CimarronCSI

Wireless Data Collection System

Operations Manual

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* Remote Terminal Unit (RTU) 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. Advantages include elimination of the high installed capital costs of power and communications cabling, and the enhanced reliability provided by *CCSI's* patent pending network architecture.

General

The *CCSI* Wireless Sensor Network is a self organizing, self repairing, power optimized mesh network, which collects data from sensors attached to each node and routes that data to a central collection point. There are three types of nodes 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 node, at least one primary node, and zero or more secondary nodes. At total of 250 nodes are supported by one DCU. Primary and secondary nodes are used to monitor and record data from connected analog sensors and discrete switches. Secondary nodes transmit when polled by a primary node, which can be as often as once per minute or as infrequently as once per day. Primary nodes aggregate data from zero or more secondary nodes and transmit this data (along with their directly connected sensor data) to the data collection node. The primary reporting interval can also be anywhere from once per minute to once per day. If a primary is not within range of a DCU, it will route its report through other primary nodes in order to reach the DCU. At the DCU, all the network data is made available via a serial communications port using industry standard Modbus or Allen-Bradley DF-1 protocols. In addition to scheduled reports, both primary and secondary nodes can be configured to transmit a report whenever a user defined exception occurs.

Hardware Specifications:

Frequency:	902 MHz to 928 MHz, frequency hopping spread spectrum.
Network Topology:	Self organizing, self repairing, power optimized mesh network.
Encryption:	80 bit block encryption with user specified key.
Rx Sensitivity:	-103 dBm
Tx Output Power:	-15 dBm to +29 dBm
Input Power:	Three size AA batteries: NiMh rechargeable (1.2vdc nominal), or lithium primary cell (1.5vdc nominal).
Battery Charging:	Integrated solar panel or external 5vdc @ 300ma power supply for use with rechargeable batteries only.
Temperature:	The lithium batteries are rated for operation from –40 to +60 degrees C. The NiMh batteries are rated for operation from 0 to +50 degrees C.

Network Design Considerations

The DCU is designed to be always on and therefore requires a mains connected power supply to keep its batteries charged. 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. Alternatively, default values for all parameters allow an operational network to be assembled without any configuration whatsoever.

The primary terminal units act as data collectors, message routing nodes, and data concentrators. Two analog inputs and four discrete inputs can be connected to each primary node. The analog inputs can be either high level (4-20ma or 0-2.5v) or low level (up to 100mv) signals. High level inputs are converted to a value from 0-32767, which represents 0-20ma or 0-2.5v. Low level inputs are assumed to be bridge type transducers. These are energized by 3.3v from the RTU and are converted to a value from 0-32767, which represents 0-30 mv/V. The ability to handle millivolt inputs means that unamplified pressure or RTD 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 primary unit 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, the current value of each analog input, and the value of each totalizer. 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 primary unit is not within radio range of the DCU, it will send the report to another primary unit which 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 primary units. Redundant primaries can be installed to allow for alternate routes in case of device failure or changes in path characteristics. Primary units are designed to use rechargeable batteries with either an integrated solar panel or an external 5vdc power supply.

The secondary terminal units have the same process input capabilities as the primary units, but they generate reports only when polled by a primary, or when a user defined exception occurs. This reduces overall network traffic and allows the secondary units to operate in a very low power mode. The secondary unit automatically discovers its neighboring primaries and selects one to poll it. If the selected primary fails, the secondary unit will repeat the discovery process and associate itself with another available primary unit. Each primary unit

can poll up to 50 secondary units. Depending on the polling and exception rates, a secondary unit can operate for up to 5 years on a single set of 3000 mAh lithium AA batteries.

The main design decisions required in setting up a network are the assignment of either a primary or secondary unit for each node, and the location of the nodes based on sensor location, terrain, and availability of sunlight for solar powered nodes. Each transmission will use only as much output power as is required. The transmitter power ranges from –15 dBm up to 30 dBm (nominal output power). 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.

RTU Mounting and Wiring Considerations

1) Mount each unit so that it's 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 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 water tight cable grip or water tight 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 RTU enclosure. The other end of the shield should be unterminated.

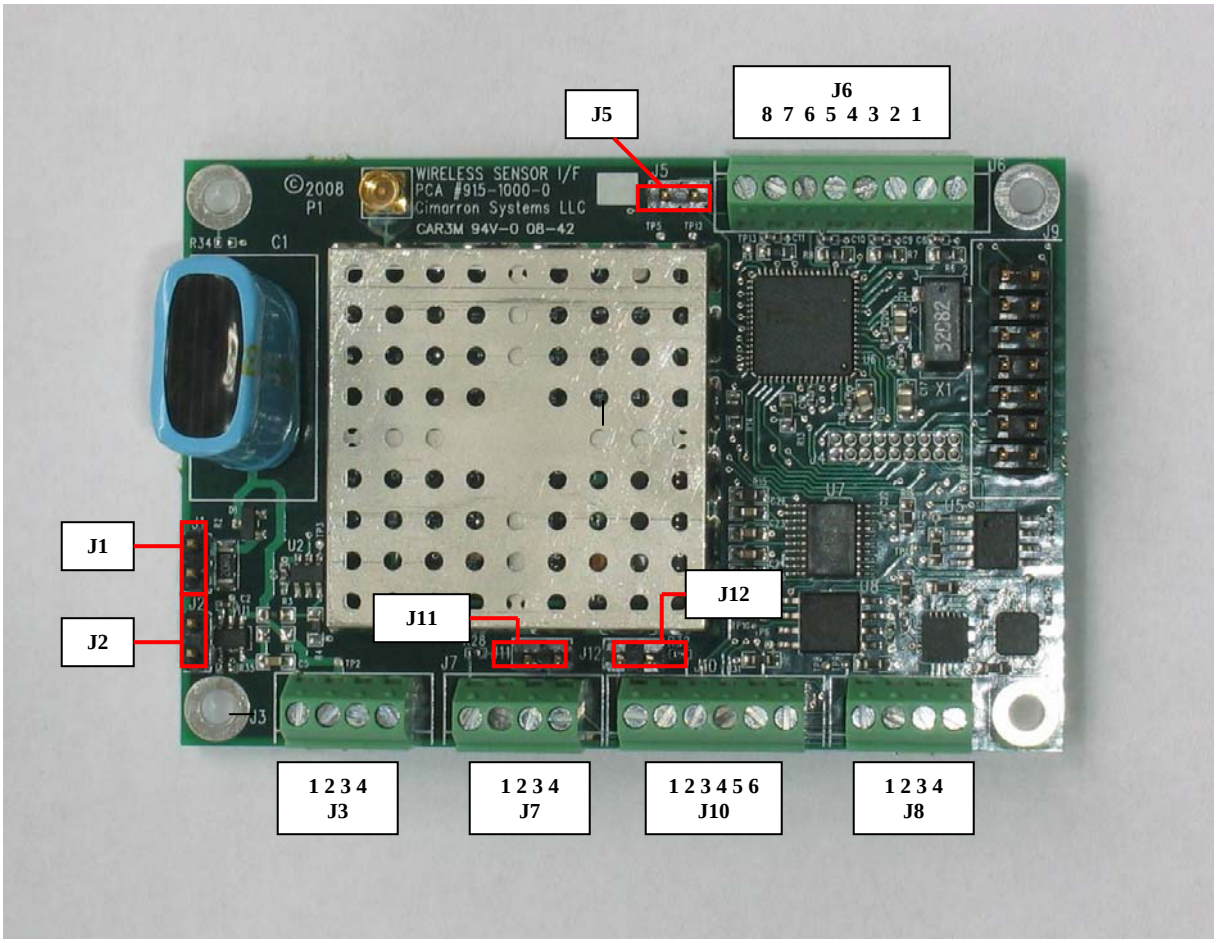
Network Installation

When installing a new network the following procedure should be used:

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 the primary units 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 primary.
3) Install the remaining primary units so that each additional unit is within range of a previously installed and communicating primary. Verify communications with the DCU before proceeding to the next primary.
4) Install the secondary units. Verify communications with the DCU before proceeding to the next secondary.

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

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.
- **J11:** Install the two pin shorting block if analog input #1 (J7) is a 4-20ma current loop device.
- **J12:** Install the two pin shorting block if analog input #2 (J8) is a 4-20ma current loop device.

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:

Pin 1: Negative (-) supply return (should connect to ground of external loop power supply).
Pin 2: Not used (Ground)
Pin 3: Positive (+) sensor output.
Pin 4: Not used.

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

Pin 1- Rx Data input (RS232 levels) [cable to DB9 pin 3]
Pin 2- Tx Data output (RS232 levels) [cable to DB9 pin 2]
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)

Network Structure and Register Map
The DCU is capable of interfacing to 250 RTUs, in any combination of primary and secondary units.

Process data from the remotes is stored in 3500 input registers, referred to with indices 0-3499. These correspond to registers 30001 through 33500 for Modbus protocol and N100 through N113 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.

Holding registers 0 through 4249 comprise the Network Parameters Table. This is a collection of values which apply to the entire network.

Holding registers 4250 through 4749 comprise the RTU Index Table. Each entry in the table is two registers and the Nth entry contains the serial number of the Nth RTU. These can be configured in any order desired, or the DCU will automatically add RTU serial numbers to this table in the order that data reports are received.

Holding registers 4750 through 7249 comprise the RTU Parameters Table. Each entry in the table is 10 registers which are used to set RTU specific configuration parameters. The primary reporting or secondary polling interval, the discrete alarm configuration (see note 1), and a deadband value for up to four analog inputs (see note 2). These parameters are used when values other than the network defaults are required for specific RTUs. The default value for these parameters is -1, which indicates that no RTU specific parameters are defined.

Holding registers 7250 through 9749 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 RTU. 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.

The following RTU data values are specified in the Data Descriptor Block Table:

Timestamp: Double register value representing seconds since 1/1/1970

Status register: The low order 8 bits (0-7) represent the hardware discrete inputs from the RTU. Bits 8-11 contain the Tx power level index for the message originator. Bit 15 is set if the data is not current, and bit 14 is set if the RTU has an I/O expansion board.

System Voltage: RTU processor Vcc voltage level in volts * 10.

Battery Voltage: RTU battery voltage in volts * 10.

Register Select Bit Map: Bits 0-3 correspond to analog inputs 0-3. Bits 4-11 correspond to meter inputs 0-7. If the bit is set, the corresponding register is saved. If the bit is clear, the corresponding register is skipped.

Analog Values: Last reported values of analog inputs. There are two analogs inputs in the standard RTU, four analogs if an I/O expansion board is installed. They are stored in sequential input registers starting with the address specified. See Note 3 for data format.

Meter Values: Double register values representing the cumulative count of each discrete input. There are four discrete inputs in the standard RTU, eight if an I/O expansion board is installed. They are stored in sequential input registers starting with the address specified.

Note 1: The default values for the reporting and polling intervals are 60 minutes. The alarm mask parameter is used to indicate for each discrete input whether it should be treated as an alarm or not. A value of 1 in bit position N specifies that the Nth input is an alarm. When an alarm point changes state, the Primary RTU will send a report at the next opportunity, whether it is scheduled or not. The default is input 0 is not an alarm while inputs 1-3 are alarms.

Note 2: The analog deadband is specified in ADC counts (as described in note 3). When the analog input value changes by more than this amount, the RTU will send a report at the next opportunity, whether it is scheduled or not. The default value is 328 which is 1% of the total span of 32767 counts.

Note 3: There are two different analog data formats depending on whether the input is a high level (eg 4-20ma or 0-2.5v) sensor or a low level sensor (eg. Millivolt pressure transducer or RTD). The high level inputs are scaled as 0-32767 counts representing 0-2.5v or 0-20ma. The low level sensors are assumed to be bridge networks which are energized by the RTU. In this case, the ADC value is 0-32767 representing 0-30 mv/V.

Network Parameters

Network Parameters		Modbus	DF-1	DF-1	Base= 40001
Data Type	Offset	Register	File	Register	Description
INT32	0	40001	N200:	0	Current Network Timestamp
INT16	2	40003	N200:	2	Restart Type (0=Coldstart, 1=Warmstart)
INT16	3	40004	N200:	3	# of DCU Watchdog timer resets
INT16	4	40005	N200:	4	# of DCU Flash disk errors
INT16	5	40006	N200:	5	# of DCU packet transmission attempts
INT16	6	40007	N200:	6	# of DCU packet transmission failures
INT16	7	40008	N200:	7	# of DCU packet acknowledge errors
INT16	8	40009	N200:	8	# of DCU packet receive attempts
INT16	9	40010	N200:	9	# of DCU packet receive errors
INT16	10	40011	N200:	10	Spare
INT16	11	40012	N200:	11	Spare
INT16	12	40013	N200:	12	Spare
INT16	13	40014	N200:	13	Spare
INT16	14	40015	N200:	14	Reserved (For DF1 system time download)
INT16	15	40016	N200:	15	Reserved
INT16	16	40017	N200:	16	Reserved
INT16	17	40018	N200:	17	Reserved
INT16	18	40019	N200:	18	Host Protocol (0=Modbus RTU, 1=DF1)
INT16	19	40020	N200:	19	Station Address
INT16	20	40021	N200:	20	Baud Rate
INT16	21	40022	N200:	21	RTS On delay, ms
INT16	22	40023	N200:	22	RTS Off delay, ms
INT16	23	40024	N200:	23	Network ID
INT16	24	40025	N200:	24	Hop Table Number
CHAR*10	25	40026	N200:	25	Network encryption key
INT16	30	40031	N200:	30	Default Reporting Interval
INT16	31	40032	N200:	31	Default Polling Interval
INT16	32	40033	N200:	32	Default Alarm Mask
INT16	33	40034	N200:	33	Default Analog 1 deadband, ADC counts
INT16	34	40035	N200:	34	Default Analog 2 deadband, ADC counts
INT16	35	40036	N200:	35	Default Analog 3 deadband, ADC counts
INT16	36	40037	N200:	36	Default Analog 4 deadband, ADC counts
INT16	37	40038	N200:	37	Spare
INT16	38	40039	N200:	38	Spare
INT16	39	40040	N200:	39	Spare
INT16	40	40041	N200:	40	Spare
INT16	41	40042	N200:	41	Spare
INT16	42	40043	N200:	42	Force RTU update. If set to an RTU index value, the DCU will update that RTU's parameters at the start of the next minute. Reset to -1 when complete.
INT16	43	40044	N200:	43	Force parameter update. If set =0, the DCU will update the parameters in each RTU in the network at the start of the next hour. Reset to –1 when completed.
INT16	44	40045	N200:	44	Input register address for RTU error counters

Network Parameters		Modbus	DF-1	DF-1	Base= 40001
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**
INT16	45	40046	N200:	45	Input register address for timestamp value (2 registers)
INT16	46	40047	N200:	46	Input register address for status register
INT16	47	40048	N200:	47	Input register address for system voltage
INT16	48	40049	N200:	48	Input register address for battery voltage
INT16	49	40050	N200:	49	Register select bit map
INT16	50	40051	N200:	50	Input register address for analog values
INT16	51	40052	N200:	51	Input register address for meter values (2 registers each)
INT16	52	40053	N200:	52	Spare
INT16	53	40054	N200:	53	Spare
INT16	54	40055	N200:	54	Spare
INT16	55	40056	N200:	55	Default data block size

Note: Registers from offset 45 through 54 comprise the default data block descriptor. The input registers entered here are those for RTU #1. The input registers for RTUs 2 through 250 will be calculated using the default data block size.

RTU Index Table

RTU Index Table		Modbus	DF-1	DF-1	Base=	44251
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**	
INT32	0	44251	N:217	0	Serial Number for RTU #	1
INT32	2	44253	N:217	2	Serial Number for RTU #	2
INT32	4	44255	N:217	4	Serial Number for RTU #	3
INT32	6	44257	N:217	6	Serial Number for RTU #	4
INT32	8	44259	N:217	8	Serial Number for RTU #	5
INT32	10	44261	N:217	10	Serial Number for RTU #	6
INT32	12	44263	N:217	12	Serial Number for RTU #	7
INT32	14	44265	N:217	14	Serial Number for RTU #	8
INT32	16	44267	N:217	16	Serial Number for RTU #	9
INT32	18	44269	N:217	18	Serial Number for RTU #	10
INT32	20	44271	N:217	20	Serial Number for RTU #	11
INT32	22	44273	N:217	22	Serial Number for RTU #	12
INT32	24	44275	N:217	24	Serial Number for RTU #	13
INT32	26	44277	N:217	26	Serial Number for RTU #	14
INT32	28	44279	N:217	28	Serial Number for RTU #	15
INT32	30	44281	N:217	30	Serial Number for RTU #	16
INT32	32	44283	N:217	32	Serial Number for RTU #	17
INT32	34	44285	N:217	34	Serial Number for RTU #	18
INT32	36	44287	N:217	36	Serial Number for RTU #	19
INT32	38	44289	N:217	38	Serial Number for RTU #	20
INT32	40	44291	N:217	40	Serial Number for RTU #	21
INT32	42	44293	N:217	42	Serial Number for RTU #	22
INT32	44	44295	N:217	44	Serial Number for RTU #	23
INT32	46	44297	N:217	46	Serial Number for RTU #	24
INT32	48	44299	N:217	48	Serial Number for RTU #	25
INT32	50	44301	N:217	50	Serial Number for RTU #	26
INT32	52	44303	N:217	52	Serial Number for RTU #	27
INT32	54	44305	N:217	54	Serial Number for RTU #	28
INT32	56	44307	N:217	56	Serial Number for RTU #	29
INT32	58	44309	N:217	58	Serial Number for RTU #	30
INT32	60	44311	N:217	60	Serial Number for RTU #	31
INT32	62	44313	N:217	62	Serial Number for RTU #	32
INT32	64	44315	N:217	64	Serial Number for RTU #	33
INT32	66	44317	N:217	66	Serial Number for RTU #	34
INT32	68	44319	N:217	68	Serial Number for RTU #	35
INT32	70	44321	N:217	70	Serial Number for RTU #	36
INT32	72	44323	N:217	72	Serial Number for RTU #	37
INT32	74	44325	N:217	74	Serial Number for RTU #	38
INT32	76	44327	N:217	76	Serial Number for RTU #	39
INT32	78	44329	N:217	78	Serial Number for RTU #	40
INT32	80	44331	N:217	80	Serial Number for RTU #	41
INT32	82	44333	N:217	82	Serial Number for RTU #	42
INT32	84	44335	N:217	84	Serial Number for RTU #	43
INT32	86	44337	N:217	86	Serial Number for RTU #	44

RTU Index Table		Modbus	DF-1	DF-1	Base= 44251
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**
INT32	88	44339	N:217	88	Serial Number for RTU # 45
INT32	90	44341	N:217	90	Serial Number for RTU # 46
INT32	92	44343	N:217	92	Serial Number for RTU # 47
INT32	94	44345	N:217	94	Serial Number for RTU # 48
INT32	96	44347	N:217	96	Serial Number for RTU # 49
INT32	98	44349	N:217	98	Serial Number for RTU # 50
INT32	100	44351	N:217	100	Serial Number for RTU # 51
INT32	102	44353	N:217	102	Serial Number for RTU # 52
INT32	104	44355	N:217	104	Serial Number for RTU # 53
INT32	106	44357	N:217	106	Serial Number for RTU # 54
INT32	108	44359	N:217	108	Serial Number for RTU # 55
INT32	110	44361	N:217	110	Serial Number for RTU # 56
INT32	112	44363	N:217	112	Serial Number for RTU # 57
INT32	114	44365	N:217	114	Serial Number for RTU # 58
INT32	116	44367	N:217	116	Serial Number for RTU # 59
INT32	118	44369	N:217	118	Serial Number for RTU # 60
INT32	120	44371	N:217	120	Serial Number for RTU # 61
INT32	122	44373	N:217	122	Serial Number for RTU # 62
INT32	124	44375	N:217	124	Serial Number for RTU # 63
INT32	126	44377	N:217	126	Serial Number for RTU # 64
INT32	128	44379	N:217	128	Serial Number for RTU # 65
INT32	130	44381	N:217	130	Serial Number for RTU # 66
INT32	132	44383	N:217	132	Serial Number for RTU # 67
INT32	134	44385	N:217	134	Serial Number for RTU # 68
INT32	136	44387	N:217	136	Serial Number for RTU # 69
INT32	138	44389	N:217	138	Serial Number for RTU # 70
INT32	140	44391	N:217	140	Serial Number for RTU # 71
INT32	142	44393	N:217	142	Serial Number for RTU # 72
INT32	144	44395	N:217	144	Serial Number for RTU # 73
INT32	146	44397	N:217	146	Serial Number for RTU # 74
INT32	148	44399	N:217	148	Serial Number for RTU # 75
INT32	150	44401	N:217	150	Serial Number for RTU # 76
INT32	152	44403	N:217	152	Serial Number for RTU # 77
INT32	154	44405	N:217	154	Serial Number for RTU # 78
INT32	156	44407	N:217	156	Serial Number for RTU # 79
INT32	158	44409	N:217	158	Serial Number for RTU # 80
INT32	160	44411	N:217	160	Serial Number for RTU # 81
INT32	162	44413	N:217	162	Serial Number for RTU # 82
INT32	164	44415	N:217	164	Serial Number for RTU # 83
INT32	166	44417	N:217	166	Serial Number for RTU # 84
INT32	168	44419	N:217	168	Serial Number for RTU # 85
INT32	170	44421	N:217	170	Serial Number for RTU # 86
INT32	172	44423	N:217	172	Serial Number for RTU # 87
INT32	174	44425	N:217	174	Serial Number for RTU # 88
INT32	176	44427	N:217	176	Serial Number for RTU # 89
INT32	178	44429	N:217	178	Serial Number for RTU # 90

RTU Index Table		Modbus	DF-1	DF-1	Base= 44251
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**
INT32	180	44431	N:217	180	Serial Number for RTU # 91
INT32	182	44433	N:217	182	Serial Number for RTU # 92
INT32	184	44435	N:217	184	Serial Number for RTU # 93
INT32	186	44437	N:217	186	Serial Number for RTU # 94
INT32	188	44439	N:217	188	Serial Number for RTU # 95
INT32	190	44441	N:217	190	Serial Number for RTU # 96
INT32	192	44443	N:217	192	Serial Number for RTU # 97
INT32	194	44445	N:217	194	Serial Number for RTU # 98
INT32	196	44447	N:217	196	Serial Number for RTU # 99
INT32	198	44449	N:217	198	Serial Number for RTU # 100
INT32	200	44451	N:217	200	Serial Number for RTU # 101
INT32	202	44453	N:217	202	Serial Number for RTU # 102
INT32	204	44455	N:217	204	Serial Number for RTU # 103
INT32	206	44457	N:217	206	Serial Number for RTU # 104
INT32	208	44459	N:217	208	Serial Number for RTU # 105
INT32	210	44461	N:217	210	Serial Number for RTU # 106
INT32	212	44463	N:217	212	Serial Number for RTU # 107
INT32	214	44465	N:217	214	Serial Number for RTU # 108
INT32	216	44467	N:217	216	Serial Number for RTU # 109
INT32	218	44469	N:217	218	Serial Number for RTU # 110
INT32	220	44471	N:217	220	Serial Number for RTU # 111
INT32	222	44473	N:217	222	Serial Number for RTU # 112
INT32	224	44475	N:217	224	Serial Number for RTU # 113
INT32	226	44477	N:217	226	Serial Number for RTU # 114
INT32	228	44479	N:217	228	Serial Number for RTU # 115
INT32	230	44481	N:217	230	Serial Number for RTU # 116
INT32	232	44483	N:217	232	Serial Number for RTU # 117
INT32	234	44485	N:217	234	Serial Number for RTU # 118
INT32	236	44487	N:217	236	Serial Number for RTU # 119
INT32	238	44489	N:217	238	Serial Number for RTU # 120
INT32	240	44491	N:217	240	Serial Number for RTU # 121
INT32	242	44493	N:217	242	Serial Number for RTU # 122
INT32	244	44495	N:217	244	Serial Number for RTU # 123
INT32	246	44497	N:217	246	Serial Number for RTU # 124
INT32	248	44499	N:217	248	Serial Number for RTU # 125
INT32	250	44501	N:218	0	Serial Number for RTU # 126
INT32	252	44503	N:218	2	Serial Number for RTU # 127
INT32	254	44505	N:218	4	Serial Number for RTU # 128
INT32	256	44507	N:218	6	Serial Number for RTU # 129
INT32	258	44509	N:218	8	Serial Number for RTU # 130
INT32	260	44511	N:218	10	Serial Number for RTU # 131
INT32	262	44513	N:218	12	Serial Number for RTU # 132
INT32	264	44515	N:218	14	Serial Number for RTU # 133
INT32	266	44517	N:218	16	Serial Number for RTU # 134
INT32	268	44519	N:218	18	Serial Number for RTU # 135
INT32	270	44521	N:218	20	Serial Number for RTU # 136

RTU Index Table		Modbus	DF-1	DF-1	Base= 44251
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**
INT32	272	44523	N:218	22	Serial Number for RTU # 137
INT32	274	44525	N:218	24	Serial Number for RTU # 138
INT32	276	44527	N:218	26	Serial Number for RTU # 139
INT32	278	44529	N:218	28	Serial Number for RTU # 140
INT32	280	44531	N:218	30	Serial Number for RTU # 141
INT32	282	44533	N:218	32	Serial Number for RTU # 142
INT32	284	44535	N:218	34	Serial Number for RTU # 143
INT32	286	44537	N:218	36	Serial Number for RTU # 144
INT32	288	44539	N:218	38	Serial Number for RTU # 145
INT32	290	44541	N:218	40	Serial Number for RTU # 146
INT32	292	44543	N:218	42	Serial Number for RTU # 147
INT32	294	44545	N:218	44	Serial Number for RTU # 148
INT32	296	44547	N:218	46	Serial Number for RTU # 149
INT32	298	44549	N:218	48	Serial Number for RTU # 150
INT32	300	44551	N:218	50	Serial Number for RTU # 151
INT32	302	44553	N:218	52	Serial Number for RTU # 152
INT32	304	44555	N:218	54	Serial Number for RTU # 153
INT32	306	44557	N:218	56	Serial Number for RTU # 154
INT32	308	44559	N:218	58	Serial Number for RTU # 155
INT32	310	44561	N:218	60	Serial Number for RTU # 156
INT32	312	44563	N:218	62	Serial Number for RTU # 157
INT32	314	44565	N:218	64	Serial Number for RTU # 158
INT32	316	44567	N:218	66	Serial Number for RTU # 159
INT32	318	44569	N:218	68	Serial Number for RTU # 160
INT32	320	44571	N:218	70	Serial Number for RTU # 161
INT32	322	44573	N:218	72	Serial Number for RTU # 162
INT32	324	44575	N:218	74	Serial Number for RTU # 163
INT32	326	44577	N:218	76	Serial Number for RTU # 164
INT32	328	44579	N:218	78	Serial Number for RTU # 165
INT32	330	44581	N:218	80	Serial Number for RTU # 166
INT32	332	44583	N:218	82	Serial Number for RTU # 167
INT32	334	44585	N:218	84	Serial Number for RTU # 168
INT32	336	44587	N:218	86	Serial Number for RTU # 169
INT32	338	44589	N:218	88	Serial Number for RTU # 170
INT32	340	44591	N:218	90	Serial Number for RTU # 171
INT32	342	44593	N:218	92	Serial Number for RTU # 172
INT32	344	44595	N:218	94	Serial Number for RTU # 173
INT32	346	44597	N:218	96	Serial Number for RTU # 174
INT32	348	44599	N:218	98	Serial Number for RTU # 175
INT32	350	44601	N:218	100	Serial Number for RTU # 176
INT32	352	44603	N:218	102	Serial Number for RTU # 177
INT32	354	44605	N:218	104	Serial Number for RTU # 178
INT32	356	44607	N:218	106	Serial Number for RTU # 179
INT32	358	44609	N:218	108	Serial Number for RTU # 180
INT32	360	44611	N:218	110	Serial Number for RTU # 181
INT32	362	44613	N:218	112	Serial Number for RTU # 182

RTU Index Table		Modbus	DF-1	DF-1	Base= 44251
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**
INT32	364	44615	N:218	114	Serial Number for RTU # 183
INT32	366	44617	N:218	116	Serial Number for RTU # 184
INT32	368	44619	N:218	118	Serial Number for RTU # 185
INT32	370	44621	N:218	120	Serial Number for RTU # 186
INT32	372	44623	N:218	122	Serial Number for RTU # 187
INT32	374	44625	N:218	124	Serial Number for RTU # 188
INT32	376	44627	N:218	126	Serial Number for RTU # 189
INT32	378	44629	N:218	128	Serial Number for RTU # 190
INT32	380	44631	N:218	130	Serial Number for RTU # 191
INT32	382	44633	N:218	132	Serial Number for RTU # 192
INT32	384	44635	N:218	134	Serial Number for RTU # 193
INT32	386	44637	N:218	136	Serial Number for RTU # 194
INT32	388	44639	N:218	138	Serial Number for RTU # 195
INT32	390	44641	N:218	140	Serial Number for RTU # 196
INT32	392	44643	N:218	142	Serial Number for RTU # 197
INT32	394	44645	N:218	144	Serial Number for RTU # 198
INT32	396	44647	N:218	146	Serial Number for RTU # 199
INT32	398	44649	N:218	148	Serial Number for RTU # 200
INT32	400	44651	N:218	150	Serial Number for RTU # 201
INT32	402	44653	N:218	152	Serial Number for RTU # 202
INT32	404	44655	N:218	154	Serial Number for RTU # 203
INT32	406	44657	N:218	156	Serial Number for RTU # 204
INT32	408	44659	N:218	158	Serial Number for RTU # 205
INT32	410	44661	N:218	160	Serial Number for RTU # 206
INT32	412	44663	N:218	162	Serial Number for RTU # 207
INT32	414	44665	N:218	164	Serial Number for RTU # 208
INT32	416	44667	N:218	166	Serial Number for RTU # 209
INT32	418	44669	N:218	168	Serial Number for RTU # 210
INT32	420	44671	N:218	170	Serial Number for RTU # 211
INT32	422	44673	N:218	172	Serial Number for RTU # 212
INT32	424	44675	N:218	174	Serial Number for RTU # 213
INT32	426	44677	N:218	176	Serial Number for RTU # 214
INT32	428	44679	N:218	178	Serial Number for RTU # 215
INT32	430	44681	N:218	180	Serial Number for RTU # 216
INT32	432	44683	N:218	182	Serial Number for RTU # 217
INT32	434	44685	N:218	184	Serial Number for RTU # 218
INT32	436	44687	N:218	186	Serial Number for RTU # 219
INT32	438	44689	N:218	188	Serial Number for RTU # 220
INT32	440	44691	N:218	190	Serial Number for RTU # 221
INT32	442	44693	N:218	192	Serial Number for RTU # 222
INT32	444	44695	N:218	194	Serial Number for RTU # 223
INT32	446	44697	N:218	196	Serial Number for RTU # 224
INT32	448	44699	N:218	198	Serial Number for RTU # 225
INT32	450	44701	N:218	200	Serial Number for RTU # 226
INT32	452	44703	N:218	202	Serial Number for RTU # 227
INT32	454	44705	N:218	204	Serial Number for RTU # 228

RTU Index Table		Modbus	DF-1	DF-1	Base= 44251
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**
INT32	456	44707	N:218	206	Serial Number for RTU # 229
INT32	458	44709	N:218	208	Serial Number for RTU # 230
INT32	460	44711	N:218	210	Serial Number for RTU # 231
INT32	462	44713	N:218	212	Serial Number for RTU # 232
INT32	464	44715	N:218	214	Serial Number for RTU # 233
INT32	466	44717	N:218	216	Serial Number for RTU # 234
INT32	468	44719	N:218	218	Serial Number for RTU # 235
INT32	470	44721	N:218	220	Serial Number for RTU # 236
INT32	472	44723	N:218	222	Serial Number for RTU # 237
INT32	474	44725	N:218	224	Serial Number for RTU # 238
INT32	476	44727	N:218	226	Serial Number for RTU # 239
INT32	478	44729	N:218	228	Serial Number for RTU # 240
INT32	480	44731	N:218	230	Serial Number for RTU # 241
INT32	482	44733	N:218	232	Serial Number for RTU # 242
INT32	484	44735	N:218	234	Serial Number for RTU # 243
INT32	486	44737	N:218	236	Serial Number for RTU # 244
INT32	488	44739	N:218	238	Serial Number for RTU # 245
INT32	490	44741	N:218	240	Serial Number for RTU # 246
INT32	492	44743	N:218	242	Serial Number for RTU # 247
INT32	494	44745	N:218	244	Serial Number for RTU # 248
INT32	496	44747	N:218	246	Serial Number for RTU # 249
INT32	498	44749	N:218	248	Serial Number for RTU # 250

RTU Parameters Table

RTU Parameter Table		Modbus	DF-1	DF-1	Base=	44751	
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**		
INT16	0	44751	N219:	0	Data Changed Flag		**RTU # 1**
INT16	1	44752	N219:	1	Report/Poll Interval, Minutes		
INT16	2	44753	N219:	2	Alarm Mask		
INT16	3	44754	N219:	3	Analog 1 deadband, ADC counts		
INT16	4	44755	N219:	4	Analog 2 deadband, ADC counts		
INT16	5	44756	N219:	5	Analog 3 deadband, ADC counts		
INT16	6	44757	N219:	6	Analog 4 deadband, ADC counts		
INT16	7	44758	N219:	7	Spare		
INT16	8	44759	N219:	8	Spare		
INT16	9	44760	N219:	9	Spare		

The above is repeated for each of the 250 RTUs supported by a DCU with Modbus Registers through 47250.

Data Block Descriptor Table

Data Block Descriptors		**Modbus**	**DF-1**	**DF-1**	**Base=**	**47251**	
Data Type	**Offset**	**Register**	**File**	**Register**	**Description**		
INT16	0	47251	N229:	0	Input register address for timestamp value (2 registers)		**RTU # 1**
INT16	1	47252	N229:	1	Input register address for status register		
INT16	2	47253	N229:	2	Input register address for system voltage		
INT16	3	47254	N229:	3	Input register address for battery voltage		
INT16	4	47255	N229:	4	Register select bit map.		
INT16	5	47256	N229:	5	Input register address for analog values		
INT16	6	47257	N229:	6	Input register address for meter values (2 registers each)		
INT16	7	47258	N229:	7	Spare		
INT16	8	47259	N229:	8	Spare		
INT16	9	47260	N229:	9	Spare		

The above is repeated for each of the 250 RTUs supported by a DCU with Modbus Registers through 49750.

Agency Certifications
The *CCSI* Wireless Sensor Network modules comply 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.

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.

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.

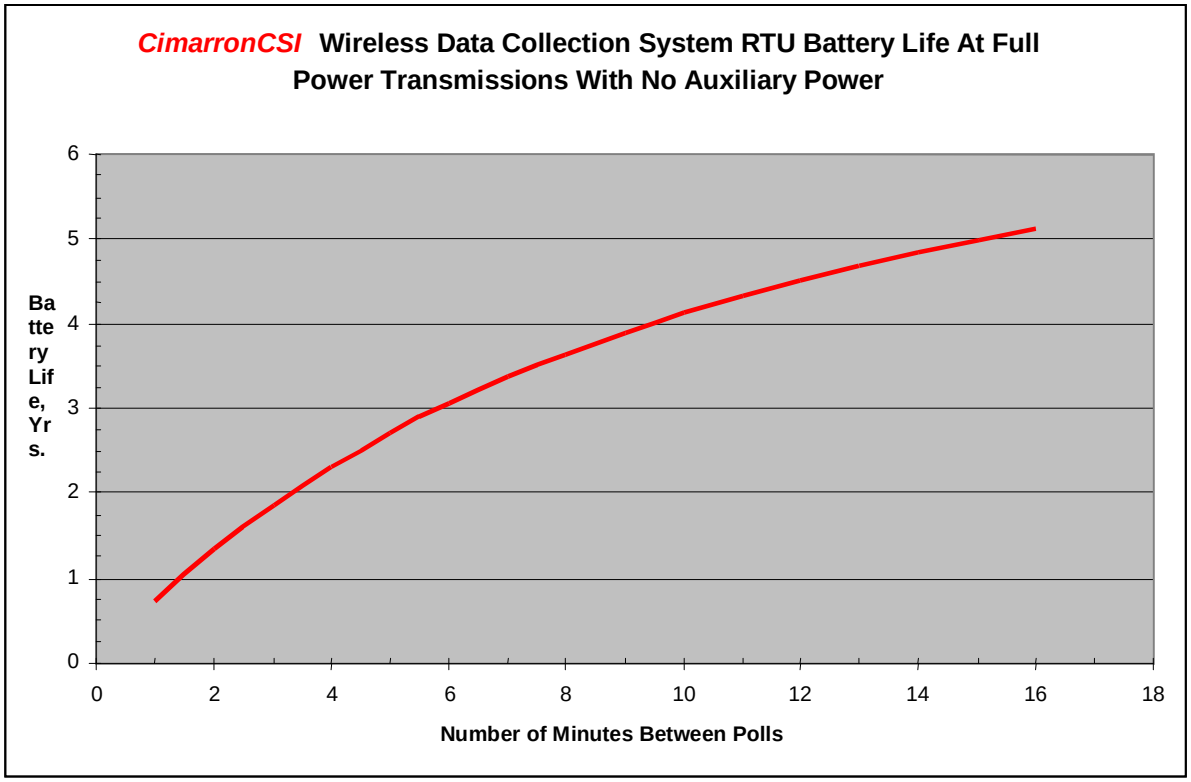
- Nearson p/n S467FL-L-RMM-915S

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

Approximate Battery Life Prediction for *CCSI* RTUs at full power transmissions with no auxiliary power source.



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.