Tealware I/O
User's Guide

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CHAPTER 1 - PRODUCT LINE OVERVIEW

SoftPLC Corporation's Tealware is an "open architecture" I/O system. The term "open architecture" means that not only can you use Tealware with SoftPLC Corporation provided products, but also with equipment from other vendors. For purposes of this Manual, “Tealware” refers to the hardware components of the system, such as the I/O modules, power supplies, backplanes, I/O adapters and cables.

With any SoftPLC controller, you can use Tealware I/O in remote configurations via Ethernet (using Modbus TCP/UDP communication.) With a Smart SoftPLC (Cat Nos SMx), you can also use Tealware I/O on a high-speed local bus.

This manual describes the Tealware I/O components and system configurations. Use of Tealware with other vendor’s equipment or SoftPLC functions not specific to Tealware are described in other documents.

TOPDOC NexGen (Cat No TDNG-FN) is the ladder logic development, documentation, and maintenance software for SoftPLC controllers. TOPDOC NexGen is used to configure Tealware when used with a SoftPLC controller. TOPDOC NexGen must be installed on a Windows or Linux computer, and it connects to the SoftPLC via Ethernet.

1.1 ELECTRICAL/ENVIRONMENTAL SPECIFICATIONS

The table below provides specifications for all Tealware I/O modules, power supplies and backplanes.

Table 1.1 - General Electrical & Environmental Specifications

ELECTRICAL AND ENVIRONMENTAL SPECIFICATIONS	
Ambient Operating Temperature	0 to 65 °C (32 to 149 °F)
Ambient Storage Temperature	-20 to 70 °C (-4 to 158 °F)
Airflow Clearance	50.8 mm (2 in.) above and below unit for ambient airflow
Humidity	15 to 90% non-condensing
Electrical Noise Immunity	1000 V peak to peak, 1 µs noise width at 30 to 100 Hz
Vibration Resistance	10 to 55 Hz, amplitude 0.075 mm for 60 min.
Shock Resistance	10 g 3 times in 3D directions
Dielectric Withstand Voltage	1500 VAC for 1 min. across AC ext. terminal and ground
Impedance	75 MΩ at 500 VDC
Electrical Safety	Class 2 grounding
Operating Atmosphere	Non-corrosive atmosphere with minimum dust
Certifications & Compliance	CE rated; UL, UL(C) most components

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CHAPTER 2 - SYSTEM COMPONENTS

Tealware I/O can be used in both local and remote configurations. Local I/O requires use of a Smart SoftPLC equipped with a Tealware interface daughter board (either a Backplane3 or a LocalPorts interface). If I/O above the local configuration limits of I/O count or physical distance is required, local and remote I/O can be mixed in a Smart SoftPLC System.

Tealware remote I/O uses Modbus TCP/UDP Ethernet for communications. Any model SoftPLC controller (or third party controller capable of acting as a ModbusTCP master), can use Tealware as remote I/O, when combined with a Smart Adapter interface.

Tealware is a modular I/O system. I/O Modules are available for a wide range of signal types to meet most application requirements. The following sections describe the components and the physical hardware configurations possible.

2.1 TEALWARE I/O MODULES

A variety of Tealware modules provide interface to different input and output signal types and voltages. All modules fit either into a Tealware Base module slot or onto a Smart SoftPLC or Adapter with a Backplane3 interface. Any mix of modules can be used, with no backplane power calculation required.

Most Tealware modules include a detachable wiring terminal block, with a swinging cover. Some modules have one or two higher density terminal block connectors. These are removable without disturbing the field wiring, by gently prying them off with a small flat-blade screwdriver. High-density modules have a D-shell connector, and require a cable (Cat No HDIO-CBL) which connects to a terminal block used for landing the field wiring.

Figure 2.1: 3 Types of Field Wiring Connections

All Tealware modules are fully enclosed in a plastic case, and are the same size. Modules also have LED's on the front to display module and channel status.

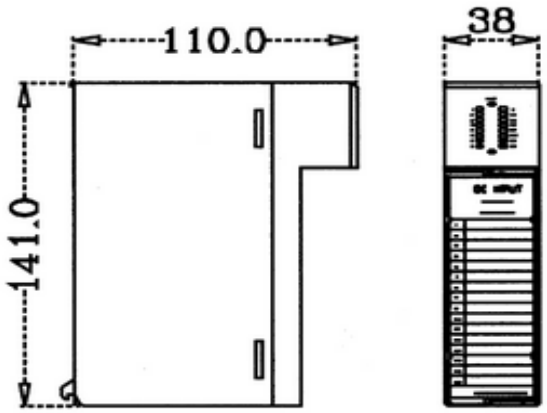


Figure 2.2: I/O Module Dimensions (in mm)

Table 2.1 - Available Tealware I/O Modules

AVAILABLE TEALWARE I/O MODULES							
INPUTS				OUTPUTS			
Type	**Pts**	**Signal Type**	**Cat #**	**Type**	**Pts**	**Signal Type**	**Cat #**
Discrete	16	85-132 VAC	SXAC10	Discrete	16	85-264 VAC	SYAC10
	16	9-28 VDC Sink/Source	SXDC10		16	10-35 VDC NPN/Sink	SYDC10
	32	9-28 VDC Sink/Source	SXDC32		16	10-35 VDC PNP/Source	SYDC20
Analog	4	Voltage/Current, 15 bit	AD020		32	10-35 VDC NPN/Sink	SYDC30
	8	Voltage, 15 bit	AD030A		32	10-35 VDC PNP/Source	SYDC40
	8	Current, 15 bit	AD031A		16	Relay, 2A/pt	SYRY10
	16	Voltage, Isolated, 15 bit	AD046		16	Isolated Relay, 2A/pt	SYRY20
	16	Current, Isolated, 15 bit	AD047		8	Isolated Relay, 2A/pt	SYRY21
Temp	5	Thermocouple, 12 bit	THM10	Analog	4	Voltage/Current	DA020
	4	RTD, PT-100/Ni-200	RTD10		8	Voltage	DA030
	8	RTD, PT-100	RTD26		8	Current	DA031
Special	3	Counter/Frequency, 50KHz	HSC11				

2.1.1 MODULE INSTALLATION INTO BACKPLANE

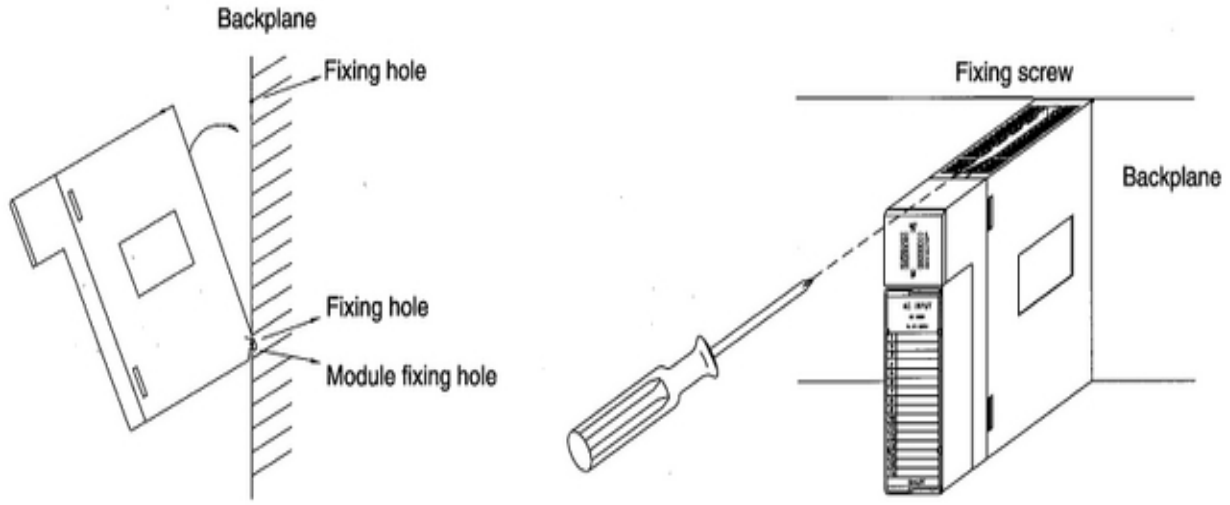


Figure 2.3: Module Installation into Backplane

2.2 POWER SUPPLY MODULES

For systems that use I/O bases (racks), each rack requires a Power Supply Module. There are two (2) available Power Supply modules, one for AC input power (Cat No PWS11) and the other for 24VDC input power (Cat No PWS20C).

Both fit into the first slot of the I/O base, and provide 5VDC backplane power for any mix of I/O modules.

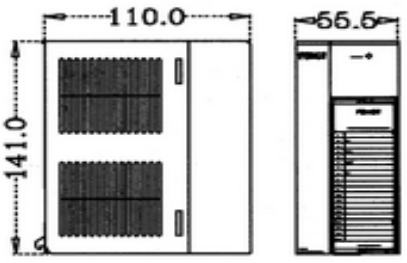


Figure 2.4: Power Supply Module Dimensions (in mm)

2.2.1 PWS11 – AC POWER SUPPLY MODULE

Table 2.2 - PWS11 Specifications

PWS11 SPECIFICATIONS	
Input Voltage	110 / 240 VAC, 50/60 Hz, Single Phase
Input Voltage Range	Autoranging 85-264 VAC
Maximum Operation Current	0.5 A at 110-240 VAC. Fuse rating 2A SloBlow
Input frequency	50 to 60 Hz
DC output voltage	5V
Output voltage tolerance	2%
Output rated current	9A
Output current range	0.1 to 9A
Ripple & Noise (p-p)	100mV
DC output power	45W
Efficiency	74%
Over voltage protection	5.75 to 6.2 V
Fuse rating	2A
Output protection	When shorted, shutdown
External connections	20pt terminal block, max wire size #14 AWG
Weight	440 g

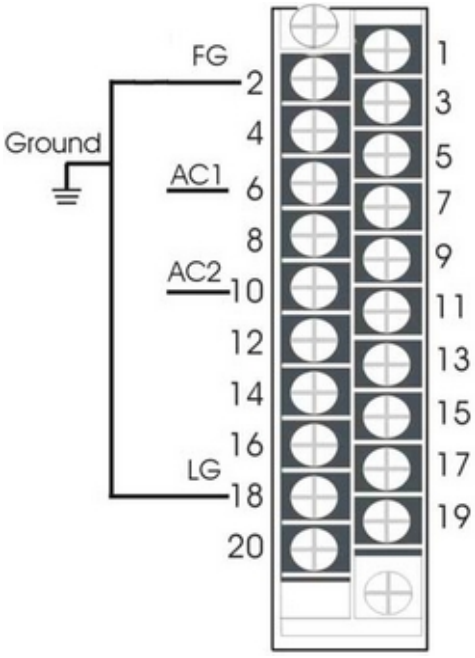


Figure 2.5 -PWS11 Wiring Diagram

NOTE

24 VDC output voltage is NOT available for powering I/O devices.

2.2.2 PWS20C – DC POWER SUPPLY MODULE

Table 2.3 - PWS20C Specifications

PWS20C SPECIFICATIONS	
Input Power	60 W
Input Voltage Range	18 ~ 36 VDC
Input frequency	50 ~ 60 Hz
DC output voltage	5 V
Output voltage tolerance	3%
Output rated current	7 A
Output current range	0.3 A ~ 8.0 A
Ripple & Noise (p-p)	< 50 mV
DC output power	40 W max
Efficiency	> 65% at full load of 24 VDC
Fuse rating	10 A
External connections	20pt terminal block, max. wire size #14 AWG
Weight	420 g

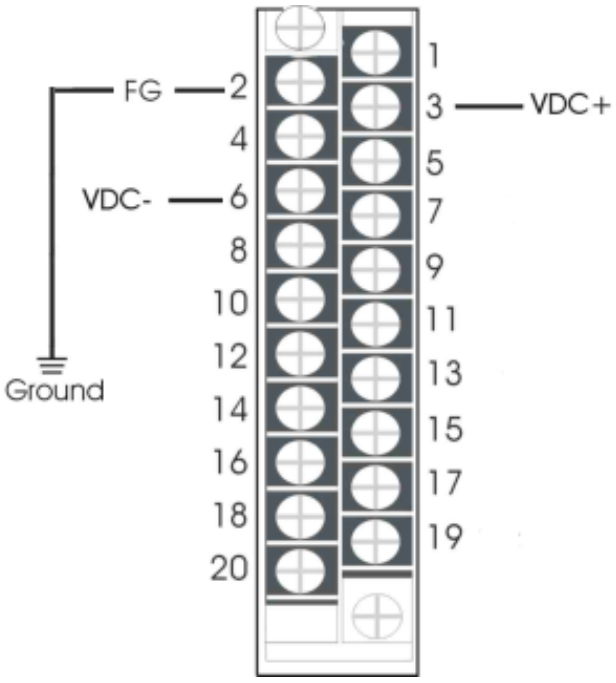


Figure 2.6: PWS20C Wiring Diagram

NOTE

24 VDC output voltage is NOT available for powering I/O devices.

2.3 TEALWARE RACKS (BASES)

For locations with 3 or fewer modules, you can use a Smart SoftPLC or Smart Adapter equipped with a Backplane3 interface, and no rack or power supply module is needed.

Figure 2.7: Backplane3 System w/o Modules

Figure 2.8: Backplane3 System w/ Modules

When more than 3 modules are required at a location, the modules install into an I/O backplane, called an Expansion Base. A Tealware Rack consists of an I/O base (Cat Nos IOBASEx), a Power Supply Module (Cat Nos PWSx), and various I/O modules. Bases are connected to each other and to the Smart SoftPLC or Smart Adapter via I/O Expansion Cables (Part Nos EXCBLxx).

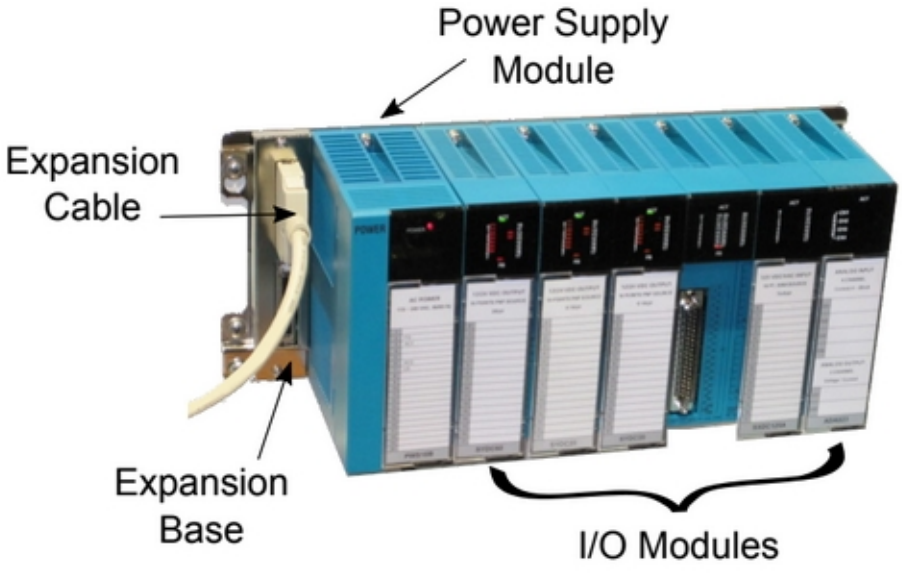


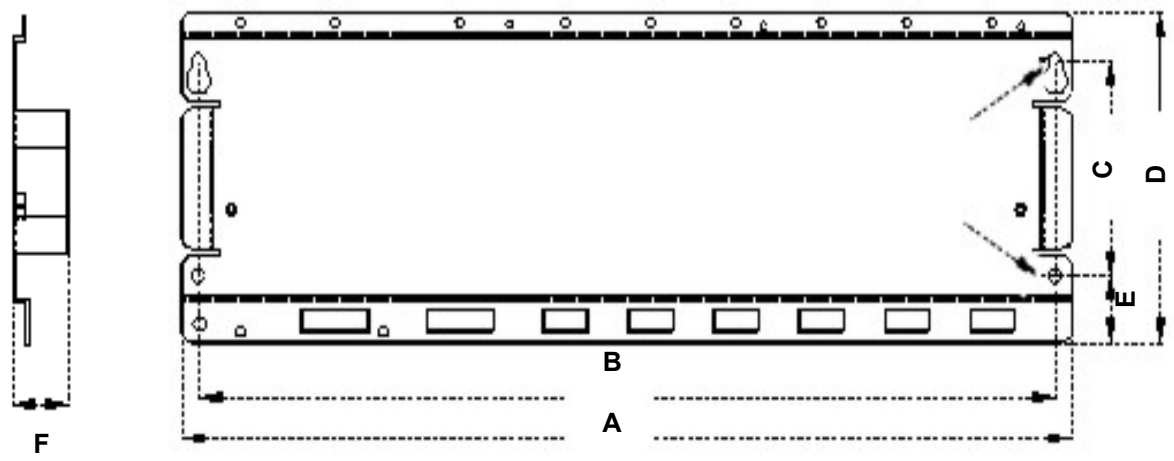
Figure 2.9: Tealware Rack Components

Two sizes of Expansion Bases are available, and can accommodate one power supply module and up to 6 modules (Cat Number IOBASE06) or up to 8 modules (Cat Number IOBASE08). Each Base can accommodate any mix of I/O modules, power calculation is not necessary. Expansion cables are available in 2, 4, 6 and 10-foot lengths.

Table 2.4: I/O Base Dimensions

I/O BASE DIMENSIONS (MM)		
REFERENCE	**IOBASE06**	**IOBASE08**
A	345	421
B	330	406
C	91.5	91.5
D	141	141
E	28.5	28.5
F	25	25

Guide
A - Exterior length
B - Distance from keyhole to keyhole
C - Distance from Keyhole to screw hole
D - Exterior height
E - Distance from screw hole to bottom edge
F - Exterior depth



2.4 LOCAL CONFIGURATIONS

Local I/O is supported via a Smart SoftPLC CPU equipped with either a Backplane3 or LocalPorts interface. Tealware local I/O is a high-speed bus, and the I/O scan is synchronous to the logic scan in the SoftPLC.

2.4.1 SMART SOFTPLC WITH BACKPLANE3 INTERFACE

In this configuration, any three Tealware I/O modules can be mounted onto a Smart SoftPLC CPU. The recommended Smart SoftPLC power supply (Cat No ICO-PSH1524) is sufficient to also power the modules.

If the selected modules also require an external 24VDC power supply for the outputs, it is recommended to use a separate power supply for the outputs for protection of the CPU. If you choose not to do this, be sure the system power supply has sufficient current for both the Smart SoftPLC and the module load(s).

Figure 2.10: Smart SoftPLC w/ Backplane3 Interface

2.4.2 SMART SOFTPLC WITH LOCALPORTS INTERFACE

The Smart LocalPorts interface has 4 connectors, each referred to as a "Bus," numbered 0 to 3. Each connector on the LocalPorts interface can be connected to up to three (3) Tealware Expansion Bases using I/O Expansion Cables. Bases (racks) are numbered 0 to 2 on each Bus. I/O slots are numbered from 1 to 8.

Figure 2.11: Smart SoftPLC with LocalPorts Interface

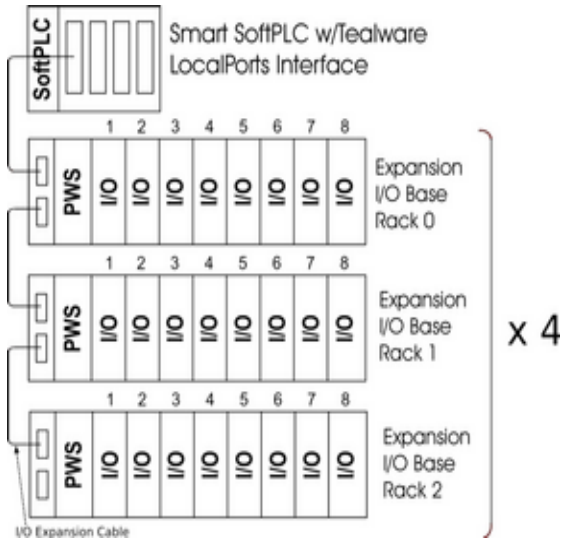


Figure 2.12: Local I/O Configuration using Smart SoftPLC with LocalPorts Interface

The maximum distance from each LocalPorts connector to its last Expansion Base is 30 feet. So, with four LocalPorts connectors with 3 bases each, a total of 12 bases are supported on a single Smart SoftPLC, with 30 foot of distance allowed from each port to its 3 bases.

2.5 REMOTE CONFIGURATIONS

Over Ethernet, Tealware I/O can be used in further distance and distributed configurations. A grouping of Tealware I/O connected this way is referred to as a "drop." Every drop requires a Smart Adapter. There are two types of Smart Adapters *(see next sections for more detail)*:

- Backplane3 Adapter, which supports up to 3 of any mix of Tealware modules.
- LocalPorts Adapter, which supports up to 3 expansion bases. This means a maximum of 24 I/O modules may be installed in a LocalPorts remote drop. The total number of I/O points allowed is a factor of the types of modules used.

In either case, the Adapter port is Bus 0. Bases are numbered from 0 to 2. I/O slots are numbered from 1 to 8. Up to 128 remote drops, numbered 0 to 127, can be configured for a single SoftPLC controller. The maximum distance between drops is determined by the type of Ethernet cabling, following the published guidelines.

The Smart Adapters connect to the SoftPLC via Ethernet, using ModbusTCP protocol. With its built-in Ethernet switch, multiple Tealware drops can be easily daisy-chained as shown in the following figure:

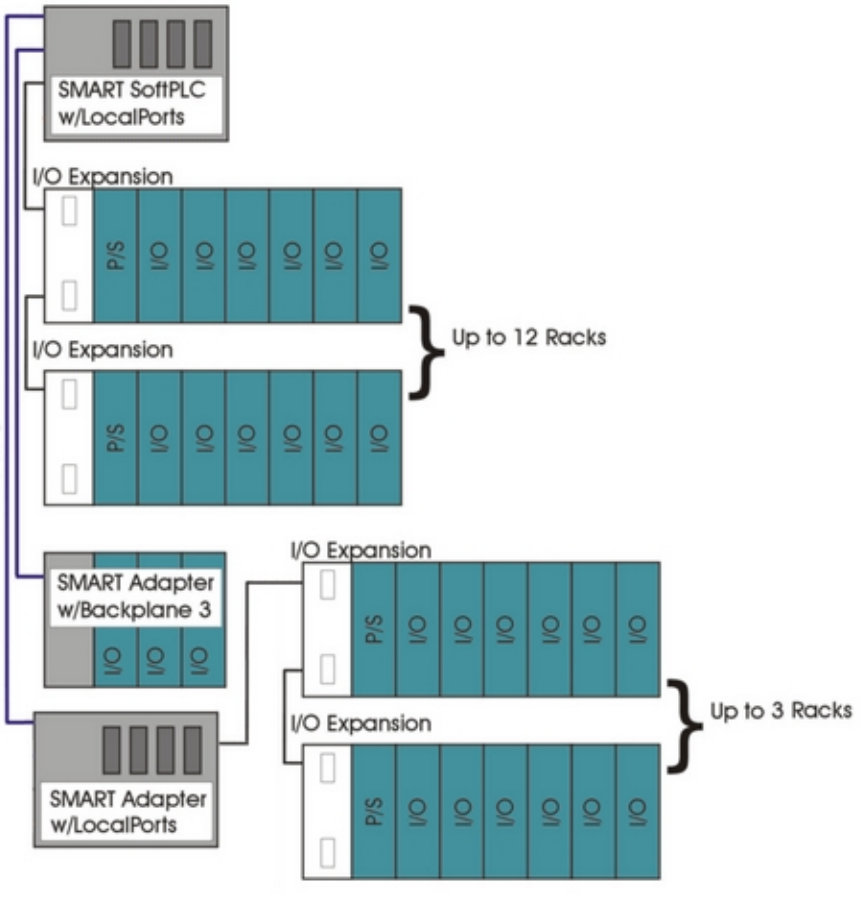


Figure 2.13: Example Configuration with both Local and Remote I/O

2.5.1 SMART ADAPTER WITH BACKPLANE3 INTERFACE

Figure 2.14: Remote Drop with Backplane3

In this configuration, any three Tealware I/O modules can be mounted onto the Smart Adapter. The recommended Smart SoftPLC power supply (Cat No ICO-PSH1524) is sufficient to also power the modules, and will use approximately 2W.

If the selected modules also require an external 24 VDC power supply for the outputs, it is recommended to use a separate power supply for the outputs for protection of the CPU. If you choose not to do this, be sure the system power supply has sufficient current for both the Smart SoftPLC and the module load(s).

2.5.2 SMART ADAPTER WITH LOCALPORTS INTERFACE

Figure 2.15: Remote I/O Adapter with LocalPorts Interface

This configuration provides support for up to 3 racks of Tealware I/O, numbered 0 to 2. The Bus 0 connector on the LocalPorts interface can be connected to up to 3 Tealware Expansion Bases (Cat Nos IOBASE0x), using I/O Expansion Cables (Cat Nos EXCBLxx). The maximum distance from the LocalPort connector to its last Expansion Base is 30 feet.

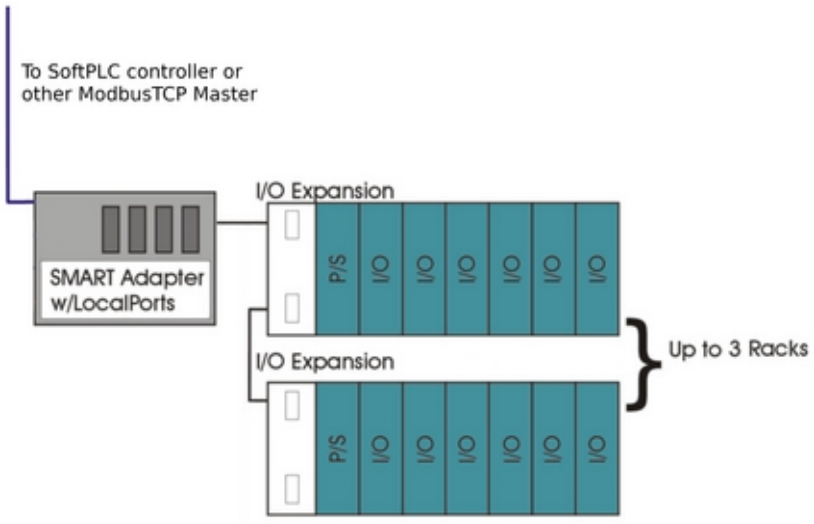


Figure 2.16: Remote Drop Configurations via LocalPorts Interface

2.5.3 ETHERNET REMOTE I/O ADAPTER SPECIFICATIONS

Table 2.5: Smart Adapter Hardware Specifications

SMART ADAPTER HARDWARE SPECIFICATIONS	
Input Voltage Range	12 to 48 VDC
Power Requirements	2W
Ethernet	(5) 1000 BaseT Ethernet ports (w/ multiple unique host interfaces-MAC ID's)
Dimensions (HxWxD)	without Tealware modules: 5.75 x 6 x 1.5 in. (146.1 x 152.4 x 38.1 mm) with Tealware modules: 5.75 x 6 x 5.625 in. (146.1 x 152.4 x 142.88 mm)
Operating Temp	0 to 60°C (-20 to 70°C extended temp option)
Storage Temp	-20 to 85 °C
Humidity	0 to 95%, non-condensing
Weight	Approx. 1-1.5 lbs. (450-680 g) based on options
Packaging	Fan-less / Disk-less system, metal enclosure DIN-rail Mount or (Optional) Panel Mount bracket
Local I/O Interfaces (only one interface/system)	Backplane3: (3) Tealware™ modules LocalPorts: (1) available Expansion Base connector for connecting up to 3 racks

Figure 2.17: Smart Adapter with optional Panel Mount Bracket (Cat No SM-VBKT)

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CHAPTER 3 - INSTALLATION GUIDELINES / WIRING

3.1 POWER PROTECTION

3.1.1 WIRING OF POWER SUPPLY

Connect an insulating transformer or a noise filter to minimize the excessive noise from the AC source.

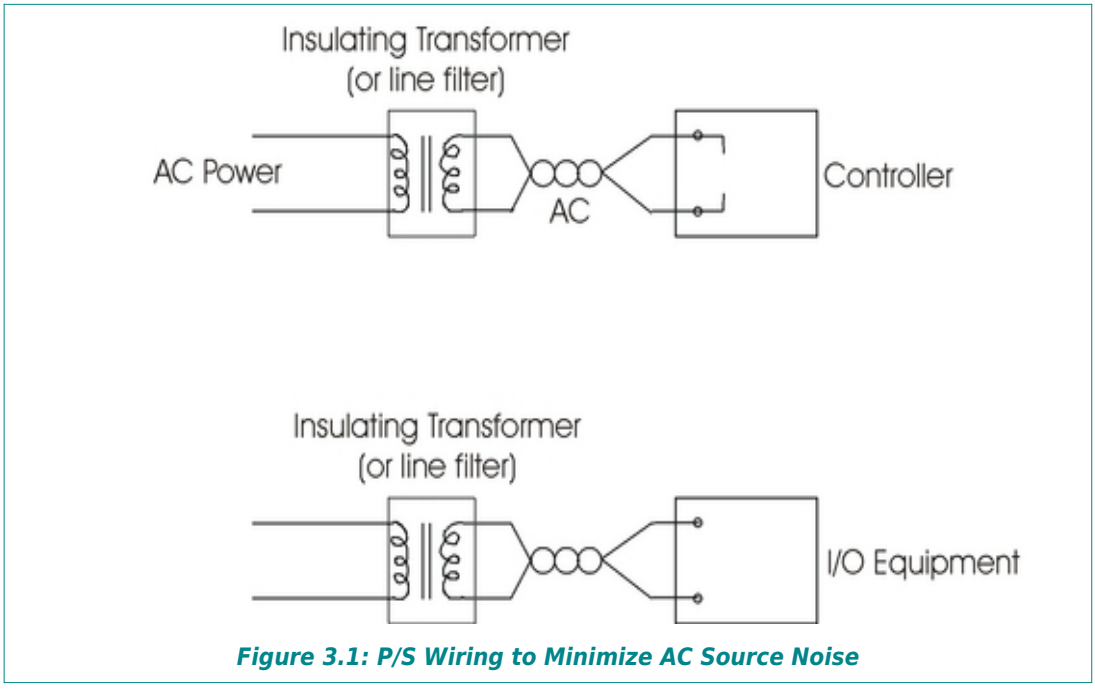

Figure 3.1: P/S Wiring to Minimize AC Source Noise

When wiring, separate the PC power supply from the I/O and power equipment as shown below.

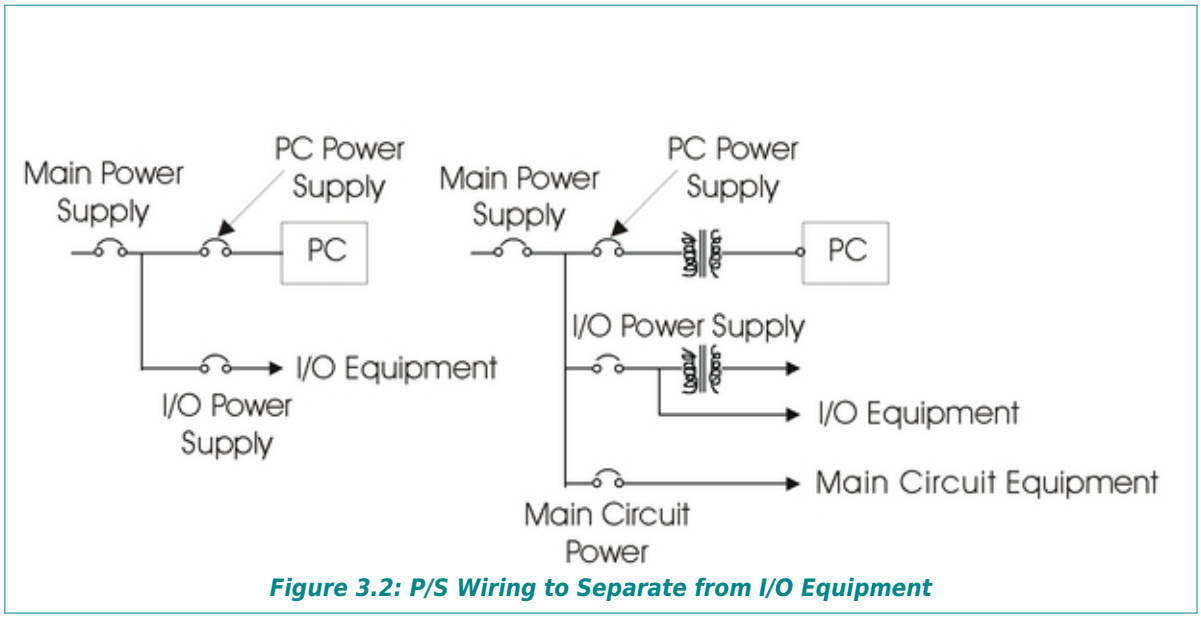

Figure 3.2: P/S Wiring to Separate from I/O Equipment

Do not bundle the 100 VAC and 24 VDC cables with main-circuit wires or the I/O signal wires (high-voltage, large-current). If possible, provide more than 100 mm (4 in.) distance between the cables and wires.

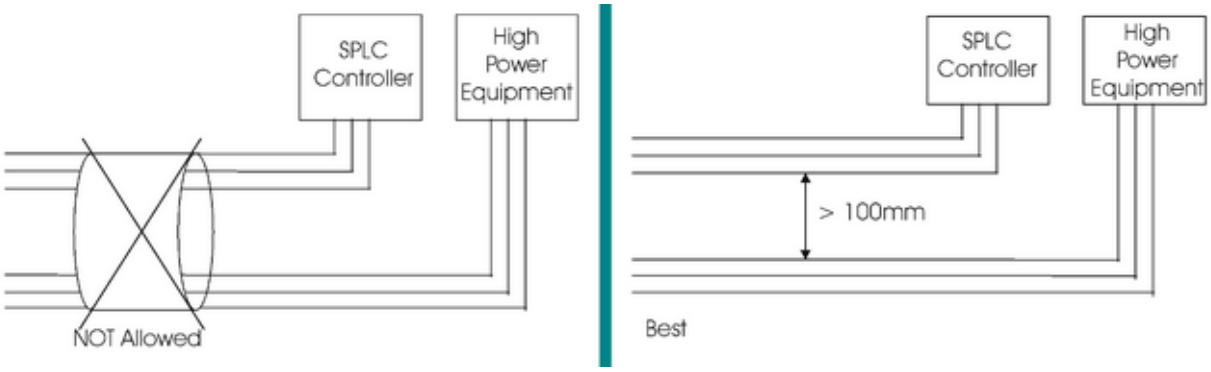

Figure 3.3: P/S Wiring to Separate AC & DC Wiring

As a lightning-protection measure, connect a surge absorber as shown below.

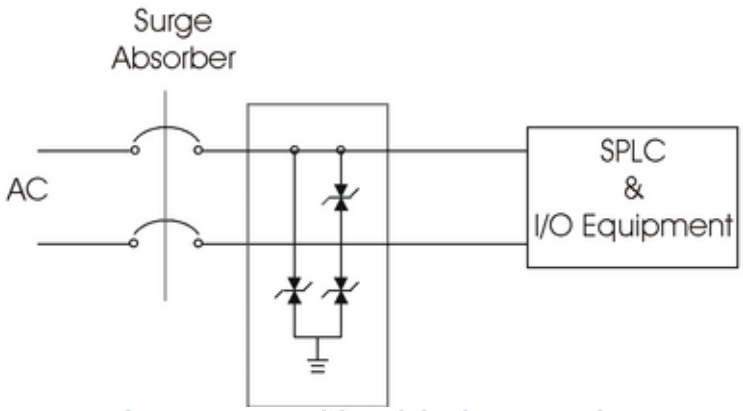

Figure 3.4: P/S Wiring Lightning Protection

3.2 I/O WIRING

Applicable size of wire to the terminal block connector is 0.75 mm2 (#18 AWG) to 1.5 mm2 (#14 AWG). However, it is recommended to use wires of 0.75 mm2 (#18 AWG) for best results.

- Separate the input and output lines.
- Separate the 24 VDC I/O cables from the 100 VAC and 200 VAC cables.
- I/O signal wires must be at least 100 mm (4 in.) away from high-voltage and large-current circuit wires.

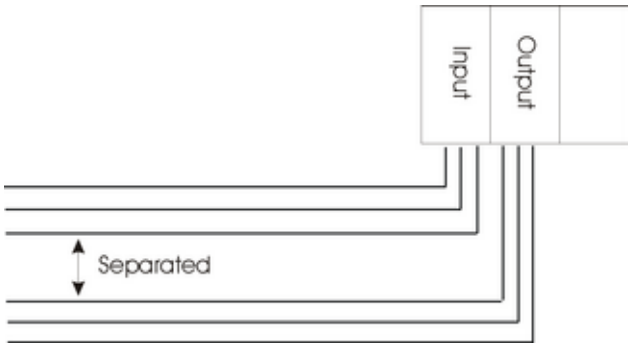

Figure 3.5: I/O Wiring Input & Output Separation

- When the I/O signal wires cannot be separated from the main circuit wires and power wires, shield the signal wires, and ground on the controller side with batch-shielded cables. Under some conditions, it may be preferable to ground on the other side.

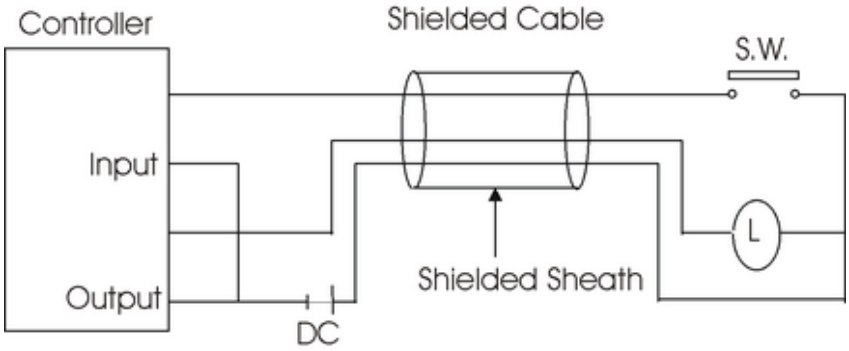

Figure 3.6: I/O Signal Wiring Shielding & Grounding Recommendations

- If wiring has been done with piping ground the piping.

- It is recommended that you connect the varister to the magnetic switch located near the I/O cables.

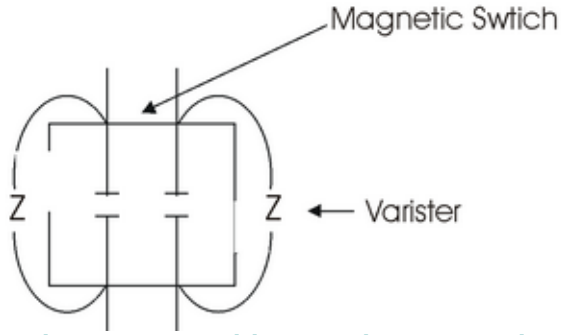

Figure 3.7: I/O Wiring - Varister/Magnetic Switch

3.3 GROUNDING

- LG: AC line ground must be connected to the ground line of incoming power.
- FG: framing ground must be connected to earth ground.
- Earth grounding should be as independent as possible.
- Ground the controller and other equipment as independently as possible.
- Class 3 earth grounding should be used (resistance 100 Ω or less).
- When independent earth grounding is impossible, use the joint grounding method as shown in the figure below.
- If a malfunction occurs due to grounding, disconnect terminals from grounding.

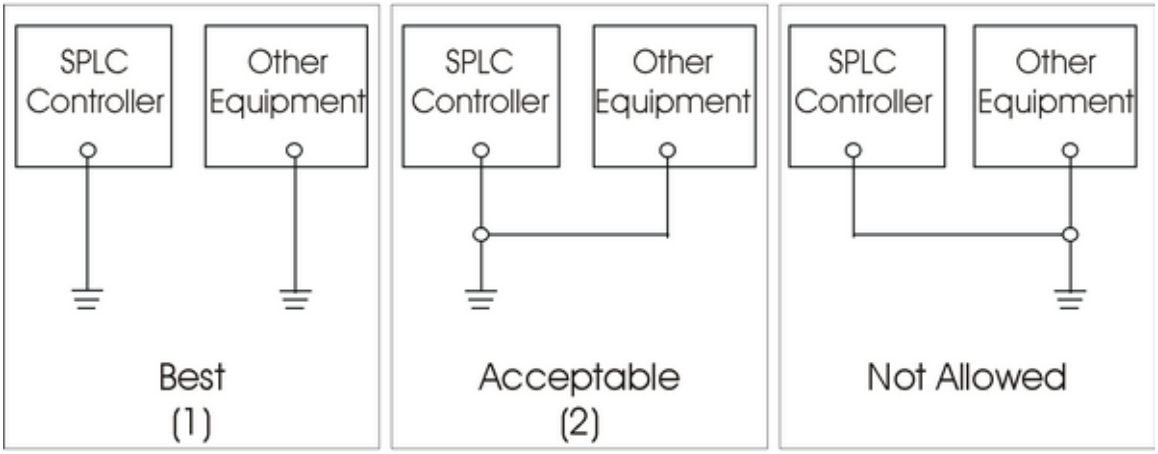

Figure 3.8: Recommended Grounding Practices

3.4 CIRCUIT PROBLEMS & CORRECTIVE ACTIONS

3.4.1 CURRENT LEAKAGE

Current leakage may be caused by an input switch with a neon lamp, an input driven by a non-contact switch, an input switch with an LED indicator, an AC line capacitor with long wiring cable or the sneak path of the circuit. If the circuit's leaking current is larger than the module's turn OFF current, problems with the module's I/O signal will result. The basic preventive measures are as follows:

AC INPUT MODULE

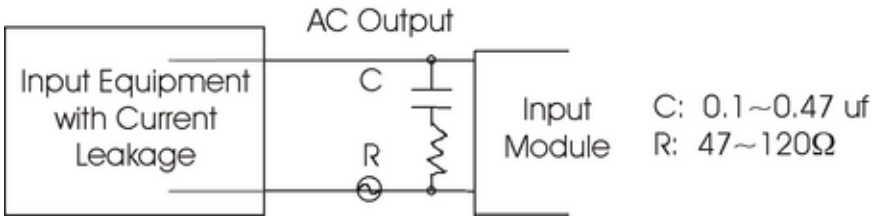

Figure 3.9: Avoiding Current Leakage with AC Input Modules

DC INPUT MODULE

$$R < \left(\frac{\text{Vin OFF x Rin}}{\text{Rin x iL-VinOFF}} \right) \text{ x } 0.5$$

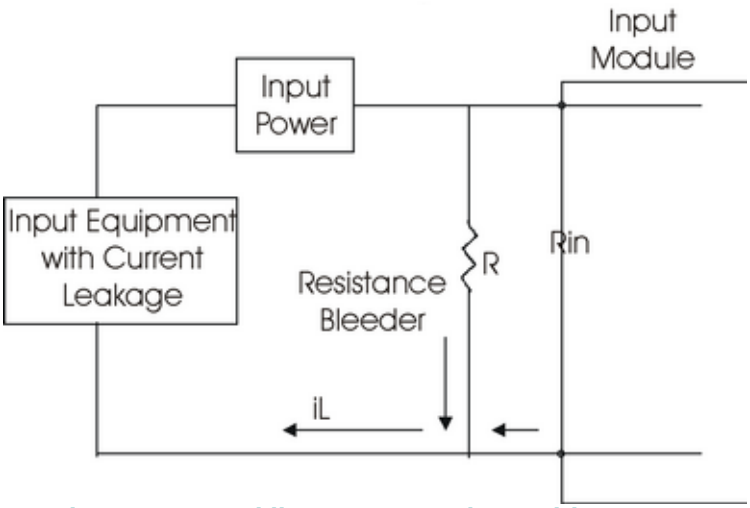

Figure 3.10: Avoiding Current Leakage with DC Input Modules

AC OUTPUT MODULE

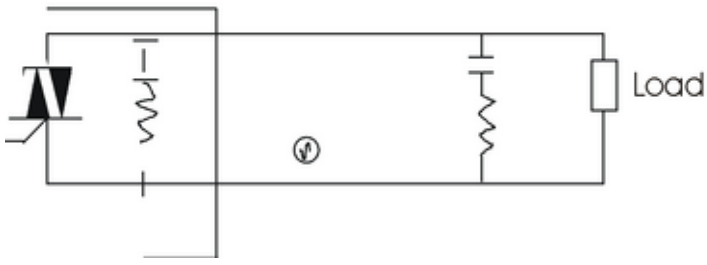

Figure 3.11: Avoiding Current Leakage with AC (Triac) Output Modules

3.4.2 INDUCTIVE LOAD

The ON / OFF action of an inductive load may generate high surge voltage and influence the output module's operation. The basic corrective actions can be done as follows:

RELAY OUTPUTS

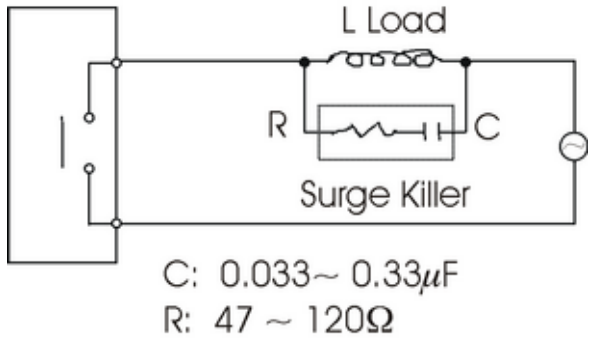

Figure 3.13: Inductive Load Correction - Relay Output (AC)

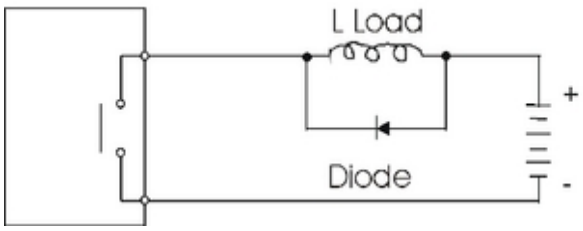

Figure 3.12: Inductive Load Correction - Relay Output (DC)

TRANSISTOR OUTPUTS

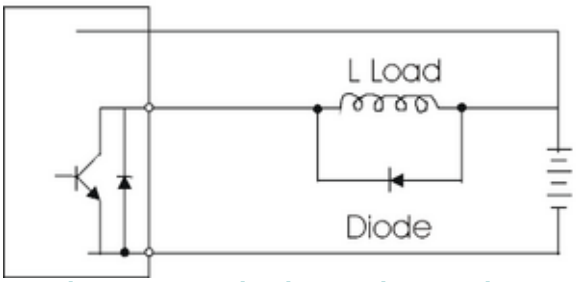

Figure 3.14: Inductive Load Correction - Transistor (MOSFET) Outputs

AC (TRIAC) OUTPUTS

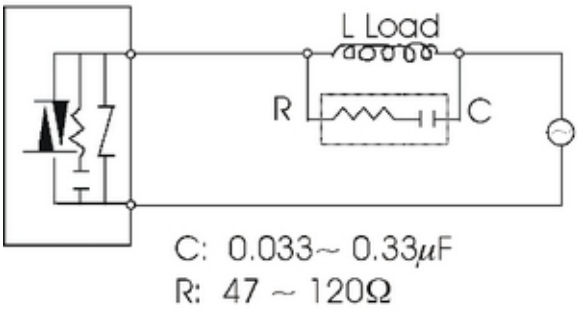

Figure 3.15: Inductive Load Correction - AC (TRIAC) Outputs

3.5 PANEL LAYOUT

The controller was designed to be installed in a metal or fiberglass cabinet. Please follow the design guidelines listed below. Note: if there are other components to be installed in the same cabinet, care must be taken for the installation of each component.

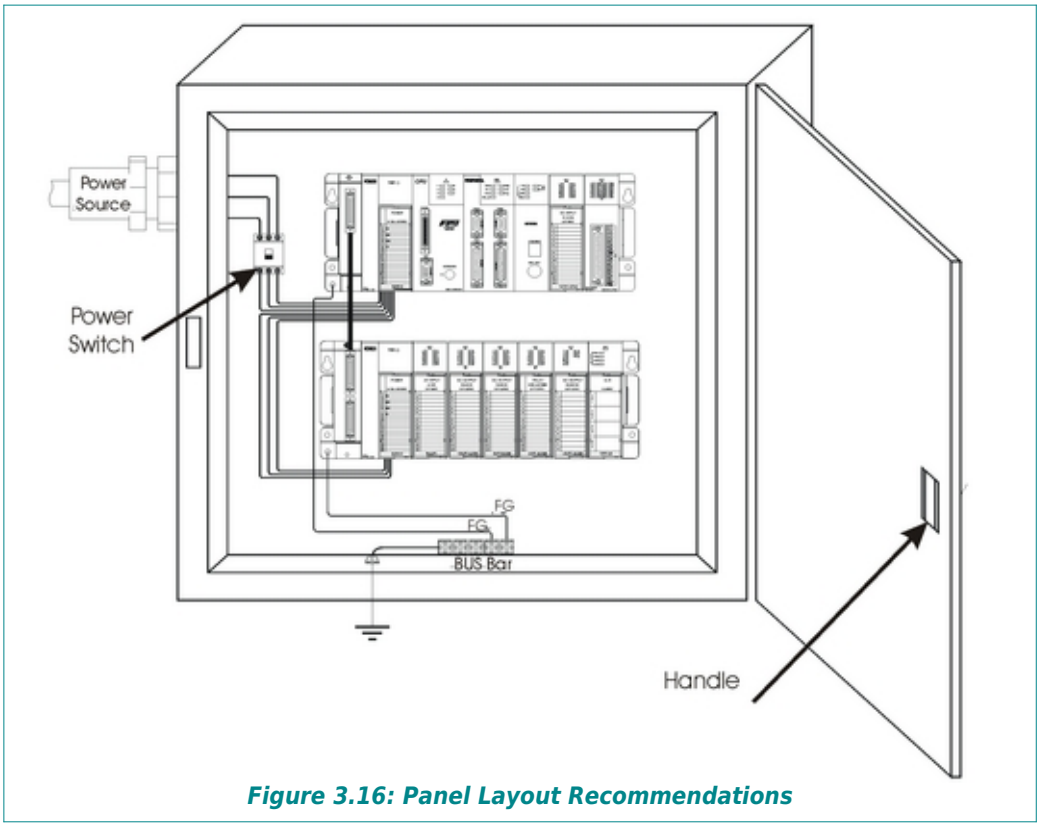

Figure 3.16: Panel Layout Recommendations

1. Mount the base (rack) horizontally to provide proper ventilation. Vertical or upside-down mounting is not allowed.

2. A good common ground is essential for proper operation of controller. The ground terminal on the controller must be connected to a single point ground. Use a copper bus bar to achieve low impedance. The ground termination must be connected to earth ground. Earth ground may be achieved by:

   a) Installing a ground rod as close to the panel as possible.
   b) Connecting to incoming power system ground.

3. The ambient temperature should be within specifications. If ambient temperature is not within the upper or lower limits of the specification, install a cooling or heating source.

4. For operating safety, a power switch in front of the power supply module is recommended. Be sure to turn off the power switch if removing the power module is required. Only authorized maintenance personnel should be allowed to open the panel cabinet. A warning label such as “DANGER: To Be Opened by Authorized Personnel Only” should be affixed to the cabinet.

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Part 2
I/O Driver Configuration

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CHAPTER 4 - I/O DRIVER CONFIGURATION OVERVIEW

NOTE

This manual describes how to configure Tealware I/O for use with a SoftPLC controller, for both local and remote I/O configurations. If you are using Tealware I/O on ModbusTCP with another vendor's controller, contact support@softplc.com for configuration information.

In order to use Tealware I/O with a SoftPLC controller, you use TOPDOC NexGen's Module Editor. The TOPDOC NexGen Manual and help system describe how to use the Module Editor. The following chapters assume you understand the use of TOPDOC NexGen's Module Editor, and other SoftPLC configuration procedures.

4.1 SELECTING I/O DRIVER(S)

You need to first determine and load the appropriate I/O driver(s) for your system. For local I/O, use the Smart Driver (SMART.TLM), for Ethernet remote I/O use the ModbusTCP Master Driver (MPIPMAST.TLM).

Use the Save button in the TOPDOC NexGen Module Editor to copy the desired list of drivers on your hard drive, and use Send to save the list of Modules to the SoftPLC controller.

4.2 CONFIGURING I/O DRIVER(S)

The process of configuring an I/O driver is used to identify the I/O modules in the system, and the data table address(es) that will be assigned to each I/O point.

CAUTION

If multiple I/O drivers are used, it is the user's responsibility to ensure that data table addresses are not assigned to more than one physical I/O device. SoftPLC does not verify whether data table addresses have been defined to more than one I/O driver. This includes the case where both local and remote Tealware I/O is used on a SoftPLC system, since these are different drivers.

TOPDOC NexGen provides built-in /O driver configuration editors to create the configuration files, and save them to the SoftPLC controller. XML format files are used to store the configuration information.

HINT

If your system uses only Tealware I/O and you are only using one I/O Driver, you can perform an Auto-Configuration. An Auto-Configure function is available for SoftPLC controllers for Tealware I/O in both local and remote configurations. You can also use the TOPDOC NexGen Module Editor to manually configure and modify your Tealware I/O driver(s) for use with SoftPLC.

4.3 ENABLING & MODIFYING I/O DRIVER CONFIGURATIONS

Once you have created/edited an I/O driver XML configuration file, use the driver configuration editor's *Send* button to transfer the configuration file to the SoftPLC.

Any time you create or edit a configuration file and send it to the SoftPLC Controller, if the SoftPLC is running, you need to re-load the driver in order for SoftPLC to recognize the changes. This can be done by:

- Cycling power on the SoftPLC.
- Restarting the SoftPLC process from the console.
- Restart the I/O drivers *(which reloads the configuration file)* by doing a "program mode to program mode transition" *(also known as double-clutching)*. Using TOPDOC NexGen's Edit Remotely option, change the Mode to "Remote Program", then select "Remote Program" a second time. This pseudo transition from Remote Program to Remote Program is a signal to the Smart driver that it should reload its configuration file.

CHAPTER 5 - LOCAL I/O CONFIGURATION

The Tealware Local I/O Driver is “smart.tlm.” By default, Smart SoftPLC's with a Tealware interface (Backplane3 or LocalPorts) are shipped with this driver pre-loaded. The Smart.TLM driver is part of the standard TOPDOC NexGen installation, and is displayed in the TOPDOC NexGen Module Editor as a selectable module.

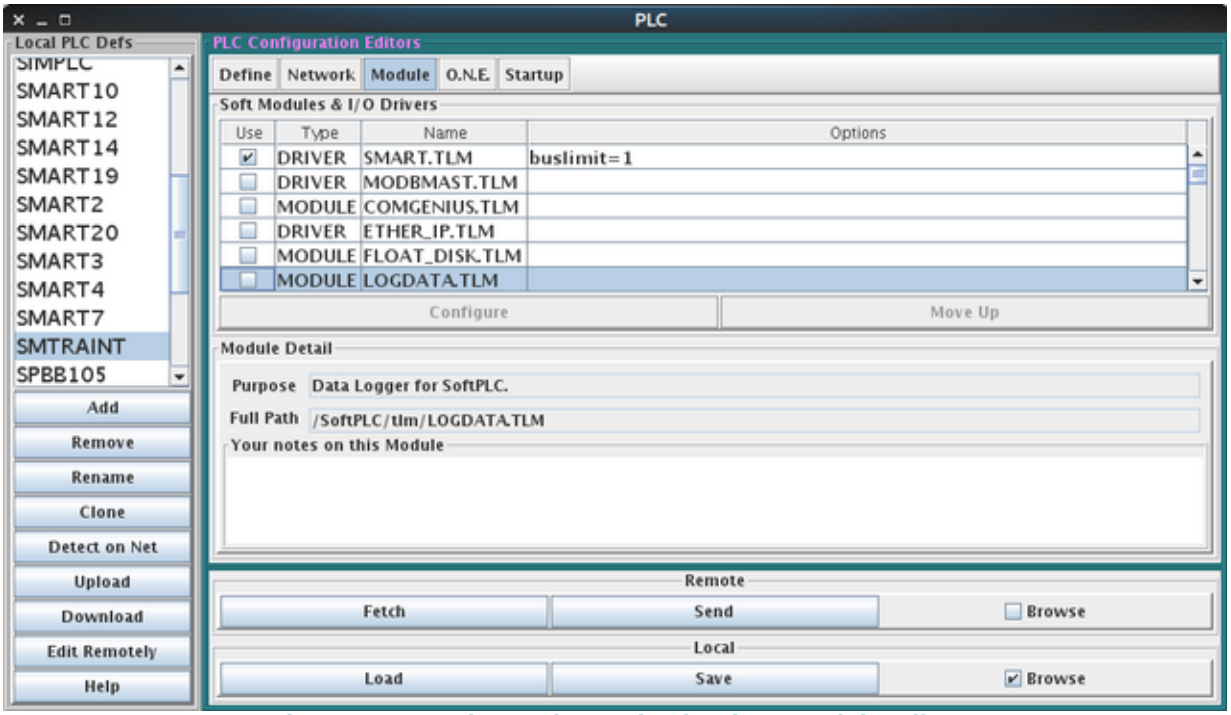

Figure 5.1: Local I/O Driver Selection from Module Editor

Check the Use box to indicate to SoftPLC to load the Tealware Local I/O driver, SMART.TLM. This driver has a parameter in the Options column, that may be required according to the following:

Table 5.1: SMART.TLM Driver Options

SMART.TLM DRIVER OPTIONS	
OPTION TEXT	**DESCRIPTION**
-backplane3	Required for Smart CPU’s equipped with a Backplane3 interface
Buslimit = <x>	Optionally enter this for Smart CPU’s equipped with a LocalPorts interface. If not entered, all 4 buses will be scanned. <x> can be 1, 2, 3, or 4 to indicate the number of bus ports to be scanned, where 1 = only bus 0, 2 = bus 0 and 1, etc. Reducing the number of buses minimizes the overall scan time.

Use the buttons at the bottom of the Module Editor to Save the module configuration to your hard drive, and use Send to save it to the SoftPLC controller.

5.1 SMART.TLM DRIVER CONFIGURATION

TOPDOC NexGen includes a graphical editor to create/edit the configuration file. After selecting to Use the smart.tlm driver, you can load the configuration editor by pressing the "Configure" button, located below the list of available Soft Modules & I/O Drivers.

The configuration file is an XML formatted text file, presented in a tree style to display the buses, racks and modules, as well as the module data table mapping as well as any detailed module parameter information. Figure 5.1 shows an example editor display.

HINT

Detailed instructions on use of the Smart Driver Configuration Editor and the file contents and format can be found by pressing Help from within the editor (when connected to the Internet) or at: http://softplc.com/usermanuals/smart/

On the left side of the online document is a contents menu. The last menu item is "ALL." If you select this, a PDF version of the entire document is loaded which you can then save and/or print a hard copy.

NOTE

You can also manually configure the driver using a text editor if TOPDOC NexGen is not available. The configuration file is called "smart.xml". On your TOPDOC PC, it is stored in the /SoftPLC/<PLC_name> folder, and in your SoftPLC is in the \SoftPLC\run\ directory.

5.1.1 ENABLING A CONFIGURATION

Once you have created/edited your configuration file (smart.xml), use the Smart Driver editor's *Send* button to transfer the configuration to the SoftPLC.

Any time you create or edit the configuration file it needs to be loaded/re-loaded in order for SoftPLC to use it. This can be done by:

- Cycling power on the SoftPLC
- Restarting the SoftPLC process from the console
- Restart the Smart driver *(which reloads the configuration file)* by doing a "program mode to program mode transition" *(also known as double-clutching)*. Using TOPDOC NexGen's Edit Remotely option, change the Mode to "Remote Program", then select "Remote Program" a second time. This pseudo transition from Remote Program to Remote Program is a signal to the Smart driver that it should reload its configuration file.

5.1.2 CONFIGURATION EDITOR USAGE

The following figure is an example file in the smart.tlm configuration editor. The elements and sub-elements in the file are presented in a tree format. The element name is at the far left of each tree row. To the right of the element name, still within the tree row, is a list of **attributes**.

When the cursor is positioned on a particular element, the attributes of the element are displayed in a table at the far right side of the editor window. That table is dynamic (eg: depends on the selected element), and has one row for each attribute.

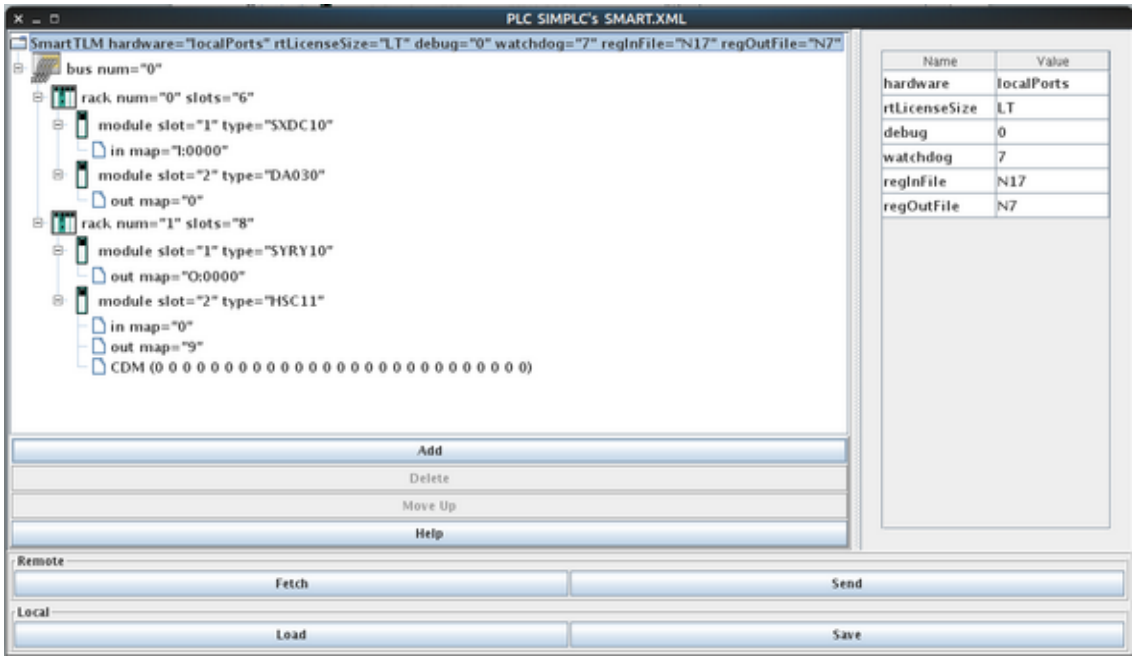

Figure 5.2: SMART.TLM Configuration Editor Display

EDITOR BUTTONS

- *Add* button will insert a new sub-element within the selected element.
- *Delete* button will deleted the selected element. It is only enabled when you are allowed to delete the selected element.
- Help button will load the online user guide for the editor, if you are connected to the internet.
- *Move Up* button will move the selected element up in the current portion of the tree.
- *Fetch, Send, Load, and Save* all have the same meaning as they do in the TOPDOC NexGen Module editor.

POPUP MENUS

There are a number of right-click invoked popup menu choices that are available when there is a tree row selected.

One choice when the top most element is selected is **Delete Configuration on Smart**. This choice will delete the SMART.XML file within the associated SoftPLC controller. When that file is missing at the time of power up, then the TLM will perform an auto-configuration.

Other choices provide functions to **reallocate/re-assign/sort** elements, to remove gaps in the data table mapping, or make the file easier to read.

5.1.3 SMART CONFIGURATION FILE STRUCTURE

The next table shows the possible Elements and Sub-Elements in a smart.xml configuration file, and the attributes for each element type are identified in the following table. Multiple instances of the sub-elements can be present. TOPDOC NexGen takes care of enforcing the rules of the configuration file.

Table 5.2: SMART.XML Configuration File Elements & Sub-Elements

SMART.XML ELEMENTS & SUB-ELEMENTS		
ELEMENT NAME	**DESCRIPTION**	**SUB ELEMENT(S)**
SmartTLM	Topmost element, holds all other elements.	bus
bus	References and configures a communications channel which talks to racks.	rack
rack	Holds I/O modules - 3 (backplane3), or 6 or 8 (LocalPorts)	module
module	Identifies a I/O module by its slot position within a rack, and its module type.	in, out, CDM, hz
In	Present only for input modules, identifies where in the SoftPLC datatable the module's input scan data will be placed. For **digital** input modules this must be in the I: section of the datatable.	
Out	Present only for output modules, identifies where in the SoftPLC datatable the module's output scan data will come from. For **digital** output modules this must be from the O: section of the datatable.	
CDM	Present only for some analog and intelligent modules, identifies a block of single shot inline configuration data that the TLM will download to the module for configuration purposes on any transition to RUN mode.	
Hz	Allowed only on HSC11 high speed counter modules, and when present enables the TLM to calculate a frequency for each of the 3 module channels via the HZ ladder instruction.	

Table 5.3: SMART.XML Configuration File Attributes of Elements

ATTRIBUTES OF SMART.XML ELEMENTS		
ELEMENT	**ATTRIBUTE**	**VALUE**
SmartTLM	debug	0, 1, or 2, meaning "enable none, some, or all debugging print statements" (defaults to 0). Statements are printed to the system log, available from the console.
	hardware	Type of connectivity to the Tealware I/O: 'LocalPorts' or 'backplane3'
	rtLicenseSize	Runtime license size: LT, 1K, 2K, or 8K, and pertains to the digital I/O capacity of the runtime license (128, 1024, 2048, 8192). Setting this correctly allows the editor to help you stay within limits imposed by the SoftPLC runtime when it loads the configuration file.
	watchdog	Each Tealware I/O module has an internal watchdog timer. This setting is sent to all modules upon a transition to RUN mode that controls how long to wait during a quiet time before a module is to turn off its outputs. Range: 1-14 deci-seconds (eg: 7 equates to 7/10ths of a second). Additionally, the special value 0xf0 means do not use the watchdog.
	digInStart	Is used to establish the starting I: address used during the allocation of input image table required by digital input modules. This controls both a) the manual (module at a time new entry) allocation and b) the full configuration auto allocation which is available by selecting the top most element and calling up the popup menu with a right click.

ATTRIBUTES OF SMART.XML ELEMENTS		
ELEMENT	**ATTRIBUTE**	**VALUE**
	digOutStart	Is used to establish the starting O: address used during the allocation of output image table required by digital output modules. This controls both a) the manual (module at a time new entry) allocation and b) the full configuration auto allocation which is available by selecting the top most element and calling up the popup menu with a right click.
	regInStart	Is used to establish the datatable file for all analog input data. The word component must be zero, but any available N: file may be used. The word element for any analog or intelligent input module is then calculated by using the associated **in** element's 'map' attribute as a word offset. For example, if regInStart is N17:0, and a module's <in map, "14">, then the module's analog data will be moved into a block starting at N17:14 during the I/O scan.
	regOutStart	Is used to establish the datatable file for all analog output data. The word component must be zero, but any available N: file may be used. The word element for any analog or intelligent output module is then calculated by using the associated **out** element's 'map' attribute as a word offset. For example, if regOutStart is N7:0, and a module's <out map, "14">, then the module's analog data will be sourced from a block starting at N7:14 during the I/O scan.
bus	num	The bus number: 0, 1, 2 or 3.
rack	num	The rack number: 0, 1 or 2.
	slots	The number of slots for the rack: 3, 6, or 8
module	slot	The slot number, which starts at 1, with a range of 1-8
	type	The type of Tealware I/O module, picked from a menu.
	scan	If Present and set to “No”, the module is used only for reserving data table space and is ignored by runtime scanning.
in	map	One of two kinds of datatable references, either absolute or relative. The absolute form is an actual datatable address and is used for digital input modules. The relative form is a zero based offset from the absolute starting address given by element SmartTLM's regInStart, and is used for non-digital input modules.
out	map	One of two kinds of datatable references, either absolute or relative. The absolute form is an actual datatable address and is used for digital output modules. The relative form is a zero based offset from the absolute starting address given by element SmartTLM's regOutStart, and is used for non-digital output modules.
hz	window	The number of samples to use in a sliding window filter, 2-4096. Frequency is calculated by subtracting the oldest count sample from the newest count sample and dividing by the elapsed time between the two samples. The oldest sample is disposed of when the newest sample is inserted into the sliding window. The sample rate is established by how often the **HZ** ladder instruction is energized for this module.

5.2 AUTO-CONFIGURATION

To Auto-Configure local Tealware I/O, install the I/O modules into the Backplane3 slots, or for a LocalPorts system, connect the base(s) to the SoftPLC, install the modules and power supply(s) into the base(s) in the desired configuration, then power the system, ensuring that the Smart SoftPLC CPU is the last component to be powered.

Upon startup, SoftPLC will identify the Tealware I/O components and automatically create the configuration file “smart.xml” that is used by the Smart driver, smart.tlm.

After you Auto-Configure, you can use TOPDOC NexGen's Module Editor to view / edit the smart.xml file by clicking on the Configure Button, then selecting Fetch. You can backup the configuration to your PC by selecting Save.

NOTE

If you want to Auto-Configure and a configuration file already exists, you simply need to delete the smart.xml file (using the TOPDOC NexGen SMART.TLM Editor or via the Linux console), and then restart or cycle power to the SoftPLC.

HINT

Currently the Auto-Configuration function uses N7 and N17 as the data table files for register (analog) module data. If you want to use different files, you can still use the Auto-Configuration function, and then re-map the analog I/O by editing only the first line in the smart.xml file.

CAUTION

The Auto-Configuration function uses only the I/O module physical locations to determine the I/O mapping. If you have an existing softplc.app (application program) and you Auto-Configure with a different physical I/O configuration, your logic may no longer be suitable. Unexpected or dangerous machine operation could result.

5.3 LADDER INSTRUCTIONS INCLUDED WITH SMART.TLM

The Smart driver includes a number of TOPDOC Loadable Instructions (TLI's); one for communications health monitoring, another for talking to an HSC11 module in a special frequency measurement mode, and still others to read/write blocks of data to specialty I/O modules on demand.

NOTE

The FPMx TLI instructions were used with now obsolete Tealware modules. They are no longer required and will not be covered in this manual. If you need information about using FPMx modules, contact support@softplc.com

5.3.1 IO_STS

This output instruction can be used to monitor the health of the communications to the racks and I/O modules within a local Tealware bus. You can program one of these instructions for each Tealware local bus that you have. It returns 4 words which are bit mapped to the individual modules for each slot on that bus.

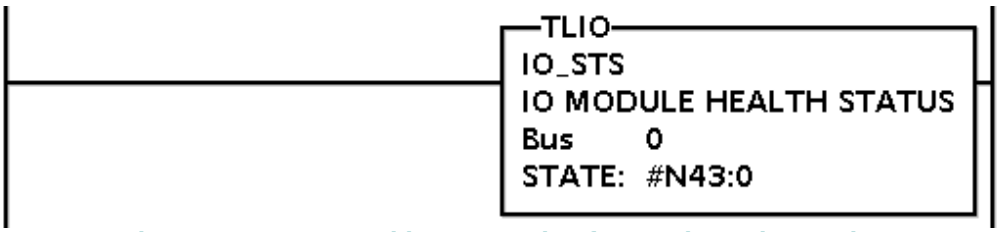

Figure 5.3: IO_STS Ladder Instruction for Local I/O Diagnostics

Table 5.4: IO_STS Instruction Parameters

IO_STS INSTRUCTION PARAMETERS	
PARAMETER	**MEANING**
Bus	An integer Tealware local bus number, 0-3.
State	The address of a 4 word integer datatable block. These 4 words receive the health status bits as described below, whenever the instruction is energized.

The first 24 bits of the instruction's STATE word block are mapped to the possible 24 slots on the bus (3 racks x 8 slots max per rack), starting with the first 8 slots available to rack 0, then the next 8 slots for rack 1, followed by the last 8 slots for rack 2. Bits are allocated starting from bit 0 in the first word and continue into the least significant 8 bits of the 2nd word. A value of "1" means that the slot contains a module that was found at system start-up.

The 3rd and 4th words are used to monitor rack status, using the same bit mapping as described above for the first 2 words. If a rack is communicating properly, all the bits corresponding to the rack slots will be a "1". By monitoring any of the bits corresponding a rack for a "0" condition you can programmatically or via a connected HMI detect rack faults.

Table 5.5 - IO_STS Bit Mapping Definitions

IO_STS TLM BIT MAPPING DEFINITIONS																
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**	**BIT #/ WORD #**
1/8	1/7	1/6	1/5	1/4	1/3	1/2	1/1	0/8	0/7	0/6	0/5	0/4	0/3	0/2	0/1	1
Unused								2/8	2/7	2/6	2/5	2/4	2/3	2/2	2/1	2
1/8	1/7	1/6	1/5	1/4	1/3	1/2	1/1	0/8	0/7	0/6	0/5	0/4	0/3	0/2	0/1	3
Unused								2/8	2/7	2/6	2/5	2/4	2/3	2/2	2/1	4

Key: <rack #> / <slot #>, eg: 2/5 = Rack 2, Slot 5

5.3.2 HZ

This instruction is used when you want to read frequency from a Tealware High Speed Counter module (Cat No HSC11). The module is designed to maintain counts, not frequency. However, with this instruction accurate timing information is applied to the counts to calculate frequency. Details on use of the HZ instruction can be found in the chapter on the HSC11 module.

If you intend to measure frequency, you must Add a “hz” sub-element in the smart.xml configuration file for the HSC11 module.

5.3.3 CDMR

This output instruction can be used to read the values in the Configuration Data Memory (CDM), present in some analog and intelligent modules. Details on CDM programming can be found in Chapter 7, and the CDM parameters for each specific module are described in the section for that module.

5.3.4 CDMW

This output instruction can be used to write values to the Configuration Data Memory (CDM), present in some analog and intelligent modules. Details on CDM programming can be found in Chapter 7, and the CDM parameters for each specific module are described in the section for that module. Because the Smart driver Configuration Editor allows you to more easily set values for the CDM parameters, this instruction is typically not used.

CAUTION

The Smart driver (smart.tlm) will send the CDM values in the configuration file smart.xml to the modules upon any transition of the SoftPLC into RUN mode. If you elect to use the CDMW instruction, it is recommended that you condition those rungs to trigger on a true condition of the first scan bit (S1/15). Otherwise unexpected operation could result.

5.4 TROUBLESHOOTING

Upon power-up, the Smart Driver will poll the configured buses and ensure that the I/O modules match the configuration file smart.xml by module ID and slot location. If there are any mis-matches or missing modules, SoftPLC will be placed into Fault mode, and a detailed error message will be written to the system log file, which you can access via the Console “logread” command.

Certain driver operation and configuration file errors will report a fault code into the Status File word S:15 as shown in the following table.

Table 5.6 - SMART.TLM Status File Error Codes

SMART.TLM STATUS FILE ERROR CODES	
FAULT CODE	**DESCRIPTION**
43	Missing Datatable
44	Cannot Map Physical
45	FPGA Init Fail
46	Missing Map File
47	No Parser Context
48	Unable to Parse
49	Bad Module ID
50	Invalid Configuration File
51	Invalid I/O Address
52	Input Overlap
53	Output Overlap
54	I/O Limit Exceeded
55	Bad Slot Number
56	Bad Rack Slot Number
57	Bad Bus Number
58	Duplicate Record
59	Missing I/O Module
60	LED Access
61	Bad HZ Window setting

If you are using the CDMR or CDMW ladder instructions, some errors are written into the .POS element of the instructions Control (Rx:x) word:

Table 5.7: CDMR/CDMW Instruction Error Code Definitions

CDMR/CDMW INSTRUCTION ERROR CODES	
ERROR VALUE	**DESCRIPTION**
1	Bad Parameter
2	No Module Present
3	CDM Read Error
4	CDM Write Error
6	FPM Read Error
7	FPM Write Error

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CHAPTER 6 - REMOTE I/O DRIVER CONFIGURATION

For remote Tealware I/O on Ethernet with any SoftPLC, you use the ModbusIP Master Driver, which is called “mbipmast.tlm." By default, SoftPLC systems with Smart Adapters (Backplane3 or LocalPorts) are shipped with this driver pre-loaded. The Modbus IP Master Driver is part of the standard TOPDOC NexGen installation, and is displayed in the TOPDOC NexGen Module Editor as a selectable module.

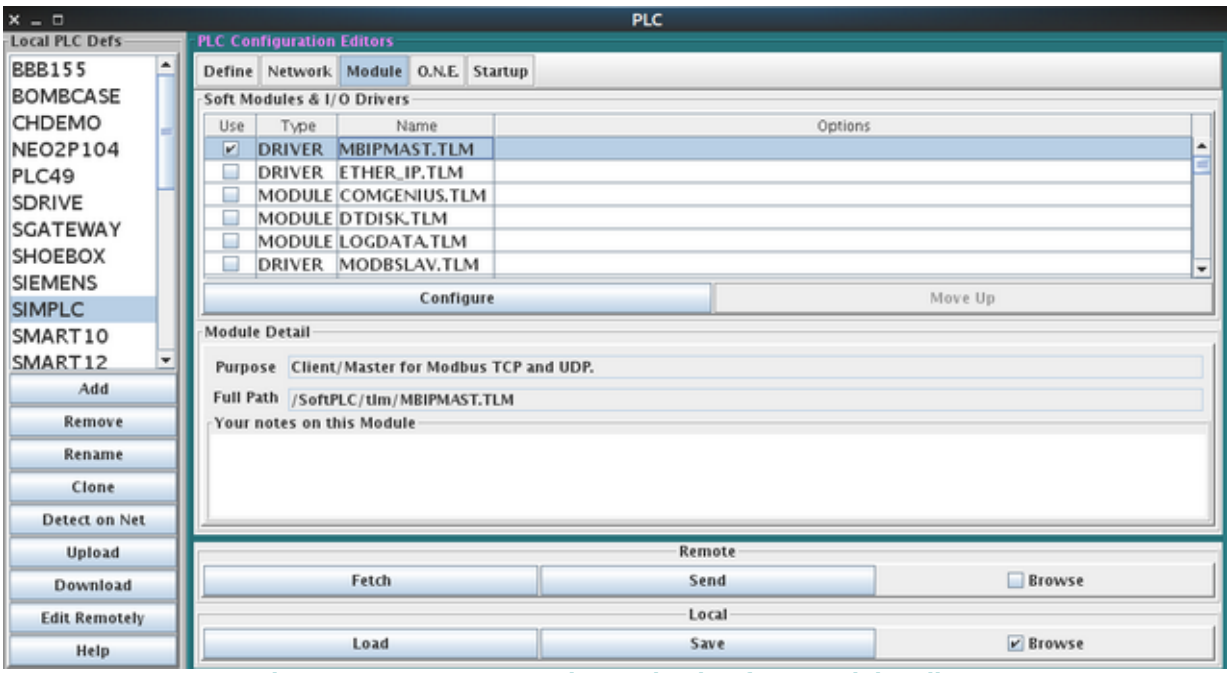

Figure 6.1: Remote I/O Driver Selection from Module Editor

Check the Use box to indicate to SoftPLC to load the Modbus IP Master /O driver.

Use the buttons at the bottom of the editor to Save the module configuration to your hard drive, and use Send to save it to the SoftPLC controller.

6.1 DRIVER CONFIGURATION

TOPDOC NexGen includes a graphical editor to create/edit the configuration file. After selecting to Use the mbipmast.tlm driver, you can load the configuration editor by pressing the “Configure” button, located below the list of available Soft Modules & I/O Drivers.

HINT

Additional detailed instructions on use of the Modbus IP Master Driver, the Configuration Editor, the file contents and format, and more can be found by pressing Help from within the editor (when connected to the Internet) or at: http://softplc.com/usermanuals/modbus_ip_master/ On the left side of the online document is a contents menu. The last menu item is “ALL." If you select this, a PDF version of the entire document is loaded which you can then save and/or print a hard copy.

6.1.1 ENABLING A CONFIGURATION

Once you have created/edited your configuration file (mbipmast.xml), use the driver configuration editor's *Send* button to transfer the configuration to the SoftPLC. Save will save the file to your TOPDOC PC's hard drive.

When you select ***Save*** or ***Send***, the configuration editor will run a verification check on the address references used for the configured Tealware **modules**. If any overlaps are found, the error will be shown. If there are no errors, the editor will automatically generate the necessary **Slave** elements with Modbus requests as appropriate for all the modules, in order to conform to the ModbusTCP protocol.

CAUTION

The Slave elements and Modbus commands generated by the editor for a Tealware drop cannot be edited, and any changes that may be needed should be made by editing the actual **module** element or its **address** component, and selecting Save and/or Send to allow the editor to re-generate a valid configuration file.

Any time you create or edit the configuration file it needs to be loaded/re-loaded in order for SoftPLC to use it. This can be done by:

- Cycling power on the SoftPLC
- Restarting the SoftPLC process from the console
- Restart the ModbusIP Master driver *(which reloads the configuration file)* by doing a "program mode to program mode transition" *(also known as double-clutching)*. Using TOPDOC NexGen's Edit Remotely option, change the Mode to "Remote Program", then select "Remote Program" a second time. This pseudo transition from Remote Program to Remote Program is a signal to the Smart driver that it should reload its configuration file.

6.1.2 CONFIGURATION EDITOR USAGE

The following figure is an example Tealware remote I/O file in the mbipmast.tlm configuration editor. The elements and sub-elements in the file are presented in a tree format. The element name is at the far left of each tree row.

To the right of the element name, still within the tree row, is a list of **attributes**. When the cursor is positioned on a particular element, the attributes of the element are displayed in a table at the far right side of the editor window. That table is dynamic (eg: depends on the selected element), and has one row for each attribute.

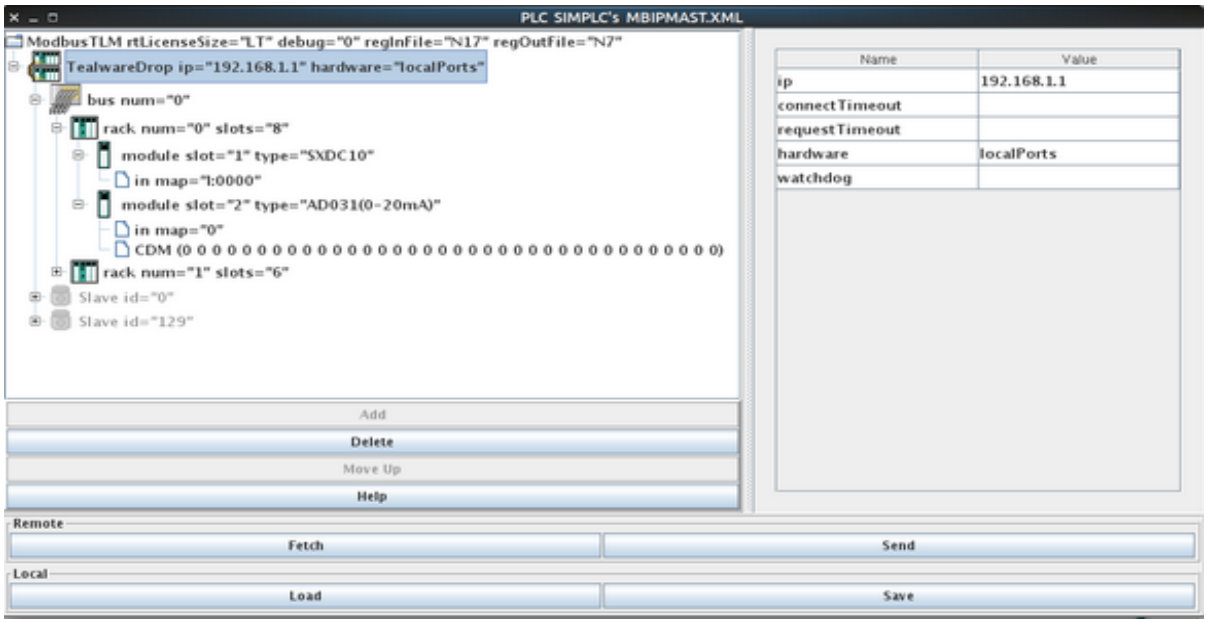

Figure 6.2: MBIPMAST.TLM Configuration Editor Example Display

EDITOR BUTTONS

- *Add* button will insert a new sub-element within the selected element. It is only enabled when you are allowed to add a sub-element to the current element.
- *Delete* button will deleted the selected element. It is only enabled when you are allowed to delete the selected element.
- Help button will load the online user guide for the editor, if you are connected to the internet.
- *Move Up* button will move the selected element up in the current portion of the tree.
- *Fetch, Send, Load, and Save* all have the same meaning as they do in the TOPDOC NexGen Module editor.

POPUP MENUS

There are a number of right click invoked popup menu choices that are available when there is a tree row selected. Choices provide functions to auto-configure, **reallocate/re-assign/sort** elements, to remove gaps in the data table mapping, or make the file easier to read.

6.1.3 MBIPMAST.XML CONFIGURATION FILE STRUCTURE

The table below shows the possible Elements and Sub-Elements you configure for a Tealware Drop in a mbipmast.xml configuration file. Multiple instances of the sub-elements can be present. TOPDOC NexGen takes care of enforcing the rules of the configuration file.

Table 6.1 MBIPMAST.XML Elements & Sub-Elements

MBIPMAST.XML ELEMENTS & SUB-ELEMENTS (FOR TEALWARE DROPS)		
ELEMENT NAME	**DESCRIPTION**	**SUB ELEMENT(S)**
ModbusTLM	Topmost element, holds all other elements.	TealwareDrop
TealwareDrop	A TCPServer that uses the hardware configuration to generate Modbus requests.	bus, rack
bus	References and configures a communications channel which talks to racks.	rack
rack	Holds I/O modules - 3 (backplane3), or 6 or 8 (LocalPorts)	module
module	Identifies a I/O module by its slot position within a rack, and its module type.	in, out, CDM
In	Present only for input modules, identifies where in the SoftPLC datatable the module's input scan data will be placed. For **digital** input modules this must be in the I: section of the datatable.	
Out	Present only for output modules, identifies where in the SoftPLC datatable the module's output scan data will come from. For **digital** output modules this must be from the O: section of the datatable.	
CDM	Present only for some analog and intelligent modules, identifies a block of single shot inline configuration data that the TLM will download to the module for configuration purposes on any transition to RUN mode.	

The attributes for each element type are identified in the table below.

Table 6.2: MBIPMAST.XML Element Attributes

ATTRIBUTES OF MBIPMAST.XML ELEMENTS (FOR TEALWARE DROPS)		
ELEMENT	**ATTRIBUTE**	**VALUE**
ModbusTLM	rtLicenseSize	Runtime license size: LT, 1K, 2K, or 8K. This pertains to the digital I/O capacity of the runtime license (128, 1024, 2048, 8192), as well as the number of allowed slaves, which are 2, 16, 32 and 128 respectively. Setting this correctly allows the editor to help you stay within limits imposed by the SoftPLC runtime when it loads the configuration file.
	debug	0, 1 or 2, meaning "enable none, some, or all debugging print statements" (defaults to 0). Statements are printed to the system log, available from the console.
	regInFile	Is used to establish the datatable file for all analog input data. Any available N: file may be used. The word element for any analog or intelligent input module is then calculated by using the associated **in** element's 'map' attribute as a word offset. For example, if regInFile is N17, and a module's <in map, "14">, then the module's analog data will be moved into a block starting at N17:14 during the I/O scan.

ATTRIBUTES OF MBIPMAST.XML ELEMENTS (FOR TEALWARE DROPS)		
ELEMENT	**ATTRIBUTE**	**VALUE**
	regOutFile	Is used to establish the datatable file for all analog output data. Any available N: file may be used. The word element for any analog or intelligent output module is then calculated by using the associated **out** element's 'map' attribute as a word offset. For example, if regOutFile is N7:0, and a module's <out map, "14">, then the module's analog data will be sourced from a block starting at N7:14 during the I/O scan.
TealwareDrop	ip	The ip address or machine name of the server/slave, e.g. "192.168.12.3" or "packer12"
	hardware	Type of connectivity to the Tealware I/O: 'LocalPorts' or 'backplane3'
	watchdog	Each Tealware I/O module has an internal watchdog timer. This setting is sent to all modules upon a transition to RUN mode that controls how long to wait during a quiet time before a module is to turn off its outputs. Range: 1-14 deciseconds (eg: 7 equates to 7/10ths of a second). Additionally, the special value 0xf0 means do not use the watchdog.
	connectTimeout	Milliseconds to wait for a connection attempt to complete.
	requestTimeout	Milliseconds to wait for a response to a request, for any request contained by this element.
bus	num	The bus number: 0, 1, 2 or 3.
rack	num	The rack number: 0, 1 or 2.
	slots	The number of slots for the rack: 3, 6, or 8.
	digInStart	(Optional) The start address for digital inputs in word form, default is I:0.
	regInStart	(Optional) The starting offset in the regInFile (analog input) set in the TLM element. This is an integer and will be used by the auto-allocation features of the editor.
	digOutStart	(Optional) The start address for digital outputs in word form, default is O:0.
	regOutStart	(Optional) The starting offset in the regOutFile (analog output) set in the TLM element. This is an integer and will be used by the auto-allocation features of the editor.
module	slot	The slot number, which starts at 1, with a range of 1-8
	type	The type (Catalog Number) of Tealware I/O module, picked from a menu.
	scan	If Present and set to “No”, the module is used only for reserving data table space and is ignored by runtime scanning.
in	map	One of two kinds of datatable references, either absolute or relative. The absolute form is an actual datatable address and is used for digital input modules. The relative form is a zero based offset from the absolute starting address given by element “rack’s” regInStart, and is used for non-digital input modules.
out	map	One of two kinds of datatable references, either absolute or relative. The absolute form is an actual datatable address and is used for digital output modules. The relative form is a zero based offset from the absolute starting address given by element “rack’s” regOutStart, and is used for non-digital output modules.

6.1.4 AUTO-CONFIGURATION

To Auto-Configure remotely attached Tealware I/O, install all the I/O modules into the Backplane3 slots, and/or for a LocalPorts system, connect the base(s) to the SoftPLC, install the modules and power supply(s) into the base(s) in the desired configuration. Then power the system, ensuring that the SoftPLC CPU is the last component to be powered.

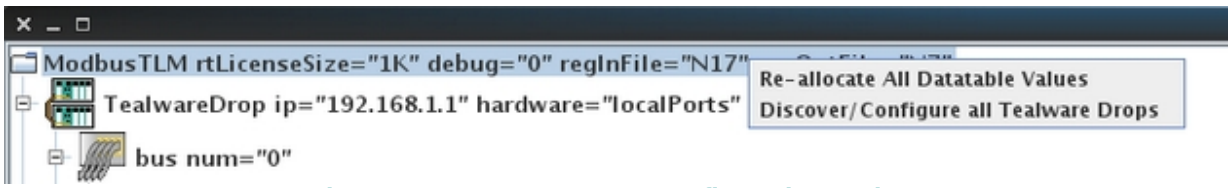

Figure 6.3: MBIPMAST Auto-Configuration Options

Right-clicking on the **ModbusTLM** root element will bring up an option to *Discover/Configure all Tealware Drops*. This performs the same function as Auto-Detect Installed Modules does for an individual TealwareDrop element (described below), but will also find and add any TealwareDrop elements as well as their components.

The configuration editor provides a network discovery utility that can detect which racks and modules are present in a **Tealware Drop**. Selecting the desired **TealwareDrop** element and right-clicking on it will show the menu options for the network discovery utility:

AUTO-DETECT INSTALLED MODULES

This option looks on the network at the IP Address specified for the selected Drop and (if successful) discovers what is present. The components for the TealwareDrop are then added and configured using the auto-increment functionality to assign addresses for the modules, while the CDM data must be manually entered. If you want to specify specific address references for any modules, you can manually change the values after running the auto-configure.

BOOTP PROTOCOL

This option will open a new dialog window that will use the BOOTP Protocol to configure the selected TealwareDrop with an IP Address. The dialog window provides additional instructions for help in configuring the TealwareDrop for BOOTP.

SET IP CONFIGURATION

This option will open another window that will allow you to manually set the permanent IP Address, Subnet Mask, and Default Gateway for the TealwareDrop. Optionally, you may check the Use BOOTP box which allows the TealwareDrop's IP Address to be configured automatically via BOOTP protocol.

WRITE MODULES TO IN-USE ID TABLE

This option will save the module ID codes to the Smart Adapter.

WRITE WATCHDOG VALUE TO NON-VOLATILE REGISTER

This option will write the Tealware Drop's watchdog value to the Smart Adapter.

After you complete the Auto-Configure, you can use TOPDOC NexGen's Module Editor to view / edit the mbipmast.xml file by clicking on the Configure Button, then selecting Fetch. You can backup the configuration to your PC by selecting Save.

If you want to Auto-Configure and a configuration file already exists, you simply need to delete the mbipmast.xml file (using the Linux console), and then restart or cycle power to the SoftPLC.

Currently the Auto-Configuration function uses N7 and N17 as the data table files for register (analog) module data. If you want to use different files, you can still use the Auto-Configuration function, and then re-map the analog I/O by editing only the first line in the mbipmast.xml file.

The Auto-Configuration function uses only the I/O module physical locations to determine the I/O mapping. If you have an existing softplc.app (application program) and you Auto-Configure with a different physical I/O configuration, your logic may no longer be suitable. Unexpected or dangerous machine operation could result.

6.2 LADDER INSTRUCTIONS

The ModbusIP Master Driver includes a number of custom ladder instructions (TLI's) that are useful for communication diagnostics and fault situations. These are described in detail in the online user manual.

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Part 3
I/O Modules

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CHAPTER 7 - I/O MODULE GENERAL OVERVIEW

The remaining Chapters of this User Guide includes the specifications, wiring diagrams, and configuration details for the currently available Tealware I/O modules. Also included is setup and programming information for the analog and special purpose modules.

CAUTION

SoftPLC datatable mapping for modules is related to their location in the I/O base. Changing the type of module in a slot could cause unexpected or unwanted operation of the system. Verify the I/O driver configuration XML file with both the physical modules and the SoftPLC application logic if you make changes to the type or location of I/O modules.

7.1 I/O MODULE FEATURES

7.1.1 LED'S

ACT LED

All modules have an ACT (Active) LED. The ACT LED will flash quickly (~5Hz) if the SoftPLC CPU is servicing the module. If the CPU does not service the module for more than 0.2 seconds, the ACT LED will flash slowly (~every 4 seconds).

Figure 7.1 : Tealware I/O Module

DIGITAL I/O STATUS LED'S

All digital modules, the high speed counter module (Cat No HSC11), and some temperature modules include status LED's for each discrete I/O point to indicate on / off status. The LED is ON if the connected point is ON.

FB LED

Digital output modules have an FB (Fuse Blown) LED that goes ON when any of the internal fuses blows.

NP LED

Relay and Analog output modules have an NP (No Power) LED that goes ON if there is no external power supply 24VDC detected or an external fuse has blown.

CH*X* (ERR) LED'S

Analog and temperature modules have LED's that can be used to indicate various errors or problems. Refer to the section on each module for details on the meaning of these LED's.

7.1.2 FIELD WIRING ATTACHMENT

Most modules have a detachable terminal block for external field wiring. You can remove the terminal block by loosening 2 screws without having to disturb the field wiring. High density modules connect via a cable to a terminal block (see section 7.2).

CAUTION

All discrete I/O modules and most analog modules can be hot-swapped with an equivalent replacement module while the system is powered on without damage to the modules. Some analog and special modules may NOT be removed under power without causing damage to the module's circuitry. Refer to the module specifications before removing them under power.

7.1.3 DIP SWITCHES

Some modules have DIP switches that determine signal type, scaling, and other features. Most DIP switches are available on the back (slot-edge) side of the module, but in some instances the DIP switches are only accessible by removing the plastic cover.

DIP switches are numbered from 1 up. When the switch is pushed down toward the number, that is considered the ON position.

Figure 7.2: DIP Switch Location on Rear of I/O Module

Figure 7.3: Module DIP switch setting

7.2 AUXILIARY EQUIPMENT FOR HIGH DENSITY MODULES

7.2.1 XDC20-TB, HDIO-CBL

The 32-point digital modules (Cat No SXDC20, SYDC30, SYDC40) require an external DIN rail mountable terminal block for wiring (Cat No XDC20-TB). Maximum wire size is #14 AWG. However, it is recommended to use wires of 0.75 mm2 (#18 AWG) for best results.

SoftPLC offers pre-made 3-foot cables that connect the module to the terminal block (Cat No HDIO-CBL).

D-shell connector parts are included with the modules and XDC20-TB for customers who wish to build their own cable.

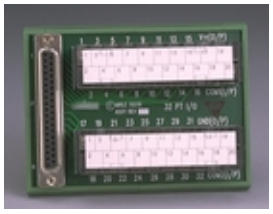


Figure 7.4: XDC20-TB Terminal Block

Figure 7.6: HDIO-CBL High Density Module to Terminal Block Cable

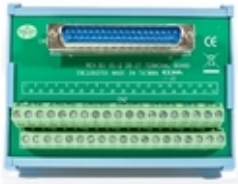


Figure 7.5: AD04x-TB Terminal Block

7.2.2 AD04X-TB, HDIO-CBL

The AD046, AD047, and RTD26 Modules require an external DIN rail mountable terminal block for wiring (Cat No AD04x-TB). Maximum wire size is #14 AWG. However, it is recommended to use wires of 0.75 mm2 (#18 AWG) for best results.

SoftPLC offers pre-made 3-foot cables that connect the module to the terminal block (Cat No HDIO-CBL.)

D-shell connector parts are included with the modules and XDC20-TB for customers who wish to build their own cable.

7.3 CONFIGURATION DATA MEMORY (CDM)

Most Tealware analog input and special purpose modules have a Configuration Data Memory (CDM) file. The CDM file provides access to certain features, such as engineering unit scaling, low and high limit testing and disabling unused channels to reduce the total processing time of the module. The CDM file can be programmed using TOPDOC NexGen's I/O driver configuration editors, and for local I/O with the Smart I/O Driver's CDMW ladder instruction.

This section provides information on the use of the CDM File that applies to all analog input modules. Specific CDM File memory layout and other details are described in the section for each individual module.

CDM values for each word are programmed as signed integers. For CDM words that represent a mapped set of bits, you must still enter the value as an integer. For example, if you want to set only bit number 11 to a “1” (which is 0800H), use 2048 as the integer value.

HINT

To easily enter bit-mapped CDM values, use the Windows Calculator accessory in Programmer Mode with the “Bit Toggling Keypad” enabled. Set the desired bits in the keypad and the equivalent integer value will be displayed in the top portion of the Calculator window.

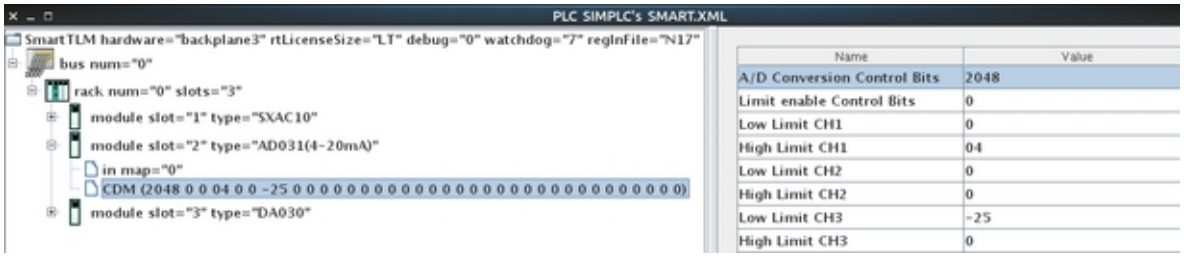


Figure 7.7: Setting CDM values with I/O Driver Configuration Editors

7.3.1 CHANNEL ENABLE/DISABLE BITS

The CDM file has one 16 bit word that can be used to disable certain input channels. By default, all channels are enabled, which equates to a bit value of “0”. To disable a channel, set the conversion disable flag bit corresponding to that channel to “1”.

7.3.2 HIGH / LOW LIMIT VALUES AND CONTROL BITS

The default is that low/high limit checking is disabled. If you do want to use low/high limit checking for an input channel, you need to set the appropriate low/high control bits and enter the desired limits into the CDM file. A bit value of “1” enables limit comparison.

If a low/high limit control bit is set to ‘1’, the module will compare the channel’s input signal to the entered low and/or high limit values in the CDM file. The low/high limit values should be entered in the same units (raw or engineering) as the channel input values.

If the input channel value is lower or higher than the corresponding limit in CDM, the corresponding low/high limit flag bit of the status register in the scan data registers will be set to ‘1’.

7.3.3 ENGINEERING UNIT SCALING

The data value for each input channel may be represented by the raw conversion data defined by the module or as user-defined engineering data. The CDM contains Conversion Data Type bits corresponding to each channel. The default status is ‘0’, which indicates that the conversion data type for each channel is raw data. If you set the bit to “1”, the conversion data type will be engineering units.

For each channel designated as engineering data, you set a low and high engineering value in the appropriate CDM addresses. The module will linearly convert the channel's input value based on the defined range of high/low engineering setting values, and store it in the corresponding channel input registers in the scan data registers.

NOTE

If the low engineering value is larger than high engineering value, the value of the channel scan data register will be '0'.

7.3.4 READING THE CDM FILE FROM THE MODULE

For local I/O configurations, if you want to verify the contents of a module's CDM file, a ladder instruction called CDMR is provided with the Smart I/O driver. This instruction can be accessed from the TLI icon at the top of the TOPDOC NexGen ladder editor panel.

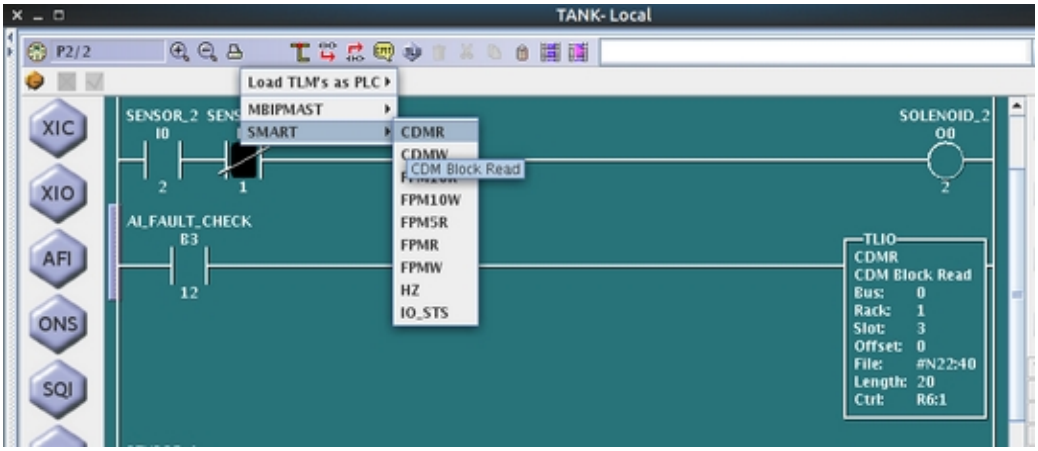


Figure 7.8: CDMR Ladder Instruction

In the CDMR instruction, the Offset is the starting address offset within the CDM you want to read the data, and the length is the number of consecutive words to be read. The File is an integer datatable location in the SoftPLC CPU where the CDM values will be written. The Bus, Rack, Slot and offset can be entered as fixed constants or datatable addresses.

7.4 ANALOG/SPECIAL MODULE PROGRAMMING USING CDMW/CDMR

CDM File programming can be done in the I/O Driver Configuration Editors (local = smart.tlm, ethernet = mbipmast.tlm). Alternatively, you can use ladder instructions that are available through the I/O Drivers to program and to read a module's CDM file.

This Appendix is an example of CDM programming for a variety of analog modules. The figure on the next page is the data table memory map (smart.xml) that was created automatically by the Smart I/O driver for this sample configuration. In the file listing, "in map" indicates the start word in N17 where the module's "Input Scan Registers" are mapped and "out map" indicates the start word in N7 where the module's "Output Scan Registers" are mapped.

There are two (2) TOPDOC Ladder Instructions (TLI's) available for reading and writing to the non-volatile CDM within the Tealware I/O modules. The CDM Read (CDMR) TLI can be used to read the current configuration values from the CDM and the CDM Write (CDMW) can be used to modify the configuration memory. In most cases, only the CDMW instruction will be utilized.

Each instruction has seven (7) parameters, which include:

Table 7.1: Parameters in CDMx Instructions

PARAMETERS FOR CDMx INSTRUCTIONS		
Drop	Local or remote drop number	0 to 3
Rack	Local rack number	0 to 2
Slot	Where module is installed in rack	1 to 8
Offset	Offset within CDM	0 and up
File	Integer file to store the data	(ie: #N11:n)
Length	Module's CDM File size (LEN of Ctrl)	1+
Ctrl	Control element	(ie: R6:n)

Both the CDMR and CDMW instructions are available from the TLI icon in TOPDOC NexGen when the Smart Driver or the ModbusTCP Master driver are used. For Local APP editing with TOPDOC NexGen, a PLC configuration must first be created and then selected in the Local APP Editor using the TLI's icon "Load TLM's as PLC."

Normally, the configuration settings for an analog module only need to be set once during the first ladder scan. SoftPLC's internal Status File contains a "Processor First Program Scan Status Bit" (S:1/15) which is set true (1) during the first ladder scan and then reset to false (0) on the next and subsequent scans. This status bit is a perfect choice to be assigned to a permissive normally open contact (XIC) prior to execution of the CDMW TLI.

It is vital that the CDMW TLI executes during the single scan that it will be activated. If the instruction's Control Element status word's (R6.n.CTL) done (DN) or error (ER) bit is set when the rung transitions to TRUE, the CDMW instruction will not execute. To insure this does not happen, it is recommended that R6.n.CTL be cleared using SoftPLC's "CLR" instruction prior to executing the CDMW instruction.

Table 7.2: smart.tlm XML Settings for Analog Programming Example

```
<?xml version, "1.0"?>
<!DOCTYPE SmartTLM_v1.0 SYSTEM "SmartTLM.dtd">
<SmartTLM_v1.0 debug, "0" watchdog, "7" digInStart, "I:0" regInStart, "N17" digOutStart, "O:0" regOutStart, "N7">
    <bus num, "1">
        <rack num, "0" slots, "8">
            <module slot, "1" type, "AD020(1-5V)">
                <in map, "0"/>
            </module>
            <module slot, "2" type, "AD030(0-10V)">
                <in map, "5"/>
            </module>
            <module slot, "3" type, "DA020(0-10V)">
                <out map, "0"/>
            </module>
            <module slot, "4" type, "ADA020">
                <in map, "15"/>
                <out map, "5"/>
            </module>
            <module slot, "5" type, "THM10">
                <in map, "20"/>
                <out map, "8"/>
            </module>
            <module slot, "6" type, "RTD10">
                <in map, "26"/>
            </module>
            <module slot, "7" type, "HSC11">
                <in map, "31"/>
                <out map, "14"/>
            </module>
        </rack>
    </bus>
</SmartTLM_v1.0>
```

A companion ladder program is provided in Listing 1 that illustrates the techniques discussed above and implements the programming for each module as described in the discussion below. In the example program, integer file 11 is used as the source data file for the CDMW TLI and it has a maximum length of two hundred and sixty-eight words (N11:000-267). Each module that has a CDM File interface has an area allocated for its maximum CDM file requirement. A complete data table map of the contents of Integer file 11 is provided in Listing 2.

An example is also provided that shows a case when the CDMR TLI might be used. Please see the discussion on the HSC11 module in slot 7 for details.

HINT

In order to fully understand the discussion below it is recommended that the CDM File definition for each module type be consulted as a reference.

SLOT 1: AD020 - 4 CHANNEL ANALOG INPUT MODULE

Rung P2/0 of the example program illustrates how to insure that the defaults are set for a module. In this case, the default setting would be to fill the entire 20 word CDM File with zeros and write the data to the module using the CDMW TLI. The CDM File is preset to zeros using SoftPLC's "File Fill" (FLL) ladder instruction prior to execution of the CDMW TLI. Since the module settings are set in non-volatile memory, adding this step to your program insures that if the module is replaced in the field that the defaults will be reset prior to channel processing. The CDM source file values are set as follows:

CDM [0]	N11:0 , 0	Zero entire CDM File
...	...	
CDM[19]	N11:19 , 0	

SLOT 2: AD030A - 8 CHANNEL ANALOG INPUT MODULE

Rung P2/1 of the example program illustrates how to setup this module to use the internal engineering scaling feature. It also exemplifies use of the CDMW offset variable to write to a segment of the CDM starting somewhere within the CDM; in this case starting at offset 19. The engineering data type enable bits are located in the low byte of file offset 19 and the minimum and maximum engineering values are set in file offsets 20 thru 35. To specify that all channels use engineering units, offset 19 must be set to 255 (00FFh). If all eight (8) channels are to be set to a minimum value of zero (0) and a maximum value of ten thousand (10000) then the source file would be set as follows:

CDM [19]	N11:49 , 255	(00FFh)	Conversion Data Type
CDM [20]	N11:50 , 0		CH1 Minimum
CDM [21]	N11:51 , 10000		CH2 Maximum
...	...		...
CDM [34]	N11:64 , 0		CH8 Minimum
CDM [35]	N11:65 , 10000		CH8 Minimum

SLOT 3: DA020 - 4 CHANNEL ANALOG OUTPUT MODULE

No CDM file.

SLOT 4: ADA020 - 4 CHANNEL ANALOG INPUT & 2 CHANNEL ANALOG OUTPUT MODULE

Rung P2/2 of the example program illustrates disabling unused analog input channel 4 to decrease the module update time. In this case, the control register, CDM file offset 1, is set to 2048 (0800h). For example:

CDM[1]	N11:71 , 2048	(0800h)	Control Register

SLOT 5: THM10 - 5 CHANNEL THERMOCOUPLE MODULE

Rung P2/3 of the example program illustrates setting the data conversion type for all five (5) channels to degrees C. In this case, the Data Conversion Type word at CDM File offset 21 is set to 31 (001Fh). For example:

CDM[21]	N11:101 , 31	(001Fh)	Data Conversion Type

SLOT 6: RTD10 - 4 CHANNEL RESISTIVE THERMOMETER

Rung P2/4 of the example program illustrates setting the Low / High Limits for Channel 1 and disabling Channels 2 thru 4. In this case the control word at CDM File offset 1 is set to 3587 (0E03h). The Low and High limits are then set in offsets 2 and 3 respectively. For example:

CDM[1]	N11:131 , 3587	(0E03h)	Conversion Data Type
CDM[2]	N11:132 , 320	(032.0 Deg C)	CH1 Low Limit
CDM[3]	N11:133 , 1220	(122.0 Deg C)	CH1 High Limit

SLOT 7: HSC11 - 3 CHANNEL HIGH SPEED COUNTER

Rung P2/5 of the example program illustrates how to set the “Preset Value” and enable the External Outputs (O1, O2 & O3) to be energized when the counter value is greater than or equal to (≥) a “Comparison Value”. For this example the “External Output Enable” byte at CDM File offset 2 must be set to 56 (38h) to enable the three (3) Outputs. Then the Output Comparison Value for channels 1 thru 3 (offsets 15 to 20) must be set to a value; in this case 1000. Finally, the channel’s Preset Values (offsets 3 to 8) are also set to 1000.

After the configuration is completed on the first scan, the counter value in the Input Data Scan Registers (N17:32-37) will be set to the Preset Value of 1000 whenever the channels “Count Enable” bit is set to true (1) in the Output Data Scan’s Command Register (N7:14). As a result of the counter being preset to 1000, the outputs O1, O2, and O3 will be energized because the value is equal to the comparison value.

CDM[2]	N11:142 , 56	(38h)	External Output Enable (low byte)
CDM[3]	N11:143 , 0		CH1 Preset Value (high word)
CDM[4]	N11:144 , 1000		CH1 Preset Value (low word)
CDM[5]	N11:145 , 0		CH2 Preset Value (high word)
CDM[6]	N11:146 , 1000		CH2 Preset Value (low word)
CDM[7]	N11:147 , 0		CH3 Preset Value (high word)
CDM[8]	N11:148 , 0		CH3 Preset Value (low word)
...	...		
CDM[15]			CH1 Output Comparison Value (high word)
CDM[16]			CH1 Output Comparison Value (low word)
CDM[17]			CH2 Output Comparison Value (high word)
CDM[18]			CH2 Output Comparison Value (low word)
CDM[19]			CH3 Output Comparison Value (high word)
CDM[20]			CH3 Output Comparison Value (low word)

The HSC11 is one of the exception modules that has some read only data values within the CDM. In this case, the saturation flag status bits are located in the CDM File at offset 27. If the counter was configured to run in Saturation Mode (CDM offset 1 low byte = 03h), then the saturation status bits would need to be monitored. Rung P2/6 shows an example of reading the saturation flag register into a single binary address B12:0.

LISTING 1: LADDER DIAGRAM

TOPDOC NexGen 1.5.090306

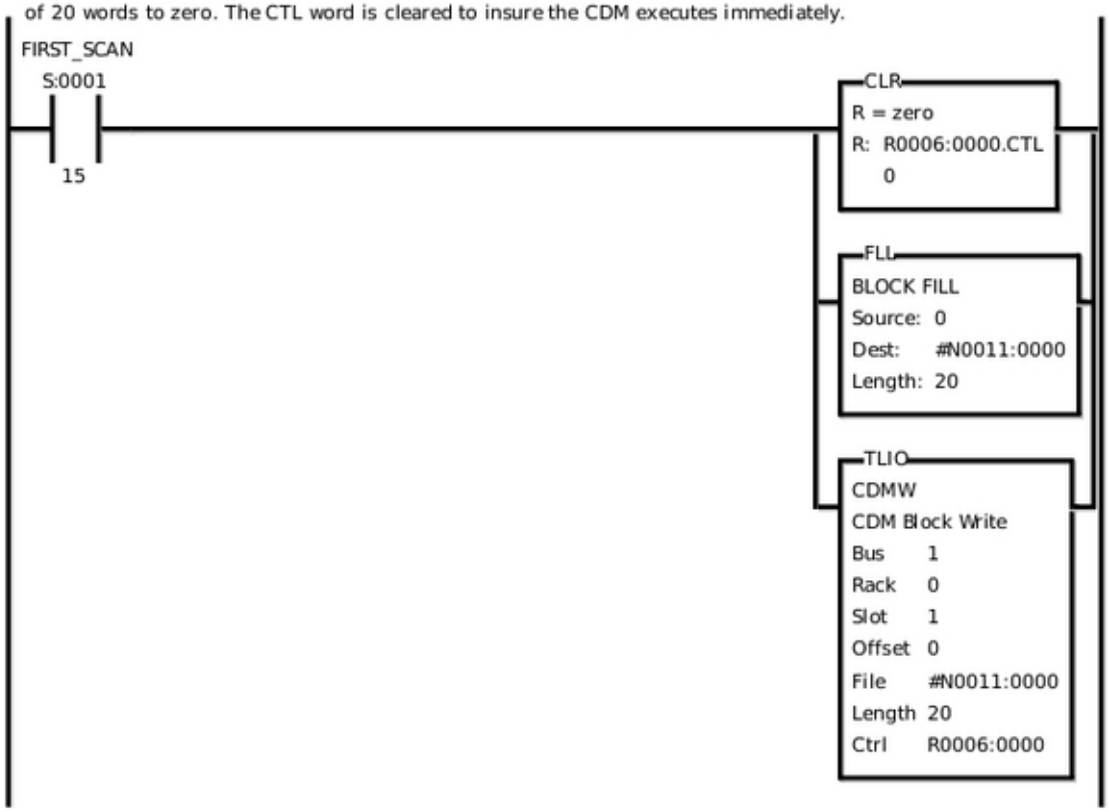
App: AMOD_MEX
Comment: null
Modified by: DEFAULT, Wed May 5 09:37:52 2010

Page: 1
Printed: Wed May 05 13:44:15 CDT 2010

Ladder Diagram

P2/0 AD020 - 4 CHANNEL ANALOG INPUT MODULE

Example of setting the module so that all channels are enabled and the Data Type is RAW. Since this is the default setting, the CDM Block Write is not required unless the previous settings were different than the defaults. To restore the default settings, set the entireCDM file of 20 words to zero. The CTL word is cleared to insure the CDM executes immediately.



TOPDOC NexGen 1.5.090306

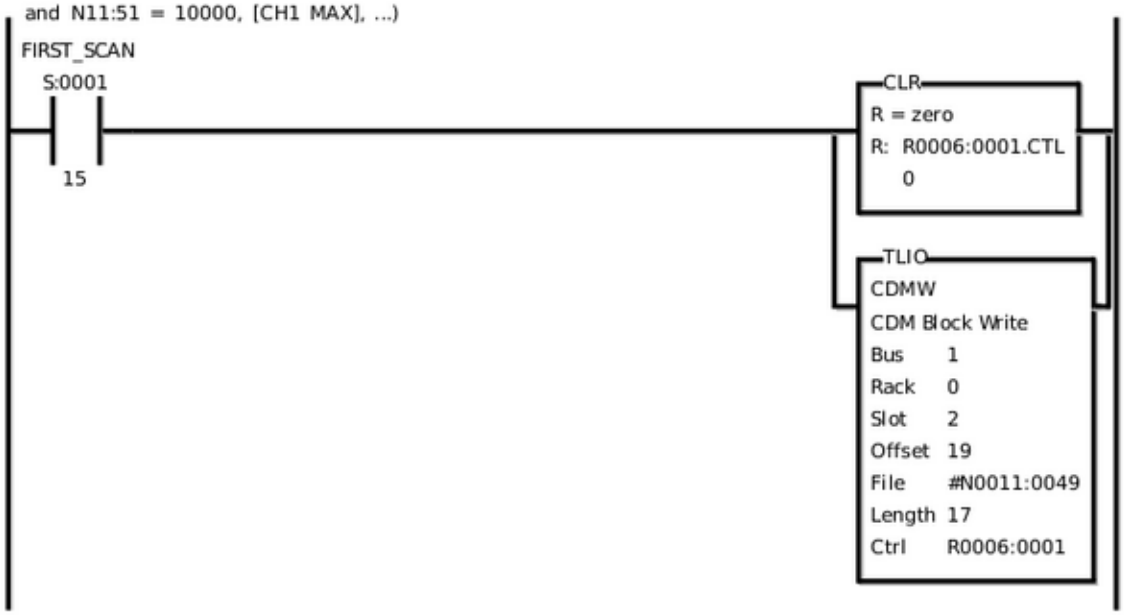
App: AMOD_MEX
Comment: null
Modified by: DEFAULT, Wed May 5 09:37:52 2010

Printed: Wed May 05 13:44:15 CDT 2010

Ladder Diagram

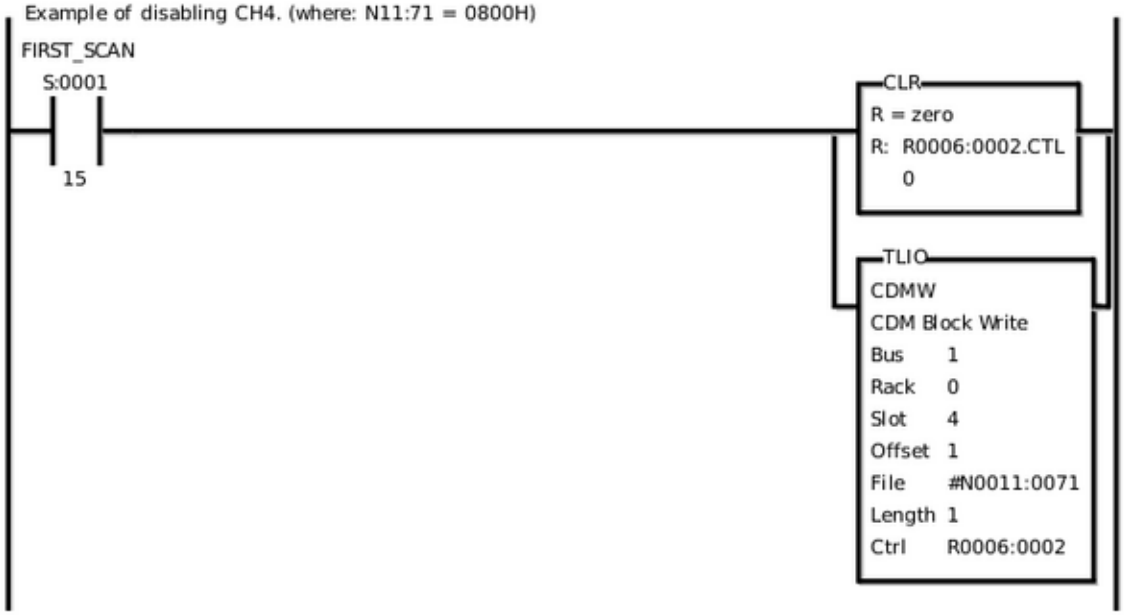
P2/1 AD030 - 8 CHANNEL ANALOG INPUT MODULE

Example of setting Engineering Units scaling for all 8 channels. In this case, only the upper half of the CDM words needs to be set. (Where: N11:49=00FFH, then N11:50 = 0 [CH1 MIN] and N11:51 = 10000, [CH1 MAX], ...)



P2/2 ADA020 - 4 CHANNEL ANALOG INPUT / 2 CHANNEL ANALOG OUTPUT MODULE

Example of disabling CH4. (where: N11:71 = 0800H)



TOPDOC NexGen 1.5.090306

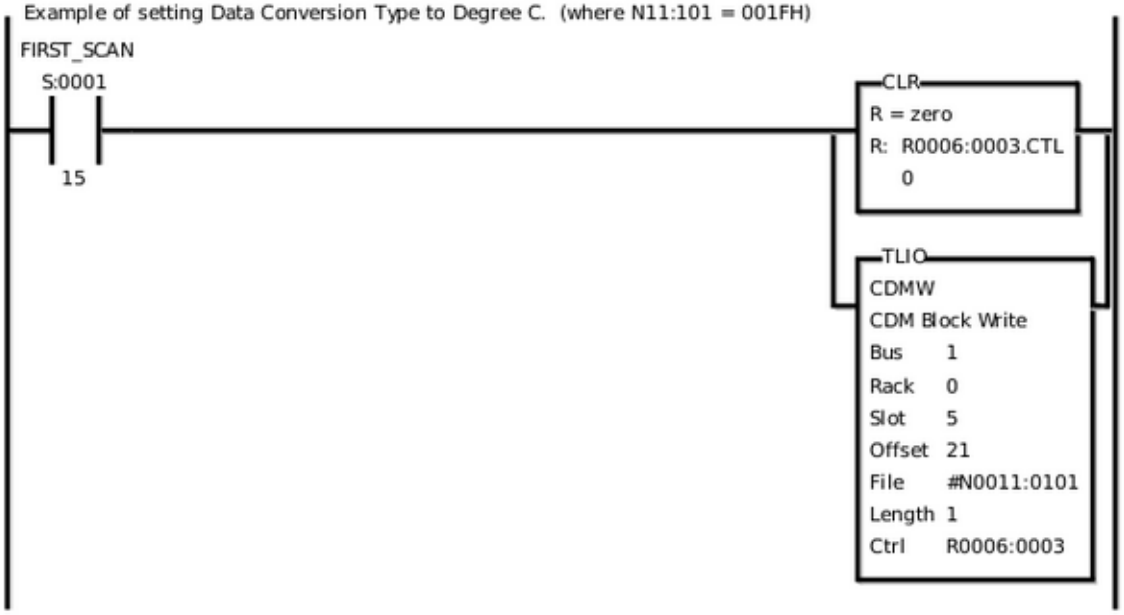
App: AMOD_MEX
Comment: null
Modified by: DEFAULT, Wed May 5 09:37:52 2010

Printed: Wed May 05 13:44:15 CDT 2010

Ladder Diagram

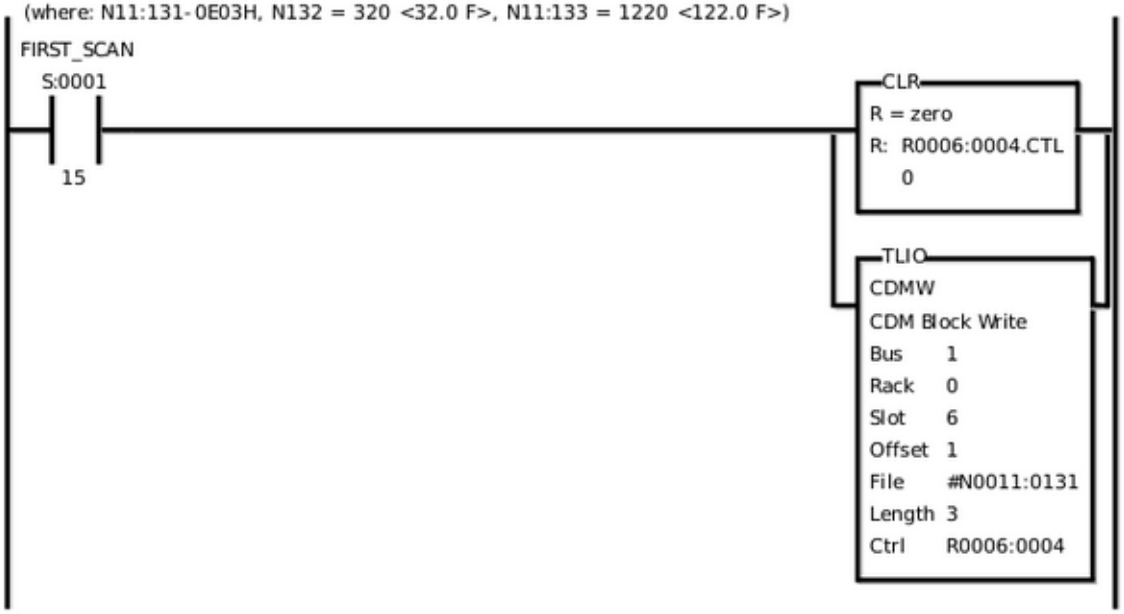
P2/3 THM10 - 5 CHANNEL THERMOCUPLE MODULE

Example of setting Data Conversion Type to Degree C. (where N11:101 = 001FH)



P2/4 RTD10 - 4 CHANNEL RESISTANCE THERMOMETER MODULE

Example of setting the Low/High Limits in Degree F for CH1 and disable of CH2, CH3, and CH4.
(where: N11:131-0E03H, N132 = 320 <32.0 F>, N11:133 = 1220 <122.0 F>)



TOPDOC NexGen 1.5.090306

App: AMOD_MEX
Comment: null
Modified by: DEFAULT, Wed May 5 09:37:52 2010

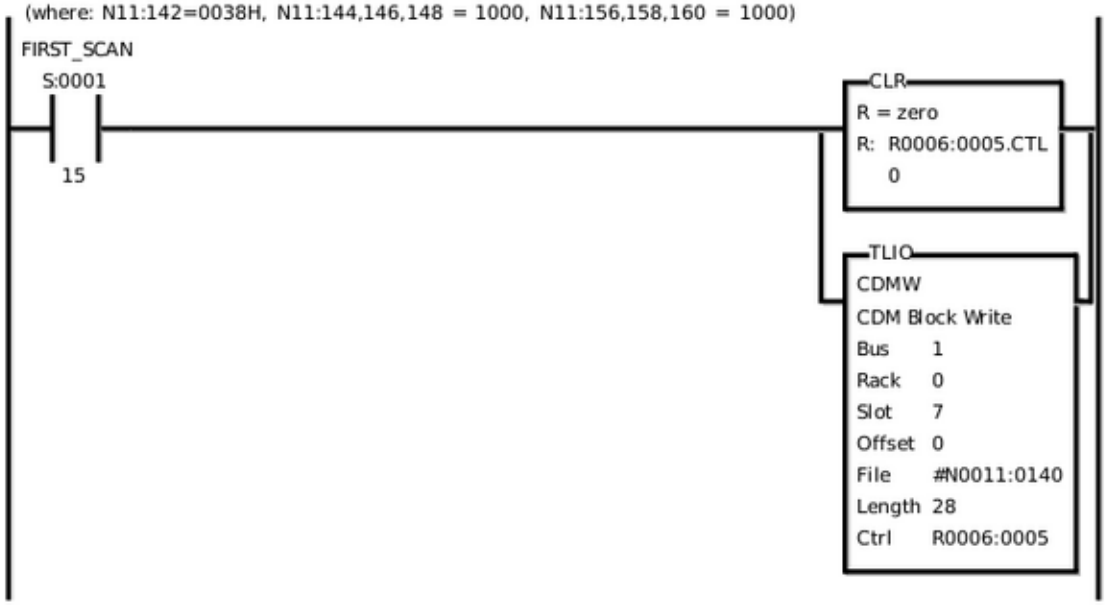
Page: 4
Printed: Wed May 05 13:44:15 CDT 2010

Ladder Diagram

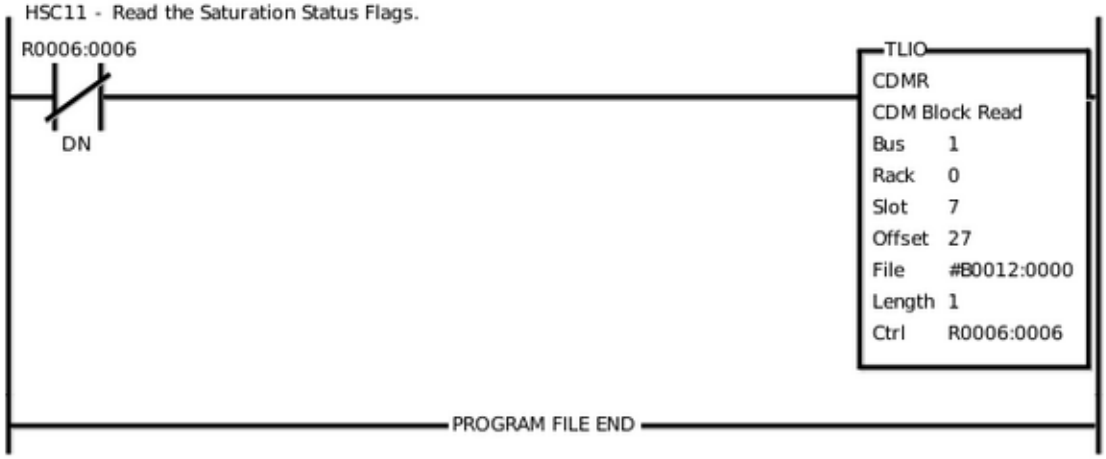
P2/5 HSC11 - 3 CHANNEL HIGH SPEED COUNTER

Example of setting the Preset and Comparision values to 1000 and the External Ouputs (O1,O2,O3) to be ON when the channel value is ">=" the comparision value.

(where: N11:142=0038H, N11:144,146,148 = 1000, N11:156,158,160 = 1000)



P2/6 HSC11 - Read the Saturation Status Flags.



P2/7 PROGRAM FILE END

LISTING 2: CDM INTEGER SOURCE FILE 11 DATA TABLE CONTENTS

TOPDOC NexGen 1.5.090306

App: AMOD_MEX Page: 5
Comment: null
Modified by: DEFAULT, Wed May 5 09:37:52 2010 Printed: Wed May 05 13:44:15 CDT 2010

Data Table Report

Address	+0	+1	+2	+3	+4	+5	+6
N0011:0000	0	0	0	0	0	0	0
N0011:0007	0	0	0	0	0	0	0
N0011:0014	0	0	0	0	0	0	0
N0011:0021	0	0	0	0	0	0	0
N0011:0028	0	0	0	0	0	0	0
N0011:0035	0	0	0	0	0	0	0
N0011:0042	0	0	0	0	0	0	0
N0011:0049	255	0	10000	0	10000	0	10000
N0011:0056	0	10000	0	10000	0	10000	0
N0011:0063	10000	0	10000	0	10000	0	10000
N0011:0070	0	2048	0	0	0	0	0
N0011:0077	0	0	0	0	0	0	0
N0011:0084	0	0	0	0	0	0	0
N0011:0091	0	0	0	0	0	0	0
N0011:0098	0	0	0	31	0	0	0
N0011:0105	0	0	0	0	0	0	0
N0011:0112	0	0	0	0	0	0	0
N0011:0119	0	0	0	0	0	0	0
N0011:0126	0	0	0	0	0	3587	320
N0011:0133	1220	0	0	0	0	0	0
N0011:0140	0	0	56	0	1000	0	1000
N0011:0147	0	1000	0	0	0	0	0
N0011:0154	0	0	1000	0	1000	0	1000
N0011:0161	0	0	0	0	0	0	0
N0011:0168	0	0	0	0	0	0	0
N0011:0175	0	0	0	0	0	0	0
N0011:0182	0	0	0	0	0	0	0
N0011:0189	0	0	0	0	0	0	0
N0011:0196	0	0	0	0	0	0	0
N0011:0203	0	0	0	0	0	0	0
N0011:0210	0	0	0	0	0	0	0
N0011:0217	0	0	0	0	0	0	0
N0011:0224	0	0	0	0	0	0	0
N0011:0231	0	0	0	0	0	0	0
N0011:0238	0	0	0	0	0	0	0
N0011:0245	0	0	0	0	0	0	0
N0011:0252	0	0	0	0	0	0	0
N0011:0259	0	0	0	0	0	0	0
N0011:0266	0	0					

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CHAPTER 8 - DISCRETE INPUT MODULES

Table 8.1: Discrete Input Modules Summary

DISCRETE INPUT MODULES SUMMARY					
TYPE	**OPERATING VOLTAGE**	**NUMBER OF POINTS**	**RESPONSE TIME**	**RATED CURRENT / POINT**	**CATALOG NUMBER**
AC Input Photocoupler	85 to 132 VAC	16 points 8 points / COM	On < 20 ms Off < 35 ms	15 mA @ 110 VAC	SXAC10
DC Input Sink / Source	9 to 28 VDC	16 points 8 points / COM	On < 2 ms Off < 2 ms	3 mA @ 12 VDC 7 mA @ 24 VDC	SXDC10
DC Input Sink	9 to 28 VDC	32 points 16 points / COM	On < 2 ms Off < 2 ms	3 mA @ 12 VDC 7 mA @ 24 VDC	SXDC20

8.1 SXAC10 - 16 POINT 110 VAC INPUT MODULE

Table 8.2: SXAC10 Specifications

SXAC10 SPECIFICATIONS		
Number of input points		16 points
Rated input voltage		100 to 120 VAC, 50 to 60 Hz
Rated input current		15 mA (110 VAC, 60 Hz)
Operating voltage range		85 to 132 VAC (50 to 60 Hz +/- 5%)
Turn ON state		Higher than 80 VAC / 9 mA
Turn OFF state		Lower than 30 VAC / 2 mA
Input impedance		10KΩ (60 Hz)
Maximum Simultaneous input points		100% simultaneous ON (at 110 VAC)
Response time	OFF→ON	20 ms or less
	ON→OFF	35 ms or less
Common terminal arrangement		8 points / common
Internal current consumption		max 100 mA, (all points ON)
External connections		20pt terminal block, max wire size #14 AWG
Weight		285 g

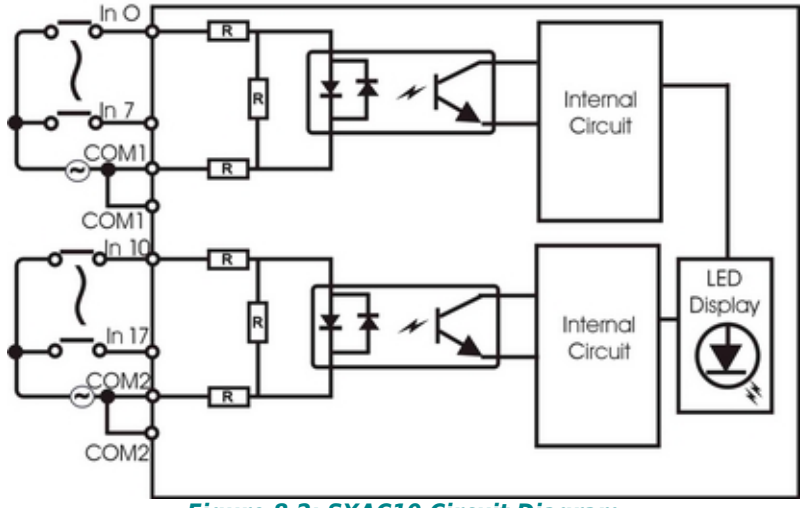

Figure 8.2: SXAC10 Circuit Diagram

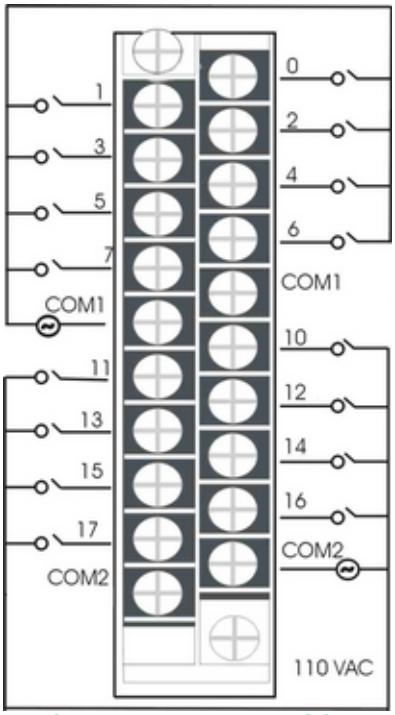

Figure 8.1: SXAC10 Wiring Diagram

8.2 SXDC10 - 16 POINT 12/24 VDC INPUT MODULE

Table 8.3: SXDC10 Specifications

SXDC10 SPECIFICATIONS			
Number of input points		16 points, Sink/Source	
Insulation method		Photocoupler	
Rated input voltage		12 VDC	24 VDC
Rated input current		3 mA	7 mA
Operating voltage range		9 VDC to 28 VDC	
Turn ON state		Higher than 8 VDC / 2 mA	
Turn OFF state		Lower than 4 VDC / 1 mA	
Input impedance		3.3 KΩ	
Maximum Simultaneous input points		100% simultaneous ON (at 28 VDC)	
Response time	OFF→ON	2 ms or less (24 VDC)	
	ON→OFF	2 ms or less (24 VDC)	
Common terminal arrangement		8 points / common	
Internal current consumption		max 100 mA (all points ON)	
External connections		20pt terminal block, max wire size #14 AWG	
Weight		255 g	

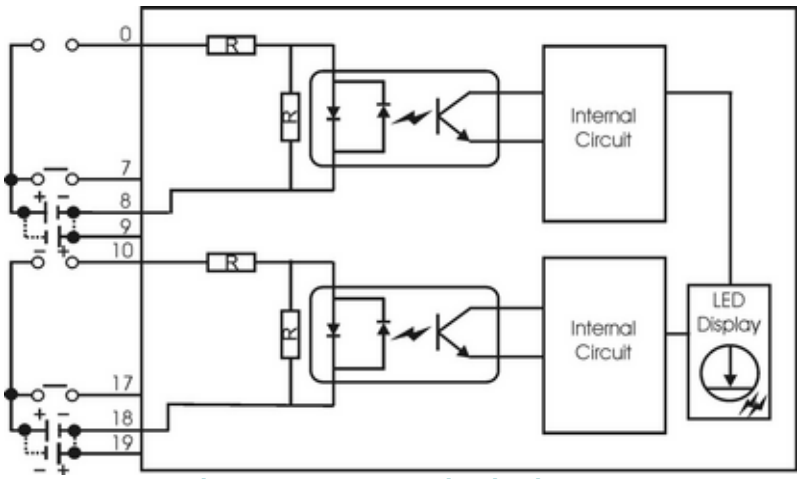

Figure 8.4: SXDC10 Circuit Diagram

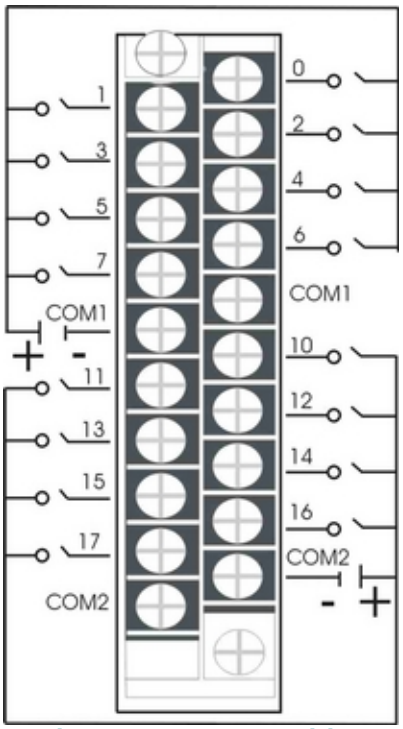

Figure 8.3: SXDC10 Wiring Diagram

NOTE

Wiring diagram is for SINK wiring. For SOURCE wiring, change the polarity of the DC power source.

8.3 SXDC20 - 32 POINT 12/24 VDC INPUT MODULE

Table 8.4: SXDC20 Specifications

SXDC20 SPECIFICATIONS			
Number of input points		32 points, Sink / Source	
Insulation method		Photocoupler	
Rated input voltage		12 VDC	24 VDC
Rated input current		3 mA	7 mA
Operating voltage range		9 to 28 VDC	
Turn ON state		Higher than 8 VDC / 2 mA	
Turn OFF state		Lower than 4 VDC / 1 mA	
Input impedance		3.3 K Ω	
Maximum simultaneous input points		100% simultaneous ON (at 28 VDC)	
Response time	OFF→ON	2 ms or less (24 VDC)	
	ON→OFF	2 ms or less (24 VDC)	
Common terminal arrangement		16 points / common	
Internal current consumption		max 180 mA (all points ON)	
External connections		37-pt. D sub connector	
Weight		265 g	

NOTE

This module requires purchase of a high density I/O cable (Cat No HDIO-CBL) and terminal block (Cat No XDC20-TB).

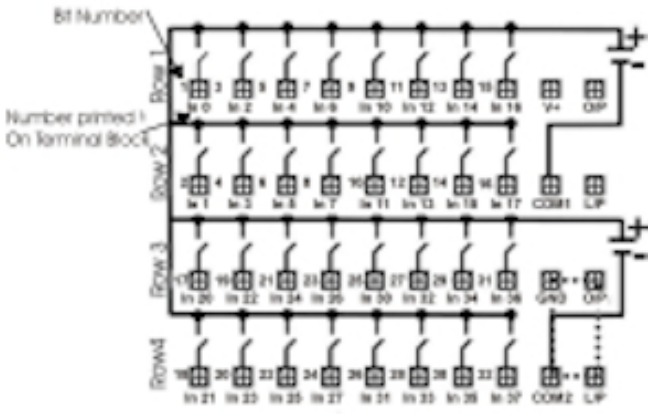

Figure 8.5: SXDC20 Wiring to Terminal Block (Cat No XDC20-TB)

NOTE

Wiring diagram is for SINK wiring. For SOURCE wiring, change the polarity of the DC power source.

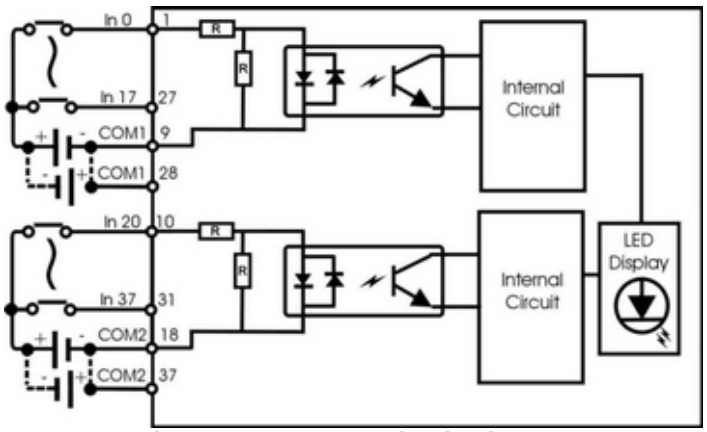

Figure 8.6: SXDC20 Circuit Diagram

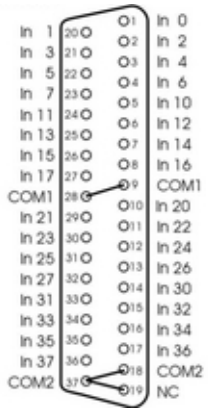

Figure 8.7: SXDC20 Module Connector Pinout

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CHAPTER 9 - DISCRETE OUTPUT MODULES

Table 9.1: Discrete Output Modules Summary

DISCRETE OUTPUT MODULES SUMMARY						
TYPE	**OPERATING VOLTAGE**	**EXT 24VDC P/S REQ'D?**	**NUMBER OF POINTS**	**RESPONSE TIME**	**RATED CURRENT PER POINT**	**CATALOG NUMBER**
AC Output	85 to 264 VAC	No	16 pts., 8 / COM Fuses (2) 5A	On <1/2 cycle-1 ms Off < 1/2 AC cycle	0.6 A / pt 4.8 A / Com	SYAC10
DC Output NPN / Sink	10 to 35 VDC	Yes	16 pts., 8 / COM Fuses (2) 2A	On < 2 ms Off < 2 ms	0.1 A / pt 0.8 A / fuse	SYDC10
DC Output PNP / Source	10 to 35 VDC	Yes	16 pts., 8 / COM Fuses (2) 2A	On < 2 ms Off < 2 ms	0.1 A / pt 0.8 A / fuse	SYDC20
DC Output NPN / Sink	10 to 35 VDC	Yes	32 pts., 32 / COM Fuses (4) 2A	On < 2 ms Off < 2 ms	0.1 A / pt 0.8 A / fuse	SYDC30
DC Output PNP / Source	10 to 35 VDC	Yes	32 pts., 32 / COM Fuses (4) 2A	On < 2 ms Off < 2 ms	0.1 A / pt 0.8 A / fuse	SYDC40
Relay Output Dry	5 to 125 VDC 12 to 250 VAC	Yes	16 pts., 8 / COM	On < 10 ms Off < 5 ms	2 A / pt 8 A / Com	SYRY10
Relay Output Dry	12 to 125 VDC 12 to 250 VAC	Yes	16 pts., Isolated	On < 6 ms Off < 3 ms	2 A / pt	SYRY20
Relay Output Dry	12 to 125 VDC 12 to 220 VAC	Yes	8 pts., Isolated	On < 6 ms Off < 3 ms	2 A / pt	SYRY21

9.1 SYAC10 - 16 POINT AC OUTPUT MODULE

Table 9.2: SYAC10 Specifications

SYAC10 SPECIFICATIONS		
Number of points		16 points
Rated load voltage		85 to 264 VAC, 50 to 60 Hz
Maximum load voltage		270 VAC
Maximum load current		0.6 A / point, 4.8 A / common
Maximum 1-cycle peak current		20 A
Minimum leakage current		2 mA
Response time	OFF→ON	1/2 cycle less 1 ms
	ON→OFF	Less than 1/2 AC cycle
Maximum voltage drop at ON circuit		1.5 V (rms)
Common terminal arrangement		8 points / common
Fuse		2 fuses of 5 A each
Internal current consumption		200 mA (all points ON)
External Connection		20pt terminal block, max wire size #14 AWG
Weight		370 g

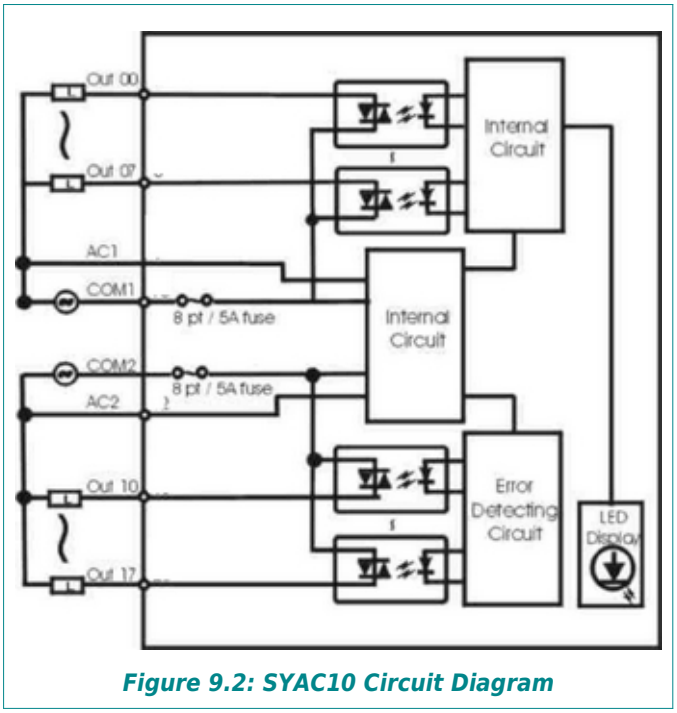

Figure 9.2: SYAC10 Circuit Diagram

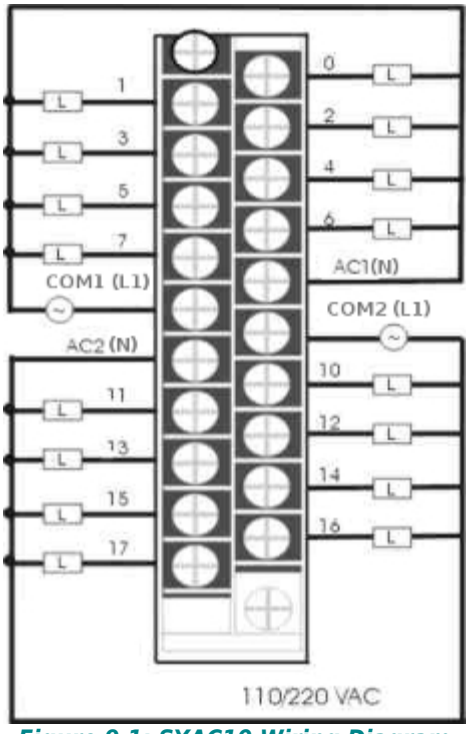

Figure 9.1: SYAC10 Wiring Diagram

9.2 SYDC10 - 16 POINT 12/24 VDC NPN/SINK OUTPUT MODULE

Table 9.3: SYDC10 Specifications

SYDC10 SPECIFICATIONS		
Number of input points		16 points NPN / Sink
Insulation method		Photocoupler
Rated load voltage		12 / 24 VDC
Operating voltage range		10 to 35 VDC
Maximum load current		0.1 A / pt, 0.8 A / fuse
Maximum output current		0.4 A / 10 ms or less
Leakage current at OFF circuit		0.1 mA or less
Maximum voltage drop at ON circuit		1.5 V or less
Response time	OFF→ON	2 ms or less (24 VDC)
	ON→OFF	2 ms or less (24 VDC)
Common terminal arrangement		8 points / fuse
Fuse rating		2 fuses of 2 A each
External power supply	Voltage	12 / 24 VDC (10 to 35 VDC)
	Current	100 mA
Internal current consumption		100 mA (all points ON)
External connections		20pt terminal block max wire size #14 AWG
Weight		270 g

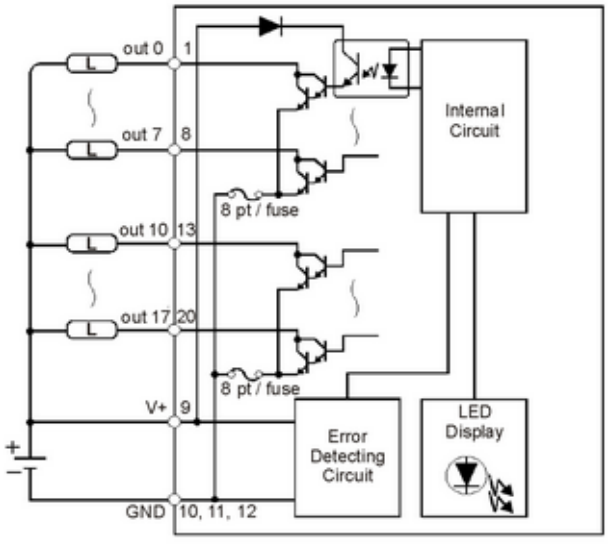

Figure 9.4: SYDC10 Circuit Diagram

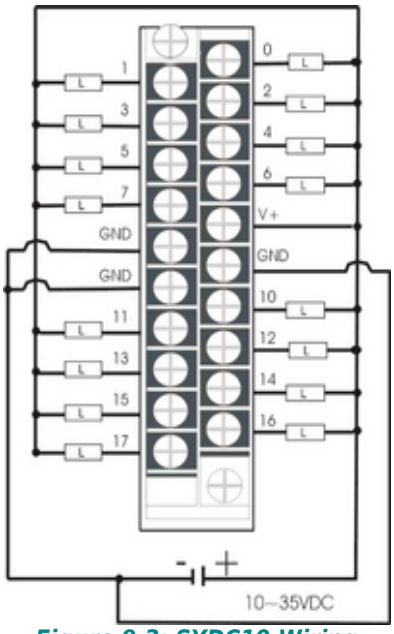

Figure 9.3: SYDC10 Wiring Diagram

9.3 SYDC20 - 16 POINT 12/24 VDC PNP/SOURCE OUTPUT MODULE

Table 9.4: SYDC20 Specifications

SYDC20 SPECIFICATIONS		
Number of input points		16 points, PNP / Source
Insulation method		Photocoupler
Rated load voltage		12 / 24 VDC
Operating voltage range		10 to 35 VDC
Maximum load current		0.1 A / pt, 0.8 A / fuse
Maximum output current		0.4 A / 10 ms or less
Leakage current at OFF circuit		0.1 mA or less
Maximum voltage drop at ON circuit		1.5 V or less
Response time	OFF→ON	2 ms or less (24 VDC)
	ON→OFF	2 ms or less (24 VDC)
Common terminal arrangement		8 points / common
Fuse rating		2 fuses of 2 A each
External power supply	Voltage	12 / 24 VDC (10 to 35 VDC)
	Current	100 mA
Internal current consumption		100 mA (all points ON)
External connections		20pt terminal block, max wire size #14 AWG
Weight		270 g

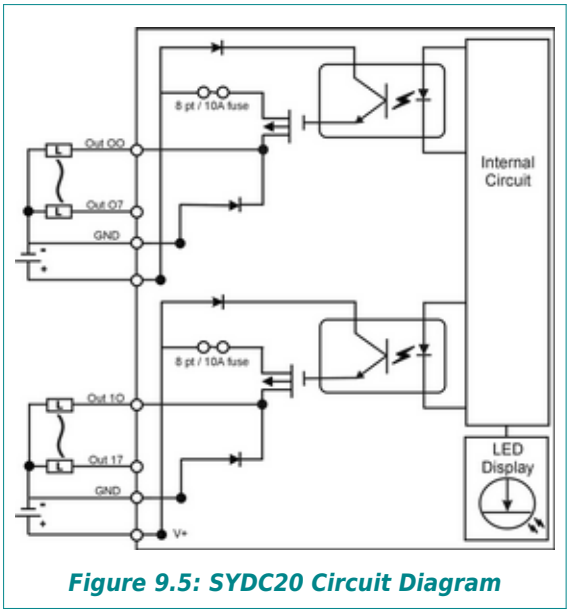

Figure 9.5: SYDC20 Circuit Diagram

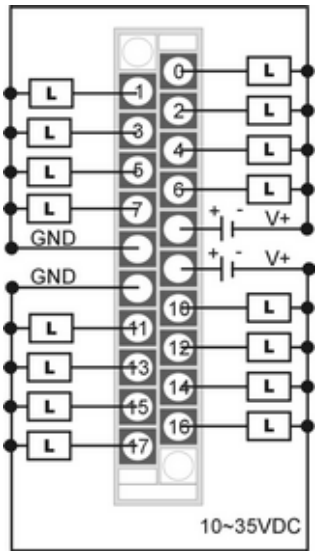

Figure 9.6: SYDC20 Wiring Diagram

9.4 SYDC30 - 32 POINT 12/24 VDC NPN/SINK OUTPUT MODULE

Table 9.5: SYDC30 Specifications

SYDC30 SPECIFICATIONS		
Number of output points		32 points, NPN / Sink
Insulation method		Photocoupler
Rated load voltage		12 / 24 VDC
Operating voltage range		10 to 35 VDC
Maximum load current		0.1 A / pt, 0.8 A / fuse
Maximum output current		0.4 A / 10 ms or less
Leakage current at OFF circuit		0.1 mA or less
Maximum voltage drop at ON circuit		1.5 V or less
Response time	OFF→ON	2 ms or less (24 VDC)
	ON→OFF	2 ms or less (24 VDC)
Common terminal arrangement		32 points / common
Fuse rating		4 fuses of 2 A each
External power supply	Voltage	12 / 24 VDC (10 to 35 VDC)
	Current	120 mA
Internal current consumption		100 mA, (all points ON)
External connections		37-pin D sub-connector
Weight		260 g

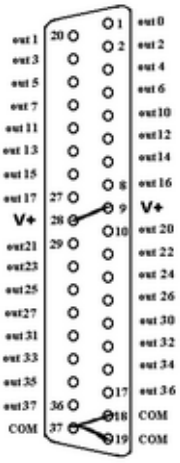

Figure 9.7: SYDC30 Connector Pinout

NOTE

This module requires purchase of a high density I/O cable (Cat No HDIO-CBL) and terminal block (Cat No XDC20-TB).

9.4.1 SYDC30 WIRING/CIRCUIT DIAGRAMS

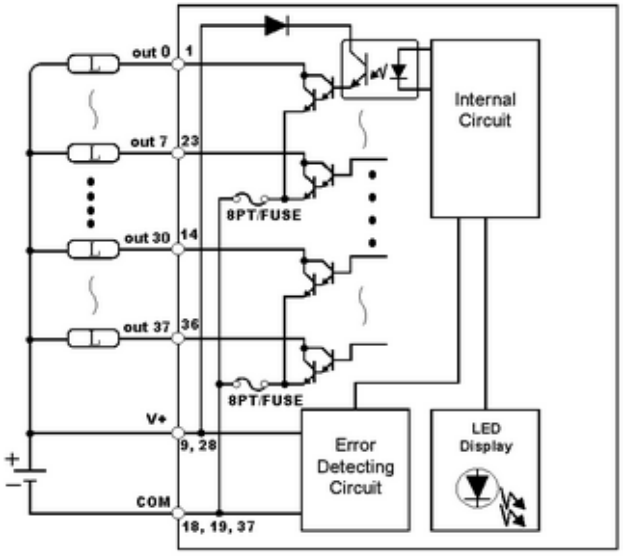

Figure 9.8: SYDC30 Circuit Diagram

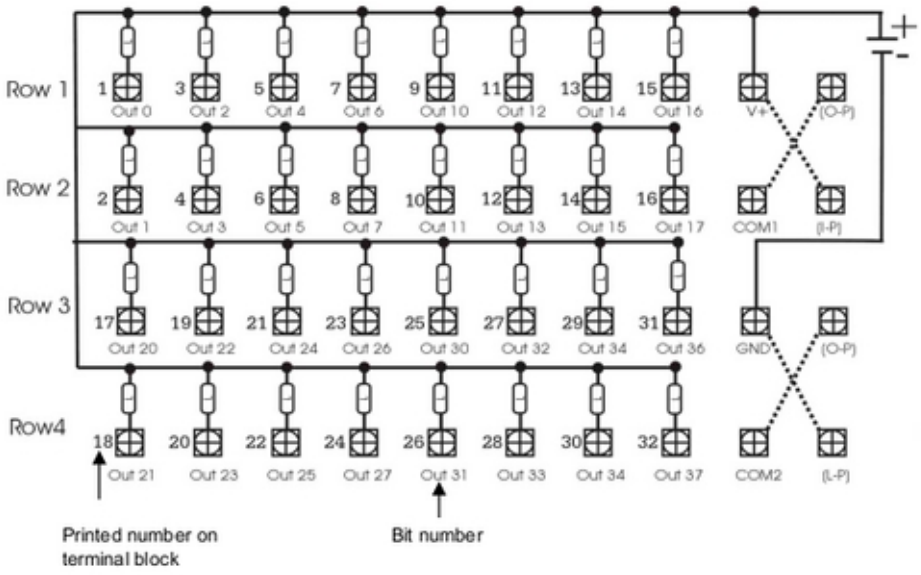

Figure 9.9: SYDC30 Field Wiring to XDC20-TB Terminal Block

9.5 SYDC40 - 32 POINT 12/24 VDC PNP/SOURCE OUTPUT MODULE

Table 9.6: SYDC40 Specifications

SYDC 40 SPECIFICATIONS		
Number of output points		32 points, PNP / Source
Insulation method		Photocoupler
Rated load voltage		12 / 24 VDC
Operating voltage range		10 to 35 VDC
Maximum load current		0.1 A / pt., 0.8 A / fuse
Maximum output current		0.4 A / 10 ms or less
Leakage current at OFF circuit		0.5 mA or less
Maximum voltage drop at ON circuit		0.3 V or less
Response time	OFF→ON	2 ms or less (24 VDC)
	ON→OFF	2 ms or less (24 VDC)
Common terminal arrangement		32 points / common
Fuse rating		4 fuses of 2 A each
External power supply	Voltage	12 / 24 VDC (10 to 35 VDC)
	Current	120 mA
Internal current consumption		100 mA (all points ON)
External connections		37-pt. D sub connector.
Weight		270 g

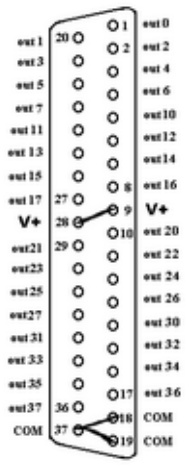

Figure 9.10: SYDC40 Connector Pinout

NOTE

This module requires purchase of a high density I/O cable (Cat No HDIO-CBL) and terminal block (Cat No XDC20-TB).

9.5.1 SYDC40 WIRING/CIRCUIT DIAGRAMS

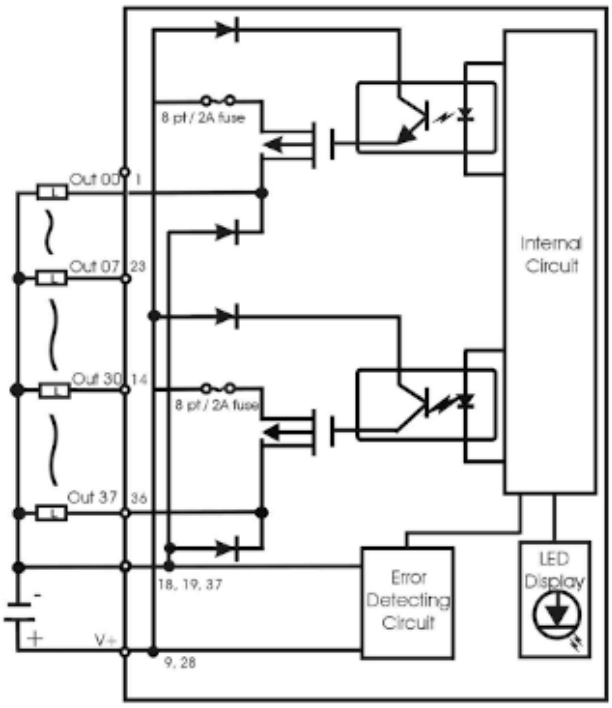

Figure 9.11: SYDC40 Circuit Diagram

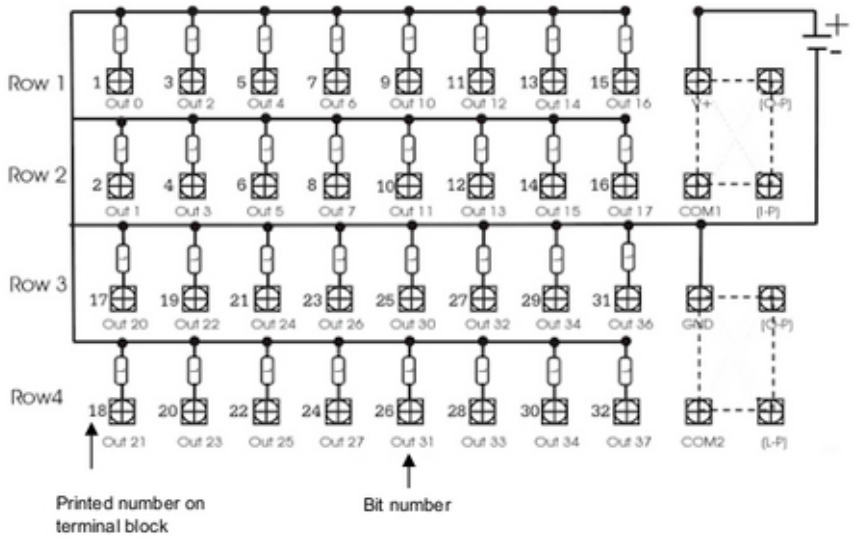

Figure 9.12: SYDC40 Field Wiring to XDC20-TB Terminal Block

9.6 SYRY10 - 16 POINT DRY CONTACT OUTPUT MODULE

Table 9.7: SYRY10 Specifications

SYRY10 SPECIFICATIONS		
Number of input points		16 points
Insulation method		Photocoupler
Rated Voltage		5 to 125 VDC or 12 to 250 VAC (only 1 AC power source allowed per module)
Rated Current		max 2 A / pt., 8 A / common, min 0.1 mA
Insulation method response time	OFF→ON	10 ms or less
	ON→OFF	5 ms or less
Maximum switching frequency		3600 times per hour
Common terminal arrangement		8 points / common
External Power Supply	Voltage	Voltage: 24 VDC +/- 10%, Ripple voltage: 4 V p-p or less
	Current	90 mA (24 VDC, all points ON)
Service Lift	Mechanical	More than 20 million times
	Electrical	250 VAC / 2 A, 30 VDC / 2 A more than 100,000 times
Internal current consumption		100 mA (all points ON)
External Connections		20pt terminal block, max wire size #14 AWG
Weight		310 g

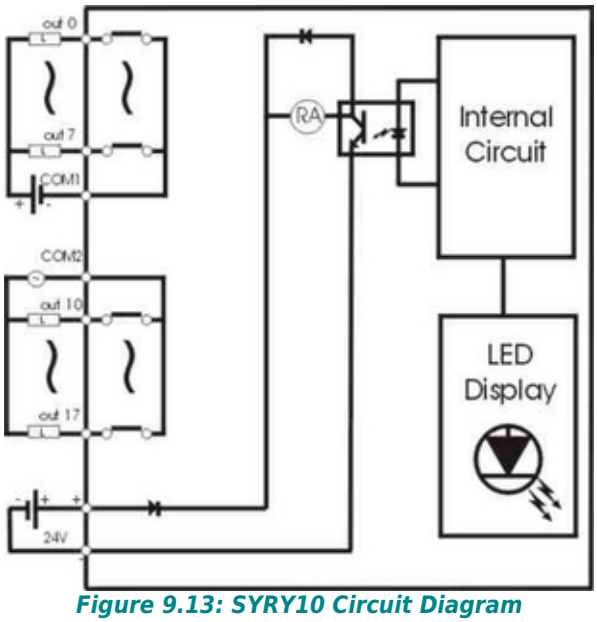

Figure 9.13: SYRY10 Circuit Diagram

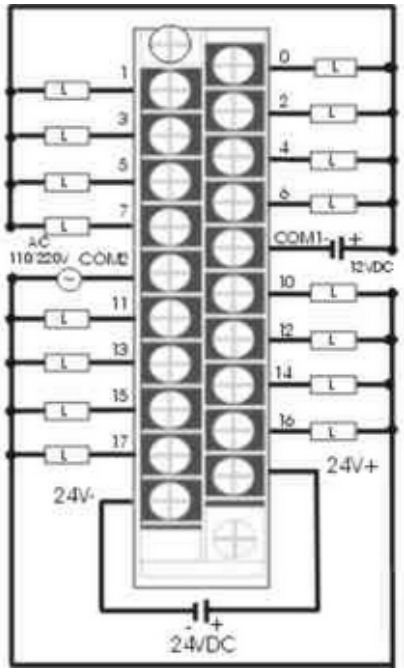

Figure 9.14: SYRY10 Wiring Diagram

9.7 SYRY20 - 16 POINT ISOLATED RELAY OUTPUT MODULE

Table 9.8: SYRY20 Specifications

SYRY20 SPECIFICATIONS		
Number of input points		16 points individually isolated, Dry Contact
Insulation method		Photocoupler
Rated Voltage		12 to 125 VDC, 12 to 250 VAC
Rated Current		max 2 A / pt., 8 A / common, min 0.1 mA
Response time	OFF→ON	6 ms or less
	ON→OFF	3 ms or less
Maximum switching frequency		3600 times per hour
Common terminal arrangement		16 points / independent
External Power Supply	Voltage	Voltage: 24 VDC +/- 10%, Ripple voltage: 4 V p-p or less
	Current	90 mA
Service Lift	Mechanical	More than 20 million times
	Electrical	250 VAC / 2 A, 30 VDC / 2 A more than 100,000 times
Internal current consumption		100 mA (all points ON)
External Connection		(2) 18pt terminal blocks, max wire size #14 AWG
Weight		340 g

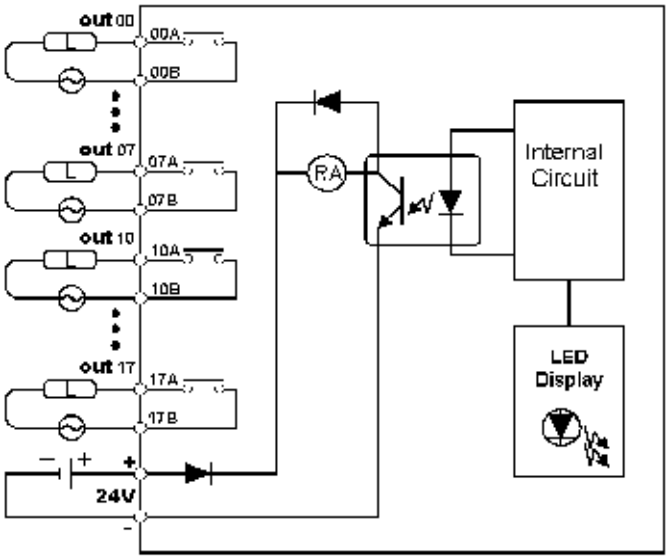

Figure 9.16: SYRY20 Circuit Diagram

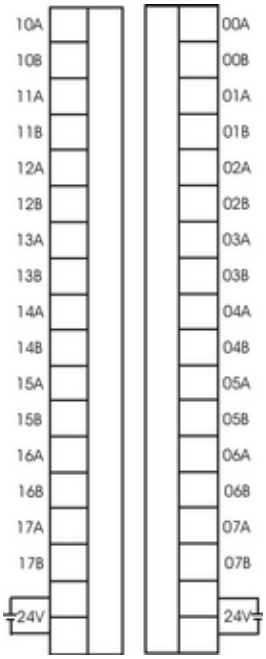

Figure 9.15: SYRY20 Wiring Diagram

9.8 SYRY21 - 8 POINT ISOLATED RELAY OUTPUT MODULE

Table 9.9: SYRY21 Specifications

SYRY21 SPECIFICATIONS		
Number of input points		8 points, individually isolated, Dry contact
Insulation method		Photocoupler
Rated Voltage		12 to 125 VDC 12 to 250 VAC
Rated Current		max 2 A / pt., 8 A / common, min 0.1 mA
Response time	OFF→ON	6 ms or less
	ON→OFF	3 ms or less
Maximum switching frequency		3600 times per hour
Common terminal arrangement		8 points / independent
External Power Supply	Voltage	Voltage: 24 VDC +/- 10%, Ripple voltage: 4 V p-p or less
	Current	90 mA
Service Lift	Mechanical	More than 20 million times
	Electrical	250 VAC / 2 A, 30 VDC / 2 A more than 100,000 times
Internal current consumption		100 mA (all points ON)
External Connection		18pt terminal block, max wire size #14 AWG
Weight		330 g

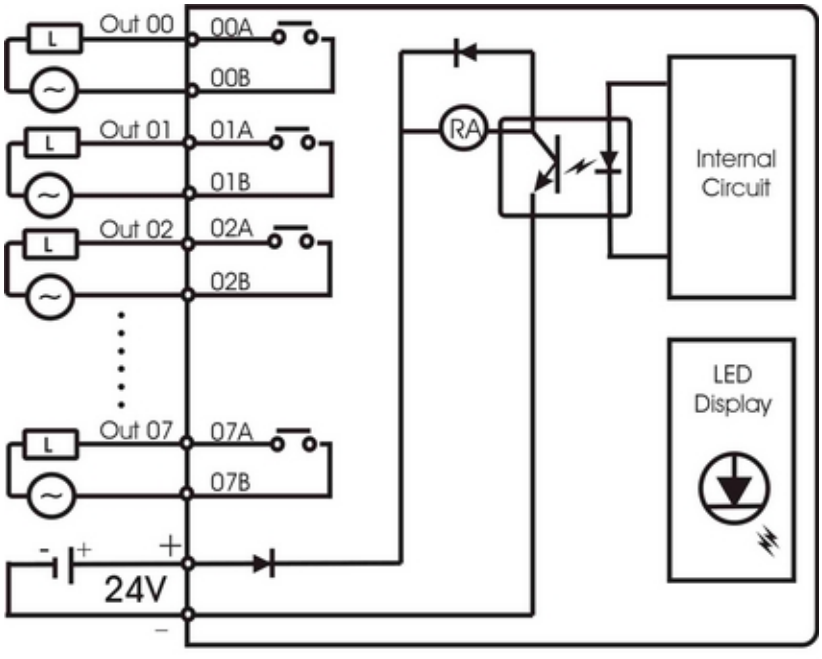

Figure 9.17: SYRY21 Circuit Diagram

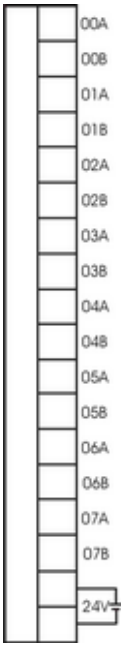

Figure 9.18 - SYRY21 Wiring Diagram

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CHAPTER 10 - ANALOG INPUT MODULES

Table 10.1: Analog Input Modules Summary

ANALOG INPUT MODULES SUMMARY				
OPERATING RANGE	**NUMBER OF CHANNELS**	**RESPONSE TIME**	**RESOLUTION**	**CATALOG NUMBER**
0 to 1, 1 to 5, +/- 10 VDC 0 to 20, 4 to 20, +/- 20 mA	4 Differential	18 ms / channel	15 bit	AD020
0 to 10, 1 to 5, +/- 10 VDC	8 Differential	18 ms / channel	12 bit	AD030A
0 to 20, 4 to 20, +/- 20 mA	8 Differential	18 ms / channel	12 bit	AD031A
0 to 1, 1 to 5, +/- 10 VDC	16 Differential	18 ms / channel	16 bit	AD046
0 to 20, 4 to 20, +/- 20 mA	16 Differential	18 ms / channel	16 bit	AD047

10.1 WIRING ANALOG SINGLE-ENDED AND DIFFERENTIAL INPUTS

CAUTION

To prevent shock hazard, care should be taken when wiring the module to analog signal sources. Before wiring any analog module, disconnect power from the SoftPLC system and from any other source to the analog module.

10.1.1 WIRING GUIDELINES

Follow these guidelines when wiring analog input modules:

- To ensure proper operation and high immunity to electrical noise, use shielded, twisted pair communication cable (eg: Belden 8761 or equivalent) and keep length as short as possible.
- To limit noise, keep signal wires as far away as possible from power and load lines.
- Connect only one end of the cable shield to earth ground.
- Connect the shield drain wires for the first half channels to the top shield terminal.
- Connect the shield drain wires for the second half channels to the bottom shield terminal.
- Shield terminals are internally connected to chassis ground which is connected to earth ground via the IOBASExx backplane.
- Single-Ended source commons may be jumpered together at the terminal block.
- Channels are not isolated from each other, except for 16 channel modules AD046/47.
- If a differential signal source has an analog common, it can not and must not be connected to the module.
- The module does not provide power for the analog inputs.
- Use a power supply that matches the transmitter (sensor) specifications

10.1.2 WIRING INPUT DEVICES TO THE MODULE

CAUTION

Care should be taken to avoid connecting a voltage source to a channel configured for current input. Improper module operation or damage to the voltage source can occur.

After the analog input module is properly installed in the base, follow the wiring procedure below:

1. At each end of the cable, strip some casing to expose the individual wires.
2. Trim the signal wires to 2-inch lengths. Strip about 3/16 inch (5 mm) of insulation away to expose the end of the wire.

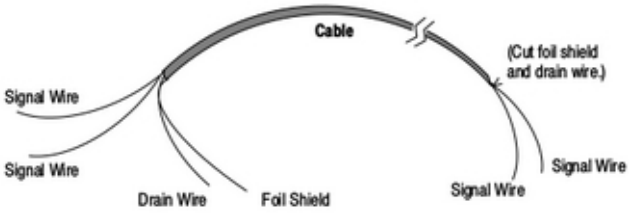


Figure 10.1: Analog Wiring Preparation

3. At one end of the cable, twist the drain wire and foil shield together. This end of the cable will be connected to one of the shield terminals on the module (first half channels to top shield terminal, second half channels to bottom shield terminal).
4. At the other end of the cable, cut the drain wire and foil shield back to the cable.
5. Connect the signal wires and the shield drain wire to the module terminal block. Connect the other end of the cable to the input device.
6. Repeat steps 1 through 5 for each channel on the module.

10.1.3 TYPES OF 4-20MA CONNECTIONS

All devices in a 4-20 mA current loop need to be supplied power from somewhere in order to function. Two-wire devices receive their power from the process signal loop itself. The power for the loop usually comes from the transmitter power supply or some other kind of external power supply, and all of the power for the system travels through the wires that also carry the signal. This is possible because current is the same throughout the loop, so voltage drops caused by loop-powered devices do not affect the current signal. Loop-powered devices are simple, easy to wire and use very little power. Since this setup only requires two wires, loop-powered instruments are also referred to as two-wire devices.

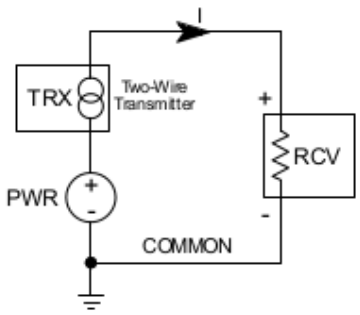


Figure 10.2: Powering 2-Wire Loop-Powered Devices

Three and four-wire devices, by contrast, receive the power they require to function from a power supply that is separate (but not necessarily isolated) from the current loop which allows them to feature much more advanced components such as brighter LED displays and advanced output options. These devices cannot be loop-powered. Three and four-wire devices might not always be the appropriate option, however, if running additional power is infeasible or they need to operate in a hazardous area with Intrinsic Safety or Non-incendive approvals.

A four-wire connection uses the current loop as a means to transmit the 4-20 mA process signal only. This type of connection will not draw the power it needs from the current loop. It will create a voltage drop on the loop, but this is minimal when compared to that of a loop-powered device. The power four-wire devices need is instead provided by an external power supply. This can be either an alternating or direct current power supply because the device is powered independently from the direct current loop.

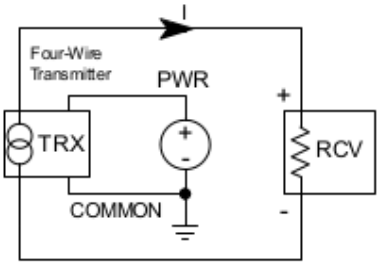


Figure 10.3: Powering 4-Wire 4-20ma Devices

Isolated four-wire connected devices "float" within the current loop. This means that the common, or the return process signal wire from the device does not connect to the power supply ground. As may be apparent from the name "four-wire," two wires connect the power supply to the device and two wires connect the process signal to the device. Isolation, therefore, is built into the system. There is no electrical connection between the power supply and the process signal.

A three-wire connection is essentially the same as a four-wire connection except that the isolation just discussed is not present; a three-wire device does not float in comparison to the current loop. In a three-wire connection, the process signal return from the device and the common of the power supply are a shared connection.

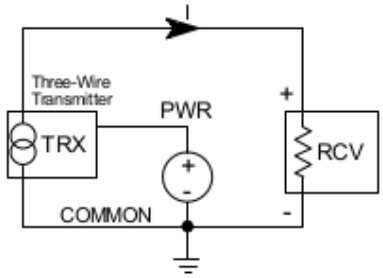


Figure 10.4: Powering 3-Wire 4-20ma Devices

10.1.4 WIRING SCHEMATICS FOR 2, 3 AND 4-WIRE ANALOG INPUT DEVICES

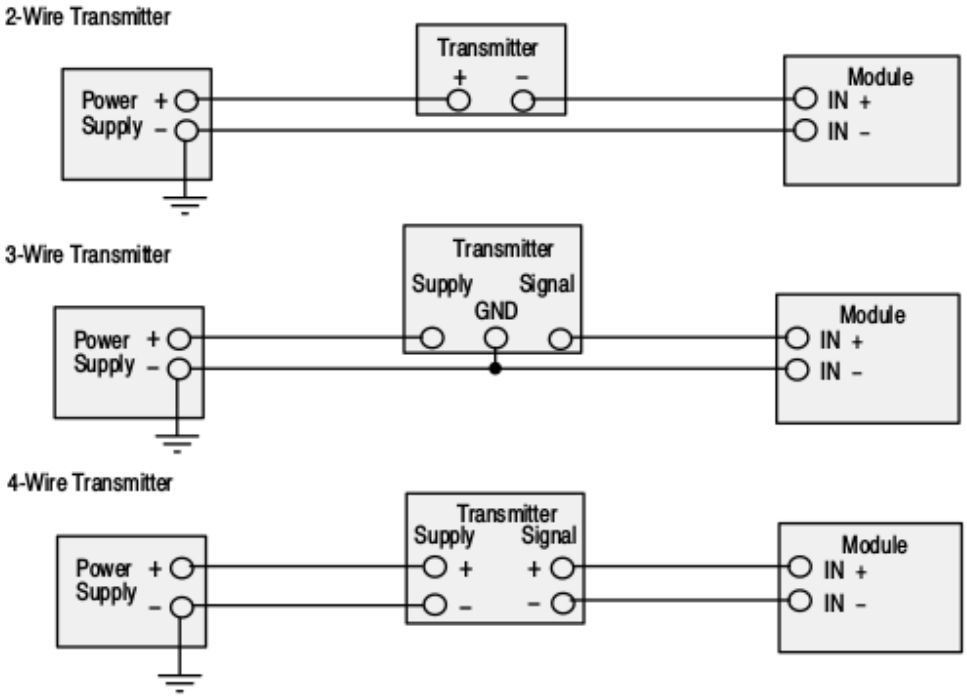


Figure 10.5: Wiring Schematics for 2/3/4 Wire AI Devices

10.1.5 WIRING SCHEMATIC FOR SINGLE-ENDED ANALOG INPUT CONNECTIONS

When wiring single-ended analog input devices to the analog input module, the number of total wires necessary can be limited by jumpering all ”IN-” terminals together. Note that differential inputs are more immune to noise than single-ended inputs.

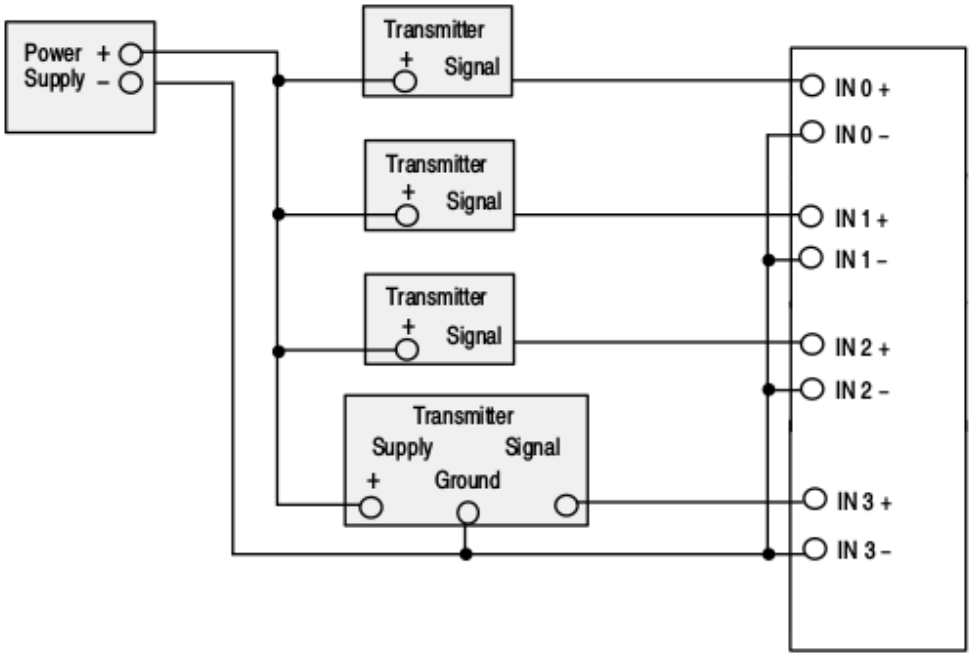


Figure 10.6: Single-Ended Analog Input Wiring Schematic

10.1.6 TRANSDUCER SOURCE IMPEDANCE

If the source impedance of the input device and associated cabling is too high, it will affect the accuracy of the channel data word. Source impedance of 500 ohms will produce up to 0.05% of module error over and above the specified accuracy of the module. You can compensate for device impedance error by implementing the following equation in your ladder program, where:

$$V_S = V_{measured} \times \left[\frac{(R_s + R_{in})}{R_{in}} \right]$$

- Vs , input device voltage
- Rs , input device source impedance
- Rin , module input impedance (1 MΩ)

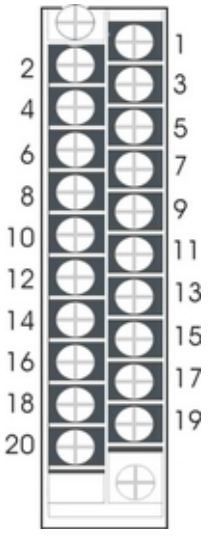
10.2 AD020 - 4 CH ANALOG VOLTAGE/CURRENT INPUT MODULE

Table 10.3: AD020 Specifications

AD020 SPECIFICATIONS	
Number of input channels	4 differential
Input ranges	0 to 10 V, 1 to 5 V, +/- 10 V (input impedance 10MΩ)
	0~20mA, 4~20mA, +/- 20mA (input impedance 250Ω)
Line break detection	For ranges of 1~5 V and 4~20 mA
Resolution	15 bits
Accuracy	+/- 0.1% FSR
Drift	Zero drift: +/- 0.06, µV / °C , Span drift: +/- 30 PPM / °C
Step response (5 to 95%)	18 ms / channel
Setup time	20 ms / channel
Settle time	50 ms / channel
Conversion method	Sigma-Delta
Rejection mode	Common: 150 dB @60 Hz Normal: 150 dB @60 Hz
Isolation	2.5 KV optical isolation between input signals & CPU
Internal current consumption	400mA
Range selection	DIP Switches, all channels must be same range
External connections	20pt terminal block, max wire size #14AWG
Weight	390 g

Table 10.2: AD020 Terminal Block Wiring

TERMINAL #	SIGNAL
1	CH1_V+
2	CH1_V-
3	CH1_I+
4	CH1_I-
5	CH2_V+
6	CH2_V-
7	CH2_I+
8	CH2_I-
9	CH3_V+
10	CH3_V-
11	CH3_I+
12	CH3_I-
13	CH4_V+
14	CH4_V-
15	CH4_I+
16	CH4_I-
17	GND
18	GND
19	FG
20	FG



ERROR LEDs

The AD020 has (4) error LED's labeled CH1-4. If the high/low limit checking is enabled and either limit has been reached on a particular input channel, the corresponding LED will be illuminated.

10.2.1 WIRING DIAGRAMS

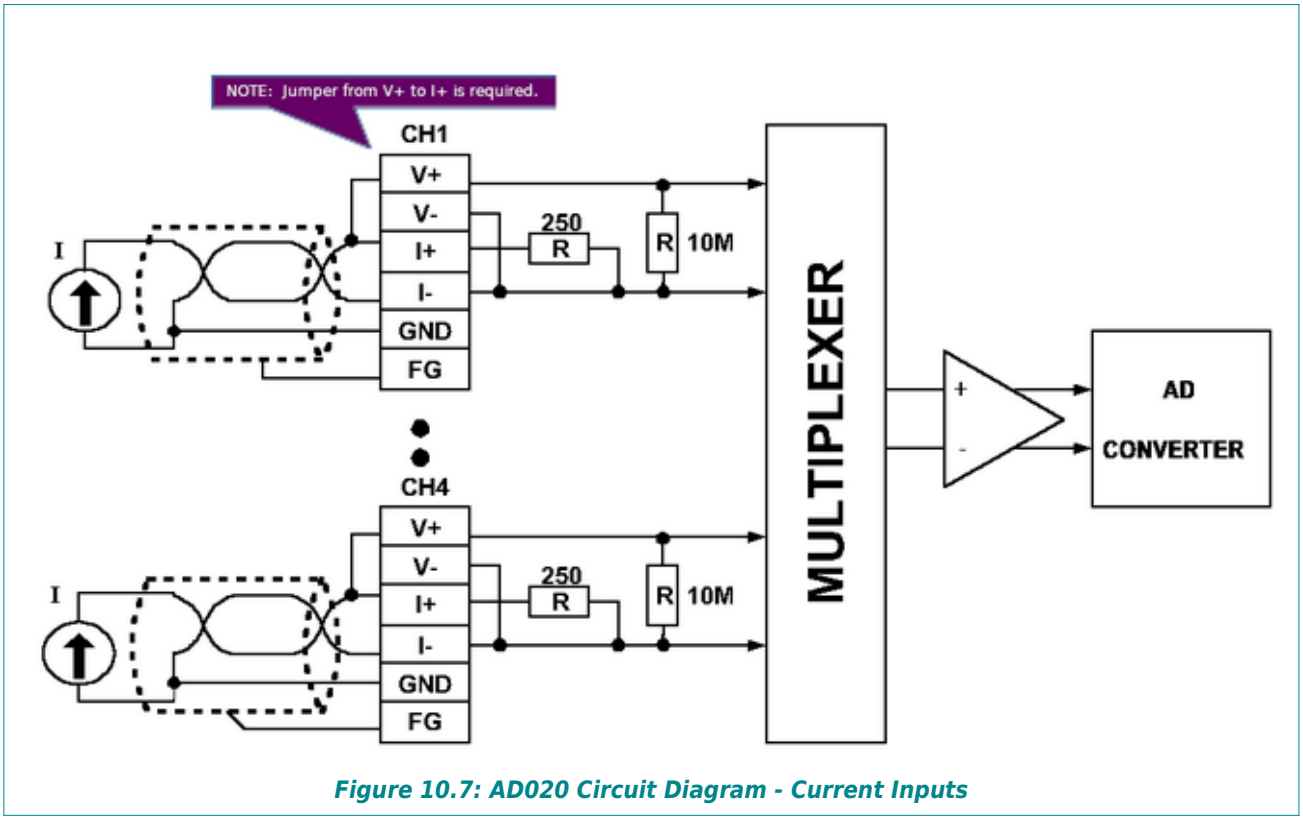


Figure 10.7: AD020 Circuit Diagram - Current Inputs

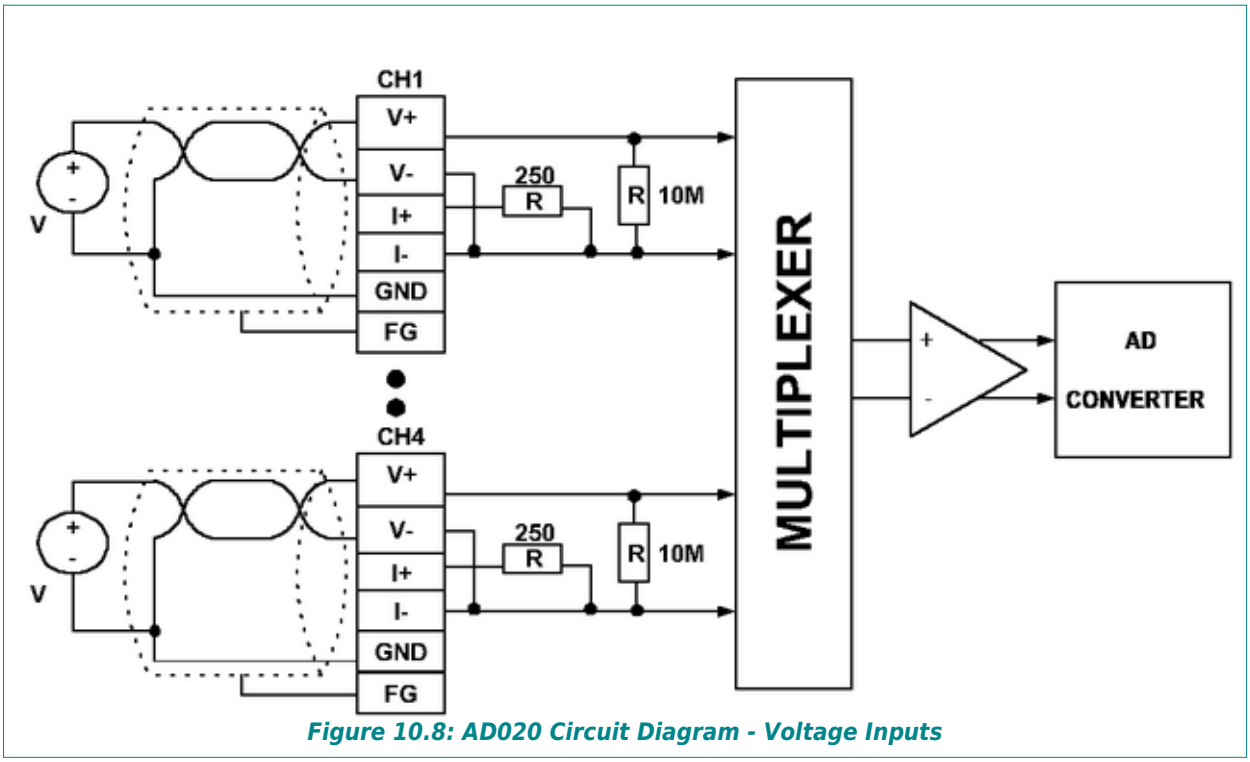


Figure 10.8: AD020 Circuit Diagram - Voltage Inputs

10.2.2 AD020 OVERVIEW

The AD020 module is a 4-channel analog-to-digital converter. It embeds a microprocessor to provide high-precision conversion and is equipped with voltage input or current measuring capability. The AD020 module has the following features:

- Four differential input channels with 15-bit resolution
- Six built-in operation ranges
  - Voltage inputs: 0~10 , 1~5 , -10~+10V
  - Current inputs: 0~20mA, 4~20mA, -20~+20mA
- 2.5 KV Optical Isolation between input signals and CPU
- Built-in AC 50/60Hz differential rejection capability
- Built-in high / low limit detection capabilities
- Individual channel enable / disable (for 1~5V and 4~20 mA ranges)
- Engineering Unit Scaling

10.2.3 OPERATION SUMMARY

A status word and four (4) analog input values are mapped directly to SoftPLC's datatable registers. By default, the AD020 analog input module is configured with all channels enabled and the values presented in RAW data format. The Status Register contains bit flags that indicate whether an individual input channel is above or below a preset value and if an input has a broken signal wire (when operating in 1-5V or 4-20mA input ranges).

Some features of the AD020 can only be activated by modifying the contents of the Configuration Data Memory (CDM) File. These include engineering unit scaling, low and high limit testing and channel conversion. Disabling the conversion of unused analog input channels will reduce the total processing time of the module. The CDM File is programmed with the I/O driver configuration editors.

Since a single module supports multiple voltage and current ranges, an external DIP Switch is provided to set the device to the desired signal range. All channels must use the same signal range.

10.2.4 USING AN AD020 MODULE

The following steps are recommended to use the AD020 module in your SoftPLC system:

1. Define the Operating Range and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.
2. Wire the module to your I/O device(s) per the provided diagrams.
3. Determine the mapping location of the Scan Data Registers in SoftPLC's datatable. This is done using the I/O driver's configuration editor appropriate for your system (local = smart.tlm, Ethernet = mbipmast.tlm).
4. If necessary, program the CDM File.
5. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code will be written to status file word S:15. For remote I/O, operation will vary.

6. If SoftPLC starts properly and enters RUN mode, but the module does not operate as expected, the DIP Switches and the CDM settings should be confirmed. If necessary, the CDM memory can be read and verified using the CDMR TLI instruction.

10.2.5 DEFINING OPERATING RANGE AND DATA TYPE

The AD020 can be set for either voltage or current operation mode. In addition, either signed or unsigned data format may be selected. The specific selections are set via DIP Switches located on the back or slot edge of the module. All four channels will have the same settings.

NOTE

Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4=ON).

Table 10.4: AD020 DIP Switch Settings

AD020 DIP SWITCH SETTINGS				
SW1	SW2	SW3	SW4	OPERATING RANGE
OFF	OFF	OFF	OFF	0 to 10 V (unsigned data)
OFF	OFF	OFF	ON	0 to 10 V (signed data)
OFF	ON	OFF	OFF	1 to 5 V (unsigned data)
OFF	ON	OFF	ON	1 to 5 V (signed data)
OFF	OFF	ON	OFF	+/- 10 V (unsigned data)
OFF	OFF	ON	ON	+/- 10 V (signed data)
ON	OFF	OFF	OFF	0 to 20 mA (unsigned data)
ON	OFF	OFF	ON	0 to 20 mA (signed data)
ON	ON	OFF	OFF	4 to 20 mA (unsigned data)
ON	ON	OFF	ON	4-20 mA (signed data)
ON	OFF	ON	OFF	+/- 20 mA (unsigned data)
ON	OFF	ON	ON	+/- 20 mA (signed data)

If SW4 is set to the ON position, the data reported in the Scan Data Registers from the AD020 module will be in signed raw data format. The signed data range is from -32768 to +32767. Data will be in unsigned raw data format if SW4 is set to the OFF position. Unsigned data range is 0 to 65535. Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4, ON).

Table 10.5: AD020 Channel Data Range

AD020 DATA RANGE		
DATA TYPE	SIGNED	UNSIGNED
Raw	-32768 to 32767	0 to 65535
Scaled	User specified engineering units where range is MIN to MAX (set via CDM)	

The following table illustrates the relationship of the raw data conversion to various voltage and current signals.

Table 10.6: AD020 Raw Values Related to Input Signals

AD020 DATA REGISTER RAW VALUES RELATED TO INPUT SIGNALS							
SIGNED DATA		RANGE					
		0 - 10 V	1 -5 V	+/- 10 V	0 -20 mA	4 -20 mA	+/- 20 mA
-32768	(8000h)			-10 V			-20 mA
-16384	(C000h)			-5 V			-10 mA
0	(0000h)	0 V	1 V	0 V	0 mA	4 mA	0 mA
8191	(1FFFh)	2.5 V	2V	2.5 V	5 mA	8 mA	5 mA
16383	(3FFFh)	5 V	3 V	5 V	10 mA	12 mA	10 mA
24575	(5FFFh)	7.5 V	4 V	7.5 V	15 mA	16 mA	15 mA
32767	(7FFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA
UNSIGNED DATA		RANGE					
		0 - 10 V	1 - 5 V	+/- 10 V	0 - 20 mA	4 -20 mA	+/- 20 mA
0	(0000h)	0 V	1 V	-10 V	0 mA	4 mA	-20 mA
16383	(3FFFh)	2.5 V	2V	-5 V	5 mA	8 mA	-10 mA
32767	(7FFFh)	5 V	3 V	0 V	10 mA	12 mA	0 mA
49151	(BFFFh)	7.5 V	4 V	5 V	15 mA	16 mA	10 mA
65535	(FFFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA

10.2.6 DATA REGISTER DESCRIPTIONS & OPERATING MODE SETTINGS

SCAN DATA REGISTERS

The AD020 module interfaces directly to the SoftPLC datatable via five (5) consecutive 16 bit registers or words called the Scan Data Registers. The address mapping for the Scan Data Registers into the datatable is done in the I/O Driver Configuration editor(s). The Scan Data Registers are read-only and defined as follows:

Table 10.7: AD020 Scan Data Registers

AD020 SCAN DATA REGISTERS			
SCAN DATA REGISTER WORDS	DESCRIPTION	CHANNEL	DATA FORMAT
0	Status register (flags)		*See next table*
1	Input Register	CH1	Raw or Scaled *
2	Input Register	CH2	
3	Input Register	CH3	
4	Input Register	CH4	

** Data format is determined by CDM "Conversion Data Type" word (offset 11, bits 0-3)*

Table 10.8: AD020 Status Register Flags

AD020 STATUS REGISTER (FLAGS)		
SOFTPLC SCAN REGISTER WORD 0 (DATATABLE WORD OFFSET 0)		
Bit 0	Low Limit Flag	CH1
Bit 1	High Limit Flag	
Bit 2	Low Limit Flag	CH2
Bit 3	High Limit Flag	
Bit 4	Low Limit Flag	CH3
Bit 5	High Limit Flag	
Bit 6	Low Limit Flag	CH4
Bit 7	High Limit Flag	
Bit 8	Line break detection flag	CH1
Bit 9	Line break detection flag	CH2
Bit 10	Line break detection flag	CH3
Bit 11	Line break detection flag	CH4
Bit 12-15	Reserved	

NOTE

Line break detection flags are valid for 1-5V and 4-20mA ranges only.

10.2.7 CONFIGURATION DATA MEMORY (CDM)

The AD020 module has a Configuration Data Memory (CDM) file that can be programmed to disable individual channel conversion, set up automatic engineering unit scaling, and activate the corresponding low and high limit alarm flags.

If maximum performance speed is desired, disabling unused analog channels will decrease the module processing time. If the high and low limit flags are not going to be used and the channel data will be read in raw format, the CDM file does not need to be altered from the default settings. If any of these features are desired, the corresponding CDM file values must be set.

The CDM file has a length of twenty (20) words and is defined as follows:

Table 10.9: AD020 CDM File Word Offset Definitions

AD020 CONFIGURATION DATA MEMORY OFFSETS		
CDM FILE OFFSET	**DESCRIPTION**	**CHANNEL**
0	Not used	
1	Control bits for High/Low limits & Enable/Disable conversion	See next table
2	Low limitation value [1]	CH1
3	High limitation value [1]	
4	Low limitation value [1]	CH2
5	High limitation value [1]	
6	Low limitation value [1]	CH3
7	High limitation value [1]	
8	Low limitation value [1]	CH4
9	High limitation value [1]	
10	Not used	
11	Conversion data type (bits 0-3)	Raw or Engineering
12	Low Engineering Setting Value [2]	CH1
13	High Engineering Setting Value [2]	
14	Low Engineering Setting Value [2]	CH2
15	High Engineering Setting Value [2]	
16	Low Engineering Setting Value [2]	CH3
17	High Engineering Setting Value [2]	
18	Low Engineering Setting Value [2]	CH4
19	High Engineering Setting Value [2]	

[1] *Values must be in the same units (raw or scaled) as the channel values.*
[2] *Minimum and Maximum Engineering Unit values for each channel.*

Table 10.10: AD020 Control Bits (CDM Offset Word 1)

AD020 LOW / HIGH LIMIT & CONVERSION ENABLE CONTROL BITS			
CDM FILE OFFSET 1	**DESCRIPTION**	**CHANNEL**	**SETTING**
Bit 0	Low Limitation Control Bit	CH1	0 = Disabled (Default) 1 = Enabled
Bit 1	High Limitation Control Bit		
Bit 2	Low Limitation Control Bit	CH2	
Bit 3	High Limitation Control Bit		
Bit 4	Low Limitation Control Bit	CH3	
Bit 5	High Limitation Control Bit		
Bit 6	Low Limitation Control Bit	CH4	
Bit 7	High Limitation Control Bit		
Bit 8	A/D Conversion Disable Control Bit	CH1	0 = Disabled (Default) 1 = Enabled
Bit 9	A/D Conversion Disable Control Bit	CH2	
Bit 10	A/D Conversion Disable Control Bit	CH3	
Bit 11	A/D Conversion Disable Control Bit	CH4	
Bits 12-15	Unused		

NOTE

Disabled channel input values will be retained and refreshed with the last converted value.

Table 10.11: AD020 Conversion Data Type Control Bits

AD020 CONVERSION DATA TYPE CONTROL BITS		
CDM FILE OFFSET 11, BIT #	**DESCRIPTION**	**SETTINGS**
Bit 0	CH1 Data Type	0 =Raw Value (Default) 1= Engineering Value
Bit 1	CH2 Data Type	
Bit 2	CH3 Data Type	
Bit 3	CH4 Data Type	
Bits 4-15	Unused	

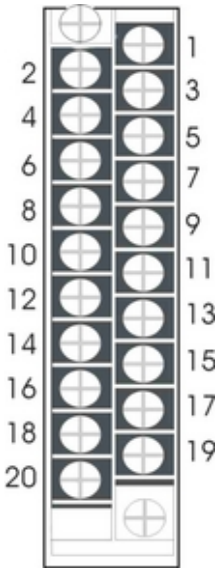
10.3 AD030A/AD031A - 8 CHANNEL ANALOG INPUT MODULES

Table 10.12: AD03x Field Terminal Wiring

TERMINAL #	SIGNAL
1	CH1+
2	CH1-
3	CH2+
4	CH2-
5	CH3+
6	CH3-
7	CH4+
8	CH4-
9	GND
10	FG
11	CH5+
12	CH5-
13	CH6+
14	CH6-
15	CH7+
16	CH7-
17	CH8+
18	CH8-
19	GND
20	FG

Table 10.13: AD030A / AD031A Specifications

AD030A/AD031A SPECIFICATIONS		
	AD030A (VOLTAGE)	AD031A (CURRENT)
Number of channels	8 differential	
Input ranges	0-10V, 1-5V, -+/-10V Input impedance 10 MΩ	0-20ma 4-20ma, +/- 20ma Input impedance 250 Ω
Line break detection	1 to 5 V	4–20 mA
Resolution	16 bits	
Accuracy	+/- 0.1% max at 25 oC	
Drift	Zero Drift: + / -0.06 µV / oC Span Drift: + / -30 PPM / oC	
Step response (5-95%)	50 ms / channel	
Setup time	20 ms / channel	
Settle time	50 ms / channel	
Conversion method	Sigma-Delta	
Rejection mode	Common: 150 dB@60 Hz Normal: 150 dB@60 Hz	
Isolation	2.5 KV optical isolation between input signals & CPU	
Internal consumption	400 mA	
Range selection	DIP Switches, all channels must be same range	
External connectors	20-pt. terminal block connector, max wire size #14 AWG	
Weight	395 g	



ERROR LEDs

The AD03x module has (8) LED's labeled CH1-8. If the high/low limit checking is enabled and either limit has been reached on a particular input channel, the corresponding LED will be illuminated.

10.3.1 CIRCUIT DIAGRAMS

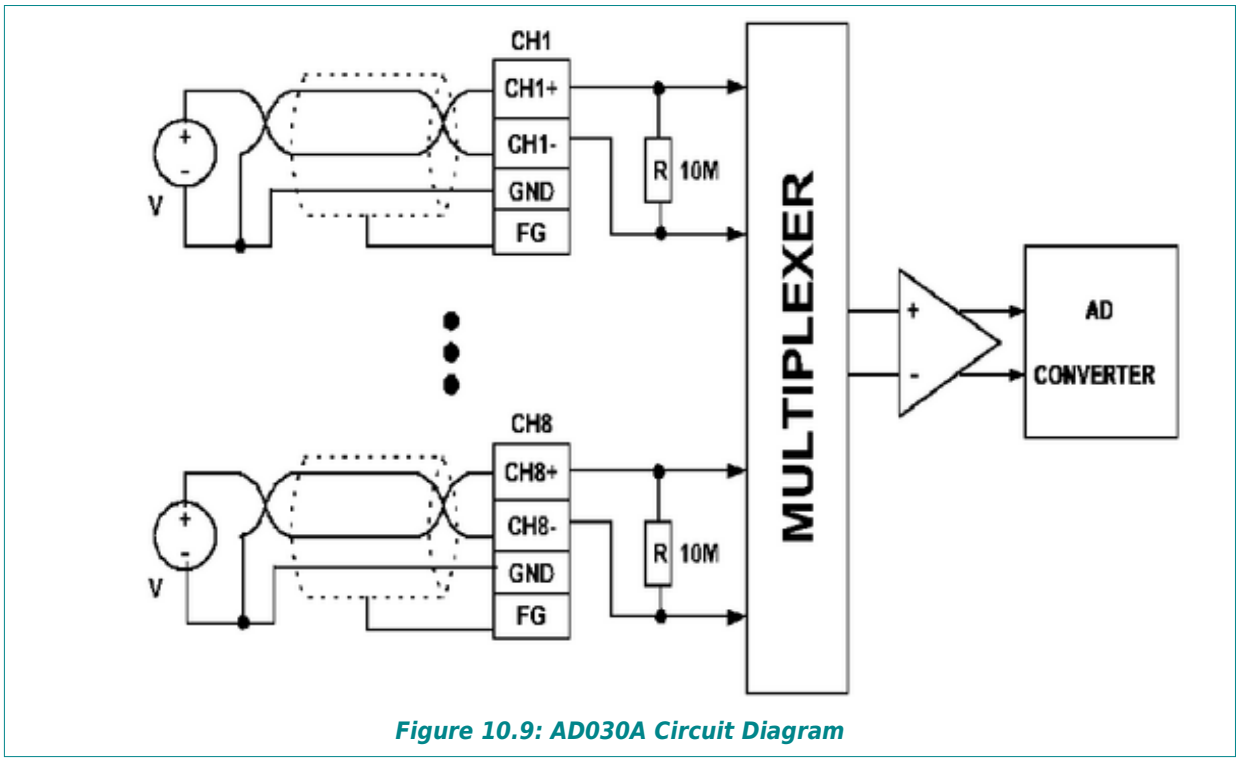


Figure 10.9: AD030A Circuit Diagram

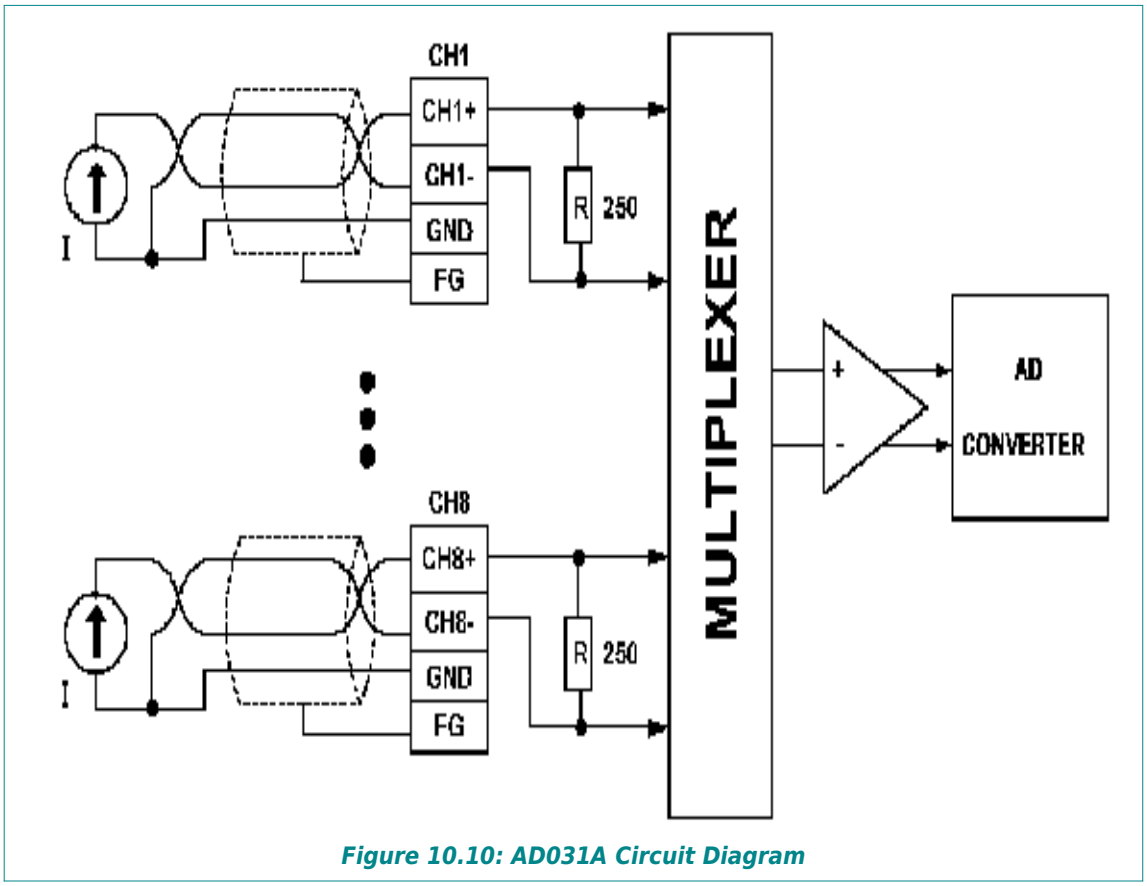


Figure 10.10: AD031A Circuit Diagram

10.3.2 AD030A / AD031A FEATURES

The AD030A / AD031A modules offer the following features:

- Eight (8) differential input channels with 16-bit "extended" resolution
- Module is hot swappable under power
- Three built-in operation ranges:
  - Voltage inputs: 0 to 10 V, 1 to 5 V, -10 to +10 V (AD030A only)
  - Current inputs: 0 to 20 mA, 4 to 20 mA, -20 to +20 mA (AD031A only)
- 2.5 KV Optical Isolation between input signals and CPU
- Built-in AC 50 / 60 Hz differential rejection capabilities
- Built-in high / low limit detection capabilities
- Individual channel enable / disable
- Engineering Unit Scaling
- Line break detection

10.3.3 OPERATION SUMMARY

Two (2) status words and eight (8) analog input values are mapped directly to SoftPLC's datatable registers. The first status word contains the Line Break flags and the second contains the High / Low Limit flags. By default, the analog input modules are configured with all channels enabled and the values presented in RAW data format. The Status Registers contain bit flags that indicate whether an individual channel is above or below a preset value and if an input has a broken signal wire (when operating in 1-5V or 4-20mA input ranges).

Some of the features of the AD030A / AD031A can only be activated by modifying the contents of the Configuration Data Memory (CDM) File. These include engineering unit scaling, low and high limit testing, and channel conversion. Disabling the conversion of unused analog input channels will reduce the total processing time of the module. The CDM File is programmed using the I/O driver configuration editors.

Since a single module supports multiple voltage or current ranges, an external DIP Switch is provided to set the device to the desired signal range. All channels must use the same signal range.

10.3.4 USING AN AD030A/AD031A MODULE

The following steps are recommended to use the AD030A/AD031A module in your SoftPLC system:

1. Define the Operating Range and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.
2. Wire the module to your I/O per the provided diagrams.
3. Determine the mapping location of the Scan Data Registers in SoftPLC's Data Table. This is done using the I/O driver's configuration editor appropriate for your system (local , smart.tlm, Ethernet, mbipmast.tlm).

4. If necessary, program the CDM File.
5. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code is written to status file word S:15. For remote I/O, operation will vary.
6. If SoftPLC starts properly and enters RUN mode, but the module does not operate as expected, the DIP Switches and the CDM settings should be confirmed. If necessary the CDM memory can be read and verified using the CDMR TLI instruction.

10.3.5 DEFINING OPERATING RANGE AND DATA TYPE

The AD030A can be setup in one of three voltage ranges and the AD031A can be setup in one of three current ranges. In addition, either signed or unsigned data format may be selected. The specific selection is set via DIP Switches located on the back side (slot edge) of the module. All eight channels will have the same settings.

NOTE

Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4=ON).

Table 10.14: AD030A DIP Switch Settings

AD030A DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	RANGE	TYPE
OFF	OFF	OFF	OFF	0 to 10 V	Unsigned
OFF	OFF	OFF	ON	0 to 10 V	Signed
OFF	ON	OFF	OFF	1 to 5 V	Unsigned
OFF	ON	OFF	ON	1 to 5 V	Signed
OFF	OFF	ON	OFF	+/- 10 V	Unsigned
OFF	OFF	ON	ON	+/- 10 V	Signed

Table 10.15: AD031A DIP Switch Settings

AD031A DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	AD031	TYPE
ON	OFF	OFF	OFF	0-20 mA	Unsigned
ON	OFF	OFF	ON	0-20 mA	Signed
ON	ON	OFF	OFF	4-20 mA	Unsigned
ON	ON	OFF	ON	4-20 mA	Signed
ON	OFF	ON	OFF	+/- 20 mA	Unsigned
ON	OFF	ON	ON	+/- 20 mA	Signed

If SW4 is set to the ON position, the data reported in the Scan Data Registers from the AD030A / AD031A module will be in signed data format. The signed data range is from -32768 to +32767. It will be in unsigned data format if SW4 is set to the OFF position. Unsigned data may be from 0 to 65535. Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4, ON).

Table 10.16 AD03x Channel Data Range

AD030A/AD031A Data Range		
DATA TYPE	**SIGNED**	**UNSIGNED**
Raw	-32768 to 32767	0 to 65535 (unsigned)
Scaled	User specified engineering units where range is MIN to MAX (set via CDM)	

The following table illustrates the relationship of raw conversion data between the input signal of the module and the channel register's data in the module.

Table 10.17: AD03x Raw Values Related to Input Signals

AD030A/AD031A DATA REGISTER RAW VALUES RELATED TO INPUT SIGNALS						
SIGNED DATA	**AD030A RANGE**			**AD031A RANGE**		
	0 - 10V	**1 - 5V**	**+/- 10V**	**0 - 20mA**	**4 - 20mA**	**+/- 20 mA**
-16384 (C000h)			-5 V			-10 mA
-32768 (8000h)			-10 V			-20 mA
0 (0000h)	0 V	1 V	0 V	0 mA	4 mA	0 mA
8191 (1FFFh)	2.5 V	2 V	2.5 V	5 mA	8 mA	5 mA
16383 (3FFFh)	5 V	3 V	5 V	10 mA	12 mA	10 mA
24575 (5FFFh)	7.5 V	4 V	7.5 V	15 mA	16 mA	15 mA
32767 (7FFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA
UNSIGNED DATA	**AD030A RANGE**			**AD031A RANGE**		
	0 -10V	**1 - 5V**	**+/- 10V**	**0 - 20mA**	**4 - 20mA**	**+/- 20mA**
0 (0000h)	0 V	1 V	-10 V	0 mA	4 mA	-20 mA
16383 (3FFFh)	2.5 V	2 V	-5 V	5 mA	8 mA	-10 mA
32767 (7FFFh)	5 V	3 V	0 V	10 mA	12 mA	0 mA
49151 (BFFFh)	7.5 V	4 V	5 V	15 mA	16 mA	10 mA
65535 (FFFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA

10.3.6 DATA REGISTERS & OPERATING MODE SETTINGS

SCAN DATA REGISTERS

Table 10.18: AD03x Scan Data Registers

AD030A/AD031A SCAN DATA REGISTERS			
SCAN DATA REGISTER WORD OFFSETS	**DESCRIPTION**	**CHANNEL**	**DATA FORMAT**
0	Line Break Detection Status Register *(See table 10.19)*		Bit Flags
1	High / Low Limit Status Register *(See table 10.20)*		Bit Flags
2	Input Register	CH1	Raw or Scaled *
3	Input Register	CH2	Raw or Scaled *
4	Input Register	CH3	Raw or Scaled *
5	Input Register	CH4	Raw or Scaled *
6	Input Register	CH5	Raw or Scaled *
7	Input Register	CH6	Raw or Scaled *
8	Input Register	CH7	Raw or Scaled *
9	Input Register	CH8	Raw or Scaled *

** Data format is determined by CDM "Conversion Data Type" word (offset 19, bits 8-15)*

Table 10.19: AD03x Line Break Detection Flags Status Register Bits

AD030A/AD031A LINE BREAK DETECTION FLAGS STATUS REGISTER	
SCAN DATA WORD OFFSET 0, BIT #	**CHANNEL**
Bit 0	CH1
Bit 1	CH2
Bit 2	CH3
Bit 3	CH4
Bit 4	CH5
Bit 5	CH6
Bit 6	CH7
Bit 7	CH8
Bits 8-15	Not used

NOTE

Line break detection flags are valid for 1-5V and 4-20mA ranges only.

Table 10.20: AD03x High/Low Limit Flags Status Register Bits

AD030A/AD031A HIGH / LOW LIMIT FLAGS STATUS REGISTER		
SCAN DATA WORD OFFSET 1, BIT #	**FLAG**	**CHANNEL**
Bit 0	Low Limit flag	CH1
Bit 1	High Limit flag	
Bit 2	Low Limit flag	CH2
Bit 3	High Limit flag	
Bit 4	Low Limit flag	CH3
Bit 5	High Limit flag	
Bit 6	Low Limit flag	CH4
Bit 7	High Limit flag	
Bit 8	Low Limit flag	CH5
Bit 9	High Limit flag	
Bit 10	Low Limit flag	CH6
Bit 11	High Limit flag	
Bit 12	Low Limit flag	CH7
Bit 13	High Limit flag	
Bit 14	Low Limit flag	CH8
Bit 15	High Limit flag	

CONFIGURATION DATA MEMORY (CDM)

The AD030A / AD031A modules have a Configuration Data Memory (CDM) File that can be programmed to disable individual channel conversion, set up automatic engineering unit scaling, and activate the corresponding low and high limit alarm flags.

Disabling unused analog channels will decrease the module processing time. If the high and low limit flags are not going to be used, and the channel data will be read in raw format, the CDM file does not need to be altered from the default settings. If any of these features are desired, the corresponding CDM file values must be set.

The CDM File has a length of thirty-six (36) words and is defined in the following tables:

Table 10.21: AD03x CDM File Content Definition

AD030A/AD031A CONFIGURATION DATA MEMORY FILE CONTENTS		
CDM FILE OFFSET	**DESCRIPTION**	**CHANNEL**
0	A / D Conversion Disable Control Bits	*See Table 10.22*
1	High / Low Limit Enable Control Bits	*See Table 10.23*
2	Low Limit Value [1]	CH1
3	High Limit Value [1]	

AD030A/AD031A CONFIGURATION DATA MEMORY FILE CONTENTS		
CDM FILE OFFSET	**DESCRIPTION**	**CHANNEL**
4	Low Limit Value [1]	CH2
5	High Limit Value [1]	
6	Low Limit Value [1]	CH3
7	High Limit Value [1]	
8	Low Limit Value [1]	CH4
9	High Limit Value [1]	
10	Low Limit Value [1]	CH5
11	High Limit Value [1]	
12	Low Limit Value [1]	CH6
13	High Limit Value [1]	
14	Low Limit Value [1]	CH7
15	High Limit Value [1]	
16	Low Limit Value [1]	CH8
17	High Limit Value [1]	
18	Reserved	
19	Conversion data type Control Bits – Raw or Engineering	*See Table 10.24*
20	Minimum Engineering Value [2]	CH1
21	Maximum Engineering Value [2]	
22	Minimum Engineering Value [2]	CH2
23	Maximum Engineering Value [2]	
24	Minimum Engineering Value [2]	CH3
25	Maximum Engineering Value [2]	
26	Minimum Engineering Value [2]	CH4
27	Maximum Engineering Value [2]	
28	Minimum Engineering Value [2]	CH5
29	Maximum Engineering Value [2]	
30	Minimum Engineering Value [2]	CH6
31	Maximum Engineering Value [2]	
32	Minimum Engineering Value [2]	CH7
33	Maximum Engineering Value [2]	
34	Minimum Engineering Value [2]	CH8
35	Maximum Engineering Value [2]	

[1] Values must be in the same units (raw or scaled) as the channel values.
[2] Minimum and Maximum Engineering Unit values for each channel.

Table 10.22: AD03x A/D Conversion Disable Control Bits

AD030A/AD031A A/D CONVERSION DISABLE CONTROL BITS		
CDM OFFSET 0, BIT #	**CHANNEL**	**SETTINGS**
Bits 0-7	Reserved	
Bit 8	CH1	0 = A/D Conversion Enabled (Default) 1= A/D Conversion Disabled
Bit 9	CH2	
Bit 10	CH3	
Bit 11	CH4	
Bit 12	CH5	
Bit 13	CH6	
Bit 14	CH7	
Bit 15	CH8	

NOTE

Disabled channel input values will be retained and refreshed with the last converted value.

Table 10.23: AD03x Low/High Limit Enable Control Bits

AD030A/AD031A LOW / HIGH LIMIT ENABLE CONTROL BITS			
CDM OFFSET 1, BIT #	**DESCRIPTION**	**CHANNEL**	**SETTINGS**
Bit 0	Low Limit Enable	CH1	0 = Disable Limit (Default) 1 = Enable Limit
Bit 1	High Limit Enable		
Bit 2	Low Limit Enable	CH2	
Bit 3	High Limit Enable		
Bit 4	Low Limit Enable	CH3	
Bit 5	High Limit Enable		
Bit 6	Low Limit Enable	CH4	
Bit 7	High Limit Enable		
Bit 8	Low Limit Enable	CH5	
Bit 9	High Limit Enable		
Bit 10	Low Limit Enable	CH6	
Bit 11	High Limit Enable		
Bit 12	Low Limit Enable	CH7	
Bit 13	High Limit Enable		
Bit 14	Low Limit Enable	CH8	
Bit 15	High Limit Enable		

Table 10.24: AD03x Conversion Data Type Control Bits

AD030A/AD031A CONVERSION DATA TYPE CONTROL BITS		
CDM OFFSET 19, BIT #	**CHANNEL**	**SETTINGS**
Bit 0	CH1	0 = Raw Values (Default) 1 = Engineering Units
Bit 1	CH2	
Bit 2	CH3	
Bit 3	CH4	
Bit 4	CH5	
Bit 5	CH6	
Bit 6	CH7	
Bit 7	CH8	
Bits 8-15	Not Used	

10.4 AD046 / AD047 - 16 CHANNEL ANALOG INPUT MODULES

TERMINAL #	SIGNAL
1	CH1+
2	CH1-
3	CH2+
4	CH2-
5	CH3+
6	CH3-
7	CH4+
8	CH4-
9	CH5+
10	CH5-
11	CH6+
12	CH6-
13	CH7+
14	CH7-
15	CH8+
16	CH8-
17	GND
18	FG
19	CH9+
20	CH9-
21	CH10+
22	CH10-
23	CH11+
24	CH11-
25	CH12+
26	CH12-
27	CH13+
28	CH13-
29	CH14+
30	CH14-
31	CH15+
32	CH15-
33	CH16+
34	CH16-
35	GND
36	FG

Table 10.25: AD046 / AD047 Specifications

AD046 / AD047 SPECIFICATIONS		
	AD046 (VOLTAGE)	AD047 (CURRENT)
Number of channels	16 differential, individually isolated	
Input ranges	0-10V, 1-5V	0-20mA, 4-20mA (input impedance 250Ω)
Resolution	16 bits	
Accuracy	+/- 0.1% max at 25 °C	
Drift	Zero drift: +/- 0.06 µV / °C Span drift: +/- 30 PPM / °C	
Conversion Speed	Max 900 ms/16 channel	
Rejection mode	Common: 150 dB@60 Hz Normal: 150 dB@60 Hz	
Isolation	2.5 KV optical isolation between input signals and CPU	
Internal current consumption	600 mA	
Range selection	DIP Switches, all channels must be same range	
External connections	36pt. terminal block connector, max wire size #14 AWG	
Weight	485 g	

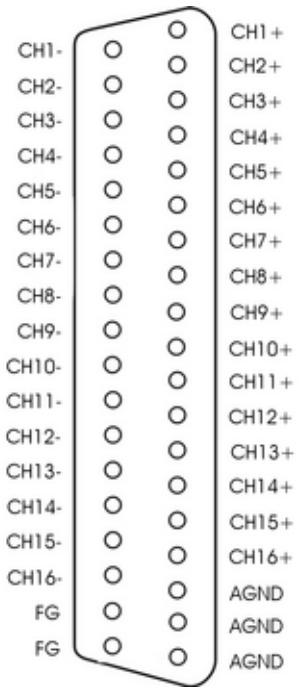


Figure 10.11: AD04x Field Wiring Pinouts

ERROR LED

The AD04x module has an ERR LED. At this time, it has no functionality.

NOTE

These modules require purchase of a high density I/O cable (Cat No HDIO-CBL) and terminal block (Cat No AD04x-TB).

10.4.1 CIRCUIT DIAGRAMS

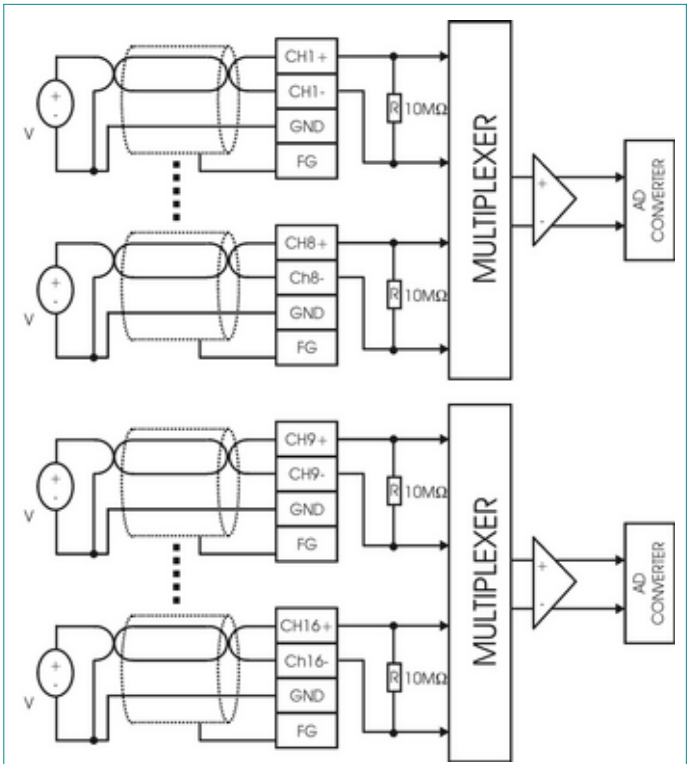


Figure 10.12: AD046 Circuit Diagram

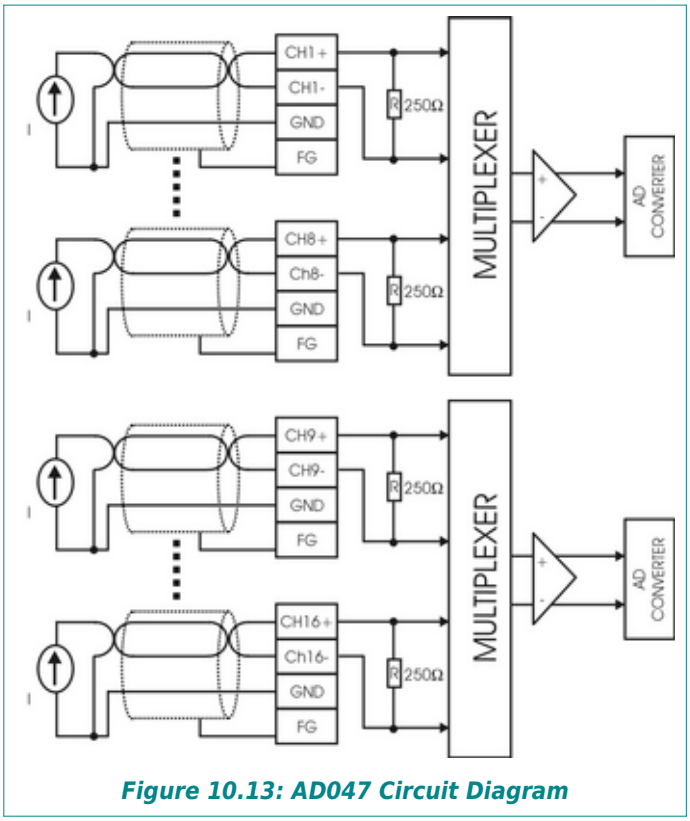


Figure 10.13: AD047 Circuit Diagram

10.4.2 AD046/AD047 FEATURES

The AD046 / AD047 modules offer the following features:

- Sixteen (16) differential input channels with 16-bit resolution, individually isolated
- Two built-in operation ranges
  - Voltage inputs: 0~10V, 1~5V (AD046)
  - Current inputs: 0~20mA, 4~20mA (AD047)
- 2.5 KV Optical Isolation between input signals and CPU
- Built-in AC 50 / 60 Hz differential rejection capabilities
- Engineering Unit Scaling

10.4.3 AD046 AND AD047 OPERATION SUMMARY

Three (3) status words and sixteen (16) analog input values are mapped directly to SoftPLC's datatable registers. The first status word contains the Line Break flags and the second and nineteenth are used by the SoftPLC.

Since a single module supports multiple voltage or current ranges, an external DIP Switch is provided to set the device to the desired signal range. All channels must use the same signal range.

10.4.4 USING THE AD046/AD047 MODULES

The following steps are recommended to use the modules in your SoftPLC system:

1. Define the Operating Range and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.
2. Wire the module to your I/O per the provided diagrams.
3. Determine the mapping location of the Scan Data Registers in SoftPLC's Data Table. This is done using the I/O driver's configuration editor appropriate for your system (local=smart.tlm, Ethernet= mbipmast.tlm).
4. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code is written to status file word S:15. For remote I/O, operation will vary.
5. If SoftPLC starts properly and enters RUN mode, but the module does not operate as expected, the DIP Switches should be confirmed.

10.4.5 DEFINING OPERATING RANGE AND DATA TYPE

The AD046 can be setup in one of two voltage ranges and the AD047 can be setup in one of two current ranges. Both modules can be set to format the data as signed or unsigned. The specific selection is set via DIP switches located on the back side (slot edge) of the module.

NOTE

Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4=ON).

Table 10.26: AD046 DIP Switch Settings

AD046 OPERATING RANGE & DATA TYPE DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	RANGE	TYPE
OFF	OFF	OFF	OFF	0 to 10 V	Unsigned
OFF	OFF	OFF	ON	0 to 10 V	Signed
OFF	ON	ON	OFF	1 to 5 V	Unsigned
OFF	ON	ON	ON	1 to 5 V	Signed

Table 10.27: AD047 DIP Switch Settings

AD047 OPERATING RANGE & DATA TYPE DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	RANGE	TYPE
OFF	ON	ON	OFF	0-20 mA	Unsigned
OFF	ON	ON	ON	0-20 mA	Signed
OFF	OFF	OFF	OFF	4-20 mA	Unsigned
OFF	OFF	OFF	ON	4-20 mA	Signed

If SW4 is set to the ON position, the data reported in the Scan Data Registers from the AD046 / 47 module will be in signed data format. The signed data range is from -32768 to +32767. It will be in unsigned data format if SW4 is set to the OFF position. Unsigned data may be from 0 to 65535. Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4=ON).

Table 10.28: AD046/47 Data Range

AD046/AD047 DATA RANGE CHANNELS 1-16		
DATA TYPE	SIGNED	UNSIGNED
Raw	-32768 to 32767	0 to 65535 (unsigned)
Scaled	User specified engineering units where range is MIN to MAX (set via CDM)	

The following tables illustrate the relation of raw conversion data between the input signal of the module and the channel register's data in the module.

Table 10.29: AD046 /AD047 Signed Raw Data vs Input Signal

AD046/AD047 SIGNED DATA VOLTAGE/CURRENT INPUT				
SIGNED DATA	AD046 RANGE		AD047 RANGE	
	0 to 10 V	1 to 5 V	0 to 20 mA	4 to 20 mA
-32768 (8000h)				
-16384 (C000h)				
0 (0000h)	0 V	1 V	0 mA	4 mA
8191 (1FFFh)	2.5 V	2 V	5 mA	8 mA
16383 (3FFFh)	5 V	3 V	10 mA	12 mA
24575 (5FFFh)	7.5 V	4 V	15 mA	16 mA
32767 (7FFFh)	10 V	5 V	20 mA	20 mA

Table 10.30: AD046/AD047 Unsigned Raw Data vs Input Signal

AD046/AD047 UNSIGNED DATA VOLTAGE / CURRENT INPUT				
UNSIGNED DATA	AD046 RANGE		AD047 RANGE	
	0 to 10 V	1 to 5 V	0 to 20 mA	4 to 20 mA
0 (0000h)	0 V	1 V	0 mA	4 mA
16383 (3FFFh)	2.5 V	2 V	5 mA	8 mA
32767 (7FFFh)	5 V	3 V	10 mA	12 mA
49151 (BFFFh)	7.5 V	4 V	15 mA	16 mA
65535 (FFFFh)	10 V	5 V	20 mA	20 mA

10.4.6 SCAN DATA REGISTER DESCRIPTIONS

The AD046 / AD047 modules interface directly to the SoftPLC Data Table via nineteen (19) consecutive 16 bit words called the Scan Data Registers. The address mapping for the Scan Data Registers into the datatable is done in the I/O Driver Configuration editors.

These registers are defined as follows:

Table 10.31: AD046/AD047 Scan Data Registers

AD046/AD047 SCAN DATA REGISTERS		
SCAN DATA REGISTER WORD OFFSETS	**DESCRIPTION**	**DATA FORMAT**
0001	Line Broken Detection Flags	*(See Next Table)*
0002	Reserved for System Use	
0003	Channel 1	Raw data
0004	Channel 2	
0005	Channel 3	
0006	Channel 4	
0007	Channel 5	
0008	Channel 6	
0009	Channel 7	
0010	Channel 8	
0011	Channel 9	
0012	Channel 10	
0013	Channel 11	
0014	Channel 12	
0015	Channel 13	
0016	Channel 14	
0017	Channel 15	
0018	Channel 16	
0019	Reserved for System Use	

NOTE

Line break detection flags are valid for 1-5V and 4-20mA ranges only.

Table 10.32: AD046/AD047 Line Break Detection Status Register

AD046 / AD047 LINE BREAK DETECTION STATUS REGISTER		
DATATABLE WORD OFFSET 1, BIT #	**CHANNEL**	
Bit 0	CH1	0 = Normal (Default) 1 = Line Broken
Bit 1	CH2	
Bit 2	CH3	
Bit 3	CH4	
Bit 4	CH5	
Bit 5	CH6	
Bit 6	CH7	
Bit 7	CH8	
Bit 8	CH9	
Bit 9	CH10	
Bit 10	CH11	
Bit 11	CH12	
Bit 12	CH13	
Bit 13	CH14	
Bit 14	CH15	
Bit 15	CH16	

CHAPTER 11 - ANALOG OUTPUT MODULES

Table 11.1: Analog Output Modules Summary

ANALOG OUTPUT MODULES					
OPERATING RANGE	EXT 24VDC P/S REQ'D?	NUMBER OF CHANNELS	RESPONSE TIME	RESOLUTION	CATALOG NUMBER
0 to 10, 1 to 5, + 10 VDC 0 to 20, 4 to 20, +/- 20 mA	Yes	4 single-ended	+ 0.1 µV / °C	14 bit	DA020
0 to 10, 1 to 5, +/- 10 VDC 0 to 20, 4 to 20, +/- 20 mA	Yes	8 single-ended	+ 0.1 µV / °C	14 bit	DA030
0 to 10, 1 to 5, +/- 10 VDC 0 to 20, 4 to 20, +/- 20 mA	Yes	8 single-ended	+ 0.1 µV / °C	15 bit	DA031

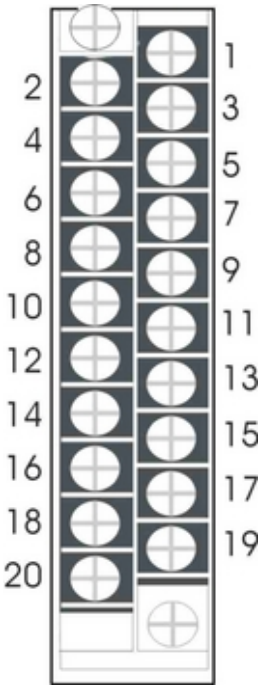
11.1 DA020 – 4 CHANNEL ANALOG OUTPUT MODULE

Table 11.2: DA020 Specifications

DA020 SPECIFICATIONS	
Output channels	4 single-ended
Output ranges	0 to 10 V,1 to 5 V,+/- 10 V 0 to 20 mA,4 to 20 mA, +/- 20 mA
Resolution	14 bits
Accuracy	+/- 0.2%FSR
Zero drift	+/- 0.1 µV / °C
Span drift	+/- 30 PPM / °C
Isolation	2.5 KV optical isolation between input signals and CPU, channels not individually isolated
Internal current consumption	400 mA
Range selection	DIP Switches, all channels must be same range
External voltage source	24 VDC required
External connections	20pt. terminal block, max wire size #14 AWG
Weight	390 g

Table 11.3: DA020 Field Wiring

TERMINAL #	SIGNAL
1	CH1_V+
2	CH1_V-
3	CH1_I+
4	CH1_I-
5	CH2_V+
6	CH2_V-
7	CH2_I+
8	CH2_I-
9	CH3_V+
10	CH3_V-
11	CH3_I+
12	CH3_I-
13	CH4_V+
14	CH4_V-
15	CH4_I+
16	CH4_I-
17	FG
18	FG
19	24V
20	GND



ERROR LED'S

The DA020 Module has 4 Error LED's. These currently have no documented purpose

11.1.1 CIRCUIT DIAGRAMS

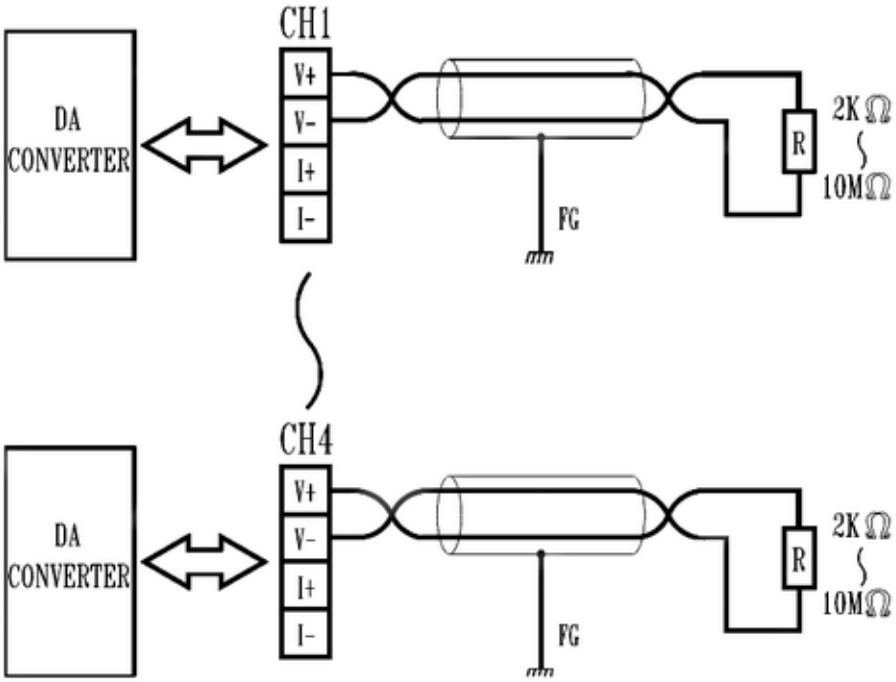


Figure 11.1: DA020 Voltage Outputs Circuit Diagram

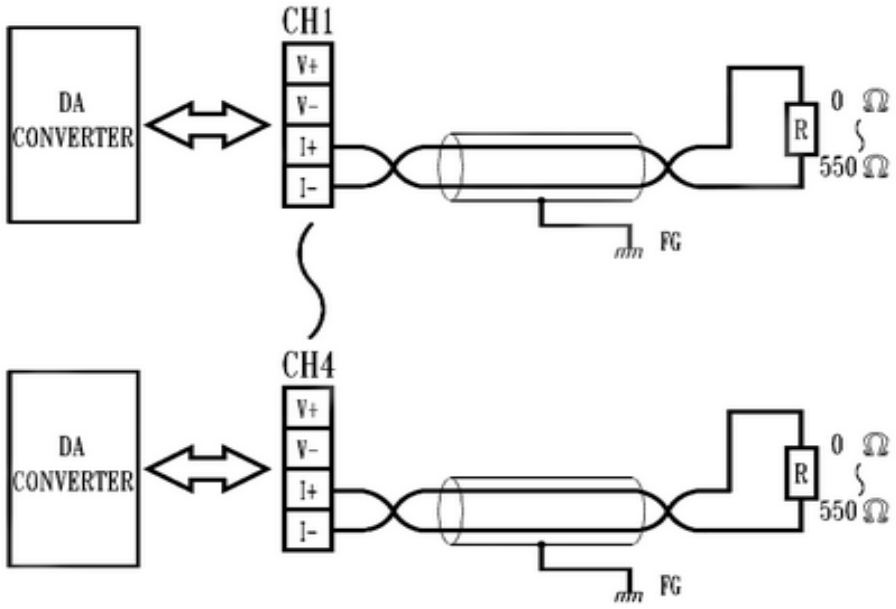


Figure 11.2: DA020 Current Outputs Circuit Diagram

11.1.2 DA020 FEATURES

The DA020 modules are 4-channel digital-to-analog output modules featuring:

- Four (4) analog output channels with 14-bit resolution
- Six (6) built-in operation ranges
- Voltage outputs: 0 to 10 V, 1 to 5 V, +/- 10 V
- Current output: 0 to 20 mA, 4 to 20 mA, +/- 20 mA
- 2.5 KV Optical Isolation between input / output signals and CPU
- Output Channel Enable / Disable
- Last State Hold or Clear (zero) Control

11.1.3 OPERATING SUMMARY

A control word and four (4) analog output values map directly to SoftPLC's datatable registers. By default, output channel conversion is enabled and the respective values are set to zero when the CPU stops or a communication timeout occurs. The control register can be used to disable the output conversion for all channels and enable last state value capture on error. The analog output values must be supplied in 16 bit "extended" signed or unsigned RAW data format. There is no Configuration Data Memory (CDM) associated with this module. An external 24 VDC voltage source is required for operation.

Since a single module supports multiple voltage or current ranges, an external DIP Switch is provided to set the device to the desired signal range. All channels must use the same signal range.

11.1.4 USING A DA020 MODULE

The following steps are recommended to use the DA020 module in your SoftPLC system:

1. Define the Operating Range and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.
2. Wire the module to your I/O per the provided diagrams.
3. Determine the mapping location of the Scan Data Registers in SoftPLC's datatable. This is done using the I/O driver's configuration editor appropriate for your system (local=smart.tlm, ethernet = mbipmast.tlm).
4. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code will be written to status file word S:15. For remote I/O, operation will vary.
5. If SoftPLC starts properly and enters RUN mode, but the module does not operate as expected, confirm the DIP switch settings and the wiring.

11.1.5 DEFINING OPERATING RANGE AND DATA TYPE

The DA020 can be set in one of 6 voltage/current ranges. In addition, either signed or unsigned data type or format may be selected. The specific selections are set via DIP Switches located on the back or slot edge of the module.

NOTE

Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4=ON).

Table 11.4: DA020 DIP Switch Settings

DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	OPERATING RANGE	DATA TYPE
OFF	OFF	OFF	OFF	0 to 10 V	Unsigned
OFF	OFF	OFF	ON	0 to 10 V	Signed
OFF	ON	OFF	OFF	1 to 5 V	Unsigned
OFF	ON	OFF	ON	1 to 5 V	Signed
OFF	OFF	ON	OFF	+/- 10 V	Unsigned
OFF	OFF	ON	ON	+/- 10 V	Signed
ON	OFF	OFF	OFF	0 to 20 mA	Unsigned
ON	OFF	OFF	ON	0 to 20 mA	Signed
ON	ON	OFF	OFF	4 to 20 mA	Unsigned
ON	ON	OFF	ON	4-20 mA	Signed
ON	OFF	ON	OFF	+/- 20 mA	Unsigned
ON	OFF	ON	ON	+/- 20 mA	Signed

If SW4 is set to the ON position, the data reported in the Scan Data Registers from the module will be in signed data format. Signed data range is from -32768 to +32767. Data will be in unsigned data format if SW4 is set to the OFF position. Unsigned data range is 0 to 65535. Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4=ON).

Table 11.5: DA020 Data Range

DA020 DATA RANGE	
SIGNED	UNSIGNED
-32768 to 32767	0 to 65535

The following tables illustrate the relation of raw conversion data between the input signal of the module and the channel register's data in the module.

Table 11.6: DA020 Raw Data vs Input Signal

DA020 DATA REGISTER VALUES RELATED TO VOLTAGE/CURRENT OUTPUT						
SIGNED DATA	VOLTAGE RANGE			CURRENT RANGE		
	0 - 10 V	1 - 5 V	+/- 10 V	0 -20mA	4 - 20mA	+/- 20mA
-32768 (8000h)			-10 V			-20 mA
-24575 (CFFFh)			-5 V			-10 mA
0 (0000h)	0 V	1 V	0 V	0 mA	4 mA	0 mA
8191 (1FFFh)	2.5 V	2V	2.5 V	5 mA	8 mA	5 mA
16383 (3FFFh)	5 V	3 V	5 V	10 mA	12 mA	10 mA
24575 (5FFFh)	7.5 V	4 V	7V	15 mA	16 mA	15 mA
32767 (7FFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA
UNSIGNED DATA	**0 - 10 V**	**1 - 5 V**	**+/- 10 V**	**0 - 20 mA**	**4 - 20mA**	**+/- 20mA**
0 (0000h)	0 V	1 V	-10 V	0 mA	4 mA	-20 mA
16383 (3FFFh)	2.5 V	2V	-5 V	5 mA	8 mA	-10 mA
32767 (7FFFh)	5 V	3 V	0 V	10 mA	12 mA	0 mA
49151 (BFFFh)	7.5 V	4 V	5 V	15 mA	16 mA	10 mA
65535 (FFFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA

11.1.6 DATA REGISTER DESCRIPTIONS & OPERATING MODE SETTINGS

The DA020 module interfaces directly to the SoftPLC Datatable via five (5) consecutive 16 bits words called the Scan Data Registers. The first word is the Control Flag Register, which is used to disable the outputs and or control the last state value of the output channels. The five (5) registers are defined as follows:

Table 11.7: DA020 Scan Data Registers

DA020 SCAN DATA REGISTERS		
SCAN DATA REGISTERS	DESCRIPTION	CHANNEL
0	Control Register	
1	Output Register	CH1
2	Output Register	CH2
3	Output Register	CH3
4	Output Register	CH4

Table 11.8: DA020 Control Register Bits

DA020 CONTROL REGISTER			
DATATABLE WORD OFFSET 0, BIT #	**DESCRIPTION**	**CHANNEL**	
Bit 0	Output Control Bit	All Channels	0=enable (Default), 1=disable
Bit 1-3	Not Used		
Bit 4	Last State Control Bit	CH1	0 = Enable (Default) 1 = Disable
Bit 5	Last State Control Bit	CH2	
Bit 6	Last State Control Bit	CH3	
Bit 7	Last State Control Bit	CH4	
Bit 8	Not Used		

NOTE

The Last State Control Bit is only effective when there is a CPU failure or communications timeout. As a result, setting the Output Control Bit to disable during runtime will always result in the output channel values being set to zero (0).

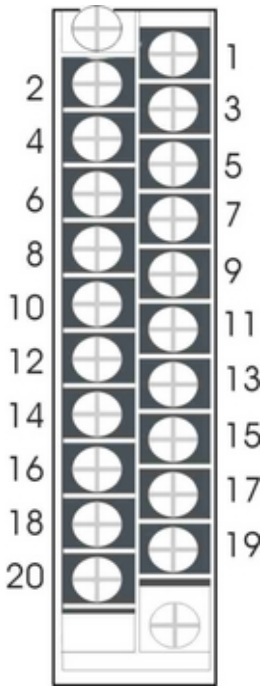
11.2 DA030/DA031 - 8 CHANNEL ANALOG OUTPUT MODULES

Table 11.9: DA030/DA031 Specifications

DA030 / DA031 SPECIFICATIONS	
Output channels	8 single-ended
Output ranges	DA030: 0 to 10 V,1 to 5 V,+/- 10 V DA031: 0 to 20 mA, 4 to 20 mA, +/- 20 mA
Resolution	15 bits
Accuracy	+/- 0.2%FSR
Zero drift	+/- 0.1 µV / °C
Span drift	+/- 30 PPM / °C
Isolation	2.5 KV optical isolation between output signals and CPU, channels not individually isolated
Internal current consumption	400 mA
Range selection	DIP Switches, all channels must be same range
External voltage source	24 VDC required
External connections	20pt. terminal block , max wire size #14 AWG
Weight	390 g

Table 11.10: DA030/31 Field Wiring

TERMINAL #	SIGNAL
1	CH1+
2	CH1-
3	CH2+
4	CH2-
5	CH3+
6	CH3-
7	CH4+
8	CH4-
9	CH5+
10	CH5-
11	CH6+
12	CH6-
13	CH7+
14	CH7-
15	CH8+
16	CH8-
17	FG
18	FG
19	24V
20	GND



11.2.1 CIRCUIT DIAGRAMS

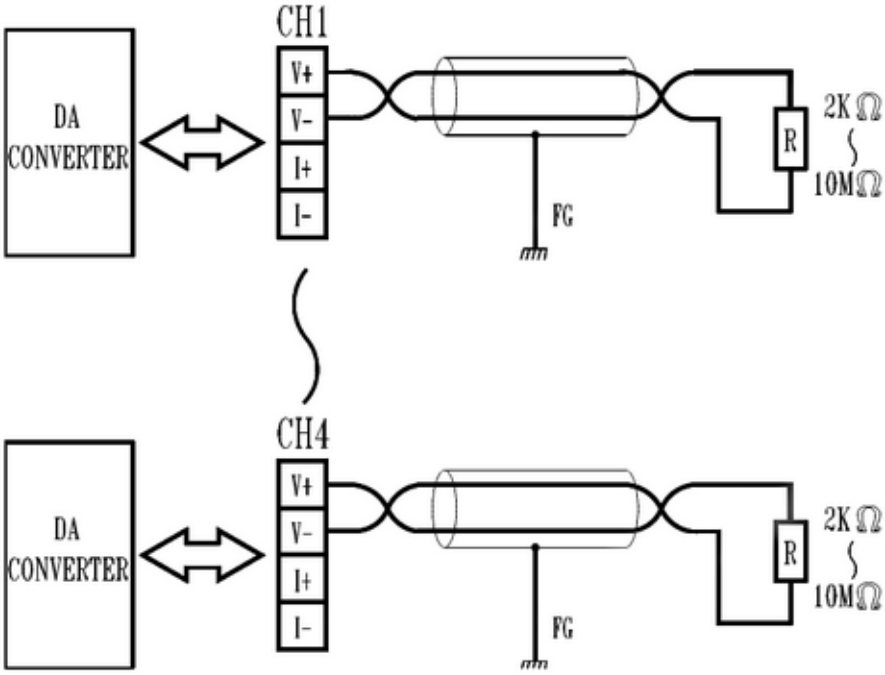


Figure 11.3: DA030 Circuit Diagram

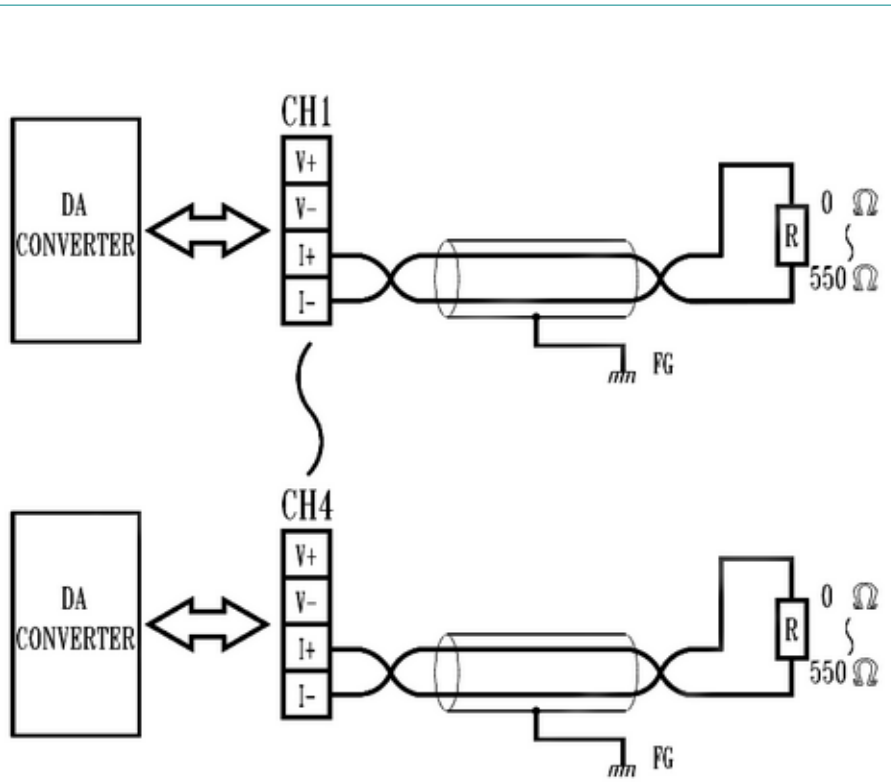


Figure 11.4: DA031 Circuit Diagram

11.2.2 DA030, DA031 FEATURES

The DA030/DA031 modules are 8 channel digital-to-analog output modules featuring:

- Eight (8) analog output channels with 15-bit resolution
- Three (3) built-in operation ranges
- Voltage outputs: 0 to 10 V, 1 to 5 V, +/- 10 V (DA030)
- Current output: 0 to 20 mA, 4 to 20 mA, +/- 20 mA (DA031)
- 2.5 KV Optical Isolation between input / output signals and CPU
- Output Channel Enable / Disable
- Last State Hold or Clear (zero) Control

11.2.3 OPERATION SUMMARY

A control word and eight (8) analog output values map directly to SoftPLC's datatable registers. By default, the respective values are set to zero when the CPU stops or a communication timeout occurs. The control register can be used to enable last state value capture on error by channel. The analog output values must be supplied in 16 bit "extended" signed or unsigned RAW data format. There is no Configuration Data Memory (CDM) associated with this module. An external 24 VDC voltage source is required for operation.

Since a single module supports multiple voltage or current ranges, an external DIP Switch is provided to set the device to the desired signal range. All channels must use the same signal range.

11.2.4 USING A DA030/DA031 MODULE

The following step are recommended to use the DA030/DA031 module in your SoftPLC system:

1. Define the Operating Range and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.
2. Wire the module to your I/O per the provided diagrams.
3. Determine the mapping location of the Scan Data Registers in SoftPLC's datatable. This is done using the I/O driver's configuration editor appropriate for your system (local = smart.tlm, ethernet = mbipmast.tlm).
4. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code will be written to status file word S:15. For remote I/O, operation will vary.
5. If SoftPLC starts properly and enters RUN mode, but the module does not operate as expected, confirm the DIP switch settings and the wiring.

11.2.5 DEFINING OPERATING RANGE AND DATA TYPE

The DA030/DA031 can be setup in either voltage or current operation mode. In addition, either signed or unsigned data type or format may be selected. The specific selection is set via DIP Switches located on the slot edge of the module.

NOTE

Since SoftPLC's internal integer data types are signed, it is recommended that the signed data format be selected (SW4, ON).

Table 11.11: DA030 DIP Switch Settings

DA030 DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	OPERATION RANGE	DATA TYPE
OFF	OFF	OFF	OFF	0 to 10 V	Unsigned
OFF	OFF	OFF	ON	0 to 10 V	Signed
OFF	ON	OFF	OFF	1 to 5 V	Unsigned
OFF	ON	OFF	ON	1 to 5 V	Signed
OFF	OFF	ON	OFF	+/- 10 V	Unsigned
OFF	OFF	ON	ON	+/- 10 V	Signed

Table 11.12: DA031 DIP Switch Settings

DA031 DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	OPERATION RANGE	DATA TYPE
ON	OFF	OFF	OFF	0 to 20 mA	Unsigned
ON	OFF	OFF	ON	0 to 20 mA	Signed
ON	ON	OFF	OFF	4 to 20 mA	Unsigned
ON	ON	OFF	ON	4-20 mA	Signed
ON	OFF	ON	OFF	+/- 20 mA	Unsigned
ON	OFF	ON	ON	+/- 20 mA	Signed

If SW4 is set to the ON position, the data reported in the Scan Data Registers from the module will be in signed data format. Signed data range is from -32768 to +32767. It will be in unsigned data format if SW4 is set to the OFF position. Unsigned data may be from 0 to 65535.

Table 11.13: DA030/DA031 Data Range

DA030/DA031 DATA RANGE	
SIGNED	UNSIGNED
-32768 to 32767	0 to 65535

The following table illustrates the relation of raw conversion data between the channel register's data in the module and the output signal of the module.

Table 11.14: DA030/DA031 Raw Values vs Output Signal

DA030/DA031 RAW VALUES RELATED TO OUTPUT SIGNAL						
SIGNED DATA	VOLTAGE RANGE			CURRENT RANGE		
	0 - 10V	1 - 5V	+/- 10V	0 - 20mA	4 - 20mA	+/- 20mA
-32768 (8000h)			-10 V			-20 mA
-24575 (CFFFh)			-5 V			-10 mA
0 (0000h)	0 V	1 V	0 V	0 mA	4 mA	0 mA
8191 (1FFFh)	2.5 V	2V	2.5 V	5 mA	8 mA	5 mA
16383 (3FFFh)	5 V	3 V	5 V	10 mA	12 mA	10 mA
24575 (5FFFh)	7.5 V	4 V	7V	15 mA	16 mA	15 mA
32767 (7FFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA
UNSIGNED DATA	**0 - 10V**	**1 - 5V**	**+/- 10V**	**0 - 20mA**	**4 - 20mA**	**+/- 20mA**
0 (0000h)	0 V	1 V	-10 V	0 mA	4 mA	-20 mA
16383 (3FFFh)	2.5 V	2V	-5 V	5 mA	8 mA	-10 mA
32767 (7FFFh)	5 V	3 V	0 V	10 mA	12 mA	0 mA
49151 (BFFFh)	7.5 V	4 V	5 V	15 mA	16 mA	10 mA
65535 (FFFFh)	10 V	5 V	10 V	20 mA	20 mA	20 mA

11.2.6 DATA REGISTER DESCRIPTION & OPERATING MODE SETTINGS

The DA030/DA031 modules interface directly to the SoftPLC datatable via nine (9) consecutive 16 bit registers (words) called the Scan Data Registers. The first word is the Control Flag Register, which is used to control the last state value of the output channels.

The definition of the 9 registers are described below:

Table 11.15: DA030/DA031 Scan Data Registers

DA030/DA031 SCAN DATA REGISTERS		
SCAN DATA REGISTER WORDS	**DESCRIPTION**	**CHANNEL**
0	Control Flags Register	*See Next Table*
1	Output Register	CH1
2	Output Register	CH2
3	Output Register	CH3
4	Output Register	CH4
5	Output Register	CH5
6	Output Register	CH6
7	Output Register	CH7
8	Output Register	CH8

Table 11.16: DA030/DA031 Control Register Bits

DA030/DA031 CONTROL REGISTER BITS			
SCAN DATA WORD OFFSET 0, BIT#	**DESCRIPTION**	**CHANNEL**	**VALUE**
0	Last State Control Bit	CH1	0 = reset when CPU stops or system times out (Default) 1 = last value remains on when CPU stops or system times out
1	Last State Control Bit	CH2	
2	Last State Control Bit	CH3	
3	Last State Control Bit	CH4	
4	Last State Control Bit	CH5	
5	Last State Control Bit	CH6	
6	Last State Control Bit	CH7	
7	Last State Control Bit	CH8	
8-15	Unused		

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CHAPTER 12 - TEMPERATURE INPUT MODULES

Table 12.1: Summary of Available Temperature Modules

TEMPERATURE INPUT MODULES SUMMARY						
OPERATING RANGE		EXTERNAL 24VDC P/S REQ'D?	NUMBER OF CHANNELS	RESPONSE TIME	RESOLUTION	CATALOG NUMBER
Type B	200 to 1800 °C	Opt	5 differential	18 ms / channel	12 bit	THM10
Type E	0 to 1000 °C					
Type J	-50 to 750 °C					
Type K	0 to 1200 °C					
Type R	0 to 1700 °C					
Type S	0 to 1700 °C					
Type T	-100 to 400 °C					
PT-100	-150 to 600 °C	Opt	4 differential	18 ms / channel	15 bit	RTD10
Ni-200	-50 to 300 °C					
PT-100	-150 to 600 °C	No	8 differential	10 Hz	15 bit	RTD26

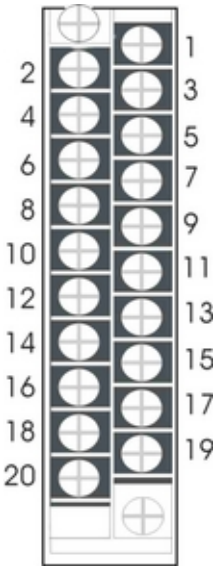
12.1 THM10 – 5 CHANNEL THERMOCOUPLE MODULE

Table 12.3: THM10 Specifications

THM10 Specifications	
Number of channels	5 differential, not individually isolated
Input ranges	Type B: 200 to 1800 °C Type E: 0 to 1000 °C Type J: -50 to 750 °C Type K: 0 to 1200 °C Type R: 0 to 1700 °C Type S: 0 to 1700 °C Type T: -100 to 400 °C
Resolution	12 bits (1 in 4096)
Accuracy	+/- 1% FSR
Span drift	+/- 30 PPM / °C
Step response (5 to 95%)	18 ms / channel
Setup time	20 ms / channel
Settle time	50 ms / channel
Conversion method	Sigma-Delta
Range selection	By DIP Switch
Cold junction compensation	Automatic
Isolation	2.5 KV optical isolation between input signal and CPU, channels not individually isolated
Outputs	5 PWM isolated outputs
Internal current consumption	400 mA
External connections	20pt. terminal block , max wire size #14 AWG
Weight	380 g

Table 12.2: THM10 Field Wiring

TERMINAL #	SIGNAL
1	CH1+
2	CH1-
3	CH2+
4	CH2-
5	CH3+
6	CH3-
7	CH4+
8	CH4-
9	CH5+
10	CH5-
11	O1
12	O2
13	O3
14	O4
15	O5
16	24V
17	GND
18	SNR+
19	SNR+
20	SNR-



LED'S

ERR: The Error LED will be illuminated if a line break is detected on any channel's input. To eliminate line break errors on unused channels; a closed loop wire may be connected between CH+ and CH-.

01, 02, 03, 04, 05: The five(5) Output LED's will illuminate while the corresponding channels Pulse Width Modulated (PWM) output is ON.

12.1.1 WIRING & CIRCUIT DIAGRAMS

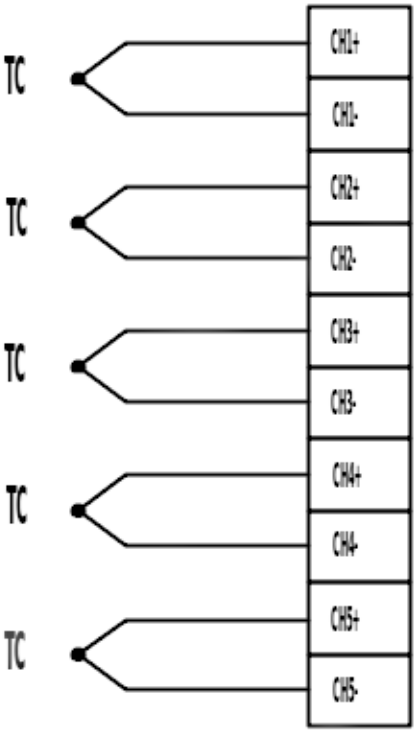


Figure 12.1: THM10 T/C Wiring to Terminal Block

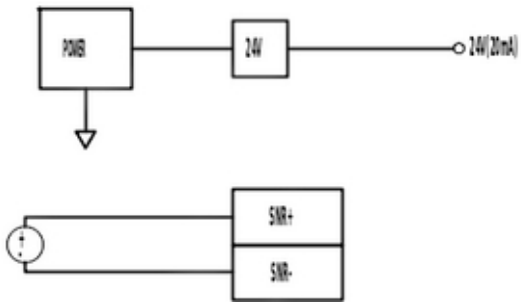


Figure 12.3: THM10 SNR & Ext P/S Wiring

NOTE

External 24 VDC power source not required if PWM outputs are not used.

HINT

The SNR+ and the SNR- are connectors for the temperature compensation sensor. The temperature difference of the environments of the compensation sensors and the thermocouple modules must be maintained within +/- 3 °

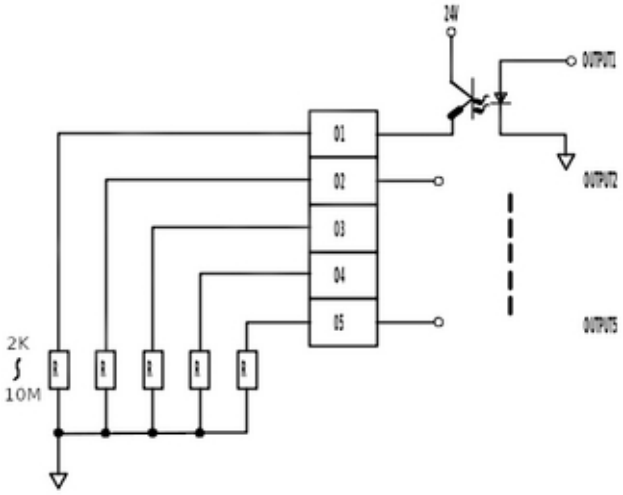


Figure 12.2: THM10 Circuit Diagram

12.1.2 THM10 FEATURES

The THM10 module is a multi-channel thermocouple temperature-sensing module and PID controller. The embedded microprocessor has five (5) channel inputs and five (5) Pulse Width Modulated (PWM) control outputs. The THM10 has the following features:

- Five (5) input channels with 12-bit resolution
- 2.5 KV optical isolation between input/output signals and the CPU
- Supports seven (7) thermocouple input types (B, E, J, K, R, S, and T)
- Thermocouple wire break detection
- Individual channel conversion enable/disable
- Five (5) Pulse Width Modulated (PWM) optically isolated discrete outputs
- Raw or scaled temperature values
- Internal PID Loop controllers

12.1.3 OPERATION SUMMARY

A status word and five (5) thermocouple values map directly to SoftPLC's datatable registers. By default, all thermocouple channels are continuously scanned and report the temperature read in RAW (0 to 32767) integer format. If desired, the module can be configured to automatically scale the RAW values to Centigrade values (oC). If all channels are not being used, one or more can be disabled to decrease the conversion time. In addition, each channel can be configured to control a Process Variable using an internal PID controller.

A Pulse Width Modulated (PWM) Output is available for each channel and it can be controlled directly by the internal PID controller or manually via the Output Scan Data Registers. In the event an open thermocouple is detected, the associated "Line Break Detection Flag" is set, the channels value is set to -1 (FFFFh), and the error (ERR) LED on the front of the module will illuminate. In manual mode, the line break flag can be monitored and used to determine when to set the PWM value to zero.

CAUTION

The sensor's last value is retained if a wire breaks, it is imperative that the user monitors the status of the line break detection flags to determine if the thermometer value is valid and/or to use the PWM output value .

In order to activate the PID controllers or enable automatic scaling to Centigrade, the modules internal Configuration Data Memory (CDM) must be configured. The module's DIP Switch settings must also be set to match the type of thermocouple that is connected. All channels must use the same type thermocouple and data type.

12.1.4 USING A THM10 MODULE

The following procedures are recommended to configure and connect the THM10 module to SoftPLC.

1. Define the Thermocouple and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.

2. Wire the module to your I/O per the provided diagrams.
3. Determine the mapping location of both the Input Scan Data Registers and the Output Scan Data Registers in SoftPLC's datatable. This is done using the I/O driver's configuration editor appropriate for your system (local=smart.tlm, ethernet=mbipmast.tlm).
4. If necessary, program the CDM File.
5. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code will be written to the status file word S:15. For remote I/O, operation will vary.
6. If SoftPLC starts properly and enters RUN mode, but the module does not operate as expected, the DIP Switches and the CDM settings should be confirmed. If necessary, the CDM Memory can be read and verified using the CDMR TLI instruction.

12.1.5 DEFINING OPERATION RANGE AND DATA TYPE SETTING

The THM10 has a DIP Switch on the rear (slot edge) of the module that must be set to match the connected thermocouple type or T/C range.

NOTE

Since SoftPLC's internal data types are signed, it is recommended the signed data format be selected (SW4, ON.)

Table 12.4: THM10 DIP Switch Settings

THM10 DIP SWITCH SETTINGS					
SW1	SW2	SW3	SW4	TYPE	DATA TYPE
OFF	OFF	OFF	OFF	J	Unsigned
OFF	OFF	OFF	ON	J	Signed
OFF	OFF	ON	OFF	R	Unsigned
OFF	OFF	ON	ON	R	Signed
OFF	ON	OFF	OFF	T	Unsigned
OFF	ON	OFF	ON	T	Signed
OFF	ON	ON	OFF	B	Unsigned
OFF	ON	ON	ON	B	Signed
ON	OFF	OFF	OFF	K	Unsigned
ON	OFF	OFF	ON	K	Signed
ON	OFF	ON	OFF	S	Unsigned
ON	OFF	ON	ON	S	Signed
ON	ON	OFF	OFF	E	Unsigned
ON	ON	OFF	ON	E	Signed

Table 12.5: THM10 Temperature Value Range

THM10 TEMPERATURE VALUE RANGE	
READING	**RANGE**
Raw	0 to 32767 (7FFFh)
Scaled	-500 to 18000 °C (possible range) Actual range depends on the T/C and data type selected via DIP Switches .

NOTE

Scaled integer values are 10 times (x 10) greater than actual value. Disabled channel input values will be retained and refreshed with the last converted value.

Table 12.6: THM10 Temperature vs Input Values

THM10 THERMOCOUPLE VALUE RESULTS				
T/C TYPE	**TEMP IN °C**	**SIGNED SCALED**	**UNSIGNED SCALED**	**RAW VALUE**
J	-50	-500	0	0
	350	3500	3500	16383
	750	7500	8000	32767
R	100	1000	1000	0
	900	9000	9000	16383
	1700	17000	17000	32767
T	-100	-1000	0	0
	150	1500	1500	16383
	400	4000	5000	32767
B	200	2000	2000	0
	1000	10000	10000	16383
	1800	18000	18000	32767
K	0	0	0	0
	600	6000	6000	16383
	1200	12000	12000	32767
S	100	1000	1000	0
	900	9000	9000	16383
	1700	17000	17000	32767
E	0	0	0	0
	500	5000	5000	16383
	1000	10000	10000	32767

12.1.6 DATA REGISTER DESCRIPTIONS & OPERATING MODE SETTINGS

SCAN DATA REGISTERS

The THM10 module interfaces directly to the SoftPLC datatable via six (6) consecutive input words and six (6) consecutive output words (this module has both input and output Scan Data Registers). The Input Scan Data Registers provide the status and values for each of the five (5) thermocouple channels. The Output Scan Data Registers include Output Control Registers and the Pulse Width Modulation (PWM) frequency value for each of the (5) outputs.

Table 12.7: THM10 Input Scan Data Registers

THM10 INPUT SCAN DATA REGISTERS		
SCAN DATA REGISTER OFFSETS	**DESCRIPTION**	**CHANNEL**
0	Status Register Flag Bits	*(See Next Table)*
1	Input Register	CH1
2	Input Register	CH2
3	Input Register	CH3
4	Input Register	CH4
5	Input Register	CH5

Table 12.8: THM10 Input Status Register Flag Bits

THM10 STATUS REGISTER BITS				
DATATABLE WORD OFFSET 0, BIT #	**B2**	**B1**	**B0**	**T/C TYPE**
Bits 0 to 2	0	0	0	J
	0	0	1	K
	0	1	0	T
	0	1	1	E
	1	0	0	R
	1	0	1	S
	1	1	0	B
	DESCRIPTION		**CHANNEL**	**VALUE**
Bit 3	PWM Output Bit Status		O1	0 = Off (Default) 1 = On
Bit 4	PWM Output Bit Status		O2	
Bit 5	PWM Output Bit Status		O3	
Bit 6	PWM Output Bit Status		O4	
Bit 7	PWM Output Bit Status		O5	
Bit 8	Line Break Detection Flag		CH1	0 = Normal (Default) 1 = Break
Bit 9	Line Break Detection Flag		CH2	
Bit 10	Line Break Detection Flag		CH3	

THM10 STATUS REGISTER BITS			
Bit 11	Line Break Detection Flag	CH4	
Bit 12	Line Break Detection Flag	CH5	
Bits 13 to 15	Not Used		

Table 12.9: THM10 Output Scan Data Registers

THM10 OUTPUT SCAN DATA REGISTERS		
OUTPUT SCAN DATA REGISTER OFFSETS	DESCRIPTION	CHANNEL
0	Output Control Register Flag Bits	*(See Next Table)*
1	PWM Value	CH1
2	PWM Value	CH2
3	PWM Value	CH3
4	PWM Value	CH4
5	PWM Value	CH5

NOTE

PWM value in the Output Scan Data Register offsets 1-5 is 0 to 8191 ms (0~1FFFH) and is used to set the frequency at which the associated optically isolated outputs are turned ON and OFF when a particular channel is in manual control, or if a line break occurs during PID control.

Table 12.10: THM10 Output Control Register Bits

THM10 OUTPUT CONTROL REGISTER BITS			
DATATABLE OFFSET WORD 0, BIT #	DESCRIPTION	CHANNEL	VALUE
Bit 0	PWM Output Source	CH1	0 = PWM Value (Default) 1=PID
Bit 1	PWM Output Source	CH2	
Bit 2	PWM Output Source	CH3	
Bit 3	PWM Output Source	CH4	
Bit 4	PWM Output Source	CH5	
Bits 5 to 7	Not Used		
Bit 8	Temperature Conversion Disable Control	CH1	0 = Enable (Default)
Bit 9	Temperature Conversion Disable Control	CH2	

THM10 OUTPUT CONTROL REGISTER BITS			
DATATABLE OFFSET WORD 0, BIT #	DESCRIPTION	CHANNEL	VALUE
Bit 10	Temperature Conversion Disable Control	CH3	1 = Disable
Bit 11	Temperature Conversion Disable Control	CH4	
Bit 12	Temperature Conversion Disable Control	CH5	
Bits 13-15	Not Used		

Table 12.11: THM10 Pulse Width Modulation Output Data Source

THM10 PWM OUTPUT DATA SOURCE			
PWM SOURCE CONTROL BIT (VALUE = 0)	TEMP CONVERSION CONTROL BIT (ENABLE = 0)	LINE BREAK STATUS BIT (OK = 0)	SOURCE DATA USED FOR PWM OUTPUT
0	0	0	Channel PWM Value
0	0	1	Channel PWM Value
0	1	0	Channel PWM Value
0	1	1	Channel PWM Value
1	0	0	PID Control
1	0	1	Channel PWM Value
1	1	0	None
1	1	1	None

CAUTION

If the channel's PWM Source Control Bit is set to Value Mode (0), the PWM Output will be controlled by the PWM Value, even if the associated Temperature Conversion Control Bit is set to disable (1).

CONFIGURATION DATA MEMORY (CDM)

The THM10 module also has a Configuration Data Memory (CDM) File that can be defined to enable data conversion to Centigrade as well as to set up the PID Setpoint and constant values.

Table 12.12: THM10 CDM File

THM10 CONFIGURATION DATA MEMORY (CDM)			
CDM FILE OFFSET	**DESCRIPTION**	**CHANNEL**	**SETTING**
0	Setpoint Value (SP)	CH1	Default=0
1	Kp constant of PID	CH1	
2	Ki constant of PIC	CH1	
3	Kd constant of PID	CH1	
4	Setpoint Value (SP)	CH2	
5	Kp constant of PID	CH2	
6	Ki constant of PIC	CH2	
7	Kd constant of PID	CH2	
8	Setpoint Value (SP)	CH3	
9	Kp constant of PID	CH3	
10	Ki constant of PIC	CH3	
11	Kd constant of PID	CH3	
12	Setpoint Value (SP)	CH4	
13	Kp constant of PID	CH4	
14	Ki constant of PIC	CH4	
15	Kd constant of PID	CH4	
16	Setpoint Value (SP)	CH5	
17	Kp constant of PID	CH5	
18	Ki constant of PIC	CH5	
19	Kd constant of PID	CH5	
20	Reserved		
21	Data Conversion Type		Raw or Centigrade
22 to 39	Reserved		
40	U1 (PID Calculation result)	CH1	
41	U2 (PID Calculation result)	CH2	
42	U3 (PID Calculation result)	CH3	
43	U4 (PID Calculation result)	CH4	
44	U5 (PID Calculation result)	CH5	

NOTE

All PID constants must be entered in Raw data format (range 0-32767).

PID Calculation: $U(n) = (Kp/10 * Ep) + (Ki/10 * \int Ep\ dt) + (Kd\ dEp/dt)$

Table 12.13: THM10 PID Parameters

THM10 PID PARAMETERS		
PARAMETER	DEFINITION	STATUS
Ep	SP-PV(t)	Error
Kp	Proportional Gain Constant (0 to 32767)	Default=0
Ki	Integrate Gain Constant (0 to 32767)	Default=0
Kd	Derivative Gain Constant (0 to 32767)	Default=0
U(n)	Result of PID Calculation	
SP	Setting Value of Temperature (0 to 32767)	Default=0
PV(t)	Current Temperature (0 to 32767)	Default=0

Table 12.14: THM10 Data Conversion Type

THM10 DATA CONVERSION TYPE		
CDM OFFSET 21, BIT #	CHANNEL	SETTING
Bit 0	CH1	0=Raw (Default) 1= °C
Bit 1	CH2	
Bit 2	CH3	
Bit 3	CH4	
Bit 4	CH5	

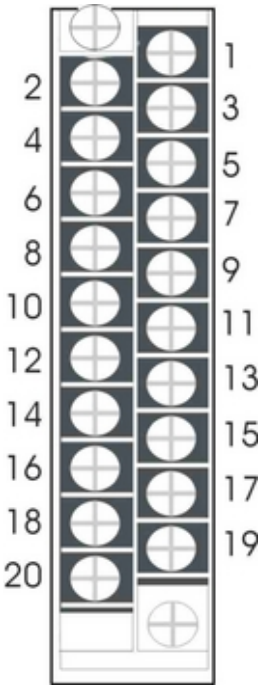
12.2 RTD10 – 4 CHANNEL RTD INPUT MODULE

Table 12.15: RTD10 Specifications

RTD10 SPECIFICATIONS	
Number of channels	4 differential
Input sensor types	PT-100 (100Ω at 0 °C, 0.00385 Ω per °C, Ni-120 (120Ω at 0 °C)
Resolution	15 bit
Accuracy	+/- 0.1% FSR
Span drift	+/- 30 PPM / °C
Step response (5 to 95%)	18 ms / channel
Setup time	20 ms / channel
Settle time	300 ms / channel
Conversion method	Sigma-Delta
Range	PT-100: -150 to 600 °C Ni-120: - 50 to 300 °C
Channel Isolation	2.5 KV optical isolation between input/output signal & CPU, channels not individually isolated
Internal current consumption	400 mA
3/4 wire selection	DIP Switches
Weight	380 g

Table 12.16: RTD10 Wiring Diagram

TERMINAL #	SIGNAL
1	CH1_S
2	CH1_M+
3	CH1_M-
4	CH12_D
5	CH2_M-
6	CH2_M+
7	CH2_S
8	CH3_S
9	CH3_M+
10	CH3_M-
11	CH34_D
12	CH4_M-
13	CH4_M+
14	CH4_S
15	O1
16	O2
17	O3
18	O4
19	24V
20	NC



LED DISPLAY

ERR: The Error LED will be illuminated if a line break is detected on any active channel. To eliminate line break errors on unused channels; the conversion disable flag should be set in the CDM File (offset 1 high byte).

01, 02, 03, 04: The four (4) Output LED's will illuminate when the high limit or low limit status bits are on for the corresponding channel.

NOTE

If the outputs are to be used, a 24 VDC voltage supply connection is required. See the I/O wiring diagram.

12.2.1 WIRING & CIRCUIT DIAGRAMS

3 WIRE

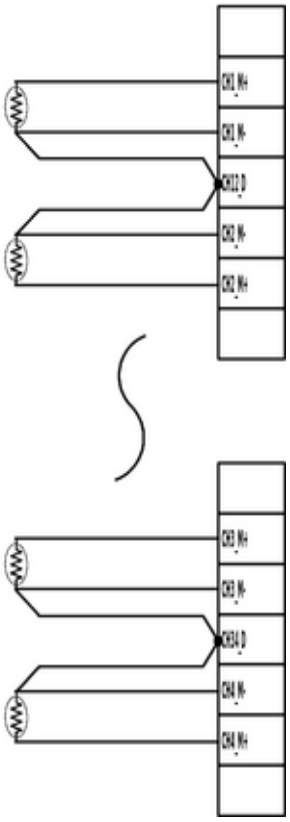


Figure 12.4: 3-Wire RTD Wiring Diagram

4 WIRE

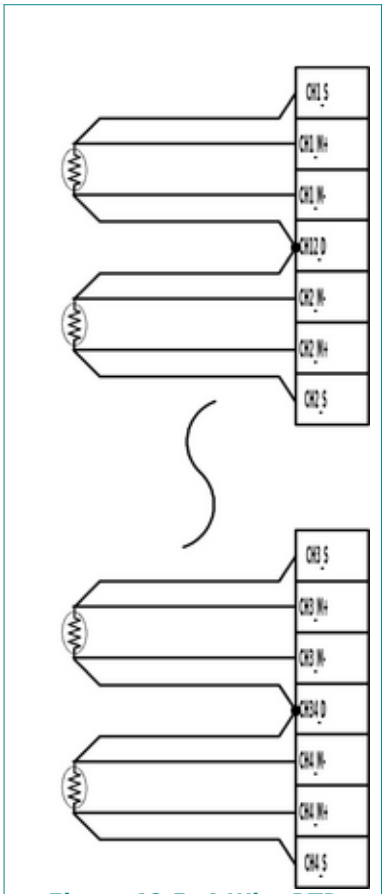


Figure 12.5: 4-Wire RTD Wiring Diagram

OUTPUTS

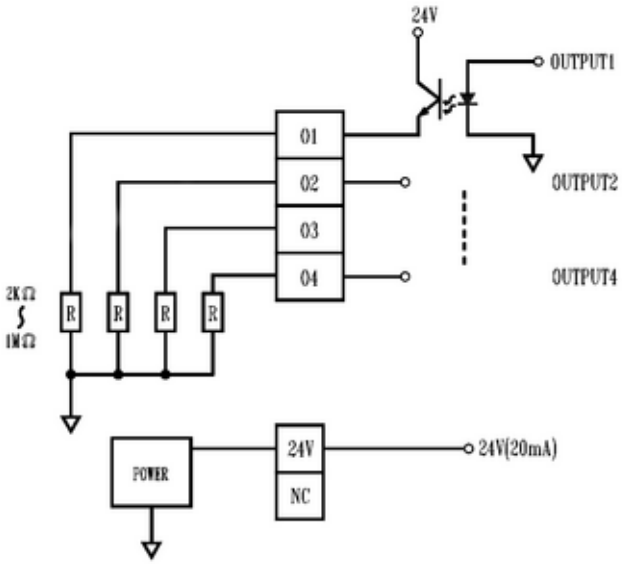


Figure 12.6: RTD10 Digital Outputs Circuit Diagram

12.2.2 RTD10 FEATURES

The RTD10 module supports both PT100 (Platinum) and Ni120 (Nickel) Resistance Temperature Detectors (RTD's). The module has an embedded microprocessor to provide automatic linearization, and provides for four (4) channel inputs and four (4) transistor discrete outputs. The RTD10 modules have the following features:

- Four (4) input channels with 15-bit resolution
- Suitable for the PT100 or Ni 120 with 3 or 4 wire input
- PT-100 Range: -150 to 600 °C
- Ni-120 Range -50 to 300 °C
- 2.5 KV optically isolation between input/output signals and CPU
- Thermometer wire break detection
- Four (4) optically isolated NPN / Sink transistor outputs

NOTE

The design of the module involves a software filter and each channel acquires 20 samples of data in one scan.

12.2.3 OPERATION SUMMARY

One (1) status word and four (4) analog input values for the RTD channels map directly to the SoftPLC datatable registers. The status word contains the Line Break flags and the High / Low Limit flags. By default, the modules are configured with all channels enabled. The Status Registers contain bit flags that indicate whether an individual channel is above or below a preset value and if an input has a broken signal wire.

If a thermometer wire break is detected, the associated "Line Break Detection Flag" will be set in the Status Register and the channel value will remain set to the last valid value read from the sensor.

CAUTION

Since the sensor's last value is retained if a wire breaks, it is imperative that the user monitors the status of the line break detection flags to determine if the thermometer value is valid.

Some of the features of the RTD10 can only be activated by modifying the contents of the Configuration Data Memory (CDM) File. These include low and high limit testing, and channel conversion. Disabling the conversion of unused input channels will reduce the total processing time of the module. The CDM File is programmed using the I/O driver configuration editors.

Since a single module supports multiple RTD types, an external DIP Switch is provided to set the device to the desired input type and signal range. All channels must use the same type input and signal range.

12.2.4 USING AN RTD10 MODULE

The following steps are recommended to use the RTD10 module in your SoftPLC system:

1. Define the Operating Range and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.
2. Wire the module to your I/O per the provided diagram.
3. Determine the mapping location of the Scan Data Registers in SoftPLC's datatable. This is done using the I/O Driver's configuration editor appropriate for your system (local = smart.tlm, ethernet = mbipmast.tlm).
4. Since the channel values do not automatically go to full scale value when an open sensor is detected, it is imperative that the "Line Break" status bits are monitored and any necessary procedures programmed accordingly.
5. If necessary, modify the contents of the CDM File.
6. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code will be written to status file word S:15. For remote I/O, operation will vary.
7. If SoftPLC starts properly and enters RUN Mode, but the module does not operate as expected, the DIP Switches and the CDM settings should be confirmed. If necessary the CDM memory can be read and verified using the CDMR TLI instruction.

12.2.5 DEFINING OPERATING RANGE AND DATA TYPE

The RTD10 has a DIP Switch on the rear (slot edge) of the module that must be set to match the connected thermometer; the desired temperature scale, and the supported data type.

NOTE

Since SoftPLC's internal integer data types are signed, it is recommended that the signed/scaled data format be selected (SW4=ON).

Table 12.17: RTD10 DIP Switch Settings

RTD10 DIP SWITCH SETTINGS				
SWITCH POSITION	SW1 3 OR 4-WIRE	SW2 RTD TYPE	SW3 TEMP SCALE	SW4 DATA TYPE
OFF	3 Wire Type	PT-100	Celsius	Unsigned/raw data
ON	4 Wire Type	Ni-120	Fahrenheit	Signed/scaled data

Table 12.18: RTD10 Data Range

RTD10 DATA RANGE	
Raw	0 to 7500 (raw Celsius) or 0 to 13500 (raw Fahrenheit)
Scaled	-1500 to 6000 °C or -2380 to 11120 °F

NOTE

Scaled values are 10 times greater than actual value.

The following tables illustrate the relationship between the Unsigned/Raw and Signed/Scaled Data Types for both Celsius and Fahrenheit operating modes in PT-100 and Ni-120 type thermometers.

Table 12.19: PT-100 RTD Data Values related to Input Signal

PT-100 RTD DATA REGISTER VALUES RELATED TO INPUT SIGNAL		
ACTUAL TEMPERATURE °C	**UNSIGNED DATA**	**SIGNED DATA (X 10)**
-150	0	-1500
0	1500	0
150	3000	1500
300	4500	3000
450	6000	4500
600	7500	6000
ACTUAL TEMPERATURE °F	**UNSIGNED DATA**	**SIGNED DATA (X 10)**
-238	0	-2380
32	2700	320
302	5400	3020
572	8100	5720
840	10800	8420
1112	13500	11120

Table 12.20: Ni-120 RTD Data Values related to Input Signal

NI-120 RTD DATA REGISTER VALUES RELATED TO INPUT SIGNAL		
ACTUAL TEMPERATURE °C	**UNSIGNED DATA**	**SIGNED DATA (X 10)**
-50	0	-500
0	500	0
100	1500	1000
200	2500	2000
300	3500	3000
ACTUAL TEMPERATURE °F	**UNSIGNED DATA**	**SIGNED DATA (X 10)**
-58	0	-580
32	900	320
212	2700	2120
392	4500	3920
572	6300	5720

12.2.6 DATA REGISTER DESCRIPTIONS & OPERATING MODE SETTINGS

SCAN DATA REGISTERS

The RTD10 module interfaces directly to the SoftPLC Data Table via five (5) consecutive 16 bit words called the Scan Data Registers. The address mapping for the Scan Data Registers into the datatable is done in the I/O Driver Configuration editor(s).

The Scan Data Registers are read-only and defined as follows:

Table 12.21: RTD10 Scan Data Registers

RTD10 SCAN DATA REGISTERS		
SCAN DATA REGISTER WORD OFFSETS	**DESCRIPTION**	**CHANNEL**
0	Status Register Flag Bits	*(See Next Table)*
1	Input Register	Channel 1
2	Input Register	Channel 2
3	Input Register	Channel 3
4	Input Register	Channel 4

Table 12.22: RTD10 Status Register Bit s 0-11

RTD10 STATUS REGISTER (FLAGS)		
DATATABLE OFFSET WORD 0, BIT #	DESCRIPTION	CHANNEL
Bit 0	Low Limit Flag	CH1
Bit 1	High Limit Flag	CH1
Bit 2	Low Limit Flag	CH2
Bit 3	High Limit Flag	CH2
Bit 4	Low Limit Flag	CH3
Bit 5	High Limit Flag	CH3
Bit 6	Low Limit Flag	CH4
Bit 7	High Limit Flag	CH4
Bit 8	Line Break Detection Flag	CH1
Bit 9	Line Break Detection Flag	CH2
Bit 10	Line Break Detection Flag	CH3
Bit 11	Line Break Detection Flag	CH4

Table 12.23: RTD10 Status Register Bits 12-15

RTD10 STATUS REGISTER FLAG BITS 12-15				
DATATABLE OFFSET WORD 0, BIT #	SENSOR TYPE	WIRE TYPE	BIT 13	BIT12
Bits 12-13	PT-100	3 wires	0	0
	PT-100	4 wires	0	1
	Ni-120	3 wires	1	0
	Ni-120	4 wires	1	1
Bits 14-15	Unused			

DISCRETE OUTPUTS

The RTD10 module has four (4) integrated NPN / Sink transistor discrete outputs (O1, O2, O3, & O4). These outputs will be enabled in direct relationship to the status of the low or high limit flags in the Status Register (Scan Data Register offset 0.) As a result, O1 will allow current flow when either the low or high limit flag is set. In a like manner, outputs O2, O3, and O4 will be energized when the corresponding low or high limit flag is set.

NOTE

If the discrete outputs are to be used, a 24 VDC voltage supply connection is required. See the I/O wiring diagram for connection details.

CONFIGURATION DATA MEMORY (CDM)

The RTD10 modules have a Configuration Data Memory (CDM) file that can be defined to activate one or more channel's high and low limit flags, or disable the temperature conversion.

If the low and high limit flags are not going to be used and all channels are to be enabled, the CDM file does not need to be altered from the default setting. However, if either feature is required, the corresponding CDM values must be set using the I/O Driver Configuration Editor.

If the low and high limit values are set for a channel, the module will compare the channel's input signal to detect if the input signal is higher or lower than the limit value. If the value of an input channel is higher or lower than the data stored in CDM, the corresponding flag bit in the Status Register (Data Scan Register word 0) will be set to '1'. Additionally, if a low and high operation range is defined, the associated output will be triggered directly by the RTD10's microprocessor to facilitate an immediate signal regardless of the SoftPLC's ladder scan.

Unused channels can be disabled by setting one or more of the conversion disable bits (CDM File offset 1 bits 8 thru 11.) Disabling unused channels will lower the total conversion time of the module.

NOTE

Disabled channel input values will be retained and refreshed with the last converted value.

The CDM file has a length of ten (10) words and is defined as follows:

Table 12.24: RTD10 CDM File

RTD10 CONFIGURATION DATA MEMORY		
CDM FILE OFFSET	**DESCRIPTION**	**CHANNEL**
0	Not Used	
1	Low/High Limit and Conversion Enable/Disable Control Bits	
2	Low Limit Value	CH1
3	High Limit Value	CH1
4	Low Limit Value	CH2
5	High Limit Value	CH2
6	Low Limit Value	CH3
7	High Limit Value	CH3
8	Low Limit Value	CH4
9	High Limit Value	CH4

NOTE

Low / High limit values must be in the same units (raw or scaled) as the channel values.

Table 12.25: RTD10 CDM File Control Bits

RTD10 CDM CONTROL BITS			
CDM OFFSET WORD 1, BIT #	**DESCRIPTION**	**CHANNEL**	**SETTING**
Bit 0	Low Limit Flag	CH1	0 = Disable (Default) 1 = Compare Enable
Bit 1	High Limit Flag	CH1	
Bit 2	Low Limit Flag	CH2	
Bit 3	High Limit Flag	CH2	
Bit 4	Low Limit Flag	CH3	
Bit 5	High Limit Flag	CH3	
Bit 6	Low Limit Flag	CH4	
Bit 7	High Limit Flag	CH4	
Bit 8	Temperature Conversion Enable Flag	CH1	0 = Enable (Default) 1 = Disable
Bit 9	Temperature Conversion Enable Flag	CH2	
Bit 10	Temperature Conversion Enable Flag	CH3	
Bit 11	Temperature Conversion Enable Flag	CH4	

12.3 RTD26 – 8 CHANNEL RTD INPUT MODULE

Table 12.26: RTD26 Specifications

RTD26 SPECIFICATIONS	
Number of channels	8 differential
Input Sensor Type	PT-100 (100Ω at 0 °C, 0.00385 Ω per °C
Operation Mode	PT-100/50ms PT-100/100ms *defined by DIP Switches
Resolution	15 bit
Accuracy	+/- 0.1% FSR
Span drift	+/- 30 PPM / °C
Conversion Speed	10 Hz
Range	PT-100: -150 to 600 °C
Channel Isolation	2.5 KV optical isolation between I/O signal & CPU, channels not individually isolated
Internal current consumption	400 mA
Weight	380 g

TERMINAL #	SIGNAL
1	FG
2	GND
3	GND
4	CH8+
5	GND
6	CH7+
7	GND
8	CH6+
9	GND
10	CH5+
11	GND
12	CH4+
13	GND
14	CH3+
15	GND
16	CH2+
17	GND
18	CH1+
19	GND
20	FG
21	GND
22	GND
23	CH8-
24	GND
25	CH7-
26	GND
27	CH6-
28	GND
29	CH5-
30	GND
31	CH4-
32	GND
33	CH3-
34	GND
35	CH2-
36	GND
37	CH1-

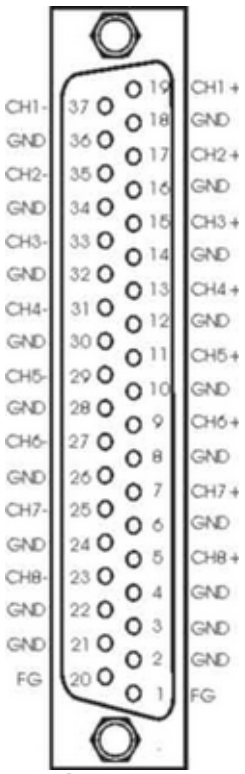


Figure 12.7: RTD26 Field Wiring & Connector

LED DISPLAY

ERR: The Error LED will be illuminated if a line break is detected on any active channel. To eliminated line break errors on unused channels; the conversion disable flag should be set in the CDM File (offset 1 high byte).

12.3.1 WIRING DIAGRAM

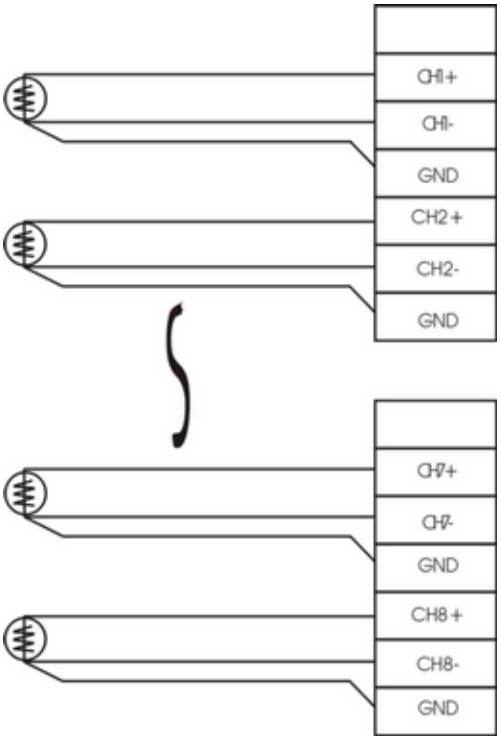


Figure 12.8: RTD26 Wiring Diagram

12.3.2 RTD26 FEATURES

The RTD26 module supports PT100 (Platinum) Resistance Temperature Detectors (RTD's). The module has an embedded microprocessor to provide automatic linearization, and provides for eight (8) channel inputs. The RTD26 module has the following features:

- Eight (8) input channels with 15-bit resolution
- Suitable for the PT100 with 3-wire input
- Range -150 to 600°C
- 2.5 KV optically isolation between input/output signals and CPU
- Thermometer wire break detection

NOTE

The design of the module involves a software filter and each channel acquires 20 samples of data in one scan.

12.3.3 OPERATION SUMMARY

One (1) status word and four (8) analog input values for the RTD channels map directly to the SoftPLC datatable registers. The status word contains the Line Break flags and the High / Low Limit flags. By default, the modules are configured with all channels enabled. The Status Registers contain bit flags that indicate whether an individual channel is above or below a preset value and if an input has a broken signal wire.

If a thermometer wire break is detected, the associated "Line Break Detection Flag" will be set in the Status Register and the channel value will remain set to the last valid value read from the sensor.

CAUTION

Since the sensor's last value is retained if a wire breaks, it is imperative that the user monitors the status of the line break detection flags to determine if the thermometer value is valid.

An external DIP Switch is provided to set the device to the desired input type and signal range. All channels must use the same type input and signal range.

12.3.4 USING AN RTD26 MODULE

The following steps are recommended to use the RTD26 module in your SoftPLC system:

1. Define the Operating Range and Data Type for the module using the DIP Switches on the rear (slot edge) of the module.
2. Wire the module to your I/O per the provided diagram.
3. Determine the mapping location of the Scan Data Registers in SoftPLC's datatable. This is done using the I/O Driver's configuration editor appropriate for your system (local = smart.tlm, ethernet = mbipmast.tlm).
4. Since the channel values do not automatically go to full scale value when an open sensor is detected, it is imperative that the "Line Break" status bits are monitored and any necessary procedures programmed accordingly.
5. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code will be written to status file word S:15. For remote I/O, operation will vary.
6. If SoftPLC starts properly and enters RUN Mode, but the module does not operate as expected, the DIP Switches should be confirmed.

12.3.5 DEFINING OPERATING RANGE AND DATA TYPE

The RTD26 has a DIP Switch on the rear (slot edge) of the module that must be set to determine the conversion speed; the desired temperature scale, and the input data type.

NOTE

Since SoftPLC's internal integer data types are signed, it is recommended that the signed/scaled data format be selected (SW4=ON).

Table 12.27: RTD26 DIP Switch Settings

RTD26 DIP SWITCH SETTINGS				
SWITCH POSITION	SW1 CONV SPEED	SW2 UNUSED	SW3 TEMP SCALE	SW4 DATA TYPE
OFF	PT-100 / 50ms	n/a	Celsius	Unsigned/raw data
ON	PT-100 / 100ms	n/a	Fahrenheit	Signed/scaled data

Table 12.28: RTD26 Data Range

RTD26 DATA RANGE	
Raw	0 to 7500 (raw Celsius) or 0 to 13500 (raw Fahrenheit)
Scaled	-1500 to 6000 °C or -2380 to 11120 °F

NOTE

Scaled values are 10 times greater than actual value.

The following tables illustrate the relationship between the Unsigned/Raw and Signed/Scaled Data Types for both Celsius and Fahrenheit operating modes.

Table 12.29: RTD26 °C Data Register Values related to Input Signals

RTD26 CENTIGRADE VALUES RELATED TO INPUT SIGNALS		
ACTUAL TEMPERATURE °C	UNSIGNED DATA	SIGNED DATA (X 10)
-150	0	-1500
0	1500	0
150	3000	1500
300	4500	3000
450	6000	4500
600	7500	6000

Table 12.30: RTD26 °F Data Register Values related to Input Signals

RTD26 FAHRENHEIT VALUES RELATED TO INPUT SIGNALS		
ACTUAL TEMPERATURE °F	UNSIGNED DATA	SIGNED DATA (X 10)
-238	0	-2380
32	2700	320
302	5400	3020
572	8100	5720
840	10800	8420
1112	13500	11120

12.3.6 DATA REGISTER DESCRIPTIONS

The RTD26 module interfaces directly to the SoftPLC Data Table via five (9) consecutive 16 bit words called the Scan Data Registers. The address mapping for the Scan Data Registers into the datatable is done in the I/O Driver Configuration editor(s).

The Scan Data Registers are read-only and defined as follows:

RTD26 SCAN DATA REGISTERS		
SCAN DATA REGISTER WORD OFFSETS	DESCRIPTION	CHANNEL
0	Status Register Flag Bits	*(See Next Table)*
1	Input Register	Channel 1
2	Input Register	Channel 2
3	Input Register	Channel 3
4	Input Register	Channel 4
5	Input Register	Channel 5
6	Input Register	Channel 6
7	Input Register	Channel 7
8	Input Register	Channel 8

Table 12.31: RTD26 Status Register Bits

RTD26 STATUS REGISTER (BIT FLAGS)		
DATATABLE OFFSET WORD 0, BIT #	**DESCRIPTION**	**CHANNEL**
Bit 0	Line Break Detection Flag	CH1
Bit 1	Line Break Detection Flag	CH2
Bit 2	Line Break Detection Flag	CH3
Bit 3	Line Break Detection Flag	CH4
Bit 4	Line Break Detection Flag	CH5
Bit 5	Line Break Detection Flag	CH6
Bit 6	Line Break Detection Flag	CH7
Bit 7	Line Break Detection Flag	CH8
Bits 8-15	Unused	

CHAPTER 13 - HIGH SPEED COUNTER/FREQUENCY MODULE

Table 13.1: HSC11 Summary

HIGH SPEED COUNTER MODULE					
OPERATING RANGE	**EXTERNAL 24VDC P/S REQ'D?**	**NUMBER OF CHANNELS**	**RESPONSE TIME**	**RESOLUTION**	**CATALOG NUMBER**
5 or 24 VDC Phase or Pulse	Opt	3, Individually Optically Isolated	50kHz max	32 bit	HSC11
Frequency *			HZ - Counts/Second		

* Local I/O configurations only

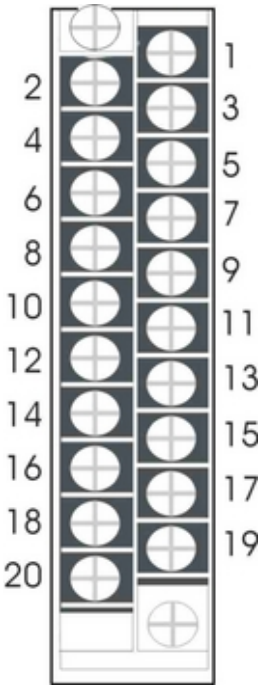
13.1 HSC11 – 3 CH HIGH SPEED COUNTER/FREQUENCY MODULE

Table 13.2: HSC11 Specifications

HSC11 SPECIFICATIONS	
Number of input channels	3 Individual optically isolated
Input type of counter	A-B phase, up-down pulse, or direction pulse, individual channel selectable
Count range	32 bits (-2147483648 to +2147483647)
Counter modes	4 modes
Counter Input level	24 VDC (default),or 12VDC (Switch Selectable)
Logic 0 Level	24 VDC: logic 0 when < 15VDC, 12VDC: logic 0 when < 9VDC
Maximum counter frequency	50KHz
External Input points	3 individual optically isolated, DC 12/24V
External Output points	3 individual optically isolated, 0.1A/pt. 12-24 VDC
Isolation	2.5KV optical isolation between I/O signals & CPU
Internal current consumption	400 mA
External connectors	20 pt terminal block, max wire size #14 AWG
Weight	370g

Table 13.3: HSC11 Field Wiring

TERMINAL #	SIGNAL
1	CH1_A+
2	CH1_A-
3	CH1_B+
4	CH1_B-
5	CH2_A+
6	CH2_A-
7	CH2_B+
8	CH2_B-
9	CH3_A+
10	CH3_A-
11	CH3_B+
12	CH3_B-
13	X1
14	O1
15	X2
16	O2
17	X3
18	O3
19	24V
20	GND



LED DISPLAY

O1, O2, O3: The Output LED's illuminate when the corresponding channels output is ON. .

CNT1, CNT2, CNT3: The Counting LED's illuminate when the corresponding channel receives an input pulse.

X1, X2, X3: The Input LED's illuminate when the corresponding channels External Trigger Input or "GATE" has a positive voltage

CAUTION

The HSC11 Module should only be removed from an I/O Base when the Power Supply Module is turned OFF!

13.1.1 WIRING & CIRCUIT DIAGRAM

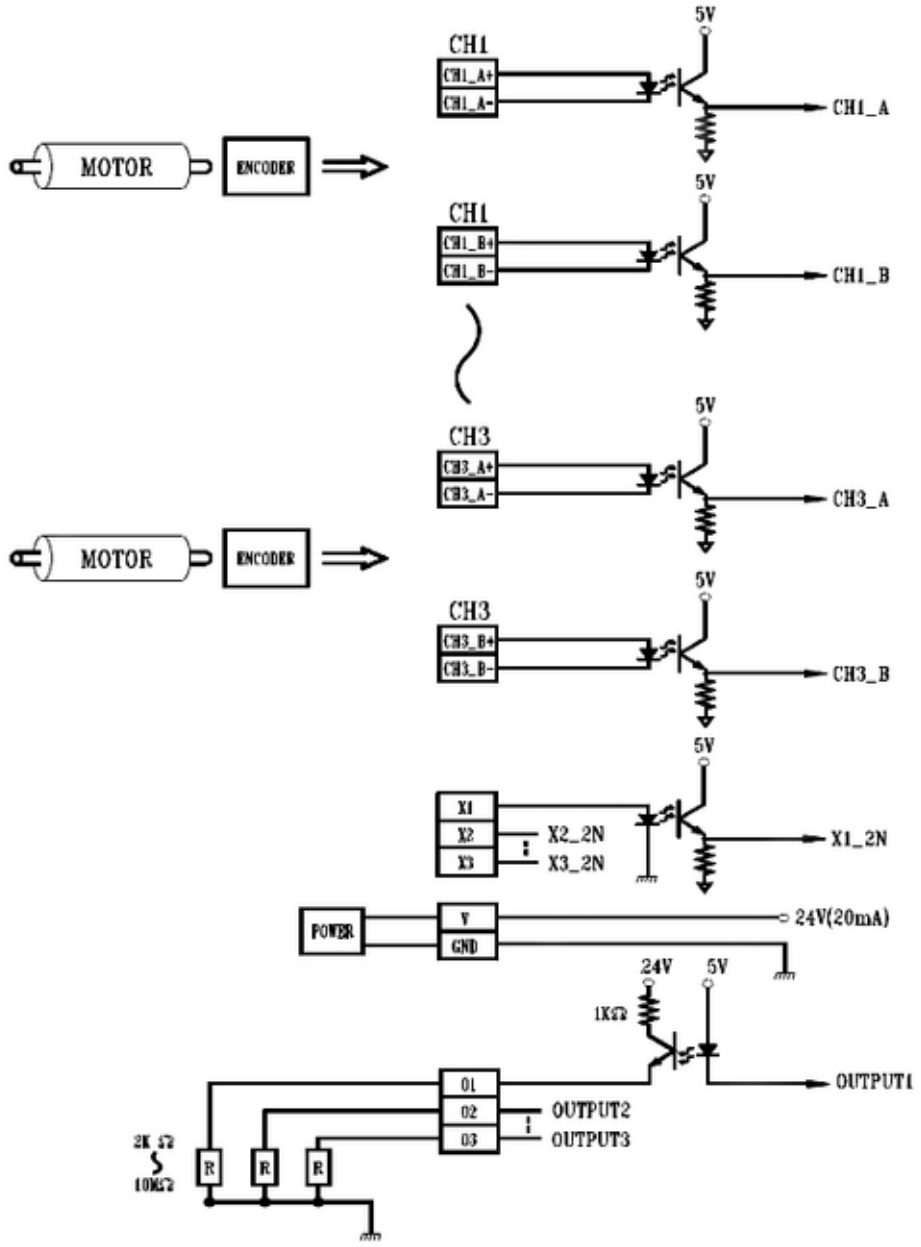


Figure 13.1: HSC11 Wiring & Circuit Diagram

NOTE

If the outputs are to be used, a 24 VDC voltage supply connection is required. See the I/O wiring diagram.

13.1.2 HSC11 FEATURES

The HSC11 module is a multi-channel high-speed counter module. It has an embedded microprocessor and has the following features:

- Three (3) differential input channels (max input frequency 50 kHz)
- Three (3) input types (A-B phase, direction pulse, and up-down pulse)
- Four (4) counter operation modes (Normal, Ring, Comparison, and Saturated)
- Thirty-two (32) bit resolution counters
- Three (3) rising or falling edge trigger inputs
- Three (3) conditional discrete outputs
- 2.5 KV optical isolation between input/output signals and the CPU
- Can be used for frequency input in local configurations

13.1.3 OPERATION SUMMARY

The HSC11 module has a status word , 2 words for each of the three (3) channel's values, and an output command register. These are mapped directly to SoftPLC's datatable. By default, the HSC11 is configured for the A-B Phase counter type, normal count mode, and to utilize internal commands for enabling and resetting the counters to a preset value of zero (0). The counter is both enabled and preset by setting control bits in the command register. The Status register contains bit flags that indicate whether an individual counter is in counting or preset mode.

To program the advanced features of the HSC11, the Configuration Data Memory (CDM) File must be programmed. The data file architecture enables setting of the counter type, the counter operation mode, individual preset, ring and comparison values, enable external triggering and the trigger type, and to utilize the internal storage buffers. If the counter is programmed for saturation mode, saturation status flags are available but must be read from CDM using the CDMR instruction.

13.1.4 USING AN HSC11 MODULE

The following steps are recommended to use the HSC11 module in your SoftPLC system:

1. Determine the Input Voltage level for the module, changing the internal DIP switches if 12V operation is desired.
2. Wire the module to your I/O per the provided diagram. If the outputs (O1, O2, O3) are to be used, an external 24 VDC voltage is required at terminals 19 and 20 (GND).
3. Determine the mapping location of the both the Input Scan Data Registers and the Output Scan Data Registers in SoftPLC's datatable. This is done using the I/O driver's configuration editor appropriate for your system (local=smart.tlm, ethernet=mbipmast.tlm).
4. If necessary, program the CDM File.

5. If the Active (ACT) LED blinks slowly, there is a configuration error. For local I/O configurations, this is normally a fatal error. SoftPLC will be set to FAULT mode and the error code will be written to status file word S:15. For remote I/O, operation will vary.

6. If SoftPLC starts properly and enters RUN Mode but the module does not operate as expected, the CDM settings should be checked. The CDM memory can be read and verified using the CDMR TLI instruction.

13.1.5 DEFINING INPUT VOLTAGE LEVEL/DIP SWITCH SETTINGS

The voltage signal level for the counter channels (CH1, CH2, CH3) and the external triggers (X1, X2, X3) can be set to 24 Volts (default) or 12 volts using the internal DIP switches. When all ten (10) DIP switches are in the OFF position, the voltage level is 24 volts. When all ten (10) DIP switches are in the ON position, the power level is 12 volts. To access the DIP switches, the front cover of the HSC11 module must be removed.

The four (4) DIP switches on the back, or slot edge of the HSC11 module have no function nor any effect on its operation.

13.1.6 DATA REGISTER DESCRIPTIONS & OPERATION MODE SETTINGS

SCAN DATA REGISTERS

The HSC11 module interfaces directly to the SoftPLC datatable via six (7) consecutive input words and one (1) output word. This module has both Input and Output Scan Data Registers. The Input Scan Data Registers include a Status word and three 32 bit (2 word) counter values. The single word Output Scan Data Register is a command or control register.

Table 13.4: HSC11 Input Data Range

HSC11 COUNTER INPUT DATA RANGE
-2147483648 (800000000H) to +2147483647 (7FFFFFFFH)

Table 13.5: HSC11 Input Scan Data Registers

HSC11 INPUT SCAN DATA REGISTERS			
OFFSET WORD	**DESCRIPTION**		**CHANNEL**
0	Status Register Flag Bits		*(See Next Table)*
1	Counter Register	High Word	CH1
2		Low Word	
3	Counter Register	High Word	CH2
4		Low Word	
5	Counter Register	High Word	CH3
6		Low Word	

Table 13.6: HSC11 Status Register Flag Bits

HSC11 STATUS REGISTER FLAG BITS			
DATATABLE WORD OFFSET 0, BIT #	**DESCRIPTION**	**CHANNEL/POINT**	**VALUE**
Bit 0	Output Status	O1	0=Off, 1=On
Bit 1		O2	
Bit 2		O3	
Bit 3	Not Used		
Bit 4	Input Status	X1	0=Off, 1=On
Bit 5		X2	
Bit 6		X3	
Bit 7	Not Used		
Bit 8	Channel Status	CH1	0=Counting, 1=Preset Status
Bit 9		CH2	
Bit 10		CH3	
Bits 11 to 15	Not Used		

Table 13.7: HSC11 Output Scan Data Register

HSC11 OUTPUT SCAN DATA REGISTER		
WORD OFFSET	**DESCRIPTION**	**VALUE**
0	Command Register	Preset & Count Enable

Table 13.8: HSC11 Output Command Register Bits

HSC11 COMMAND REGISTER			
DATATABLE OFFSET WORD 0, BIT #	**DESCRIPTION**	**CHANNEL**	**VALUE**
Bit 0	Preset Enable	CH1	0 = Disable (Defautl)
Bit 1		CH2	
Bit 2		CH3	1 = Enable
Bits 3 to 7	Not Used		
Bit 8	Count Enable	CH1	0 = Disable (Defautl)
Bit 9		CH2	
Bit 10		CH3	1 = Enable
Bits 11-15	Not Used		

CAUTION

The counters will NOT count if the Count Enable bit for the selected counter is not set true (1). The Preset Enable should only be set when it is desired to reset the counter to the associated "Preset Value" defined in the Configuration Data Memory (CDM) file. When enabled, the preset will be reset on the next count or pulse.

CONFIGURATION DATA MEMORY (CDM)

The HSC11 module also has a Configuration Data Memory (CDM) File that is configured with the appropriate I/O Driver Configuration Editor or with the CDMW TLI instruction. The data in this file is used to select the counter type, alter the way the counters operate, and how they are enabled, triggered and preset. The file has a length of twenty-eight (28) words and is defined as follows:

Table 13.9: HSC11 CDM File Registers

HSC11 CONFIGURATION DATA MEMORY FILE OFFSETS			
WORD OFFSET	**HIGH-BYTE**	**LOW-BYTE**	
0	Counter Command Mode	External Input Trigger Flags	
1	Input Counter Type	Counter Operation Mode	
2	Storage Buffer Assignments	External Output Control Flags	
	DESCRIPTION	**WORD**	**CHANNEL**
3	Preset Value	High-Word	CH1
4		Low-Word	
5		High-Word	CH2
6		Low-Word	
7		High-Word	CH3
8		Low-Word	
9	Ring Value	High-Word	CH1
10		Low-Word	
11		High-Word	CH2
12		Low-Word	
13		High-Word	CH3
14		Low-Word	
15	Output Comparison Value	High-Word	CH1
16		Low-Word	
17		High-Word	CH2
18		Low-Word	
19		High-Word	CH3
20		Low-Word	
21	Counter Storage Buffer	High-Word	CH1

HSC11 CONFIGURATION DATA MEMORY FILE OFFSETS			
22		Low-Word	
23		High-Word	CH2
24		Low-Word	
25		High-Word	CH3
26		Low-Word	
27	Saturation Status	Read Only!	Flags

Table 13.10: HSC11 External Input Trigger Flags (CDM Offset 0, Low Byte)

HSC11 EXTERNAL INPUT TRIGGER FLAG BITS			
CDM OFFSET WORD 0, LOW BYTE	TYPE	INPUT	CHANNEL
Bit 1, 0	External Trigger	X1	CH1
Bit 3, 2		X2	CH2
Bit 5, 4		X3	CH3
Bit 6 to 7	Not Used		

TRIGGER BIT DESCRIPTIONS		
B(N+1)	B(N)	PROGRAMMABLE TRIGGER DESCRIPTIONS
0	0	High Level Trigger
0	1	Rising Edge Trigger
1	0	Low Level Trigger
1	1	Falling Edge Trigger

Table 13.11: HSC11 Counter Command Mode (CDM Offset 0, High Byte)

HSC11 COUNTER COMMAND MODE BITS		
CDM OFFSET WORD 0, HIGH BYTE	DESCRIPTION	CHANNEL
Bit 9, 8	Counter Command Mode	CH1
Bit 11, 10		CH2
Bit 13, 12		CH3
Bit 14 to 15	Not Used	

COUNTER COMMAND MODE BIT DEFINITIONS				
B(N+1)	B(N)	ENABLE COUNTING	PRESET COUNTER VALUE	STORE TO BUFFER
0	0	Internal Command	Internal Command	N/A (default)
0	1	Internal Command	Internal Command or External Input	
1	0	External Input	Internal Command	

COUNTER COMMAND MODE BIT DEFINITIONS				
1	1	Internal Command	Internal Command	External Input *(See Note Below)*

NOTE

The "Store to Buffer" feature stores the channel's current counter value to the pre-programmed "Counter Storage Buffer" (CDM File offsets 21 to 26) when the associated External Trigger Input is detected (X1, X2, or X3). The particular buffer used is set up via the "Storage Buffer Assignments" control byte. See the tables defining "Storage Buffer Assignments" (CDM File Offset 2 <High-Byte>) for further programming details.

Table 13.12: HSC11 Counter Operating Mode (CDM Offset 1, Low Byte)

HSC11 COUNTER OPERATING MODE BITS		
CDM WORD OFFSET 1, LOW BYTE	**DESCRIPTION**	**CHANNEL**
Bits 1, 0	Operating Mode	All 3 Counters
Bits 2 to 7	Not Used	

OPERATING MODE BITS 0 & 1		
BIT 1	**BIT 0**	**MODE *(descriptions below table)***
0	0	Normal
0	1	Ring
1	0	Comparison
1	1	Saturated

NORMAL MODE

In Normal mode, the range of the counter value is from -2147483648 to +2147483647. The counter value will loop back if the counter value is over the maximum value (+2147483647) or less than the minimum value (-2147483648.)

RING MODE

If the current counter value is larger than the ring value (CDM offsets 9-14), the counter value will be restarted from the preset value. If the current counter value is smaller than the preset value (CDM offsets 3-8), the counter value will be set to ring value and start to count from the ring value. Valid counter range is -2147483648 to +2147483647.

COMPARISON MODE

If the counter value is larger than the ring value (CDM offsets 9-14), the counter value will restart from the preset value(CDM offsets 3-8). Valid counter range is -2147483648 to +2147483647.

SATURATION MODE

If the counter values reach +2147482547 (7FFFFFFFH), counter values will stay at the value of +2147482547 and the corresponding positive saturated flag in CDM File offset 27 will be set to ' 1'. The counter will not continue to count until you initiate the preset flag (CDM offset 0, bits 8-10).

If the counter values reach -2147482548 (800000000H), counter values will stay at the value of -2147482548 and the corresponding negative saturated flag in CDM File offset 27 will be set to '1'. The counter will not continue to count until you initiate the preset flag (CDM offset 0, bits 8-10).

Table 13.13: HSC11 Saturation Status Flags

HSC11 SATURATION STATUS FLAGS (READ-ONLY!)		
CDM OFFSET WORD 27, BIT #	**DESCRIPTION**	**CHANNEL**
Bits 0 to 7	Not Used	
Bit 8	Negative Saturation Status Flag	CH1
Bit 9		CH2
Bit 10		CH3
Bit 11	Positive Saturation Status Flag	CH1
Bit 12		CH2
Bit 13		CH3

Table 13.14: HSC11 Input Counter Type

HSC11 INPUT COUNTER TYPE		
CDM OFFSET WORD 1, HIGH BYTE	**DESCRIPTION**	**CHANNEL**
Bit 9, 8	Input Type	CH1
Bit 11, 10	Input Type	CH2
Bit 13, 12	Input Type	CH3
Bit 15, 14	Not Used	

INPUT COUNTER TYPE BIT DEFINITIONS		
B(N+1)	**B(N)**	**DESCRIPTION**
0	0	A-B Phase Pulse (Default)
0	1	Direct Pulse
1	0	Up-Down Pulse
1	1	Undefined

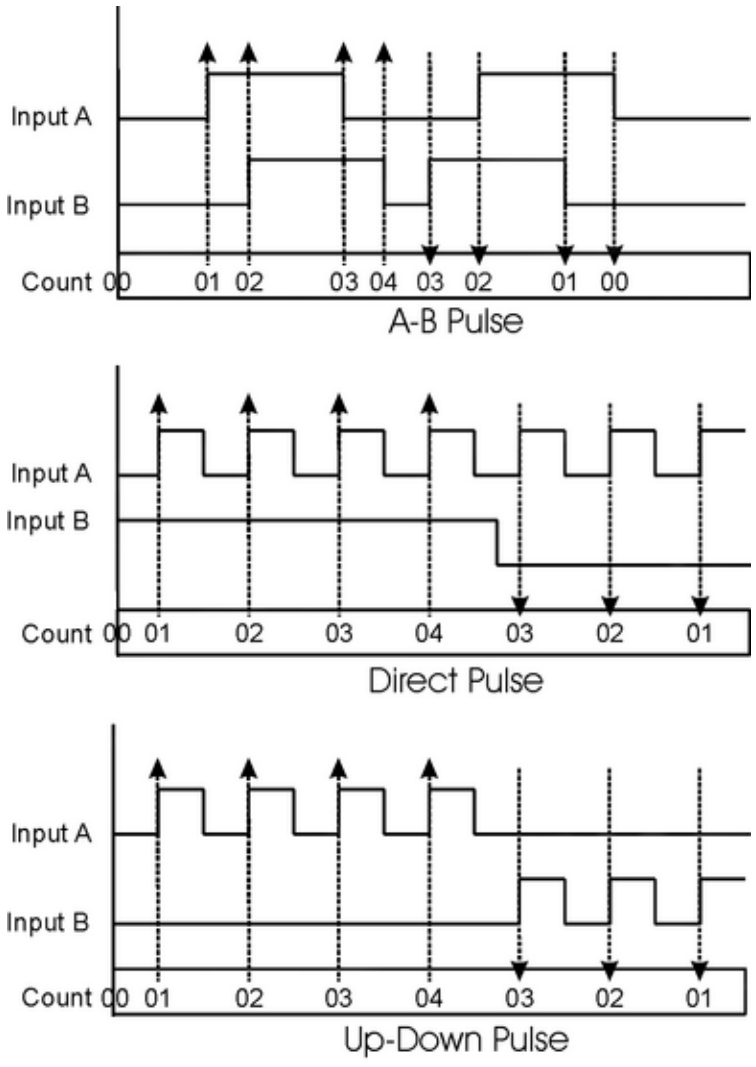


Figure 13.2: HSC11 Input Counter Types Timing Diagrams

Table 13.15: HSC11 External Output Enable Bits

HSC11 EXTERNAL OUTPUT ENABLE				
CDM OFFSET WORD 2, LOW BYTE	DESCRIPTION	OUTPUT	CHANNEL	VALUE
Bit 0	Output Condition Flag	O1	CH1	Default = 0 = [≥]
Bit 1		O2	CH2	
Bit 2		O3	CH3	
Bit 3	Output Enable Flag	O1	CH1	Default = 0 = disable
Bit 4		O2	CH2	
Bit 5		O3	CH3	
Bits 6-7	Not Used			

By default, the Outputs (O1, O2, & O3) are disabled. When the corresponding enable bits are set, the outputs will be energized in accordance with the rule associated with the bit value of the channels conditional flag. The rules for the conditional flags are as follows:

1. If the conditional flag is the default value zero (0), the output will be ON if the channels current value is greater than or equal (≥) to the corresponding “Comparison Value” stored in the CDM File (offsets 16-21).

2. If the conditional flag is set to one (1), the output will be ON if the channels current value is less than (<) the corresponding “Comparison Value” stored in the CDM File (offsets 16-21).

Table 13.16: HSC11 Storage Buffer Assignments

HSC11 STORAGE BUFFER ASSIGNMENTS		
CDM FILE OFFSET 2, HIGH BYTE	DESCRIPTION	STORAGE BUFFER
Bits 9, 8	Counter channel number assigned to	Buffer 1
Bits 11, 10	Counter channel number assigned to	Buffer 2
Bits 13, 12	Counter channel number assigned to	Buffer 3
Bits 14 to 15	Not Used	

STORAGE BUFFER ASSIGNMENT BIT DEFINITIONS		
B(N+1)	B(N)	COUNTER CODE NUMBER INDICATES
0	0	CH1
0	1	CH2
1	1	CH3

The Storage Buffer Assignments need to be programmed if the associated channel’s Counter Command Mode (CDM File Offset 0 <High Byte>) is set to store the counter value to a Storage Buffer (mode=11). In this case, the Storage Buffer number programmed here would determine to which buffer the associated counter's value is stored.

13.1.7 READING FREQUENCY – THE HZ INSTRUCTION

When an HSC11 module is used in local configurations (using the smart.tlm I/O driver), you can also use it to read frequency. The smart.tlm includes a ladder instruction called HZ that applies accurate timing information to the counts to calculate frequency.

To use this instruction, each of the module's 3 high speed counter channels must be put into the "continuous count up" mode *(described below)*. The instruction will convert each of those 3 increasing counts into a separate frequency, 3 separate frequencies per module. It is not possible to use less than all 3 channels on any given HSC11 in a non frequency mode. It is all or none.

Energizing the instruction causes both a new set of samples to be stored into each of the 3 sliding windows, and also the calculations to be performed and returned. The instruction might not need be energized on every scan.

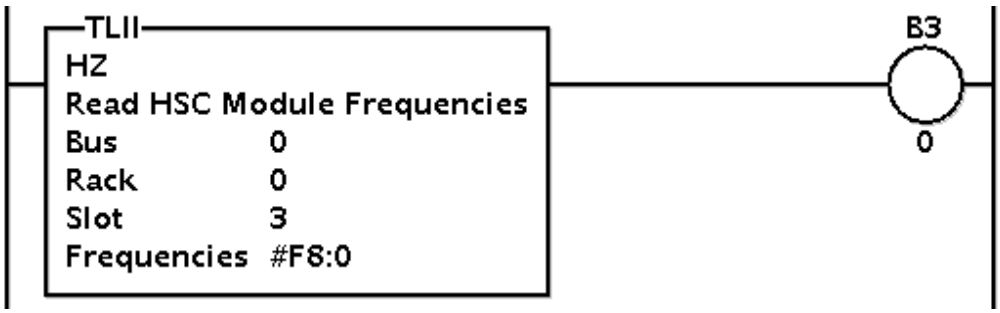


Figure 13.3: HZ Frequency Ladder Instruction

Table 13.17: HZ Instruction Parameter Definitions

HZ INSTRUCTION PARAMETER DEFINITIONS	
PARAMETER	**MEANING**
Bus	The Tealware bus number, 0-3.
Rack	The Tealware rack on said bus, 0-2.
Slot	The Tealware slot number within said rack, 1-8.
Frequencies	The datatable address of a block of 3 floats which will receive the 3 channel frequency calculations in units of HZ (counts/second).

To put each channel into the "continuous count up" mode is a two step process. First, you must add a “hz” sub-element in the smart.xml configuration file for the HSC11 module. This will establish the continuous count mode for all 3 channels on that module in software, but not the counting direction (up or down).

Second, the counting direction must be set by hardware separately for each channel by wiring a high signal to one of the channel's wiring terminals. Without this the frequencies will be negative.

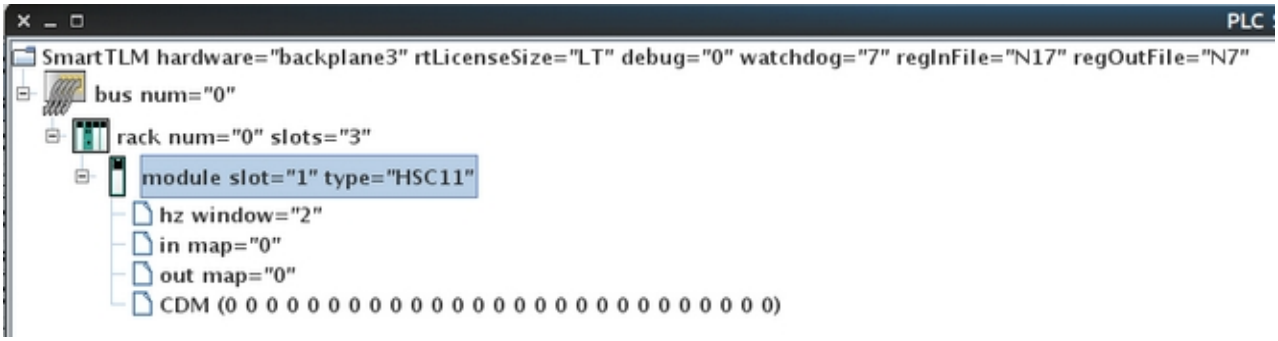


Figure 13.4: HZ Sub-Element for HSC11 in smart.tlm Configuration Editor

FREQUENCY CALCULATION

A channel's frequency is calculated by subtracting the oldest sliding window count sample from the newest (higher count) and dividing by the elapsed time between the two. This is an average over the sliding window. By using only these two points the calculation is fast and allows dividing by a larger delta time, leading to less signal noise. The sliding window average is a digital filter, and you have the tuning knobs to control how it works based on a) the window size and b) the rate at which you energize the instruction. This algorithm should work fine as long as the change in counts between oldest and newest samples does not exceed 2 billion.

For example, with a window size of 200, and the instruction energized every 100 msecs, this is a total span of time of 200 x .1 sec = 20 secs. So the calculation (frequency measurement) would give you an average frequency across the last 20 seconds, but do so every 100 msecs. If the window size was reduced down to 40 samples, then 40 x .1 sec = 4 seconds window width. If you wanted something even more responsive, say an average of the last 250 msecs, (a reasonable scenario in fluid flow metering application), and you had a program scan time of about 10 msecs, then you could set the window size at 250 and simply leave the instruction energized for every scan. Then 25 x .01 seconds = 0.250 seconds sliding window time span.

Table 13.18: Window Size Effect on Frequency Calculation

WINDOW SIZE EFFECT ON FREQUENCY CALCULATION		
WINDOW SIZE	**INSTRUCTION EXECUTION RATE**	**FREQUENCY CALCULATION SPAN**
200	100 msec	20 seconds
40	100 msec	4 seconds
250	10msec	0.25 seconds

CHANGE LOG *(CHANGES AFTER OCT 2020)*

2/21 - RTD26, removed description of output LED’s, n/a for this module

END OF USER GUIDE