INSTALLATION GUIDE FOR

SOLAR POWERED RTU SITES

March 12, 2013
NOTICE

These instructions are intended as a general guide for personnel specifically trained and experienced in the installation of this type of equipment and related system components only. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment. Persons not qualified should not attempt to install this equipment nor attempt repairs according to these instructions.

Data Flow Systems, Inc. shall not be responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks. During installation and operation of this equipment, local building codes and fire protection standards must be observed. All wiring should conform to federal, state, and local electrical codes.

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Questions about this manual?

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OVERVIEW

A solar-powered RTU202 is ideal for monitoring remote data such as water levels, system pressures, and rainfall accumulation where commercial power is not available or practical. It is also useful for a utility that desires to take a site "off the grid."

A typical solar-powered RTU comes equipped with a Solar Power Module (SPM), an 18 Ah battery, and a 50-watt solar panel to provide power to a Telemetry Interface Module (TIM), Analog Monitor Module (AMM), and Digital Monitor Module (DMM).

The nominal design described above provides power to an RTU202 for up to 3 days without sunlight.

Solar mode requires that the TIM be polled using DFS’ solar Derivative Fractional Protocol (DFP). A configuration setting in HT3 sets DFP to solar mode. Solar mode is essentially the same behavior as standard DFP with an added sleep function to conserve power.

RTU Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>Solar RTU202</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Panel Watts</td>
<td>50 W (+10% / -5%)</td>
</tr>
<tr>
<td>Battery Rating</td>
<td>18 Ah (Sealed Lead Acid)</td>
</tr>
<tr>
<td>Days Without Sunlight*</td>
<td>3 to 5 days depending on modules and load; age of battery and temperature will also affect battery performance</td>
</tr>
<tr>
<td>Digital Monitoring</td>
<td>Up to 12 inputs (24 VDC) with up to 2 inputs being available for use as pulse inputs</td>
</tr>
<tr>
<td>Analog Monitoring</td>
<td>Up to 4 inputs (4-20 mA)</td>
</tr>
<tr>
<td>Enclosure Size</td>
<td>19.62” x 17.61” x 8.82”</td>
</tr>
<tr>
<td>Enclosure Material</td>
<td>Fiberglass / Polyester</td>
</tr>
<tr>
<td>Solar Panel Size</td>
<td>21.2” x 33.0” x 2.0”</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-22 to 131° F (-30 to 55° C)</td>
</tr>
<tr>
<td>Operating Humidity</td>
<td>Up to 95%, non-condensing</td>
</tr>
<tr>
<td>Battery Temperature</td>
<td></td>
</tr>
<tr>
<td>Dependency of Capacity</td>
<td>104° – 102%</td>
</tr>
<tr>
<td>(20 hour rate)</td>
<td>77° – 100%</td>
</tr>
<tr>
<td></td>
<td>32° – 85%</td>
</tr>
<tr>
<td></td>
<td>5° – 65%</td>
</tr>
</tbody>
</table>

* Refer to “Battery Performance” on page 6.
Installation Guide for Solar Powered RTU

Solar Power Module

2 Slots Available for Function Modules (typically AMM & DMM)

DIN-rail for Mounting Terminal Blocks

18 Ah Battery

Antenna Coax Connector

Ground Lug

Telemetry Interface Module (TIM007)
Solar Mode Operation

**IMPORTANT:** For systems with older DFS equipment, the CTU’s modules will need to be upgraded. DFP requires a TIM007 in the CTU. Additionally, the NIM001.exe on the CTU’s Network Interface Module (NIM) must be up to date. See “CTU Checklist” on page 13.

Solar Derivative Fractional Protocol (DFP)

Solar operation requires that the station be configured for solar Derivative Fractional Protocol (DFP) mode. (The station is added to a standard DFS driver; a record is added to the HT3 registry to configure that specific station for solar DFP mode.)

Solar DFP mode is essentially the same behavior as standard DFP with an added sleep function to conserve power. With standard DFP, HT3 doesn’t send change/no change queries, but instead polls the stations for table information. In this mode, the overhead of asking for changes and then polling for status is eliminated.

How Solar Stations Are Polled

With solar-mode DFP, HT3 uses a special algorithm to vary the order in which solar stations are queried. This ensures that all stations have the opportunity to respond when queried by the central server.

**Polling Operation:**

- The TIM wakes three (3) seconds before the top of each minute and polls the RTU’s modules. Based on battery voltage, the TIM will either wait for a query from HT3 or return to sleep mode.
- After the TIM queries the modules, it will wait up to 20 seconds to receive a query from HT3. It will then return to sleep mode until the next minute.
- In Sleep Mode the TIM powers down all but a clock component on its module, and also switches power off to the module bus.
- The TIM responds every minute to HT3 if the battery voltage is greater than or equal to 12.8 volts.
- If the voltage is less than or equal to 12.7 volts, the TIM will stay up and respond to the driver at the minute that is equivalent to the modulus (remainder) of its station address divided by 5. This limits the number of stations responding each minute.

The modulus result will always be an integer between 0 – 4. The TIM divides the 60 minute hour into 5 minute, 0 to 4 segments.

For example, if the station number is 82, the modulus would be 2. (82 /5 = 16 with a remainder of 2). As a result, station 82 would respond during the following minutes (indicated with an asterisk):

| 15:40 = 0 minute | 15:46 = 1 minute | 15:41 = 1 minute |
| 15:47 = 2 minute * | 15:42 = 2 minute * | 15:48 = 3 minute |
| 15:43 = 3 minute | 15:49 = 4 minute | 15:44 = 4 minute |
| 15:50 = 0 minute | 15:45 = 0 minute |
Low Voltage Threshold

If the TIM007 detects that voltage has reached the low voltage threshold of 9.1 volts, it will shut down all RTU modules other than the Solar Power Module (SPM). The SPM is needed to charge the battery. The TIM007 will only shut down the DC bias supply on the SPM. (The SPM is not a load on the battery when the DC bias supply is off.)
**SOLAR RTU MODULES AND BATTERY**

The solar RTU comes installed with a Solar Power Module (SPM) and a Telemetry Interface Module (TIM). Depending on your I/O needs, an Analog Monitor Module (AMM) and/or a Digital Monitor Module (DMM) will also be installed.

### Battery

The recommended 18 Ah battery provides power to the RTU overnight and during times when there is limited or no sun. The nominal design (18 Ah SLA battery and 50 W solar panel) provides power to an RTU202 for up to 3 days without sunlight.

#### Avoid Continuous Load to the Battery

**IMPORTANT:** Avoid adding a continuous load to the battery. (Continuous loads are devices that are powered directly from the battery and do not turn off with sleep mode.) Adding such a load to the battery will result in continuous depletion of the battery after the RTU modules have hit their low voltage shutoff point of 9.1 volts. By not adding a continuous load, the RTU modules will shut off at their low voltage threshold thereby preventing the battery from further discharge.

#### Typical Battery Voltage

Typical battery voltage ranges from 12.3 volts at night to 13.9 volts during full sunlight. To check battery voltage, use the procedure “Verify Proper Battery Voltage” on page 19.

### Battery Specifications

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nominal Voltage</strong></td>
<td>12 V</td>
</tr>
<tr>
<td><strong>Rated Capacity (20 hour rate)</strong></td>
<td>8.0 Ah</td>
</tr>
<tr>
<td><strong>Dimension</strong></td>
<td>5.94” x 2.56” x 3.94”</td>
</tr>
<tr>
<td><strong>Approximate Weight</strong></td>
<td>4.96 lbs</td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>77° F (25° C)</td>
<td></td>
</tr>
<tr>
<td>20 hour rate (0.40 A) – 8.0 Ah</td>
<td></td>
</tr>
<tr>
<td>10 hour rate (0.74 A) – 7.44 Ah</td>
<td></td>
</tr>
<tr>
<td>5 hour rate (1.36 A) – 6.80 Ah</td>
<td></td>
</tr>
<tr>
<td>1 hour rate (4.80 A) – 4.8 Ah</td>
<td></td>
</tr>
<tr>
<td><strong>Internal Resistance</strong></td>
<td></td>
</tr>
<tr>
<td>Full charged battery – 77° F (25° C)</td>
<td>Approximately 23 mΩ</td>
</tr>
<tr>
<td><strong>Temperature Dependency of Capacity</strong></td>
<td></td>
</tr>
<tr>
<td>(20 hour rate)</td>
<td></td>
</tr>
<tr>
<td>104° – 102%</td>
<td></td>
</tr>
<tr>
<td>77° – 100%</td>
<td></td>
</tr>
<tr>
<td>32° – 85%</td>
<td></td>
</tr>
<tr>
<td>5° – 65%</td>
<td></td>
</tr>
<tr>
<td><strong>Self Discharge</strong></td>
<td></td>
</tr>
<tr>
<td>(Residual capacity after standing X months)</td>
<td>3 months – 91%</td>
</tr>
<tr>
<td>6 months – 82%</td>
<td></td>
</tr>
<tr>
<td>12 months – 64%</td>
<td></td>
</tr>
<tr>
<td><strong>Anticipated Lifespan</strong></td>
<td>3 years</td>
</tr>
</tbody>
</table>

* These are average values obtained within three charge/discharge cycles – not the minimum values.
Battery Performance

The table below provides estimates for battery performance (hours and days) based on typical configurations.

Notes:

- Hours and Days calculations are estimates based on fully charged 18 Ah battery with nominal average temperature (25°C/77°F). Temperatures below or far above the nominal temperature will reduce battery efficiency.
- The maximum charge rate of the SPM002 is 4.5 amps. At this charge rate a depleted 18ah battery will be recharged in 4 to 6 hours of full sunlight.

<table>
<thead>
<tr>
<th>Modules are:</th>
<th>Average</th>
<th>Hours</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On*</td>
<td>Asleep†</td>
<td>Communicating</td>
</tr>
<tr>
<td>AMM002 Only</td>
<td>0.45A</td>
<td>0.03A</td>
<td>0.17A</td>
</tr>
<tr>
<td>AMM002 + DMM003</td>
<td>0.52A</td>
<td>0.04A</td>
<td>0.17A</td>
</tr>
<tr>
<td>AMM002 + DMM002-02†</td>
<td>0.57A</td>
<td>0.14A</td>
<td>0.17A</td>
</tr>
</tbody>
</table>

* On current includes 80 mA for 4 analog inputs, and 20 mA for 10 energized digital inputs.
† Loops in the AMM are not powered when the module is in sleep mode.
‡ The DMM002-02 is a legacy module modified for solar operation; power down is bypassed.
Solar Power Module (SPM)

The Solar Power Module (SPM) requires photovoltaic solar panel technology to capture energy from the sun. The nominal design provides power to an RTU202 for up to 3 days without sunlight, requiring a 50-watt solar panel and 18 Amp Hour sealed lead acid (SLA) battery. The SPM simultaneously powers the RTU and charges the SLA battery.

The SPM’s charger applies constant panel-to-battery connection until the battery is charged, then modulates. The 12 volt, 50-watt solar panel supplies up to 2.5 amps charging current:

- Typical solar panel voltage ranges from 0 (zero) volts at night to 21 volts during full sunlight.
- Typical battery voltage ranges from 12.3 volts at night to 13.9 volts during full sunlight.

An I/O list for the SPM is provided on page 23.

SPM Features

- Can control charging currents of up to 4.5 Amps
- Will charge a completely drained battery
- Isolated DC bias
- Can accommodate up to two solar panels
- LEDs for power and DC bias status
- RTU power on/off switch
- Momentary on/off switches (2) for solar panel testing
- Test points for measuring panel and battery voltage and charge current
- Removable without disturbing field wiring
- No on-board adjustments, switches, or straps (selfconfiguring)

SPM Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>SPM002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board Size</td>
<td>5.25” x 6.850”</td>
</tr>
<tr>
<td>Input Voltage (maximum)</td>
<td>30 VDC Voc</td>
</tr>
<tr>
<td>Input Voltage for Battery Charging (minimum)</td>
<td>+1.5 VDC</td>
</tr>
<tr>
<td>Minimum Operating Voltage</td>
<td>6 VDC</td>
</tr>
<tr>
<td>Input Current (maximum)</td>
<td>4.5 Amps</td>
</tr>
<tr>
<td>Bias Output Drive</td>
<td>Up to 12 digital input points (24 VDC)</td>
</tr>
<tr>
<td>Output Voltage (maximum)</td>
<td>14.1 VDC</td>
</tr>
<tr>
<td>LEDs</td>
<td>Power and DC bias</td>
</tr>
</tbody>
</table>
Telemetry Interface Module (TIM)

The Telemetry Interface Module (TIM) is a microprocessor-controlled module with an integrated radio. The TIM is specifically designed for use with our 200 Series RTUs. A TIM installed at a solar site has been factory configured for solar mode.

A data buffer on the TIM enables it to query its modules for status between radio polling loops and store that information until it is requested from the central site. The central site polls the solar RTU using the solar mode of DFS’ Derivative Fractional Protocol (DFP). The TIM also features a wake up / report / sleep mode that aids in battery conservation in solar-powered applications. The RTU is powered only when the TIM is polling the modules for status and sending status updates to the central site server.

The TIM includes a service port to provide communications link monitoring as well as the ability to directly monitor and/or control each module in the remote terminal unit using WinRTU Test software.

An I/O list for the TIM is provided on page 26.

TIM Features

- Supports DFS’ Derivative Fractional Protocol (DFP)
- Wake up / report / sleep operation keeps power consumption to a minimum
- Board-mounted high-speed serial digital radio (analog radio option available)
- Data buffer stores status changes between polls and during communication failures
- Communicates with function modules at 9600 baud
- 2x8 LCD display field diagnostics and support data
- 3-button user interface
- LCD has a radio test sub-menu that provides a counter for good and bad messages.
- Piezo buzzer beeps on good messages to assist in antenna alignment.
- RS-232 serial port monitor
- Test mode switch for radio service
- Uses data-compression algorithm on radio link
- Monitors RTU power and DC bias
- 7 status LEDs
- On-board voltage regulation
- On-board communications and functional firmware
- No on-board adjustments, switches, or straps (self-configuring)
TIM Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>TIM007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board Size</td>
<td>5.25” x 6.850”</td>
</tr>
<tr>
<td>Service Port</td>
<td>RS-232 (ASCII)</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>12-14 Vdc, 165 mA average, 1 A peak</td>
</tr>
<tr>
<td>Radio Interface</td>
<td>Digital, High-speed digital, TTL</td>
</tr>
<tr>
<td>Status LEDs</td>
<td>Transmit Data (TX), Receive Data (RX), Clear to Send (CTS), Request to Send (RTS), Carrier Detect (CD), Key, and Power</td>
</tr>
<tr>
<td>User Interface</td>
<td>2x8 LCD display and 3-button user interface</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>Up to 95%, non-condensing</td>
</tr>
</tbody>
</table>

Radio Specifications

Note: These specifications are for the T200 radio, which is typically specified due to lower power consumption. Customers with a high speed radio link can order the optional Voyager Video and Data Radio (VDR). Contact the DFS Sales Department for more information.

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>216 to 255 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Control</td>
<td>On-board PIC synthesizer; frequency programming via PC COM1/2</td>
</tr>
<tr>
<td>Channel Spacing</td>
<td>12.5 to 25 KHz</td>
</tr>
<tr>
<td>Channel Capacity</td>
<td>16 pre-programmed channels</td>
</tr>
<tr>
<td>Switching Bandwidth</td>
<td>Maximum of 10 MHz</td>
</tr>
<tr>
<td>RF Output</td>
<td>Up to 2 watts</td>
</tr>
<tr>
<td>Receiver Sensitivity</td>
<td>-115 dB at 12 dB SINAD for all models</td>
</tr>
<tr>
<td>I/O</td>
<td>Configurable as either digital (TTL) or analog (modem)</td>
</tr>
<tr>
<td>Frequency Response</td>
<td>9Hz to 3000Hz at -3dB</td>
</tr>
<tr>
<td>Type Acceptance</td>
<td>FCC Type Acceptance</td>
</tr>
<tr>
<td>DC Supply</td>
<td>10 to 14 Vdc; Nominal 12 VDC; 500 mA at 2 W RF out and 50 mA on receive</td>
</tr>
<tr>
<td>Connectors</td>
<td>Antenna connector is BNC or SMB/C; DB9 for signal and DC</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>Antenna connector is BNC or SMB/C; DB9 for signal and DC</td>
</tr>
<tr>
<td>Transmitter Duty Cycle</td>
<td>50% at 2 W</td>
</tr>
<tr>
<td>Transmitter Switching Time</td>
<td>&lt; 25 ms</td>
</tr>
<tr>
<td>Receiver Audio</td>
<td>250 mV p-p into 10L ohms for analog I/O; 5VDC TTL for digital I/O</td>
</tr>
<tr>
<td>Receiver Squelch</td>
<td>Noise operated; carrier detect on I/O connector (pin is active low when no signal)</td>
</tr>
<tr>
<td>Receiver RSSI</td>
<td>+1 to +3 VDC nominal; appears on I/O connector</td>
</tr>
<tr>
<td>Dimensions</td>
<td>4.5” x 2.0” x .75” including connectors</td>
</tr>
<tr>
<td>Enclosure Material</td>
<td>Metal with four-point chassis mounting</td>
</tr>
</tbody>
</table>
Analog and Digital Monitoring Modules

A typical solar-powered RTU includes an Analog Monitor Module (AMM002) and a Digital Monitor Module (DMM003). A brief overview of the modules is provided below.

Information on wiring and configuring analog and digital monitor points can be found in the TAC II SCADA System Installation Planning Guide. Information specific to the solar-powered RTU can be found in the Solar RTU Electrical and Mechanical Drawings. Both of these documents are available for download on the DFS website at www.dataflowsys.com/support/literature.php.

Analog Monitor Module (AMM002)

The Analog Monitor Module (AMM) is a microprocessor-controlled multiple-input card used to monitor from one (1) to four (4) analog inputs. The inputs are optically isolated; each input can be configured to receive a 0-20 mA or 0-5 V signal.

This module can also monitor four (4) optically isolated digital inputs.

The alarm limits (upper and lower) and the reporting dead-band are configured over the communications link by the central site.

AMM Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>AMM002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board Size</td>
<td>5.25” X 6.88”</td>
</tr>
<tr>
<td>Analog Input Type</td>
<td>0-5V or 0-20 mA</td>
</tr>
<tr>
<td>Analog Input Impedance</td>
<td>249 Ohm for 0-20 mA; &gt;100K Ohm for 0-5V</td>
</tr>
<tr>
<td>Protection</td>
<td>Transorb &amp; opto-isolated</td>
</tr>
<tr>
<td>Digital Input Voltage</td>
<td>10-30V (AC or DC); 31-300V (AC or DC) with inline resistors</td>
</tr>
<tr>
<td>Digital Input Impedance</td>
<td>6K Ohm</td>
</tr>
<tr>
<td>Bias Supply Voltage</td>
<td>24 VDC</td>
</tr>
<tr>
<td>Bias Supply Current</td>
<td>90 mA</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>8 to 14 VDC, 230 mA</td>
</tr>
<tr>
<td>LEDs</td>
<td>Power, receive data, transmit data, CPU failure, digital input status</td>
</tr>
</tbody>
</table>
**Digital Monitor Module (DMM003)**

The Digital Monitor Module (DMM003) is a microprocessor-controlled, digital input module designed to monitor from one to 12 digital inputs. Each input is optically isolated with transient suppression for protection from voltage spikes.

The DMM003’s inputs are user-configurable as pulse inputs making it capable of monitoring pulse inputs such as those produced by a tipping bucket rain gauge.

The DMM003 features a solar mode that uses awake/sleep cycles to conserve battery power when installed in solar RTUs. During a sleep phase, the DMM003 uses only approximately 15 percent of the power typically expended while it is “awake.” The DMM003’s design allows it to continue to monitor and count pulses for up to two inputs even while it is “asleep.”

The DMM003 can directly monitor AC or DC voltages from 10 to 30 V. By inserting a 22/47/100 K ohm resistor in series, an input can monitor from 31 to 300 VAC/DC. Each change at the monitored point is time-tagged to within 2 seconds of occurrence to maintain accurate event logging. This is critical when calculating pump run times and derived flows.

**DMM Specifications**

<table>
<thead>
<tr>
<th>Model</th>
<th>DMM003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board Size</td>
<td>5.25” x 6.88”</td>
</tr>
<tr>
<td>Input Voltages</td>
<td>10-30 VAC/VDC; 31-300 VAC/VDC with inline resistors</td>
</tr>
<tr>
<td>Input Protection</td>
<td>M.O.V., Transorb, and Opto-isolated</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>9 to 14 VDC</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>80 mA: non-solar operation / awake</td>
</tr>
<tr>
<td>Power Requirements</td>
<td>10 mA: sleep mode</td>
</tr>
<tr>
<td>Minimum Pulse Width</td>
<td>10 ms</td>
</tr>
<tr>
<td>Maximum Burst Frequency</td>
<td>60 PPS: non-solar operation / awake</td>
</tr>
<tr>
<td>Maximum Burst Frequency</td>
<td>40 PPS: sleep mode</td>
</tr>
<tr>
<td>Maximum Continuous Frequency</td>
<td>Non-solar operation: [4095 / polling time (s)] or 60 PPS, whichever is lower.</td>
</tr>
<tr>
<td>Maximum Continuous Frequency</td>
<td>Solar operation: The TIM007 is polled every minute, allowing for the maximum 60Hz (awake) / 40Hz (asleep).</td>
</tr>
<tr>
<td>LEDs</td>
<td>Power, receive data, transmit data, input status, CPU fault</td>
</tr>
<tr>
<td>Solar Application Requirements</td>
<td>TIM007 Telemetry Interface Module</td>
</tr>
<tr>
<td>Solar Application Requirements</td>
<td>CTU’s NIM must have correct NIM001.exe code installed</td>
</tr>
<tr>
<td>Solar Application Requirements</td>
<td>Hyper SCADA Server with HT3 3.1.1 or newer installed</td>
</tr>
<tr>
<td>Solar Application Requirements</td>
<td>Must be polled with solar mode of Derivative Fractional Protocol (DFP)</td>
</tr>
<tr>
<td>Pulse Inputs Notes</td>
<td>For a DMM003 used in a solar application, only inputs 11 and 12 can be configured as pulse inputs.</td>
</tr>
</tbody>
</table>
INSTALLING THE SOLAR RTU

What You'll Need

Before you begin installation, verify that you have all of the appropriate hardware as well as the additional documentation listed in “Companion Documentation,” below.

Hardware

- Solar Powered RTU, which typically includes the following:
  - RTU202, Rev. C1 (AC components and RIM battery connections are depopulated)
  - Solar Power Module (SPM) installed in Power Supply Module (PSM) slot
  - Telemetry Interface Module (TIM) factory configured for solar mode
  - Analog Monitor Module (AMM)
  - Digital Monitor Module (DMM003 or DMM002-2)
  - 18 Ah sealed lead acid (SLA) battery
- 12 volt, 50 watt solar panel
- Steel pole 2-3 inches in diameter and 11-13 feet tall for mounting the solar panel
- Hyper SCADA Server with HT3 3.1.1 or newer installed
- CTU with TIM007 installed. NIM in CTU must have proper code installed (see “CTU Checklist,” next page)
- Computer with Windows operating system installed

Companion Documentation

Download these companion documents from www.dataflowsys.com/support/literature.php

- TAC II SCADA System Installation Planning Guide – Information on wiring and configuring analog and digital monitor points.
- RTU Tower Installation Procedure – Information on installing and grounding the RTU tower and antenna.
- Solar Panel Tower Assembly Drawing – Information on installing and grounding the solar panel tower.
- Solar RTU Electrical and Mechanical Drawings – Information on wiring the solar RTU (DC power and analog loop).
- HT3 User Guide – Information on adding a standard DFS driver and a station in the HT3 SCADA software. (This must be done prior to configuring HT3 to poll the RTU with solar DFP.)
CTU Checklist

Verify that the Central Terminal Unit (CTU) has a Telemetry Interface Module TIM007 installed in the CTU’s radio slot.

Verify that the CTU’s Network Interface Module (NIM) has the proper NIM001.exe code installed.

1. Login to HT3.
2. Select Patch from the Tools menu.
3. Select the Nim tab.
4. In the Available Nim Files column, select nim001.exe.
5. In the Configure Nim Stations column, select the CTU’s NIM.
6. Click Directory Check (below the Nim Directory column).
7. Evaluate the contents of the Nim Directory to determine if the update is needed. The old nim001.exe file size is 260634 (or smaller for older releases). If the directory check of the Nim is 260634 or smaller, contact DFS’ Service Department to have your NIM updated to the proper code.

Installation Checklist

✓ Install RTU tower and antenna (page 13)
✓ Mount solar panel on steel pole (page 13)
✓ Mount RTU (page 14)
✓ Configure station address (page 15)
✓ Wire solar panel and battery to SPM (page 15)
✓ Align antenna (page 15)
✓ Test communication between TIM and CTU (page 16)
✓ Wire I/O modules to monitoring equipment (page 16)
✓ Configure HT3 to poll RTU using solar mode Derivative Fractional Protocol (DFP) (page 17)

Install RTU Tower

Install the RTU tower and antenna following the procedures provided in the RTU Tower Installation Procedure (available for download on the DFS website at www.dataflowsys.com/support/literature.php).

Mount Solar Panel

Note: Refer to the Solar Panel Tower Assembly Drawing when installing and grounding the solar panel (available for download on the DFS website at www.dataflowsys.com/support/literature.php)

The 12-volt, 50-watt solar panel recommended by DFS supplies up to 2.5 amps charging current for charging the 18 Ah battery. The solar panel provides power to the RTU during the day; the battery takes over at night.

The solar panel is installed near the RTU on a steel pole set in the ground in concrete. The pole is typically between 2- and 3-inches in diameter and 11 to 13 feet in length.
When selecting a site for your solar panels, be careful not to place them in an area that is shaded by trees or buildings or any other object. Note that shadows made by these objects move at least 20 feet farther to the south in the winter. If necessary, install a taller pole to avoid shading from nearby trees or buildings.

The diameter of the hole is usually 18 inches to 2 feet (18 inches plus the diameter of the pole). The depth of the hole must be 1/2 of the height of the pole above ground. The solar panel is attached to the pole by bolting or welding it into place.

The solar panel should be facing due south at an angle equivalent to the site's latitude (e.g., if the site is at 28° north, the panel's slope should be 28 degrees).

To maximize the output of your solar panel, you can adjust the angle through the year to follow the sun's changing position.

The rule of thumb is to set the panel at your latitude minus 15 in summer, and latitude plus 15 in the winter:

- Early February: Same angle as your latitude.
- Early May: Same angle of your latitude minus 15 degrees.
- Early August: Same angle as your latitude.
- Early November: Same angle of your latitude plus 15 degrees.

**Mount Solar Powered RTU**

A typical solar powered RTU is an RTU202 with modified backplane (AC components and RIM battery connections are depopulated). The RTU includes the following modules:

- Solar Power Module (SPM) installed in Power Supply Module (PSM) slot
- Telemetry Interface Module (TIM)
- Analog Monitor Module (AMM)
- Digital Monitor Module (DMM)

Install and ground the RTU as detailed in the *RTU Tower Installation Procedure* (available for download on the DFS website at www.dataflowsys.com/support/literature.php)
Configure Station Address

Address the RTU station as 1-250 or 256-511 using the DIP switches on the modular backplane. A TIM is addressed using the DIP switches on the modular backplane. The DIP switch for the TIM is above and just to the left of the TIM’s module slot.

Each DIP switch has an assigned bit value. The address is derived by totaling the values of the bits that are not grounded.

A DIP switch is grounded if it is in the CLOSED (or ON) position except for the 256-bit DIP switch, which is inverted. The 256-bit DIP switch is grounded if it is in the OPEN (or OFF) position.

The DIP switch example on the right shows a station address of 208.

We arrive at the station address by totaling the bit values of the switches that are OFF (or OPEN).

\[128 + 64 + 16 = 208\]

Wiring the Solar Power Module

The RTU202 (Rev. C1) is designed to accommodate solar power applications using the Solar Power Module (SPM002). The PSM slot is reconfigured by bringing the connections necessary for the SPM002 out to terminals. Nonessential components are removed from the board.

All solar installations should have an AMM installed in module slot A.

Solar Panel 2 and Battery 2 are parallel to Panel 1 and Battery 1, respectively, on the SPM.

An I/O list for the SPM is provided on page 23.

Refer to *Solar RTU Electrical and Mechanical Drawings* (available for download on the DFS website at www.dataflowsys.com/support/literature.php).

Align the Antenna

Test mode is a temporary mode used for antenna alignment. When the TIM is in Test Mode, the TIM’s piezo buzzer can be used to properly align the antenna.

Placing the TIM in Test Mode temporarily changes the RTU's station address to 255. When the central site detects that the RTU's station address is 255, it polls this RTU more frequently. (The HSS sends a full status message to the station every other message.)

While in test mode, the TIM’s Piezo speaker beeps for each “good” message received. Additionally, the TIM’s LCD has a radio test sub-menu that provides a counter for “good” and “bad” messages. This allows you to monitor the ratio of “good” and “bad” responses and make changes to the antenna alignment.

- 15 -
The objective is to fine-tune the alignment of the remote site antenna to ensure an optimal communications path. Make your initial alignment with a hand compass. Use the radio study information for the proper bearing.

Once you complete the initial alignment:

1. Temporarily install additional attenuation, as needed, between the radio and the antenna to continue testing.
2. Power down the TIM.
3. Power up the TIM while holding down the TIM’s center button (the middle button next to the TIM’s LCD screen).
4. Listen for the Piezo beeps and monitor the “good” and “bad” responses.
5. Turn the antenna for optimal alignment. Swing the antenna one direction until communications degrade. Then swing it the other direction until communications equally degrade. Position the antenna half way between these points.

Be sure to remove the attenuation and take the TIM out of test mode when antenna alignment is complete.

**Test Radio Communication between TIM and CTU**

When the TIM is placed in test mode, its piezo buzzer and LCD screen can be used to test radio communication between it and the CTU.

To place the TIM in test mode, press and hold the Enter button (center button) while powering up the TIM.

The LCD displays good and bad counts of the TIM-to-CTU radio communication. The piezo buzzer will beep each time a message is successfully sent and received. No beep indicates a problem with radio communication. If this occurs, refer to “Troubleshooting Communication Problems” on page 18.

**Wire I/O Modules**

**IMPORTANT:** Avoid adding a continuous load to the battery. (Continuous loads are devices that are powered directly from the battery and do not turn off with sleep mode.) Adding such a load to the battery will result in continuous depletion of the battery after the RTU modules have hit their low voltage shutoff point of 9.1 volts. By not adding a continuous load, the RTU modules will shut off at their low voltage threshold thereby preventing the battery from further discharge.

Information on wiring and configuring analog and digital monitor points can be found in the **TAC II SCADA System Installation Planning Guide** (available for download on the DFS website at www.dataflowsys.com/support/literature.php). Module wiring is the same regardless of power supply type.
Configure HT3 to Poll Using Solar DFP

Before the central site server can begin polling the solar powered RTU, the HT3 software must be configured to poll the TIM for solar power mode.

This is a two step process.

**Step 1:** Add and configure the TIM station under a standard DFS driver in HT3’s Configuration Editor. Detailed procedures can be found in the *HT3 User Guide* (an online user guide is available for download from the DFS website at http://www.dataflowsys.com/support/literature.php).

**Step 2:** Configure the TIM station to use solar DFP mode by configuring it in HT3’s Registry Editor (requires DFS login; MGR login can view the Registry Editor but can’t make changes to any setting other than server time and date).

**Add DFP Solar Station to Registry Editor**

1. Open the Registry Editor (click **Configure** on HT3’s main menu; click **System** on the Configure submenu.
2. Expand the Drivers branch and click **DFS_DRIVER**.
3. In the “Add New Property to DFS_DRIVER” form, enter DFP_SOLAR_XXXX in the left form field (where XXXX is the station’s address):
   - For stations configured under driver 1 or up, the station’s address is the driver number followed by three-digit station number. For example, 3017 for station 17 configured under driver number 3 (you must include a leading 0 for a station number that is less than 100).
   - Stations configured under driver 0 do not require a leading 0 in the station number if the station number is less than 100. For example, DFP_TABLE_21 for station number 21 configured under driver 0.
4. In the right form field, enter the word TRUE.
5. Click **Submit**.
6. Return to Configuration Editor and perform “Update Polling.”

**Note:** If you need the station to use TAC II protocol for troubleshooting purposes, select the station in the Registry Editor and enter the word FALSE in the station property field. “Update Polling” must be performed after changing the registry entry. The DFS Driver will now poll the solar RTU every minute, but will only expect to receive a response every five minutes.
Troubleshooting Communication Problems

If you are experiencing communication problems between a solar RTU and the Central Terminal Unit (CTU), follow the troubleshooting procedures in this section to pinpoint and correct the problem.

Has the CTU Been Updated to Support DFP Protocol?

In order for the CTU to communicate with Solar RTUs, the CTU must have a Telemetry Interface Module TIM007 in the radio slot. Additionally, the CTU’s NIM must have the proper nim001.exe code installed. Review the information in “CTU Checklist” on page 13.

Check Solar Panel and Battery Connections

Verify that the solar panel and battery connections are properly wired. Review the information in “Wiring the Solar Power Module” on page 15.

Is Solar Panel Clear of Obstructions That Could Prevent Full Sunlight?

When selecting a site for your solar panels, be careful not to place them in an area that is shaded by trees or buildings or any other object. Note that shadows made by these objects move at least 20 feet farther to the south in the winter. If necessary, install a taller pole to avoid shading from nearby trees or buildings.

Check Solar Panel Voltage

The Solar Power Module (SPM) has two test points (PNL_1+ or PNL_2+) for measuring solar power voltage.

Attach multimeter probes to the ground pin (GND) and to the test point of the panel you want to measure voltage for (PNL_1+ or PNL_2+).

Optimal solar panel voltage is 12 to 18 volts.
Verify Proper Battery Voltage

The Solar Power Module (SPM) has two momentary on/off switches that can be used to test that the solar panels are properly charging the RTU’s battery. There are two switches – one for each panel that can be connected to the SPM.

Procedure:
1. Attach multimeter probes to the BAT+ and GND terminals.
2. Hold the momentary switch in the off position.

Optimal battery voltage is 12.3 to 13.8 volts.

Do the TIM and RTU Modules Cycle In and Out of Sleep Mode Properly?

When a TIM is configured for solar mode, it enters a sleep mode after polling the RTU’s modules and waiting for a query from HT3 (as described in “Solar Mode Operation” beginning on page 3).

If the TIM is not entering and exiting sleep mode as expected, it may not have received its configuration from HT3. Verify that the station has been properly configured in HT3 as described in “Configure HT3 to Poll Using Solar DFP” beginning on page 17.

Check Coax and Antenna Connections

Verify that the coax and antenna connections are correct. Perform standard field antenna tests as described in the RTU Tower Installation Procedure (available for download on the DFS website at www.dataflowsys.com/support/literature.php).
**Is the TIM Receiving Messages?**

Observe the DS3 (Receive) LED activity to verify that the TIM’s radio is receiving messages (LED blinks when messages are received).

If there is no RX activity, first verify antenna alignment using the procedure, “Align the Antenna,” on page 15.

If antenna alignment is correct, install a different TIM at the site to see if the problem is with the TIM itself.

**Is the TIM Transmitting Messages?**

Observe the DS2 (Transmit) LED to verify that the TIM’s radio is transmitting messages (LED blinks when messages are transmitted).

If there is no TX activity, verify that the TIM is configured with the correct station address by comparing the address configured in HT3 with the one displayed on the TIM’s LCD screen.

The TIM’s LCD screen provides station configuration and status information. The TIM’s “home” screen lists the module name (TIM007) and the current time.

The second screen displays the TIM’s configured station address and its configuration (Cfg indicates that status of the invert, swap, 9600, and factory reserved bit.

The three buttons located next to the LCD are used to navigate through the screens:

- Press the bottom navigation button to view the next screen.
- Press the top navigation button to view the previous screen.

If the station address listed on the TIM’s LCD screen differs from the one configured in HT3, set the TIM to the correct station address using the procedure describe in “Configure Station Address” beginning on page 15.

(For more information on the TIM’s screens, see the *TIM007 Installation and Operation Manual*, available for download on the DFS website at www.dataflowsys.com/support/literature.php)
Is the TIM’s Clock Set to the Correct Time?

When the TIM first boots up, it waits for a time message from the Hyper SCADA Server and updates the time when the message is received. For a solar-powered TIM, the time is updated once a day. If the TIM’s time is incorrect, either the TIM has not received the Time broadcast from HT3 or the clock on the module is bad.

Check TIM’s Current Time

The TIM’s LCD screen provides station configuration and status information. The TIM’s “home” screen lists the module name (TIM007) and the current time.

```
TIM007
14:19:38
```

The three buttons located next to the LCD are used to navigate through the screens:

- Press the bottom navigation button to view the next screen.
- Press the top navigation button to view the previous screen

(For more information on the TIM’s screens, see the TIM007 Installation and Operation Manual, available for download on the DFS website at www.dataflowsys.com/support/literature.php)

Reset Time Manually with WinRTU Test

The clock can be set manually with WinRTU Test if necessary. This requires that the laptop itself have the right time and that it have WinRTU Test installed.

1. Connect the laptop to the TIM’s service port:
   a) Use the service cable included in the RTU Test Kit to connect the computer to the TIM. The service cable has a DB9 female connector on one end and a 10-pin dual row female connector on the other end.
   b) Connect the DB9 female connector to a serial port on the computer. If the computer doesn’t have a serial port, use the USB-to-serial adapter included in the RTU Test Kit.
   c) Connect the 10-pin dual row female connector to the TIM’s Service Port (located near the top of the module card).

2. Start WinRTU Test and login.
3. Select Module Config from the Form menu.
4. Click the Set Time button.
5. The Tx field will briefly show the time set message.
6. Observe the TIM’s LCD screen again to verify it accepted the message and is now showing the correct time.
Are Modules Receiving and Transmitting at the Correct Module Address?

1. Connect the laptop to the TIM’s service port:
   a) Use the service cable included in the RTU Test Kit to connect the computer to the TIM. The service cable has a DB9 female connector on one end and a 10-pin dual row female connector on the other end.
   b) Connect the DB9 female connector to a serial port on the computer. If the computer doesn’t have a serial port, use the USB-to-serial adapter included in the RTU Test Kit.
   c) Connect the 10-pin dual row female connector to the TIM’s Service Port (located near the top of the module card).
2. Start WinRTU Test and login.
3. Select Module from the Form menu. A Digital Module form appears.

4. Choose Auto from the Configure menu. WinRTU Test polls all of the RTU's modules. Depending on the type of module, either a Digital or Analog Module form is displayed for each module found.

5. WinRTU Test then cycles through each module’s digital and analog points. A beep sounds each time WinRTU Test detects an error in the receive message.

6. Compare the address in WinRTU Test to that which is configured in HT3. If necessary, change the module address in the HT3 configuration to match what is shown in WinRTU Test.

# Analog Monitor Module I/O List

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>(Strap) Module Address Ground</td>
<td>Ground</td>
</tr>
<tr>
<td></td>
<td>System DC Voltage+ (Bus)</td>
<td>42</td>
</tr>
<tr>
<td>41</td>
<td>(Strap) Module Address Bit 3</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>System Ground (Bus)</td>
<td>40</td>
</tr>
<tr>
<td>39</td>
<td>(Strap) Module Address Bit 2</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>Power Down (Bus)</td>
<td>38</td>
</tr>
<tr>
<td>37</td>
<td>(Strap) Module Address Bit 1</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Request To Send (Bus)</td>
<td>36</td>
</tr>
<tr>
<td>35</td>
<td>(Strap) Module Address Bit 0</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Clear To Send (Bus)</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>If 4-20 mA, strap to pin 31</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>(BK) Shunt #4</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Receive Data (Bus)</td>
<td>32</td>
</tr>
<tr>
<td>31</td>
<td>(BK) Analog #4-</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Transmit Data (Bus)</td>
<td>30</td>
</tr>
<tr>
<td>29</td>
<td>(WT/RD) Analog #4+</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>(WT/RD) 24 VDC+ Bias</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>System Ground</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>If 4-20 mA, strap to pin 23</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>(BK) Shunt #3</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>23 (BK) Analog #3-</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Transient Ground (Solid)</td>
<td>22</td>
</tr>
<tr>
<td>21</td>
<td>(WT/RD) Analog #3+</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Qualifier #1- (BK)</td>
<td>20</td>
</tr>
<tr>
<td>19</td>
<td>(WT/RD) 24 VDC+ Bias</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Qualifier #1+ (RD)</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>If 4-20 mA, strap to pin 15</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>(BK) Shunt #2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Qualifier #2- (BK)</td>
<td>16</td>
</tr>
<tr>
<td>15</td>
<td>(BK) Analog #2-</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Qualifier #2+ (RD)</td>
<td>14</td>
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<td>13</td>
<td>(WT/RD) Analog #2+</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Qualifier #3- (BK)</td>
<td>12</td>
</tr>
<tr>
<td>11</td>
<td>(WT/RD) 24 VDC+ Bias</td>
<td>10</td>
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<tr>
<td></td>
<td>Qualifier #3+ (RD)</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>If 4-20 mA, strap to pin 7</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>(BK) Shunt #1</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Qualifier #4- (BK)</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>(BK) Analog #1-</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Qualifier #4+ (RD)</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>(WT/RD) Analog #1+</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Qualifier #4+ (RD)</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>(WT/RD) 24 VDC+ Bias</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Qualifier #4+ (RD)</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>(BK) Bias Supply Return</td>
<td></td>
</tr>
</tbody>
</table>
# Digital Monitor Module I/O List

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>(Strap) Module Address Ground</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>System DC Voltage+ (Bus)</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>(Strap) Module Address Bit 3</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>System Ground (Bus)</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>(Strap) Module Address Bit 2</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Power Down (Bus)</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>(Strap) Module Address Bit 1</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Request to Send (Bus)</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>(Strap) Module Address Bit 0</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Clear to Send (Bus)</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Receive Data (Bus)</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Transmit Data (Bus)</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>(GY/OR) Input 7-</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>(OR) Input 7+</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>(GY/PK) Input 6-</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Transient Ground (Solid)</td>
<td></td>
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## SOLAR POWER MODULE I/O LIST

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# Telemetry Interface Module I/O List

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