

**PROPRIETARY-MATERIAL-USE  
PUBLIC-INTEREST FINDING**

*PROGRAMMATIC APPROVAL*

PROGRAMMATIC APPROVAL PERIOD: July 1, 2016 – June 30, 2019

FHWA OVERSIGHT: YES  NO

**PROPRIETARY MATERIAL:**

Sensys Networks, Inc.  
Sensys Wireless Vehicle Detection System

Background

The Sensys Wireless Vehicle Detection System received programmatic approval on May 16, 2012 for a two year term. It was renewed for another two year term that ends on June 30, 2016.

Product Selection

Recurring special provision 805-T-173 contains specifications for wireless vehicle detection, which is a common alternative to inductive vehicle detection loops at signalized intersections. The Sensys Wireless Vehicle Detection System is a useful alternative to the conventional method in the following situations:

- An inductive loop design will not function well due to limitations such as right-of-way, geometrics, pavement conditions, obstructed conduit paths, etc.
- A full inductive loop design has been considered and there is significant post-design life cycle cost advantage to using a full wireless vehicle detection system.
- A hybrid design using inductive loops at the stop line and wireless detectors for the advance vehicle detection and the hybrid design is the most cost effective, based on post-design life cycle cost.
- Temporary use at a temporary traffic signal or at a permanent traffic signal until such time as other vehicle detection methods can be installed.

Designers will have to submit a completed Wireless Vehicle Detection System Justification Form, when specifying wireless vehicle detection on a particular project. A copy of this Form is attached as Appendix A.

Product Components

The Sensys Wireless Vehicle Detection System includes all of the components necessary for a complete installation, including:

- FlexConnect – Access Point Series
- Flex Control
- Flex Isolator

- Master (CC) and Expansion (EX) Cards
- Flex Repeater and Flex Solar Repeaters
- VSN240-T-2 Sensor
- VSN240-F-2 Sensor
- VSN240-T-GR Sensor
- VSN240-F-GR Sensor

#### Product History

The Sensys Wireless Vehicle Detection System is listed on INDOT's Approved Materials List for Traffic Signal Control Equipment under the counting vehicle detectors section. The ability to count vehicles and communicate this data is important if a vehicle detection device is to be a true alternative to traditional inductive vehicle detection loops.

#### Project Compatibility

The product desired would be compatible with many traffic signal installation and traffic signal modernization projects throughout the State. The product would be intended for use at all traffic signal projects when its advantages outweigh its disadvantages.

#### Product Availability

The product desired is the only product of its type that is currently on the INDOT's Approved Materials List. INDOT is in the process of evaluating a second manufacturer's product, the Trafficware Valonce Pod, but the evaluation will likely not be completed until later this year. And while having two manufacturers would provide for more competitive bidding, the device would still be considered proprietary until a third manufacturer comes along.

#### Product Cost

The most recent unit price summaries show an average unit price of \$877 each for a Wireless Magnetometer Detector (pay item 805-10107) and a total quantity statewide of 620 units. The conventional inductive loop may be more or less than this depending on the amount of conduit, saw cutting and signal cable necessary. For projects where the Wireless Vehicle Detection System would be less expensive, the designer will show this in the project file, a copy of the justification form is attached as Appendix A.

#### Maintenance

The product has some maintenance costs associated with it, as the batteries in the sensors must be replaced every ten years. However, the inductive loops also require periodic maintenance because the conductor wires are susceptible to being torn over time by the pavement. Therefore, depending on pavement condition, the maintenance work for wireless vehicle detectors can be less expensive and it has the advantage of being easier to schedule since it is known when the batteries will need to be replaced.

Product Alternatives – Summary Table

	Wireless Vehicle Detection Systems	Video Detection Systems	Microloop Detectors	Traditional Inductive Loops
Avoids using conduit to connect detectors with controller	Yes, the sensors are connected wirelessly	Yes, system installed on traffic signal mast arms	Yes, system bored underneath pavement	No, requires saw cutting for loops
High Accuracy Rate	Yes, meets <u>ITM 934</u>	No, see JTRP Report <u>2005-30</u>	Yes, meets <u>ITM 934</u>	Yes, meets <u>ITM 934</u>
Acceptable if pavement is in poor condition	Yes, the sensor is sealed in a 4" pavement core	Yes, system installed on traffic signal cantilever	Yes, detectors bored underneath pavement	No, cables can be cut by deteriorating pavement
Capable of Providing Vehicle Counts	Yes	Yes	Yes	Yes
Proprietary Item	Yes, <u>FlexMag Sensor</u> by Sensys Networks	No, multiple manufacturers	Yes, <u>Canoga</u> by GTT	No, multiple manufacturers

PREPARED BY:

Date: 5/26/2016

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Traffic Administration Engineer  
INDOT – Traffic Support Division  
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Based upon the above finding, the use of the proprietary material listed is in the public interest and is hereby approved.

APPROVED: James M. Peter  
Deputy Commissioner, Engineering  
& Asset Management, INDOT

Thomas Duncan  
Pavement & Materials Engineer,  
FHWA

Date: 6/03/2016

Date: 6/13/2016

APPENDIX A

WIRELESS VEHICLE DETECTION SYSTEM – JUSTIFICATION FORM

Intersection: \_\_\_\_\_

Des No: \_\_\_\_\_ Contract No: \_\_\_\_\_

A wireless vehicle detection system is needed at the intersection listed above for the following reason(s):

Check all that apply

- An inductive loop design will not function due to physical limitations described below

<b>Physical Limitations</b>
<input type="checkbox"/> Right-of-Way or Intersection Geometrics ( <i>attach aerial photo or intersection diagram</i> )
<input type="checkbox"/> Pavement Condition ( <i>attach pavement photos</i> )
<input type="checkbox"/> Obstructed Conduit Paths ( <i>attach intersection diagram</i> )
<input type="checkbox"/> Other: _____

- A full inductive loop design for vehicle detection has been evaluated and there is a post-design life cycle cost advantage, summarized below, to using a full wireless vehicle detection system

<b>Post-Design Life Cycle Cost Estimate for Full Loop Install</b>
Full Loop Installation Cost: _____
Signal Conduit Quantity: _____
Full Loop Maintenance Cost: _____
Full WVDS Installation Cost: _____
Full WVDS Maintenance Cost: _____

- A hybrid design using inductive loops at the stop line and wireless detectors for the advance vehicle detection is the most cost-effective vehicle detection method based post-design life cycle costs, as summarized below

<b>Post-Design Life Cycle Cost Estimate for Hybrid Install</b>
Full Loop Installation Cost: _____
Signal Conduit Quantity: _____
Full Loop Maintenance Cost: _____
Hybrid WVDS Installation Cost: _____
Hybrid WVDS Maintenance Cost: _____

- Temporary use

<b>Reason for Temporary Use</b>
<input type="checkbox"/> Temporary Traffic Signal
<input type="checkbox"/> Permanent Traffic Signal _____ <i>(enter timeframe needed)</i>

RECOMMENDED:

APPROVED:

Name: \_\_\_\_\_  
Title: \_\_\_\_\_

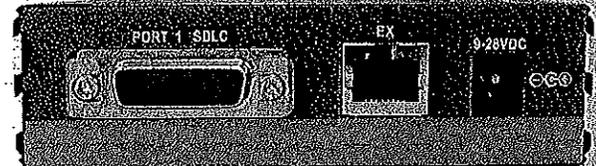
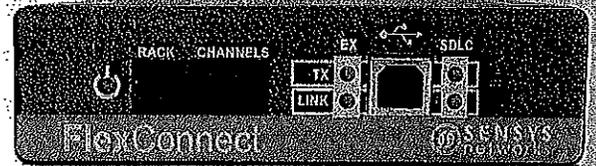
Name: \_\_\_\_\_  
District Traffic Engineer

Date: \_\_\_\_\_  
Copies To:  
Project Manager  
Highway Design & Tech Support Office

## FlexConnect

**Sensys Networks FlexConnect** is a stand-alone unit that provides an SDLC interface to TS2 controllers\* for APCCs and Access Points (AP240-S†). FlexConnect replaces the functionality of the EX cards. This reduces system costs and the need for additional card slots for expansion cards and multiple racks in controller cabinets.

FlexConnect connects to the EX port on the APCC or the CC card (for the AP240-S†). FlexConnect conforms to the Port 1 interface communications and indicator requirements specified in the NEMA TS2-2003 standard. FlexConnect is powered through the 9-28VDC barrel connector or the USB port. The front panel display shows the channel status of the 64 channels arranged as four racks of 16 channels each. Racks can be independently enabled or disabled. TrafficDOT is used to configure the channels and download firmware updates.



### Functions / Features

**Directly connects an APCC or CC card to a TS2 controller via the SDLC link**

- Eliminates the need for EX cards and additional card slots in the cabinet.
- Adheres to NEMA Standard TS2-2003 requirements: 8.6.1, 8.6.2.

**FlexConnect is programmable via TrafficDOT**

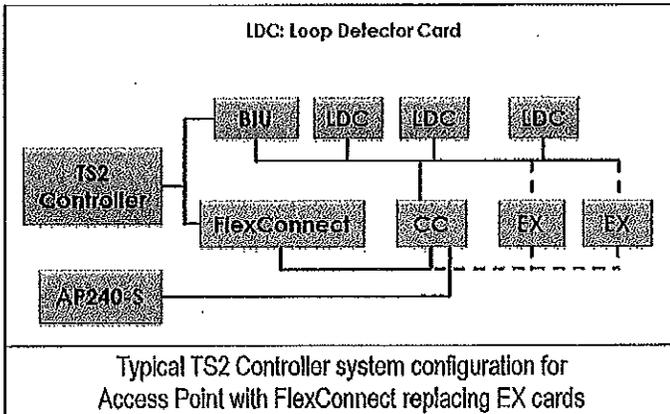
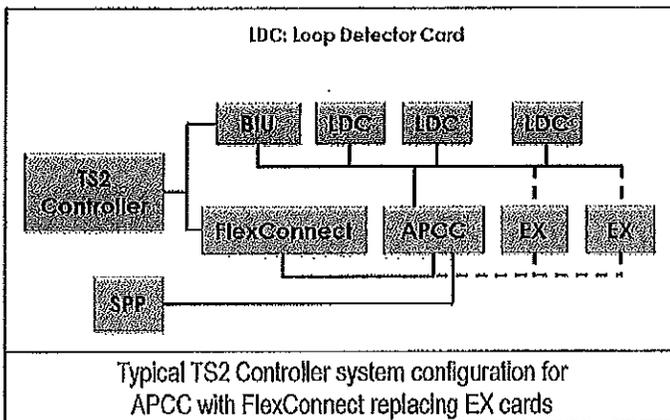
- Utilizes the same configuration interface as CC and EX cards.
- All current CC and EX card configuration options are supported.
- FlexConnect supports a total of 64 channels.

### Simple Installation

- Mounts in traffic cabinet with DIN mount or bracket mount. Mounting kit supplied with module.

### Software Compatibility

- AP firmware v1.8.9 or later.
- APCC firmware v2.10.3 or later.
- TrafficDOT software v2.12.2 or later.



\* And other controllers that support Port 1 SDLC connections

† And variants of AP240-S series

### Front Panel

power LED indicator	for unit power
TX LED indicators	for SDLC and EX port connections
Link LED indicators	for SDLC and EX port connections
channel LED display	rack number indicator and 16 channel status states: call, no call, recall, disabled
push button	for rack number selection and rack enable/ disable
USB B connector	USB port connection to APCC for SDLC monitor data and debug data and power

### Back Panel

power connector	to cabinet power adapter or terminal blocks
DB15 connector	SDLC link to TS2 controller
RJ45 connector	connection to EX port

### Power, Physical, & Environmental

input voltage	<ul style="list-style-type: none"> <li>• 9-28 VDC (24 VDC nominal): 5.5 mm x 2.1 mm barrel power connector, or</li> <li>• 5 VDC nominal USB port</li> </ul>
power consumption	less than 300 mW
dimensions	4.3" x 3.5" x 1.2" (10.9 cm x 8.8 cm x 3 cm) without mount
weight	7.8 oz (221.1 g) without mount
operating temp	industrial -40°C to 80°C
mounting	DIN or cabinet mount

### Available Products

Order Code	Description
FLEX-CONN-M	FlexConnect (DIN and bracket mounting kit included).
FLEX-CONN-ACC-1	FlexConnect Y-Cable: Splitter cable (0.5'/3') to connect FLEX-CONN-M to used SDLC port.
FLEX-CONN-ACC-2	FlexConnect Power Cord (6'): Cord to connect FlexConnect with cabinet power terminal blocks.
FLEX-CONN-ACC-3	FlexConnect Power Supply (60W, 12V): Industrial rated cabinet power adapter with cords (6' AC/4' DC)
FLEX-CONN-ACC-4	FlexConnect Straight Cable (3'): Thru cable to connect FLEX-CONN-M to spare SDLC port.

### Compliance

safety	2006/95/EC
EMC	<ul style="list-style-type: none"> <li>• FCC: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.</li> <li>• 2004/108/EC</li> <li>• IC: This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.</li> <li>• IC : Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.</li> </ul>

**Local Distributor**

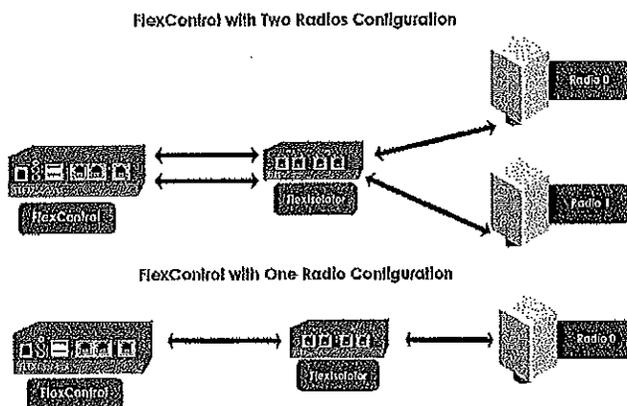
## FlexControl

The Sensys Networks FlexControl is a compact module that controls the components of the Sensys Networks Wireless Vehicle Detection System (VDS). It maintains two-way wireless links to the sensors and repeaters, establishes overall time synchronization, transmits configuration commands and message acknowledgements, and receives and processes data from the sensors. The FlexControl then relays the sensor detection data to a roadside traffic controller or remote server traffic management system. The FlexControl provides equivalent functionality as the Access Point Controller Card (APCC) except for the internal contact closures.

The FlexControl uses an ARM-based Linux computer to provide layers of processing and networking. Processing includes analytics for traffic data, traffic signal control, specialized control applications (e.g., wrong way ramp detection and speed enforcement), and system performance and diagnostic reports. Networking includes complete SNP+ functions, SNP security and proxying, as well as Linux-based IP, VPN, secure access (ssh), and secure web server (https) capabilities. Custom add-ons can be developed by qualified customers for their own remote applications.

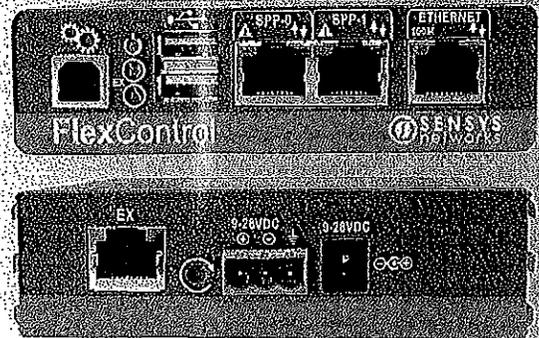
The FlexControl includes dual Radio ports (SPP-0 and SPP-1) and an expansion (EX) port. The EX port connects to the EX card or the FlexConnect module to relay detection events to a traffic controller. The FlexControl has two USB 2.0 full speed host ports, one 10/100Base-T Ethernet port, and one USB device port. The FlexControl is powered by a 9-28 VDC source via a barrel connector or a pluggable terminal block connector. The FlexControl includes a DIN mount and a bracket mount kit for installation in a traffic cabinet. The FlexControl module is configured by TrafficDOT over the Ethernet port.

### FlexControl System Configuration



A typical FlexControl system configuration consists of one FlexControl and two Radios with a FlexIsolator. The system can also consist of a FlexIsolator and a Radio. The FlexIsolator offers electrical isolation up to 2,500 V, surge protection up to 12 A, and AC power cross protection.

†SNP (Sensys NanoPower) is a proprietary wireless link protocol.



## Functions / Features

### Processing of sensor data

- Per-lane or per-vehicle data
- Data binning over selectable time intervals
- Data filtering (e.g., adaptive holdover)
- Platform for remote applications

### Storage of sensor data

- Data buffering (event caching) 500 KB
- Data storage (processed data) 1 MB

### Master timebase for all supported wireless sensors

- Common clock for sensor timestamps
- Can be synchronized to NIST timing signals

### SNP radio communications

- To/from Radio modules

### Relay of sensor data

- Via EX card or FlexConnect SDLC link to traffic controller
- Via IP connectivity (wired or wireless) to traffic controllers and upstream servers.

### Diagnostics and Supervisory

- Daily diagnostic report
- Intrusion detection and packet authentication
- Sensor health monitor (RSSI, battery, downtime)

### Firmware upgrades

- Upgraded via IP connectivity
- Delivers upgrades to all other Sensys Networks VDS devices

### Simple installation

- Mounts in traffic cabinet with DIN mount or bracket mount. Mounting kit supplied with module.

### Software Compatibility

- Requires TrafficDOT software 2.12.7 or later

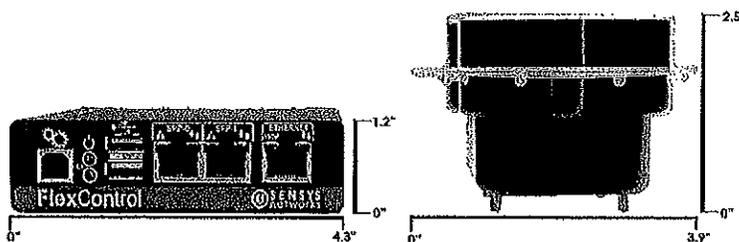
**FlexControl Front Panel**

	USB B device port
	Link LED for Radio/Ethernet ports: on (operational); off (no link); blinking (data transmission)
	Fault LED for Radio ports: on (an enabled link has a fault)
	Power LED: on (operational); off (no power)
	Link LED for EX port: on (operational); off (no link); blinking (data transmission)
	Fault LED for EX port: on (an enabled channel has a fault)
	USB host ports for USB device connections
<b>SPP-0 and SPP-1</b>	RJ45 ports for Radio connections
<b>ETHERNET</b>	Ethernet port for PC or network connections
<b>100M</b>	Ethernet port speed LED: on (speed at 100Base-T); off (speed at 10Base-T)

**FlexControl Back Panel**

	Master Reset: resets board (hold for 20 seconds to restore factory defaults)
<b>EX</b>	RJ45 port to EX card or FlexConnect
	9-28 VDC barrel power socket to power adapter or cabinet power terminal blocks
	9-28 VDC power socket to pluggable power terminal block

**Relative Size of FlexControl**



The picture above shows the relative size of the FlexControl compared to a VSN240-F-2 sensor.

**Functional Specifications**

<b>interfaces</b>	<ul style="list-style-type: none"> <li>• (2) RS-422 full duplex to Radio(s) via RJ45 connector</li> <li>• (2) USB 2.0 full speed host ports</li> <li>• (1) RS-485 full duplex to EX cards via RJ45 connector</li> <li>• (1) 10/100Base-T Ethernet port via RJ45 connector</li> <li>• (1) USB device port</li> </ul>
<b>IP connectivity</b>	<ul style="list-style-type: none"> <li>• HTTP, HTTPS, Open VPN, PPP, PPTP, SSH, optional encryption over tunnel</li> </ul>
<b>per-lane data processing</b>	<ul style="list-style-type: none"> <li>• counts (volume)</li> <li>• occupancy</li> <li>• average and median speeds</li> <li>• binned speeds and vehicle lengths over selectable time intervals</li> <li>• output formats include Caltrans, AustRoads, TTI, and CSV</li> </ul>
<b>per-vehicle data processing</b>	<ul style="list-style-type: none"> <li>• initial vehicle detect time</li> <li>• gap</li> <li>• speed</li> <li>• length</li> <li>• output formats include Marksman and CSV</li> </ul>
<b>processor</b>	<ul style="list-style-type: none"> <li>• 400 MHz ARM9 processor</li> <li>• Linux 3.14 operating system</li> <li>• 256 MB Flash</li> <li>• 128 MB SDRAM</li> </ul>
<b>over-the-air protocol</b>	Sensys NanoPower (SNP) protocol (TDMA-based)

**Power, Physical, & Environmental**

<b>input voltage</b>	<ul style="list-style-type: none"> <li>• 9-28 VDC: 5.5 mm x 2.1 mm barrel power connector, or</li> <li>• 9-28 VDC: pluggable terminal block (3 pos 5 mm) for 24-12 gage wire</li> </ul>
<b>power consumption</b>	less than 700 mW
<b>dimensions</b>	4.3" x 3.5" x 1.2" (10.9 cm x 8.8 cm x 3 cm) without mount
<b>weight</b>	8.5 oz (240.9 g) without mount
<b>operating temp</b>	industrial -40°C to 85°C
<b>mounting</b>	DIN or bracket mount

**Available Products**

Order Code	Description
FLEX-CTRL-M	FlexControl Module: Controls radios and wireless links to detection sensors and relays detection data (DIN and bracket mounting kit included).
FLEX-CTRL-M-E	FlexControl Module Enhanced: Controls radios and wireless links to detection sensors, relays detection data, and generates traffic data statistics (DIN and bracket mounting kit included).
FLEX-CTRL-ACC-2:	FlexControl Power Leads: Leads to connect FlexControl with cabinet power terminal block .
FLEX-CTRL-ACC-3:	FlexControl Power Supply with power cords: Industrial rated power supply adapter (US only).

**Compliance**

safety	2006/95/EC
EMC	<ul style="list-style-type: none"> <li>• FCC: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.</li> <li>• 2004/108/EC</li> <li>• IC: This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.</li> <li>• IC : Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.</li> </ul>

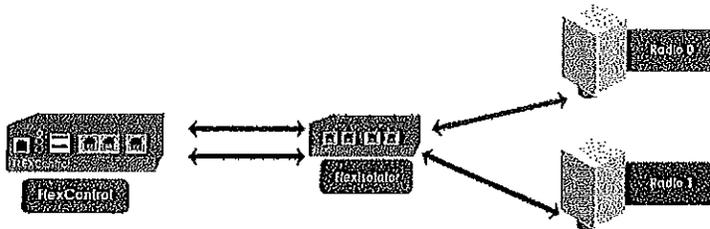
**Local Distributor**

## Flexisolator

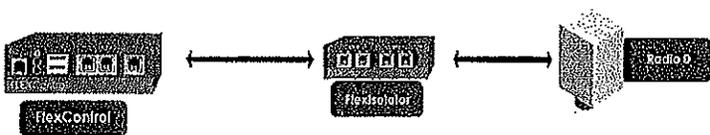
The Sensys Networks Flexisolator module provides both safety and length extension for the FlexControl† to Radio wired interface. The Flexisolator provides two independent isolator ports, one for each Radio connection.

A typical FlexControl system consists of one FlexControl and two Radios with one Flexisolator. The system can also consist of a Flexisolator and a Radio.

FlexControl with Two Radios Configuration



FlexControl with One Radio Configuration



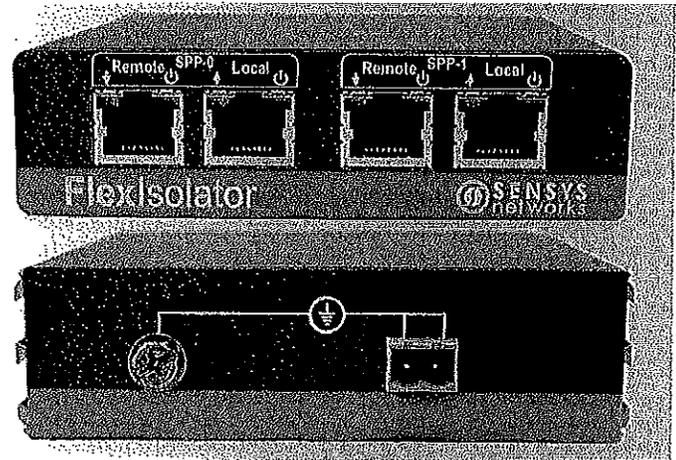
### Flexisolator

A Flexisolator isolates and protects signals from the FlexControl to the Radio and provides up to 2,000 feet (610 meters) of 24 AWG CAT5 cable communication for the FlexControl to and from the Radio using RS-422 drivers.

The Flexisolator serves three purposes:

- Equipment protection from electrical surges.**  
 Surge protection prevents unwanted electrical surge currents, for example from lightning, to enter the controller cabinet and destroy electronic circuitry.
- Protection from electrical shock.**  
 Ground isolation prevents dangerous voltages in a cable from shorting onto the ground or power supply in the cabinet.
- Length extension.**  
 The power supply voltage on the CAT5 between the FlexControl and the Radio is normally 5 V which allows only limited connection length. To increase the connection length the Flexisolator boosts this voltage to 15 V.

†Applicable also to the Access Point Controller Card (APCC)



## Functions / Features

### Safety Assurance

- Provides surge protection up to 12 A
- Provides electrical isolation up to 2,500 Vrms

Increases connection length between FlexControl and Radio

Power and Activity indicators for both Local (i.e. FlexControl) and Remote (i.e. Radio) connections

Two types of ground terminations

Mounts in traffic cabinet with DIN mount or bracket mount

### Flexisolator Front Panel

SPP-0 and SPP-1	RJ45 ports for Radio connections
Remote	Activity LED for SPP ports: off (not receiving data); blinking (receiving data from Radio)
Remote	Power LED for Radio: on (+ 15 V on); off (no power)
Local	Activity LED for SPP ports: off (not transmitting data); blinking (transmitting data to Radio)
Local	Power LED for Flexisolator: on (+ 5 V on); off (no power)

### Flexisolator Back Panel

	Both Phoenix and screw (# 8) grounding lugs (only connect one).
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### Power, Physical, & Environmental

<b>output voltage</b>	15 VDC unregulated 2 W
<b>power consumption</b>	600 mW per Radio
<b>dimensions</b>	4.3" x 3.5" x 1.2" (10.9 cm x 8.8 cm x 3 cm) without mount
<b>weight</b>	7.8 oz (221.5 g) without mount
<b>operating temp</b>	industrial -40°C to 85°C
<b>surge protection</b>	<ul style="list-style-type: none"> <li>• IEC 61000-4-2 (ESD) ±15 kV (air), ±8 kV (contact)</li> <li>• IEC 61000-4-4 (EFT) 40 A (5/50 ns)</li> <li>• IEC 61000-4-5 (Lightning) 12 A (8/20 µs)</li> </ul>
<b>electrical isolation</b>	2500 Vrms
<b>connection length extension</b>	up to 2,000 ft (610 m)
<b>mounting</b>	DIN or bracket mount

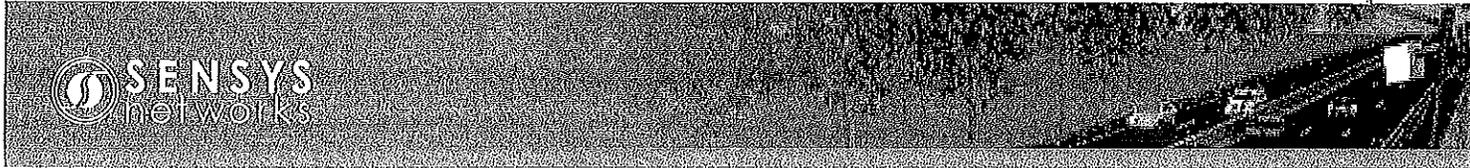
### Available Product

Order Code	Description
<b>FLEX-ISOL-M</b>	FlexIsolator module (2 port); Provides surge protection, electrical isolation, and CAT5 cable length extension (DIN and bracket mounting kit included).

### Compliance

<b>safety</b>	2006/95/EC
<b>EMC</b>	<ul style="list-style-type: none"> <li>• FCC: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.</li> <li>• 2004/108/EC</li> <li>• IC: This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.</li> <li>• IC : Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.</li> </ul>

*Local Distributor*



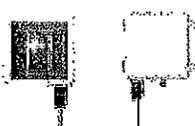
## FLEX-RP Solar Repeater

The Sensys Networks Solar Repeater offers a power pack delivering a 15 year life that virtually eliminates the ongoing maintenance cost for the effective life of the wireless sensor networking system. The solar repeater utilizes a hybrid power source: solar power which feeds into a super capacitor as its primary power source and lithium batteries to provide backup power if required. The repeater and power pack are individually aimed to provide optimal RF and solar power performance. The solar repeater eliminates repeater battery replacement and saves time and resources.

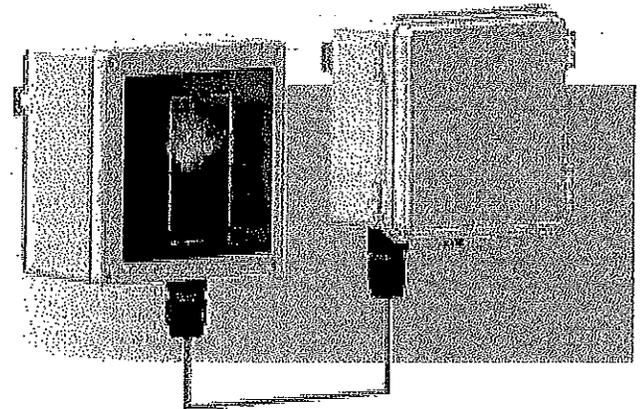
The FLEX-RP Solar Repeater includes the enhanced RF chipsets and external antenna options of the FLEX family of second generation repeaters. The enhanced RF chipsets improve the RF robustness and reduce the energy consumption. The FLEX-RP Solar Repeater has an internal antenna and connects with the FLEX External Antenna.

**Antenna options.** The FLEX External Antenna connects to the FLEX-RP Solar Repeater via a coaxial cable. The antenna allows the repeater to be aimed in two directions simultaneously utilizing a pole located between the sensor and access point.

Two types of FLEX External Antenna are supported: (i) the FLEX-ANT-1 with the same RF coverage as the internal antenna and (ii) the FLEX-ANT-2 with Long Range RF coverage. The FLEX-RP Solar Repeater can also operate without an external antenna.

		
FLEX Repeater and FLEX Solar	FLEX Repeater, FLEX Solar, and Long Range External Antenna	FLEX Repeater, FLEX Solar, and Standard External Antenna

FLEX Solar Repeater Configurations



## Functions / Features

### Relay of radio communications

- To/from wireless sensors
- To/from access point
- To/from another repeater (FLEX or RP240)

### Extension of range and coverage of the access point

- Can be operated in tandem – one repeater and its supported sensors can communicate with another repeater and then to the access point
- Maximum single-hop range of ~2000 feet (610 meters) from supporting access point or repeater
- Maximum single-hop range of ~300 feet (91 meters) from sensors with Long Range External Antenna

### Fully wireless operation – no cable connections

### Radio signal quality measurements (of each link to wireless sensor or tandem repeater)

- Receive Signal Strength Indicator (RSSI, in dBm)
- Link Quality Index (LQI, figure of merit 40-99)

### Firmware upgrades over-the-air from access point

### Simple installation

- Any roadside location that provides adequate signal coverage to sensors and the access point or repeater
- No special requirements regarding setback, relative angle of the sun or mounting stability

### No calibration or adjustment required

### No battery replacement

## Functional Specifications

<b>interfaces</b>	<ul style="list-style-type: none"> <li>• to/from sensors via 802.15.4 PHY radio</li> <li>• to/from repeaters via 802.15.4 PHY radio</li> <li>• to/from access point via 802.15.4 PHY radio</li> </ul>
<b>over-the-air protocol</b>	Sensys Networks NanoPower (SNP) protocol (TDMA)
<b>physical layer protocol</b>	IEEE 802.15.4 PHY
<b>modulation</b>	Direct Sequence Spread Spectrum Offset Quadrature Phase-Shift Keying (DSSS O-QPSK)
<b>transmit/receive bit rate</b>	250 kbps
<b>frequency band</b>	2400 to 2483.5 MHz (ISM unlicensed band)
<b>frequency channels</b>	16
<b>channel bandwidth</b>	2 MHz
<b>antenna type</b>	microstrip patch antenna (behind front face panel)
<b>antenna field of view</b>	±60° (azimuth & elevation)
<b>nominal output power</b>	3 dBm
<b>spurious emissions</b>	<ul style="list-style-type: none"> <li>• 30 - 1000 MHz: &lt; -36 dBm</li> <li>• 1 - 12.75 GHz: &lt; -30 dBm</li> <li>• 1.8 - 1.9 GHz: &lt; -44 dBm</li> <li>• 5.15 - 5.3 GHz: &lt; -47 dBm</li> </ul>
<b>typical receive sensitivity</b>	-101 dBm (PER ≤ 1%)
<b>saturation (max input level)</b>	≥ 10 dBm

## Power, Physical, & Environmental

<b>power supply</b>	<ul style="list-style-type: none"> <li>• the power supply is rechargeable super capacitor with primary battery back up</li> <li>-primary battery back up is lithium iron phosphate</li> </ul>
<b>recommended unit replacement</b>	every 15 years
<b>dimensions</b>	<ul style="list-style-type: none"> <li>• FLEX-RP: 6.5" x 6.55" x 6" (16.5 cm x 16.6 cm x 15.2 cm)</li> <li>• FLEX-Solar: 6.25" x 6.25" x 3.5" (15.9 cm x 15.9 cm x 8.9 cm)</li> <li>• FLEX-ANT-1: 5.65" x 3.54" x 4.80" (14.4 cm x 9 cm x 12.2 cm)</li> <li>• FLEX-ANT-2: 9.5" x 9.5" x 4.38" (24.10 cm x 24.10 cm x 11.10 cm)</li> </ul>
<b>weight</b>	<ul style="list-style-type: none"> <li>• FLEX-RP: 1.01 lb (0.46 kg)</li> <li>• FLEX-Solar: 4.44 lb (2.01 kg)</li> <li>• FLEX-ANT-1: 0.94 lb (0.43 kg)</li> <li>• FLEX-ANT 2: 2.2 lb (1 kg)</li> </ul>
<b>environmental</b>	<ul style="list-style-type: none"> <li>• designed for weatherproof, outdoor operation</li> <li>• NEMA Type 4x enclosure</li> <li>• IP65 ingress protection</li> </ul>
<b>operating temp</b>	-40°F to 176°F / -40°C to +80°C

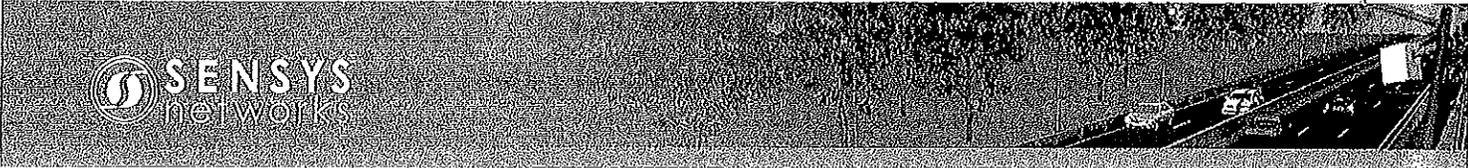
## Available Products

Product	Description
FLEX-RP	FLEX Repeater for use with FLEX-Solar
FLEX-Solar	Solar Powered Hybrid Power Pack for FLEX-RP
FLEX-ANT-1	FLEX Standard External Antenna
FLEX-ANT-2	FLEX Long Range External Antenna

## Compliance

<b>safety</b>	2006/95/EC
<b>EMC</b>	<ul style="list-style-type: none"> <li>• FCC: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.</li> <li>• 2004/108/EC</li> </ul>

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## FlexMag Flush and Deep (GR) Sensors

The Sensys Networks VDS240 Wireless Vehicle Detection System uses wireless magneto-resistive sensors to detect the presence and movement of vehicles. The sensors – installed in holes cored in the roadway and covered with epoxy – transmit detection data in real-time via low-power radio technology to a nearby Sensys Networks access point. Vehicle detections are further relayed to a traffic signal controller, remote traffic management center, or other system.

The new FlexMag Flush and Deep sensor developed by Sensys Networks utilizes the next generation of RF chipsets and circuitry. The FlexMag Flush sensors are installed flush with the roadway surface in plastic shells. The plastic shells enable the removal and replacement of sensors during roadway milling operations. The FlexMag Deep sensors are installed without plastic shells at depth of up to 4.25 inches (10.8 cm) from the roadway surface to the top of the sensor. Sensors installed at these depths do not have to be removed and replaced during most roadway milling operations.

In typical traffic management applications, a sensor is placed in the middle of a traffic lane to detect the presence and passage of vehicles. Vehicle speeds and length are measured by two sensors installed in the same lane with the exact distance between them configured in software. The recommended distance between sensors depends on the range of expected speeds to be measured: for typical freeway applications, a separation of 20 to 24 feet (6.1 to 7.3 meters) is recommended; for typical arterial applications, a separation of 10 to 12 feet (3.1 to 3.7 meters) is preferred.

### Advanced Magnetometer-Based Vehicle Detection.

The state-of-the-art magneto-resistive sensing devices in each wireless sensor measure the x-, y-, and z-axis components of the Earth's magnetic field at a 128 Hz sampling rate. As vehicles come within range, changes in the x, y, or z axes of the measured magnetic field become apparent. When no vehicles are present, sensors continually measure the background magnetic field to estimate a reference. Each sensor automatically self-calibrates to the local environment, and to any long-term variations of the local magnetic field, by allowing this reference value to change over time.

### Types of FlexMag Flush and Deep Sensors:

#### VSN240-F-2

- Flush-mount wireless sensor for in-pavement installation
- For all freeway, arterial, and signal control applications

#### VSN240-T-2

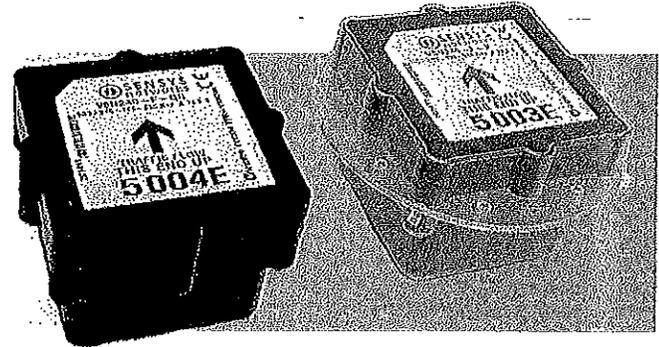
- Flush-mount wireless sensor for in-pavement installation
- For signal control applications only

#### VSN240-F-GR

- For up to 4.25" (10.8 cm) depth (to top of sensor) in-pavement installation
- For all freeway, arterial, and signal control applications

#### VSN240-T-GR

- For up to 4.25" (10.8 cm) depth (to top of sensor) in-pavement installation
- For signal control applications only



### Functions / Features

#### Lower power consumption

#### 3-axis magnetometer for vehicle detection

- 128 Hz sampling rate
- Count and presence detection modes
- Modes for bicycle and motorcycle detection

#### Flush mount or up to 4.25" (10.8 cm) depth (to top of sensor) in-pavement installation with no wires or lead-in cabling

#### Fast and simple installation

- Installs in less than 10 minutes in small hole using a hammer or core drill
  - Hole 4" (10 cm) diameter; a maximum of 6.5" (16.5 cm) deep
  - Covered with fast-drying epoxy
- Minimal lane closure time
- No saw cuts

#### Expected 10 year battery life

- Rugged mechanical design
- Auto-calibration

#### Reliable 2-way radio communications with access point

- Uniquely addressable and configurable
- Firmware can be upgraded over-the-air

#### Readily deployed where other systems cannot be used

- Split roadways
- High water tables
- Damaged pavement

## Functional Specifications

detection technique	3-axis magnetic field sensing
sampling rate	128 Hz
programmable vehicle detection parameters (mode B only)	<ul style="list-style-type: none"> <li>Z-axis detect threshold (mG)</li> <li>Z-axis undetect threshold (mG)</li> <li>X-axis undetect threshold (mG)</li> <li>onset filter (ms)</li> <li>holdover (ms)</li> <li>auto-recalibration timeout (secs)</li> </ul>
over-the-air protocol	Sensys Networks NanoPower (SNP) protocol (TDMA)
physical layer protocol	IEEE 802.15.4 PHY
modulation	Direct Sequence Spread Spectrum Offset Quadrature Phase-Shift Keying (DSSS O-QPSK)
transmit/receive bit rate	250 kbps
frequency band	2405 to 2480 MHz (ISM unlicensed band)
frequency channels	16
channel bandwidth	2 MHz
antenna type	microstrip patch antenna (mounted below top surface of sensor)
antenna field of view	±60° (azimuth & elevation)
nominal output power	+3 dBm
spurious emissions	<ul style="list-style-type: none"> <li>30 - 1000 MHz: &lt; -36 dBm</li> <li>1 - 12.75 GHz: &lt; -30 dBm</li> <li>1.8 - 1.9 GHz: &lt; -44 dBm</li> <li>5.15 - 5.3 GHz: &lt; -47 dBm</li> </ul>
typical receive sensitivity	-101 dBm (PER = 1%)
saturation (max input level)	≥ 10 dBm

## Sensor Modes

mode	application	description
B (event)	count stations; advance detection	<ul style="list-style-type: none"> <li>sends timestamped ON and OFF detection events using configurable detection parameters</li> <li>not supported by VSN240-T-2 or VSN240-T-GR</li> </ul>
F (Idle)	status reporting	disables magnetometer and sends sensor hardware and software version information
STOPBAR-# (presence detection)	stop bar detection; ramp management	sends timestamped ON and OFF detection events using pre-configured detection parameters
<ul style="list-style-type: none"> <li>16 different stop bar detection modes can be selected</li> <li>recommended stop bar detection modes for specific applications:</li> </ul>		
	STOPBAR-0	bicycles/scooters
	STOPBAR-2	motorcycles
	STOPBAR-5	passenger vehicles (normal recalibration)
	STOPBAR-7	passenger vehicles (fast recalibration)
	STOPBAR-14	light rail

## Power, Physical, & Environment

power supply	<ul style="list-style-type: none"> <li>non-replaceable primary Li-SOCl<sub>2</sub> 3.6v battery pack</li> <li>8.5 Ah (nominal capacity)</li> </ul>
dimensions	2.9" x 2.9" x 2.2" (7.4 cm x 7.4 cm x 5.6 cm)
weight	<ul style="list-style-type: none"> <li>0.47 lbs/0.213 kg (without shell)</li> <li>0.53 lbs/0.238 kg (with shell)</li> </ul>
environmental	<ul style="list-style-type: none"> <li>designed for in-pavement mounting</li> <li>NEMA Type 6P enclosure</li> <li>IP68 ingress protection</li> </ul>
operating temp	-40°F to 176°F / -40°C to +85°C

## Compliance

safety	2006/95/EC
EMC	<ul style="list-style-type: none"> <li>FCC: This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.</li> <li>CE0678</li> <li>2004/108/EC</li> <li>IC: This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.</li> <li>IC: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.</li> </ul>

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