CimarronCSI

Wireless Data Collection System

Operations Manual

April, 2011

CimarronCSI

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Description

Cimarron Control Systems, Inc. *(CCSI)* has developed an inexpensive, reliable, battery and solar powered, wireless data gathering product line for industrial applications. *CCSI's* Wireless Data Collection products are easily configured to interface with PLC and host computer systems in use throughout industry today. *CCSI* offers a quick, low cost solution to data gathering requirements. Benefits include:

- Elimination of the high installed capital costs of power and communications cabling.
- Enhanced reliability provided by *CCSI's* self-healing mesh network architecture.
- Ability to interface to a wide variety of sensors, including un-amplified pressure sensors, strain gauges, and RTD temperature sensors for low power and high reliability, as well as externally powered 4-20ma output transducers.
- Ability to integrate data from any device that supports Modbus or A-B DF-1 protocol.
- Self-organizing network- the only configuration required is to specify installed serial numbers, desired reporting interval(s), and connected devices.
- Archiving of all collected data in flash memory, allowing a flexible retrieval schedule.
- Support for over the air firmware updating if necessary.

General

The *CCSI* Wireless Data Collection Network is a self-organizing, self-repairing, power optimized mesh network. Data is collected from sensors and/or devices (e.g. PLC's, RTU's, flow computers) attached to each unit and automatically routed to a central collection point where it is archived and made available to host devices supporting Modbus or A-B DF-1 protocol. There are three types of units in the network:

1) Data collection unit (Model Number 915-1000-0-DCU).
2) Primary terminal units (Model Number 915-1000-0-PRI).
3) Secondary terminal units (Model Number 915-1000-0-SEC).

A network is composed of one Data Collection Unit (DCU), at least One Primary Terminal Unit (PTU), and, optionally, one or more Secondary Terminal Units (STU). A total of 150 Primary or Secondary Units are supported by one DCU. PTUs and STUs are used to monitor and record data from connected analog sensors and discrete switches, as well as any device that supports Modbus or Allen-Bradley DF-1 protocol via an RS-232 serial interface.

STUs discover and associate themselves with the neighboring PTU that has the best signal strength. The STU then transmits its data when polled by a PTU, which can be as often as once per minute or as infrequently as once per day.

PTUs aggregate data from any associated secondary units, along with their directly connected sensor and polled device data, and transmit the combined data report to the DCU. The primary reporting interval can also be anywhere from once per minute to once per day. If a PTU is not within range of a DCU, it will automatically route its report through neighboring PTUs in order to reach the DCU. In addition to scheduled reports, both PTUs and STUs can be configured to transmit a report whenever a user-defined exception occurs.

At the DCU, all the network data is archived in flash memory, and the most recent report data is made available via a serial communications port using industry standard Modbus or DF-1 protocols.

Network Design Considerations

The DCU is designed to be always on and therefore requires a mains connected power supply. Rechargeable batteries provide backup in case of a power outage. Additionally, a host computer or PLC will normally be used to analyze, archive, and/or perform alarm checking on the collected data. Connection to the host computer or PLC is made using the DCU's RS232 serial interface, which supports either Modbus RTU or Allen-Bradley DF-1 protocol. The organization of the data from both the Modbus and DF-1 perspective is provided in this document in the section titled Network Structure and Register Map. The operation of the entire network can be specified using registers in the DCU. To assist with this, a PC based *Network Configuration Utility* program is provided. This program can also be used to view current data from any device in the network, retrieve the archived data from the DCU and save it to disk, and view plots of all archived data.

The Primary Terminal Units (PTUs) act as data collectors, message routers, and data concentrators. Two analog inputs and four discrete inputs can be connected to each primary node. An optional IO Expansion board adds two more analog inputs, three more discrete inputs, and a form C relay output. The main board analog inputs can be either high level (4-20ma or 0-2.5v) or low level (mV) signals. Expansion board inputs are switch selectable as low level (mV), 4-20ma, 0-5v, or 0-10v. Analog inputs are converted to a value from 0-32767, which represents zero to full scale. Each analog input is capable of supplying 3.3v to energize a bridge type input. This, along with the auto-ranging, high-gain front end, means that unamplified pressure or strain gauge sensors can be used. This eliminates the need for loop power supplies and the extra cost and failure modes of sensors with integrated electronics. The discrete inputs are designed for dry contact closures. In addition to the on-off state of each contact, a 32-bit totalizer is maintained for each input. At a user defined interval (default is 60 minutes), the PTU will send a data report to the DCU. The minimum interval is 1 minute. The maximum interval is 1440 minutes (1 day). A data report consists of the battery voltage, the regulated system voltage, the state of each discrete input, and, optionally, the current value of each analog input, the value of each totalizer, and any data scanned from a serially attached device. In addition to the scheduled reports, a data report will be sent if a user defined exception condition occurs. An exception condition consists of a discrete input, which is defined as an alarm point, changing state, or an analog input value changing by more than its defined deadband value. As a default, switch inputs 2-4 are defined as alarm points and the deadband for all analog inputs is set to 1% of span (328 counts). Switch input 1 defaults to a totalizer input. If a PTU is not within radio range of the DCU, it will send the report to another PTU that is closer to the DCU. This will continue until the message is forwarded to the DCU. This behavior is automatic and requires no user configuration other than the selection of sites for the PTUs. Redundant PTUs can be installed to allow for alternate routes in case of device failure or changes in path characteristics. PTUs are designed to use rechargeable batteries with either an integrated solar panel or an external 5vdc power supply.

The Secondary Terminal Units (STUs) have the same process input capabilities as the PTUs, but they generate reports only when polled by a PTU, or when a user defined exception occurs. This reduces overall network traffic and allows the STUs to operate in a very low power mode. The STU automatically discovers its neighboring PTUs and selects one to poll

it. If the selected PTU fails, the STU will repeat the discovery process and associate itself with another available PTU. Each PTU can poll up to 50 STUs. Depending on the polling and exception rates, an STU can operate for over 5 years on a single set of 3000 ma-H lithium AA batteries.

The main design decisions required in setting up a network are the assignment of either a PTU or STU for each process point, and the location of the units based on sensor location, terrain, and availability of sunlight for solar powered units. Each transmission will use only as much output power as is required. The transmitter power ranges from –15 dBm up to 29 dBm. Range at full power can vary from a few thousand feet in an indoor or urban setting, to several miles with a clear line of sight and adequate elevation.

Unit Mounting and Wiring Considerations

1) Mount each unit so that its antenna is oriented vertically with respect to the earth. The antenna bends up to 90 degrees, so the enclosure can be mounted vertically, horizontally, or at an angle to maximize exposure to the sun.
2) Try to locate the unit so that the antenna is as exposed as much as possible. Avoid surrounding the antenna with metal objects.
3) WARNING: The unit must be installed to provide an antenna separation distance of at least 5 inches (12 cm) from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter for satisfying RF exposure compliance.
4) Four holes are provided in the enclosure for cable entry. These should each be fitted with either a watertight cable grip or watertight plug.
5) Shielded cable should be used for transducer, power, and serial interface connections. The shield should be connected to a ground terminal inside the unit enclosure. The other end of the shield should not be terminated.
6) This equipment is suitable for installation in Class I, Division 2, Group A,B,C,D hazardous locations or non-hazardous locations only.

Network Installation

When installing a new network the following procedure is recommended:

1) Install the DCU and host computer or PLC. The host should set the time in the DCU and update the time once per hour.
2) Install a PTU within range of the DCU. For each one, mount the unit, connect the sensors, and install the power jumper. Verify communications with the DCU before proceeding to the next PTU.
3) Install the remaining PTUs so that each additional unit is within range of a previously installed and communicating PTU. Verify communications with the DCU before proceeding to the next PTU.
4) Install the STUs. Verify communications with the DCU before proceeding to the next STU.

In order to expedite the installation process when long reporting or polling times are used, a data report is generated immediately after each PTU or STU joins the network.

Wireless Sensor Interface - Hardware Specifications:

Frequency:	902 MHz to 928 MHz
Modulation:	Frequency hopping spread spectrum, GFSK
Rx Sensitivity:	-103 dBm
Tx Output Power:	-15 dBm to +29 dBm
Total Link Budget:	+136 dBm with 2dBi antennas.
Network Topology:	Self-organizing, self-repairing, power optimized mesh network.
Security:	80-bit block encryption with user specified key.
Analog Inputs:	Two inputs, jumper selectable for 0-2.5v or 0-20ma. The auto ranging, high-gain front end has a 76 microvolt resolution.
Discrete Inputs:	Four dry contact inputs. Max pulse input rate 4Hz.
Current Consumption:	45 uA average in idle mode, 16 ma in Rx mode, 17-1000 ma in Tx mode.
Input Power:	Three series connected size AA batteries: NiMh rechargeable (1.2vdc nominal each), or lithium primary cell (1.5vdc nominal each).
Battery Charging:	Integrated solar panel or external 5vdc @ 300ma power supply for use with rechargeable batteries only.
Environmental:	The circuit board is protected with a conformal coating and housed in a waterproof enclosure. The operating temperature range with lithium primary batteries is –40 to +60 degrees C. The NiMh batteries are rated for operation from 0 to +50 degrees C.

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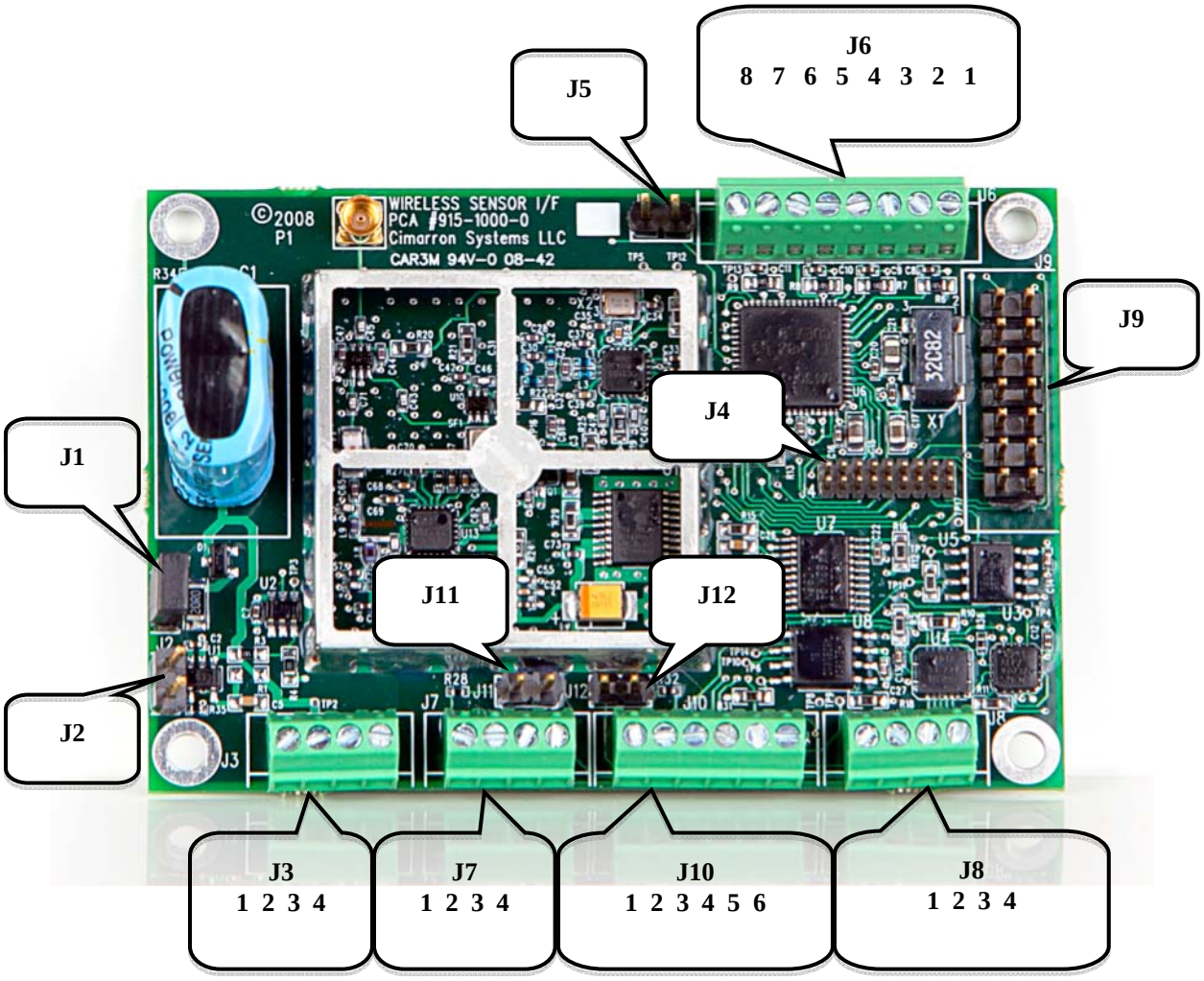
Wireless Sensor Interface Board
Field Connections / Configuration Guide



Jumpers

- **J1:** Install the two pin shorting block if the unit is configured with a solar panel, otherwise leave open.
- **J2:** Install the two pin shorting block to put the unit in active mode after the field connections have been made and the enclosure installed. Leave this jumper open when the unit is being stored or transported in order to avoid running down the battery.
- **J5:** Install on DCU if DF-1 protocol is desired. Leave off for Modbus RTU protocol.
- **J11:** Install the two pin shorting block if analog input #1 (J7) is a 4-20ma current loop device or an RTD.
- **J12:** Install the two pin shorting block if analog input #2 (J8) is a 4-20ma current loop device or an RTD.

Power and I/O Connections (Pin 1 is on the left as you face each connector)

J3: Power Input

Pin 1: External power (+) connection- either +5v power supply or integrated solar panel.
Pin 2: Battery (+) lead.
Pin 3: Battery (-) lead.
Pin 4: External power (-) connection - either +5v power supply or integrated solar panel.

J7: Analog Input #1
J8: Analog Input #2

When connecting low level output sensors, such as millivolt output pressure transducers:

Pin 1: Negative (-) sensor output.
Pin 2: Negative (-) supply (WSI board ground)
Pin 3: Positive (+) sensor output.
Pin 4: Positive (+) supply (provided by WSI board)

When connecting 4-20 ma output sensors (install jumper J11 or J12):

Pin 1: Negative (-) supply return (should connect to ground of external loop power supply).
Pin 2: Connect a 1000-ohm, 1/4W resistor between pins 1 and 2.
Pin 3: Positive (+) sensor output.
Pin 4: Not used.

When connecting an RTD sensor (install jumper J11 or J12):

Pin 1: Install a shorting jumper between pins 1 and 2.
Pin 2: Install a shorting jumper between pins 1 and 2.
Pin 3: Connect one side of the RTD.
Pin 4: Connect the other side of the RTD.

J10: Serial communications (Default parameters are 19200, 8, N, 1)

Pin 1- Rx Data input (RS232 levels) [cable to DB9 pin 3 (DTE) or pin 2 (DCE)]
Pin 2- Tx Data output (RS232 levels) [cable to DB9 pin 2 (DTE) or pin 3 (DCE)]
Pin 3- RTS output (RS232 levels) [cable to DB9 pin 7 if needed]
Pin 4- Ground [cable to DB9 pin 5]
Pin 5- Rx Data input (logic levels)
Pin 6- Tx Data output (logic levels)

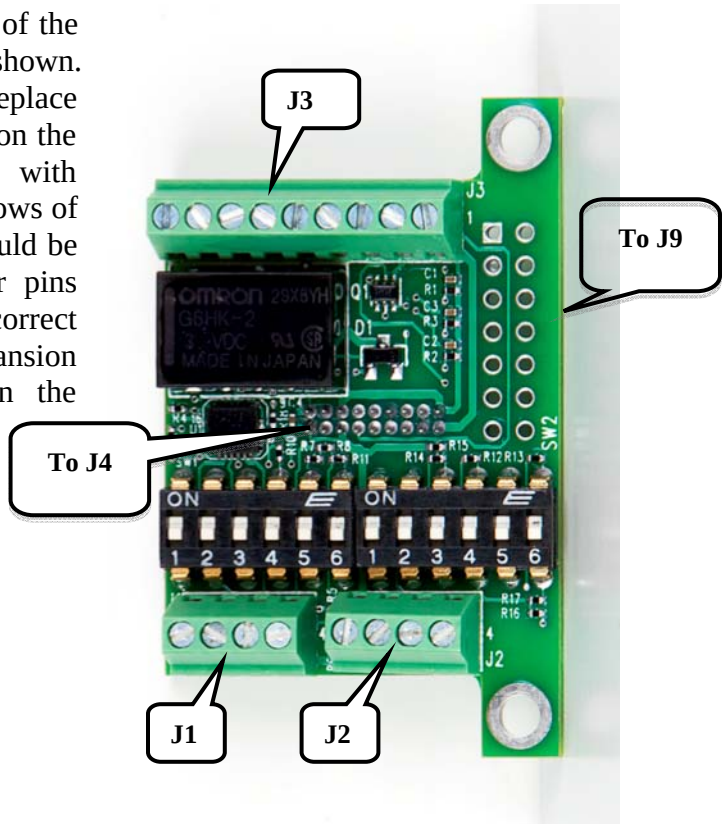
J6: Discrete inputs (Dry contacts)

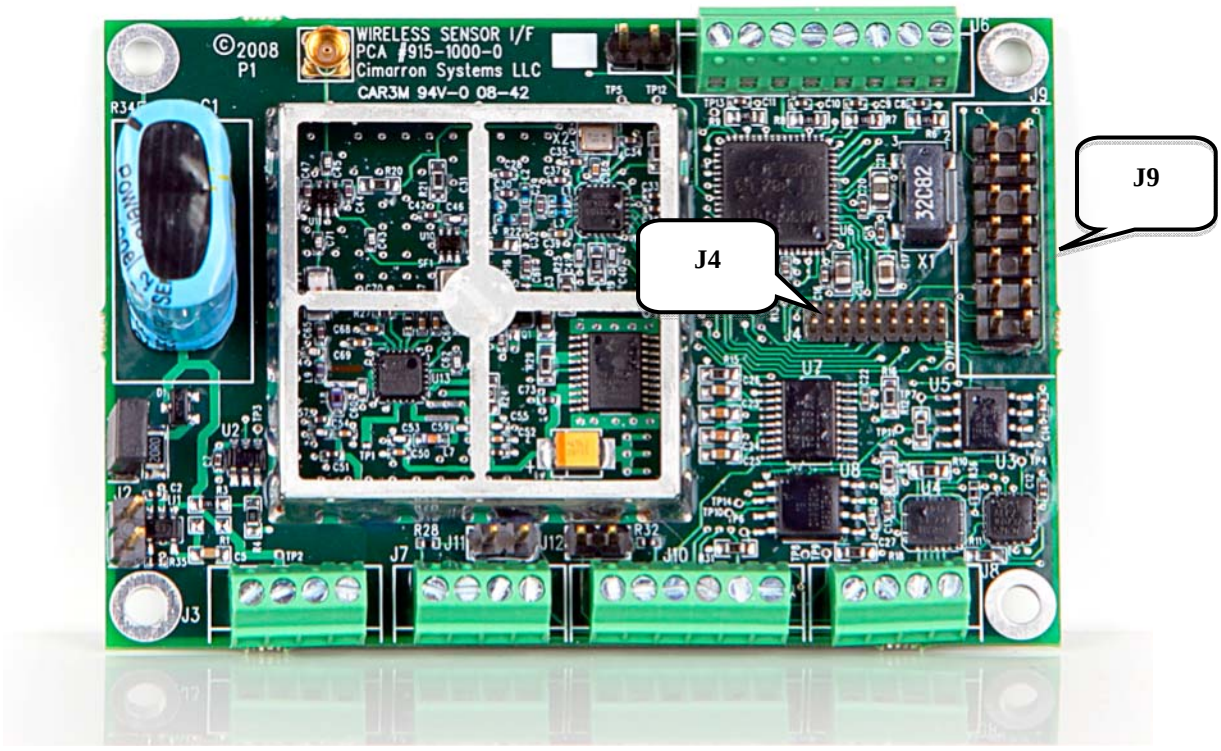
Pins 1-2: Switch 4 input. (Defaults as alarm contact input)
Pins 3-4: Switch 3 input. (Defaults as alarm contact input)
Pins 5-6: Switch 2 input. (Defaults as alarm contact input)
Pins 7-8: Switch 1 input. (Defaults as totalizer input)

IO Expansion Board
Installation / Field Connections / Configuration Guide

Installation

The IO expansion board mounts on top of the wireless sensor interface board as shown. Remove the two mounting screws and replace with the supplied standoffs. The socket on the bottom of the expansion board mates with header J4 on the main board. The two rows of seven holes on the expansion board should be inserted into the corresponding header pins (J9) on the main board to provide the correct alignment. Press firmly until the expansion board mounting holes are resting on the standoffs. Re-install the mounting screws to hold the expansion board in place.





Field Connections and Configuration
J1: Analog Input #3
J2: Analog Input #4
When connecting low level output sensors, such as millivolt output pressure transducers:
Pin 1: Negative (-) sensor output.
Pin 2: Negative (-) supply (WSI board ground)
Pin 3: Positive (+) sensor output.
Pin 4: Positive (+) supply (provided by WSI board)

When connecting 4-20 ma, 0-5v, or 0-10v output sensors:
Pin 1: Negative (-) supply return (should connect to ground of external loop power supply).
Pin 2: Not used
Pin 3: Positive (+) sensor output.
Pin 4: Not used.

When connecting an RTD sensor (set switches for 4-20ma type input):
Pin 1: Install a shorting jumper between pins 1 and 2.
Pin 2: Install a shorting jumper between pins 1 and 2.
Pin 3: Connect one side of the RTD.
Pin 4: Connect the other side of the RTD.

SW1: Analog Input #3 Configuration
SW2: Analog Input #4 Configuration
For the input types listed below, close the switch positions indicated with an 'x', leaving the other positions open.

Input type	mV	4-20ma	0-5v	0-10v
Pos 1:	x	x		
Pos 2:		x		
Pos 3:		x		
Pos 4:			x	x
Pos 5:			x	x
Pos 6:			x	

J3: Discrete inputs / Relay Outputs
Pin 1: Relay N.O. contact (Max 60 volts @ 0.5 amps, or 30 volts @ 1A)
Pin 2: Relay Common
Pin 3: Relay N.C. contact
Pins 4-5: Switch 7 input.
Pins 6-7: Switch 6 input.
Pins 8-9: Switch 5 input.

Network Structure and Register Map

The DCU is capable of interfacing to 150 units, in any combination of PTUs and STUs.

Process data from the remotes is stored in 3000 input registers, referred to with indices 0-2999. These correspond to registers 30001 through 33000 for Modbus protocol and N100 through N111 for A-B DF-1 protocol. Each A-B file contains 250 elements.

Configuration data for the network and for individual remotes is stored in 9750 holding registers, referred to with indices 0-9749. These correspond to registers 40001 through 49750 for Modbus protocol and N200 through N238 for A-B DF-1 protocol. Each A-B file contains 250 elements. A general description of each configuration table follows. Details are provided in the document, *DCU_Register_Map.xls*, which is available on our web site at www.cimcsi.com.

Holding registers 0 through 149 comprise the Network Parameters Table. This is a collection of values, which apply to the entire network.

Holding registers 150 through 449 comprise the Unit Index Table. Each entry in the table is two registers and the nth entry contains the serial number of the nth unit. These can be configured in any order desired.

Holding registers 450 through 599 comprise the Unit Control Table. Each entry in the table is one register and the nth entry contains the most recent relay output configuration for the nth unit.

Holding registers 750 through 4499 comprise the Unit Parameters Table. Each entry in the table is 25 registers, which are used to set unit specific configuration parameters. These parameters are used when values other than the network defaults are required for specific units. The default value for these parameters is -1, which indicates that no unit specific parameters are defined.

Holding registers 4500 through 6000 comprise the Data Block Descriptor Table. Each entry in the table is 10 registers, which are used to assign input registers to received data values. The nth entry corresponds to the nth unit. Input registers are indexed starting at 0. A value of -1 indicates that the value in the default data block descriptor is to be used to compute the input register. If the value in the default data block descriptor is -1, the value is not stored.

Agency Certifications
The *CCSI* Wireless Data Collection Network modules comply with Part 15 of the FCC Rules and Industry Canada Specification RSS-210. 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.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. If this equipment does cause harmful interference to radio or television reception, try to correct the interference by following one or more of the following suggestions:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a different circuit.
- Consult the dealer or an experienced radio/TV technician for help.

The *CCSI* Wireless Data Collection Network modules are suitable for installation in Class I, Division 2, Group A,B,C,D hazardous locations or non-hazardous locations only.

Antennas
This device has been designed to operate with the antennas listed below, and having a maximum gain of +2 dBi. Antennas not included in this list or having a gain greater than +2dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

- Nearson p/n S467FL-L-RMM-915S

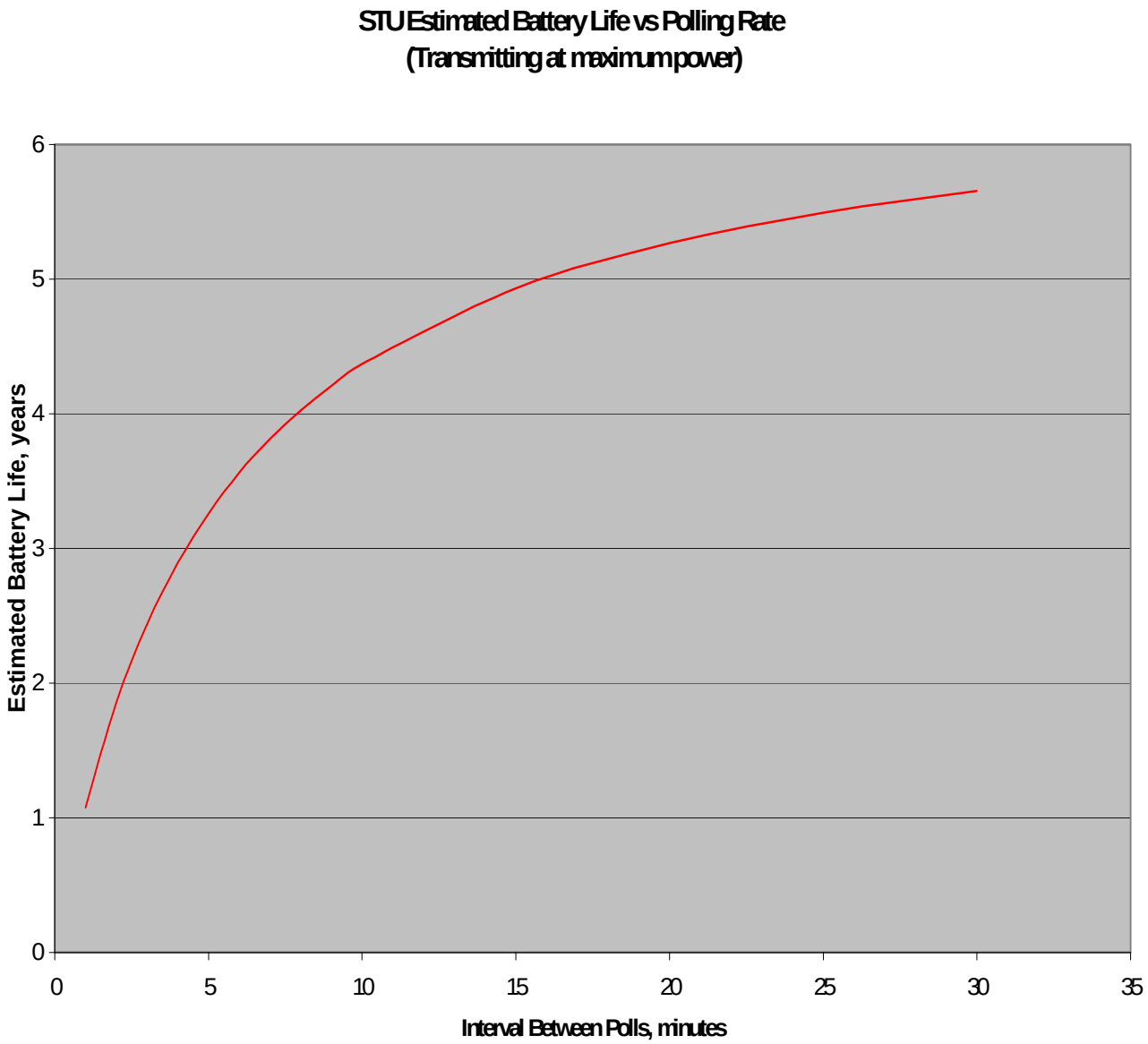
To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

Modifications to Equipment
WARNING: Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

RF Exposure
WARNING: Separation distances of 12 centimeters (5 inches) or more should be maintained between the antenna of this device and nearby persons during operation. To ensure compliance, operation at distances closer than this is not recommended.

Battery Life

Estimated battery life for *CCSI* Secondary Terminal Units transmitting at full power, using three AA lithium batteries rated at 3000 mAh.



PRODUCT WARRANTY

I. WARRANTY COVERAGE:

Cimarron Control Systems, Inc. (*CCSI*) warrants *CCSI* manufactured products ("Product") to be free of workmanship and material defects for a period of eighteen (18) months from the date of shipment to Buyer or twelve (12) months from the date of installation. *CCSI*, at its option, will at no charge either repair, replace, or refund the purchase price of the Product during the warranty period, provided it is returned in accordance with the terms of this warranty to 20319 Spoonwood Dr., Humble, Texas, USA 77346, or at *CCSI's* option, may include the replacement of parts or boards with functionally equivalent reconditioned or new parts or boards. Replaced parts or boards are warranted for the balance of the original applicable warranty period. All replaced parts, boards or Product shall become the property of *CCSI*. Shipping costs are to be borne by the purchasing party. This express warranty is extended by *CCSI* to the party purchasing the Product ("Buyer") and is not assignable or transferable to any other party. This is the complete warranty for the Products, except as modified by separate agreement between *CCSI* and Buyer. *CCSI* is not responsible under this warranty for ancillary equipment, whether or not manufactured by *CCSI***,** which is attached to or used in connection with the Product, nor for operation of the Product with any such ancillary equipment. Because each Product system is unique, *CCSI* disclaims liability for range, coverage, or operation of the system as a whole under this warranty. This warranty applies within the fifty (50) United States and the District of Columbia.

II. WHAT THIS WARRANTY DOES NOT COVER:

(a) Defects or damage resulting from use of the Product in other than its normal and customary manner,

(b) Defects or damage from misuse, accident or neglect,

(c) Defects or damage from improper testing, operation, maintenance, installation, alteration, modification or adjustment,

(d) Product disassembled or repaired in such a manner as to adversely affect performance or prevent adequate inspection and testing to verify any warranty claim,

(e) Product which has had the serial number removed or made illegible,

(f) Rechargeable batteries if:

(i) any of the seals on the battery enclosure of cells are broken or shown evidence of tampering, or,

(ii) the damage or defect is caused by charging or using the battery in equipment or service other than Product for which it is specified.

III. HOW TO GET WARRANTY SERVICE:

To receive warranty service, call 281-812-5438.

IV. GENERAL PROVISIONS:

This warranty sets forth the full extent of *CCSI* responsibilities and liability regarding the Product, and repair, replacement, or refund of the purchase price, at *CCSI* option, is Buyer's exclusive remedy. THIS WARRANTY IS GIVEN IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHICH ARE SPECIFICALLY EXCLUDED INCLUDING, WITHOUT LIMITATION, IMPLIED WARRANTIES OF

MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL *CCSI* BE LIABLE FOR DAMAGES IN EXCESS OF THE PURCHASE PRICE OF THE PRODUCT, FOR ANY LOSS OF USE, LOSS OF TIME, INCONVENIENCE, COMMERCIAL LOSS, LOST PROFITS OR SAVINGS, OR OTHER INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE SUCH PRODUCT.

V. PATENT AND SOFTWARE PROVISIONS:

CCSI will defend at its own expense any suit brought against Buyer to the extent that it is based on a claim that the Product or parts infringes a United States patent, and *CCSI* will pay those costs and damages finally awarded against Buyer in any such suit which are attributable to any such claim, but such defense and payments are conditioned on the following:

(i) that *CCSI* will be notified promptly in writing by Buyer of any notice of such claim; and,

(ii) that *CCSI* will have sole control of the defense of such suit and all negotiations for its settlement or compromise; and,

(iii) should the Product or parts become, or in *CCSI's* opinion be likely to become, the subject of a claim of infringement of a United States patent, that Buyer will permit *CCSI*, at its option and expense, either to procure for Buyer the right to continue using the Product or parts or to replace or modify the same so that it becomes non-infringing or to grant Buyer a credit for the Product or parts as depreciated and accept its return. The depreciation will be an equal amount per year over the lifetime of the Product or parts as established by *CCSI*. *CCSI* will have no liability with respect to any claim of patent infringement which is based upon the combination of the Product or parts furnished hereunder with software, apparatus or devices not furnished by *CCSI*, nor will *CCSI* have any liability for the use of ancillary equipment or software not furnished by *CCSI* which is attached to or used in connection with the Product. The foregoing states the entire liability of *CCSI* with respect to infringement of patents by the Product or any parts thereof. Laws in the United States and other countries preserve for *CCSI* certain exclusive rights for copyrighted *CCSI* software such as the exclusive rights to reproduce in copies and distribute copies of such *CCSI* software. *CCSI* software may be copied into, used in and redistributed with only the Products associated with such *CCSI* software. No other use, including without limitation disassembly, of such *CCSI* software or exercise of exclusive rights in such *CCSI* software is permitted. No license is granted by implication, estoppel or otherwise under the patent rights of *CCSI* or any third party.