SCADAPack E

350E Hardware Manual

Version: 8.12.4

Date: March 2016

Table of Contents

1 Legal Information

The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

Trademarks

Schneider Electric, ClearSCADA, SCADAPack, Trio, Modbus and StruxureWare are trademarks and the property of Schneider Electric SE, its subsidiaries and affiliated companies. All other trademarks are the property of their respective owners.

Microsoft and Windows are registered trademarks or trademarks of Microsoft Corporation in the United States and/or other countries.

Address

Schneider Electric
Telemetry & Remote SCADA Solutions
415 Legget Drive, Suite 101, Kanata, Ontario K2K 3R1 Canada
Direct Worldwide: +1 (613) 591-1943
Fax: +1 (613) 591-1022
Toll Free within North America: 1 (888) 267-2232
www.schneider-electric.com

2 Technical Support

Questions and requests related to any part of this documentation can be directed to one of the following support centers.

Technical Support: Americas, Europe, Middle East, Asia

Available Monday to Friday 8:00am – 6:30pm Eastern Time

Toll free within North America	1-888-226-6876
Direct Worldwide	+1-613-591-1943
Email	supportTRSS@schneider-electric.com

Technical Support: Australia

Inside Australia	1300 369 233
Email	au.help@schneider-electric.com

3 Safety Information

Important Information

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a Danger or Warning safety label indicates that an electrical hazard exists, which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **can result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, **can result in** minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

Before You Begin

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

⚠ WARNING

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

Failure to follow these instructions can result in death or serious injury.

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future reference.

Test all software in both simulated and real environments.

Verify that the completed system is free from all short circuits and grounds, except those grounds installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to help prevent accidental equipment damage.

Operation and Adjustments

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to help prevent unauthorized changes in operating characteristics.

Acceptable Use

SCADAPack E remote Programmable Automation Controllers (rPACs), Remote Terminal Units (RTUs) and input/output (I/O) modules are intended for use in monitoring and controlling non-critical equipment only. They are not intended for safety-critical applications.

⚠ WARNING

UNACCEPTABLE USE

Do not use SCADAPack E rPACs, RTUs, or I/O modules as an integral part of a safety system. These devices are not safety products.

Failure to follow this instruction can result in death or serious injury.

⚠ CAUTION

EQUIPMENT OPERATION HAZARD

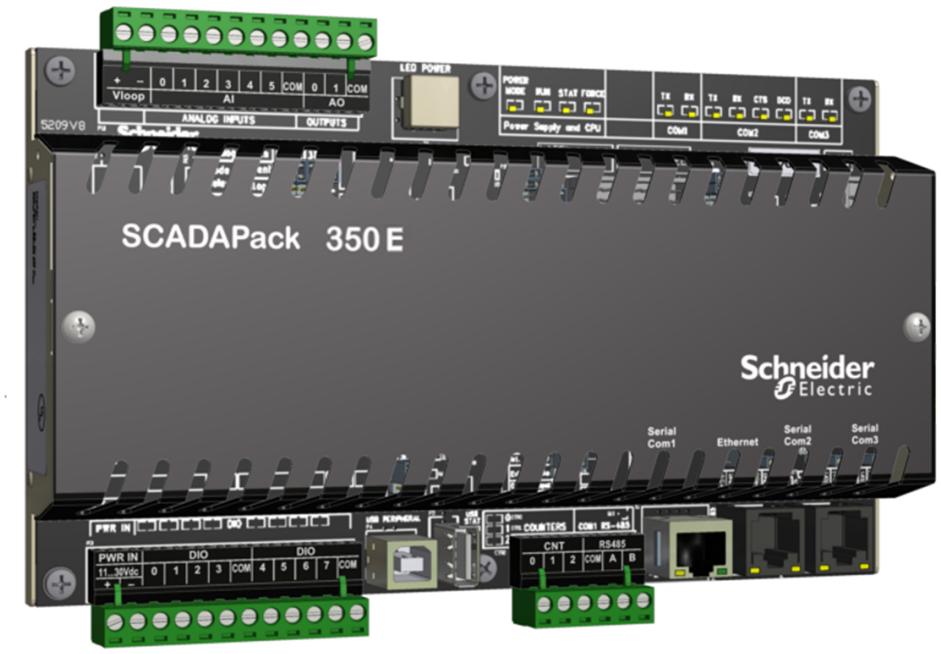
When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Use only Schneider Electric software or approved software with Schneider Electric hardware products.

Failure to follow these instructions can result in minor or moderate injury.

4 Documentation Check

Before you begin installation, verify that you are viewing the correct documentation. If your SCADAPack 350E looks like this (with green connectors and Ethernet and USB ports oriented such that you can plug in the cables from the front), continue with this manual.



SCADAPack 350E

If your SCADAPack 350E looks like this (with white connectors and Ethernet and USB ports oriented such that you have to plug in the cables from below), you will need to get the manual from **Start > All Programs > Schneider Electric > SCADAPack E > User and Reference Manuals > Legacy Hardware Manuals**.

SCADAPack 350E (Previous Version)

5 Introduction

The SCADAPack 350E is an intelligent microprocessor based telemetry and control unit. The SCADAPack 350E may operate Stand-alone providing data acquisition, process control and telemetry functions, or in conjunction with other SCADAPack E RTUs, I/O modules, and peripherals such as PLC's. The SCADAPack 350E features extensive communications capabilities including Ethernet and USB interfaces and a powerful embedded micro-controller to provide the user with a sophisticated telemetry Remote Terminal Unit (RTU) in an Open Systems environment.

Many operational facilities can be configured, depending on the required telemetry and control application. This manual describes the hardware aspects of the SCADAPack 350E.

The SCADAPack 350E has an extensive on-board I/O capability. The on-board switch mode power supply allows a wide range of voltage operation from a single external voltage supply (11...30 Vdc).

The use of FLASH memory chips allows new firmware to be downloaded both locally and remotely via the interfaces of the SCADAPack 350E, without removing the SCADAPack 350E from its enclosure, or removing the lid.

RTU configurations are maintained in the on-board battery backed RAM and may be modified locally or remotely.

The RTU may be integrated with a lower I/O module known as the 5606. When supplied in the same enclosure, these modules together are known as the SCADAPack 357E.

See the **5606 Hardware Manual** for more information.

6 Installation

For ATEX and IECEx applications only

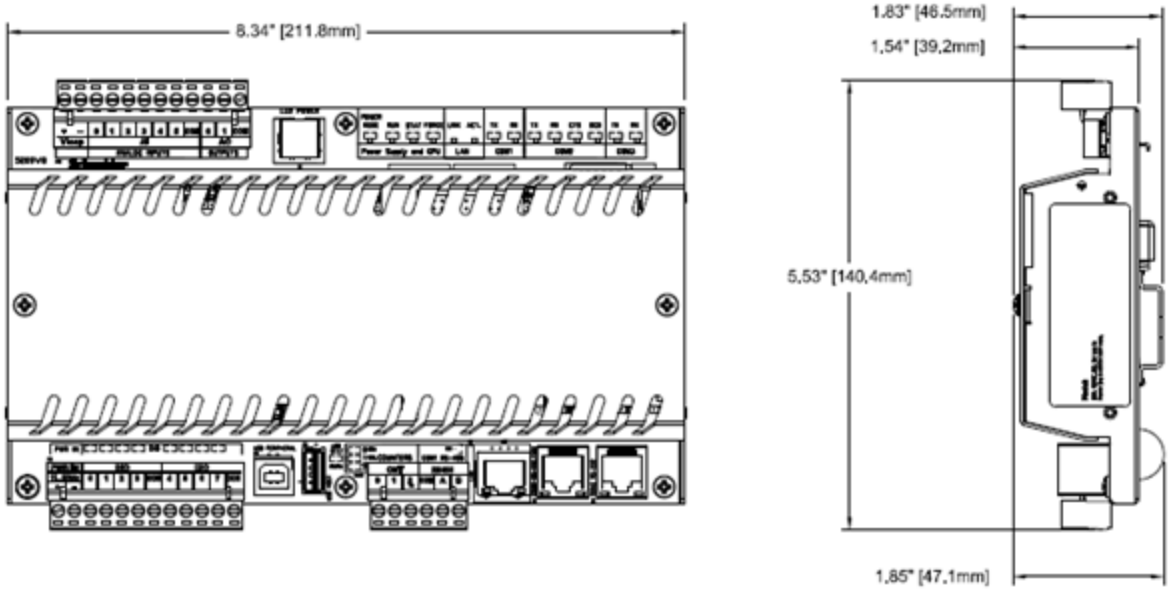
⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

- Install this equipment in an enclosure certified for use, providing a degree of protection of IP54 or better.
- The free internal volume of the enclosure must be dimensioned in order to keep the temperature rating.
- For products using solid state relays (5415, 5606 and 5607 modules and SCADAPacks using 5606 and 5607 modules), a T4 rating is acceptable for maximum loads of 2 A. When 3 A loads are connected to the solid state relays, the maximum ambient rating is lowered to 50 °C (122 ºF) in order to maintain the T4 rating.

Failure to follow these instructions can result in death or serious injury.

The following diagram shows the dimensions of the SCADAPack 350E.



SCADAPack 350E Dimensions

5606 Input/Output Module

The SCADAPack 350E may include an optional 5606 lower I/O module. The Model 5606 Input Output Module adds eight (8) analog inputs, 32 digital inputs, and 16 relay digital outputs to the 5000 Series input/output system.

Refer to the SCADAPack E 5606 Input/Output (I/O) hardware manual for details.

Together the SCADAPack 350E and 5606 I/O module in the same enclosure are known as the SCADAPack 357E.

The installation of the RTU requires mounting it on the 7.5 mm x 35 mm (0.30 in. x 1.38 in.) DIN rail and optionally connecting the RTU to a system I/O Bus.

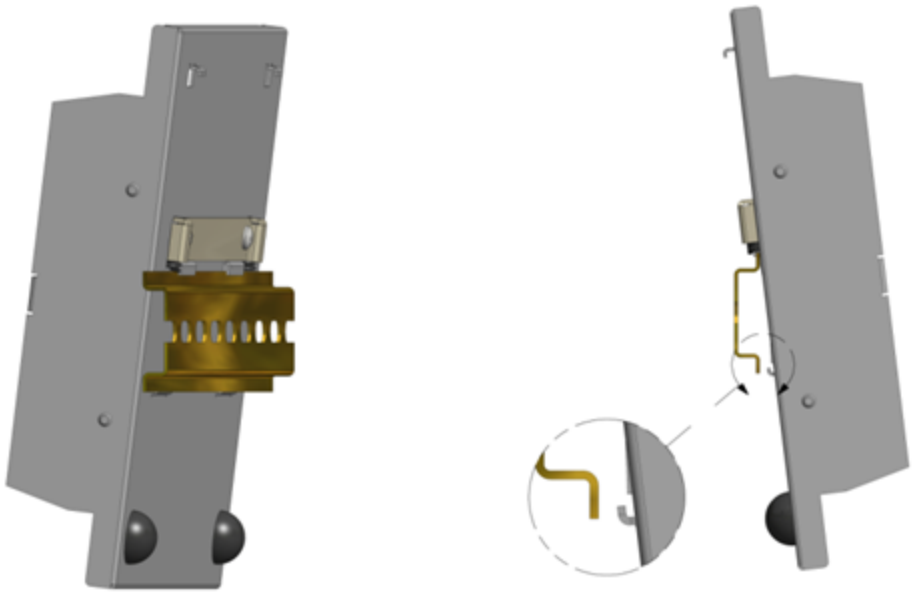
6.1 Mounting the SCADAPack 350E

To Mount the SCADAPack 350E on a DIN Rail

The illustrations below show the correct way to mount the device on a horizontally oriented 7.5 mm by 35 mm (0.30 in. by 1.38 in.) DIN rail. The steps to mount the device on a vertically oriented DIN rail are the same. Your device may look different from the device shown in the illustrations.

1. With the lower part of the device tilted away from the DIN rail, position the mounting guide line on the side of the device so that it is just above the edge of the DIN rail.

   The springs on the back of the device should rest on the DIN rail and the edge of the DIN rail should be under the support claws that are adjacent to the springs, as shown below.

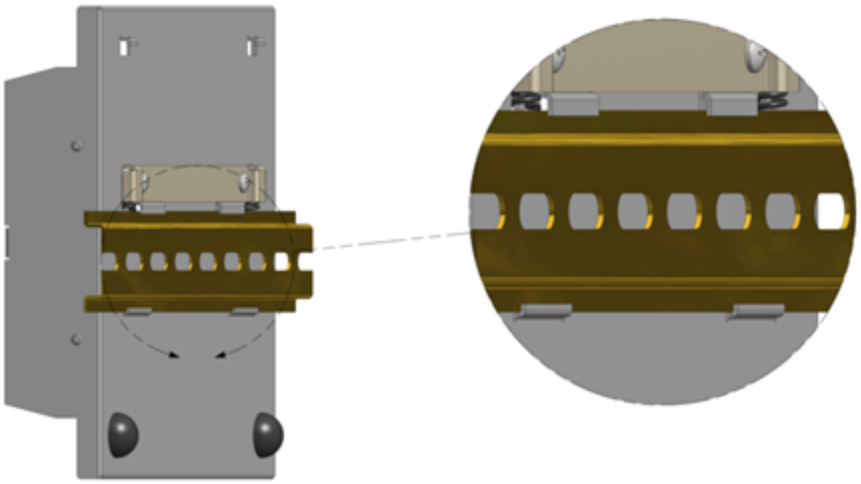


DIN Rail Alignment for Device Mounting

2. Push firmly on the device while tilting it toward the DIN rail until the DIN rail is positioned under both the upper and lower claws on the back of the device.
3. Release the pressure on the springs so that the DIN rail is held firmly in place between the upper and lower claws.

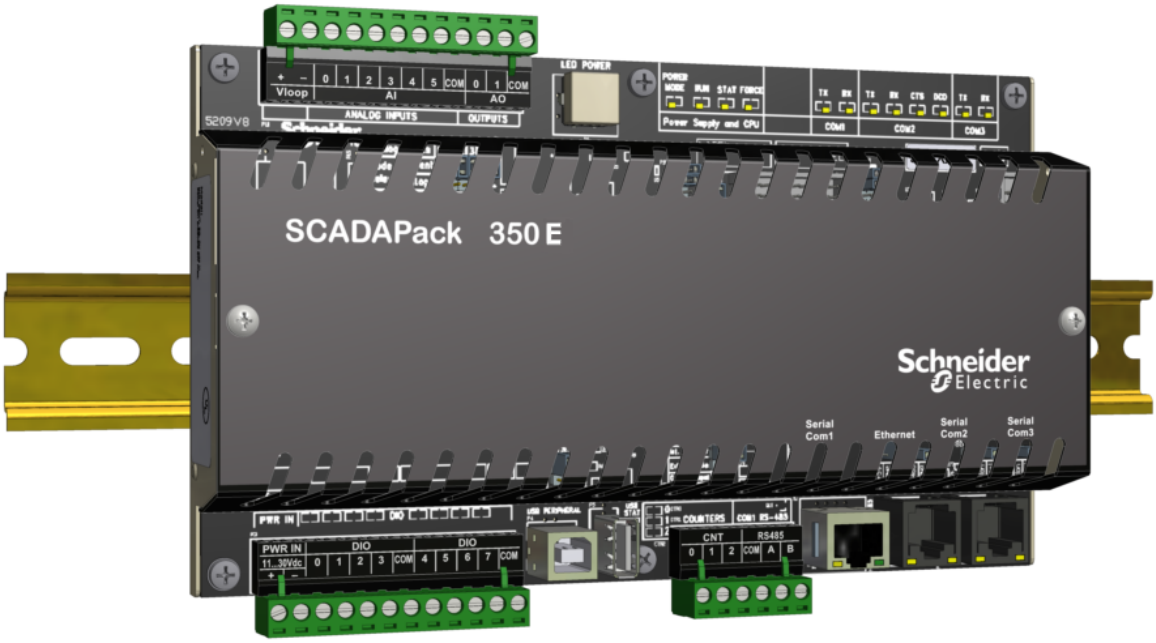
   The mounting guide line should be aligned with the edge of the DIN rail.

   The figure below shows a device with the DIN rail correctly positioned in the upper and lower claws on the back of the device.



Rear View of a Correctly Mounted Device

The figure below shows the front view of a device that is mounted on a horizontally oriented DIN rail.



Device Mounted on a Horizontally Oriented DIN Rail

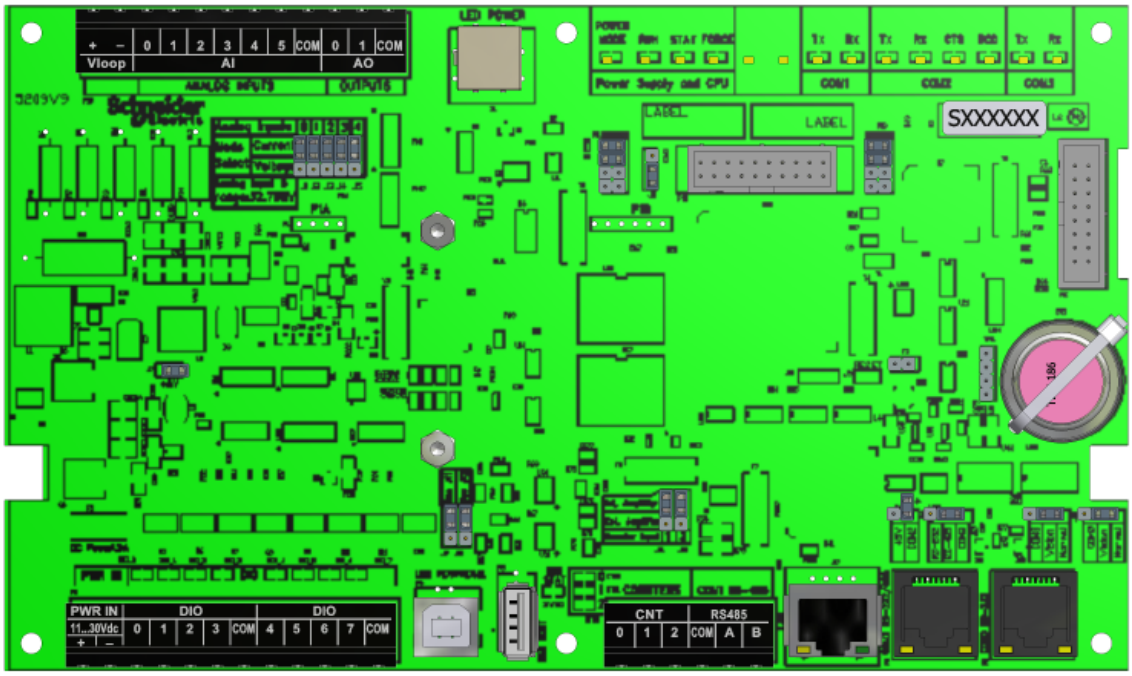
7 Field Wiring

SCADAPack E Smart RTUs use screw termination style connectors for termination of field wiring. These connectors accommodate solid or stranded wires from 3.3...0.08 mm² (12...22 AWG.)

Refer to the Board Layout 18 diagram for connector locations.

- The two RS-232 communication ports, COM 2 and COM 3, connect to 8 pin modular jacks. Refer to Section RS-232 Serial Communications Ports 50 for pinout details and wiring diagrams for these modular jacks.
- One Ethernet port connects to an 8 pin modular jack. Refer to Section Ethernet Communication 73 for pinout details.
- The serial and Ethernet ports on the RTU can be connected to:
  - A SCADA master system such as StruxureWare SCADA Expert ClearSCADA
  - Other SCADAPack E RTUs
  - Devices such as Programmable Logic Controllers (PLCs)
  - The SCADAPack E Configurator computer
- Other field wiring terminates in removable terminal connectors. Connector pinouts and wiring examples are described in each of the respective sections of this manual.
- The USB ports use conventional USB-A and USB-B interface connectors. Refer to Section USB Ports 74 for details.

The following diagram shows the locations of connectors and jumpers.



Board Layout

Wiring information is provided in the following topics:

7.1 Wiring Screw-Termination Connectors

Screw-termination style connectors are provided to terminate wiring from:

- Power supplies
- RS485 devices
- Input/output (I/O) devices

These 5 mm (0.197 in.) pitch connectors support solid or stranded wires from 3.3 mm² to .08 mm² (12 AWG to 28 AWG).

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment being monitored or controlled by the RTU or the I/O expansion module before removing power.

Failure to follow these instructions can result in death or serious injury.

NOTICE

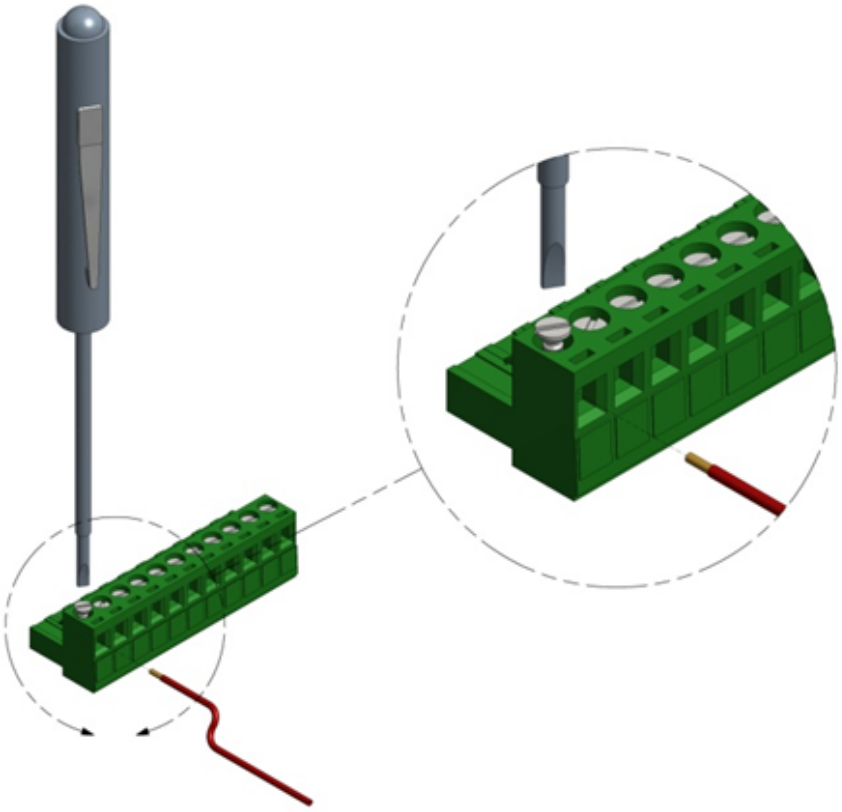
UNEXPECTED EQUIPMENT OPERATION

Remove power from the RTU before servicing.

Failure to follow these instructions can result in equipment damage.

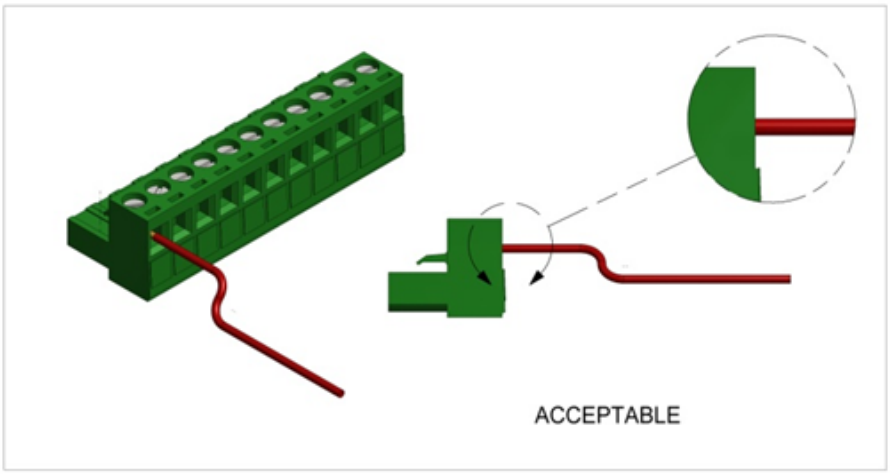
To wire a connector

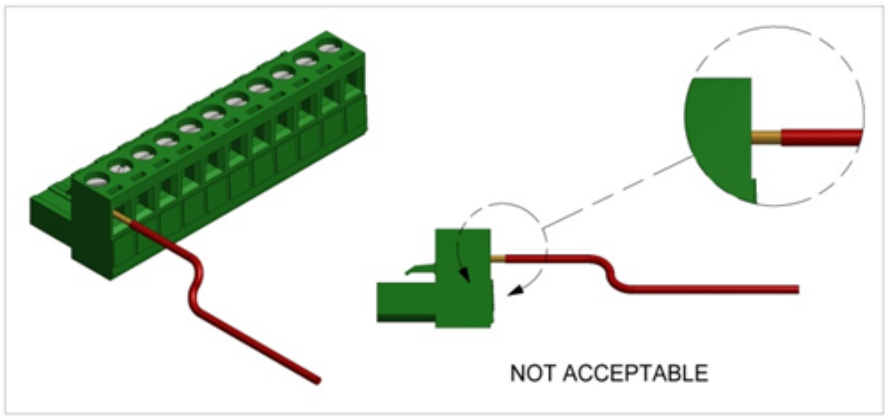
1. Use a slotted screwdriver to loosen the termination screw.



Loosening the Termination Screw

2. Insert the stripped wire into the connector so that the bared wire is located under the screw. As illustrated below, the bared wire should be placed fully within the connector.





Inserting the Wire into the Connector

3. Apply 0.5 Nm (4.5 lb-in.) torque to tighten the screw so the wire is held firmly in place.

7.2 Installing and Removing Termination Connectors

The termination connectors are removable, allowing replacement of the SCADAPack RTU without disturbing the field wiring. Leave enough slack in the field wiring for the connector to be removed.

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment being monitored or controlled by the device before removing power.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

HAZARD OF ELECTRIC SHOCK

Remove power from all devices before connecting or disconnecting inputs or outputs to any terminal or installing or removing any hardware.

Failure to follow these instructions can result in death or serious injury.

NOTICE

UNEXPECTED EQUIPMENT OPERATION

Do not exceed the maximum voltage specified for each analog and digital input.

Failure to follow these instructions can result in equipment damage.

To install the termination connector:

1. Line up the pins on the module with the holes in the connector. Make sure all the pins line up properly.
2. Push the connector onto the pins. Apply even pressure to both ends on the connector.

To remove the termination connector:

- Pull the connector upward from the board. Apply even pressure to both ends of the connector.

8 Power Supply Overview & Requirements

The RTU is powered from an 11 Vdc...30 Vdc input power source.

- Input power is applied to the positive (+) and negative (-) terminals on connector P3.

  Refer to Section Specifications 100 of this manual for the minimum and maximum operating voltages and input power requirements.

- When the input voltage is below the minimum recommended voltage the SCADAPack 350E will turn off.
- Exceeding the maximum input voltage or applying a reverse voltage will blow the input power fuse.

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Safety Extra Low Voltage (SELV) or Protective Extra Low Voltage (PELV) power supplies are required on the power input and I/O points. Power supplies with 100…240 Vac inputs that comply with safety standard IEC/EN 60950 generally have SELV outputs. Check with the manufacturer or the agency certification listing to confirm that they have SELV outputs.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

The input power supply must be a filtered DC supply.

Failure to follow these instructions can result in death or serious injury.

NOTICE

UNEXPECTED EQUIPMENT OPERATION

Do not connect to power sources such as 16 Vac transformers, as this will blow the fuse.

Failure to follow these instructions can result in equipment damage.

The DC power-input voltage is used to generate 5 Vdc at 1.2 A (6 W) some of which is used for the controller onboard circuitry. The output capacity of the 6 W is sufficient to power the RTU, a SCADAPack Vision operator interface and a limited number of 5000 Series I/O modules.

The power available for any 5000 Series expansion I/O modules is limited to 5.5 W (5 Vdc at 1200 mA) and depends on the features enabled.

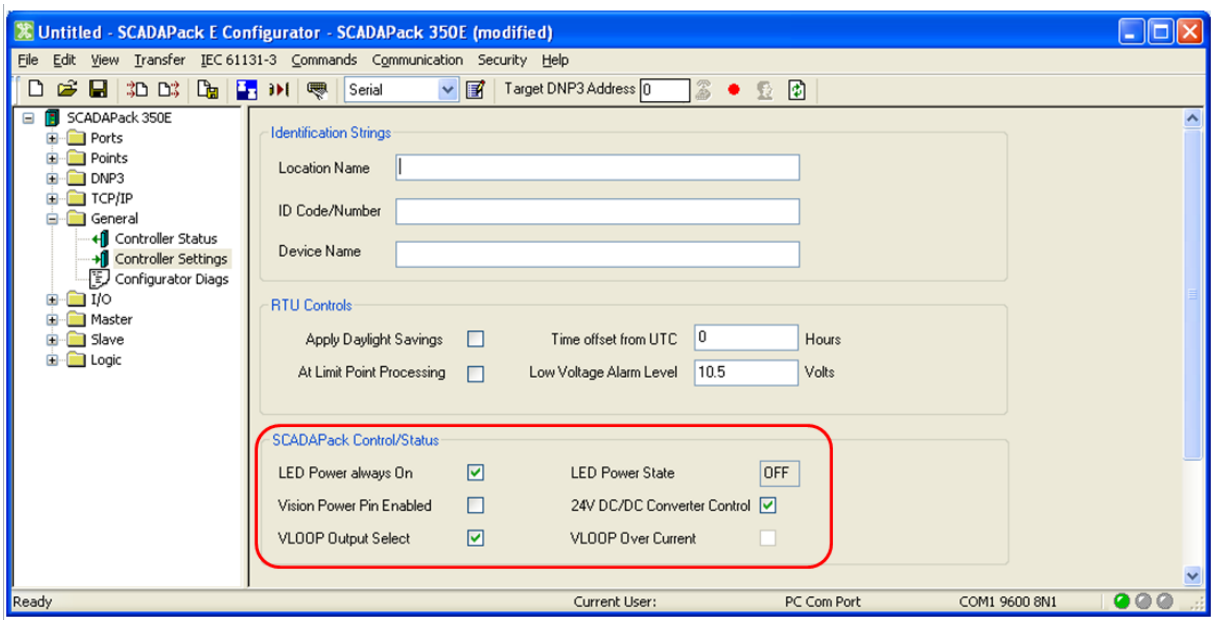
For 12 Vdc input voltages, an onboard DC/DC converter with an output capacity of 3.36 W (24 Vdc at 140 mA) can be used to power five 20 mA analog inputs and two 20 mA output devices (loop-powered transmitters). The 24 V DC/DC converter is controlled by the user application program and may be turned on or off. Refer to Section 24 V DC/DC Converter Control 30 for more information on DC/DC converter control.

8.1 System Grounding

Ground the system by connecting the system power supply common, to the chassis or panel ground. The negative (–ve) side of the DC power input terminal as well as I/O point terminals labeled GND are connected to chassis ground.

8.2 Power Management Features

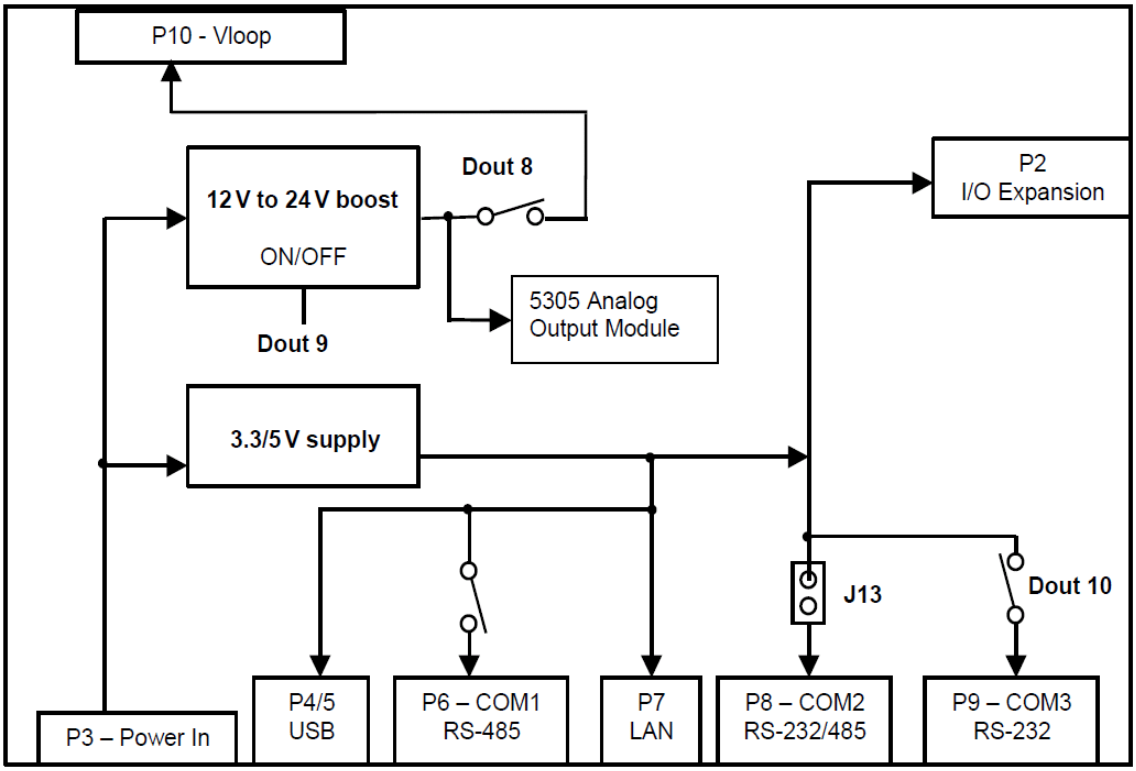
The RTU provides a number of special features to reduce power consumption. These features can be managed via binary system points that can be controlled in SCADAPack E Configurator or by the user application. SCADAPack E Configurator controls for the power management features are accessed from the **General > Controller Settings** page, shown in the image below.



The power management features with their associated binary system points are described in the following sections:

- COM3 Serial Port Power Control (50750) 27
- VLOOP Power Control (50610) 28
- VLOOP Over-Current Protection (50760) 29
- 24 V DC/DC Converter Control (50751) 30
- LED Power Control (50752) 31

See the diagram below for an overview of the power management features.



Power Management

8.2.1 COM3 Serial Port Power Control (50750)

The COM3 serial port is for use with the SCADAPack Vision or other Human Machine Interface (HMI).

Pin 1 of the RJ-45 connector provides a switched 5 Vdc power for the SCADAPack Vision or other HMI.

Refer to Section COM3 RS-232 Serial Port 55 for information on COM3 and Section RS-232 Cables (RJ-45 to SCADAPack Vision) 62 for wiring examples.

Binary System Point 50750

HMI power is controlled in the following ways.

- When the LED power is enabled, the HMI power is turned on.
- When the LED power is disabled and **Binary System Point 50750** is **ON** (**SCADAPack E Configurator Vision Power Pin Enabled ON**) HMI power is turned on.
- When the LED power is disabled and **Binary System Point 50750** is **OFF** (**SCADAPack E Configurator Vision Power Pin Enabled OFF**) HMI power is turned off.

Binary System Point 50750 indicates the status of COM3 serial port power. It is set when COM3 serial port power is on and is cleared when COM3 serial port power is off.

HMI power is turned on whenever the LED power is enabled. This feature is provided for service and diagnostics.

Refer to Section LED Power Control 31 for further information on this feature.

The **Vision Power Pin Enabled** control, found in the **SCADAPack E Configurator General > Controller Settings** page, can also be used to control the Vision (or other HMI) power.

8.2.2 VLOOP Power Control (50610)

Binary System Point 50610

The DC/DC converter output can be used to power analog input current loops or other instrumentation. This output, VLOOP, is controlled for intermittent or continuous operation. Turning the VLOOP output off when it is not required can save considerable electrical power.

The switched VLOOP power source is the output of the 24 V DC/DC Converter if it is turned on. See Section 24 V DC/DC Converter Control 30 for converter information. The VLOOP power source is the applied input power if the DC-DC converter is turned off.

- Turn on system **Binary System Point 50610** to turn ON the VLOOP Power Control (**SCADAPack E Configurator VLOOP Output Select ON**).
- Turn off system **Binary System Point 50610** to turn OFF the VLOOP Power Control (**SCADAPack E Configurator VLOOP Output Select OFF**)

Reading system **Binary System Point 50610** indicates the status of VLOOP power. It is set when VLOOP power is **ON** and is cleared when VLOOP power is **OFF**.

When VLOOP is first turned on, the user application program needs to wait some period of time for input readings to stabilize. This time period is depended on the field sensors and transmitters connected. Documentation for these devices should be consulted.

The VLOOP output is turned **ON** when the LED power is enabled. This feature is provided for service and diagnostics. Refer to Section LED Power Control 31 for further information on this feature.

8.2.3 VLOOP Over-Current Protection (50760)

Binary System Point 50760

When **VLOOP Power Control** is **ON**, it is monitored for excessive current consumption caused by field wiring or instrumentation.

If sustained over-current is detected (for over 100 ms), the **VLOOP Power Control** is turned **OFF** even though **Binary System Point 50610** is **ON**. This protection stops unnecessary fuse blowing, circuitry damage and rapid battery depletion.

When **VLOOP Power Control** is turned on using **Binary System Point 50610** (**SCADAPack E Configurator VLOOP Output Select ON**), and a short circuit or over-current is detected, VLOOP will turn off. VLOOP will turn on to try again 5 seconds after turning off. If the condition still exists, VLOOP will again turn off and retry after a 5 second delay.

While the condition exists, system **Binary System Point 50760** will be **ON** (**SCADAPack E Configurator > Controller Settings > VLOOP Over Current** indicator).

8.2.4 24 V DC/DC Converter Control (50751)

Binary System Point 50751

The 24 V DC/DC converter is used to provide 24 Vdc for VLOOP power and for the Analog Output module.

The converter should be turned on if the RTU is equipped with analog outputs for which 24 Vdc drive capability is required. Otherwise, the DC/DC converter can be turned off to conserve power.

- Turn on **Binary System Point 50751** to turn on the 24 V DC/DC converter (**SCADAPack E Configurator 24 V DC/DC Converter Control ON**). When the converter is turned on, 24 Vdc is provided to the VLOOP power and to the Analog Output module.
- Turn off **Binary System Point 50751** to turn off the 24 V DC/DC converter (**SCADAPack E Configurator 24 V DC/DC Converter Control OFF**). When the converter is turned off, VLOOP power and the Analog Output module use is the applied input power.

Internal **Binary System Point 50751** indicates the status of the 12 V to 24 V DC/DC converter. It is set when the 24 V DC/DC converter is on and is cleared when the 24 V DC/DC converter is off.

The 24 V DC/DC converter is turned on when the LED power is enabled. This feature is provided for service and diagnostics. Refer to Section LED Power Control 31 for further information on this feature.

8.2.5 LED Power Control (50752)

The LEDS on the RTU can be disabled to conserve power. This is particularly useful in solar powered or unattended installations.

LED Power State - Binary System Point 50761

The **Power Mode LED** indicates the status of the LEDs. It is on when the **LED Power State** control (**50761**) is enabled in the **SCADAPack E Configurator General > Controllers Settings** page .

LED Power Always ON - Binary System Point 50752

The **LED POWER** push-button toggles the LED power signal. Press the **LED POWER** push-button to toggle LED power from off to on, or from on to off.

The SCADAPack E Configurator enables the LED power mode.

- If the **LED Power Always On** control (**50752**) in the **SCADAPack E Configurator General > Controller Settings** page is active, the **LED POWER** button has no effect and the LEDs are on.
- If the **LED Power Always On** control (**50752**) in the **SCADAPack E Configurator General > Controller Settings** page is inactive, the state of LEDs at RTU startup is **Enabled**. 60 seconds after the controller has started the LEDs will be Disabled. While the controller is running, when the LED POWER button is pushed the LED displays are enabled for a period of 60 seconds. After this time the LED displays are again disabled.

The LED state is independent of the VLOOP, DC/DC Converter and Vision display controls on the RTU. The user may programmatically relate these items together through ISaGRAF logic if required (e,g. activate the DC/DC converter and Vision display when the LEDs are activated.)

9 Analog Inputs

The RTU provides six single ended analog inputs available for external wiring.

The external inputs provide 15-bit resolution over the range of the input.

Five external inputs can be configured for voltage or current mode.

The sixth external input is available for voltage mode only and will measure 0...32.768 Vdc. This input can be used to monitor the input power or a battery voltage. Wiring of the external outputs is covered in the following sections of this manual.

The analog inputs, identified as Channel 0 through Channel 5 are transient protected and share a common return (GND) that is connected to the chassis.

Analog Input Descriptions

Input	Type	Description
0 to 4	external	Jumper selectable for Voltage Inputs up to 10 Vdc or Current Inputs up to 40 mA.
5	external	0...32.768 Vdc for battery monitoring (Voltage mode only)

Access to the analog input points in a user application is achieved using an I/O connection in ISaGRAF. Refer to the SCADAPack E Target 3 Technical Reference Manual for more information.

When configured for current mode a 250 W current sense resistor will produce a 5 Vdc input at 20 mA. See Section Analog Input Mode Jumpers and Data Format 33 for information on setting the range.

When assigning RTU database points to the channels using SCADAPack E Configurator, you can select the mode of operation for each analog input channel. See Analog Inputs Mode Jumpers & Data Format 33.

The RTUs provide an internal system point for monitoring the RTU input power supply. This is independent of AI channel 5, allowing it to be used for other purposes.

Internal Analog Points are provided for monitoring of onboard controller variables. These can be used in a user application to monitor input voltage, RAM battery voltage, controller board ambient temperature and DC\DC converter voltage used for VLOOP.

Analog Inputs Mode Jumpers & Data Format 33

Analog Input Wiring 34

Analog Input Wiring Examples 35

9.1 Analog Inputs Mode Jumpers and Data Format

Analog Inputs Mode Jumpers

Channels 0 through 4 can be user configured for either voltage or current operation, using jumper links.

A sample illustration of the analog input mode selection using jumpers J1-J5 is given in Analog Input Wiring 36. A jumper link installed in the Current position of the header results in a 250 W resistor across the appropriate analog input. A jumper link installed in the Voltage position of the header results in a high impedance analog input.

Refer to the Board Layout 18 diagram in Field Wiring for the location of the analog input mode selection jumpers.

Analog Inputs Data Format

The I/O analog inputs have a 16-bit, unipolar, analog to digital (A/D) converter that measures input voltages from 0 to 10 Vdc. The analog inputs are factory calibrated to scale the data and represent it with a 15 bit unsigned number.

The following Input Type ranges can be configured by SCADAPack E Configurator for each SCADAPack 350E analog input channel:

- 0...10 Vdc / 0...40 mA
- 0...5 Vdc / 0...20 mA
- 1...5 Vdc / 4...20 mA

To select **Voltage** or **Current** mode for each analog input channel, set the Analog Inputs Mode Jumpers on the controller board.

When an analog input is configured for a voltage mode, 10 Vdc input is represented with 15 bits of data. The input resolution is 0.305 mV per A/D count from the A/D converter. The Input Type voltage range selected is scaled to the **Raw Min**. to **Raw Max**. range configured for the individual analog input point when point integer values are used. The **Eng. Min. to Eng. Max.** range for the point is used to scale the analog input **Engineering Floating Point** database value.

When an analog input is configured for current mode, 40 mA input is represented with 15 bits of A/D data. The input resolution is 1.22 µA per A/D count. The **Input Type** current range selected is scaled to the **Raw Min. to Raw Max.** range configured for the individual analog input point when point integer values are used. The **Eng. Min. to Eng. Max.** range for the point is used to scale the analog input **Engineering Floating Point** database value.

For example, if a SCADAPack 350E analog input point's attributes are **RAW_MIN = 0, RAW_MAX = 10000** and the input channel is selected for 4...20 mA: a 20 mA input is 100% of the selected input signal range and corresponds to 10000 counts. a 4 mA input is 0% of the selected input signal range and corresponds to 0 counts.

See SCADAPack E **Data Processing Technical Reference** manual for more information on scaling.

Channel 5 analog input is configured for voltage mode only. 32.768 Vdc is represented with 15 bits of data. The input resolution is 0.001 Vdc/count.

9.2 Analog Input Wiring

This section describes the wiring of analog inputs.

The analog inputs support loop powered and self-powered transmitters. Loop powered transmitters are two terminal devices that connect between a power supply and the analog input. The loop current continues from the power supply, through the transmitter and to ground through a 250 W resistor built into the 20 mA input circuit. Self-powered transmitters have three terminals typically labeled Power In, Signal Out and Common. Self-powered transmitters can have a current or voltage output.

- **Power In** connects to a power supply
- **Signal Out** connects to the Analog Input Channel
- **Common** connects to COM.

There are three options for the user when selecting the power source. In each case the user needs to confirm that the transmitter has enough voltage for proper operation. The transmitter manufacturer supplies the minimum operating voltage specification of the transmitter. The analog input requires a minimum of 5 Vdc.

- The first option is to use the RTU VLOOP Supply that steps up the input voltage to 24 Vdc. The stepped up voltage is available on the Analog Connector P10 and is labeled VLOOP. There is sufficient power available here for the five analog inputs and two analog outputs operating at 20 mA. Significant power saving is possible by switching the Loop Supply off.
- The second option is similar to the first except that the power supply is not stepped up to 24 Vdc. This can be used with low voltage transmitters or when then the input voltage is sufficiently high that further stepping up is not necessary. It is still possible to switch the supply off under program control. When the step up is turned off, VLOOP is approximately 0.5 Vdc less that the power input voltage.
- The third option is to power the transmitter from a power supply supplied by the user.

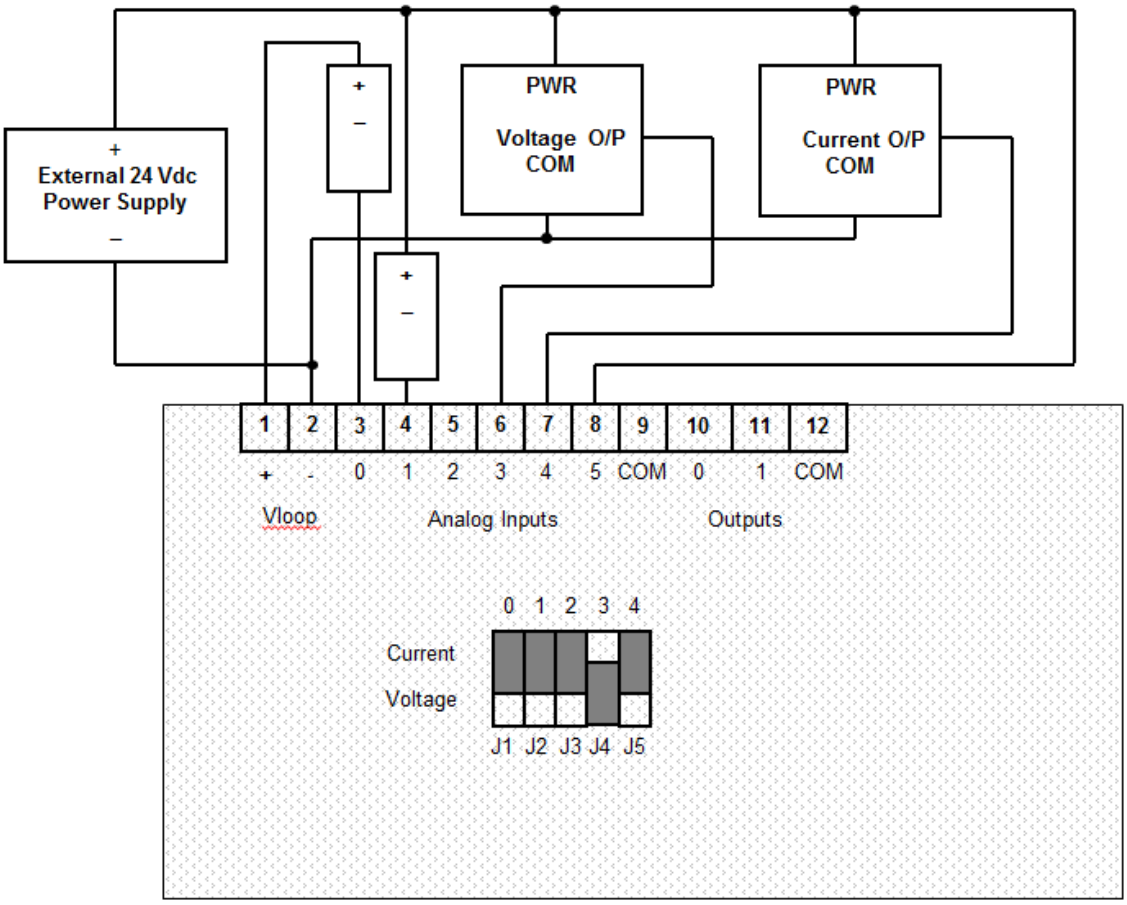
9.3 Analog Input Wiring Examples

NOTICE
UNEXPECTED EQUIPMENT OPERATION If a transducer or transmitter connected to an analog channel is placed outside of the building or structure where the RTU or I/O expansion module that provides the analog inputs is installed, there is an increased possibility of extremely severe power surges caused by lightning. In these cases, additional surge protection must be supplied by the user. **Failure to follow these instructions can result in equipment damage.**

NOTICE
UNEXPECTED EQUIPMENT OPERATION Analog input signals must be shielded using Belden 9322 or equivalent, when the unit is operating in an electrically noisy environment or to meet the requirements of EN61000-6-2. **Failure to follow these instructions can result in equipment damage.**

Example wiring of several transmitters is illustrated in the diagram below.

- Channel 0 has a loop powered current transmitter connected to VLOOP.
- Channel 1 has a loop powered current transmitter connected to an external 24 Vdc power supply.
- Channel 2 is unused.
- Channel 3 has a self-powered voltage transmitter connected to an external 24 Vdc power supply.
- Channel 4 has a self-powered current transmitter connected to an external 24 Vdc power supply.
- Channel 5 is used to monitor the external 24 Vdc power supply.



Analog Input Wiring

10 Analog Outputs

The SCADAPack 350E may include two analog output channels if this option was requested at time of purchase.

Refer to the SCADAPack E Target 3 Technical Reference Manuals for information on how to use the SCADAPack 350E Analog Outputs in application programs. Access to the analog output registers is achieved using an I/O connection in ISaGRAF.

Analog output channels can be directly controlled from SCADAPack E communications such as DNP3, Modbus, IEC60870-5 protocols without the need for an ISaGRAF application.

10.1 Current Outputs

The optional analog output module provides two 20 mA analog outputs.

The analog outputs use a 12-bit, unipolar, digital to analog (D/A) converter. There are 4096 discretization steps in the output signal range. The 0...20 mA output range resolution is 4.88 µA per D/A count.

One of the following ranges can be configured on SCADAPack E Configurator I/O | SCADAPack I/O page for the 5209 module. Both AO channels use the same range:

- 0...20 mA
- 4...20 mA

The internal power supply powers the analog output circuits. The user can, under program control or by selection on SCADAPack E Configurator, boost the DC Input Power to 24 V. This is required when generating current outputs into high resistance loads. Refer to Section 24 V DC/DC Converter Control 30 for further information.

NOTICE
UNEXPECTED EQUIPMENT OPERATION Analog input signals must be shielded using Belden 9322 or equivalent, when the unit is operating in an electrically noisy environment or to meet the requirements of EN61000-6-2. **Failure to follow these instructions can result in equipment damage.**

Analog Output Wiring 39 shows example wiring of the analog outputs.

10.2 Voltage Outputs

To obtain voltage outputs, connect a load resistor in series with the current output channel and the voltage device across the load resistor. The table below list resistance values and output range settings for two common voltage ranges. The resistance value listed is the parallel resistance of the device and the load resistor.

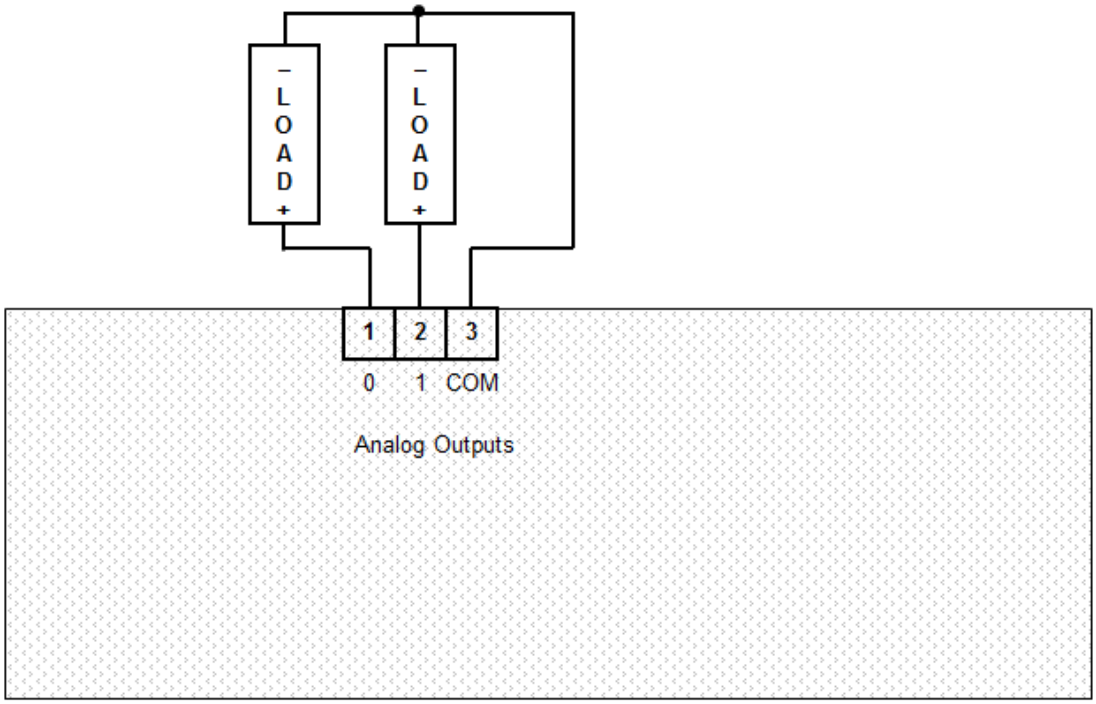
Resistance Values and Output Range Settings

Voltage Range	Resistance	Output Range
0...5 Vdc	250 ohms	0...20 mA
0...10 Vdc	500 ohms	0...20 mA

Analog Output Wiring 39 shows example wiring of the analog outputs.

10.3 Analog Output Wiring

The diagram below illustrates how to connect the analog outputs.



Analog Output Wiring

11 Digital Inputs/Outputs

The RTU provides eight universal digital inputs and outputs. The inputs are for use with dry contacts such as switches and relay contacts. The RTU provides the wetting current for the contacts.

If LED power is enabled, the RTU continuously sources approximately 5 mA wetting current into each dry contact input. Indicator LEDs will be at their maximum brilliance if on. This facilitates field service and diagnostics.

If LED power is disabled then the wetting current is turned on only when the digital inputs are scanned by the RTU. Indicator LEDs are dim in this condition. This is normal.

The following digital inputs can be read from a user application:

User Application Digital Inputs

Input	Type	Description
0 to 7	external	Dry contact inputs. These inputs are located on terminal P3. 0 = contact open (associated is LED off) 1 = contact closed (associated is LED on)
8	internal	VLOOP output status 0 = off 1 = on See Section VLOOP Power Control 28 for details.
9	internal	DC/DC converter status This bit reports the true status of the DC/DC converter. If over-current causes the converter to be turned off, this bit will clear. 0 = off 1 = on See Section 24V DC/DC Converter Control 30 for details.
10	internal	VLOOP over-current status Indicates VLOOP over-current has been detected. This input clears when VLOOP output is off, or the over-current condition clears. 0 = off 1 = on See Section VLOOP Over-Current Protection 29 for details.

Input	Type	Description
11	internal	Digital output mismatch Known outputs are compared to the corresponding inputs to detect incorrect outputs. A point is compared if it has been turned on at any time since controller reset. This input indicates if one or more outputs mismatch. The source of the mismatch can be determined by comparing each digital input against the corresponding digital output. 0 = off 1 = on
12	Internal	COM3 (HMI) power. 0 = off 1 = on See Section COM3 Serial Port Power Control 27 for details.

Refer to the appropriate software manual for information on using the Digital Inputs and Outputs in application programs.

For ISaGRAF applications refer to the **I/O Complex Equipment** for RTU I/O.

Digital outputs are open-collector/open drain type for use with sustained DC loads up to 1 ampere. Higher peak loads can be tolerated.

The negative side of the load is connected to the desired terminal on the controller terminal block P3. The positive side of the load connects to a power supply. When the load is on, the load current is switched through the controller to terminal labeled GND. GND needs to be connected to the negative side of the power supply.

Inductive load transient suppression is built into each digital output point. It is not necessary to add additional inductive load transient suppression unless highly inductive loads (greater than 1 H) are operated continuously at greater than 0.5 Hz.

11.1 Digital I/O Wiring

NOTICE

UNEXPECTED EQUIPMENT OPERATION

External lightning protection is required if the device being controlled is outside the physical area (cubicle or building) in which the SCADAPack 350E is located.

Failure to follow these instructions can result in equipment damage.

NOTICE

UNEXPECTED EQUIPMENT OPERATION

When wiring digital inputs:

- Confirm that the connection to the digital input does not exceed the ratings for the digital input. See the Specifications 100 section for details.
- Confirm that the polarity of the connection is correct with the two positive terminals wired together and the two negative terminals wired together.

Failure to follow these instructions can result in equipment damage.

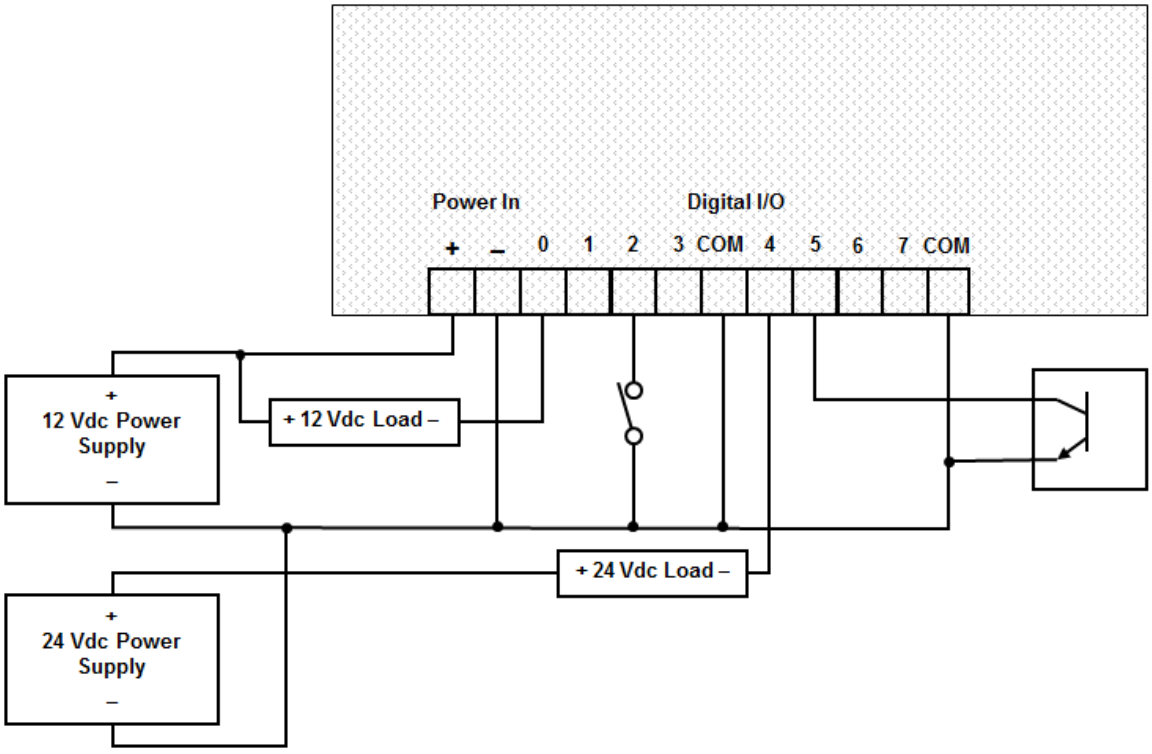
Various I/O point wiring examples are shown in the diagram below.

Digital I/O point 0 is shown connected to a 12 Vdc load that uses the same 12 Vdc power supply that powers the RTU.

Digital I/O point 4 is shown connected to a 24 Vdc load and external 24 Vdc power supply.

Digital I/O point 2 is shown monitoring a dry contact.

Digital I/O point 5 is shown monitoring an open collector contact. Transient voltage suppression is included on each I/O point.



Digital Input/Output Wiring

12 Counter Inputs

The RTU has three counter inputs, identified as Counter 0, 1 and 2.

Two of the counter inputs, Counter 1 and 2, are designed for millivolt level turbine meters.

The third, Counter 0, is a high level digital input for use with open collector/drain output amplifiers.

Refer to the appropriate software manual for information on using the Counter Inputs in application programs.

- Assign RTU database point indexes to the Counter In field(s) using the controller (5209 Composite I/O) in **SCADAPack E Configurator's I/O > SCADAPack I/O** page.
- For Target 3 applications use an rtuXXctr Input Board or complex equipment type for the RTU to read the controller board counters.
- For Target 5 applications use an RTU_COUNTER_READ I/O device for the RTU to read the controller board counters.
- Use the Counter Input point directly by using a Counter Point in the RTU database for the assigned DNP Point Number.

Turbine Meter Counter Inputs 1 and 2 43

12.1 Turbine Meter Counter Inputs 1 and 2

The RTU allows for the direct connection of two turbine meter sensors. These sensors produce millivolt outputs and an additional pre-amplifier is not required to be connected to an RTU. The turbine meter inputs should be used in low noise environments with shielded cabling.

There are four jumper links positions: J9, J10, J11 and J12, associated with configuring the turbine meter counter inputs for either millivolt signals (direct to sensor) or high level signals from turbine meters with external amplifiers, dry contacts or open collector outputs.

Jumpers J9 and J11 enable the SCADAPack E Smart RTU pre-amplifier on turbine counter input 1.

Jumpers J10 and J12 enable the SCADAPack E Smart RTU pre-amplifier on turbine counter input 2.

Directly Connecting to Low Voltage Turbine Meters 46

Connecting to Higher Voltage Turbine Meters 47

Connecting to Open Collector / Dry Contact Turbine Meters 49

12.2 Counter Input Wiring

This section describes the wiring of counter inputs.

NOTICE

UNEXPECTED EQUIPMENT OPERATION

Do not exceed the maximum voltage specified for each counter input.

Failure to follow these instructions can result in equipment damage.

NOTICE

UNEXPECTED EQUIPMENT OPERATION

When wiring counter inputs:

- Confirm that the connection to the counter input does not exceed the ratings for the input. See the ***Specifications*** section for details.
- Confirm that the polarity of the connection is correct with the two positive terminals wired together and the two negative terminals wired together.

Failure to follow these instructions can result in equipment damage.

NOTICE

UNEXPECTED EQUIPMENT OPERATION

Counter input signals must be shielded using Belden 9322 or equivalent, when the unit is operating in an electrically noisy environment or to meet the requirements of EN61000-6-2.

Failure to follow these instructions can result in equipment damage.

Counter Input 0 45

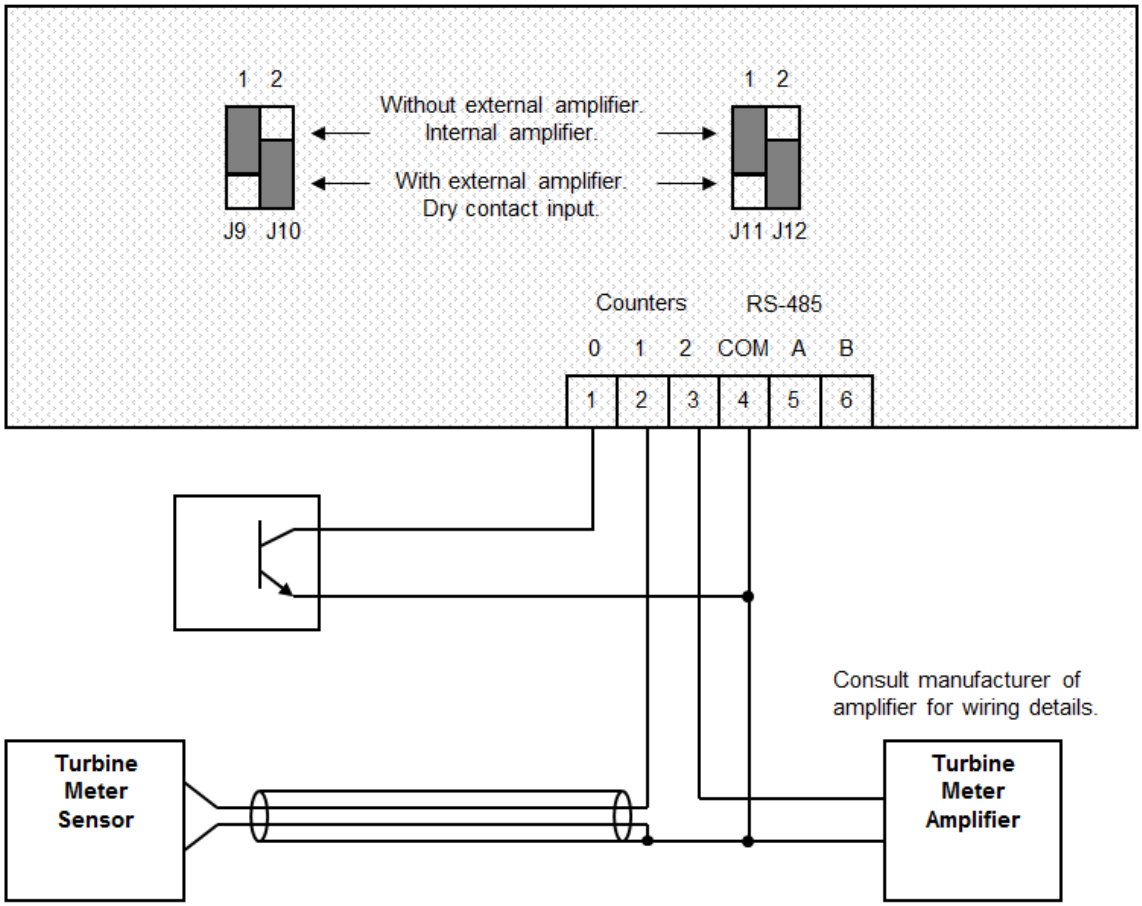
Directly Connecting to Low Voltage Turbine Meters 46

Connecting to Higher Voltage Turbine Meters 47

Connecting to Open Collector/Dry Contact Turbine Meters 49

12.2.1 Counter Input 0

Counter Input 0 is used to count contact closures. The input circuitry includes a 1000-ohm resistor from the counter input to the 5 Vdc power supply. Refer to the diagram Counter Input Wiring 45 for an example of wiring to an open collector output.



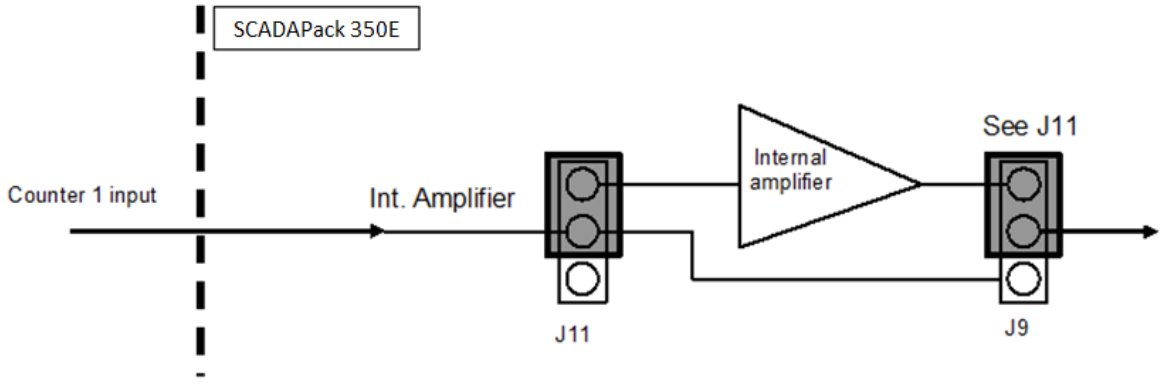
Counter Input Wiring

Counter 1 is shown as a millivolt input with a direct connection to a turbine meter sensor. Shielded wiring is used and the shield is connected at one end only. Counter 2 is shown connected to an external turbine meter pre-amplifier. Refer to the following sections for details on connecting to the turbine meter counter inputs.

12.2.2 Directly Connecting to Low Voltage Turbine Meters

When connecting a low voltage (millivolt) turbine meter directly to counter input 1, enable the RTU internal pre-amplifier on this input as follows:

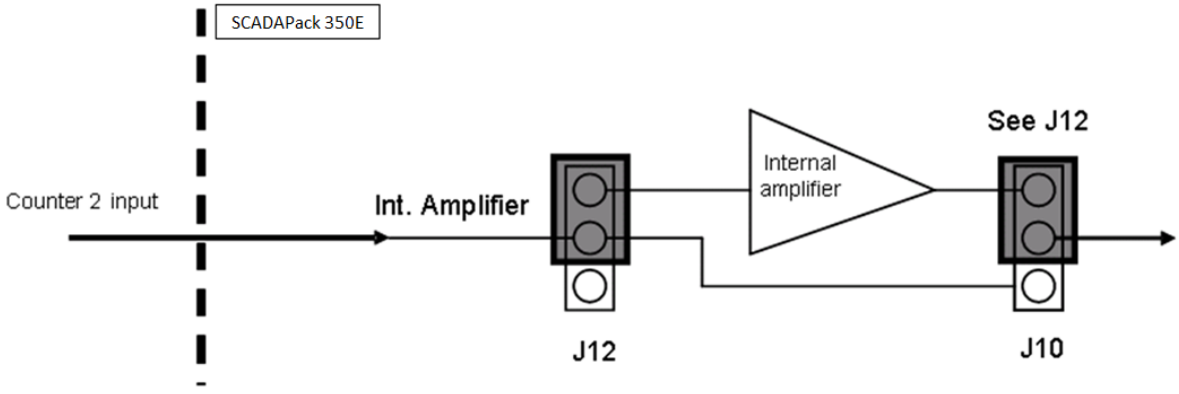
1. Install jumper J11 on the 'Int Amplifier' position.
2. Install jumper J9 on the 'See J11' position, as shown below.



Setting Jumpers on Counter Input 1 for Low Voltage Turbine Meters

Similarly, when connecting a low voltage (millivolt) turbine meter directly to the counter input 2,

1. Install jumper J12 on the 'Int Amplifier' position.
2. Install jumper J10 on the 'See J12' position, as shown below.



Setting Jumpers on Counter Input 2 for Low Voltage Turbine Meters

12.2.3 Connecting to Higher Voltage Turbine Meters

Counter inputs 1 and 2 inputs can also be configured for use with a turbine meter featuring an integrated or standalone amplifier. In this configuration, the SCADAPack's internal amplifiers needs to be bypassed.

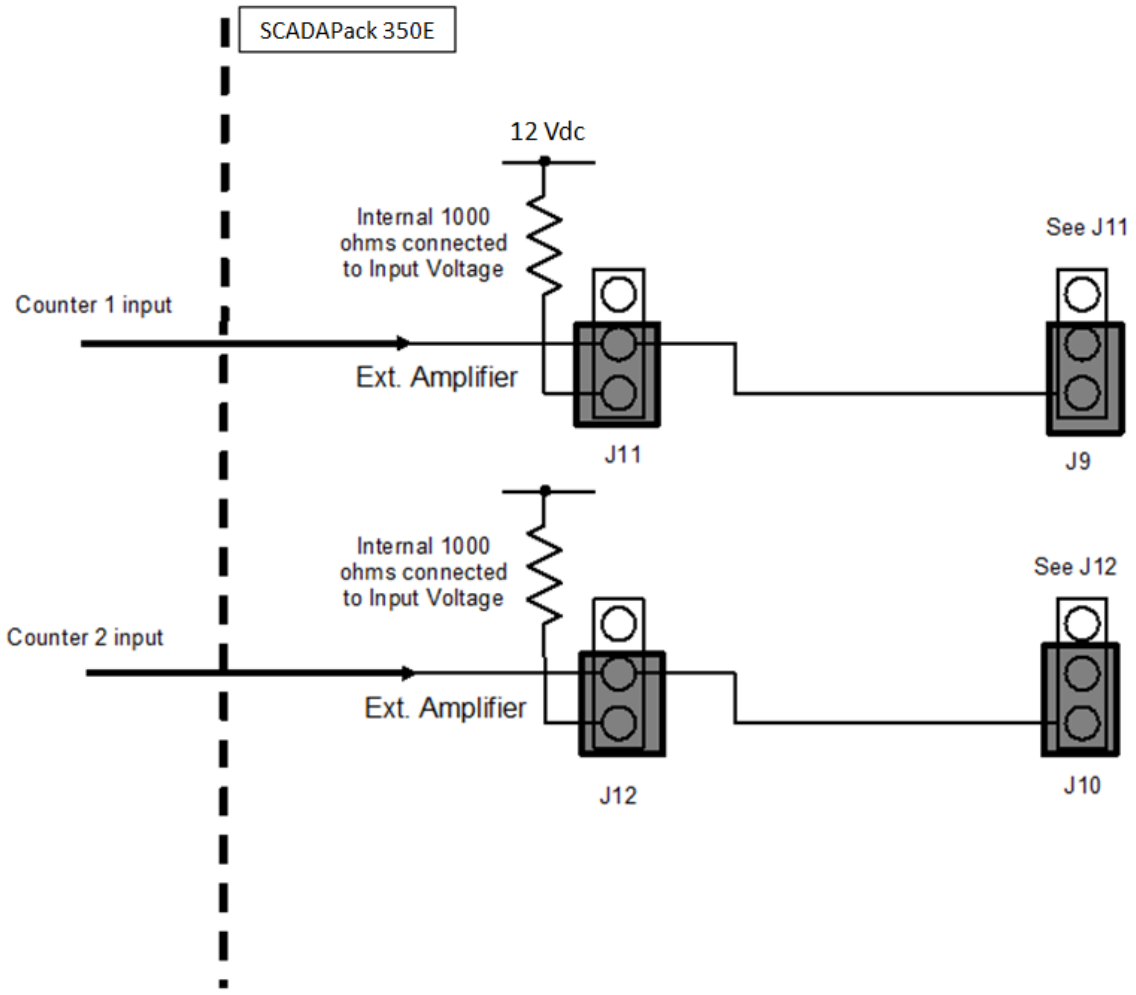
For Counter 1:

1. Install jumper J11 in the 'Ext Position'.
2. Remove jumpers J9 from the 'See J11' position and install on the other two pins.

For Counter 2:

1. Install jumper J12 in the 'Ext Position'.
2. Remove jumpers J10 from the 'See J12' position and install on the other two pins.

Refer to the figure below for an illustration.



Setting Counter Input 1 and 2 for Turbine Meters with amplified signals

Your standalone amplifier may have a specific current requirement as specified by the manufacturer. As

shown in the figure above, the RTU includes a 1000-ohm resistor from the counter input to the DC input power source, when the jumpers J11 and J12 are installed in the **Ext Amplifier** position, as described above. The above configuration is the recommended wiring for a **Halliburton Low Power Pre-Amp**, when the RTU is powered from 12 Vdc.

On the other hand, if your amplifier requires a pull-up resistor greater than 1000 ohms, jumper J11 and J12 should not be installed in either position, while J9 and J10 should remain installed as shown in Connecting External Pull-Up Resistors to Counter Inputs 1 and 2 49. The appropriate external pull-up resistor should then be connected between the counter input and the positive terminal of your power supply, as shown in the above diagram.

12.2.4 Connecting to Open Collector / Dry Contact Turbine Meters

Counter Inputs 1 and 2 can also used with conventional sources such as open collector transistors and contacts. In this scenario, the 1000 ohm pull-up resistors described above can be used if the RTU is powered from 12 Vdc.

For Counter 1:

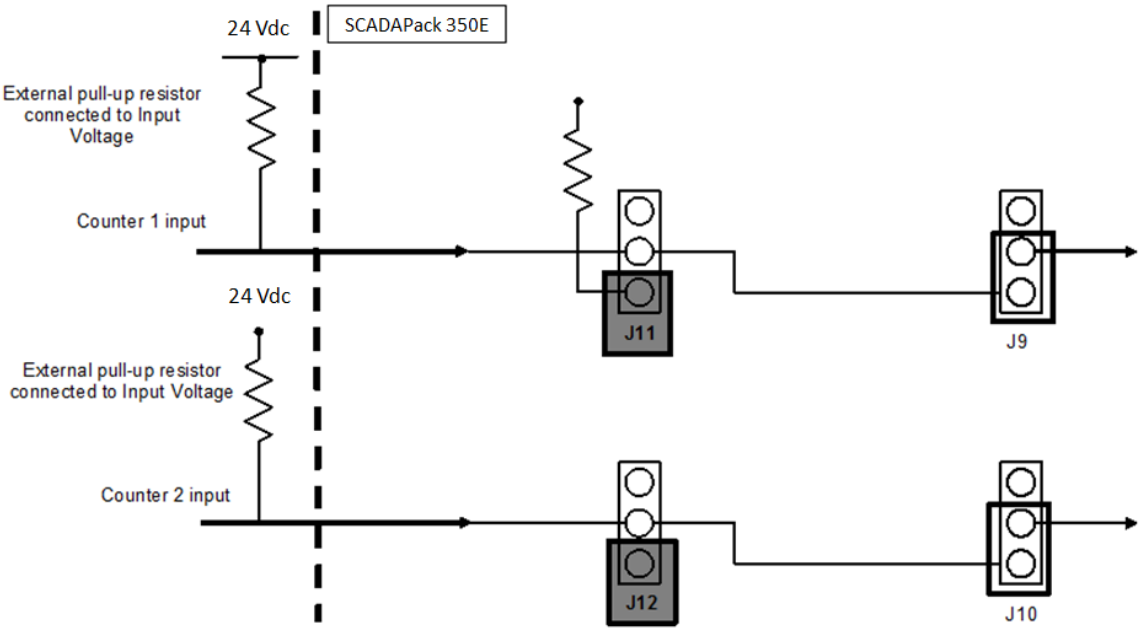
1. Install jumper J11 in the 'Ext Position'.
2. Remove jumpers J9 from the 'See J11' position and install on the other two pins.

For Counter 2:

1. Install jumper J12 in the 'Ext Position'.
2. Remove jumpers J10 from the 'See J12' position and install on the other two pins.

The above configuration applies only when the RTU is being powered using 12 Vdc.

If 24 Vdc is used to power the RTU, the internal 1000-ohm pull-up resistor should not be used, as power dissipation can become excessive. In this case, you need to wire an external pull-up resistor between the counter input and the positive side of your power supply, as illustrated in Connecting External Pull-Up Resistors to Counter Inputs 1 and 2 49. Also check that jumpers J11 and J12 are removed while J9 and J10 are installed.



Connecting External Pull-Up Resistors to Counter Inputs 1 and 2

13 Serial Communication

The RTU is equipped with three serial communication ports labeled COM1, COM2 and COM3, which support RS-232 and RS-485 communication.

These ports correspond to PORT1, PORT2, PORT3 when using SCADAPack E Configurator and in SCADAPack E diagnostics.

- COM1 is a dedicated 2-wire RS-485 port.
- COM2 can be configured for RS-232 or 2-wire RS-485.
- COM3 is a dedicated RS-232 port.

Details of the operation and properties of each serial port are described in the following sections:

RS-232 Serial Communications Ports 50

RS-485 Serial Communications Ports 64

13.1 RS-232 Serial Communications Ports

COM2 and COM3 support RS-232 communication. RS-232 wiring needs to use shielded cable. The shield should be connected to chassis ground at one point. Improperly shielding the cable may result in the installation not complying with Federal Communications Commission (FCC) or Department of Communications (DOC) radio interference regulations.

COM2 RS-232 Serial Port 51

COM3 RS-232 Serial Port 55

RS-232 Wiring Examples 59

RS-232 Cables 62

13.1.1 COM2 RS-232 Serial Port

Serial port COM2 can be configured as either a six-line RS-232 port or as a two-wire RS-485 port.

For RS-232 operation J13 on the controller board needs to have the jumper link installed in position “RS-232”. This section covers RS-232 operation.

For RS-485 operation refer to section ***COM2 RS-485 Serial Port*** 67.

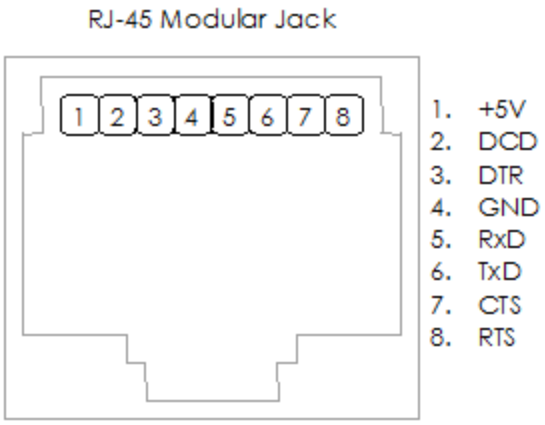
The following table shows the serial and protocol communication parameters supported by COM2. These parameters are set from SCADAPack E Configurator or from an application program running in the RTU. Default values are set when a **Factory Defaults Initialization** (COLD BOOT) is performed on the RTU.

COM2 Serial and Protocol Communication Parameters

Parameter	Supported Values
Baud Rate	300 600 1200 2400 4800 9600 19200 38400 57600 115200 Default: 9600
Duplex	Full or Half, depending on the Port Mode
Data Mode	8-bit No Parity 1 Stop Bit 8-bit Even Parity 1 Stop Bit 8-bit Odd Parity 1 Stop Bit 7-bit Even Parity 1 Stop Bit 7-bit Odd Parity 1 Stop Bit 8-bit No Parity 2 Stop Bits Default: 8-bit No Parity 1 Stop Bit
Serial Port Control	RS232 (RTS On) RS232 (RTS Keyed)

Parameter	Supported Values
	RS485 2w Hayes Modem GPRS 1xRTT RS232 (RTS Off)
Protocol	NONE ISaGRAF DNP3 Command Line PLC Device ISaGRAF-User PPP/TCPIP TCP Service Modbus Master (Modbus RTU) Modbus Slave DNP VT Service IEC60870-5-103 Master IEC60870-5-101 Slave NTP GPS Receiver SLIP CSLIP
Configuration & Diagnostics	When referenced in SCADAPack E Configuration and Diagnostic facilities, this port is known as PORT2

Connections to COM2 are made through a RJ-45 modular connector. COM2 supports six signals plus Ground and 5 Vdc power. The following diagram shows the pin connections for the RS-232 (RJ-45) port connector for COM2.



RJ-45 Connector Pinout

- The transmitters used in COM2 generate RS-232 compatible ±5 Vdc levels. Cables should be limited to a maximum of 3 m (10 ft.)
- For RS-232 operation, (RxD) J13 needs to have the jumper link in position **RS-232**.

The following table provides a description of the function of each pin of the RJ-45 connector. In this table a **MARK** level is a voltage of +3 Vdc or greater and a **SPACE** level is a voltage of –3 Vdc or lower.

RJ-45 Connector Pin Description

Pin	Function	Description
1	5 Vdc (Output)	This pin can be connected to the 5 Vdc power supply by installing a jumper at J14 on the SCADAPack 350E. This 5 Vdc output is used to power Vision terminals and other Schneider Electric accessories. Check that cables connecting this pin have no voltage.
2	DCD (Input)	The DCD led is on for a **MARK** level.
3	DTR (Output)	This pin is normally at a **MARK** level. This pin is at a **SPACE** level when DTR is de-asserted.
4	GND	This pin is connected to the system ground.
5	RxD (Input)	The level is **SPACE** on standby and **MARK** for received data. The LED is lit for a **MARK** level.
6	TxD (Output)	The level is **SPACE** on standby and **MARK** for transmitted data. The LED is lit for a **MARK** level.

Pin	Function	Description
7	CTS (Input)	This level needs to be a **MARK** for the communication port to transmit data. When the attached device does not provide this signal, the controller keeps the line at a **MARK**. When the attached device does provide this signal, it needs to set CTS to **MARK** to allow the controller to transmit data.
8	RTS (Output)	This pin is a **MARK** if full-duplex operation is selected for the port. This pin is set to a **MARK** just before and during transmission of data if half-duplex operation is selected. This pin is set to a **SPACE** when no data is being transmitted. The LED is ON for a **MARK** level.

13.1.2 COM3 RS-232 Serial Port

The following table shows the serial and protocol communication parameters supported by COM3. These parameters are set from SCADAPack E Configurator or from an application program running in the RTU. Default values are set when a **Factory Defaults Initialization** (COLD BOOT) is performed on the RTU.

COM3 Supports only RS-232.

COM3 Serial and Protocol Communication Parameters

Parameter	Supported Values
Baud Rate	300 600 1200 2400 4800 9600 19200 38400 57600 115200 Default: 9600
Duplex	Full or Half (protocol dependent) Full Full or Half (protocol dependent)
Data Mode	8-bit No Parity 1 Stop Bit 8-bit Even Parity 1 Stop Bit 8-bit Odd Parity 1 Stop Bit 7-bit Even Parity 1 Stop Bit 7-bit Odd Parity 1 Stop Bit 8-bit No Parity 2 Stop Bits Default: 8-bit No Parity 1 Stop Bit
Serial Port Mode	RS232: DTR/DCD or VISION Display Mode (Jumper Selectable)

Parameter	Supported Values
Serial Port Control	RS232 (RTS On) RS232 (RTS Keyed) Hayes Modem GPRS 1xRTT RS232 (RTS Off)
Protocol	NONE ISaGRAF DNP3 Command Line PLC Device ISaGRAF-User PPP/TCPIP TCP Service Modbus Master (Modbus RTU) Modbus Slave DNP VT Service IEC60870-5-103 Master IEC60870-5-101 Slave NTP GPS Receiver SLIP CSLIP
Configuration & Diagnostics	When referenced in SCADAPack E Configuration and Diagnostic facilities, this port is known as PORT3

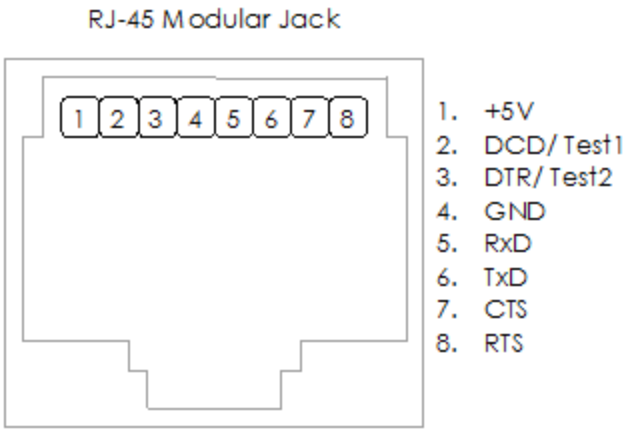
Connections to COM3 are made through a RJ-45 modular connector. COM3 supports six signals plus Ground and 5 Vdc power. COM3 is designed to be able to operate with the SCADAPack Vision operator interface and has several special features noted below. Two of the signals (DTR and DCD) are shared with the test signals used to detect the **ON** switch closure on the Vision interface.

To use the signals as DTR, DCD, install jumper links J15 and J16 in the **Normal** position.

To use the COM3 port with a Vision interface, install jumpers J15 and J16 in the **Vision** position.

For proper operation, both jumper links (J15 and J16) need to be installed in the same position, either **Vision** or **Normal**.

The following diagram shows the pin connections for the RS-232 (RJ-45) port connector for COM3.



RJ-45 Connector Pinout

- +5 Vdc is available on Pin 1 when turned on by the user under program control or, provided J15 and J16 jumper links are in the **Vision** position, when the RTU detects the contact closure of the **ON** switch of the SCADAPack Vision or the LEDs are turned on. This 5 Vdc output is used to power Vision terminals and other Schneider Electric accessories. Check that cables connecting this pin have no voltage.
- The SCADAPack Vision **ON** switch is wired to Pins 2 and 3.

NOTICE
UNEXPECTED EQUIPMENT OPERATION If not using a SCADAPack Vision, ensure that J15 and J16 jumper links are in the **Normal** position to prevent a CPU interrupt due to a change in the state of the DCD signal. **Failure to follow these instructions can result in equipment damage.**

- The transmitters used in COM3 generate RS-232 compatible ±5 Vdc levels. Cables should be limited to a maximum of 3 m (10 ft.)

The following table provides a description of the function of each pin of the RJ-45 connector. In this table a **MARK** level is a voltage of +3 Vdc or greater and a **SPACE** level is a voltage of –3 Vdc or lower.

RJ-45 Connector Pin Description

Pin	Function	Description
1	5 Vdc (Output)	+5 Vdc power for the SCADAPack Vision. This 5 Vdc output is used to power Vision terminals and other Schneider Electric accessories. Check that cables connecting this pin have no voltage.
2	DCD / Test1 (Input)	With J15 and J16 jumper links in the **Normal** position, used as DCD signal. With J15 and J16 jumper links in the **Vision** position, used to detect SCADAPack Vision ON switch closure.
3	DTR / Test2 (Output)	With J15 and J16 jumper links in the **Normal** position, used as DTR signal. With J15 and J16 jumper links in the **Vision** position, used to detect SCADAPack Vision **ON** switch closure.
4	GND	This pin is connected to the system ground.
5	RxD (Input)	The level is **SPACE** on standby and **MARK** for received data. The LED is lit for a **MARK** level.
6	TxD (Output)	The level is **SPACE** on standby and **MARK** for transmitted data. The LED is lit for a **MARK** level.
7	CTS (Input)	This level needs to be a **MARK** for the communication port to transmit data. When the attached device does not provide this signal, the controller keeps the line at a **MARK**. When the attached device does provide this signal, it needs to set CTS to **MARK** to allow the controller to transmit data.
8	RTS (Output)	This pin is a **MARK** if full-duplex operation is selected for the port. This pin is set to a **MARK** just before and during transmission of data if half-duplex operation is selected. This pin is set to a **SPACE** when no data is being transmitted. The LED is ON for a **MARK** level.

13.1.3 RS-232 Wiring Examples

⚠WARNING

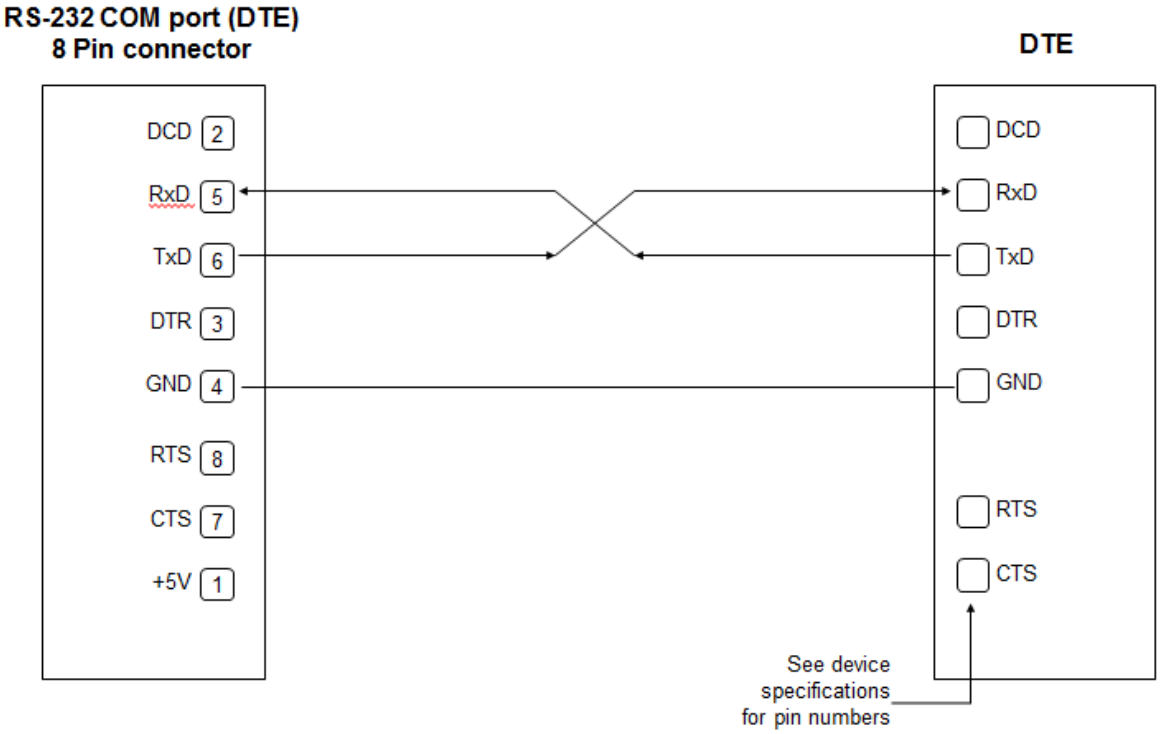
HAZARD OF ELECTRIC SHOCK

Remove power from all devices before connecting or disconnecting inputs or outputs to any terminal or installing or removing any hardware.

Failure to follow these instructions can result in death or serious injury.

DTE to DTE without Handshaking

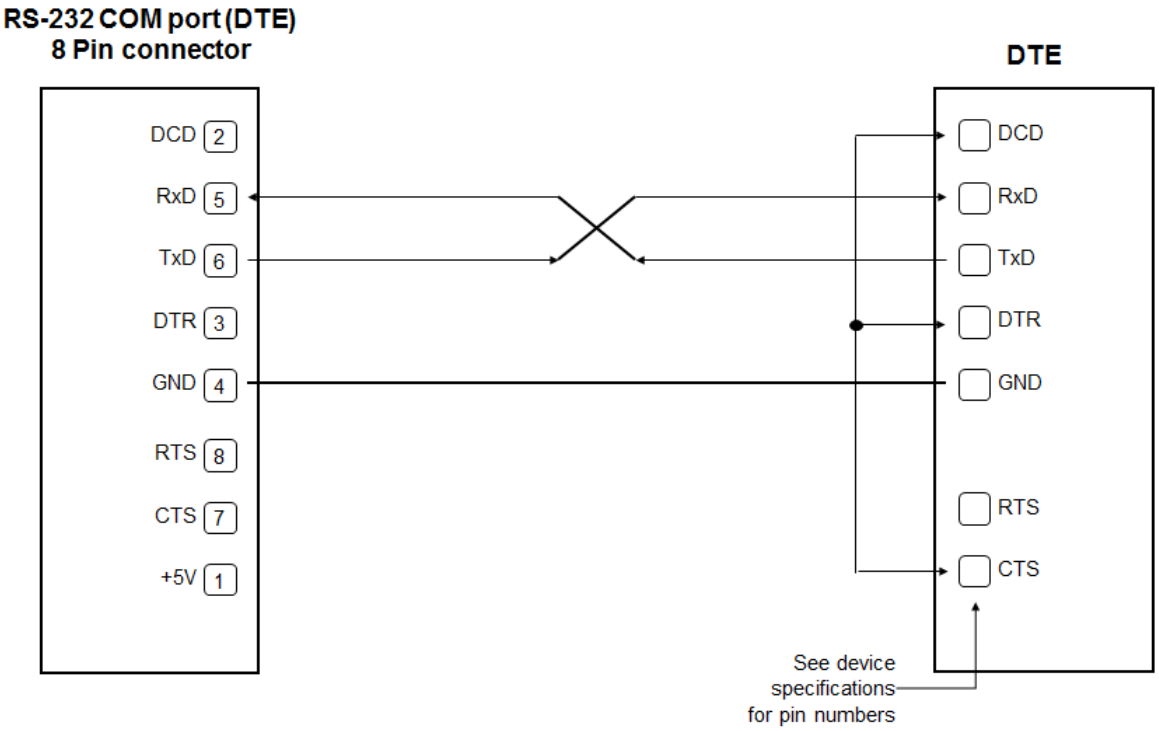
There are several methods for wiring the RS232 COM port to DTE (Data Terminal Equipment) and DCE (Data Communications Equipment) devices. The simplest connection requires only 3 wires: RxD, TxD and signal ground. The following diagram shows a common RS232 COM port to DTE device.



RS-232 DTE to RS-232 DTE without Handshaking

DTE to DTE with Handshaking

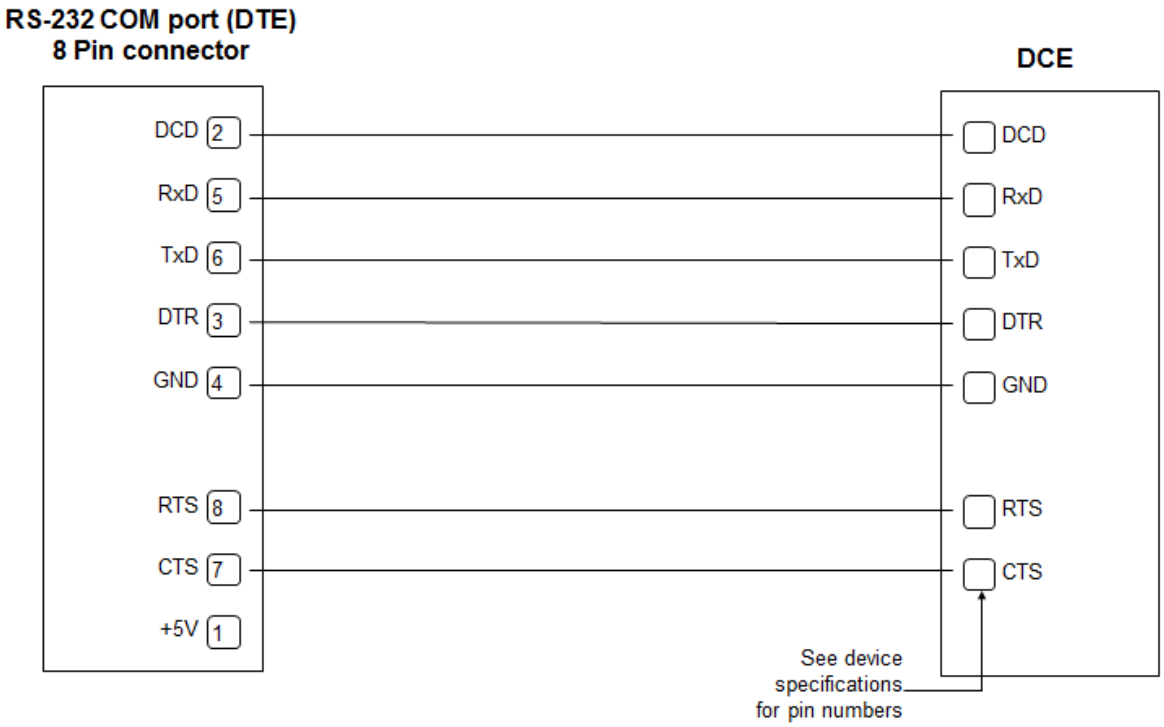
Some DTE devices may require hardware handshaking lines. Common lines are the CTS and RTS lines. Less common are the DTR and DCD lines. The RTU does not require these lines. Refer to the specifications of the external device for exact requirements. The following diagram shows a common connection of an RS232 COM port with a DTE device requiring handshaking lines.



RS-232 DTE to RS-232 DTE with Handshaking

DTE to DCE with Handshaking

DCE devices require different wiring. The handshaking lines need to be connected in many cases. Many DCE devices are half-duplex. Select half-duplex operation with these devices. The diagram below shows common connection of a SCADAPack E RTU with a DCE device requiring handshaking lines.



RS-232 DTE to RS-232 DCE With Handshaking

13.1.4 RS-232 Cables

RJ-45 to DE-9S DTE

This cable is used to connect from an RJ-45-based RS-232 port on the RTU to a DE-9S connector on DTE such as a PC. A 3 m (10 ft.) long cable is available from Schneider Electric using part number TBUM297217.

RJ-45 to DE-9S DTE Cable Description

RJ-45 8 Pins	SCADAPack DTE Function	DE-9S DTE Function	DE-9S
			Shield connects to shell
6	TxD	RxD	2
5	RxD	TxD	3
4	GND	GND	5
1, 2, 3, 7 and 8 are not connected at this end.			Wires not connected at this end.

RJ-45 to SCADAPack Vision

This cable is used to connect from the COM3 (RJ-45-based RS-232) port on the RTU to a DE-9S connector on a SCADAPack Vision. A 1.5 m (5 ft.) long cable is available from Schneider Electric using part number TBUM297237.

RJ-45 to SCADAPack Vision Cable Description

RJ-45 8 Pins	SCADAPack E Function	SCADAPack Vision Function	DE-9S
			Shield connects to shell
6	TxD	RxD	2
5	RxD	TxD	3
4	GND	GND	5

3	DTR / Test 2	ON switch	1
2	DCD / Test 1	ON switch	4
1	+5 Vdc Out	+5 Vdc In	9
7 and 8 are not connected at this end.			Wires not connected at this end.

RJ-45 to DE-9P DCE

This cable is used to connect from an RJ-45-based RS-232 port on the RTU to a DE-9P connector on DCE such as a modem. A .38 m (15 in.) long cable is available from Schneider Electric using part number TBUM297218.

RJ-45 to DE-9P DCE Cable Description

RJ-45	SCADAPack E DCE Function	DE-9P DCE Function	DE-9P
			Shield connects to shell
3	DTR	DTR	4
6	TxD	TxD	3
5	RxD	RxD	2
2	DCD	DCD	1
4	GND	GND	5
7	CTS	CTS	8
8	RTS	RTS	7
1	+5 Vdc	+5 Vdc	9

13.2 RS-485 Serial Communications Ports

COM1 and COM 2 support RS-485 communication. RS-485 wiring needs to use shielded cable. The shield should be connected to chassis ground at one point. Improperly shielding the cable may result in the installation not complying with Federal Communications Commission (FCC) or Department of Communications (DOC) radio interference regulations.

13.2.1 COM1 RS-485 Serial Port

Serial port COM1 is configured as a two-wire RS-485 serial communication port.

The following table shows the serial and protocol communication parameters supported by COM1. These parameters are set from SCADAPack E Configurator or from an application program running in the RTU. Default values are set when a **Factory Defaults Initialization** (COLD BOOT) is performed on the RTU.

COM1 Serial and Protocol Communication Parameters

Parameter	Supported Values
Baud Rate	300 600 1200 2400 4800 9600 19200 38400 57600 115200 Default: 9600
Duplex	Half
Data Mode	8-bit No Parity 1 Stop Bit 8-bit Even Parity 1 Stop Bit 8-bit Odd Parity 1 Stop Bit 7-bit Even Parity 1 Stop Bit 7-bit Odd Parity 1 Stop Bit 8-bit No Parity 2 Stop Bits Default: 8-bit No Parity 1 Stop Bit
Receive Flow Control	None
Transmit Flow Control	None
Protocol	DNP3

Parameter	Supported Values
	PLC Device IEC 60870-5-103 Master IEC 60870-5-101 Slave Modbus RTU Slave None Default: None
Configuration & Diagnostics	When referenced in SCADAPack E Configuration and Diagnostic facilities, this port is known as PORT1

COM1 transmits and receives differential voltages to other RS-485 devices on a network. The RS-485 specification allows a maximum of 32 devices connected on a single RS-485 network. The specification for RS-485 recommends that the cable length should not exceed a maximum of 1200 m (4000 ft.)

The signal grounds of the RS-485 devices in the network are not connected together but instead are referenced to their respective incoming electrical grounds.The grounds of the RS-485 devices on the network need to be within several volts of each other. The RTU ground is connected to the chassis.

13.2.2 COM2 RS-485 Serial Port

Serial port COM2 can be configured as either a six-line RS-232 port or as a two-wire RS-485 port. For RS-485 operation J13 need to have the jumper link installed in position “RS-485”. This section covers RS-485 operation. For RS-232 operation refer to Section ***COM2 RS-232 Serial Port*** 51.

The following table shows the serial and protocol communication parameters supported by COM2. These parameters are set from SCADAPack E Configurator or from an application program running in the RTU. Default values are set when a **Factory Defaults Initialization** (COLD BOOT) is performed on the RTU.

COM2 Serial and Protocol Communication Parameters

Parameter	Supported Values
Baud Rate	300 600 1200 2400 4800 9600 19200 38400 57600 115200 Default: 9600
Duplex	Half Default: Half Full or Half, depending on the Port Mode Half Default: Half
Data Mode	8-bit No Parity 1 Stop Bit 8-bit Even Parity 1 Stop Bit 8-bit Odd Parity 1 Stop Bit 7-bit Even Parity 1 Stop Bit 7-bit Odd Parity 1 Stop Bit 8-bit No Parity 2 Stop Bits Default: 8-bit No Parity 1 Stop Bit

Parameter	Supported Values
Receive Flow Control	None
Transmit Flow Control	None
Protocol	RS232 (RTS On) RS232 (RTS Keyed) RS485 2w Hayes Modem GPRS 1xRTT RS232 (RTS Off)
Port Function	NONE ISaGRAF DNP3 Command Line PLC Device ISaGRAF-User PPP/TCPIP TCP Service Modbus Master (Modbus RTU) Modbus Slave DNP VT Service IEC60870-5-103 Master IEC60870-5-101 Slave NTP GPS Receiver SLIP CSLIP
Configuration & Diagnostics	When referenced in SCADAPack E Configuration and Diagnostic facilities, this port is known as PORT2

COM2 transmits and receives differential voltages to other RS-485 devices on a network. The RS-485 specification allows a maximum of 32 devices connected on a single RS-485 network. The specification

for RS-485 recommends that the cable length should not exceed a maximum of 1200 m (4000 ft.)

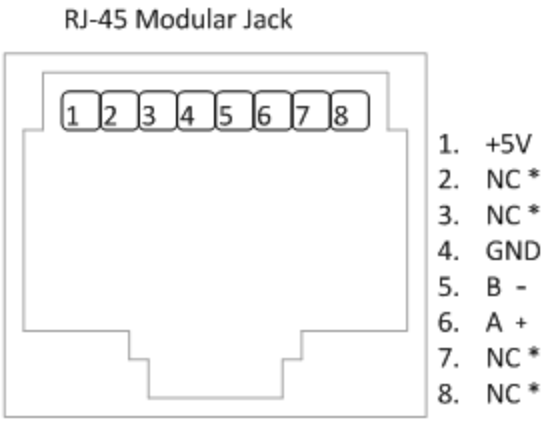
The signal grounds of the RS-485 devices in the network are not connected together but instead are referenced to their respective incoming electrical grounds. The grounds of the RS-485 devices on the network need to be within several volts of each other. Controller ground is connected to the chassis.

The following table provides a description of the function of each pin of the RJ-45 connector.

RJ-45 Connector Pin Description

Pin	Function	Description
1	5 Vdc (Output)	This pin can be connected to the 5 Vdc power supply by installing a jumper at J14 on the RTU.
2	NC	Not used in RS-485 mode. Should be left open.
3	NC	Not used in RS-485 mode. Should be left open.
4	GND	This pin is connected to the system ground.
5	B (Input/ Output)	For RS-485 operation J13 needs to have the jumper link in position “RS-485”. This pin is the B signal of the RS-485 bus.
6	A (Input/ Output)	For RS-485 operation J13 needs to have the jumper link in position “RS-485”. his pin is the A signal of the RS-485 bus.
7	NC	Not used in RS-485 mode. Should be left open.
8	NC	Not used in RS-485 mode. Should be left open.

Connections to COM2 are made through an RJ-45 modular connector. COM2 supports two signals plus Ground and 5 Vdc power. The following diagram shows the pin connections for the RS-485 (RJ-45) port connector for COM2 operating in RS-485 mode.



COM2 RJ-45 Connector

13.2.3 RS-485 Bias & Termination Resistors

RS-485 Bias Resistors

The RS-485 receiver inputs on the RTU are biased so that received data is driven to a valid state (space) when there are no active drivers on the network. The value of these bias resistors is 5100 ohms from Ground to the B inputs and 5100 ohms from +5 Vdc to the A inputs.

RS-485 Termination Resistors

Termination resistors are required in long networks operating at the highest baud rates. Networks as long 1200 m (4000 ft.) operating at 9600 baud will function without termination resistors. Terminations should only be considered if the baud rate is higher.

When termination resistors are required, they are installed on the first and last station on the RS-485 wire pair. Other stations should not have termination resistors.

If required, RS-485 networks are terminated with 120 ohm resistors on each end. The required 120 ohm resistor is supplied and installed by the user. When using termination resistors it may be necessary to increase the line biasing by adding lower value bias resistors in order to generate at least 0.2 Vdc across RS-485 line. The suggested value of the bias resistors is 470 ohms. One bias resistor is installed from the B signal to COM. The second bias resistor is installed from the A signal to +5 Vdc. +5 Vdc is available on P8 pin 1 when J14 is installed.

13.2.4 RS-485 Wiring Example

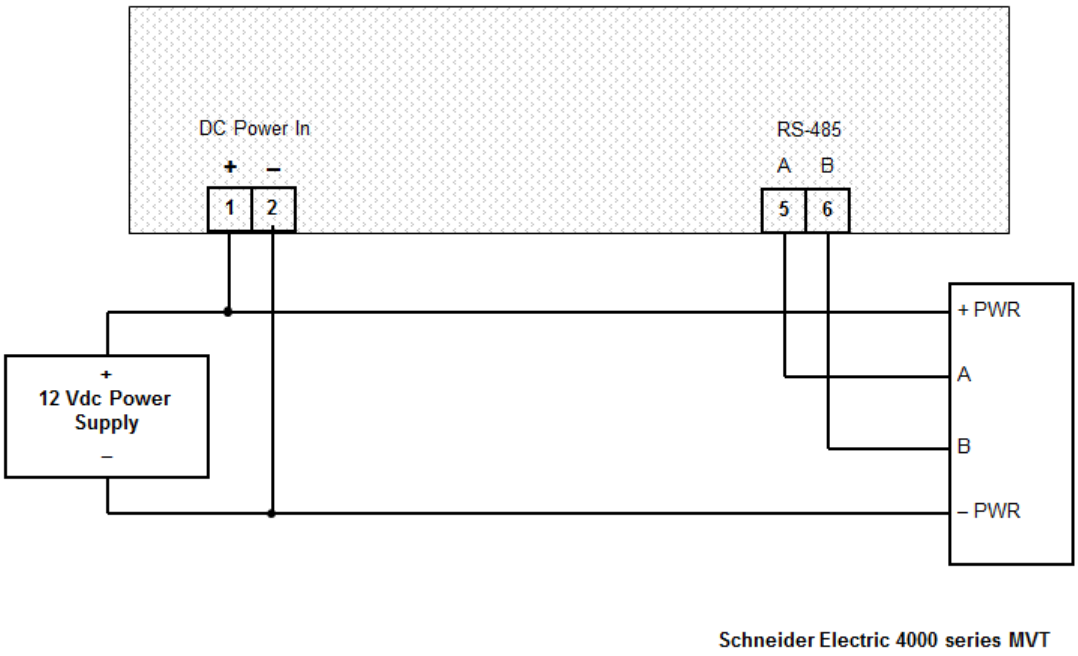
⚠WARNING

HAZARD OF ELECTRIC SHOCK

Remove power from all devices before connecting or disconnecting inputs or outputs to any terminal or installing or removing any hardware.

Failure to follow these instructions can result in death or serious injury.

A typical RS-485 wiring example is shown below. COM1 is shown connected to a multivariable transmitter such as a Schneider Electric 4000 series MVT. The power for the transmitter can come from the RTU power input source or can be obtained from the 24 Vdc VLOOP output for possible power savings.



Schneider Electric 4000 series MVT

RS-485 Wiring

14 Ethernet Communication

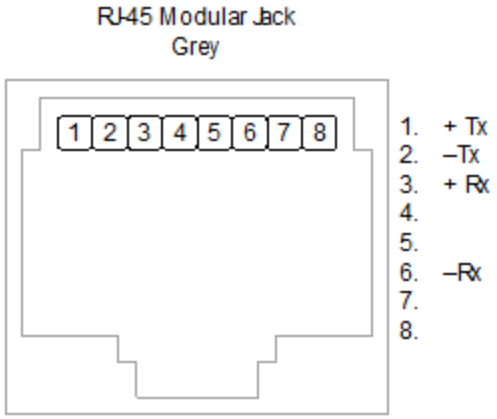
The RTU has one 10/100 Base-T Ethernet port. This is a single communications channel running at 10/100 Mbs over unshielded, twisted-pair cabling, using differential signaling. It supports both half-duplex and full-duplex operation. The interface supports auto-negotiation for both the speed and half/full-duplex mode selection.

When referred to in SCADAPack E configuration and diagnostic facilities, the Ethernet port is referred to as communications channel number 10.

Connections to the Ethernet port are made through an RJ-45 modular connector. The wiring and pin connections for this connector are described in section RJ-45 Modular Connector for Ethernet 73.

14.1 RJ-45 Modular Connector for Ethernet

The RTU can be connected directly to a wall jack or hub using standard RJ-45 Category 5 patch cables. The following diagram shows the pin connections for the RJ-45 modular connector.



10/100Base-T has a maximum run of 100 m (350 ft), but the actual limit is based on signal loss and the noise in the environment. Running the Ethernet cables in parallel with power cables or any cables that generate noise will reduce the practical distance to less than 100 m (350 ft).

15 USB Ports

The RTU has two USB 2.0 compliant ports, supporting both low-speed (1.5 Mb/s) and full-speed (12 Mb/s). One of the ports allows the RTU to act as a host (Host Port), while the second port allows connection to a USB host (Peripheral Port), such as a notebook computer. The two USB ports can be used simultaneously.

- USB Peripheral Port - provides DNP3 communications for local connection to SCADAPack E Configurator.
- USB Host Port - Not currently supported by SCADAPack E operating system.

⚠WARNING

EXPLOSION RISK

Do not use USB ports in hazardous applications or hazardous locations.

Use USB ports only for non-hazardous applications in locations that are known to be in a non-hazardous state.

Failure to follow these instructions can result in death or serious injury.

USB Connections

The connectors used for the USB ports are compliant with the USB specification.

USB Host Port 74

USB Peripheral Port 76

15.1 USB Host Port

The host port features a USB series “A” receptacle. For bus-powered USB devices, the host port can provide up to 100 mA at 5 Vdc. The following diagram shows the connections for the host USB port.

⚠WARNING

EXPLOSION RISK

Do not use USB ports in hazardous applications or hazardous locations.

Use USB ports only for non-hazardous applications in locations that are known to be in a non-hazardous state.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

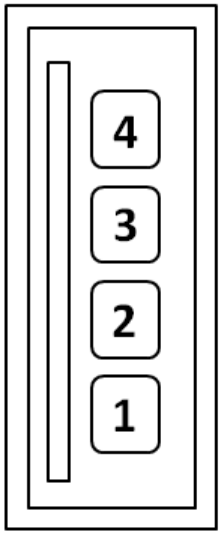
UNEXPECTED EQUIPMENT OPERATION

Verify that the data transfer between the RTU and the plug-in USB drive is complete before removing the USB drive from the USB host port.

Removing a plug-in USB drive from the host port while the data transfer is in progress can impact system performance and result in a system restart.

Failure to follow these instructions can result in death or serious injury.

USB series "A" receptacle



1. VBUS
2. D-
3. D+
4. GND

Host USB Port Connections

This port is not currently supported by the SCADAPack E operating system.

15.2 USB Peripheral Port

⚠WARNING

EXPLOSION RISK

Do not use USB ports in hazardous applications or hazardous locations.

Use USB ports only for non-hazardous applications in locations that are known to be in a non-hazardous state.

Failure to follow these instructions can result in death or serious injury.

The peripheral port uses a USB series “B” receptacle.

The peripheral port is used for local connection of SCADAPack E Configurator using DNP3 protocol.

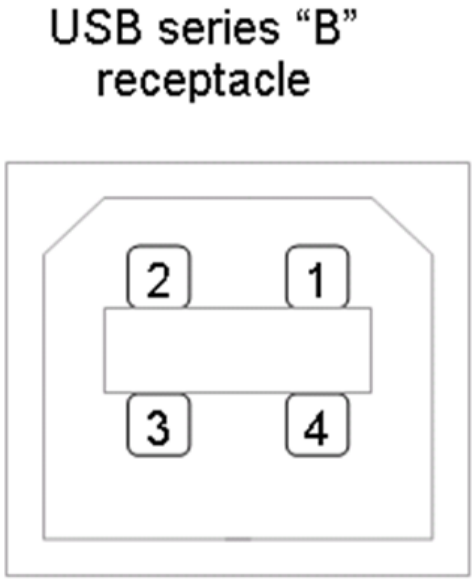
This ports correspond to PORT0 when using SCADAPack E Configurator and in SCADAPack E diagnostics.

The RTU will not draw any significant power from the host over the USB peripheral port.

USB Peripheral Port Communication Parameters

Parameter	Supported Values
USB	USB 2.0 compliant, Peripheral port
Data Rate	Auto detect. Low-speed (1.5Mb/s) and Full-speed (12Mb/s)
Protocol	DNP3
Configuration & Diagnostics	When referenced in SCADAPack E Configuration and Diagnostic facilities, this port is known as PORT0

The following diagram shows the connections of the peripheral USB port.



Peripheral USB Port Connections

16 Operation

Once the RTU is installed and wired, it is useful to have an understanding of the various operating modes available upon startup, what the LED indicators mean, and how to configure the jumpers. Typically, you will start up in RUN mode, but in some circumstances another operating mode may be necessary. The following topics provide important operating information:

16.1 Operating Modes

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment monitored and controlled by the SCADAPack E RTU prior to initializing the SCADAPack E RTU.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Starting the RTU in COLD BOOT or FACTORY BOOT mode returns RTU configuration parameters to their default settings and erases application programs. This information must be reloaded into the RTU for correct RTU operation.

Before starting the RTU in COLD BOOT or FACTORY BOOT mode, save a copy of the RTU configuration information, user-created applications, logs and other data to an external drive so it can be reloaded when the procedure is complete.

Failure to follow these instructions can result in death or serious injury.

An RTU may start up in RUN, SERVICE, COLD BOOT or FACTORY BOOT modes.

- Start up in the RUN mode automatically loads the RTU database, executes ISaGRAF programs in the RTU memory, and communicates on its interfaces, as per its configuration.
- Start up in the SERVICE mode stops the ISaGRAF user applications and overrides RTU ports with DNP3 communications at node address “0” to allow RTU reprogramming and initialization.
- Start up in the COLD BOOT mode initializes the RTU and erases user application programs.
- Start up in FACTORY BOOT reformats the Flash file system, initializes the RTU and erases user application programs.

Each BOOT mode is determined by the amount of time that the LED power switch is depressed when power is applied or a board reset occurs.

The BOOT mode is not performed until the LED power switch is released. As such power can be removed prior to releasing the LED power switch without performing the selected BOOT mode.

The following sections describe each operating mode in detail.

RUN Mode 80

SERVICE Mode 80

COLD BOOT Mode 82

FACTORY BOOT Mode 83

BOOT Mode Effects 84

16.1.1 RUN Mode

The RUN mode is the normal operating mode of the RTU. No action is required to select RUN mode.

When the RTU starts:

- The RTU loads the defined serial and Ethernet communication parameters, for each COM ports.
- The RTU database configuration and point attributes are loaded.
- ISaGRAF application programs are loaded and executed.
- If there is no ISaGRAF application program in RAM and there is an application program in flash ROM then the flash ROM program will be loaded in RAM and executed.

16.1.2 SERVICE Mode

SERVICE mode is used for configuration, programming and maintenance work, usually when the communication settings are unknown.

When an RTU starts in SERVICE mode:

- DNP3 node address zero (0) is set, enabling communication via SCADAPack E Configurator at a known DNP address. Connect SCADAPack E Configurator to the USB port or serial port 2 or 3.
- The ISaGRAF user applications are stopped.
- Programs and configurations are retained in non-volatile memory.
- Serial port configurations are restored to default (see tables below.)

To select SERVICE mode.

1. Remove power from the RTU.
2. Hold down the LED POWER button.
3. Apply power to the RTU.
4. Continue holding the LED POWER button until the STAT LED turns on.
5. Release the LED POWER button.

   If the LED POWER button is released before the STAT LED turns on, the RTU will start in RUN mode.

Default Port Settings

	USB	COM1	COM2	COM3
Serial interface type	USB Peripheral	RS485*	RS232*	RS232
Port speed	Auto	9600 bps	9600 bps	9600 bps
Duplex	-	Half	Full	Full

Parity	-	None	None	None
Data bits	-	8-bits	8-bits	8-bits
Stop bits	-	1-bit	1-bit	1-bit
Protocol	SCADAPack E Configurator DNP3	None (disabled)	DNP3	ISaGRAF

* Default software configuration setting shown. Check that hardware jumpers match this setting.

16.1.3 COLD BOOT Mode

COLD BOOT mode is used when it is required to clear a configuration from the RTU. It is optional after installing new SCADAPack E firmware.

COLD BOOT mode does not format the Flash file system (see FACTORY BOOT Mode 83 for doing this.)

When an RTU starts in COLD BOOT mode:

- The ISaGRAF user applications are erased.
- The RTU point database is cleared.
- RTU configurations are returned to default.
- DNP3 Device Address is set to 0.
- Ethernet configurations are restored to default (Ethernet communications disabled.)
- Serial port configurations are restored to default (see tables below.)

To select COLD BOOT mode:

1. Remove power from the RTU.
2. Hold down the LED POWER button.
3. Apply power to the RTU.
4. Continue holding the LED POWER button for 20 seconds until the STAT LED begins to flash on and off repeatedly.
5. Release the LED POWER button.

   If the LED POWER button is released before the STAT LED turns on, the RTU will start in RUN mode.

Default Port Settings

	USB	COM1	COM2	COM3
Serial interface type	USB Peripheral	RS485*	RS232*	RS232
Port speed	Auto	9600 bps	9600 bps	9600 bps
Duplex	-	Half	Full	Full
Parity	-	None	None	None
Data bits	-	8-bits	8-bits	8-bits
Stop bits	-	1-bit	1-bit	1-bit
Protocol	SCADAPack E Configurator DNP3	None (disabled)	DNP3	ISaGRAF

* Default software configuration setting shown. Check that hardware jumpers match these settings.

16.1.4 FACTORY BOOT Mode

FACTORY BOOT mode is used to reformat the Flash File system and initialize the RTU to factory default settings.

When the RTU starts in FACTORY BOOT mode:

- The ISaGRAF user applications are erased.
- The RTU point database is cleared.
- RTU configurations are returned to default.
- The Flash File system is reformatted.
- Ethernet configurations are restored to default (Ethernet communications disabled.)
- Serial port configurations are restored to default (see tables in COLD BOOT Mode 82.)

To select FACTORY BOOT mode:

1. Remove power from the RTU.
2. Hold down the LED POWER button.
3. Apply power to the RTU.
4. Continue holding the LED POWER button for longer than 30 seconds until the STAT LED turns solid.
5. Release the LED POWER button.

The FACTORY BOOT will take approximately 60 seconds to complete. During this time the RTU may appear unresponsive while the file system is being formatted to fix any corruption. The STAT LED will remain on until the FACTORY BOOT has completed and the RTU restarts.

16.1.5 BOOT Mode Effects

The table below summarizes the effects of the various boot modes.

Effects of Various BOOT Modes

RUN Mode	SERVICE Mode	COLD Boot	FACTORY Boot	Action
	X	X	X	DNP node address set to zero (0)
	X			Serial ports protocol set to DNP3
		X	X	Serial settings set to default
		X	X	LED power set to default
		X	X	Database initialized
		X	X	ISaGRAF applications erased
			X	Files are erased
			X	Flash File System reformatted
X				ISaGRAF applications started
	X			Settings retained in non-volatile memory
		X	X	ISaGRAF applications in flash erased
		X	X	Protocols are set to defaults

16.2 LED Indicators

There are a number of LEDs on the RTU and they can be disabled to conserve power, if desired. The table below describes the LEDs.

LED Descriptions

LED	Function
Power Mode	On when operating and the LEDs are enabled. Off when the LEDs are disabled Off when powered off
RUN	Blinking every 1.5 secs when the RTU is operating normally
STAT	Blinking when there is a status code The status code and description can be viewed from the **SCADAPack E Configurator > General > Controller Status** page The status code is also available in SCADAPack E **Analog System Point 50020**
FORCE	On when I/O points are forced (LOCKED by ISaGRAF)
USB STAT	This is under control of SCADAPack E **Binary System Point 50753** It may be controlled by an ISaGRAF application or from protocol control commands
LINK	On when the LAN port has established a link
ACT.	On to signal activity on the LAN port
RX	On when receiving data on the corresponding serial port
TX	On when transmitting data on the corresponding serial port
CTS	On when the CTS input is asserted COM2
DCD	On when the DCD input is asserted COM2
Digital I/O	On when the corresponding I/O point is on LEDs are dim in Sleep Mode when the corresponding I/O point is on
AINs	On when analog input is configured for current

LED	Function
	Off when analog input is configured for voltage Long flashes when the applied current is out of range Short flashes when the applied voltage is out of range*
Counter 0	On when the counter input is present and low
Counters 1, 2	When the input is configured to use an external amplifier, the LED is on when the counter input is present and low When the input is configured to use the internal amplifier, the LED is on when input pulses are present

* Under-range is not indicated on analog input channel LEDs on the I/O board when configured in 1...5 Vdc input range.

16.3 LED Power Control

The LEDS on the RTU can be disabled to conserve power. This is particularly useful in solar powered or unattended installations.

LED Power State - Binary System Point 50761

The **Power Mode LED** indicates the status of the LEDs. It is on when the **LED Power State** control (**50761**) is enabled in the **SCADAPack E Configurator General > Controllers Settings** page .

LED Power Always ON - Binary System Point 50752

The **LED POWER** push-button toggles the LED power signal. Press the **LED POWER** push-button to toggle LED power from off to on, or from on to off.

The SCADAPack E Configurator enables the LED power mode.

- If the **LED Power Always On** control (**50752**) in the **SCADAPack E Configurator General > Controller Settings** page is active, the **LED POWER** button has no effect and the LEDs are on.
- If the **LED Power Always On** control (**50752**) in the **SCADAPack E Configurator General > Controller Settings** page is inactive, the state of LEDs at RTU startup is **Enabled**. 60 seconds after the controller has started the LEDs will be Disabled. While the controller is running, when the LED POWER button is pushed the LED displays are enabled for a period of 60 seconds. After this time the LED displays are again disabled.

The LED state is independent of the VLOOP, DC/DC Converter and Vision display controls on the RTU. The user may programmatically relate these items together through ISaGRAF logic if required (e,g. activate the DC/DC converter and Vision display when the LEDs are activated.)

16.4 Jumpers

Headers on the RTU are user configurable and are described in the appropriate sections of this manual. Some headers and jumpers on the controller are reserved for manufacturing and test functions. Refer to the Board Layout 18 diagram for the location of jumpers.

The following table lists the jumpers and the relevant section of this manual.

Jumpers

Jumper	Function	Manual Section
J1	Analog Input 0 Range:	Analog Inputs 32
J2	Analog Input 1 Range:	Analog Inputs 32
J3	Analog Input 2 Range:	Analog Inputs 32
J4	Analog Input 3 Range:	Analog Inputs 32
J5	Analog Input 4 Range:	Analog Inputs 32

J8	Reset Jumper (Performs a controller board reset similar to power cycle)	
J9	Counter Input 1 Type:	Counter Inputs 43
J10	Counter Input 2 Type:	Counter Inputs 43
J11	Counter Input 1 Type:	Counter Inputs 43
J12	Counter Input 2 Type:	Counter Inputs 43
J13	COM2 RS-232 / RS-485 mode selection:	COM2 RS-232 Serial Port 55
J14	COM2 5 Vdc on Pin 1:	COM2 RS-232 Serial Port 51
J15, J16	COM3 Vision / Normal mode select: These jumpers need to both be in the same position, either **Vision** or **Normal**.	COM3 RS-232 Serial Port 55

16.5 Status LED

The STAT LED indicates the current RTU status condition.

The STAT LED blinks when a status code requiring attention is present

The STAT LED turns off when the status code is returned to 0.

The RTU status condition causing the STAT LED can be determined from the **Analog System Point 50020** or by viewing SCADAPack E Configurator **General > Controller Status** page - **System Error Code** field.

To clear the status code and the STAT LED indicator:

- Press the **Clear Errors** button on SCADAPack E Configurator **General > Controller Status** page.

17 Maintenance

The RTU requires little maintenance. The **Power Mode** LED indicates the status of the 5 Vdc supply. If the LED is off, the onboard fuse F1 may require replacing. If the program is lost during power outages, the lithium battery may require replacement.

The analog input and output circuitry is calibrated at the factory and does not require periodic calibration. Calibration may be necessary if the module has been repaired as a result of damage.

If the controller is not functioning correctly, contact Schneider Electric Technical Support 7 for information regarding returning the SCADAPack E Smart RTU for repair.

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment being monitored or controlled by the device before removing power.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

HAZARD OF ELECTRIC SHOCK

Remove power from all devices before connecting or disconnecting inputs or outputs to any terminal or installing or removing any hardware.

Failure to follow these instructions can result in death or serious injury.

Fuses 90

Lithium Battery 91

17.1 Fuses

A single 1.5 Amp fast-blow fuse provides protection for the power supply. The fuse is mounted under the cover. Refer to the **Board Layout** diagram in **Installation > Field Wiring** for the location.

⚠WARNING

EXPLOSION RISK

Before replacing the fuse verify that the area is non-hazardous and disconnect power.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Evaluate the operational state of the equipment monitored and controlled by the SCADAPack E RTU.

Failure to follow these instructions can result in death or serious injury.

⚠WARNING

UNEXPECTED EQUIPMENT OPERATION

Replace the fuse with a fuse of the same rating. Under no circumstances should a fuse be bypassed or replaced with a fuse of a higher rating.

Failure to follow these instructions can result in death or serious injury.

The fuse is a Littelfuse Nano-SMF, part number **045301.5** or **R45101.5**. This fuse is available in a package of 10 from Schneider Electric as part number TBUM297327.

In every case investigate and correct the cause of the blown fuse before replacement. Common causes of a blown fuse are short circuits and excessive input voltages.

17.2 Lithium Battery

A small lithium battery powers the CMOS memory and real-time clock when input power is removed. The voltage of a functioning battery should be greater than 3.0 Vdc (typically 3.5...3.7 Vdc).

The RTU monitors the lithium battery and provides a status indication if the battery voltage is less than 3.0 Vdc (RAM Battery Low - **Binary System Point 50207**). See Power Supply and Battery Status 95 in the **Troubleshooting** section.

The battery should not require regular replacement under normal conditions. The shelf life of the battery is 10 years. The battery is rated to maintain the real-time clock and RAM data for two years with the power off. Accidental shorting or extreme temperatures may damage the battery.

Battery Replacement Procedure

NOTICE
UNEXPECTED EQUIPMENT OPERATION • Treat battery with care. • Follow the manufacturer's instructions concerning battery storage, use and disposal. • Keep the battery clean and free from contaminants or other materials that could short the terminals. • Connect the new battery using the correct polarity. • Replace battery with a new unit of the same chemistry, capacity and make. • Observe the manufacturer's instructions regarding disposal of batteries. Considerable energy remains in the battery. **Failure to follow these instructions can result in equipment damage.**

The battery is plugged into the circuit board and held in place with a tie-wrap. If necessary it can be replaced with an identical battery available from Schneider Electric.

1. Save the existing configuration and ISaGRAF user applications running in the RTU, if applicable.
2. Remove power from the RTU.
3. Remove the RTU top cover and locate the battery. It is found at the far right side of the circuit board.
4. Remove the tie wrap using wire cutters.

   The battery is wrapped in place at the factory. This is to keep the battery from becoming disconnected during shipment.
5. Remove the battery by gently lifting it straight up from the circuit board.

   The battery has two pins that mate with two sockets on the circuit board.
6. Replace the battery. A replacement tie wrap is not necessary.

7. Cold boot the controller. (Refer to Section COLD BOOT Mode 82 in this manual for the COLD BOOT procedure.)

   If a cold boot is not done, the behavior of the controller is unpredictable.

8. The controller's configuration and applications may now be loaded.

18 Troubleshooting

The SCADAPack E Smart RTU provides a number of capabilities that help you monitor RTU operations and perform troubleshooting tasks. They include:

- LEDs that indicate the status of RTU ports and communications
- System points that measure input voltage, RAM battery voltage, controller board ambient temperature and DC\DC converter voltage used for VLOOP

The following topics provide a starting point for troubleshooting:

18.1 Internal Temperature Reading

Internal analog points measure the controller's ambient temperature. These can be accessed from a user application program or via remote RTU communications.

Internal Temperature °C - Analog System Point 50062

This analog system point measures the ambient temperature at the controller circuit board in degrees Celsius. It is useful for measuring the operating environment of the controller and returns an integer value in the range –40...75 °C.

The temperature reading represents temperatures in the range –40...75 °C. Temperatures outside this range cannot be measured.

- Use the system point directly by assigning an analog point of this point number (**50062**) in the RTU database
- Read the system point into a user ISaGRAF application as an Integer or Real variable from an Input Board connection

Internal Temperature °F - Analog System Point 50063

This analog system point measures the ambient temperature at the controller circuit board in degrees Fahrenheit. It is useful for measuring the operating environment of the controller and returns an integer value in the range –40...167 °F.

The temperature reading represents temperatures in the range –40...167 °F. Temperatures outside this range cannot be measured.

- Use the system point directly by assigning an analog point at this point number (**50063**) in the RTU database
- Read the system point into a user ISaGRAF application as an Integer or Real variable from an input board

18.2 Internal Supply Voltage

An internal analog point measures RTU input supply voltage. This can be accessed from a user application program or via remote RTU communications.

Analog System Point 50060

The input supply voltage measures the incoming power supply. It is useful for measuring the operating environment of the controller and returns a floating point value in the range 0...32.767 Vdc.

- Use the system point directly by assigning a point of this point number (**50060**) in the RTU database, or
- Read the system point into a user ISaGRAF application from an Input Board connection

18.3 Power Supply and Battery Status

Two internal system binary points are provided which indicate the status of the RTU input supply voltage and the on-board lithium battery. These can be accessed from a user application program or via remote RTU communications.

Local Input Power Supply Low - Binary System Point 50206

An internal binary point indicates the condition of the input power supply. It compares the **Supply Voltage System Analog Point 50060** with the **Low Voltage Alarm Level** set in the SCADAPack E Configurator **General > Controller Settings** page. If the input power supply is lower than the **Low Voltage Alarm Level** then this **Binary System Point** is activated.

- Use the system point directly by assigning a point of this point number to the RTU database.
- For ISaGRAF applications, read the status point through an Input Board connection.

Local On Board Battery Low - Binary System Point 50207

An internal binary point indicates the condition of a monitor on the lithium battery that maintains the non-volatile RAM in the RTU.

If active, the point indicates that the on-board battery needs replacement.

- Use the system point directly by assigning a point of this point number to the RTU database.
- For ISaGRAF applications, read the status point through an Input Board connection.

18.4 Analog Inputs

Condition	Action
20 mA inputs reads 0.	Check transmitter power.
Reading is at or near 0 for every input signal.	Check if the input transient suppressors are damaged.
20 mA readings are not accurate.	Check for a damaged 250 W current sense resistor.

	Inputs are 0...20 mA, not 4...20 mA.
Reading is constant.	Check that the analog input is not forced.

18.5 Analog Outputs

Condition	Action
Outputs are 0 mA	Check the 24 Vdc power.
The full-scale output is less than 20 mA.	Check the 24 Vdc power. Check that the load resistance is within specification.
Output is constant and should be changing.	Check that the analog outputs are not forced.

18.6 Digital Inputs

Condition	Action
Input LED does not come on when input signal is applied.	Check the input signal at the termination block. It should be at least 50% of the digital input range. If this is a DC input, check the polarity of the signal.
Input is on when no signal is applied. The LED is off.	Check that the digital inputs are not forced on.
Input is off when a signal is applied. The LED is on.	Check that the digital inputs are not forced off.
Input is on when no signal is applied. The LED is on.	Check that the digital output at that point is off.
The LED is dim.	This is normal operation when the controller is in low power mode or sleep mode, or when the LEDs are turned off. Check the controller digital I/Os are in the register assignment.

18.7 Digital Outputs

Condition	Action
Output LED does not come on when output is turned on.	Check the LED POWER from the SCADAPack controller.
Output LED comes on and output is on, but the field device is not activated.	Check the field wiring. Check the external device.
Output LED and output are on when they should be off.	Check that the output is not forced on.
Output LED and output are off when they should be on.	Check that the output is not forced off.
Output LED comes on but the output does not close.	Check if the relay is stuck. If so, return the board for repair.
The LED is dim.	This normal operation when the controller is in sleep mode, or when the LEDs are turned off. Check the controller digital I/Os are in the register assignment.

18.8 Counter Inputs

Condition	Action
Input LED does not come on when input signal is applied.	Check the input signal at the termination block. It should be at least 50% of the counter input range. Check the LEDs are turned on.

18.9 Calibration

The RTU is calibrated at the factory. It does not require periodic calibration. Calibration may be necessary if the module has been repaired as a result of damage. Calibration is done electronically at the factory. There are no user calibration procedures.

19 Specifications

Disclaimer: Schneider Electric reserves the right to change product specifications without notice. For more information visit http://www.schneider-electric.com.

19.1 General

Logic Control	IEC 61131-3 SCADAPack Workbench programming suite (LD, ST, FBD and SFC)
I/O Terminations	6 and 12 pole, removable terminal blocks. 3.31 mm²...0.08 mm² (12...28 AWG) Solid or stranded
Dimensions	211.8 mm (8.34 in) wide 140.4 mm (5.53 in) high 46.5 mm (1.83 in) deep
Enclosure	Corrosion resistant zinc plated steel with black enamel paint
Environment	Conformally coated 5% to 95% RH, non-condensing -40...70 °C (-40...158 °F) operating -40...85 °C (-40...185 °F) storage
Shock and Vibration	IEC 60068-2-27 (tested up to 15 g) IEC 60068-2-6
Warranty	3 years on parts and labor

19.2 Controller

Processor	32-bit ARM7 microcontroller, 32 MHz clock Integrated watchdog timer Two microcontroller I/O co-processors, 20 MHz clock
Memory	16 MB FLASH ROM 4 MB CMOS RAM 4 kB EEPROM
Event Logging Capacity	20,000 events
Database Capacity	Up to 1000 points
Data Concentrator Capacity	Up to 500 in DNP3

(Points)	
Data Concentrator Capacity (Devices)	Up to 10 in DNP3 Up to 100 in Modbus or DF1
File System Typical Storage	Internal: 6 MB
Internal Power Monitor	Power input - analog input and low indication Onboard lithium battery - low indication
Internal Temperature Monitor	Controller temperature range: -40...75 °C (-40...167 °F)

19.3 Communications

Serial Port COM1	RS-485 2-pole removable terminal block Two-wire half duplex Supports baud rates up to 115,200 bps
Serial Port COM2	RS-232 8-pin modular RJ45 jack Full or half duplex Supports baud rates up to 115,200 bps **OR** RS-485 Two-wire half duplex
Serial Port COM3	RS-232 8-pin modular RJ45 jack Full or half duplex with RTS/ CTS control and operator interface power control Supports baud rates up to 115,200 bps
Embedded Wireless	The controller may embed an unlicensed radio module (different options in 900 MHz or 2.4 GHz) that uses one of the serial ports.
Serial Protocols	DNP3 level 4 in TCP Master/Slave and peer-to-peer IEC 60870-5-101 slave Modbus Slave/Master DF1 Master
Ethernet Port	8-pin RJ-45 modular jack 10/100 mb/s UTP 10/100Base-T Transformer-isolated
IP Protocols	DNP3 level 4 in TCP Master/Slave UDP Master/Slave and peer-to-peer IEC 60870-5-104 Slave Modbus/TCP Server

	Modbus/ TCP Client Modbus RTU in TCP Client NTP Client/Server Telnet Server FTP Server BOOTP Server
Master - Slave Capability	Can simultaneously report to multiple independent active masters:3 in DNP3, 2 in IEC 60870-5-101/-104, 5 in Modbus TCP and 3 in Modbus RTU and connect to up to 100 remote devices in DNP3 peer-to-peer As a data concentrator, it can manage up to 10 local or remote DNP3 slaves, and up to 100 local slaves communicating with Modbus RTU, Modbus TCP or DF1 serial.
USB Device	USB 2.0 compliant "B"-type receptacle for local configuration

19.4 Power Supply

<table>
<tr><td>Rated Voltage</td><td>12...30 Vdc
10...11.5 Vdc turn on voltage
9...10 Vdc turn off voltage</td></tr>
<tr><td>Maximum Power</td><td>12 W at 24 Vdc maximum</td></tr>
<tr><td>Power Requirements</td><td>SCADAPack 350E typical power consumption at 20 °C/68 °F):
<table>
<tr><th></th><th>Ethernet</th><th>Controller LEDs</th><th>Vloop fully loaded</th><th>12 Vdc</th><th>24 Vdc</th></tr>
<tr><td>Use case 1</td><td>ON</td><td>OFF</td><td>OFF</td><td>1.6 W</td><td>1.5 W</td></tr>
<tr><td>Use case 2</td><td>ON</td><td>OFF</td><td>ON</td><td>5.1 W</td><td>4.9 W</td></tr>
<tr><td>Use case 3</td><td>ON</td><td>ON</td><td>ON</td><td>5.2 W</td><td>5.0 W</td></tr>
</table></td></tr>
<tr><td>Power Outputs</td><td>Maximum 140 mA at 12 Vdc (booster turned off) or 24 Vdc (booster turned on)
Can power up to 7 analog input/output loops (20 mA per analog loop)</td></tr>
<tr><td>Output Capacity</td><td>5 Vdc at 1.2 A capacity
5 Vdc at 1.1 A (current limited) for COM2 and I/O expansion
5 Vdc at 250 mA (current limited) on COM3 for Vision displays
5 Vdc at 100 mA (current limited) for USB downstream port loads</td></tr>
</table>

19.5 I/O Expansion

I/O Expansion Capacity	Maximum 8 I/O modules. To reach this limit, additional power supply modules (5103) are required. Supported modules: Current 5000 modules (except 5608 and 5610)

19.6 Analog Inputs

Input Points	5, user-selectable 0...10 Vdc or 0...20 mA plus over range 1, 0...32.7 Vdc (15-bit) for DC supply monitoring
Resolution	15 bits over the 10 Vdc measurement range. 14 bits over the 20 mA measurement range
Accuracy	±0.1% of full scale at 25 °C (77 ºF) ±0.2% over temperature range
Input Resistance	250 ohms or 20 kilohms in 20 mA or 10 Vdc configurations 60 kilohms for 32.768 Vdc
Normal Mode Rejection	27 dB at 60 Hz
Sampling Rate	170 ms

19.7 Analog Outputs

Output Points	2 (optional) 0...20 mA, 4...20 mA Voltage output may be accomplished with external precision resistor
Resolution	12 bits over 0...20 mA range
Accuracy	±0.15% at 25 °C (77 °F) ±0.35% of full scale over temperature range
Response Time	Less than 10 µs for 10%...90% signal change
Power Supply	12...30 Vdc, external
Power (Current) Requirements	10 mA plus up to 20 mA per output
Isolation	Isoated from RTU logic and chassis
Load Range	12 Vdc: 0...375 ohms 24 Vdc: 0...925 ohms
Logic End-Of-Scan to Signal Update Latency	Typically 18...27 ms
Status and Reporting	Output value
Controls	Direct Operate Select Before Operate

19.8 Counter Inputs

Counter Inputs	Counter 0: digital input counter Counter 1: turbine meter inputs Counter 2: turbine meter inputs
Counter Input 0	Maximum frequency 10 Hz Dry contact input Wetting current typically 5 mA Contact closure to ground is ON Open input is OFF
Counter Input 1 and 2	Designed for use with low voltage, turbine meter outputs Jumper link selectable for use with turbine meter amplifiers or dry contact closure
Counter Input 1 and 2 Turbine Meter Sensitivity	Minimum input 30 mVp-p at 5...50 Hz Minimum input 150 mVp-p at 150 Hz Minimum input 650 mVp-p at 5 kHz Minimum input 750 mVp-p at 10 kHz Maximum input 4 Vp-p using internal amplifier
Counter 1 and 2 Dry Contact	Maximum input 10 Vp-p without internal amplifier Maximum frequency 10 kHz
Dry Contact Input Thresholds	0.9 Vdc typical turn on input voltage Less than 0.4 Vdc turn on input voltage 1.5 V typical turn off input voltage Greater than 2.5 Vdc turn off input voltage below 1 kHz Greater than 3.5 Vdc turn off input voltage above 1 kHz
Isolation	Common ground return connected to chassis ground

19.9 Digital Inputs/Outputs

I/O points	8, user-selectable as inputs or outputs (open drain)
As Digital Inputs	Dry contact Time stamping: 170 ms
As Digital Outputs	Sinking MOSFET output, rated 30 Vdc, 1 A
Input Rating	Dry contact input 60 ohms for 32.768 Vdc inputs 250 ohms for 20 mA inputs Contact closure to ground is ON Open input is OFF
Output Rating	1.0 A maximum 0.35 Vdc maximum drop at 1 A
Digital Input Thresholds	0.9 Vdc turn on input voltage Less than 0.4 Vdc turn on input voltage 1.5 Vdc typical turn off input voltage Greater than 2.2 Vdc turn off input voltage
Contact Resistance	ON input requires less than 100 ohms contact resistance Off input requires greater than 50 kilohms contact resistance Cable contact capacitance not to exceed 0.033 uF, typically 500 m (1600 ft)
Isolation	Common ground return connected to chassis ground

20 Approvals and Certifications

Hazardous Locations - North America	Non-Incendive Electrical Equipment for Use in Class I, Division 2 Groups A, B, C and D
Hazardous Locations - Europe	ATEX II 3G, Ex nA IIC T4 per EN 60079-15, Class I, Zone 2 Does not include embedded wireless versions
Hazardous Locations - IECEx	IECEx, Ex nA IIC T4 per IEC 60079-15, Class I, Zone 2 Does not include embedded wireless versions
General Safety	UL 508 (Industrial Control Equipment)
EMC and Radio Frequency	ICES-003 Issue 5 August 2012 CE and RCM markings

Schneider Electric

Telemetry & Remote SCADA Solutions
415 Legget Drive, Suite 101, Kanata, Ontario K2K 3R1 Canada
Direct Worldwide: +1 (613) 591-1943
Fax: +1 (613) 591-1022
Toll Free within North America: 1 (888) 267-2232

www.schneider-electric.com