

# **SCADAPack 32 Controller**

Hardware Manual

## **CONTROL MICROSYSTEMS**

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## **SCADAPack 32 Controller Hardware Manual**

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# 1 Overview

The SCADAPack 32 comprises of a 5232 controller board and an optional integrated I/O module. As the most powerful model in the series using 32 bit processing, the SCADAPack 32 offers high performance, built-in Ethernet and a wide range of analog and digital I/O options. The product offers Modbus RTU and Modbus ASCII as native protocols and is remotely programmable, as a master slave, through a choice of flexible programming languages. As with all SCADAPack products, the SCADAPack 32 is based on a multiprocessor architecture with a co-processor used for handling on-board input/output channels.

The 5232 controller board provides an integrated power supply, three digital/counter inputs, an interrupt input and a status output. The 10-BaseT Ethernet port and three serial communication ports enable connection to a large variety of communication networks. Two of the serial ports support RS-232 communication only and a third port is configurable for RS-232 or RS-485 communication. The RS-232 serial ports support RTS/CTS hardware handshaking for connection to phone or radio modems and half or full-duplex communication. The serial ports operate at speeds from 300 to 38400 baud.

The 5232 onboard memory comprises of 8 MB SDRAM, 4MB flash ROM, and 1MB CMOS SRAM. The CMOS SRAM is non-volatile (battery backed.). A real time clock calendar provides for time of day operations and alarms. A hardware watchdog timer protects against application program failures.

Low power applications can benefit from the SCADAPack 32 ability to enable and disable status LED's on all modules connected to the 5000 Series I/O bus including the controller board and the integrated I/O module.

The 5232 controller board can be found in either of the following configurations:

- **SCADAPack P4:** 5232 controller board with an integrated 5601/A I/O Module. Refer to the 5601 I/O module user manual for additional information.
- **SCADAPack P4A:** 5232 controller board with an integrated 5604 I/O module. Refer to the 5604 I/O module user manual for additional information.
- **SCADAPack P4B:** 5232 Controller board with an integrated 5606 I/O module. Refer to the 5606 I/O module user manual for additional information.
- **SCADAPack 32P** comprises of the 5232 controller board only.

This manual covers wiring, configuration and operation of the 5232 controller board. It meant to be used in conjunction with the hardware manual of the respective I/O module that comes with your controller.

## 2 Important Safety Information

Power, input and output (i/o) wiring must be in accordance with Class I, Division 2 wiring methods Article 501-4 (b) of the National Electrical Code, NFPA 70 for installations in the U.S., or as specified in Section 18-1J2 of the Canadian Electrical Code for installations within Canada and in accordance with the authority having jurisdiction.



**WARNING !**  
EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY  
IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2.

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**WARNING !**  
EXPLOSION HAZARD – WHEN IN HAZARDOUS LOCATIONS, TURN  
OFF POWER BEFORE REPLACING OR WIRING MODULES.

---



**WARNING !**  
EXPLOSION HAZARD - DO NOT DISCONNECT EQUIPMENT  
UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS  
KNOWN TO BE NONHAZARDOUS.

---



## 3 Installation

The installation of SCADAPack controllers requires mounting the SCADAPack 32 controller on a 7.5mm by 35mm DIN rail and connecting the SCADAPack controller to the system I/O Bus. At the bottom of each controller is a mounting panel that is adjustable via slots on either side of the controller board. These slots are accessible only with the top cover off.

Refer to the *System Configuration Guide* for complete information on system layout, I/O Bus cable routing and SCADAPack controller installation.

**Note:** This manual covers wiring, configuration and operation of the 520x controller board only. It meant to be used in conjunction with the hardware manual of the respective I/O module that comes with your controller.

### 3.1 Integrated SCADAPack 32

An integrated SCADAPack 32 controller comprises of a 5232 controller and a lower integrated I/O module. Communication between the controller board and the I/O module occurs via an Inter Module Cable (IMC). The IMC cable also provides 5V from the controller board power supply to the integrated I/O module and expansion 5000 series modules. An Integrated SCADAPack 32 could be a SCADAPack P4, P4A or P4B.

The I/O module is configured using jumper links on the controller or I/O module circuit board. Data from the I/O module is made available to a user program using one of the following methods:

- For TelePACE applications use the *Register Assignment* to configure the I/O module you are using.
- For ISaGRAF applications use the Complex Equipment I/O connection to configure the I/O module you are using.

This manual covers wiring, configuration and operation of the 5232 controller board only. It meant to be used in conjunction with the hardware manual of the respective I/O module that comes with your controller.

### 3.2 Field Wiring

SCADAPack controllers use screw termination style connectors for termination of field wiring. These connectors accommodate solid or stranded wires from 12 to 22 AWG.

The connectors fit over pins on the controller board and the I/O modules. 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.

**CAUTION:** Always remove power before servicing unit.

#### Termination Connector Removal

- To remove the termination connector:
- Pull the connector upward from the board. Apply even pressure to both ends of the connector.

#### Termination Connector Installation

- To install the termination connector:
- Line up the pins on the module with the holes in the connector. Make sure all the pins line up properly.

- Push the connector onto the pins. Apply even pressure to both ends of the connector.

### 3.2.1 Field Wiring Connectors

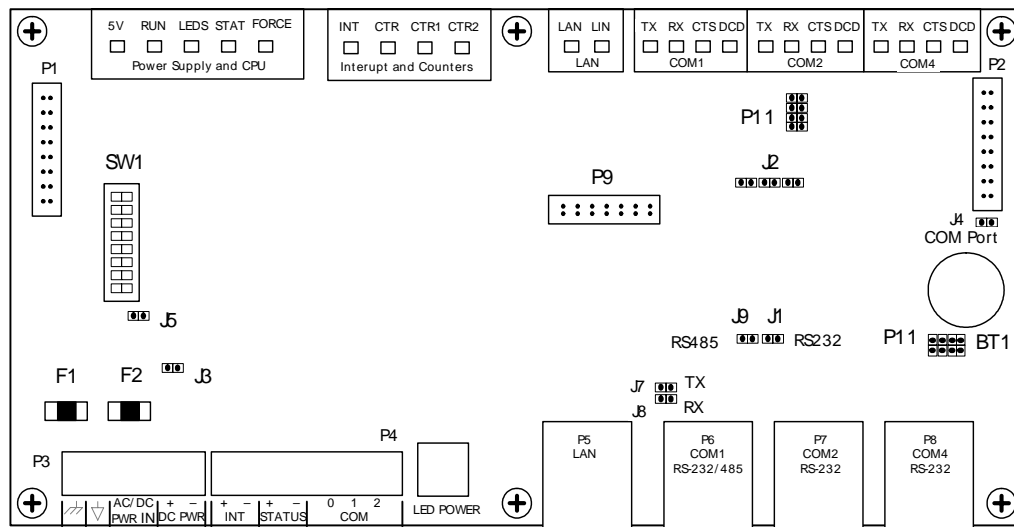
The controller board has six termination connectors for field wiring. Refer to **Figure 1: 5232 Controller Board Layout** for connector locations.

Primary power input connections; output power connection and ground connections are wired to a six-pole connector labeled P3. Refer to section **4-Power Supply** subsection for instructions on how to wire the controller board to a power supply.

The three digital/counter inputs (DIN/Counters), interrupt input/counter (INT/Cntr) and status output (STATUS) are wired to an eight-pole connector labeled P4. Refer to section **7-Digital Inputs** and section **8-Digital Outputs** for more information.

Each of the three serial communication ports is wired to black 8 pin modular RJ-45 connectors. COM1 connector is labeled P6, COM2 connector is labeled P7, and COM4 connector is labeled P8. Refer to the section **9.1-RS-232 Serial Communication Ports** for more information

The Ethernet LAN Port is wired to a gray 8 pin modular RJ-45connector labeled P5. Refer to the section **10- Ethernet Communication** for more information on Ethernet connections.



**Figure 1: 5232 Controller Board Layout**

## 4 Power Supply

### 4.1 Overview and Requirements

The SCADAPack controller is primarily a DC input powered device but can be powered with 16Vac under some conditions. The power supply requirements and setup is explained in the proceeding sections.

**Note:** Voltage referred to as  $V_{rms}$  (or VAC on some products) indicates AC power. Voltage referred to as V indicates DC power.

The 5232 Controller board can be powered from a 12Vdc to 24Vdc power source applied to the DC PWR input or a 16Vac power source applied to the AC PWR IN input. With input power applied the 5232 Controller board power supply provides an internal 5V output to power the integrated I/O module and 5000 Series modules through the inter module cable (IMC).

The 5V supply has a 1.3A output capacity of which 500mA is required by the 5232 Controller board. The remaining capacity, 800mA, is used to power the integrated I/O module and other 5000 Series modules connected through the IMC cable.

When the 5232 Controller board is powered with 16Vac power applied to the AC PWR IN input a limited amount of 24Vdc power is provided on the DC PWR terminals. The amount of 24Vdc power available is dependent on the amount of 5V output power used in the system. With the controller board consuming 500mA of current at 5Vdc, 360mA at 5Vdc is available to power external devices. However, this value linearly decreases to 80mA when the onboard power capacity is exhausted. Refer to the user manual of your respective I/O module for a sample power supply calculation.

### 4.2 Power Supply Input Connections

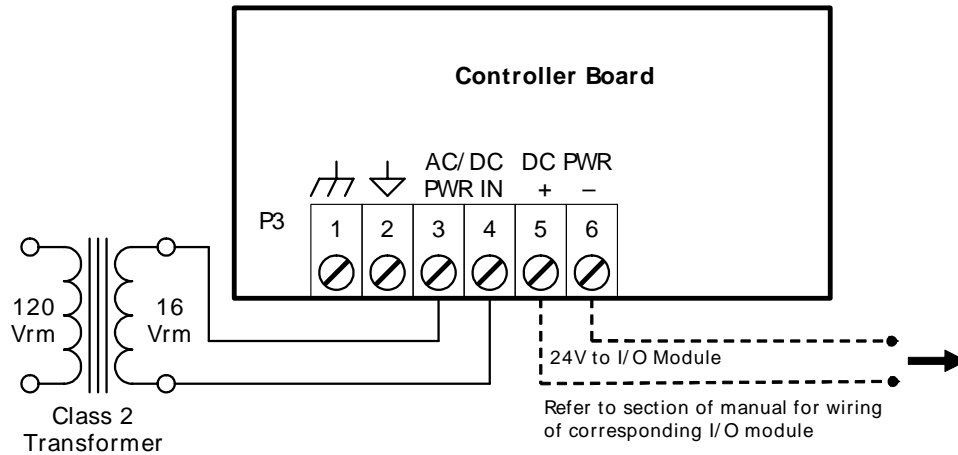
Input power is connected to the SCADAPack 32 controller board in one of the following ways:

- A 16Vac source connects to the AC/DC PWR IN terminals on the Controller board and on the 5601 I/O Module. See section **4.2.1- Recommended AC Power Supply Configuration** for an example of using a 16Vac transformer to power the SCADAPack 32 controller.
- An 11-24Vdc source connects to the DC PWR terminals on the Controller board and on the integrated I/O Module. See section **4.2.2-Recommended DC Power Supply Configuration** for an example of using a DC power source coming from an 11-24Vdc power source.
- An 11 to 24Vdc high current capacity source, such as batteries, connects to the AC PWR IN and DC PWR IN terminals on the 5232 Controller Board. See the section **4.2.3- Recommended Battery Supply Configuration** for a wiring example.
- A 5103 UPS Power Supply supplies 5Vdc to the controller board through the IMC cable and supplies 24Vdc to the integrated I/O module through the 24Vdc output. See section **4.2.4- Recommended 5103 Power Supply Configuration** for an illustration.

**CAUTION:** Power can be applied to either the AC/DC power input **OR** the DC power input. **DO NOT** apply power to both inputs. Damage to the power supply may result.

#### 4.2.1 Recommended AC Power Supply Configuration

This configuration uses a single Class 2 transformer to power the controller board and any integrated I/O modules. 24V are available on the controller module connector P3 which can be used to power the analog circuitry for the analog input and output circuits on the integrated I/O module.



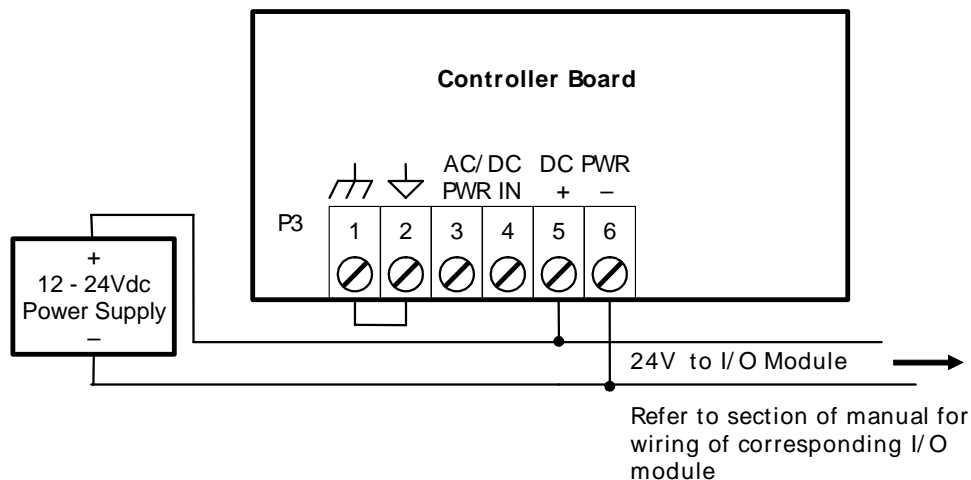
**Figure 2: Recommended AC Power Supply Configuration**

In this configuration, 24V with a **limited** current is available on the two rightmost pins, labeled DC PWR, of the same P3 connector. This can be used to power the analog portion of the integrated I/O module although the available current may not be sufficient for the specific application. Refer to the hardware manual of your corresponding I/O module for details.

#### **4.2.2 Recommended DC Power Supply Configuration**

This configuration uses a single power supply to power the controller board and 5601 I/O module. Refer to the System Configuration Guide for more information. The power supply is used to power the analog circuitry for the 5601 I/O module.

The DC power supply input inrush current can be reduced if required. Some DC power supplies will go into current limit when starting up into a high inrush current load. Battery operated systems have high current capabilities that may cause nuisance fuse blowing. If either of these situations are present in an installation, it possible to reduce the DC power supply inrush current by cutting link J3. J3 is located on the controller next to the power input connector and fuses. This link may be cut in DC applications only.



**Figure 3: Recommended DC Power Supply Configuration**

### 4.2.3 Recommended Battery Supply Configuration

This configuration uses a high capacity source, such as a battery, to power the SCADAPack 32.

The DC power supply input inrush current can be reduced if required. Battery operated systems have high current capabilities that may cause nuisance fuse blowing. It is possible to reduce the DC power supply inrush current by cutting link J3. J3 is located on the controller next to the power input connector and fuses. This link may be cut in DC applications only.

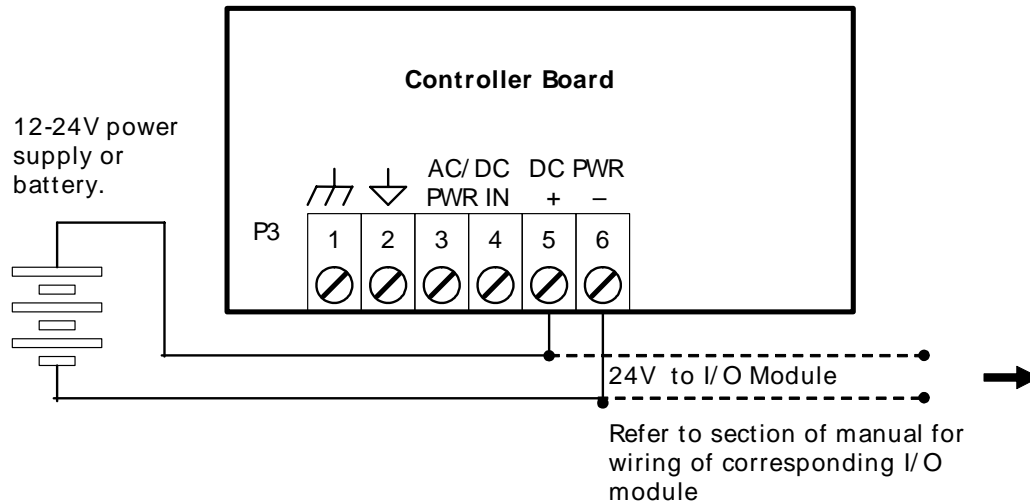


Figure 4: Recommended Battery Supply Configuration

### 4.2.4 Recommended 5103 Power Supply Configuration

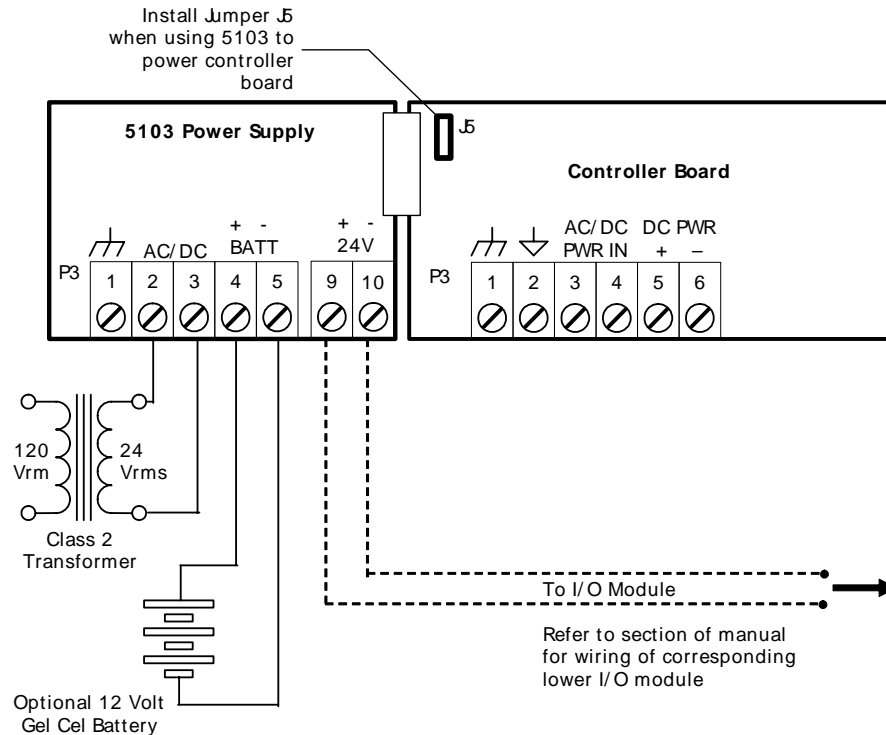
When additional power is required by the system, 5000 Series 5103 power supplies can be used in combination with the SCADAPack 32 controllers. Refer to the *System Configuration Guide* for more information.

The 5103 power supplies can be connected anywhere downstream (to the right) of the controller. They will supply power to the modules downstream of them.

The 5103 power supply may also be connected upstream (to the left) of any SCADAPack 32 Controller, but only if no power is applied to the power inputs of the controller board.

This configuration uses a 5103 Power Supply module to power a SCADAPack 32. The 24VDC output from the 5103 powers the 5601 I/O module. The 5103 power supply provides a 5V output to power the integrated I/O module, the controller board and 5000 Series modules through the IMC cables.

Note that no connection is made to the AC/DC PWR IN or DC PWR terminals on the controller board.



**Figure 5: Recommended 5103 Power Supply Configuration**

## 4.2.5 Power Supply Calculations

### 4.2.5.1 SCADAPack P4

As illustrated in section *4.2.1-Recommended AC Power Supply Configuration* the 5232 controller board may be powering a 5601 I/O module as well as other 5000 Series modules.

The following table shows current requirements of the controller board and the 5601 I/O modules:

	5V Current (mA)	24V Current (mA)
<b>5232Controller Board</b>	500	0
<b>5601 I/O Module</b>	20 + 40mA/relay	20 + 20mA/analog input
<b>Analog Outputs</b>	10	15 + 20mA/output

In the following example, a SCADAPack P4 with a 5232 Controller board, a 5601 I/O module with analog outputs is powered using the Recommended AC Setup. Using this setup, 24V is available across the DC PWR terminals on connector P3 of the controller board to power the integrated I/O board. This 24V power must be available for both analog outputs and all analog inputs that require power. In this example, both analog outputs and only 4 of the 8 analog inputs are being used. Further assume all 12 digital output relays will be on with LEDs enabled. The minimum current requirement for each module on the SCADAPack P4 is given in the table below.

	5V Current (mA)	24V Current (mA)
<b>5232 Controller Board</b>	500	0
<b>5601 I/O Module</b>	500	100
<b>Analog Outputs</b>	10	55
<b>Total</b>	1010	155

The 5232 controller board has 1300mA available from the 5V supply. A minimum of 100mA is available from the 24V supply. Additional current is available from the 24V supply when the 5V is not loaded to its 1300mA maximum.

The total 24V supply current available is calculated as follows:

$$\begin{aligned}
 \text{24V current} &= 100 + ((1300 - \text{Total Current @ 5V}) \times 0.25) \\
 &= \underline{172.5\text{mA}}
 \end{aligned}$$

where:

- 100 = Minimum current @ 24V
- 1300 = Maximum current @ 5V
- Total Current @ 5V = Sum of 5V current required for system
- 0.25 = Derating factor is a constant

In this example, when 1010mA is required at 5V, 172.5mA is available on the 24V supply on connector P3. This is greater than the 155mA required by the integrated 5601 I/O module. The ***Recommended AC Power Supply Configuration*** can therefore be used to power the SCADAPack P4 controller.

#### 4.2.5.2 SCADAPack P4A

As illustrated in section ***4.2.1-Recommended AC Power Supply Configuration*** the 5232 controller board may be powering a 5601 I/O module as well as other 5000 Series modules.

The following table shows current requirements of the controller board and the 5601 I/O modules:

	5V Current (mA)	DC Input Current (mA)
<b>5232 Controller Board</b>	500	0
<b>5604 I/O Module</b>	15 to 170 See specifications for details.	10 + 12/24V boost converter requirements. Can vary up to 550mA. See Note below.

**Note:** The DC Input current depends on the actual DC Input voltage, whether the DC Input is boosted and the load on the output.

##### 4.2.5.2.1 Example 1

In the following example a 5232 Controller board with a 5604 I/O Module and analog outputs is powered using the ***Recommended AC Setup*** such that 24V will be available across the DC PWR terminals on connector P3 to power the integrated I/O board. This 24V power must be available for both analog outputs and all analog inputs that require power. In this example, both analog outputs

and all 8 analog inputs are being used. Further assume all 32 digital I/O points will be on with the LEDs enabled. Input will not be boosted in the 5604.

	5V Current (mA)	DC Input Current (mA)
<b>5232 Controller Board</b>	500	0
<b>5604 I/O Module</b>	170	10 + 200
<b>Total</b>	670	210

The controller board has 1300mA available from the 5V supply. A minimum of 100mA is available from the 24V supply. Additional current is available from the 24V supply when the 5V is not loaded to its 1300mA maximum.

The total available 24V supply current is calculated as follows:

$$24V \text{ current} = 80 + ((1300 - \text{Total Current @ 5V}) \times 0.25) \\ = \underline{257.5mA}$$

where:

$$\begin{aligned} 100 &= \text{Minimum current @ 24V} \\ 1300 &= \text{Maximum current @ 5V} \\ \text{Total Current @ 5V} &= \text{Sum of 5V current required for system} \\ 0.25 &= \text{Derating factor is a constant} \end{aligned}$$

In this example, when 670mA is required at 5V, 257.5mA is available on the 24V supply on connector P3. This is greater than the 210mA required by the integrated 5604 I/O module. The **Recommended AC Power Supply Configuration** can therefore be used to power the SCADAPack P4A controller.

#### 4.2.5.2.2 Example 2

In this example there is a 5232 Controller board with a 5604 I/O Module and analog outputs powered using a 12V battery such that 24V is generated using the 12/24 boost converter onboard the 5604 module. This 24V must be available for both analog outputs and all 8 of the analog inputs. Also assume all 32 digital I/O points will be on with the LEDs enabled.

	5V Current (mA)	DC Input Current
<b>5232 Controller Board</b>	500	See calculation.
<b>5604 I/O Module</b>	170	See calculation.
<b>Total</b>	670	See calculation.

The 5604 DC Input supply current is calculated as follows:

$$5604 \text{ DC Input Current} = (24 \times \text{Total Current @ 24V}) / (12 \times 0.88) \\ = (24 \times 20) / (12 \times 0.88) = \underline{455mA}$$



where:

24 = 24V output  
12 = Input voltage  
Total Current @ 24V = Sum of 24V loads powered by the 12/24V  
boost converter (in mA).  
0.88 = Efficiency

The 5232 DC Input supply current is calculated as follows:

$$\begin{aligned} \text{5232 DC Input Current} &= (5 \times \text{Total Current @ 5V}) / (12 \times 0.85) \\ &= (5 \times 0.670) / (12 \times 0.85) = 328\text{mA} \end{aligned}$$

where:

5 = 5V power supply  
12 = Input voltage  
Total Current @ 5V = Sum of 5V loads powered by the 5232 (in mA).  
0.85 = Efficiency

The total current required from the 12V battery for this application is:

$$455\text{mA} + 328\text{mA} = 783\text{mA}.$$

It should be noted that in a battery-powered application such as this there are several opportunities to reduce the power consumption. There will be significant power savings when the LEDs are disabled. Switching VLOOP off under program control, when not required by the application will reduce the power required.

#### 4.2.5.3 SCADAPack P4B

As illustrated in section **4.2.1-Recommended AC Power Supply Configuration** the 5232 controller board may be powering a 5601 I/O module as well as other 5000 Series modules.

The following table shows current requirements of the controller board and the 5601 I/O modules:

	5V Current (mA)	11-30V Current (mA)
5232 Controller Board	500	0
5606 I/O Module	30 to 600mA See specifications for details.	12

In the following example, a SCADAPack P4B equipped with analog outputs is powered using the *Recommended AC* setup such that 24V will be available across the DC PWR terminals on connector P3 to power the analog circuit on the integrated I/O board. This 24V must be available for both analog outputs and only 4 of the 8 analog inputs. Assume all 12 digital output relays will be on with the LEDs enabled. The minimum current requirement for each module on the SCADAPack P4 is given in the table below.

	5V Current (mA)	11-30V Current (mA)
<b>5232 Controller Board</b>	500	0
<b>5606 I/O Module</b>	600	30 + 200mA
<b>Total</b>	1100	230

The controller board has 1300mA available from the 5V supply. A minimum of 100mA is available from the 24V supply. Additional current is available from the 24V supply when the 5V is not loaded to its 1300mA maximum.

The total available 24V supply current is calculated as follows:

$$24V \text{ current} = 100 + ((1300 - \text{Total Current @ 5V}) \times 0.25)$$

where:

100 = Minimum current @ 24V

1300 = Maximum current @ 5V

Total Current @ 5V = Sum of 5V current required for system

0.25 = Derating factor is a constant

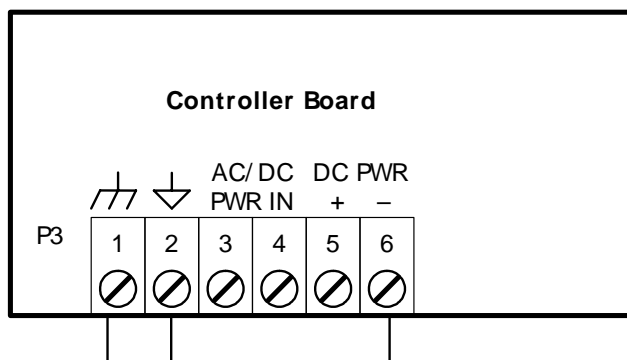
$$24V \text{ current} = 100 + ((1300 - 1100) \times 0.25) = \underline{150mA}.$$

The available current (150mA) is **less than** the required current (230mA) and as such it is not possible to operate this configuration from an AC source unless the number of current loops is reduced by 80mA.

### 4.3 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.

On the 5232 controller board, the logic ground (pin 2) and the negative terminal of the DC PWR or the 24V power source (pin 6) on connector P3 are all referenced to the earth ground (pin 1).



**Figure 6: Grounding Configuration**

## 5 Analog Inputs

The 5232 controller board has two internal analog inputs, used by application programs to monitor controller board ambient temperature and the Lithium battery voltage. The 3.6V Lithium battery provides backup power to the RAM in case of a power failure. These internal analog inputs are accessible by the user application program.

In addition, 5 or 8 analog input channels are available on the integrated I/O module. For example,

- The 5602 I/O module provides 5 single ended analog inputs.
- The 5601/5601A, 5604 or 5606 I/O modules provides 8 single ended analog inputs.

Refer to the hardware manual of your corresponding I/O module for wiring and configuration details to of the I/O module analog input channels to field data. Access of the controller board analog input data is covered in the rest of this

The ambient temperature input measures the temperature at the controller circuit board. It is useful for measuring the temperature of the controller's operating environment. The return value is of type integer and falls within the range  $-40^{\circ}\text{C}$  to  $75^{\circ}\text{C}$  or  $-40^{\circ}\text{F}$  to  $167^{\circ}\text{F}$ . Temperatures outside this range cannot be measured.

- For TelePACE applications use the *AIN Controller Temperature* register assignment to read the ambient temperature in degrees C and degrees F.
- For ISaGRAF applications use the *aintemp* I/O connection to read the ambient temperature in degrees C and degrees F.

Please refer to the respective TelePACE and ISaGRAF software manuals on how to assign the above registers.

The 3.6V lithium battery input measures the voltage of the battery that maintains the non-volatile RAM in the controller. The return value is in mV and falls within the range 0 – 5000 although a typical return value of 3600-3700mV is expected. A return value less than 3000mV indicates that the lithium battery requires replacement.

- For TelePACE applications use the *AIN Controller RAM Battery V* register assignment to read the lithium battery voltage.
- For ISaGRAF applications use the *ainbatt* I/O connection to read the lithium battery voltage.

## 6 Analog Outputs

The 5232 controller board by itself provides no analog output channels.

However, 2 analog output channels may accompany the integrated I/O module (if present), if this option was requested at time of purchase. The analog outputs produce 0-20mA of current but can easily be wired to provide an output voltage by connecting a load resistor across the output channel.

Refer to the hardware manual of your respective I/O module for details.

## 7 Digital Inputs

The 5232 controller board has four Digital / Counter inputs i.e. all four digital inputs can also be used as counter inputs. One digital input, the interrupt input, can also be used to wake up the controller from sleep mode.

In addition, 16, 32 digital inputs or 32 universal digital inputs/outputs channels are available on the integrated I/O module, if present. For example,

- The 5601/5601A I/O module provides 16 digital input channels.
- The 5604 I/O modules provide 32 universal digital input/output channels.
- The 5606 I/O module provides 32 digital input channels.

Refer to the hardware manual of your corresponding I/O module for wiring and configuration details to of the I/O module digital input channels to field data. Wiring configuration or access of the controller board digital input data is covered in the rest of this chapter.

### 7.1 Digital/Counter Inputs

The controller board has three Digital / Counter inputs. These inputs are labeled **DIN/Counter** 0, 1 and 2 on the P4 terminal connector. The DIN/Counter inputs have one standard voltage range, 24V AC or DC, and operate as digital inputs and as counter inputs.

- For DC inputs the maximum input voltage is 30V and the minimum voltage to turn the input ON is 10V.
- For AC inputs the maximum input voltage is 24Vrms and the minimum voltage to turn the input ON is 10Vrms.
- For counter inputs the maximum frequency is 5 KHz with the filters off.

The **DIN/Counter** inputs can be used as both digital inputs and counter inputs in an application program.

- For TelePACE applications use the *CNTR Controller Counter Inputs* register assignment to read the DIN/Counter inputs as counters and the *DIN Controller Digital Inputs* register assignment to read the DIN/Counter inputs as digital inputs
- For ISaGRAF applications use the **cntrCtrl** I/O connection to read the DIN/Counter inputs as counters and the **dinCtrl** I/O connection to read the DIN/Counter inputs as digital inputs.

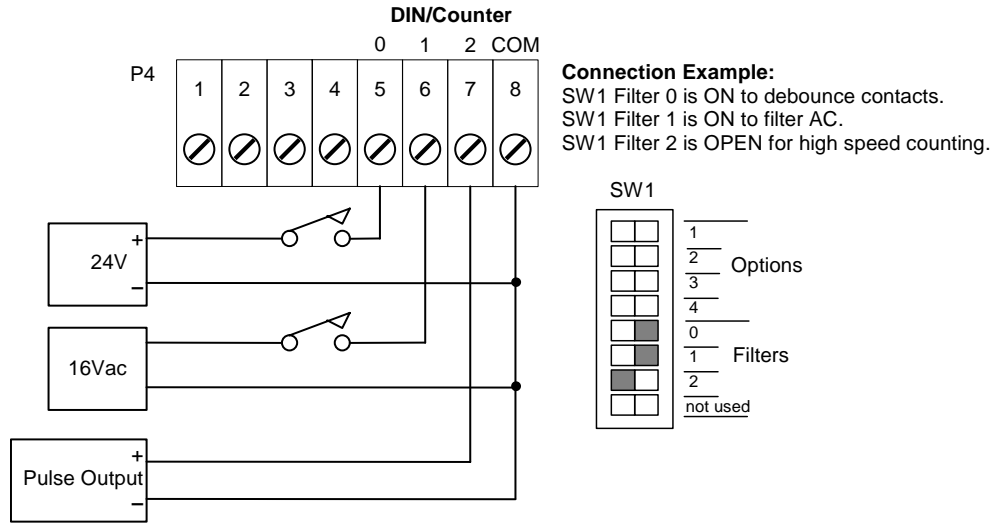
Each of the three DIN/Counter inputs on the controller has a switch selectable filter, which limits the maximum input frequency. Filtering limits the maximum digital input or counter frequency to approximately 30Hz. SW1 is used to enable or disable filtering. Refer to the section **11.5-Configuration Switches** for filter selection information using SW1.

Use a filter for 50 or 60Hz digital inputs and for low speed counting applications that experience problems due to contact bounce.

Do not use filtering for high speed counting applications.

#### 7.1.1 Wiring Examples

The figure below illustrates a wiring example where all DIN/COUNTERS channels are being used.



**Figure 7: Digital/Counter (DIN/COUNTERS) Input Wiring**

COUNTER 0 is being used as a counter in a low speed application. The low pass filter is enabled to eliminate the high frequency noise inherent in mechanical relay contacts.

COUNTER 1 is being used as a low speed counter with an AC enabling signal. The low pass filter is also enabled to filter AC.

COUNTER 2 is being used as a high speed counter with the low pass filter disabled.

## 7.2 Interrupt Input

The controller board has one Interrupt digital input. This input is labeled **INT/Cntr** on the P4 terminal connector. This input operates as a DC digital input and as a counter input.

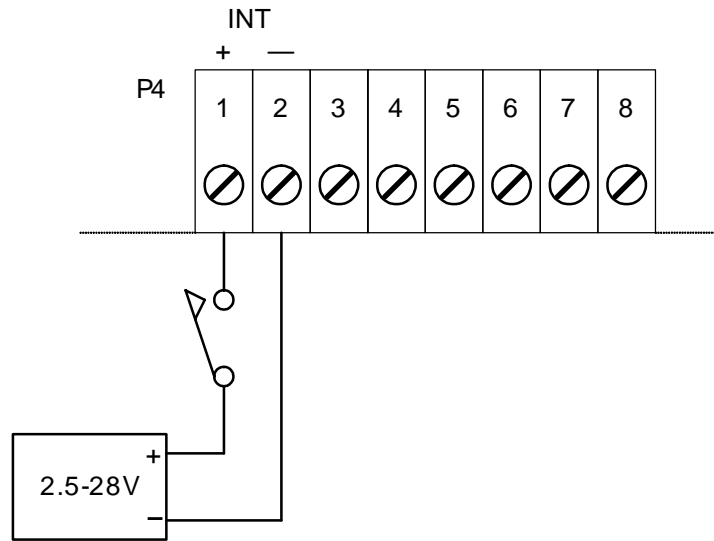
For DC input the maximum input voltage is 28V and the minimum voltage required to turn the input ON is 2.5V. For counter input the maximum frequency is 500Hz.

The **INT/Cntr** input can be used as both a digital input and a counter input in an application program.

- For TelePACE applications use the **CNTR Controller Interrupt Input** register assignment to read the INT/Cntr input as a counter and the **DIN Controller Interrupt Input** register assignment to read the INT/Cntr input as a digital input.
- For ISaGRAF applications use the **cntrint** I/O connection to read the INT/Cntr input as a counter input and the **dinint** I/O connection to read the INT/Cntr input as a digital input.

### 7.2.1 Wiring Example

The diagram below shows how to wire this input.



**Figure 8: Interrupt Input (INT) Wiring**

## 8 Digital Outputs

The 5232 controller board provides a single digital (discrete) output channel which can be used to indicate a controller alarm condition to an external. This chapter covers the controller board digital output.

In addition, 12, 16 dry contact digital outputs or 32 universal digital inputs/outputs channels may be available on the integrated I/O module. For example,

- The 5601/5601A I/O module provides 16 digital input channels.
- The 5604 I/O modules provide 32 universal digital input/output channels.
- The 5606 I/O module provides 32 digital input channels.

Refer to the hardware manual of your corresponding I/O module for wiring and configuration details of the I/O module digital output channels. Information on the controller board digital output is covered in this rest of this chapter.

The controller board status output indicates an alarm condition to an external device. The output is ON (capable of conducting current) during normal operation. The output is OFF (high impedance) during the following conditions:

- Power failure.
- Controller board RESET.
- Application program defined conditions.

The status output is an optically isolated transistor. The polarity of the output must be observed. The output current must be limited to 60mA during the ON condition. The output voltage must be limited to 30V during the OFF condition.

### 8.1 Wiring Example

A typical application of this output is shown in **Figure 9: STATUS Output Wiring**. In this scenario, STATUS is being used to energize a relay and the normally closed contacts of this relay are used to activate an alarm. The relay in this application has a 24V coil with greater than 400Ω resistance.

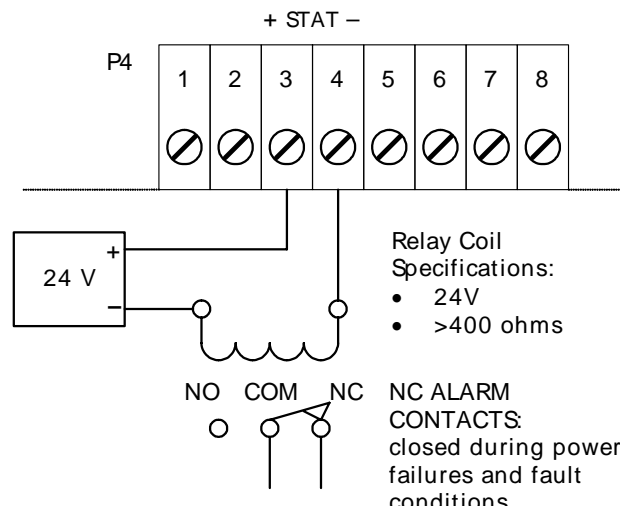


Figure 9: STATUS Output Wiring



## 9 Serial Communication

The 5232 controller board is equipped with three serial communication ports. Each of the four serial communication ports support RS-232 serial communication and one port supports both RS-232 and RS-485 serial communication. The integrated I/O module provides additional serial communication capabilities. Please refer to the section of the manual for each respective I/O module for details.

Port	Type	Description
COM1	RS-232-485	R-J45 connector designated P6 on the 5232 Controller.
COM2	RS-232	RJ-45 connector designated P7 on the 5232 Controller.
COM4	RS-232	RJ-45 connector designated P8 on the 5232 Controller.

### 9.1 RS-232 Serial Communication Ports

All RS-232 wiring must use 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.

#### 9.1.1 COM1

Serial port COM1 may be configured as an RS-232 or RS-485 serial communication port.

- A jumper must be installed on J10 to operate COM1 in RS-232 mode.
- A jumper must be installed on J9 to operate COM1 in RS-485 mode.

**Note:** For configuration of serial port type in TelePACE or ISaGRAF, **RS-232** is used for either mode of operation i.e. for RS-232 or RS-485 mode.

Refer to the drawing in **Figure 1: 5232 Controller Board Layout** for the location of COM1 and jumpers J9 and J10.

For information on using COM1 as a RS-485 serial port refer to section **9.6-RS-485 Serial Communication Port** subsection.

Connections to COM1 are made through a RJ-45 modular connector. Connections are made through a DE-9P connector. The wiring and pin connections for this connector are described in section **9.3-DE-9P Connector for RS-232**.

The following table shows the serial and protocol communication parameters supported by COM1. These parameters are set from the ISaGRAF Workbench or from an application program running in the SCADAPack 32 controller. Default values are set when a Cold Boot or Service Boot is performed on the SCADAPack 32 controller.

Parameter	Supported Values
<b>Baud Rate</b>	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. Default: 9600
<b>Duplex</b>	Full or Half Default: Full
<b>Parity</b>	Odd, None or Even Default: None

Parameter	Supported Values
<b>Data Bits</b>	7 or 8 Bits Default: 8 Bits
<b>Stop Bits</b>	1 or 2 Bits Default: 1 Bit
<b>Receive Flow Control</b>	ModbusRTU or None Default: ModbusRTU
<b>Transmit Flow Control</b>	Ignore CTS or None Default: None
<b>Station</b>	1 to 65534 Default: 1
<b>Protocol</b>	None, Modbus RTU or Modbus ASCII Default: Modbus RTU
<b>Addressing Mode</b>	Standard or Extended Default: Standard

### 9.1.2 COM2

Connections to COM2 are made through a RJ-45 modular connector. The wiring and pin connections for this connector are described in the RJ-45 Modular Connector for RS-232 subsection. Refer to **Figure 1: 5232 Controller Board Layout** for the location of COM2 on the SCADAPack 32 controller board.

The following table shows the serial and protocol communication parameters supported by COM2. These parameters are set from the ISaGRAF Workbench or from an application program running in the SCADAPack 32 controller. Default values are set when a Cold Boot or Service Boot is performed on the SCADAPack 32 controller.

Parameter	Supported Values
<b>Baud Rate</b>	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. Default: 9600
<b>Duplex</b>	Full or Half Default: Full
<b>Parity</b>	Odd, None or Even Default: None
<b>Data Bits</b>	7 or 8 Bits Default: 8 Bits
<b>Stop Bits</b>	1 or 2 Bits Default: 1 Bit
<b>Receive Flow Control</b>	ModbusRTU or None Default: ModbusRTU
<b>Transmit Flow Control</b>	Ignore CTS or None Default: None
<b>Station</b>	1 to 65534 Default: 1
<b>Protocol</b>	None, Modbus RTU or Modbus ASCII Default: Modbus RTU
<b>Addressing Mode</b>	Standard or Extended Default: Standard

### 9.1.3 COM4

Connections to COM 4 are made through a RJ-45 connector. The wiring and pin connections for this connector are described in section **9.2-RJ-45 Modular Connector for RS-232** below.

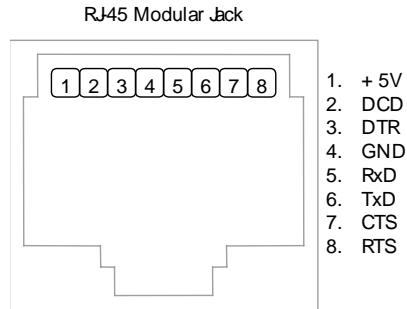
The following table shows the serial and protocol communication parameters supported by COM1. These parameters are set from TelePACE, ISaGRAF Workbench or from an application program running in the controller. Default values are set when a Cold Boot or Service Boot is performed on the controller.

Parameter	Supported Values
Baud Rate	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. Default: 9600
Duplex	Full or Half Default: Full
Parity	Odd, None or Even Default: None
Data Bits	7 or 8 Bits Default: 8 Bits
Stop Bits	1 or 2 Bits Default: 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 or Modbus ASCII Default: Modbus RTU
Addressing Mode	Standard or Extended Default: Standard

## 9.2 RJ-45 Modular Connector for RS-232

The serial communication ports on the 5232 controller board are labeled COM1, COM2 and COM4. These are RS-232 serial ports using a 8-pin female RJ-45 connectors configured as Data Terminal Equipment (DTE). The recommended specification for RS-232 cable length is a maximum of 50 feet or 15.2 meters. Shielded cable must be used and the shield should be connected to chassis ground at one end.

The following diagram shows the pin connections for the RS-232 (RJ-45) port connector for COM1, COM2 and COM4.



**Figure 10: Front View of an RJ-45 Connector for RS-232**

**NOTES:**

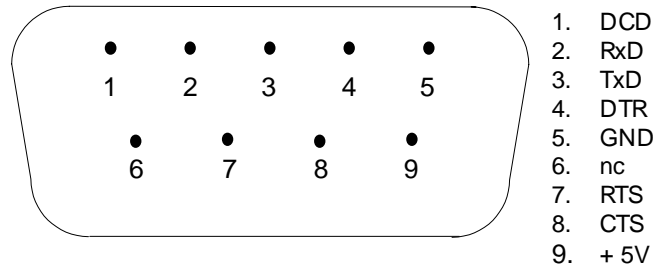
- +5V is only available on Pin 1 when a jumper is installed on J4.
- Serial port COM1 may be configured as RS-232 or RS-485. A jumper must be installed on J10 to operate COM1 in RS-232 mode. Refer to the *Figure 1* for the location of J4 and J10.

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 less.

Pin	Function	Description
1	5V (Output)	This pin can be connected to the 5V power supply by installing a jumper at J4 on the SCADAPack controller board.
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.

### 9.3 DE-9P Connector for RS-232

RS-232 ports are 9-pin male D-sub-miniature (DE-9P) connectors configured as Data Terminal Equipment (DTE). A maximum cable length of 50ft (15.2m) is allowed. **Figure 11: RS-232 Port Connector** shows the pin connections on the RS-232 connectors.



**Figure 11: RS-232 Port Connector**

Pin	Type	Description
Pin 1 DCD	input	The DCD led is on for a MARK level. (> +3V)
Pin 2 RxD	input	The level is SPACE (< -3V) on standby and MARK for received data. The RxD LED is lit for a MARK level.
Pin 3 TxD	output	The level is SPACE on standby and MARK for transmitted data. The LED is lit for a MARK level.
Pin 4 DTR	output	This pin is normally at a MARK level. This pin is at a SPACE level when DTR is de-asserted.
Pin 5 Ground		This pin is connected to the system ground.
Pin 6		This pin is not connected.
Pin 7 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.
Pin 8 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. The LED is on for a MARK level.
Pin 9	output	This pin is connected to the 5V power supply. Exercise caution when using it. This pin must NOT be connected if it is not used.

## 9.4 RS-232 Cables

### 9.4.1 RJ-45 to DE-9S DTE

This cable is used to connect from an RJ-45 based RS-232 port on the SCADAPack 32 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 297217.

RJ-45 8 Pins	SCADAPack 32 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.	GND	GND	No wires connected at this end.

### 9.4.2 RJ-45 to DE-9P DCE

This cable is used to connect from an RJ-45 based RS-232 port on the SCADAPack 32 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 297218.

RJ45	SCADAPack 32 DTE Function	DE-9P DCE Function	DE
			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

## 9.5 RS-232 Wiring Examples

### 9.5.1 DTE to DTE without Handshaking

There are several methods for wiring the RS-232 COM port to DTE and DCE (Data Communications Equipment) devices. The simplest connection requires only 3 wires: RxD, TxD and signal ground. **Figure 12: RS-232 DTE to RS-232 DTE without Handshaking** shows a common RS-232 COM port to DTE device.

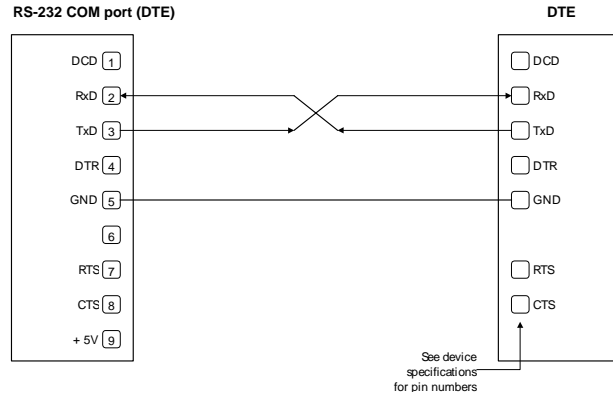


Figure 12: RS-232 DTE to RS-232 DTE without Handshaking

### 9.5.2 DTE to DTE with Handshaking

Some DTE devices may require hardware handshaking lines. The most common 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. **Figure 13: RS-232 DTE to RS-232 DTE with Handshaking** shows a common connection of an RS-232 COM port with a DTE device requiring handshaking lines.

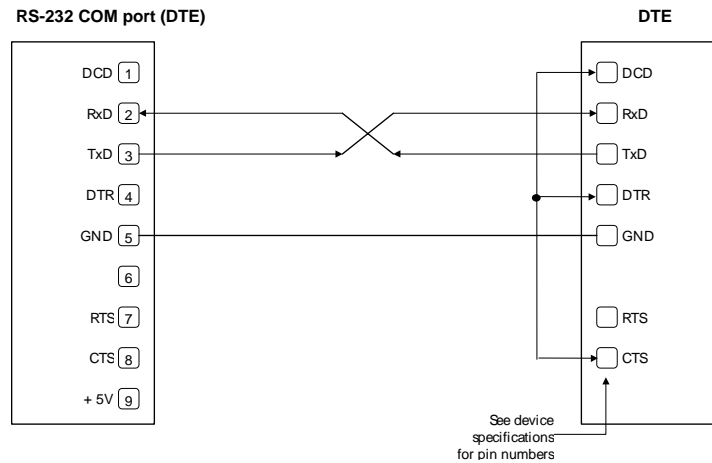
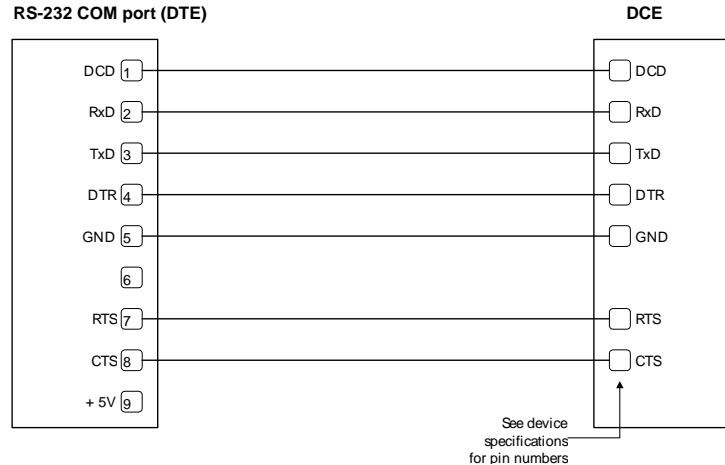


Figure 13: RS-232 DTE to RS-232 DTE with Handshaking

### 9.5.3 DTE to DCE with Handshaking

DCE devices require different wiring. The handshaking lines must be connected in most cases. Note that many DCE devices are half duplex. Select half-duplex operation with these devices. **Figure 14: RS-232 DTE to RS-232 DCE** shows common connection of a SCADAPack with a DCE device requiring handshaking lines.



**Figure 14: RS-232 DTE to RS-232 DCE**

## 9.6 RS-485 Serial Communication Port

Serial port COM1 on the SCADAPack 32 controller may be configured as an RS-485 serial communication port. A jumper must be installed on J9 to operate COM1 in RS-485 mode. Refer to **Figure 1: 5232 Controller Board Layout** for the location of J9.

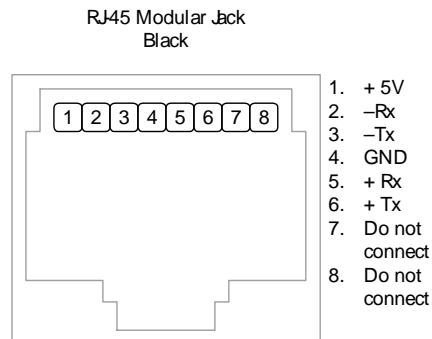
When configured as a RS-485 port COM1 transmits and receives differential voltages to other RS-485 devices on a network. The RS-485 specification allows a maximum of 32 devices connected on a single RS-485 network. The recommended specification for RS-485 is the cable length should not exceed a maximum of 4000 feet or 1200 meters. Termination resistors are required when using long cable lengths and high baud rates. Refer to the RS-485 Termination Resistors subsection for more information.

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

The RS-485 port operates in *two* or *four wire* mode.

### 9.6.1 RJ-45 Modular Connector for RS-485

The following diagram shows the pin connections for the RS-485 (RJ-45) port connector for COM1.



**Figure 15: Front View of an RJ-45 Connector for RS-485**



+5V is only available on Pin 1 when a jumper is installed on J4.

Serial port COM1 may be configured as RS-232 or RS-485. A jumper must be installed on J9 to operate COM1 in RS-485 mode. Refer to the **Figure 1: 5232 Controller Board Layout** for the location of jumpers J4 and J9.

The differential receive and transmit signals are labeled +/–Rx and +/–Tx respectively. Some RS-485 devices refer to the – side of the signal as A and the + side of the signal as B.

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 less.

Pin	Function	Description
1	5V (Output)	This pin can be connected to the 5V power supply by installing a jumper at J4 on the SCADAPack controller board.
2	–Rx (Input)	The DCD led is on for a MARK level.
3	–Tx (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	+Rx (Input)	The level is SPACE on standby and MARK for received data. The LED is lit for a MARK level.
6	+Tx (Output)	The level is SPACE on standby and MARK for transmitted data. The LED is lit for a MARK level.
7	N/C	Do not connect this pin for RS-485 operation.
8	N/C	Do not connect this pin for RS-485 operation.

### 9.6.2 RS-485 Bias Resistors

The RS-485 receiver inputs on the SCADAPack 32 controller are biased to ensure that that received data is driven to a valid state (space) when there are no active drivers on the network. The value of these bias resistors is 4700 ohms from Ground to the –Rx input and 4700 ohms from +5V to the +Rx input.

### 9.6.3 RS-485 Termination Resistors

Termination resistors are required in long networks operating at the highest baud rates. Shorter networks in high noise environments may also benefit from terminations. Networks as long 1000 ft. operating at 9600 baud will function without termination resistors. Terminations should be considered if the baud rate is higher and the network is longer.

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

RS-485 networks are generally terminated with 120-ohm resistors on each end. The required 120-ohm resistor is built into the SCADAPack 32 controller. When these termination resistors are used, the biasing generally has to be increased in order to generate at least 0.2V across the +/–Rx input.

To connect the termination resistors:

- Install a jumper across J8 to terminate the Rx pair.

- Install a jumper across J7 to terminate the Tx pair.

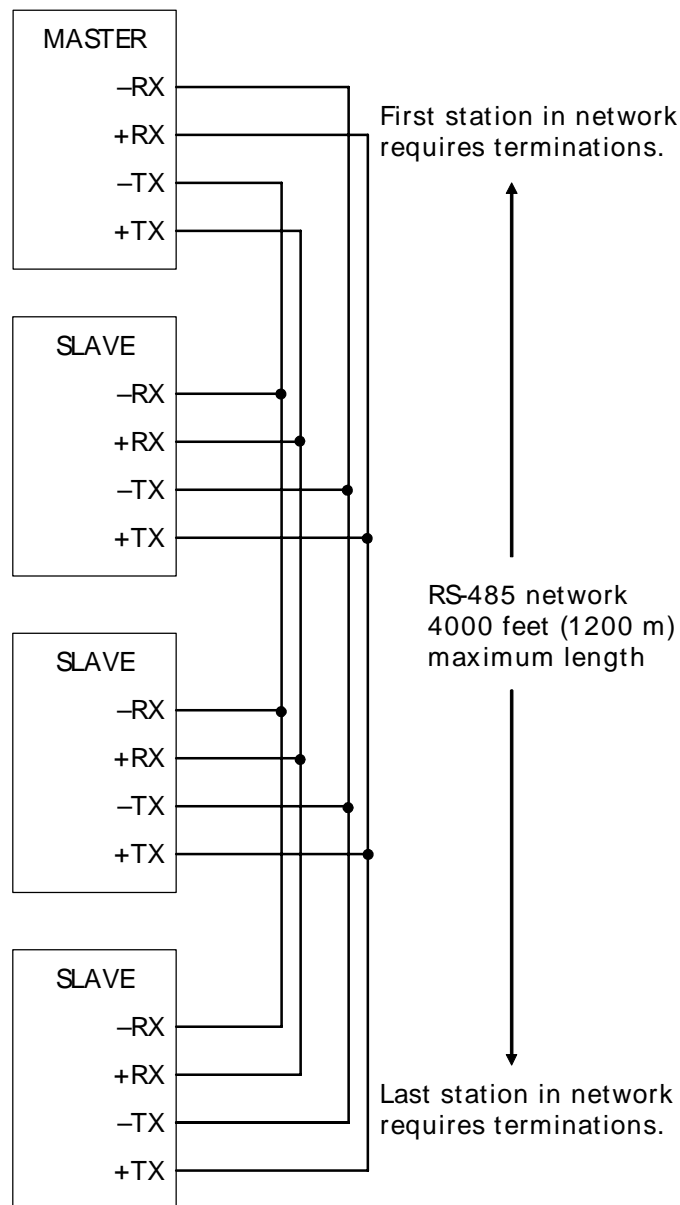
To disconnect the termination resistors:

- Remove the jumper across J8 to terminate the Rx pair.
- Remove the jumper across J7 to terminate the Tx pair.

## 9.6.4 RS-485 Wiring Examples

### 9.6.4.1 Four wire mode

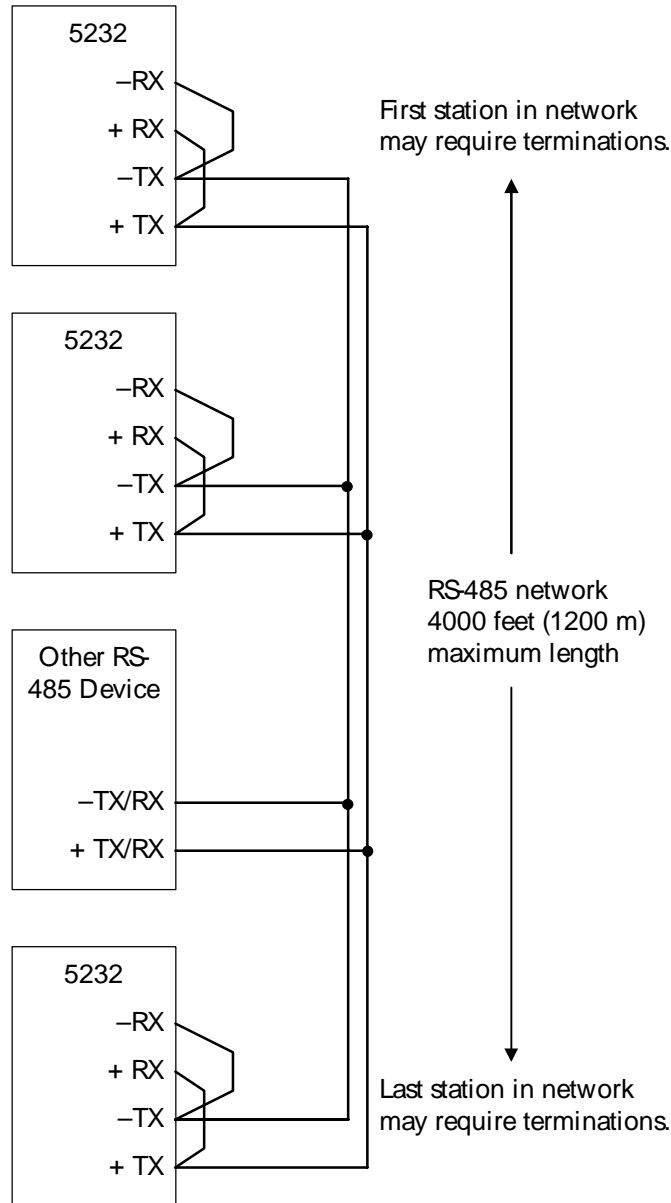
Four-wire operation uses one pair of wires for transmitting data and a second pair for receiving data. The transmitting pair is connected to the terminals marked +TX and –TX on the termination block. The receiving pair is connected to the terminals marked +RX and –RX. See the figure below for an illustrative example.



**Figure 16: RS 485 Field Wiring – Four Wire Mode**

#### **9.6.4.2 Two wire mode**

Two-wire operation uses one pair of wires for transmitting and receiving data. The +TX terminal must be connected to the +RX terminal. The –TX terminal must be connected to the –RX terminal. This pair of wires becomes the transmitting and receiving pair. See the figure below for an illustrative example.



**Figure 17: RS 485 Field Wiring – Two Wire Mode**

## 9.7 RS-485 Cable

This cable is used to connect from an RJ-45 based RS-485 port on the SCADAPack 32 controller to other RS-485 devices. The cable has a RJ-45 connector on one end and stripped wires at the other end. A 10-foot long cable is available from Control Microsystems as part number 297234.

RJ45	Function	Wire Color
	Connect to Chassis	Shield
3	-Tx	Orange
6	+Tx	Blue
5	+Rx	Grey
2	-Rx	Brown
4	GND	Black
7	Do not connect.	Yellow
8	Do not connect.	Green
1	+5V	Red

## 10 Ethernet Communication

The SCADAPack 32 controller has one 10BaseT Ethernet port on connector P5 of the controller board. This port is labeled LAN. Refer to **Figure 1: 5232 Controller Board Layout** for the location of the LAN port. 10BaseT is a single communications channel running at 10MHz over unshielded, twisted - pair cabling. 10BaseT uses differential signaling.

### 10.1 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 **10.1.3-RJ-45 Modular Connector for Ethernet**.

#### 10.1.1 TCP/IP Settings

The following table shows the TCP/IP parameters supported by the LAN port. These parameters are set from the ISaGRAF Workbench or from an application program running in the SCADAPack 32 controller. Default values are set when a Cold Boot is performed on the SCADAPack 32 controller.

Parameter	Supported Values
<b>IP Address</b>	In the format 255.255.255.255 Default: 0.0.0.0
<b>Subnet Mask</b>	In the format 255.255.255.255 Default: 0.0.0.0
<b>Gateway</b>	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.

#### 10.1.2 Modbus/TCP Settings

The following table shows the Modbus/TCP parameters supported by the LAN port. These parameters are set from the ISaGRAF Workbench or from an application program running in the SCADAPack 32 controller. Default values are set when a Cold Boot or Service Boot is performed on the SCADAPack 32 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

Parameter	Supported Values
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). 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.

The **TCP Port** parameter sets the port used by the Modbus/TCP protocol. In almost all cases 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.

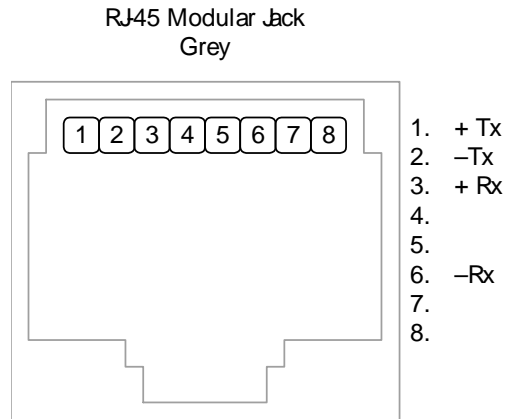
The **Addressing** parameter selects standard or extended Modbus addressing. Standard addressing allows 255 stations and is compatible with standard Modbus devices. Extended addressing allows 65534 stations, with stations 1 to 254 compatible with standard Modbus devices.

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.

### 10.1.3 *RJ-45 Modular Connector for Ethernet*

The SCADAPack 32 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: Pin Descriptions of Ethernet RJ-45 Modular Connector**

10BaseT 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.

## 11 Operation

### 11.1 Operating Modes

SCADAPack 32 Controllers may start up in RUN, SERVICE or COLD BOOT mode. Start up in the RUN mode automatically executes the application 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 all programs.

#### 11.1.1 Run

The RUN mode is the normal operating mode of the SCADAPack 32 Controller. No action is required to select RUN mode. When power is applied to the controller board:

- The user defined serial communication parameters, for all COM ports are used.
- The user defined TCP/IP and Modbus/TCP parameters are used for the Ethernet port.
- If a TelePACE or ISaGRAF application program is loaded it is executed.
- If a TelePACE or ISaGRAF C/C++ application program is loaded and the program checksum is correct, it is executed.
- The controller lock settings and password are used.

#### 11.1.2 Service

SERVICE mode is used during application programming and maintenance work. When the SCADAPack 32 controller starts in SERVICE mode:

- The default serial communication parameters are used. See section **9.1-RS-232 Serial Communication Ports** above subsection for default parameters.
- The user defined TCP/IP parameters are used for the Ethernet port.
- The default Modbus/TCP parameters are used for the Ethernet port. See section **10.1.2-Modbus/TCP Settings** for default parameters.
- If a TelePACE or ISaGRAF application program is loaded it is stopped.
- If a TelePACE or ISaGRAF C/C++ application program is loaded it is stopped.
- All 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:

1. Remove power from the controller.
2. Hold down the LED POWER button while applying power to the controller.
3. Continue holding the LED POWER button until the STAT LED turns on.
4. Release the LED POWER button.

**Note:** If the LED POWER button is released before the STAT LED turns on, the SCADAPack 32 controller will start in RUN mode.

#### 11.1.3 Cold Boot

COLD BOOT mode is used after installing new controller firmware. When the SCADAPack 32 controller starts in COLD BOOT mode:



- The default serial communication parameters are used. See section **9.1-RS-232 Serial Communication Ports** for default parameters.
- The default TCP/IP parameters are used for the Ethernet port. See the **10.1.1-TCP/IP Settings** subsection above for default parameters.
- The default Modbus/TCP parameters are used for the Ethernet port. See section **10.1.2-Modbus/TCP Settings** for default parameters.
- The TelePACE or ISaGRAF application program is erased.
- The TelePACE or ISaGRAF C/C++ application program is erased.
- The controller is unlocked.

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

1. Remove power from the controller.
2. Hold down the LED POWER button.
3. Apply power to the controller.
4. Continue holding the LED POWER button for 25 seconds until the STAT LED begins to flash on and off continuously.
5. Release the LED POWER button.

**Note:** If the LED POWER button is released before the STAT LED begins to flash, the SCADAPack 32 controller will start in SERVICE mode.

## 11.2 LED Indicators

There are 23 LEDs on the SCADAPack 32 controller board. These LEDs are used to indicate the operational status of the controller. All LEDs except the 5V LED can be disabled to conserve power. Refer to section **11.3-Led Power Control** subsection below for details.

The following table describes functions of the LEDs on the SCADAPack 32 controller board.

LED	Function
5V	On when 5V power is present in the SCADAPack 32 controller. The controller must have 5V power to operate. 5V power is supplied by the SCADAPack 32 internal power supply or from an external model 5103 power supply.
RUN	On when a TelePACE or ISaGRAF application program is running in the SCADAPack 32 controller. This LED may be controlled by a C++ Tools application, in which case the application will control the LED status.
LEDS	On when LED power is enabled.
STAT	This LED is normally off. The LED will blink when an error exists. Refer to section <b>11.4-Status LED and Output</b> for more information on this LED and the STATUS output.
FORCE	On when and SCADAPack 32 I/O points are forced in a TelePACE application, or locked in an ISaGRAF application.
INT/Counters 0 INT/Counters 1 INT/Counters 2	On when a signal is applied to the corresponding input.
INT	On when a signal is applied to the INT input

LED	Function
LAN	On when receive or transmit data on the Ethernet port.
LINK	On when Ethernet port is connected to a network.
COM1 RX COM2 RX COM4 RX.	On when receiving data on the corresponding serial port.
COM1 TX COM2 TX COM4 TX.	On when transmitting data on the corresponding serial port.
COM1 CTS COM2 CTS COM4 CTS.	On when the CTS input is asserted on the corresponding serial port.
COM1 DCD COM2 DCD COM4 DCD.	On when the DCD input is asserted on the corresponding serial port.

### 11.3 Led Power Control

Power to the LEDs on the SCADAPack 32 controller board, integrated or external I/O modules connected to the controller can be disabled to conserve power. This feature is particularly useful when the SCADAPack 32 is used in solar powered or unattended installations.

The LEDS LED on the controller board indicates the LED power state. This LED is on when power to the LEDs is enabled and off when power to the LEDs is disabled. See the *Figure 1* for the location of the LEDS LED.

The LED POWER push-button toggles the LED power state. Press the LED POWER push-button to toggle LED power state from on to off.

The default setting of the LED power state is LED power enabled. 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 state and time to return to the default state.

The LED POWER push-button does not affect some LEDs, such as digital inputs and counter inputs. These LEDs are on when a signal is applied to the corresponding input. these LEDs cannot be disabled to conserve power.

### 11.4 Status LED and Output

The status LED and output indicate alarm conditions. The STAT LED blinks and the STATUS output opens when an alarm occurs. The STAT LED turns off and the STATUS output closes when all alarms clear.

**Note:** The STATUS output remains open continuously when an alarm condition is present. The STAT LED is on continuously during reset.

The STAT LED blinks a binary sequence indicating alarm codes. The sequences consist of long and short flashes, followed by an off delay of 1 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, all leading zeros are ignored. The application program defines the values of the alarm 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
2 Long	I/O Module Error and Register Assignment Checksum Error
2 Short, 1 Long	Too many I/O operations requested
3 Long	5 = I/O Module Error Indication and Too many I/O operations requested
3 Short, 1 Long	6 = Register Assignment Checksum Error and Too many I/O operations requested
4 Long	7 = I/O Module Error and Register Assignment Checksum Error and Too many I/O operations requested

#### **11.4.1 I/O Module Error Indication**

When the Status LED flashes the controller status code 1 (i.e. a long flash, once every second), there is a communication failure with one or more I/O module. To correct the problem, do one of the following:

Ensure 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 of having failed, confirm the failure by removing the module from the Register Assignment Table. Download 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. Download the changes to the controller. The Status LED should stop flashing.

If unused modules must be intentionally left in the Register Assignment Table, the I/O error indication may be disabled from a selection box on the Register Assignment dialog.

#### **11.4.2 Register Assignment Checksum Error**

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 problem, initialize the register assignment using the TelePACE or ISaGRAF software, or alternatively, perform a COLD BOOT as described in section *11.1.3- Cold Boot* of this manual. The status LED should stop flashing.

#### **11.4.3 Too Many I/O Operations Requested Error**

When the status LED flashes the controller status code 4, this indicates that more I/O operations were requested than the I/O system could handle. This error should only occur with custom C++ applications. It indicates the custom application is requesting I/O operations faster than the system can process them and that the queue of pending operations is full. The custom application should reduce the rate at which it makes requests.

#### 11.4.4 I/O Module Error Indication

When the Status LED flashes the controller status code 1 (i.e. a long flash, once every second), there is a communication failure with one or more I/O module. To correct the problem, do one of the following:

Ensure 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 of having failed, confirm the failure by removing the module from the Register Assignment Table. Download 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. Download the changes to the controller. The Status LED should stop flashing.

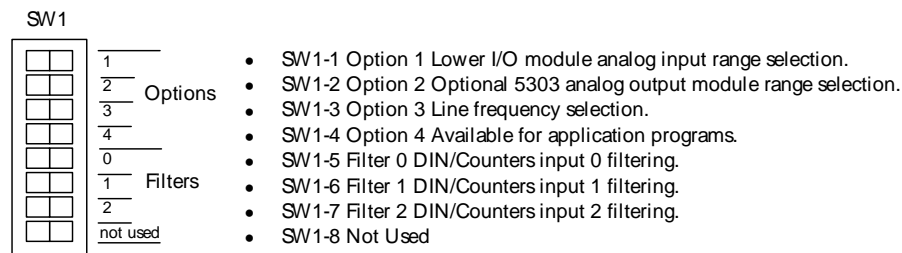
If unused modules must be intentionally left in the Register Assignment Table, the I/O error indication may be disabled from a selection box on the Register Assignment dialog.

#### 11.4.5 Register Assignment Checksum Error

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 problem, initialize the register assignment from the TelePACE software, or alternatively, perform a COLD BOOT as described in the section **11-Operation** of this manual. The status LED should stop flashing.

### 11.5 Configuration Switches

The SCADAPack32 controller board SW1 is an eight position DIP switch. The first seven switches on SW1 are used to configure digital / counter input filtering and analog input and output ranges. SW1 is shown in the following diagram. Refer to **Figure 1** for the location of SW1 on the SCADAPack 32 controller board.



**Figure 19: Description of SW1 DIP Switches.**

Configuration switches can be changed with the power applied. Configuration changes take effect immediately.

To select configuration switch functions:

Remove the module cover and locate the configuration switches. See **Figure 1** for SW1 location.

Slide the switch actuator to the right side of the switch to enable the switch function.

Slide the switch actuator to the left side of the switch to disable the switch function.

### 11.5.1 Analog Input Range Selection

The analog input channels on the integrated I/O modules on some versions of the SCADAPack 32 controller can be configured for a 0% or 20% offset using switch 'Options 1' on SW1. With the 0% offset, the input signal measurement range is 0-20mA in current mode or 0-5V in voltage mode. With the 20% offset, the input signal measurement range is 4-20mA in current mode or 1-5V in voltage mode.

On the SCADAPack P4 equipped with the 5601 I/O board, select the 0% offset by sliding switch 'Options 1' on SW1 to the left as shown in the figure below. Select the 20% offset by sliding the switch to the right.

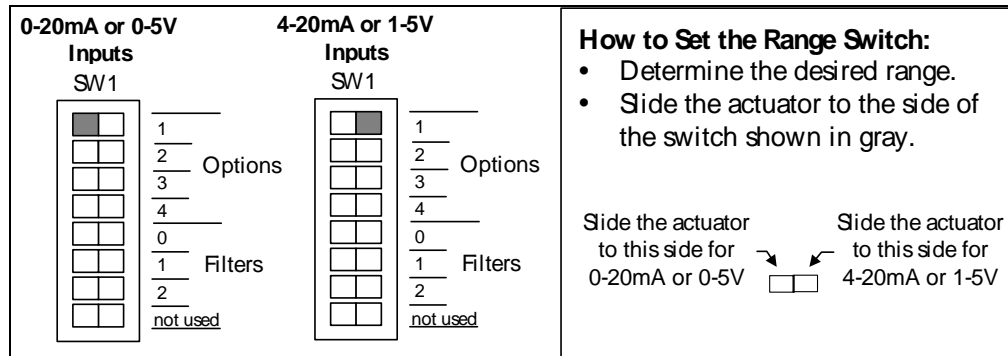


Figure 20: Analog Input Offset DIP Switches.

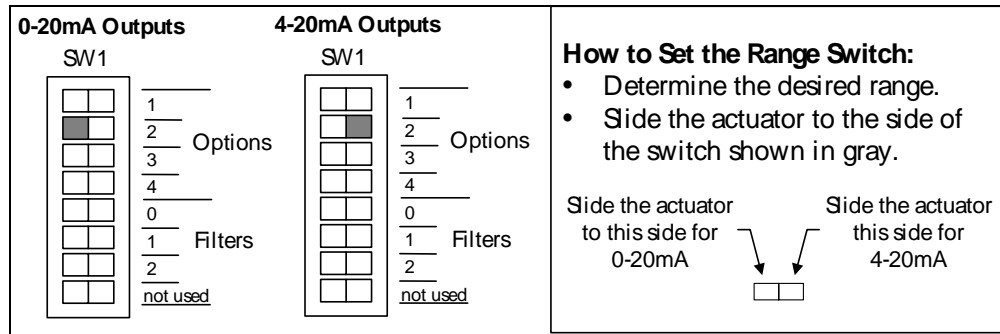
This option is not available on the SCADAPack P4A controller with the 5604 I/O module. On the SCADAPack P4B controller with the 5606 I/O module, the settings are selected in software. See the **5606 Input-Output Module** hardware manuals for details.

**Note:** The default setting for the analog inputs on the SCADAPack P4 and P4B is 0% offset or a measurement ranges of 0-20mA in current mode or 0-5V in voltage mode.

### 11.5.2 Analog Output Range Selection

The optional analog output channels of the integrated I/O modules on the SCADAPack 32 controller can be configured for a 0% or 20% offset using switch 'Options 2' on SW1. With the 0% offset, the output signal ranges from 0-20mA in current mode or 0-5V in voltage mode. With the 20% offset, the output signal ranges from 4-20mA in current mode or 1-5V in voltage mode.

On the SCADAPack P4 and P4A controllers respectively equipped with the 5601 and 5604 I/O modules, select the 0% offset by sliding switch 'Options 2' on SW1 to the left as shown in the figure below. Select the 20% offset by sliding the switch to the right. On the SCADAPack P4B the settings are selected in software. See the **5606 Input-Output Module** hardware manual for details.

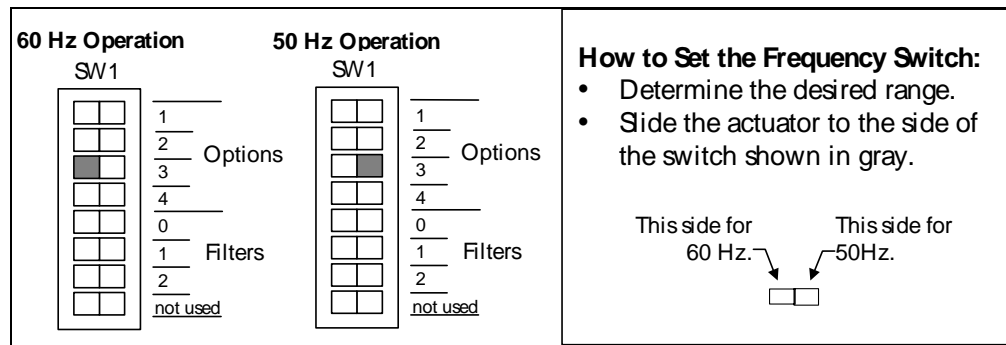


**Figure 21: Analog Output Offset DIP Switches.**

**Note:** The default setting for the optional analog outputs is the 0% offset with output signals ranging from 0-20mA in current mode or 0-5V in voltage mode.

## 11.6 Line Frequency Selection

The SCADAPack controller may select a 50 or 60 Hz line frequency for digital and analog input processing. Switch 'Options 3' on SW1 selects this option. On the SCADAPack P4 or P4A, press the left side of dip switch as shown in the figure below to select the 60Hz line frequency and the other side of the switch to select the 50Hz line frequency. On the SCADAPack P4B, select these settings when via software as the **5606 I/O** section of the manual.



**Figure 22: Line Frequency DIP Switches.**

**Note:** The 60Hz line frequency is enabled by default.

### 11.6.1 Digital Input Filters

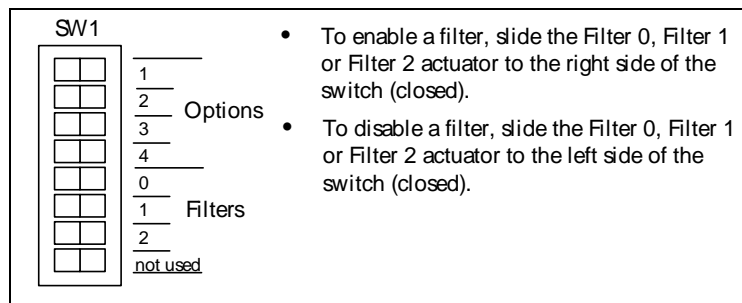
Each of the three digital / counter (DIN/Counters) inputs on the SCADAPack 32 controller board can be filtered. Filtering limits the maximum digital input or counter frequency to approximately 30Hz.

- Use a filter for 50 or 60Hz digital inputs and for low speed counting applications that experience problems due to contact bounce.
- Do not use filtering for high speed counting applications.

SCADAPack 32 controller board SW1, switches Filter 0, Filter 1 and Filter 2 switches control the input filter functions.

- Filter 0 for DIN/Counters input 0.

- Filter 1 for DIN/Counters input 1.
- Filter 2 for DIN/Counters input 2.



**Figure 23: Low Pass Filter DIP Switches.**

**Note:** Filters are disabled by default.

## 11.7 5000 Series Analog Input Module Compatibility

5000 Series analog input modules 5501 and 5521 require firmware release D (or more recent), if they are used with a controller board with a firmware release 1.23 (or more recent). The older 5501 or 5521 Series I/O module firmware must be upgraded otherwise incorrect data may be returned from the module. Check the version of the firmware in your 5501 or 5521 analog input module against the table below.

Check These Parts	Part Number	Chip Location	Revision Required
5501 firmware <u>or</u>	160246 160303	U12 U12	Must be suffix D or later Must be suffix A or later
5521 firmware <u>or</u>	160246 160303	U12 U12	Must be suffix D or later Must be suffix A or later

## 12 Maintenance

The SCADAPack32 controllers require little maintenance. The 5V power LED indicates the status of the 5V supply. If the LED is off, and the 5232 Controller is powered using the integrated power supply, on board fuse F1 or F2 may require replacing. If the LED is off, and the 5232 Controller is powered using a 5103 power supply fuse F1 (5V) or F2 (24V) on the 5103 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 SCADAPack32 controller is not functioning correctly, contact Control Microsystems Technical Support for information on returning the SCADAPack for repair.

**WARNING:** Do not connect or disconnect any field wiring, including the wiring to the RS-232 ports, unless the power is off or the area is known to be non-hazardous.

### 12.1 Fuse

Two 1.0 Amp slow-blow fuses protect the power supply. The fuse is mounted under the cover. Fuse F1 protects the 5232 Controller when powered from the AC/DC Power Input. Fuse F2 protects the controller when powered from the DC Power Input. Refer to *Figure 1* for their location.

<b>CAUTION:</b> Remove power before servicing unit.
---

Always replace a defective 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. Littelfuse part number LF R452 001. This fuse is available from Control Microsystems.

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

Refer to the DC power supply configuration subsection on each I/O module for recommendations on reducing the DC inrush current if fuse blowing is being experienced in DC power supply applications.

### 12.2 Lithium Battery

A small lithium battery powers the CMOS memory and real-time clock when input power is removed. The voltage of a functioning battery should be greater than 3.0V. An application program can monitor this voltage. Refer to the programming manual for details.

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.

### 12.3 Battery Replacement Procedure

The battery is plugged into the circuit board and secured 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 ensure the battery does not become disconnected during shipment. Cut 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 *11.1.3-Cold Boot* in of this manual for the Cold Boot procedure.)

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

The controller may now be programmed.

## 13 Troubleshooting

### 13.1 Analog Inputs

Problem	Action
20mA inputs always read 0.	Check transmitter power.
Reading is at or near 0 for all input signals.	Check if the input transient suppressers are damaged.
20mA readings are not accurate.	Check for a damaged 250Ω current sense resistor.
Reading is constant.	Check that the analog input is not forced.
Reading seems out of calibration for small inputs but improves as input increases.	Check the input range switch setting.

### 13.2 Analog Outputs

Problem	Action
Outputs are always 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.
The output is 4mA when a value of 0 is output. 0mA was expected.	The 4-20mA output range is selected. Select the 0-20mA range.
The output is 0mA when a value of 0 is output. 4mA was expected.	The 0-20mA output range is selected. Select the 4-20mA range.
The output seems to be uncalibrated at small output values. The error improves as larger values are output.	Check the setting of the output range switch. The wrong output range is probably selected.

### 13.3 Digital Inputs

Problem	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.

## 13.4 Digital Outputs

Problem	Action
Output LED does not come on when output is turned on.	Check the LED POWER from the SCADAPack controller.
Output LED is off, but the output is closed. Output LED is on, but the output is open.	Relay contacts can be normally closed and/or normally open.
Output LED comes on but the output does not close.	Check if the relay is stuck. If so, return the board for repair.
Output LED comes on and output is closed, but the field device is not activated.	Check the field wiring. Check the external device.
Output LED and relay are on when they should be off.	Check that the output is not forced on.
Output LED and relay are off when they should be on.	Check that the output is not forced off.

## 14 Specifications

*Disclaimer: Control Microsystems reserves the right to change product specifications without notice. For more information visit [www.controlmicrosystems.com](http://www.controlmicrosystems.com).*

### 14.1 General

<b>I/O Terminations</b>	6,8,9 and 10 pole, removable terminal blocks. 12 to 22 AWG 15A contacts
<b>Dimensions SCADAPack</b>	8.40 inch (213mm) wide 6.13 inch (155mm) high 2.80 inch (72mm) deep
<b>Packaging</b>	corrosion resistant zinc plated steel with black enamel paint
<b>Environment</b>	5% RH to 95% RH, non-condensing -40°C to 70°C -40°F to 158°F
<b>Processor</b>	Hitachi SH-3 32-bit CMOS microcontroller 120 MHz. clock
<b>Memory</b>	4Mbytes Flash 8Mbytes SDRAM 1024kBytes CMOS RAM
<b>Non-volatile RAM</b>	CMOS RAM with lithium battery retains contents for 2 years with no power
<b>Clock calendar</b>	±1 minute/month at 25°C +1/-3 minutes/month 0 to 50°C
<b>Internal temperature</b>	Measurement range -40°C to 75°C. Accuracy ±5°C. Measurement range -40°F to 167°F. Accuracy ±9°F.
<b>Lithium battery monitor</b>	Accuracy ±0.2V.

### 14.2 Communications

<b>Communication Ports, 5232 controller board</b>	2 RS-232 serial ports (COM2, COM4) Data Terminal Equipment (DTE) 8 pin modular jack	1 RS-485 serial port (COM1) 2 wire half duplex 4 wire full or half duplex optional termination resistors RS-232: Data Terminal Equipment (DTE) 8 pin modular jack  RS-485: 2 wire half duplex 4 wire full or half duplex optional termination resistors
<b>Baud Rates (COM1, COM2, COM 4)</b>	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. Default: 9600	

<b>Baud Rate (COM3)</b>	1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200. Default: 9600
<b>Parity</b>	none, even, or odd Default: none
<b>Word Length</b>	7 or 8 bits Default: 8 bits
<b>Stop Bits</b>	1 or 2 bits Default: 1 bit
<b>Duplex (COM1, COM2, COM4)</b>	full or half with RTS/CTS control Default: full
<b>Duplex (COM3)</b>	half with RTS/CTS control
<b>Cable Length</b>	RS-232 –maximum 50 ft (15.2 m) RS-485 –maximum 4000 ft (1200 m)
<b>Protocol</b>	TeleBUS (compatible with Modbus RTU and Modbus ASCII) DF1 and DNP Protocols optional default: Modbus RTU
<b>Ethernet</b>	RJ-45 modular connector 10BaseT (twisted pair) 10M bits per second.
<b>Protocol Modes</b>	slave, master, master/slave, store and forward

### 14.3 Visual Indicators

<b>COM1,COM2, COM4</b>	received data (RxD) LED transmitted data (TxD) LED clear to send (CTS) LED data carrier detect (DCD) LED
<b>Ethernet LAN</b>	Ethernet network receive or transmit data LAN LED Ethernet port connected to a network LINK LED
	I/O module LED power status LED Status LED (shows functional status) 5V power LED (LED power not applicable) Run LED Forced I/O LED Counter Inputs 0, 1, 2 and 3 LEDs
<b>Digital Inputs</b>	INT/CTR, CTR0, CTR1, CTR1
<b>Push-button</b>	LED power toggle

### 14.4 Power Supply

<b>Power Input</b>	16Vrms $\pm$ 20%
<b>AC/DC PWR IN</b>	14 to 30Vdc
<b>DC power Input</b>	30V maximum
<b>DC PWR</b>	10.7V typical turn on 9V typical turn off
<b>5 Volt Power Output</b>	5V at 1.3A capacity 5V at 500 mA required by SCADAPack 32 controller

<b>DC power</b>	20-24V with 1.0Vp-p maximum ripple.
<b>Output</b>	300mA available at 5V/0.5A, de-rate linearly to 100mA
<b>16Vrms applied</b>	available at 5V/1.3A
<b>Efficiency</b>	80%, 12V on DC PWR input

## 14.5 I/O Capacity

<b>5000 Series I/O Expansion Capacity</b>	<p>Maximum 40 I/O modules with a further limitation of 16 modules of any one type.</p> <p>512 digital outputs using 32 point digital output modules</p> <p>512 digital inputs using 32 point digital input modules</p> <p>128 analog inputs using 8 point analog input modules</p> <p>64 analog outputs using 4 point analog output modules</p> <p>32 counter inputs using 4 point counter input modules</p> <p>Example: 16 of the 32 point digital output modules + 16 of the 32 point digital input modules + 8 of the 8 point analog input modules would yield an expansion of 1088 I/O points.</p>
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## 14.6 Digital Inputs

<b>Input Points</b>	3 Digital Input/Counter, 1 Interrupt opto coupler isolation
<b>Digital Input, Counter</b>	<p>24Vrms/30V maximum input</p> <p>10Vrms/10V minimum ON input</p> <p>2V maximum OFF input</p> <p>Typical threshold voltage is 4 to 6V</p> <p>Typical input hysteresis 1.0V</p> <p>Typical input current     2.5mA at 10V                                       7mA at 24V</p>
<b>Counter Input Frequency (Counter 0, 1, 2)</b>	<p>5kHz maximum with filter OFF</p> <p>30Hz maximum with filter ON</p>
<b>Counter Input Frequency (Counter 3)</b>	500Hz maximum

## 14.7 Digital Outputs

<b>Status Output (STATUS)</b>	<p>Opto coupler open collector transistor</p> <p>30V, 60mA</p> <p>opens on fault</p>
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## 15 Approvals and Certifications

<b>Safety</b>	Non-Incendive Electrical Equipment for Use in Class I, Division 2 Groups A, B, C and D Hazardous Locations.
<b>Digital Emissions</b>	FCC Part 15, Subpart B, Class A Verification EN61000-6-4: 2001 Electromagnetic Compatibility Generic Emission Standard Part2: Industrial Environment
<b>Immunity</b>	EN61000-6-2: 2001 Electromagnetic Compatibility Generic Standards Immunity for Industrial Environments
<b>Declaration</b>	<p>This product conforms to the above Emissions and Immunity Standards and therefore conforms with the requirements of Council Directive 89/336/EEC (as amended) relating to electromagnetic compatibility.</p> <p>P4 (5601/A) and P4B (5606) Models with digital inputs configured below 30Vdc/60Vac are eligible to bear the CE mark. The Low Voltage Directive is not applicable to these products in applications below 30Vdc/60Vac.</p> <p>The Low Voltage Directive is not applicable to the P4A (5604) Model and is eligible to bear the CE mark.</p>