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SCADAPack 350

Installation, Operation and Maintenance Setup Manual

5/19/2011

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Table of Contents

SCADAPack 350 1

Safety Information 6

About The Book 9

Overview 10

Installation 11

SCADAPack 350 and SCADAPack 357 11
Field Wiring 11

Power Supply 14

Overview and Power Requirements 14
Understanding Power Requirements 14
Sample Power Calculations 17
System Grounding 18
Power Management Features 18
COM3 Serial Port Power Control 19
VLOOP Power Control 20
VLOOP Over-Current Protection 21
12V to 24V DC/DC Converter Control 21

Analog Inputs 22

Internal Analog Inputs 22
Controller Input Voltage 22
I/O Analog Inputs 23
Analog Input Mode Jumpers 26
Analog Inputs Data Format 26

Analog Outputs 27

Current Outputs 27
Voltage Outputs 27
Analog Outputs Data Format 28

Digital Outputs 29

Digital Inputs 31

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Digital I/O Connection Examples 34

Counter Inputs 35

Counter Input 0 35
Turbine Meter Counter Inputs 1 and 2 36

Serial Communication 41

RS-232 Serial Communications Ports 41
RS-232 Wiring Examples 46
RS-232 Cables 48
RS-485 Serial Communication Ports 50

Ethernet Communication 54

LAN Port Settings 54
TCP/IP Settings 54
Modbus/TCP Settings 55
RJ-45 Modular Connector for Ethernet 56

USB Ports 57

USB Connections 57

Operation 59

Operating Modes 59
LED Indicators 65
LED Power Control 66
Jumpers 66
Status LED 67
Firmware Loading 68

Maintenance 69

Fuses 69
Lithium Battery 69

Troubleshooting 71

Analog Inputs 71
Analog Outputs 71
Digital Inputs 71
Digital Outputs 72
Counter Inputs 72

Specifications 73

General 73
Controller 73

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Serial Ports 74
Ethernet Port 74
USB Ports 75
Visual Indicators 75
Power Supply 75
I/O Expansion Capacity 76
Analog Inputs 76
Analog Outputs 77
Counter Inputs 78
Digital Inputs/Outputs 78

Approvals and Certifications 80

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Index of Figures

Figure 2: SCADAPack 350 Board Layout 13
Figure 3: Power Management 19
Figure 4: Analog Input Wiring 26
Figure 5: Analog Output Wiring 28
Figure 6: Digital Input/Output Wiring 34
Figure 7: Counter Input Wiring 36
Figure 8: Setting Jumpers on Counter Input 1 for Low Voltage Turbine Meters . 37
Figure 9: Setting Jumpers on Counter Input 2 for Low Voltage Turbine Meters . 37
Figure 10: Setting Counter Input 1 and 2 for Turbine Meters with amplified signals 38
Figure 11: Connecting External Pull-Up Resistors to Counter Inputs 1 and 2 39
Figure 12: RJ-45 Connector Pinout 42
Figure 13: RJ-45 Connector Pinout 45
Figure 14: RS-232 DTE to RS-232 DTE without Handshaking 47
Figure 15: RS-232 DTE to RS-232 DTE with Handshaking 47
Figure 16: RS-232 DTE to RS-232 DCE With Handshaking 48
Figure 17: COM2 RJ-45 Connector 52
Figure 18: RS-485 Wiring 53
Figure 19: RJ-45 Connector for Ethernet 56
Figure 20: Host USB Port Connections 57
Figure 21: Peripheral USB Port Connections 58

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Safety Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, 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 an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠WARNING

WARNING indicates a potentially 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.

CAUTION

CAUTION used without the safety alert symbol, indicates a potentially

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hazardous situation which, if not avoided, **can result** in equipment damage..

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 and operation of electrical equipment and the installation, 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.

⚠ CAUTION

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 injury or equipment damage.

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

Software testing must be done 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 prevent accidental equipment damage.

Before energizing equipment:

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- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove ground from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

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 prevent unauthorized changes in operating characteristics.

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About The Book

At a Glance

Document Scope

This manual describes the SCADAPack 350 controller.

Validity Notes

This document is valid for all versions of the SCADAPack 350 controller.

Product Related Information

⚠WARNING

UNINTENDED EQUIPMENT OPERATION

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program, install, alter and apply this product.

Follow all local and national safety codes and standards.

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

User Comments

We welcome your comments about this document. You can reach us by e-mail at technicalsupport@controlmicrosystems.com.

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Overview

A SCADAPack 350 controller, comprising a 5209 controller board, is a low power RTU, complete with an integrated power supply, analog and digital I/O, serial communications, 10/100 Mb/s Ethernet, 12Mb/s USB A and USB B ports and turbine flow meter counter inputs. Application programs can be written in Relay Ladder Logic, IEC 61131-3 and the C language.

Several power saving features are included in the SCADAPack 350. These power saving features include Sleep Mode, 24V-power shutdown, Ethernet port shutdown, communication port power control, and SCADAPack Vision power down, USB disable and a reduced power mode that lowers the CPU clock.

The I/O capacity of the SCADAPack 350 can be expanded using 5000 I/O modules. A maximum of twenty 5000 I/O modules may be used.

This controller board can be combined with a 5606 Integrated I/O module, forming a SCADAPack 357. For information on the 5606 I/O module, refer to the ***5606 User Manual.***

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Installation

The installation of SCADAPack controllers requires mounting the controller on the 7.5mm by 35mm DIN rail and connecting the SCADAPack controller to the system I/O Bus. Refer to the ***System Configuration Guide***, at the beginning of this manual, for complete information on system layout, I/O Bus cable routing and SCADAPack controller installation.

For ATEX and IECx applications only:

This equipment is to be installed 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. A T4 rating is acceptable.
For products using Solid State Relays (5415, 5606 and 5607 modules and SCADAPack using 5606 and 5607 modules) A T4 rating is acceptable for maximum loads of 2A. When 3A loads are connected to the Solid State Relays, the maximum ambient rating is lowered to 50°C in order to maintain the T4 rating.

SCADAPack 350 and SCADAPack 357

SCADAPack 350 consists of the 5209 controller.

SCADAPack 357 consists of the 5209 controller and a 5606 Input Output Module.

The Model 5606 Input Output Module adds eight analog inputs, 32 digital inputs, and 16 relay digital outputs to the 5000 input/output system. Refer to the ***5606 Input Output Module*** hardware manual for details.

SCADAPack 350 or SCADAPack 357 Wireless controllers are equipped with one of:

- Trio KR20 spread spectrum radio.
- FreeWave spread Spectrum radio.
- MDS Spread spectrum radio.

Refer to the hardware user manual for the radio being used. These manuals are included in the Hardware manual reference.

Field Wiring

SCADAPack controllers use screw termination style connectors for termination of field wiring. These connectors accommodate solid or

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stranded wires from 12 to 22 AWG. The connectors are removable allowing replacement of the SCADAPack Controller without disturbing the field wiring. Leave enough slack in the field wiring for the connector to be removed.

Remove power before servicing unit.

To remove the termination connector:

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

To install the termination connector:

- Line up the pins on the module with the holes in the connector.
- Push the connector onto the pins. Apply even pressure to both ends on the connector.

There are eight connectors for field wiring. Refer to ***Figure 1: SCADAPack 350 Board*** Layout 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*** for pinout details and wiring diagrams for these modular jacks.
- One Ethernet port connects to an 8 pin modular jack. Refer to section

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- ***Ethernet*** Communication for pinout details.
- 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

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- ***USB*** Ports for details.

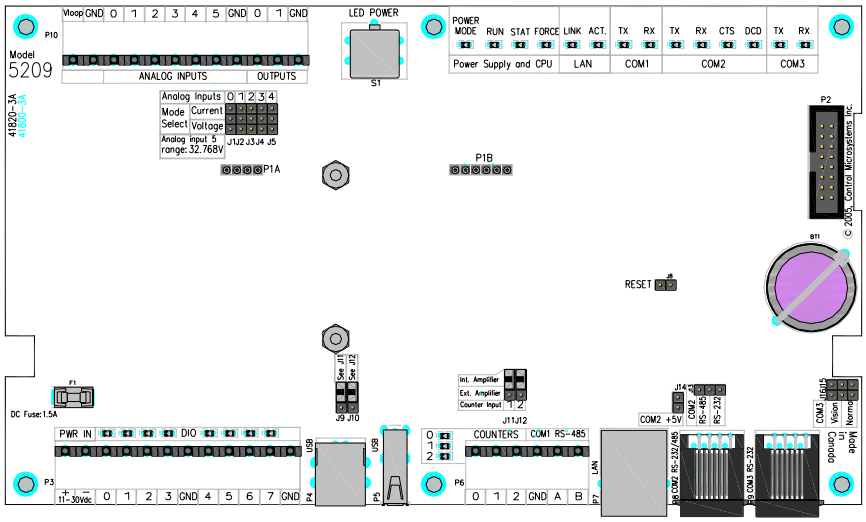


Figure 1: SCADAPack 350 Board Layout

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Power Supply

Overview and Power Requirements

The SCADAPack 350 is powered from an 11V DC to 30V DC input power source.

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

Refer to section

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Specifications 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 350 will turn off.
- Exceeding the maximum input voltage or applying a reverse voltage will blow the input power fuse.

Unlike the other members of the SCADAPack family, the SCADAPack 350 operates only on a DC power sources. Connections to power sources such as 16Vac transformers will blow the fuse and may cause damage to the SCADAPack 350.

The DC power-input voltage is used to generate 5V at 1.2A (6W) some of which is used for the controller onboard circuitry. The output capacity of the 6W is sufficient to power the SCADAPack 350 controller board, a SCADAPack Vision operator interface with a limited number of 5000 I/O modules such as the Model 5606 I/O Module integrated into the SCADAPack 357.

The power available for any 5000 expansion I/O modules is limited to 5.5W (5V at 1.1A) and depends on the controller features enabled. For 12VDC input voltages an onboard DC/DC converter with an output capacity of 3.36W (24V at 140mA) can be used to power five 20mA analog inputs and two 20mA output devices (loop-powered transmitters). The 12/24V DC/DC converter is controlled by the user application program and may turned on or off. Refer to section ***12V to 24V DC/DC Converter Control*** for more information on DC/DC converter control.

Understanding Power Requirements

In determining the power requirements for an application it is necessary to understand how the controller, and connected I/O modules, use the input power. The terms used for calculating the power requirements for an application are discussed below.

Input Power

Input power, in the range 11 to 30Vdc, is the power applied to the 11-30Vdc input on the controller.

Input Power Requirement

The input power requirement is the amount of power (i.e. voltage and current) needed by the controller and connected I/O modules for the application.

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5V Requirements

The internal hardware in the controller uses 5Vdc to operate. The hardware that uses 5Vdc include the controller board, USB ports, LAN port, serial ports, LEDs, I/O modules connected to P2 and processor power mode. The 5Vdc is converted from the input power applied to the controller.

12/24V Requirements

The only circuitry that requires 12 or 24Vdc are the analog input loops. This requirement is added to the input power requirement to determine the overall input power requirement for the application.

Power Supply Efficiency

Some of the input power is not converted into 5Vdc but is lost due to heat dissipation and other factors. The input power minus this loss is referred to as power supply efficiency. The controller has an **85%** efficiency rating.

Power Units

The power units used for requirements is Watts, or milliWatts (0.001 Watts). Watts are described as voltage x current (P=IV). Watts units are very useful in that power, current or voltage can be determined if two of the values are known. For example:

- An input of **24Vdc** at **500mA** equals **12W** (Watts)
- An input of **12Vdc** at **500mA** equals **6W** (Watts)
- An input of **12Vdc** at **1000mA** equals **12W** (Watts)

Much of the input power (12 or 24Vdc) is needed for conversion to 5Vdc an understanding of the relationship between the input power and 5Vdc power is needed.

The controller can supply a **maximum** of **1200mA @5Vdc**. For applications that do not need the entire 1200mA a calculation is done to determine what 5Vdc current is needed and convert this to the needed input power. Some examples follow.

Assume a 12 or 24Vdc input voltage and the 5Vdc requirement is the maximum 1200mA. To determine the input power for this example:

5Vdc requirement = 1200mA x 5Vdc = **6W**

Power supply efficiency = **85%**

Thus the input power times the power supply efficiency equals the requirement of 6W.

Input Power = 6W / 0.85 = 7W (maximum)

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For a 24Vdc input power supply:	For a 12Vdc input power supply:
P=IV	P=IV
7W=I x 24Vdc	7W=I x 12Vdc
I = 7W / 24Vdc = **290mA**	I = 6W / 12Vdc = **580mA**

Assume a 12 or 24Vdc input voltage and the 5Vdc requirement includes the controller board and LAN port only. To determine the input power for this example:

From the specifications section of this user manual it is seen that the controller board requires 85mA @5Vdc and the LAN port requires 135mA @ 5V.

5Vdc requirement = (85mA + 135mA) x 5Vdc = 600mW

Power supply efficiency = **85%**

Thus the input power times the power supply efficiency equals the requirement of 600mW.

Input Power = 600mW / 0.85 = 700mW

For a 24Vdc input power supply:	For a 12Vdc input power supply:
P=IV	P=IV
700mW=I x 24Vdc	700mW=I x 12Vdc
I = 700mW / 24Vdc = **29mA**	I = 700mW / 12Vdc = **58mA**

The Specification section at the end of this user manual must be used to determine how much power is required for each item used by the controller for the application.

Sample Power Calculations

Example 1

Assume we have a SCADAPack 357, a 5209 controller board with an integrated 5606 I/O module. In this example it is assumed that the controller is powered from a 12V supply, the LAN port and 12/24V DC/DC converted features are also enabled. Also assume that the five 20mA analog input channels and two 20mA analog output channels need to be powered. The controller will not be running in reduced power mode. The current requirement of the controller board and I/O module is summarized in the table below.

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	5V Current	24V Current
5209 Controller Board (base current in normal mode)	80mA	20mA x 5 = 100mA (Vloop)
LAN Port	160mA	0mA
5606 I/O Module	600mA	12mA
5305 Analog output	0mA	20mA X 2 = 40mA (Vloop)
Total	840mA	140mA (operation)
Available for I/O expansion, USB and COM/Visions	360mA remaining from 1.2A capacity	0mA

In this case, 360mA at 5V power is available for any I/O expansion, to enable the USB port and for COM/Vision power.

In this example, the total input power required from a 12V power supply is calculated as follows:

5V Power: 5V x .84A = 4.2W

24V Power: 24V x .14A = 3.36W

Total Input Power Required = 7.56W/0.85 = 8.90W (assuming 85% power supply efficiency).

Therefore your 12V power supply must be capable of providing 8.90W/12 = 0.74A of current.

The additional analog input channels on the integrated 5606 I/O module will need to be powered from an external power source.

Example 2:

Assume we have a SCADAPack 350, a 5209 controller board with two analog outputs but without the integrated 5606 I/O module. The controller board is powered from a 12V supply, is operating in reduced power mode and the LAN port is also not enabled. All five 20mA analog input channels on the controller board and two optional 20mA analog output channels are needed. To power the analog inputs and outputs using the controller board power supply, the 12/24V DC/DC converter must be enabled. The current requirements in this scenario is summarized in the table below

	5V Current	24V Current
5209 Controller Board (base current in reduced power mode)	40mA	20mA x 5 = 100mA (Vloop)
5305 Analog output	0mA	20mA X 2 = 40mA (Vloop)
Total	40mA	140mA (operation)

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	5V Current	24V Current
Available for I/O expansion, LAN, USB and COM/Visions	1160mA remaining from the 1.2A capacity	0mA

In this case, 1160mA is available to power the LAN and USB ports, COM/Vision displays as well as other expansion modules downstream the SCADAPack 350 controller.

The total input power required from a 12V power supply is calculated as follows:

5V Power: 5V x 0.04A = 0.2W

24V Power: 24V x .14A = 3.36W

Total Input power required = 3.56W/0.85 = 4.19W (assuming 85% power supply efficiency)

System Grounding

In most applications, it is desirable to 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 all I/O point terminals labeled GND are connected to chassis ground.

Power Management Features

The SCADAPack 350 provides a number of special features to reduce power consumption. Refer to ***Figure 2: Power Management*** for an overview of the power management features. These power management features are:

- COM3 serial port power control for Vision Displays
- VLOOP power control.
- 12V to 24V DC/DC Converter Control.
- LED Power control.
- Ethernet disable.
- USB disable.
- Lowering the CPU clock speed for reduced power mode.

The SCADAPack 350 provides three internal digital outputs that can be operated by the user application to manage the power saving features. Internal digital outputs 8, 9 and 10 and the power management functions they control are described in the following sections.

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Disabling and enabling of the Ethernet and USB ports as well as a reduction of the clock speed can be done in Telepace using the CNFG Power Mode register assignment. The SETPMODE/ GETPMODE functions in IEC 61131-3 allow a user application to control these power management features. For C applications, use the SetPowerMode and GetPowerMode functions. Refer to the appropriate software manual for information on using and controlling the internal Digital Outputs.

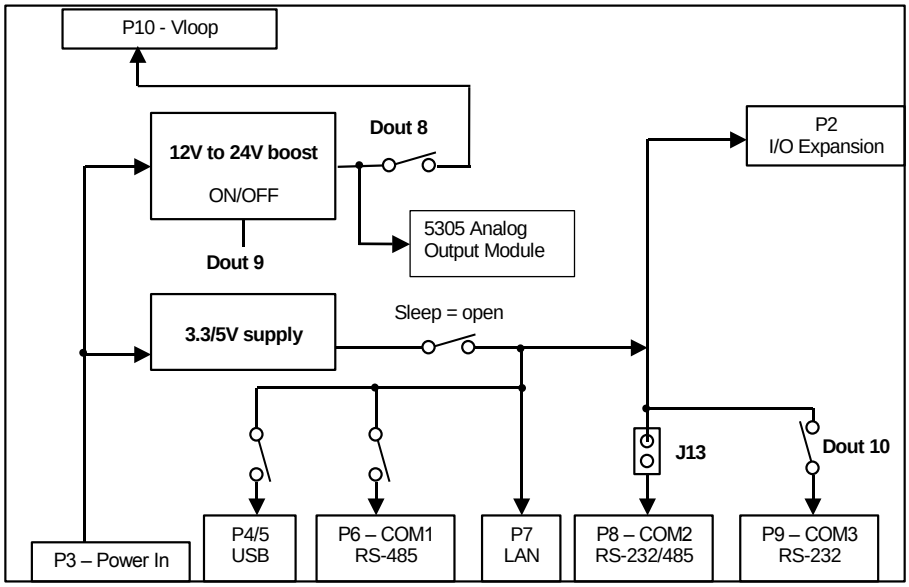


Figure 2: Power Management

COM3 Serial Port Power Control

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-volt power for the SCADAPack Vision or other HMI.

Refer to section ***COM3 RS-232 Serial Port*** for information on COM3 and section ***RJ-45 to SCADAPack Vision*** for wiring examples. 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 internal **Digital Output 10** is **ON** HMI power is turned on.
- When the LED power is disabled and internal **Digital Output 10** is **OFF** HMI power is turned off.
- HMI power is turned on for five minutes when a momentary contact is made between pin 2 (DCD) and pin 3 (DTR) on the RJ-45 connector of COM3. This permits the SCADAPack Vision or an HMI pushbutton to control HMI

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power. At each momentary contact, the five-minute power timer is reloaded. If the five-minute power timer is maintaining the HMI power on, a momentary contact between DCD and DTR will turn off HMI power. Refer to section ***RJ-45 to SCADAPack Vision*** for more information.
The **Controller LED Power Settings** register assignment,.Or the IEC61131 function **settled**, needs to be added and configured for a default state of OFF in order for the HMI to turn OFF once the five-minute power timer times out.

Internal **Digital Input 12** indicates the status of COM3 serial port power. **Digital Input 12** 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*** for further information on this feature.

VLOOP Power Control

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 DC-DC 12/24V converter if it is turned on. See section ***12V to 24V DC/DC Converter Control*** for converter information. The VLOOP power source is the applied input power if the DC-DC converter is turned off.

- Turn on **Digital Output 8** to turn **ON** the VLOOP output.
- Turn off **Digital Output 8** to turn **OFF** the VLOOP output.

Internal **Digital Input 8** indicates the status of VLOOP power. **Digital Input 8** 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 must wait some period of time for input readings to stabilize. This time period is dependent 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*** for further information on this feature.

VLOOP Over-Current Protection

When VLOOP output is turned on, it is monitored for excessive current consumption caused by field wiring or instrumentation loops. If sustained over-current is detected (100 ms), VLOOP is turned off even though

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internal Digital Output 8 is turned on. This protection prevents unnecessary fuse blowing, circuitry damage and rapid battery depletion.

When VLOOP output is turned on, using internal Digital Output 8, and a short circuit is detected VLOOP will turn off. VLOOP will turn on to try again 5 seconds after turning off. If the condition still exits VLOOP will again turn off and retry after a 5 second delay. While the condition exists internal **Digital Input 10** will be ON.

12V to 24V DC/DC Converter Control

The 12V to 24V DC/DC converter is used to provide 24V DC for VLOOP power and for the 5305 Analog Output module. The converter should be turned on if the SCADAPack 350 is equipped with analog outputs for which 24V drive capability is required. Otherwise, the DC/DC converter can be turned off to conserve power.

- Turn on **Digital Output 9** to turn **ON** the 12V to 24V DC/DC converter. When the converter is turned on 24Vdc is provided to the VLOOP power and to the 5305 Analog Output module.
- Turn off **Digital Output 9** to turn **OFF** the 12V to 24V DC/DC converter. When the converter is turned off VLOOP power and the 5305 Analog Output module use is the applied input power.

Internal **Digital Input 9** indicates the status of the 12V to 24V DC/DC converter. Digital Input 9 is set when the 12V to 24V DC/DC converter is on and is cleared when the 12V to 24V DC/DC converter is off.

The 12V to 24V 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*** for further information on this feature.

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Analog Inputs

The SCADAPack 350 provides eight analog input channels. This comprises of six single ended analog inputs available for external wiring and two internal for monitoring of onboard controller variables. 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 configured for voltage mode only and will measure 0 to 32.768V. This input can be used to monitor the input power or a battery voltage. Wiring of the external outputs is covered in this section of the manual.

The two internal inputs can be used in a user application to monitor, RAM battery voltage, controller board ambient temperature and DC\DC converter voltage used for VLOOP. See the following sections for details on how to access

Input	Type	Description
0 to 4	external	Jumper selectable for 0-10V or 0-40mA inputs.
5	external	0-32.768V for battery monitoring
6	internal	DC/DC converter output voltage
7	internal	Used internally by SCADAPack 350.

Refer to the Telepace or IEC 61131-3 software manuals for information on how to use the SCADAPack 350 Analog Inputs in application programs. Access to the analog input registers is achieved using a Register Assignment in Telepace or I/O connection in IEC 61131-3.

Internal Analog Inputs

There are three internal analog inputs which measure the controller input voltage, board ambient temperature and NV-RAM battery voltage. These internal analog inputs are accessed from a user application program.

Controller Input Voltage

The controller input voltage provides useful information for the power input to the controller such as if a battery back-up system is functioning correctly. The reading returned from this input is typically in the range from 11000 to 30000 representing the input supply in mV. The input supply voltage resolution is 100 millivolts.

- For Telepace applications use the ***Controller Input Voltage*** register assignment to read the input Voltage in millivolts.

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- For IEC 61131-3 applications use the ***ainvolt*** I/O connection to read the input Voltage in millivolts.

Controller Board Temperature

The ambient temperature internal analog input measures the temperature at the controller circuit board. It is useful for measuring the operating environment of the controller and returns an integer value in the range –40°C to 75°C or –40°F to 167°F. The temperature reading represents temperatures in the range –40°C to 75°C or –40°F to 167°F. Temperatures outside this range cannot be measured.

- For Telepace applications use the ***Controller Board Temperature*** register assignment to read the ambient temperature in degrees C and degrees F.
- For IEC 61131-3 applications use the ***aintemp*** I/O connection to read the ambient temperature in degrees C and degrees F.

Controller RAM Battery Voltage

The lithium battery internal analog input measures the voltage of the battery that maintains the non-volatile RAM in the controller. The reading returned from this input is in the range from 0 – 5000 representing the battery voltage in mV. It is useful in determining if the battery needs replacement. The 3.6V lithium battery will return a typical value of 3500 to 3700. A reading less than 3000 (3.0V) indicates that the lithium battery requires replacement.

- For Telepace applications use the ***Controller RAM Battery Voltage*** register assignment to read the lithium battery voltage.
- For IEC 61131-3 applications use the ***ainbatt*** I/O connection to read the lithium battery voltage.

I/O Analog Inputs

Six single ended analog inputs are available for measurement of field data. These analog inputs provide 15-bit resolution over the entire range of the input. 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. Refer to ***Figure 1: SCADAPack 350 Board Layout*** for the location of P10.

The analog inputs are identified as Channel 0 through Channel 5. The first five, identified as Channels 0 through 4, use range jumpers to select voltage or current mode. When set to voltage mode, the analog inputs are single ended and measure up to 10V. When configured for current mode a 250Ω current sense resistor will produce a 5V input at 20mA. See section ***Analog Input Mode Jumpers*** for information on setting the range.

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The sixth analog input, identified as Channel 5, is configured for voltage mode only and measures up to 32.768V. This input is typically used to monitor the input supply or battery voltage.

Analog input channels 0 to 4 may be read using one of two Telepace register assignments or IEC 61131-3 complex equipment modules. The

To report the analog input values **as 0-10V or 0 to 40mA** use the following:

- For Telepace applications use the ***SCADAPack 350 10V/40mA I/O*** register assignment to read the analog inputs. The analog inputs are scaled internally by the SCADAPack 350 so that a 10V or 40mA input will read full scale, 32767. See the ***Analog Inputs Data Format*** section for further details.
- For IEC 61131-3 applications use the ***sp350*** I/O connection to read the analog inputs. The analog inputs are scaled internally by the SCADAPack 350 so that a 10V or 40mA input will read full scale, 32767. See the ***Analog Inputs Data Format*** section for further details.

To report the analog input values as **0-5V or 0 to 20mA** use the following:

- For Telepace applications use the ***SCADAPack 350 5V/20mA I/O*** register assignment to read the analog inputs. The analog inputs are scaled internally by the SCADAPack 350 so that a 5V or 20mA input will read full scale, 32767. See the ***Analog Inputs Data Format*** section for further details.
- For IEC 61131-3 applications use the ***sp350v1*** I/O connection to read the analog inputs. The analog inputs are scaled internally by the SCADAPack 350 so that a 5V or 20mA input will read full scale, 32767. See the ***Analog Inputs Data Format*** section for further details.

Analog Input Wiring

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 250Ω resistor built into the 20mA 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. The *signal out* terminal connects to the Analog Input Channel, the *common* connects to GND and the *power in* connects to a power supply.

There are three options for the user when selecting the power source. The user is to ensure 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 5V.

The first option is to use the SCADAPack 350 VLOOP Supply that steps up the input voltage to 24V. The stepped up voltage is available on the

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Analog Connector P10 and is labeled VLOOP. There is sufficient power available here for the five analog inputs and two analog outputs operating at 20mA. Significant power saving is possible by switching the Loop Supply off.

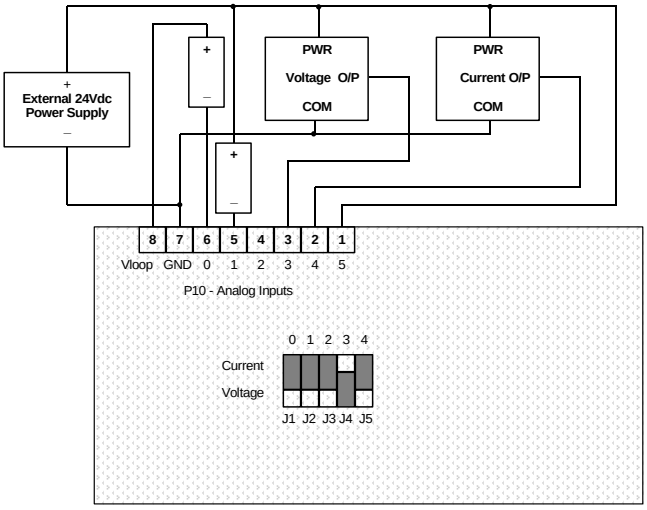
The second option is similar to the first except that the power supply is not stepped up to 24V. This can be used with low voltage transmitters or when then the input voltage is sufficiently high that further stepping up is not necessary. It is still possible to switch the supply off under program control. When the step up is turned off, VLOOP is approximately 0.5V less that the power input voltage.

The third option is to power the transmitter from a power supply supplied by the user.

Analog Input Wiring Examples

Example wiring of several transmitters is illustrated in ***Figure 3: Analog Input Wiring***.

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



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Figure 3: Analog Input Wiring

Analog Input Mode Jumpers

Channels 0 through 4 can be user configured for either voltage or current operation, using jumper links. Refer to ***Figure 1: SCADAPack 350 Board*** Layout for the location of the analog input mode selection jumpers. A sample illustration of the analog input mode selection using jumpers J1-J5 is given in ***Figure 3: Analog Input Wiring***. A jumper link installed in the Current position of the header results in a 250Ω resistor across the appropriate analog input. A jumper link installed in the Voltage position of the header results in a high impedance analog input.

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 10V. The analog inputs are factory calibrated to scale the data and represent it with a 15 bit unsigned number.

When an analog input is configured for voltage mode, 10V input is represented with 15 bits of data. The input resolution is 0.305mV/count.

When an analog input is configured for current mode, 20mA input is represented with 14 bits of data. There is 100% over range. The input resolution is 1.22µA/count.

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

The following table shows the A/D output value for several input signals. The A/D output is represented differently depending on the register assignment or IEC 61131-3 I/O module type.

Current Channel 0-4	**Voltage Channel 0-4**	**Voltage Channel 5**	**A/D Output 10V/40mA**	**A/D Output 5V/20mA**
0mA	0V	0V	0	0
1.22µA	0.305mV	0.001V	1	1
4mA	1.0V	3.277V	3277	6554
10mA	2.5V	8.192V	8192	16384
20mA	5.0V	16.384V	16384	32767
39.999mA	9.9997V	32.767V	32767	NA

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Analog Outputs

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

Refer to the Telepace or IEC 61131-3 software manuals for information on how to use the SCADAPack 350 Analog Outputs in application programs. Access to the analog output registers is achieved using a Register Assignment in Telepace or I/O connection in IEC 61131-3.

Current Outputs

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

The internal power supply powers the analog output circuits. The user can, under program control, boost the DC Input Power to 24V. This is required when generating current outputs into high resistance loads. Refer to section ***12V to 24V DC/DC Converter Control*** for further information.

Figure 4: Analog Output Wiring shows example wiring of the analog outputs.

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.

Voltage Range	Resistance	Output Range
0 to 5V	250Ω	0-20mA
0 to 10V	500Ω	0-20mA

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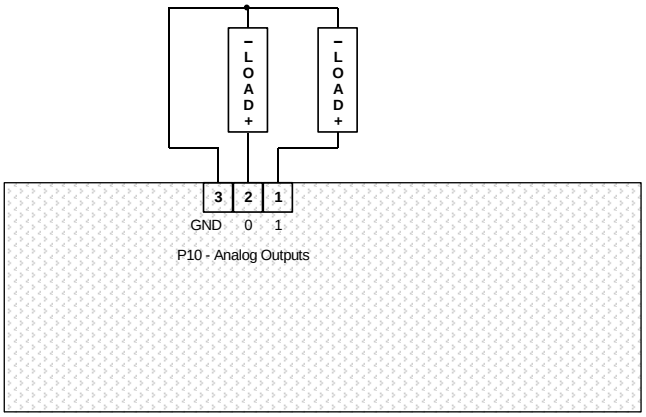


Figure 4: Analog Output Wiring

Analog Outputs Data Format

The optional analog output module has a 12-bit, unipolar, digital to analog converter. There are 4096 discretization steps in the output signal range. The 0-20mA output range resolution is 4.88µA/count. The table below shows the output current for several data values.

Data	Current
0	0mA
8	4.88µA
6552	4mA
16384	10mA
24576	15mA
32760	19.995mA

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Digital Outputs

The SCADAPack 350 controller board provides eight universal digital inputs or outputs. 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 is 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 1H) are operated continuously at greater than 0.5Hz.

The SCADAPack 350 also provides three internal digital outputs that can be controlled by the user application to manage power saving features unique to the SCADAPack 350.

Refer to the Telepace or IEC 61131-3 software manuals for information on how to use the SCADAPack 350 Digital Outputs in application programs. Access to the digital output registers is achieved using a Register Assignment in Telepace or I/O connection in IEC 61131-3.

The following table describes the SCADAPack 350 digital outputs.

Output	Type	Description
0 to 7	external	Open drain outputs. These outputs are located on terminal P3. 0 = output transistor off 1 = output transistor on
8	internal	VLOOP power control 0 = off 1 = on See section ***VLOOP Power Control*** for details.
9	internal	DC/DC converter control 0 = off 1 = on See section ***12V to 24V DC/DC Converter Control*** for details.
10	internal	com3 (HMI) power control 0 = off

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Output	Type	Description
		1 = on See section ***COM3 Serial Port Power Control*** for details.

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Digital Inputs

The SCADAPack 350 I/O Module provides eight universal digital inputs and outputs. The inputs are for use with dry contacts such as switches and relay contacts. The SCADAPack 350 provides the wetting current for the contacts.

If LED power is enabled, the SCADAPack 350 continuously sources approximately 5mA 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 SCADAPack 350. Indicator LEDs are dim in this condition. This is normal.

Refer to the appropriate software manual for information on using the SCADAPack 350 Digital Inputs and Outputs in application programs. For Telepace applications refer to the Register Assignment for SCADAPack 350 I/O module and for IEC 61131-3 applications refer to the I/O Complex Equipment for SCADAPack 350 I/O.

The SCADAPack 350 I/O Module provides the following 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*** 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 ***12V to 24V DC/DC Converter Control*** 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-

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Input	Type	Description
		current condition clears. 0 = off 1 = on See section ***VLOOP Over-Current Protection*** for details.
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

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

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*** 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 ***12V to 24V DC/DC Converter Control*** 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*** for details.
11	internal	**Digital output mismatch** Known outputs are compared to the corresponding inputs to detect incorrect outputs. A point is compared if

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Input	Type	Description
		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. The SCADAPack 350 on board digital I/O can be inputs or outputs. There is no configuration for the type, the SCADAPack 350 accepts digital inputs on a point and will write a digital output if programmed. For example if D I/O point 0 is assigned registers 10001 as an input it is also assigned as digital output 00001. If the application turns on 00001 then 10001 will be seen as ON. The internal DI 11 is turned ON if the SCADAPack 350 detects that a point has been turned on as an input and then turned on as a digital output in the application. Each time the controller is reset it begins the internal test again. 0 = off 1 = on
12	Internal	**COM3 (HMI) power.** 0 = off 1 = on See section ***COM3 Serial Port Power Control*** for details.

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Digital I/O Connection Examples

Various I/O point wiring examples are shown in ***Figure 5: Digital Input/Output Wiring.*** Digital I/O point 0 is shown connected to a 12V load that uses the same 12V power supply that powers the SCADAPack 350. Digital I/O point 4 is shown connected to a 24V load and external 24V-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.

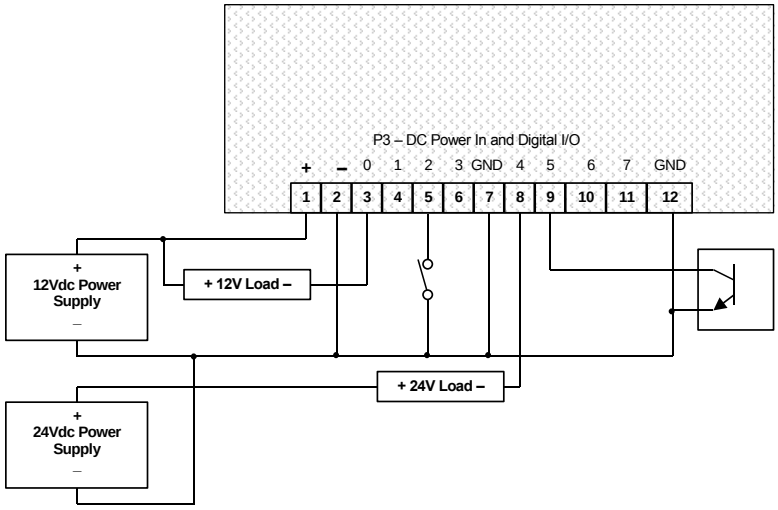


Figure 5: Digital Input/Output Wiring

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Counter Inputs

The SCADAPack 350 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 SCADAPack 350 Counter Inputs in application programs.

- For Telepace applications use the ***CNTR Controller Counter Inputs*** register assignment to read the counters.
- For IEC 61131-3 applications use the **cntrCtrl** I/O connection to read the controller board counters.
- For C applications use the ioReadCounterSP2 function.

Counter Input 0

Counter Input 0is self powered input that requires a contact closure or open collector output to pull the input to ground. The wetting voltage is provided through a 1Kohm resistor tied to the 5V power supply. Refer to ***Figure 6: Counter Input Wiring*** for an example of wiring to an open collector output.

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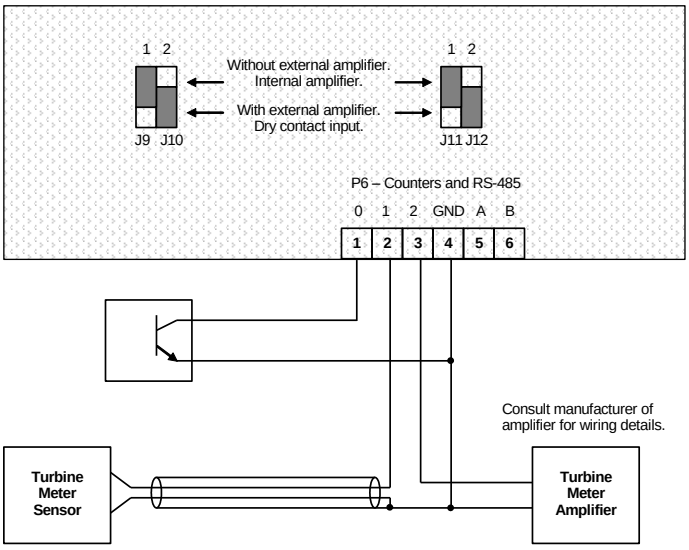


Figure 6: Counter Input Wiring

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.

Turbine Meter Counter Inputs 1 and 2

The SCADAPack 350 allows for the direct connection of two turbine meter sensors. These sensors produce millivolt outputs and an additional pre-amplifier is not required when connecting to a SCADAPack 350. 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.

Jumper positions J9 and J11 enable the SCADAPack pre-amplifier on turbine counter input 1. Jumpers J10 and J12 enable the SCADAPack pre-amplifier on turbine counter input 2.

Directly Connecting to Low Voltage Turbine Meters

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

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- Install jumper J11 on the ‘Int Amplifier’ position.
- Install jumper J9 on the ‘See J11’ position, as shown below.

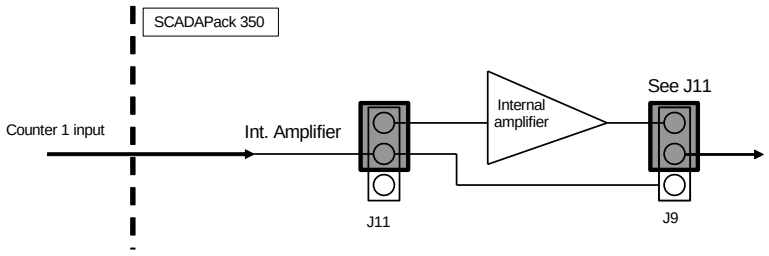


Figure 7: Setting Jumpers on Counter Input 1 for Low Voltage Turbine Meters

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

- Install jumper J12 on the ‘Int Amplifier’ position.
- Install jumper J10 on the ‘See J12’ position, as shown below.

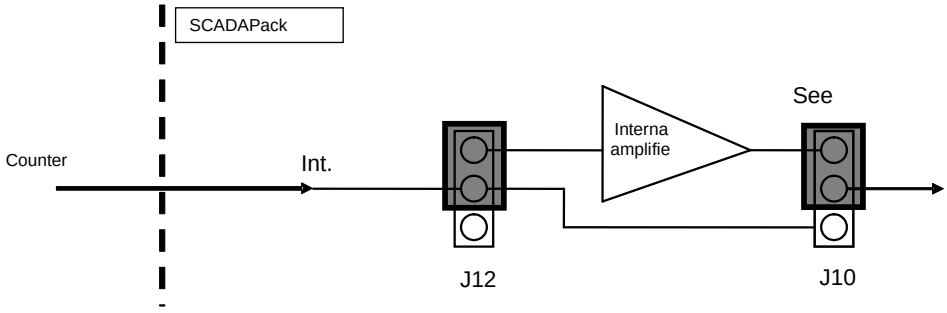


Figure 8: Setting Jumpers on Counter Input 2 for Low Voltage Turbine Meters

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 internal amplifiers are be bypassed.

For Counter 1:

- Install jumper J11 in the ‘Ext Position’.
- Remove jumpers J9 from the ‘See J11’ position and install on the other two pins.

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For Counter 2

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

Refer to the figure below for an illustration.

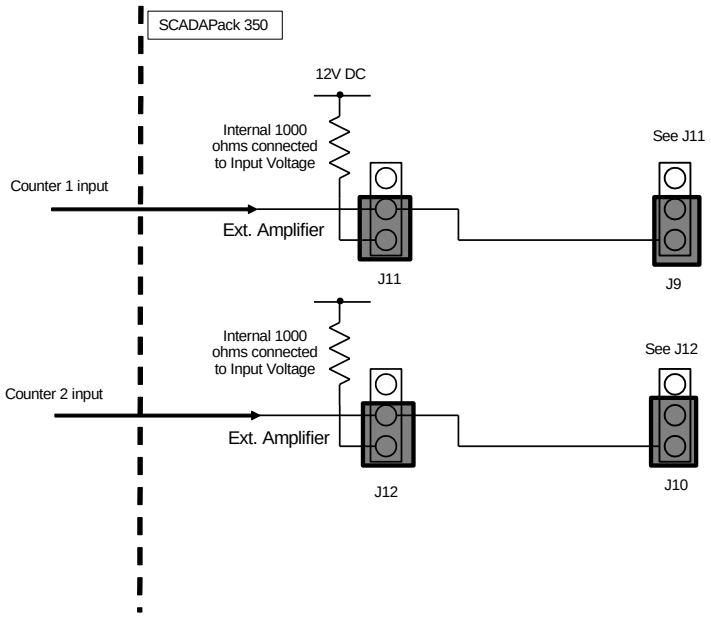


Figure 9: Setting Counter Input 1 and 2 for Turbine Meters with amplified signals

Your standalone amplifier may have a specific current requirement as specified by the manufacturer. As shown in the figure above, the SCADAPack 350 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 SCADAPack 350 is ***powered from 12V***.

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 ***Figure 10.***. The appropriate external pull-up resistor should be should then be connected between the counter input and the positive terminal of your power supply, as shown in ***Figure 10.***

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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 SCADAPack 350 is ***powered from 12V***.

For Counter 1:

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

For Counter 2

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

The above configuration applies only when the controller is being powered using 12V.

If 24V is used to power the controller, the internal 1000 Ohm pull-up resistor should not be used, as power dissipation can become excessive. In this case, an external pull-up resistor is wired between the counter input and the positive side of your power supply, as illustrated in ***Figure 10***. Check that jumpers J11 and J12 are removed while J9 and J10 are installed.

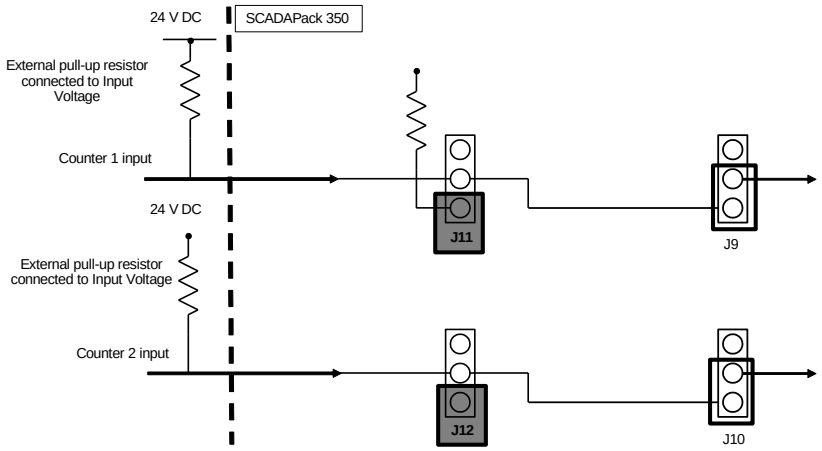


Figure 10: Connecting External Pull-Up Resistors to Counter Inputs 1 and 2

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Calculating the size of the pull-up Resistor

An input current of between 5mA and 10mA is suggested for the counter input sinking current.

Using a value of 7.5mA and 24VDC:

24VDC / 7.5mA = **3k3** resistor.

24VDC * 7.5mA = 180mW minimum **0.25W** resistor is needed.

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Serial Communication

The SCADAPack 350 controller is equipped with three serial communication ports which support RS-232 and RS-485 communication. COM1 is a dedicated RS-485 port. The serial ports are labeled COM1, COM2 and COM3. Refer to ***Figure 1: SCADAPack 350 Board*** Layout for the location of the serial ports.

COM2 can be configured for RS-232 or RS-485 while COM3 is a dedicated RS-232 port. Details of the operation and properties of each serial port is described below.

RS-232 Serial Communications Ports

COM2 and COM3 support RS-232 communication. RS-232 wiring uses shielded cable. The shield should be connected to chassis ground at one point. Failure to properly shield the cable may result in the installation not complying with FCC or DOC radio interference regulations.

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 has 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.***

The following table shows the serial and protocol communication parameters supported by COM2. These parameters are set from Telepace, IEC 61131-3 or from an application program running in the SCADAPack 350 controller. Default values are set when a Cold Boot or Service Boot is performed on the SCADAPack 350 controller.

Parameter	Supported Values
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Default: 9600
Duplex	Full or Half duplex when RS-232 is selected. Default: Half
Parity	Odd, None or Even Default: None
Data Bits	7 or 8 Bits Default: 8 Bits
Stop Bits	1 Bit

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Parameter	Supported Values
Receive Flow Control	ModbusRTU or None Default: ModbusRTU
Transmit Flow Control	Ignore CTS or None Default: None
Station	1 to 65534 Default: 1
Protocol	None, Modbus RTU, Modbus ASCII, DF1 and DNP Default: Modbus RTU
Addressing Mode	Standard or Extended Default: Standard

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

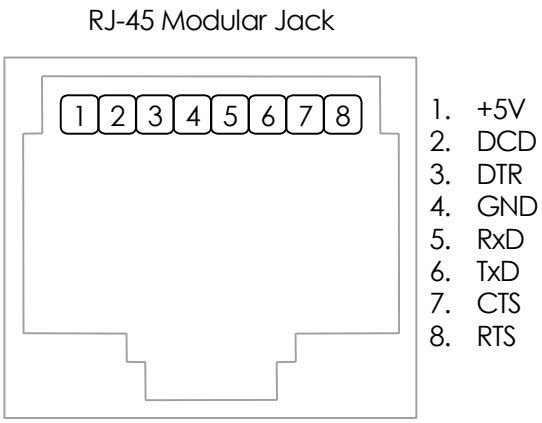


Figure 11: RJ-45 Connector Pinout

Notes:

- The transmitters used in COM2 generate RS-232 compatible ±5V levels. Cables should be limited to a maximum of 10 ft (3m).
- For RS-232 operation (RxD) J13 is in the 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 +3V or greater and a SPACE level is a voltage of –3V or lower.

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Pin	Function	Description
1	5V (Output)	This pin can be connected to the 5V power supply by installing a jumper at J14 on the SCADAPack 350. This 5V output is used to power Vision terminals and other Control Microsystems 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.
7	CTS (Input)	This level must 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 must 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.

COM3 RS-232 Serial Port

The following table shows the serial and protocol communication parameters supported by COM3. These parameters are set from Telepace, IEC 61131-3 or from an application program running in the SCADAPack 350 controller. Default values are set when a Cold Boot or Service Boot is performed on the SCADAPack 350 controller.

Parameter	Supported Values
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Default: 9600
Duplex	Full or Half

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Parameter	Supported Values
	Default: Full
Parity	Odd, None or Even Default: None
Data Bits	7 or 8 Bits Default: 8 Bits
Stop Bits	1 Bit
Receive Flow Control	ModbusRTU or None Default: ModbusRTU
Transmit Flow Control	Ignore CTS or None Default: None
Station	1 to 65534 Default: 1
Protocol	None, Modbus RTU, Modbus ASCII, DF1 and DNP Default: Modbus RTU
Addressing Mode	Standard or Extended Default: Standard

Connections to COM3 are made through a RJ-45 modular connector. COM3 supports six signals plus Ground and 5V power. The SCADAPack 350 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, in a manner similar to the SCADAPack LP.

In order to use the signals as DTR, DCD jumpers J15, J16 have their jumper links installed in position “Normal”. To use the COM3 port with a Vision interface, jumpers J15, J16 must have their jumper links installed in position “Vision”. Refer to ***Figure 1: SCADAPack 350 Board*** Layout for the location of these jumpers.

For proper operation, jumper links of J15, J16 are to be installed both 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.

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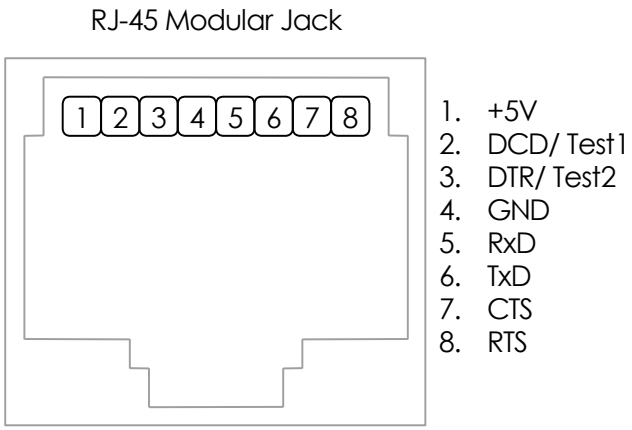


Figure 12: RJ-45 Connector Pinout

Notes:

- +5V is available on Pin 1 when turned on by the user under program control or, provided jumpers J15, J16 have their jumper links in the “Vision” position, when the SCADAPack 350 detects the contact closure of the ON switch of the SCADAPack Vision or the LEDs are turned on.

This 5V output is used to power Vision terminals and other Control Microsystems accessories. Check that cables connecting this pin have no voltage.

- The SCADAPack Vision ON switch is wired to Pins 2 and 3. It is important that when a SCADAPack Vision is not used that jumpers J15, J16 have their jumper links in the “Normal” position, to avoid generating a CPU interrupt due to a change in the state of the DCD signal.
- The transmitters used in COM3 generate RS-232 compatible ±5V levels. Cables should be limited to a maximum of 10 ft (3m).

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 +3V or greater and a SPACE level is a voltage of –3V or lower.

Pin	Function	Description
1	5V (Output)	+5V power for the SCADAPack Vision. This 5V output is used to power Vision terminals and other Control Microsystems accessories. Check that cables connecting this pin have no voltage.
2	DCD / Test1 (Input)	With jumper links of J15, J16 in the “Norm.” position, used as DCD signal. With jumper links of J15, J16 in the “Vision” position, used to detect SCADAPack Vision ON switch closure.

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Pin	Function	Description
3	DTR / Test2 (Output)	With jumper links of J15, J16 in the “Norm.” position, used as DTR signal. With jumper links of J15, J16 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 must 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 must 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.

RS-232 Wiring Examples

DTE to DTE without Handshaking

There are several methods for wiring the RS-232 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 RS-232 COM port to DTE device.

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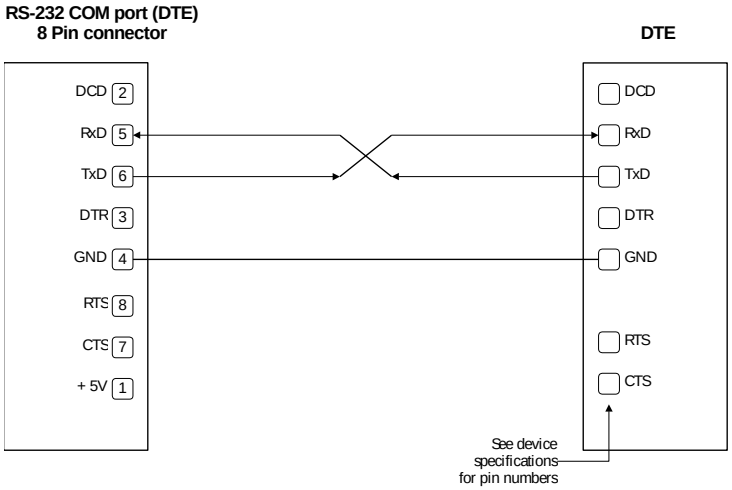


Figure 13: RS-232 DTE to RS-232 DTE without Handshaking

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 controller 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 RS-232 COM port with a DTE device requiring handshaking lines.

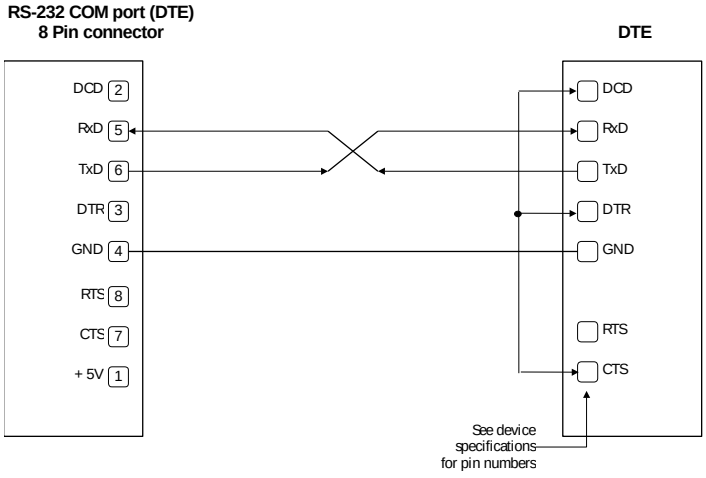


Figure 14: RS-232 DTE to RS-232 DTE with Handshaking

DTE to DCE with Handshaking

DCE devices require different wiring. The handshaking lines are connected in most cases. Many DCE devices are half-duplex. Select half-

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duplex operation with these devices. The diagram below shows common connection of a SCADAPack 350 with a DCE device requiring handshaking lines.

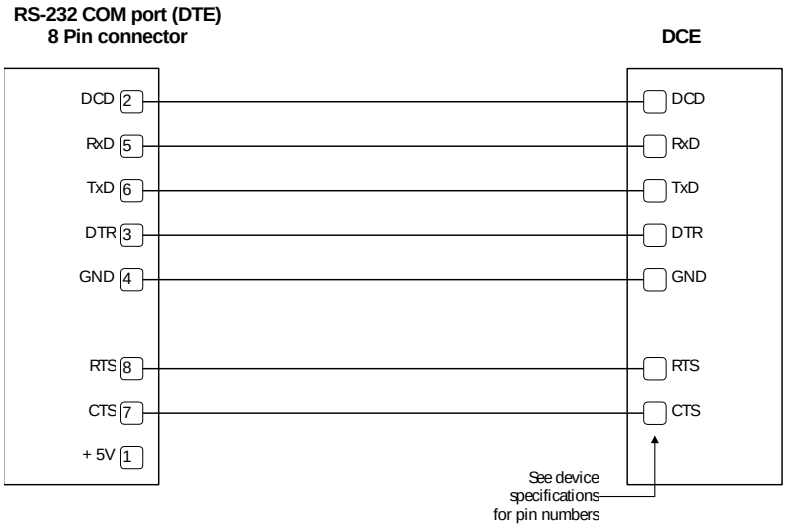


Figure 15: RS-232 DTE to RS-232 DCE With Handshaking

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 SCADAPack 350 controller to DE-9P connector on a DTE such as a PC. A 10 ft. long cable is available from Control Microsystems as part number TBUM297217.

RJ-45 8 Pins	SCADAPack DTE Function	DE9S DTE Function	DE9S
			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 COM3 (RJ-45 based RS-232) port on the SCADAPack 350 controller to DE-9P connector on a SCADAPack

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Vision. A 5-ft. long cable is available from Control Microsystems as part number TBUM297237.

RJ-45 8 Pins	SCADAPack 350 Function	SCADAPack Vision Function	DE9S
			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	+5V Out	+5V 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 SCADAPack controller to DE-9S connector on a DCE such as a modem. A 15-inch long cable is available from Control Microsystems as part number TBUM297218.

RJ45	SCADAPack 350 DTE 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	+5V	+5V	9

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RS-485 Serial Communication Ports

COM1 RS-485 Serial Port

Serial port COM1 on the SCADAPack 350 controller 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 Telepace, IEC 61131-3 or from an application program running in the SCADAPack 350 controller. Default values are set when a Cold Boot or Service Boot is performed on the SCADAPack 350 controller.

Parameter	Supported Values
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Default: 9600
Duplex	Half Default: Half
Parity	Odd, None or Even Default: None
Data Bits	7 or 8 Bits Default: 8 Bits
Stop Bits	1 Bit Default: 1 Bit
Receive Flow Control	None or Xon/Xoff Default: None
Transmit Flow Control	None or Xon/Xoff Default: None
Station	1 to 65534 Default: 1
Protocol	None, Modbus RTU or Modbus ASCII, DF1 or DNP. Default: Modbus RTU
Addressing Mode	Standard or Extended Default: Standard

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 4000 feet or 1200 meters.

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

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network are wired to be within several volts of each other. The SCADAPack 350 ground is connected to the chassis.

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 is installed in position "RS-485". This section covers RS-485 operation. For RS-232 operation refer to section ***COM2 RS-232 Serial Port.***
The following table shows the serial and protocol communication parameters supported by COM2. These parameters are set from Telepace, IEC 61131-3 or from an application program running in the SCADAPack 350 controller. Default values are set when a Cold Boot or Service Boot is performed on the SCADAPack 350 controller.

Parameter	Supported Values
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 Default: 9600
Duplex	Half Default: Half
Parity	Odd, None or Even Default: None
Data Bits	7 or 8 Bits Default: 8 Bits
Stop Bits	1 Bit Default: 1 Bit
Receive Flow Control	None or Xon/Xoff Default: None
Transmit Flow Control	None or Xon/Xoff Default: None
Station	1 to 65534 Default: 1
Protocol	None, Modbus RTU or Modbus ASCII, DF1 or DNP. Default: Modbus RTU
Addressing Mode	Standard or Extended Default: Standard

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 4000 feet or 1200 meters.

The signal grounds of the RS-485 devices in the network are not connected together but instead are referenced to their respective

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incoming electrical grounds. The grounds of the RS-485 devices on the network are wired 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.

Pin	Function	Description
1	5V (Output)	This pin can be connected to the 5V power supply by installing a jumper at J14 on the SCADAPack 350.
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 is in position “RS-485” This pin is the B signal of the RS-485 bus.
6	A (+) (Input/ Output)	For RS-485 operation J13 is in posiition “RS-485” This 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 a RJ-45 modular connector. COM2 supports two signals plus Ground and 5V power. The following diagram shows the pin connections for the RS-485 (RJ-45) port connector for COM2 operating in RS-485 mode.

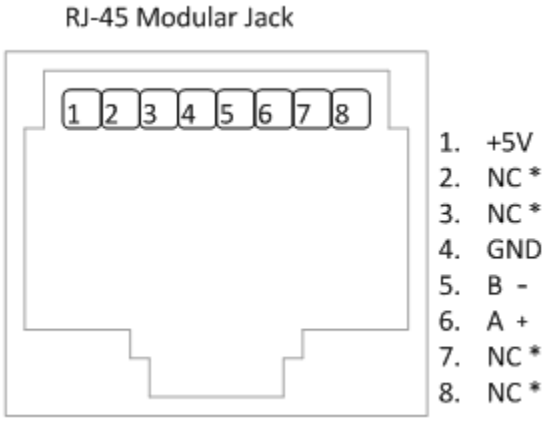


Figure 16: COM2 RJ-45 Connector

RS-485 Bias Resistors

The RS-485 receiver inputs on the controller are biased so that that received data is driven to a valid state (space) when there are no active

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drivers on the network. The value of these bias resistors is 5100 ohms from Ground to the B inputs and 5100 ohms from +5V to the A inputs.

RS-485 Termination Resistors

Termination resistors are required in long networks operating at the highest baud rates. Networks as long 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 0.2V 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 +5V. +5V is available on P8 pin 1 when J14 is installed.

RS-485 Wiring Examples

A typical RS-485 wiring example is shown below. COM1 is shown connected to a multivariable transmitter such as a Control Microsystems 4000 MVT. The power for the transmitter can come from the SCADAPack 350 power input source or can be obtained from the 24V VLOOP output for possible power savings.

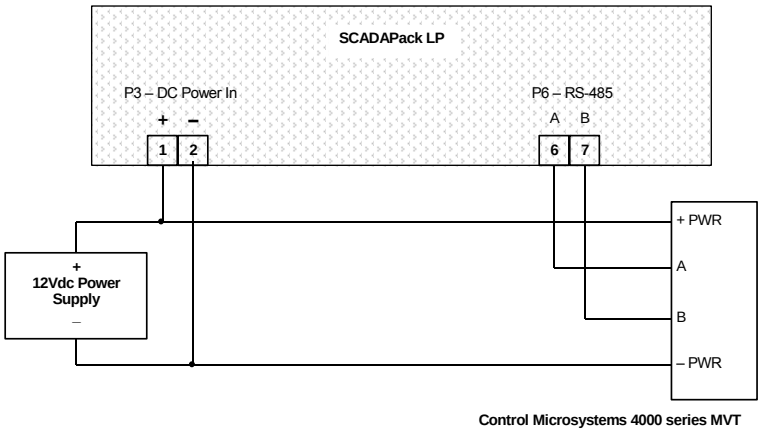


Figure 17: RS-485 Wiring

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Ethernet Communication

The SCADAPack 350 controller has one 10/100Base-T Ethernet port. This is a single communications channel running at 10/100 Mb/s 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.

LAN Port Settings

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

Refer to section ***Field Wiring*** for the location of the LAN port on the SCADAPack controller board.

TCP/IP Settings

The following table shows the TCP/IP parameters supported by the LAN port. These parameters are set from the IEC 61131-3 or from an application program running in the controller. Default values are set when a Cold Boot is performed on the controller.

Parameter	Supported Values
IP Address	In the format 255.255.255.255 Default: 0.0.0.0
Subnet Mask	In the format 255.255.255.255 Default: 255.255.0.0
Gateway	In the format 255.255.255.255 Default: 0.0.0.0

The **IP Address** is the address of the controller. The IP address is statically assigned. Contact your network administrator to obtain an IP address for the controller.

The **Subnet Mask** is determines the subnet on which the controller is located. The subnet mask is statically assigned. Contact your network administrator to obtain the subnet mask for the controller.

The **Gateway** determines how your controller communicates with devices outside its subnet. Enter the IP address of the gateway. The gateway is statically assigned. Contact your network administrator to obtain the gateway IP address.

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Modbus/TCP Settings

The following table shows the Modbus/TCP parameters supported by the LAN port. These parameters are set from the IEC 61131-3 or from an application program running in the controller. Default values are set when a Cold Boot or Service Boot is performed on the controller.

Parameter	Supported Values
Master Idle Timeout	Any value in seconds. Default: 10 seconds
Server Receive Timeout	Any value in seconds. Default: 10 seconds
Maximum Server Connections	Valid values are 1 to 20. Default: 20
TCP Port	Valid values are 1 to 65535 Default: 502
Modbus Addressing Type	Valid values are Standard or Extended Default: Standard
Modbus Station Address	Valid values are 1 to 65534. Default: 1
Store and Forward Messaging	Valid values are Enabled and disabled. Default: Disabled

The **Master Idle Timeout** parameter sets when connections to a slave controller are closed. Setting this value to zero disables the timeout; the connection will be closed only when your program closes it. Any other value sets the timeout in seconds. The connection will be closed if no messages are sent in that time. This allows the slave device to free unused connections.

The **Server Receive Timeout** parameter sets when connections from a remote device are closed. Setting this value to zero disables the timeout; the connection will be closed only when the remote device closes it. Any other value sets the timeout in seconds. The connection will be closed if no messages are received in that time. This allows the controller to free unused connections.

The **Maximum Server Connections** parameter sets the number of incoming (server) connections that the controller will allow. Incoming (server) connections are used when a remote device creates a connection to this controller. Outgoing connections are used when this controller creates a connection to a remote device (e.g. using a **masterip** function block from a Telepace or IEC 61131-3 program). Setting this value to the maximum allows the server to use all connections for incoming connections. Setting the value below the maximum limits the number of incoming connections from remote devices. This reserves the remaining connections for use by the controller for outgoing connections.

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The **TCP Port** parameter sets the port used by the Modbus/TCP protocol. This should be set to 502. This is the well-known port number for Modbus/TCP. Modbus/TCP devices use 502 by default, and on many devices the value cannot be changed. It is suggested that you change this value only if this port is used by another service on your network. Consult your network administrator to obtain a port if you are not using the default.

The **Addressing** parameter selects standard or extended Modbus addressing. Standard addressing allows 255 stations and is compatible with standard Modbus devices. Extended addressing allows 65534 stations, with stations 1 to 254 compatible with standard Modbus devices.

The **Station** parameter sets the station number of the controller. The valid range is 1 to 255 if standard addressing is used, and 1 to 65534 if extended addressing is used.

The **Store and Forward Messaging** parameter controls forwarding of messages on the Ethernet port. If this option is enabled, messages will be forwarded according to the settings in the store and forward routing table.

RJ-45 Modular Connector for Ethernet

The SCADAPack 350 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.

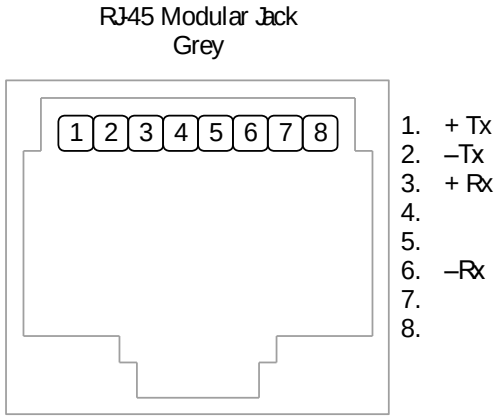


Figure 18: RJ-45 Connector for Ethernet

10/100Base-T has a maximum run of 100m or 350 feet, but the actual limit is based on signal loss and the noise in the environment. This may limit the practical distance to less than 100m or 350 feet. The Ethernet cables should not be run in parallel with power or any cables that generate noise.

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USB Ports

The SCADAPack 350 controller has two USB 2.0 compliant ports, supporting both low-speed (1.5Mb/s) and full-speed (12Mb/s). One of the ports allows the controller to act as a host, while the second port allows connection to a USB host, such as a notebook computer. The two USB ports can be used simultaneously.

The USB interface circuitry can be disabled to save power. Refer to section ***Power Management Features*** for details to enable the power to the USB interface.

USB ports may be permanently used in non-hazardous applications. USB ports may be used for corrective maintenance in locations classified as hazardous but are known to be in a non-hazardous state.

USB Connections

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

Host Port

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

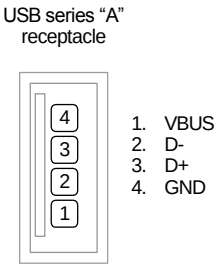


Figure 19: Host USB Port Connections

The host port supports memory stick type devices only; external USB drives are not supported. The following USB memory sticks have been tested with the SCADAPack 330 controller. They were tested at room temperature only and should be OK for typical insert-copy-and-remove applications.

- GXT Mobile Disk 512 MB flash drive
- Kingston DataTraveler (512MB)

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- Lexar JumpDrive 1 GB flash drive (JDSP1GB-04-500B)
- PNY Attache 512 MB flash drive
- SanDisk Cruzer Micro (256MB)
- SanDisk Cruzer Micro (2GB)
- SanDisk Cruzer Mini (1GB)

The following USB devices are not supported:

- USB hubs are not supported. USB hubs are devices that allow multiple USB devices to connect to a single USB port.
- Any USB memory device that incorporates an actual rotating hard-drive. These units are typically the size of a cell phone or larger and may mention in their documentation any of the following terms: IDE, 2.5”, 3.5”, or, some number of RPM.
- Any USB memory stick larger than 32GB.

For optimum performance, use your PC to format any new USB memory stick to FAT32 file format (Right click the USB drive and select Format – if you have a choice of FAT and FAT32, select FAT32.). This will get rid of any applications that may have been shipped pre-installed on your device and will provide the best performance.

Peripheral Port

The peripheral port uses a USB series “B” receptacle. A SCADAPack 350 will not draw any significant power from the host over the USB peripheral port. The following diagram shows the connections of the peripheral USB port.

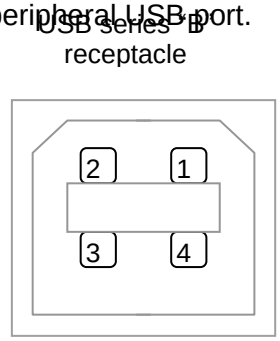


Figure 20: Peripheral USB Port Connections

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Operation

Operating Modes

A SCADAPack 350 may start up in RUN, SERVICE, COLD BOOT, FACTORY BOOT, or REENTRY BOOT modes.

- Start up in the RUN mode automatically executes Ladder Logic and C/C++ programs in the controller memory.
- Start up in the SERVICE mode stops the programs to allow reprogramming and controller initialization.
- Start up in the COLD BOOT mode initializes the controller and erases application programs.
- Start up in FACTORY boot reformats the Flash file system, initializes the controller and erases application programs.
- REENTRY boot is performed as part of the firmware download process.

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 in detail the selection of each operating mode.

Run Mode

The RUN mode is the normal operating mode of the controller. No action is required to select RUN mode. When power is applied to the controller board:

- The user defined serial communication parameters for COM ports are used.
- If a Telepace Ladder Logic or IEC 61131-3 application program is loaded in RAM, it is executed.
- If a Telepace or IEC 61131-3 C application program is loaded in RAM and the program checksum is correct, it is executed.
- If there is no application program in RAM and there is an application program in flash ROM then the flash ROM program will be executed.
- The controller lock settings and password are used.

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Service Mode

SERVICE mode is used during application programming and maintenance work. When a SCADAPack 350 controller starts in SERVICE mode:

- The default serial communication parameters are used (see section

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- ***Serial*** Communication for a description of the default parameters).
- The Telepace Ladder Logic or IEC 61131-3 program is stopped.
- The C program is stopped.
- Application programs are retained in non-volatile memory.
- The controller lock settings and password are used.

SERVICE mode is selected by performing a SERVICE BOOT using the following procedure:

- Remove power from the controller.
- Hold down the LED POWER button.
- Apply power to the controller.
- Continue holding the LED POWER button until the STAT LED turns on.
- Release the LED POWER button.

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

Cold Boot Mode

COLD BOOT mode is used after installing new controller firmware. When a SCADAPack 350 controller starts in COLD BOOT mode:

- The default serial and Ethernet communication parameters are used (see section

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- ***Serial*** Communication and

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- ***Ethernet*** Communication for a description of the default parameters).
- The Telepace Ladder Logic or IEC 61131-3 and C Tools programs are erased.
- The C program is erased.
- The registers in the I/O database or I/O Connection are initialized to their default values.
- The Register Assignment is erased.
- The controller is unlocked.

COLD BOOT mode is selected by performing a COLD BOOT using the following procedure:

- Remove power from the SCADAPack controller.
- Hold down the LED POWER button.
- Apply power to the SCADAPack controller.
- Continue holding the LED POWER button for 25 seconds until the STAT LED begins to flash on and off continuously.
- Release the LED POWER button.

If the LED POWER button is released before the STAT LED begins to flash, the SCADAPack controller will start in SERVICE mode.

Factory Boot Mode

FACTORY BOOT mode is used to reformat the Flash File system and initialize the SCADAPack 350 controller to factory default settings. When the controller starts in FACTORY BOOT mode:

- The default serial and Ethernet communication parameters are used (see section

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- ***Serial*** Communication and

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- ***Ethernet*** Communication for a description of the default parameters).
- The Telepace Ladder Logic or IEC 61131-3 and C Tools programs are erased.
- The C program is erased.
- The registers in the I/O database or I/O Connection are initialized to their default values.
- The Register Assignment is erased.
- The controller is unlocked.
- Flash File system is reformatted.

FACTORY BOOT mode is selected by performing the following procedure:

- Remove power from the SCADAPack controller.
- Hold down the LED POWER button.
- Apply power to the SCADAPack controller.
- Continue holding the LED POWER button for longer than 30 seconds until the STAT LED turns solid.
- Release the LED POWER button.

The FACTORY boot will take approximately 60 seconds to complete. During this time the controller 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.

Low RAM Battery Voltage Effect

With Firmware version 1.58 and newer a feature is added to detect if the lithium RAM battery is at a very low level and to provide a modified RUN_BOOT or SERVICE_BOOT if that is the case. The Low RAM Battery Voltage effect occurs when a RUN_BOOT or SERVICE_BOOT is performed and the RAM battery voltage is detected at 1.0V or less or the battery is removed.

The special initialization with low voltage battery including following steps:

- The registers in the I/O database or I/O Connection are initialized to their default values.
- Ladder logic applications saved in RAM are erased.
- Ladder Logic programs, including DNP configurations and register assignments, saved to Flash memory will be restarted on a Run boot.
- IEC 61131-3 applications are erased.
- The DNP configuration is erased.

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- The communication parameters for serial ports and LAN port are set to default values when a Service boot is performed and are returned to user defined values when a Run boot is performed.
- C applications are stopped during a Service boot and restarted fresh with the execution state set to first run during a Run boot condition. This enables C applications to re-initialize any “dynamic NVRAM” allocation that needs to occur when the application starts.
- Data Log and Data Log to File functions will return either Invalid ID or has not been created or Invalid logging mode errors.

Boot Mode Effects

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

Run Boot	Service Boot	Cold Boot	Factory Boot	Re-entry Boot	Action
		X	X		IP Address set to default
	X	X	X		Serial settings set to default
		X	X		Lock settings set to default
	X	X	X		S&F settings set to default
	X	X	X		Friendly IP Table set to default
		X	X		LED power set to default
		X	X		Register assignment erased
		X	X	IEC 61131-3- Yes Telepace if upgrading from firmware before 1.40	Database initialized
		X	X	IEC 61131-3 – Yes Telepace if upgrading from firmware before 1.40	Logic application erased
		X	X		C/C++ Applications Erased
		X	X		Application files are erased
			X		Flash File System

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Run Boot	Service Boot	Cold Boot	Factory Boot	Re-entry Boot	Action
					reformatted
X					C/C++ Applications started
X					Logic application started
				X	Communication settings on active interface retained
		X	X	X	Settings saved to non-volatile memory
		X	X		Ladder logic in flash is erased
	X	X	X		Protocols are set to defaults

Sleep Mode

A SCADAPack 350 Controller is capable of extremely low power operation when in sleep mode. The controller enters the sleep mode under control of the application program. During sleep mode the following happen:

- Application programs stop executing.
- The 5V power to much of the controller is switched off.
- The 5V power to the I/O bus is switched off.
- The three counter inputs on the controller board continue to function.
- The real-time clock and alarm continue to function.
- VLOOP will be turned off.

While in Sleep Mode, the processor uses a very slow speed clock.

The SCADAPack 350 Controller wakes up from sleep mode under the following conditions:

- Hardware RESET caused by power removed and applied to the controller.
- The LED POWER push-button is pressed.
- A real time clock alarm, defined by application program, occurs.
- Any of the controller board counters rolls over. This occurs every 65536 pulses on each input.

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- Assertion of Digital Input 0.
- The COM3 Test1 to Test2 pins are connected together, indicating the SCADAPack Vision is to be turned on. This can only occur if COM3 is configured to operate with SCADAPack Vision operator interface.

Reduced Power Mode

A SCADAPack 350 Controller is capable of lower power operation when in Reduced Power Mode. The controller enters this mode under control of the application program. During in Reduced Power Mode the following happens:

- The CPU runs at 12 MHz.
- The Power Mode LED blinks once a second to indicate this mode.

A SCADAPack 350 Controller exits from Reduced Power Mode under the following conditions:

- The user changes the corresponding register associated with the CNFG Power Mode register assignment in Telepace applications. Refer to the Telepace manual for more information on the CNFG Power Mode register assignment.
- For IEC 61131-3 applications, two functions can be used to change / check the power mode:

setpmode to set desired power mode

getpmode to request present power mode

Refer to the IEC 61131-3 manual for more information on these functions.

- For C applications, the user calls the SetPowerMode and GetPowerMode functions. Refer to the SCADAPack 350 C Tools manual.

Power Consumption

The power consumption of the SCADAPack 350 should be less than the values in the table below:

Power Mode	LAN Status	USB Status	Power Consumption (mW)
Normal	Enabled	Enabled	1750
Normal	Enabled	Disabled	1500
Normal	Disabled	Enabled	1000
Normal	Disabled	Disabled	750
Reduced	Enabled	Enabled	1500
Reduced	Enabled	Disabled	1250
Reduced	Disabled	Enabled	750
Reduced	Disabled	Disabled	500

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Power Mode	LAN Status	USB Status	Power Consumption (mW)
Sleep	Any	Any	15

LED Indicators

There are 25 LEDs on SCADAPack 350. LEDs can be disabled to conserve power. The table below describes the LEDs.

LED	Function
Power Mode	On when operating and the LEDs are enabled. Off when the LEDs are disabled. Off when powered off or in Sleep Mode.
RUN	On when the ladder logic program is executing.
STAT	Blinking when a controller condition exists.
FORCE	On when I/O points are forced.
USB STAT	Not currently used.
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.
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.

LED Power Control

The SCADAPack 350 controller board can disable the LEDs on the controller board and the 5000 I/O modules to conserve power. This is particularly useful in solar powered or unattended installations.

The Power Mode LED on the controller board indicates the LED power state. It is on when the controller board enables LED power.

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.

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The application program sets the default state of the LED power. The LED power returns to the default state 5 minutes after the LED POWER push-button is last pressed. The application program may change the default time and state.

When the LED power state is ON power saving modes are disabled. The 24V power supply boost is on and VLOOP power is turned ON. The SCADAPack Vision operator interface is powered on as a result of 5V being available on COM3.

Jumpers

Headers on the SCADAPack 350 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 ***Figure 1: SCADAPack 350 Board Layout*** for the location of jumpers.

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

Jumper	Function
J1	Analog Input 0 Range ***Figure 3: Analog Input Wiring***
J2	Analog Input 1 Range ***Figure 3: Analog Input Wiring***
J3	Analog Input 2 Range ***Figure 3: Analog Input Wiring***
J4	Analog Input 3 Range ***Figure 3: Analog Input Wiring***
J5	Analog Input 4 Range ***Figure 3: Analog Input Wiring***
J8	Reset Jumper (Performs a controller board reset similar to power cycle)
J9	Counter Input 1 Type ***Figure 6: Counter Input Wiring***
J10	Counter Input 2 Type ***Figure 6: Counter Input Wiring***
J11	Counter Input 1 Type ***Figure 6: Counter Input Wiring***
J12	Counter Input 2 Type ***Figure 6: Counter Input Wiring***
J13	COM2 RS-232/ RS-485 mode selection ***0-COM2 RS-232 Serial Port***
J14	COM2 5 Volts on Pin 1 ***COM2 RS-232 Serial Port***
J15, J16	COM3 Vision/ Normal mode select ***COM3 RS-232 Serial Port*** These jumpers are set to the same position, either Vision or Norm.

Status LED

The STAT LED indicates a controller condition. The STAT LED blinks when a condition exists. The STAT LED turns off when the conditions are cleared.

The STAT LED blinks a binary sequence indicating codes. The sequences consist of long and short flashes, followed by an off delay of 1

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second. The sequence then repeats. The sequence may be read as the Controller Status Code. A short flash indicates a binary zero. A long flash indicates a binary one. The least significant bit is output first. As few bits as possible are displayed, leading zeros are ignored. The application program defines the values of the codes.

The table below shows the meaning of the sequences.

Sequence	CONTROLLER STATUS CODE
Off	0 = Normal
1 Long	I/O Module Error Indication
1 Short, 1 Long	Register Assignment Checksum Error

I/O Module Indication

When the Status LED flashes the controller status code 1 (i.e. a long flash, once every second), one or more I/O module is not communicating with the controller. To correct do one of the following:

- Check that every module contained in the Register Assignment Table is connected to the controller. Check that the module address selected for each module agrees with the selection made in the Register Assignment Table.
- If a module is still suspect confirm the condition by removing the module from the Register Assignment Table. Write the changes to the controller. The Status LED should stop flashing.
- If a module is currently not connected to the controller, delete it from the Register Assignment Table. Write the changes to the controller. The Status LED should stop flashing.
- If unused modules are intentionally left in the Register Assignment Table, the I/O indication may be disabled from a selection box on the Register Assignment dialog.

Register Assignment Checksum Indication

When the status LED flashes the controller status code 2 (i.e. a short flash then a long flash followed by a 1 second of delay), this indicates the register assignment is not valid. To correct this, initialize the register assignment from the Telepace software, or alternatively, perform a COLD BOOT as described in section ***Cold Boot Mode*** section of this manual. The status LED should stop flashing.

Firmware Loading

Periodically the firmware for a controller is updated to add new features or provide bug fixes. As they become available new firmware versions may be downloaded from www.controlmicrosystems.com.

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Allowed connections for firmware loading for a **SCADAPack 350** controller are **com1, com2 or com3, Ethernet** or **USB** peripheral port.

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Maintenance

The SCADAPack 350, as with all other SCADAPack controllers, requires little maintenance. The Power Mode LED indicates the status of the 5V supply. If the LED is off, the on board 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 Control Microsystems Technical Support for information on returning the SCADAPack Controller for repair.

Do not connect or disconnect any field wiring, including the wiring to the RS-232 and USB, unless the power is off or the area is known to be non-hazardous

Fuses

A single 1.5 Amp fast-blow fuse protects the power supply. The fuse is mounted under the cover. Refer to ***Figure 1: SCADAPack 350 Board*** Layout for the location.

Remove power before servicing unit.

Replace a blown 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.

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

In all cases investigate and correct the cause of the fuse failure before replacement. Common causes of blown fuse are wiring and excessive input voltages.

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 3.0V. An application program can monitor this voltage. Refer to the programming manual for details.

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The battery should not require 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

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 Control Microsystems.

- Save the existing program running in the SCADAPack, if applicable.
- Remove power from the SCADAPack.
- Remove the SCADAPack top cover and locate the battery. It is found at the far right side of the circuit board.
- The battery tie wrapped in place at the factory. This is to keep the battery does not become disconnected during shipment. Remove the tie wrap using wire cutters.
- 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.
- Replace the battery. A replacement tie wrap is not necessary.
- Cold boot the controller. (Refer to section ***Cold Boot Mode*** in of this manual for the Cold Boot procedure.)

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

- The controller may now be programmed.

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Troubleshooting

Analog Inputs

Condition	Action
20mA inputs read 0.	Check transmitter power.
Reading is at or near 0 for input signals.	Check if the input transient suppressers are damaged.
20mA readings are not accurate.	Check for a damaged 250Ω current sense resistor. Inputs are 0-20mA, not 4-20mA.
Reading is constant.	Check that the analog input is not forced.

Analog Outputs

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

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

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	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.

Digital Outputs

Condition	Action
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.
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.

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.

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Specifications

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General

I/O Terminations	6 and 12 pole, removable terminal blocks. 12 to 22 AWG 15A contacts Screw termination - 6 lb.-in. (0.68 Nm) torque
Dimensions	8.40 inch (213mm) wide 5.00 inch (127 mm) high 1.80 inch (45mm) deep
Packaging	Corrosion resistant zinc plated steel with black enamel paint
Environment	5% RH to 95% RH, non-condensing –40°C to 70°C –40°F to 158°F

Controller

Processors	32-bit ARM7-TDMI microcontroller, 32 MHz clock integrated watchdog timer Two Microcontroller co-processors, 20 MHz clock
Memory	16MBytes FLASH ROM 4MBytes CMOS RAM 4kBytes EEPROM
Non-volatile RAM	CMOS RAM with lithium battery retains contents for 2 years with no power
Clock calendar	±1 minute/month at 25°C +1/–3 minutes/month 0 to 50°C
Input Voltage Monitor	Measurement range 11000mV to 30000mV.
Internal temperature Monitor	Measurement range -40°C to 75°C. Accuracy ±5°C. Measurement range -40°F to 167°F. Accuracy ±9°F.
Lithium battery Monitor	Accuracy ±0.2V.

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Serial Ports

Communication Port COM1	RS-485 serial port removable terminal block Two-wire half duplex Bias resistors installed.
Communication Port COM2	Jumper configurable RS-232 or RS-485 RS-232 compatible serial port Data Terminal Equipment (DTE) 8 pin modular jack Full or half duplex with RTS/CTS control Implemented: TxD, RxD, CTS, RTS, DCD, DTR, 5V power with jumper link. RS-485 mode Two-wire half duplex Bias resistors installed
Communication Port COM3	RS-232 compatible serial port Data Terminal Equipment (DTE) 8 pin modular jack Full or half duplex with RTS/ CTS control Implemented TxD, RxD, CTS, RTS, DCD, DTR and 5V power under program control. For use with SCADAPack Vision operator interface.
Baud Rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200
Parity	none, even, or odd
Word Length	7 or 8 bits
Stop Bits	1 Bit
Transient Protection	COM1, COM2: 2.5kV surge withstand capability as per ANSI/IEEE C37.90.1-1989
Isolation	Common ground return connected to Chassis Ground.
Cable Length	RS-232 –maximum 10 ft (3 m) RS-485 –maximum 4000 ft (1200 m)
Protocol	TeleBUS (compatible with Modbus RTU and Modbus ASCII) DF1 or DNP
Protocol Modes	Slave, master, master/slave, store and forward

Ethernet Port

Terminations	RJ-45 modular connector 10BaseT (twisted pair) 10/100M bits per second
Max Server Connections	20

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Protocols Supported	Modbus/TCP Modbus RTU in UDP Modbus ASCII in UDP DNP in TCP DNP in UDP FTP

USB Ports

Ports	USB Peripheral: One Port "B" connector. USB Host: One Port "A" connector with 5V/100mA capacity.
Speed	USB Peripheral: The device port operates at full speed (12 Mbps) and complies with USB 1.1 standards. USB Host: The host port operates at full speed (12 Mbps) and low speed (1.5 Mbps) and complies with USB 2.0 standards. USB 1.1 and 2.0 devices are supported.

Visual Indicators

COM1	received data transmitted data	(RX) LED (TX) LED
COM2	received data transmitted data clear to send data carrier detect	(RX) LED (TX) LED (CTS) LED (DCD) LED
COM3	received data transmitted data	(RX) LED (TX) LED
Status	Power Mode LED Run LED Status LED (shows functional status) Forced I/O LED	
Digital Inputs / Outputs	8 LEDs	
Counters	3 LEDs	
LAN	Link indicator Activity indicator	(LINK) LED (ACT.) LED
Push-button	LED power toggle	

Power Supply

DC power Input	30V maximum 10.0 to 11.5V turn on 9.5V typical turn off

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	UL508 rated 13.75-28Vdc. Class 2. 12mW at 12V during Sleep 510mW at 12V during normal operation. 32MHz., LEDs off, no expansion, LAN and USB disabled. 320mW at 12V during reduced power mode operation. 12MHz., LEDs off, no expansion, LAN and USB disabled. (Reduced power mode) 1.2W at 12V during normal operation. 32MHz., LEDs off, no expansion, LAN enabled and USB disabled. Add 25 to 100mW when enabling the LEDs. 12W at 24V maximum. 5V supply fully loaded and Vloop on and boosted, fully loaded.
Output capacity	5V at 1.2A capacity 5V at 80mA required by 5209 controller (LAN and USB disabled) 5V at 40mA required by 5209 controller (LAN and USB disabled) in reduced power mode. 5V at 160mA required by 5209 controller to enable the LAN 5V at 50mA required by 5209 controller to enable the USB 5V at 1.1A (current limited) for COM2 and I/O expansion 5V at 250mA (current limited) on COM3 for Vision displays 5V at 100mA (current limited) for USB downstream port loads Vloop: 24V at 0.14A available for the 5 analog inputs and 2 optional analog outputs
Efficiency	85%, 12Vdc input, full load

I/O Expansion Capacity

5000 I/O Expansion Capacity	Maximum 20 IO modules.

Analog Inputs

Input Points	5 at 10V/20mA: 250Ω resistance user configurable with jumper link. 1 at 32.768V
Resolution	15 bits over the 10V and 32.768V measurement range. 14 bits over the 20mA measurement range.
Input Resistance	20kΩ for 10V inputs

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	60kΩ for 32.768V inputs 250Ω for 20mA inputs
Converter type	16 bit successive approximation
Accuracy	±0.1% of full scale at 25°C (77ºF) ±0.2% over temperature range
Type	single ended
Calibration	Calibration constants stored in on board microcontroller EEPROM.
Normal mode rejection	27 dB at 60 Hz.
Over-scale Input Capacity (without damage)	10V/20mA inputs clamped at 12V. Transient: 2.5kV surge withstand capability as per ANSI/IEEE C37.90.1-1989
Isolation	Analog common side connected to Chassis Ground.
Response Time	100ms typical for 10% to 90% signal change

Analog Outputs

Output Points	2 (when optional 5305 analog outputs installed)
Output Signal Range	0-20mA
Maximum Load Resistance	925Ω with 24Vdc input voltage or when internal 24V power supply is on. 375Ω with 12Vdc input voltage 250Ω with input voltage at power supply turnoff
Output Type	Single ended regulation on positive side with common negative return
Isolation	Analog common side connected to Chassis Ground.
Resolution	12 bits
Accuracy	Specified from 0.5-20mA ±0.15% of full scale at 25°C (77°F) ±0.25% of full scale over temperature range
Noise and Ripple	0.04% maximum
Transient Protection	Transient: 2.5kV surge withstand capability as per ANSI/IEEE C37.90.1-1989
Response Time	0.5ms to 2ms for 10% to 90% signal change
Power Requirements	24V boost power supply off: Vin X output current. 24V boost power supply on: 27 X output current.

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Counter Inputs

Counter Inputs	Counter 0 Digital Input Counter Counter 1 Turbine Meter inputs Counter 2 Turbine Meter inputs
Digital Input Counter 0	Maximum frequency 10Hz. Dry contact input. Wetting current typically 5mA. Contact closure to ground is ON. Open input is OFF.
Counter 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 1 and 2 Turbine Meter Sensitivity	Minimum input 30mVp-p at 5-50Hz. Minimum input 150mVp-p at 150Hz. Minimum input 650mVp-p at 5kHz. Minimum input 750mVp-p at 10kHz. Maximum input 4Vp-p using internal amplifier.
Counter 1 and 2 Dry Contact	Maximum input 10Vp-p without internal amplifier. Maximum frequency 10KHz.
Dry Contact Input Thresholds	0.9V typical turn on input voltage. Less than 0.4V turn on input voltage. 1.5V typical turn off input voltage. Greater than 2.5V turn off input voltage below 1Khz. Greater than 3.5V turn off input voltage above 1Khz.
Transient Protection	2.5kV surge withstand capability as per ANSI/IEEE C37.90.1-1989
Isolation	Common ground return connected to Chassis Ground.

Digital Inputs/Outputs

I/O points	8 points Each point is an input and an output
Output Rating	1.0A maximum 0.35V maximum drop at 1.0A 0.05V maximum drop at 0.1A Open drain sinking when ON. 28V maximum when OFF.
Input Rating	Dry contact input. Wetting current typically 5mA, pulsed.

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	Contact closure to ground is ON. Open input is OFF.
Digital Input Thresholds	0.9V typical turn on input voltage. Less than 0.4V turn on input voltage. 1.5V typical turn off input voltage. Greater than 2.2V turn off input voltage.
Contact Resistance	ON input requires less than 100Ω contact resistance. OFF input requires greater than 50kΩ contact resistance. Cable contact capacitance not to exceed 0.033uF, typically 1600ft (500m).
Transient Protection	2.5kV surge withstand capability as per ANSI/IEEE C37.90.1-1989
Isolation	Common ground return connected to Chassis Ground.

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Approvals and Certifications

Hazardous Locations - North America	Suitable for use in Class I, Division 2, Groups A, B, C and D Hazardous Locations. Temperature Code T4 per CSA Std C22.2 No. 213-M1987 / UL1604 UL listed and CSA certified to the following standards: • CSA Std. C22.2 No. 213-M1987 - Hazardous Locations. • UL Std. No. 1604 - Hazardous (Classified) Locations.
Hazardous Locations - Europe	ATEX II 3G, Ex nA IIC T4 per EN 60079-15, protection type n (Zone 2) Does not include Wireless versions.
Hazardous Locations	IECEx, Ex nA IIC T4 per IEC 60079-15, protection type n (Zone 2) Does not include Wireless versions.
ATEX and IECEx Applications only	This equipment is to be installed 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. A T4 rating is acceptable. For products using Solid State Relays (5415, 5606 and 5607 modules and SCADAPack using 5606 and 5607 modules) A T4 rating is acceptable for maximum loads of 2A. When 3A loads are connected to the Solid State Relays, the maximum ambient rating is lowered to 50°C in order to maintain the T4 rating.
Safety	CSA (cCSAus) certified to the requirements of: CSA C22.2 No. 142-M1987 and UL508. (Process Control Equipment, Industrial Control Equipment) UL (cULus) listed: UL508 (Industrial Control Equipment)
Digital Emissions	FCC Part 15, Subpart B, Class A Verification EN61000-6-4: Electromagnetic Compatibility Generic Emission Standard Part2: Industrial Environment C-Tick compliance. Registration number N15744.
Immunity	EN61000-6-2: Electromagnetic Compatibility Generic Standards Immunity for Industrial Environments
Declaration	This product conforms to the above Emissions and Immunity Standards and therefore conforms with the requirements of Council Directive 2004/108/EEC (as amended) relating to electromagnetic compatibility and is

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	eligible to bear the CE mark. The Low Voltage Directive is not applicable to this product.

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