ITS mobile Hot Spot Trailer w/CMS



CCTV, Flow Detector and CMS, Solar Power

Live Demo

Thank you

Any Questions?

For additional information contact
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Nevada Department of Transportation, Traffic Operations
1263 S. Stewart St Carson City, NV 89712
775-888-7560 or 775-888-7665