Monitor with Confidence

L900 RSTAR Array Radio Series System Instruction Manual

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REVISION HISTORY

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G	Updated URL for software updates, added Revision Table, updated page numbers, stand-alone data logger to RSTAR conversion instructions removed, updated battery information.	2019-Aug-21	MP	CJ
H	References to Table B-2 replaced with references to Table A-1; configuration codes for DT2485 10 Channel and DT2485 40 Channel loggers updated to 0x81 and 0x85, respectively, and GAA added to table; CE, WEEE, and Anatel logos added.	2019-Dec-05	MP	CJ
I	DTSAA added to Table A-1, updated link in 3.1.1.	2020-Jul-02	JT	AB

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1.1 OVERVIEW

The RSTAR Array Radio Series System is a communications system that enables wireless data acquisition from RST DT series data loggers. DT series data loggers (Node Loggers) equipped with L900 radio kits wirelessly transmits sensor measurements to an L900 Remote Terminal Unit (RTU). Refer to Figure 1-1.

The RTU stores the last readings sent from all Node Loggers and relays the information over RS-232 or USB communications. The RTU also controls the reading interval of Node Loggers and synchronises the clocks of all the Node Loggers.

The RTU will only store the most recent readings from the Node Loggers. When purchased as part of a FlexDAQ Hub logger, Node Logger data is automatically transferred and stored in the Hub Logger each time the network takes a reading. Sensor data is stored in three locations: the Node Logger, the Hub Logger, and the base station computer.

1.2 RSTAR COMMUNICATIONS PRINCIPLES

RSTAR networks are star type. Node data loggers send and receive data from only one Hub RTU.

All Node Loggers in the network will have the same reading interval and synchronized clocks. All Node Loggers will simultaneously read their sensors when scheduled to take a reading and will transmit their data to the Hub RTU over the next 1 to 2 minutes. The Node Logger clocks will be updated and any change in reading interval will be implemented as they transmit their data.

The Hub Logger (often a Campbell Scientific data logger) will request data from the Hub RTU once the Hub RTU has finished receiving data from the Node Loggers.

2 SAFETY

- Use the provided antenna only.

CAUTION: AVOID POWERLINES WHEN INSTALLING THE ANTENNAS.

- Observe grounding rules when installing Hub Loggers that are connected to line power.
- Do not short or reverse the polarity of the Hub Logger battery. The battery may leak lead and strong sulfuric acid if improperly handled.

WARNING: SHORTING OR REVERSING THE POLARITY OF THE HUB LOGGER BATTERY MAY CAUSE LEAD AND STRONG SULFURIC ACID TO LEAK IF IMPROPERLY HANDLED.

- Never bypass the provided fuses when powering the Hub Logger.

2.1 BATTERY

3.6 V lithium-thionyl chloride batteries are recommended for use with any data logger. Standard batteries (defined as SAFT LSH 20 D-cell, or equivalent) are used for any logger with a wireless option (DT Link or RSTAR). Wireless connections will not work with other lower current batteries.

More information regarding batteries and battery life can be found in the instruction manuals for individual data loggers and in the DT Logger Host instruction manual (ELM0080).

CAUTION:

DO NOT ATTEMPT TO RECHARGE THE BATTERY.

DO NOT REPLACE THE BATTERY WITH AN ALKALINE OR ZINC-CARBON BATTERY.

REMOVE STANDARD BATTERIES PRIOR TO SHIPPING DATA LOGGERS.

3 INSTALLATION

3.1 SOFTWARE INSTALLATION

3.1.1 Installing Node Logger Host Software

1. DT Logger Host software can be found on the RST website at: https://rstinstruments.com/software-downloads/. Navigate to the website and select the appropriate data logger.

2. Follow the on-screen instructions. The default directory is:

   C:\Program Files\RST Instruments\DT Logger Host

   The drivers will install automatically. Refer to RST Instruments Manual ELM0080 if the drivers do not install.

3.1.2 Installing FlexDAQ Hub Logger Host Software

1. Insert the supplied LoggerNet™ DVD into the computer's DVD drive. The disk contains an auto-run feature.

2. Click 'Install LoggerNet' when prompted. Follow the on-screen instructions.

3.2 CONFIGURING LOGGERNET™ SOFTWARE

1. Insert the provided data logger setup USB drive.

2. Open LoggerNet™. Select the Main section and open the 'Setup' application.

3. Ensure that the application is in 'Standard mode' by clicking on the 'Std View' button located at the upper right corner of the application window. The application is already in Standard mode should the button reads 'EZ View' as seen in Figure 3-1.

4. Select 'Backup' from the toolbar. Select 'Restore Network…'. Refer to Figure 3-1.

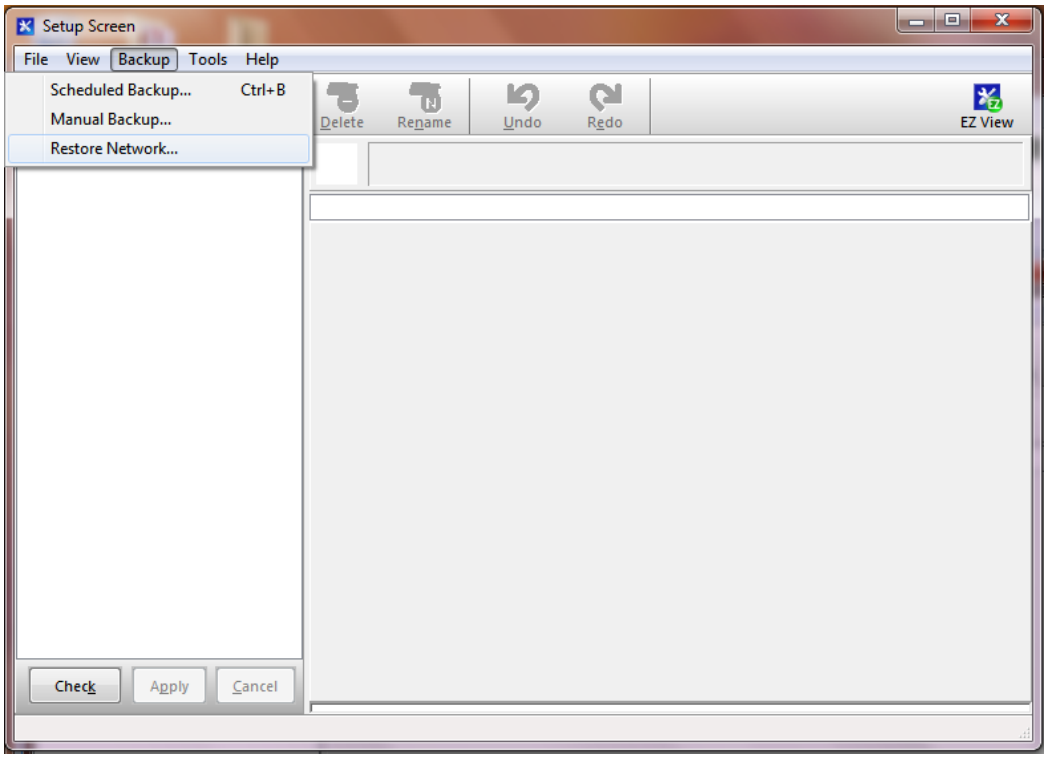

FIGURE 3-1 LOGGERNET™ BACKUP SCREEN

5 Use the file dialog to select the '.bkp' file located on the USB drive and follow the on-screen instructions. The configuration to communicate with the FlexDAQ logger will be loaded.

6 Click 'Apply' in the bottom left corner to save the settings.

7 Select the Com Port from the top of the network tree within the 'Entire Network' panel if connecting to the logger or base station radio over USB. Refer to Figure 3-2.

8 Click the 'Install USB Driver' button on the Hardware panel. Choose the appropriate interface from the resulting dialog. Refer to Figure 3-2.

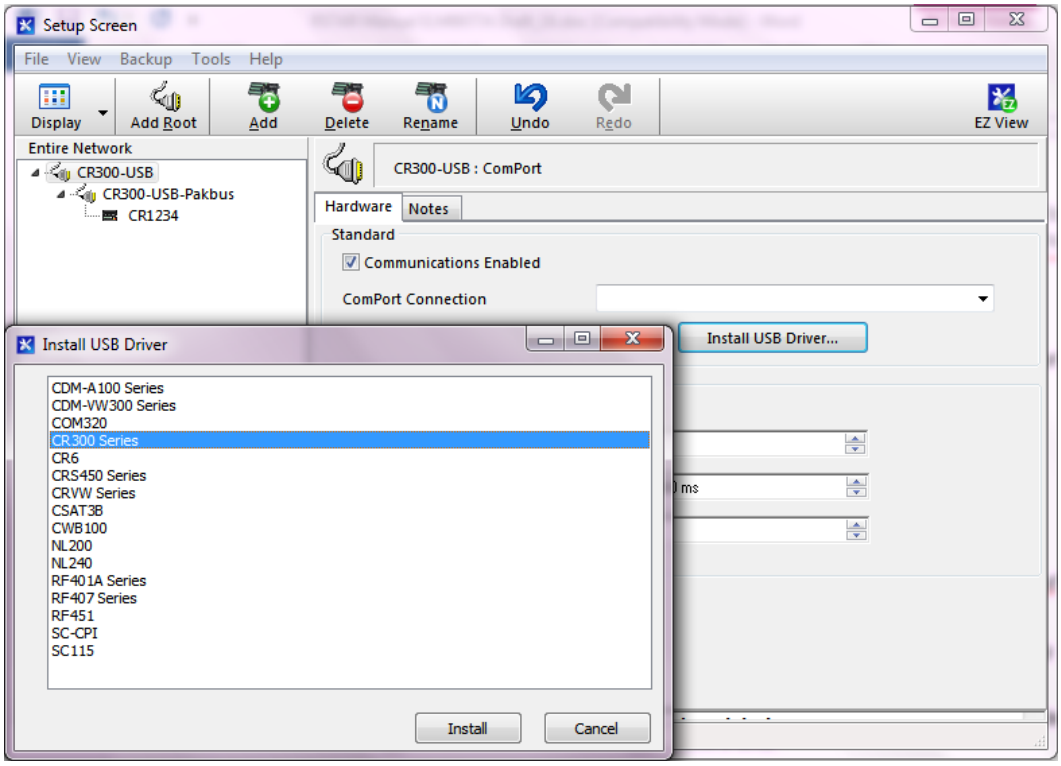

FIGURE 3-2 INSTALLING THE USB DRIVERS WITHIN LOGGERNET™

9 Connect the logger or base station radio to the PC using the USB port. Wait for the device to be recognized.

10 Select the appropriate port from the 'ComPort Connection' drop-down menu of the Hardware panel.

11 Click 'Apply' to save the settings.

12 Select the ‘Connect’ application from the ‘Main’ section within the LoggerNet™ launch window.

13 Click the 'Connect' button. The data logger should respond within 30 seconds and the connect button will show as connected.

14 Click the 'Set' button in the Clocks panel once successfully connected. All Node loggers will inherit the Hub Logger clock’s time.

NOTE: THE DATA LOGGER MAY BE CONNECTED OVER CELLULAR MODEM BY POWERING UP THE LOGGER AND ALLOWING THE MODEM TO CONNECT TO THE NEAREST CELLULAR PHONE TOWER. THIS PROCESS MAY TAKE UP TO 4 MINUTES. THE NETWORK AND SIGNAL LIGHTS ON THE MODEM WILL STOP BLINKING AND TURN GREEN. OMIT STEPS 7 THROUGH 9 ONCE CONNECTED TO THE CELL TOWER. LOGGERNET™ SETUP CAN BE VERIFIED WITH STEPS 10 THROUGH 12.

3.3 COMMISSIONING RSTAR FIELD DATA LOGGERS

3.3.1 FlexDAQ Hub Data Logger Installation

- It is strongly recommended to commission and install the FlexDAQ Hub data logger prior to installing Node Loggers.
- Choose a central location within line of sight of all Node Loggers when selecting a location for the FlexDAQ Hub data logger. The location should be as elevated as possible. It is possible to connect to Node Loggers over shorter distances that are not visible from the Hub antenna; however, signal will be reduced, especially if vegetation is present.
- Avoid installing the FlexDAQ Hub data logger near the edge of bodies of water if possible. Multi-path interference can reduce signal quality.

3.3.2 Node Data Loggers Installation

- Consult RST Instruments Manual ELM0089 for RST Instruments DT series data logger installation instructions.
- Antenna elevation will significantly improve radio link quality. Plan the Node Logger installations accordingly. Antennas at ankle height receive approximately an order of magnitude less signal than an antenna at waist height. The logger will also be subject to inundation by snow in many locations.
- Consider using a pole mounted directional antenna for Node Loggers with poor line of sight or long distances to their Hub Loggers.
- Consider using a secondary enclosure as a pre-engineered solution for antenna elevation and additional protection against vandalism and wildlife. Contact RST Instruments about Data Logger Enclosures for more details.

CAUTION: DT SERIES DATA LOGGERS SHOULD NEVER BE SUBMERGED OR INSTALLED IN A LOCATION THAT CAN BE FLOODED. ANY FAILURE TO SEAL THE ENCLOSURE AGAINST MOISTURE WILL VOID THE WARRANTY.

3.3.3 Antenna Installation

- All antenna coaxial cable connections should be finger-tight and torqued from as close to the thread as possible. Take care to avoid cross-threading the connectors.
- Ensure the antenna is oriented parallel to the Hub Omni antenna if using standard 3 dBi 'Rubber Ducky' Omni Antennas. Refer to Figure 3-3.
- Ensure that the antenna body is pointed at the Hub Omni antenna and the reflector elements are correctly polarized if using a direction Yagi-Uda antenna. Refer to Figure 3-3.

FIGURE 3-3 CORRECT ANTENNA ORIENTATION

NOTE: OMNI ANTENNAS PROVIDED BY RST INSTRUMENTS WILL BE VERTICALLY POLARIZED. ANY NODE LOGGER ANTENNAS NOT ORIENTED IN THE SAME DIRECTION WILL SUFFER A SIGNIFICANT SIGNAL PENALTY.

- Sealing the connections using Scotch® 130C Linerless Rubber Splicing Tape is recommended, especially in cold or wet environments.

3.3.4 Assessing Radio Link Quality and Deployment

In the rare event of lost packets between RSTAR data loggers and an L900 RTU HUB, RST has built-in software mechanisms that facilitate packet re-transmission for robust communications.

Signal strength can be assessed in the field with an operational commissioned Hub Logger when installing Node Loggers. The following instructions may also be used to locate the optimal aiming of Yagi antennas.

1. Connect the Node Logger to the computer via USB.
2. Open the DT Logger Host software on the computer.
3. Locate the 'Connections' tab. Select 'Wireless Settings'. Select ‘RSTAR Settings’
4. Press 'Ping' to start a constant stream of signal quality requests from the RTU.
5. The RSSI recorded at the Node Logger (Logger) and Hub (Base) will be displayed. The strongest signal measurable by the radio module is 40. Missed transmissions will begin to occur past 65-70. A returned value of 0 indicates no response packet was received.
6. Press 'Stop' to cease transmission once link quality has been optimized.
7. Press the 'Sync' button to update the Node Logger’s clock, interval, and transmission slot.

4 OPERATION

4.1 FLEXDAQ RSTAR DATA

4.1.1 Retrieving Data Table from the FlexDAQ Hub Logger

Connect to the Hub logger using the LoggerNet™ Connect application and click 'Collect Now' to retrieve the data.

Two data tables will be downloaded for each Node Logger type in the network. One file will contain sensor data. The other will contain the logger and RSTAR network diagnostic data.

4.1.2 RSTAR Sensor Data Table and Diagnostic Data Table

Each logger table will record the battery voltage and temperature of the Hub Logger as the first two data fields of the table. Subsequent columns contain the sensor or diagnostic data.

CRtest_D11data.dat (No Graph Associated) 3 Records

TIMESTAMP	RECORD	battVoltage	pTemp	DT11-1_Ch-1	DT11-1_Ch-2	DT11-2_Ch-1	DT11-2_Ch-2
2016-01-16 16:10:00	0	12.86	25.42	8744.89	22.6	8901.22	22.4
2016-01-16 16:20:00	1	12.85	25.7	8745.12	22.1	8901.45	22.2
2016-01-16 16:30:00	2	12.85	25.7	8745.75	22.4	8901.87	22.3

FIGURE 4-1 EXAMPLE SENSOR DATA FILE FOR RSTAR NETWORK WITH TWO DT2011B DATA LOGGERS

For example, the column heading 'DT11-2_Ch-1' in Figure 4-1 is the first channel of the second data logger in the network. A reading of 'NAN' indicates that data was not received at the RTU from the Node Logger.

Information about each transmission from each logger is stored within the diagnostic data file. The definitions for each field type are defined in Table 4-1.

The data logger prefix in the field name (E.G., ‘DT11-2’) is shared between the sensor data table and the diagnostic data table. This relationship is useful for determining the origin of sensor data.

For example, to find the origin logger of the data recorded in the ‘DT11-2_Ch-1’ column, simply find the serial number recorded in the ‘DT11-2_SerianNumber’ field of the diagnostic data table.

Node loggers will be in ascending serial number order in the sensor data and diagnostic data tables if no modifications have been made to the RSTAR network.

TABLE 4-1 DIAGNOSTIC DATA FILE DEFINITIONS

Field	Definition
SerialNumber	Serial number displayed on the lid of the Node Logger.
BatteryVoltage	Battery voltage of the primary cell of the node Data logger. Note that the lithium metal battery voltage is not correlated with battery life remaining. More information can be found in the manual of the corresponding data logger.
Temperature	This field is the temperature in degrees Celsius of the data logger. This does not refer to the thermistor of sensors being read by the data logger.
RRSIL	This refers to the signal strength of the response packet received at the logger node data logger.
RSSIB	This refers to the signal strength of the packet received at the RTU.
RxTime	The time from the beginning of the RSTAR transmit window that the logger's data packet was received.
TxRxStatus	This is the status code used to diagnose radio errors.
ReTxCount	This refers to the number of times the logger has failed to send a data packet. Retries are usually caused by lack of signal or noise sources near the Hub or Node Logger. If this field is increasing steadily, a higher gain antenna may be required.
Status	Diagnostic code for the Node logger's program status.
Open	Reserved for future use.

4.1.3 File Locations

LoggerNet™ saves downloaded tables in the **C:\CampbellSci\LoggerNet** directory by default. This can be changed in the 'Setup' application. Select the FlexDAQ Hub logger in the Network tree and navigate to the Data Files Tab.

Be aware that the '*.dat' files generated by LoggerNet™ are added to on subsequent data downloads. The files in the **C:\CampbellSci\LoggerNet** directory should only be copied and never be edited or renamed.

NOTE: THE DOWNLOAD LOCATION WILL RESET TO THE 'C:\CAMPBELLSCI\LOGGERNET' DIRECTORY IF THE TABLES ARE EVER CHANGED WITHIN THE FLEXDAQ HUB LOGGER BY UPLOADING A NEW PROGRAM.

4.1.4 Automatic Data Collection from FlexDAQ Hub Logger

Automatic data retrieval can be set up in the LoggerNet™ 'Setup' Application for FlexDAQ Hub Loggers connected to cellular modems or radio infrastructure.

1. Select the FlexDAQ Hub logger in the Network tree and navigate to the Schedule Tab.
2. Check the box title 'Scheduled Collection Enabled'.
3. Change the base Time to '12:01:00'.
4. Change the collection Interval to the minimum interval you plan to use for the RSTAR network.
5. Set the Primary Retry interval to 1 minute.
6. Set the number of Primary retries to 5.
7. Deselect the 'Secondary Retry Interval Enabled' box.
8. Apply the settings.

NOTE: IF THE HUB FLEXDAQ LOGGER RUNS LONG ENOUGH WITHOUT DOWNLOADING ITS DATA, THE FLEXDAQ LOGGER MEMORY WILL WRAP AND DATA WILL NEED TO BE RETRIEVED FROM THE NODE DATA LOGGERS TO FILL IN THE GAP.

4.1.5 Custom Data Tables

Custom solutions are possible for data structures. Contact RST Instruments for details.

4.1.6 Addition of Node Loggers

Contact RST regarding expanding the number of Node Loggers in an RSTAR network.

4.2 SETTING THE RSTAR MEASUREMENT INTERVAL

Network scan rates can be any period that divides evenly into 24 hours. For example, a scan rate of 60 minutes is acceptable but a scan rate of 61 minutes will result in an error.

Node data loggers will take sensor readings at each reading period starting at midnight. For example, if the interval is set to 6 hours, readings will be taken at 0000h, 0600h, 1200h, and 1800h.

The network scan rate cannot be set to less than 1 minutes or the listening window for transmit and retransmit of Node Loggers, whichever is longer.

FlexDAQ Hub loggers are configured with user selectable network intervals. The following steps outline how to view or modify the RSTAR reading interval:

1. Open the LoggerNet™ software and open the 'Connect' application from the Main menu.
2. Connect to the FlexDAQ Hub logger.
3. Open the 'Ports & Flags' interface.
4. Highlight an empty cell and click the 'Add…' button.
5. Locate the 'Public' Table. Select 'rstarMin_10' through 'rstarHr_12'. Click the 'Paste' button.
6. The current reading interval will be highlighted. Change the reading interval by clicking the desired indicator and deselecting the current interval's illuminated green indicator. This process may take 10 to 20 seconds and the indicator will be grey while the logger receives and confirms the commands sent by LoggerNet™.

Contact RST Instruments if a different measurement interval is needed.

NOTE: THE QUIESCENT CURRENT DRAW OF THE DT SERIES DATA LOGGERS IS EXTREMELY LOW. LITHIUM-THIONYL CHLORIDE BATTERIES LOSE VERY LITTLE CHARGE OVER TIME. THE BATTERY LIFE OF THE DT SERIES DATA LOGGERS IS DETERMINED BY HOW OFTEN SENSORS ARE READ. MORE INFORMATION CAN BE FOUND IN THE MANUAL FOR THE CORRESPONDING DATA LOGGER AND IN THE DT LOGGER HOST INSTRUCTION MANUAL (ELM0080).

5 MAINTENANCE

Refer to RST Instruments Manual ELM0088 for desiccant and battery replacement information for individual DT series data loggers.

6 SERVICE AND REPAIR

The product contains no user-serviceable parts. Contact RST for product service or repair not covered in this manual.

Appendix A RTU COMMUNICATIONS

The following section provides detailed instructions about communicating with the L900 RTU. The RTU Host software may also be used for some simple tasks. Please consult the RTU Host Instruction Manual (ELM0098) for further information.

POWER REQUIREMENTS

The L900 RTU can be powered through the USB or by using the 12 V and G terminals. The RTU will consume approximately 25mA of current under normal operations.

COMMUNICATION PORTS

The L900 RTU can communicate over either the USB or the Tx, Rx, and G terminals on the RS-232. Both ports will echo received transmissions.

Communications are echoed between both ports. For example, communications received on the Rx terminal of the RS-232 port will be echoed on the USB and RS-232 ports. The response of the RTU when it requests for data will be sent to both the USB and RS-232 ports.

The RS-232 port uses a baud rate of 115200 bps, 8 data bits, no parity, and 1 stop bit.

The USB port uses a baud rate of 921600 bps, 8 data bits, no parity, and 1 stop bit. **NOTE**: The USB port has a 2-character buffer which can be exceeded in the case of the processor being used for other tasks. An inter-character delay of 2 ms is recommended.

All communications except for MODBUS slave use the base ASCII character set.

Strings sent to the RTU by ASCII communications are only interpreted by the RTU processor when the carriage return character is sent (ASCII character 13 - `<CR>` henceforth). String use a space separator (ASCII character 32 - ␣ henceforth).

RTU COMMUNICATIONS FOR NETWORK READ SEQUENCE

Communications between the RTU and Hub data logger should follow the sequence below for the reading interval time T. Refer to Appendix B.

1. At `(T – 00:01:00)`, the Hub data logger should update the RTU's current time. This time will be shared with all Node Logger when they send their data.

2. At `(T + 00:00:10)`, the Hub logger will request the RSTAR listening state. The RTU response indicates whether or not the RTU is still waiting for Node data logger Transmissions. If this response is not received, the data logger should wait an appropriate interval before requesting the listening state again. Standard programs use 10 seconds between requests.

3 At (T + n * 00:00:10), when the RTU responds that it has received all data from Node Loggers, the Hub will request the Node logger sensor reading timestamp.

4 At (T + n * 00:00:10), Node Logger data is requested and transmitted from the Hub RTU via MODBUS master by the Hub data logger.

5 At (T + n * 00:00:10), once all node data has been received by the Hub Logger, the Hub Logger acknowledges the data transmission and clears the RTU memory for the next node sensor reading.

SETTING THE CURRENT TIME IN THE RTU

Use the following command to set the current time in the RTU:

'WT␣<Y>␣<M>␣<D>␣<h>␣<m>␣<s><CR>' where <Y> is the year, <M> is the month, <D> is the day of month, <h> is the hour (midnight is 0), <m> are the minutes, and <s> are the second.

For example 'WT␣2010␣11␣12␣13␣14␣15<CR>' would set the time to 1:14:15 PM, November 12th, 2010.

NOTE: THE REALTIME() FUNCTION IN CRBASIC WILL RETURN THE TIME AT THE START OF THE SCAN INTERVAL AND NOT THE TIME WHEN THE FUNCTION WAS CALLED. DELAYS AND PROCESSING TIME BEFORE THE TIME IS WRITTEN TO THE RTU WILL RESULT IN AN OFFSET IN SEND TIME.

READING THE CURRENT TIME IN THE RTU

Use the following command to read the current time in the RTU:

'RT<CR>' where the order of returned date-time values is the same as write time ('WT') command.

READING THE DT LOGGERS SENSOR TIMESTAMP

Use the following command to query the time when the DT loggers last read their sensors:

'DT<CR>' where the order of returned date-time values is the same as write time ('WT') command.

SETTING THE NETWORK READ INTERVAL

Use the following command to set the network read interval:

'INTW␣<h>:<m>:<s><CR>' where <h> are hours, <m> are the minutes, and <s> are the second.

DETERMINE RSTAR LISTENING STATE

Use the following command to determine the RSTAR listening state:

'QT<CR>'

The RTU will respond with ',1,...' Or ',0,…' indicating outside or inside RSTAR listening interval respectively.

This function can be used to make sure that all possible data is collected before retrieving data from the RTU.

RETRIEVING DATA FROM THE RTU

MODBUS MASTER

Data for each DT logger type can be queried from the RTU using MODBUS function 4 (read coils). The MODBUS addresses for different logger types are summarized in Table A-1.

For each logger of a requested type, the RTU will return 10 diagnostic fields, then the sensor data. As an example, for a network of two DT2011B Node Loggers: the first 10 returned values will be diagnostic from the first Node DT2011B, the next two channels will be sensor data from first Node DT2011B, the next 10 channels (13th through 22nd inclusive) will be diagnostic data from the second Node DT2011B, and the 23rd and 24th values will be the sensor data from the second Node DT2011B. See Table 4-1 for the identities of each the diagnostic fields.

MODBUS MASTER IN CAMPBELL DATA LOGGERS

The Following is a general case use of the MODBUS master function for Campbell Scientific Loggers:

'ModbusMaster(<ModbusResultVar>,<ComPort>,115200,<Modbus Address>,4,<TargetDataArray>,1,<totalChannels>,3,100)'

Contact RST if the total channels is greater than 720.

TABLE A-1 MODBUS ADDRESSES FOR DIFFERENT LOGGER TYPES

Logger Type	MODBUS Address	Configuration code	Channels per Node Logger
DT2011B	128 (0x80)	0x11	12
DT2055B	129 (0x81)	0x55	20
DT2040	130 (0x82)	0x40	50
DT TILT	131 (0x83)	0x65	12
DT4205	132 (0x84)	0x42	20
DT2485 10 Channel	134 (0x86)	0x81	20
DT2485 40 Channel	133 (0x85)	0x85	50
DT2485 70 Channel	135 (0x87)	0x87	80
DT2485 100 Channel	136 (0x88)	0x80	110
DT2485 130 Channel	137 (0x89)	0x83	140
DT2485 170 Channel	138 (0x8A)	0x8F	180
DT2350	139 (0x8B)	0x35	20
DT2306	140 (0x8C)	0x23	*Contact RST
GAA	142 (0x8E)	0xAA	11
DTSAA	144 (0x90)	0x5A	*Variable

ACKNOWLEDGING DATA TRANSMISSION FROM RTU

Clear the current data to allow the next transmission interval to proceed once all data has been correctly received from the RTU. Use the command:

'ND␣1<CR>'

Appendix B EXAMPLE CRBASIC CODE

The following program will assign sensor and diagnostic data from 2 DT2011B Loggers to the DT11Data() array. The reading interval of the network is 10 minutes and the RTU is wired to the C1/C2 Com port on a CR300™ type data logger.

```
'Declare number of DT2011B loggers in RSTAR network
Const nDT2011B = 2

'Declare variables
Public DT11Data(nDT2011B * 12)
Public i, timeSendString as string * 28, rstarTime(9)
Public RTUflag As String * 16, parsedRTUflag(6) As String * 10
Public rstarTimeString As String * 32, modBusResult

BeginProg
  Scan(1,Min,0,0)
    If TimeIntoInterval(0,10,Min) Then 'Execute when RSTAR network begins gathering data at the RTU

      SerialOpen(Com1,115200,0,0,100)

      RTUflag = "" 'Reset RTU flag to guard against failed query

      For i = 1 To 30 'Try every 10 seconds for 5 minutes
        Delay(0,10,Sec)
        SerialOut(Com1,"QT"+CHR(13),"",0,10) 'Query for RSTAR Listening State
        SerialIn(RTUflag,Com1,50,0,100)
        SplitStr(parsedRTUflag(1),RTUflag,",",1,0) 'Parse response
        SerialFlush(Com1)

        If parsedRTUflag(1) = 1 Then 'Execute if RTU is no longer listening for Node logger transmissions
          Delay(0,500,mSec)
          SerialOut(Com1,"DT"+CHR(13),"",0,100) 'Ask RTU for date-time of last RSTAR transmission
          SerialIn(rstarTimeString,Com1,50,0,100)
          Delay(0,500,mSec)
          SerialFlush(Com1)
          SerialClose(Com1)

          ModbusMaster(modBusResult,Com1,115200,128,4,DT11Data(),1,nDT2011B * 12,3,100) 'Query RTU for collected RSTAR data

          SerialOpen(Com1,115200,0,0,100)
          SerialFlush(Com1)
          Delay(0,500,mSec)
          SerialOut(Com1,"ND 1"+CHR(13),"",0,100) 'Acknowledge data from RTU
          SerialFlush(Com1)
          SerialClose(Com1)
          ExitFor
        End If

      Next i

    Else If TimeIntoInterval(9,10,Min) Then 'Execute 1 minute before RSTAR network begins gathering data at the RTU
      SerialOpen(Com1,115200,0,0,100)
      RealTime(rstarTime()) 'Get current time of CR300 logger
      timeSendString = "WT " + rstarTime(1) + " " + rstarTime(2) + " " + rstarTime(3) + " " + rstarTime(4) + " " + rstarTime(5) + " " + rstarTime(6) + " " + rstarTime(7) + CHR(13) 'Package CR300 time into compatible format for RTU
      SerialOut(Com1,timeSendString,"",0,100) 'Send CR300 time to RTU
      SerialFlush(Com1)
      SerialClose(Com1)
    End If
  NextScan
EndProg
```

CONFIGURING THE NUMBER AND ORDER OF NODE LOGGERS IN RTU

ADDING NEW NODE LOGGERS WITH SYNC FUNCTION

If the maximum number of loggers in RTU has not been reached, new data loggers can be added to the network by using the sync function in DT Logger Host software.

CLEARING RTU CONFIGURATION

RTU configuration can be cleared using the command '`WLC␣0<CR>`'.

CONFIGURING MAXIMUM ALLOWED NUMBER OF LOGGERS

The maximum number of loggers allowed in the RSTAR network is specified by the input '`WLC␣<nLoggers><CR>`'. For example, setting the maximum number of loggers to 30 would require the command '`WLC␣30<CR>`'.

READING THE CURRENT RTU CONFIGURATION

The current RTU configuration can be queried using '`RLC<CR>`'.

SPECIFYING AN RTU NODE LOGGER CONFIGURATION

Use the command '`WLC␣-1␣<configurationCode>,<serialNumber><CR>`' to specify the order of Node Loggers in the RSTAR network. See Table A-1 for configuration codes for all DT logger types. For example, the following commands would be used to configure a network of five DT2011B loggers with serial numbers ranging from 1111 to 1115 in serial number order:

```
'WLC␣-1␣11,1111 <CR>'
'WLC␣-1␣11,1112 <CR>'
'WLC␣-1␣11,1113 <CR>'
'WLC␣-1␣11,1114 <CR>'
'WLC␣-1␣11,1115 <CR>'
```

Note that loggers are added in the order in which the RTU receives them. The configuration must be cleared to edit the configuration.

READING THE RTU RADIO SETTINGS

The radio settings of the RTU can be read back using the 'INFO<CR>' command. Many of the RTU's parameters including the radio serial number, network ID, logging interval, and RTU configuration will be read back. Example RTU response below:

```
INFO,23<CR><LF>
RTU, Tx/Re  , 0,0,ms,115200,baud,1<CR><LF>
XBee Dest   , -<CR><LF>
XBee SN     , 0013A200,416289A1<CR><LF>
XBee ID/Pre , 7EAA,00,CM,00,FF,FF,FF,FF,FF,F7,FF,FF<CR><LF>
Data ID     , -<CR><LF>
Freq/Type   , 900.0,MHz,1,XBP9B-DPUT-001,CA<CR><LF>
XBee Key    , 0,0<CR><LF>
XMega       , 35,58,30,34,32,31,19,06,00,0A,00<CR><LF>
Pulse Power , -<CR><LF>
Tx Count    , R,-,S,-,D,-,E,-<CR><LF>
Power Down  , -<CR><LF>
Reset Count , w:7 p:7 e:0 b:0 s:0 i:0 r:80000120<CR><LF>
Error Code  , 80000120,00000025<CR><LF>
Logger Time , 2015/12/22 08:44:16.264<CR><LF>
Alarm Time  , 2015/12/22,08:50:00.000,343.720<CR><LF>
Interval    , 00:10:00<CR><LF>
Record Num  , 0,0,0,0,0,0<CR><LF>
Reset>Sleep , -<CR><LF>
Buffer Cmds , -<CR><LF>
Serial Num  , 03100, Firmware, 1.41,
2015/11/17,11:26:33<CR><LF>
Battery     , 6.36,-<CR><LF>
Logger Info ,
T,5,M,50,U,1,DT2011,5,DT2055,0,DT2040,0,TILT,0,DT4205,0,DT2350
,0,DT2306,0,DT2033,0,DT2485:10,40,70,100,130,170,0,0,0,0,0,0<C
R><LF>
RTU Temp    , -<CR><LF>
```