Version 2.0
37-0169

SMART CONTROLS

User's Guide
Smart I/O™: S-EC230-F

LonWorks® Independent Developer

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Introduction

Thank you for purchasing SMART CONTROLS control products for LONWORKS™ systems.

The SMART CONTROLS EC230 series contain core circuits to interface with analog inputs, analog outputs, digital input signals (including dry contact closures), and outputs using relay contacts.

SMART I/O modules include the I/O interface hardware, Neuron, programmable "FLASH" EPROM, and LonWorks communication transceiver. These modules can be programmed with VisualControl™, LonBuilder or NodeBuilder™ with the new application profile downloaded over a LONWORKS network.

1.1 Steps to Put Your EC230 to Work

To put your EC230 to work, we suggest the following steps:

1. Read the User's Manual.
2. Plan your I/O interfaces and power needs and configure the jumpers on the circuit board appropriately.
3. (Optional) Develop new software with VisualControl, LonBuilder, NodeBuilder, or third party tools with the appropriate files from the Programming Support Files Disk.
4. (Optional) Using the above tools, connect and download the new program to the EC230 module.
5. Physically install the EC230.
6. Do your network (logical) installation.

That's all there is to it!

1.2 Related Documentation

For developing software for the EC230 series products, the following Echelon documents are suggested reading:

Neuron® C Programmer's Guide (29300)

Neuron® C Reference Guide (29350)

LONMARK Application Layer Interoperability Guidelines (078-0120-01B)

How to use SNVTs in LONWORKS Applications Engineering Bulletin (005-0002-01)

The SNVT Master List and Programmer's Guide (005-0027-01)

1.3 Technical Support

If you experience a problem with the use of SMART CONTROLS products which cannot be answered by this document or the above Echelon documents, contact SMART CONTROLS Technical Support:

SMART CONTROLS
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Phone: (618) 394-0300
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1.4 Revision History

Rev. 2.0
- Updated drawings sections to reflect additional jumpers and enclosure design.
- Expanded section 4.6 on Resistive Measurements.

Rev. 1.1
- Updated Electrical Specifications:
  1. Changed lower AC input from 15 to 21 V.
  2. Updated the maximum current draw to include all outputs on.
  3. Changed the Power Supply protection circuitry.
  4. Added a sensor power spec.
  5. Changed the output current for the Analog Outputs from 16 to 10 mA.
  6. Changed the gain error of the analog outputs from 0.75% to 1%.
- Changed the maximum temperature from 70 to 50°C to protect the relays.

Rev. 1.0
- Initial release.

2

Configuration and Connections

The EC230 has been designed to be very flexible and fit many applications. This section describes how to configure and connect your EC230 for your particular application.

2.1 Configuration and Connection Overview

> ***Warning!*** *The module's circuits are static sensitive. The user must employ electrostatic discharge precautions, such as the use of a grounding strap, when touching the inside of the module.*

Universal Analog Inputs

The Analog Inputs are "universal" inputs that can interface with almost any type of common analog or digital input. These channels can be configured for measuring the following kinds of inputs:

1) 0-5 Volts
2) 0-10 Volts
3) 0-20 mA Current
4) Resistive sensors
5) Dry contacts (e.g. switches), or TTL compatible inputs

There are 11 jumper headers (JP1-11) that are used to configure the Analog Inputs. Shunt jumpers on the headers define the configurations, summarized later in this section and covered in detail in this chapter.

> *Note: If the Analog Inputs are not used, they need to be configured to measure resistive sensors, 0-10 V, or current so the inputs are not left floating. Floating inputs may cause measurement errors on other analog channels.*

Analog Outputs

The EC230 has four channels of Analog Outputs that can output 0-10 Volts only. *Do not remove or reconfigure the jumpers at positions JP13-JP16. They must remain in the V (Voltage) Position or no output signal will be generated.*

Digital Inputs

The EC230 has seven digital input channels that can interface with dry contact (voltage-free) inputs such as relay or switch contacts or with 0-5 Volt logic sources.

Relay Outputs

The EC230 has seven relay output channels. Each relay is connected to a common pin to simplify wiring.

Terminal Labels

Figure 2.1 is a drawing showing the terminal labels for the EC230.

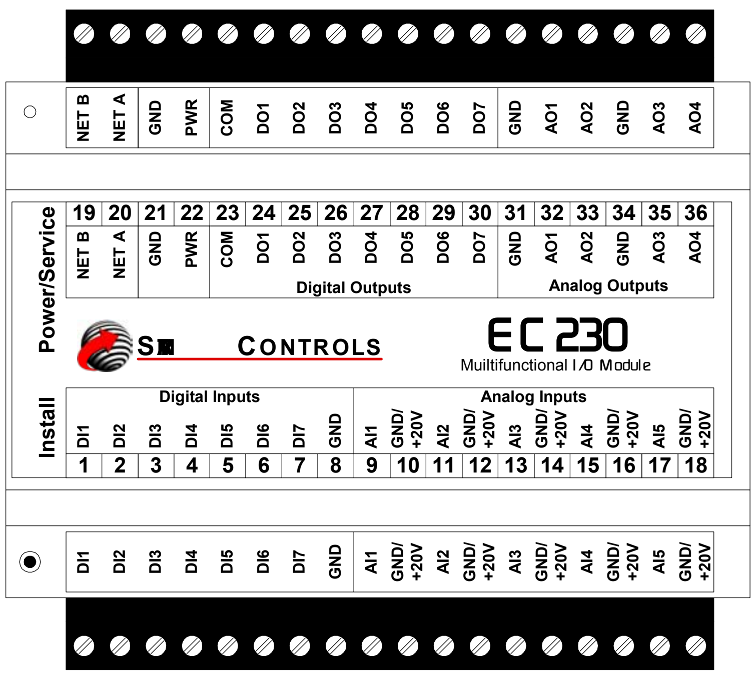


Figure 2.1 *EC230 Terminal Labels*

Jumper Locations

Figure 2.2 shows the location of the user selectable jumpers on the EC230.

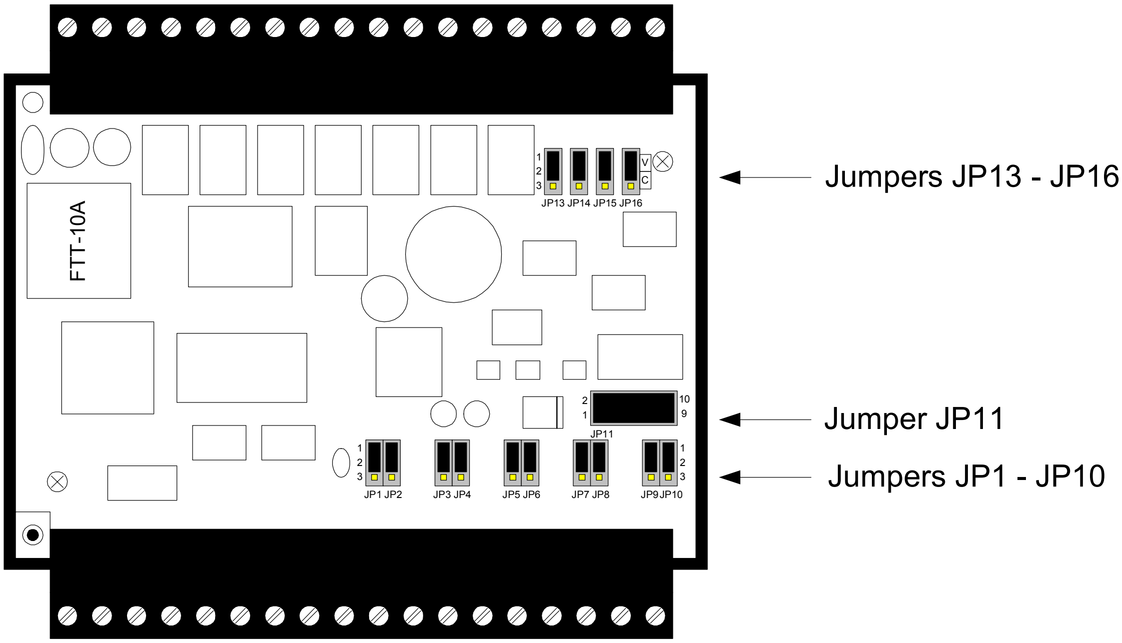


Figure 2.2 *Jumper Locations*

Factory Default Jumper Settings

Figure 2.3 shows the factory default settings for the EC230. The EC230 is set for Resistive or Dry Contact Inputs. The outputs are set for voltage.

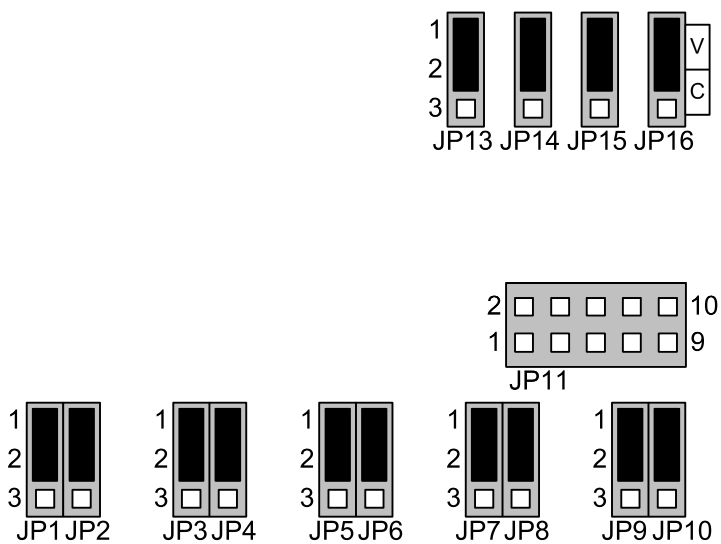


Figure 2.3 *Layout of jumper headers.*

Jumper Summary

Tables 2.1 and 2.2 show a summary of the positions of the jumper shunts and their corresponding channels and configurations.

Jumper	Channel	I/O Pin	I/O Name	Function
JP1	U/AI1	9	AI1	Sensor Type (Resistive sensor or 0-20mA)
JP2		10	GND/+20V	Ground (Signal Return) or +20V
JP3	U/AI2	11	AI2	Sensor Type (Resistive sensor or 0-20mA)
JP4		12	GND/+20V	Ground (Signal Return) or +20V
JP5	U/AI3	13	AI3	Sensor Type (Resistive sensor or 0-20mA)
JP6		14	GND/+20V	Ground (Signal Return) or +20V
JP7	U/AI4	15	AI4	Sensor Type (Resistive sensor or 0-20mA)
JP8		16	GND/+20V	Ground (Signal Return) or +20V
JP9	U/AI5	17	AI5	Sensor Type (Resistive sensor or 0-20mA)
JP10		18	GND/+20V	Ground (Signal Return) or +20V
JP11, pins: 1-2 3-4 5-6 7-8 9-10	 U/AI1 U/AI2 U/AI3 U/AI4 U/AI5	 9 11 13 15 17	 AI1 AI2 AI3 AI4 AI5	0-10 VDC measurement
JP13	AO1	32	AO1	Voltage or Current (Voltage ONLY on EC230)
JP14	AO2	33	AO2	Voltage or Current (Voltage ONLY on EC230)
JP15	AO3	35	AO3	Voltage or Current (Voltage ONLY on EC230)
JP16	AO4	36	AO4	Voltage or Current (Voltage ONLY on EC230)

Table 2.1 *Channel assignments of jumpers*

Jumper Header	I/O Pin	Jumper Position	Function
JP1-9 (odd)	9-17 (odd)	1-2 2-3 Off	Resistive sensor measurement or switch input. 0-20mA current measurement. 0-5 V or 0-10 V measurement.
JP2-10 (even)	10-18 (even)	1-2 2-3 Off	Ground (circuit return to power supply negative) Fused 20 V for sensor power. Open (not recommended).
JP11	9-17 (odd)	 1-2 3-4 5-6 7-8 9-10	0-10 V measurement for input channel: 1 2 3 4 5
JP13-16	32,33 35,36	1-2 2-3	0-10 V Voltage Output (available on Ec230, EC231) 4-20 mA Current Output (available on EC231 only)

Table 2.2 *Summary of shunt jumper positions.*

2.2 Connector Pin-Out and Sample Connections

Figure 2.4 shows the connector pin-out with an example of the I/O, communication and power connections. The sections that follow describe in detail how to configure and connect the EC230 for your particular application.

Note: The Analog and Digital Returns (grounds) are connected internally and are isolated from the Relay Common.

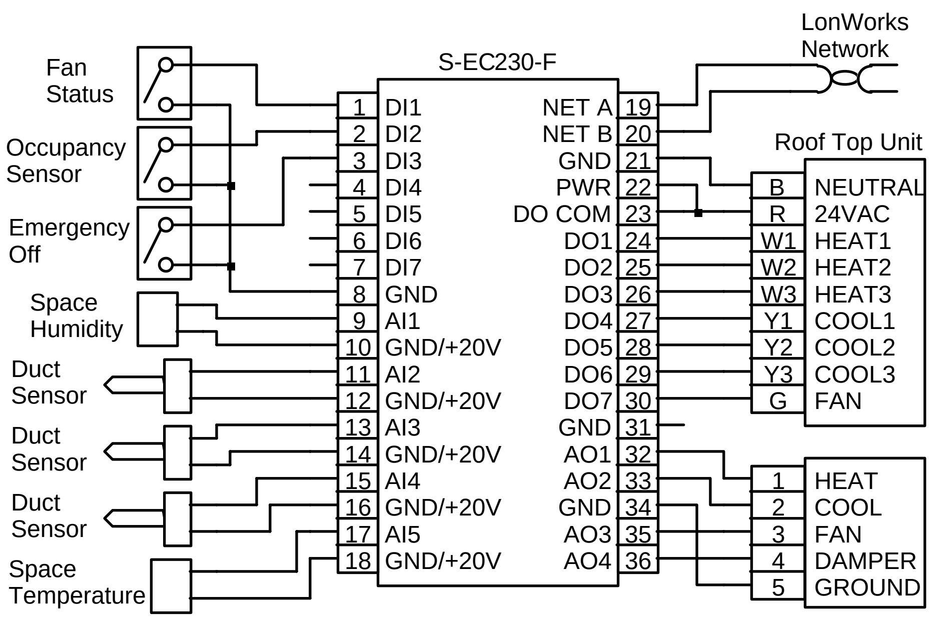


Figure 2.4 *Example connections show the versatility of the EC230 series.*

2.3 Resistive Sensor Measurements

Each Universal Input can be individually configured to resistive sensors, such as thermistors, RTDs, etc.

Figure 2.5 shows the jumper placements for all the channels configured to measure resistive sensors. Refer to Table 2.1 for the channel assignments of the jumper headers.

Figure 2.6 shows the wiring and equivalent circuit of the jumper configurations to measure a resistive sensor.

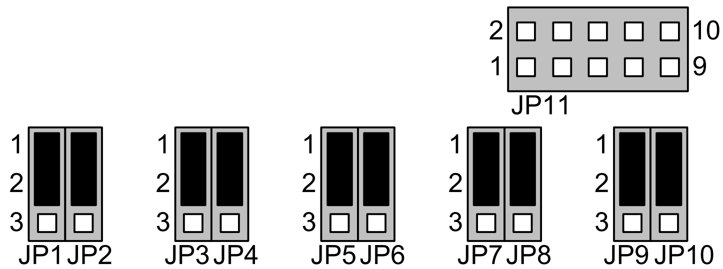


Figure 2.5 *Jumper shunt positions for measuring resistive sensors.*

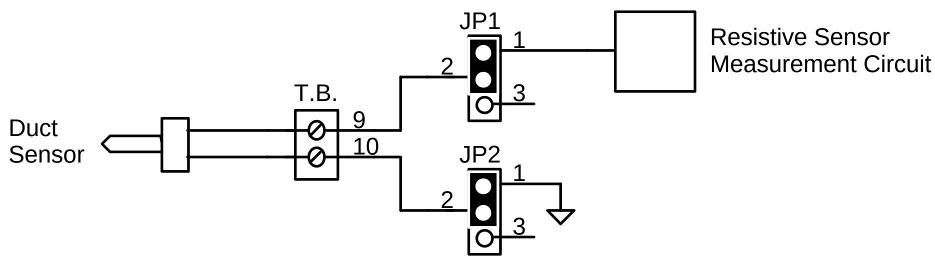


Figure 2.6 *Example wiring and equivalent circuit for measuring a resistive sensor on Universal Analog Input Channel 1.*

Refer to the chapter on Programming Considerations on how to program code to read values using resistive sensors.

2.4 Current Inputs

Each Universal Analog Input channel can be individually configured to measure 0-20 mA of current. The even pins can be configured to provide power to 2-wire current transmitters. The module can also be configured to interface with 3-wire current transmitters.

2-Wire Current Transmitters

Figure 2.7 shows the jumper placements for all the channels configured to interface with 2-wire current transmitters. The odd headers are set to measure current and the even headers are jumpered to provide 20 VDC to the current transmitters. Refer to Table 2.1 for the channel assignments of the jumper headers.

Figure 2.8 shows the wiring and equivalent circuit of the jumper configurations to interface with a 2-wire current transmitter.

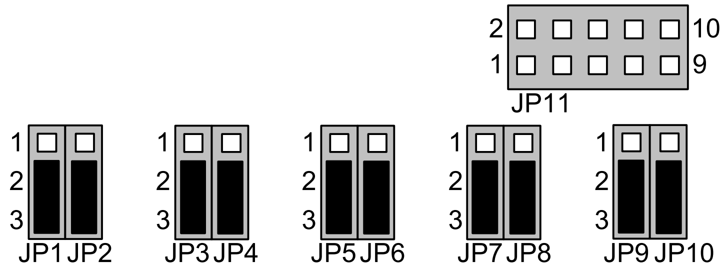


Figure 2.7 *Jumper shunt positions for interfacing with 2-wire current transmitters.*

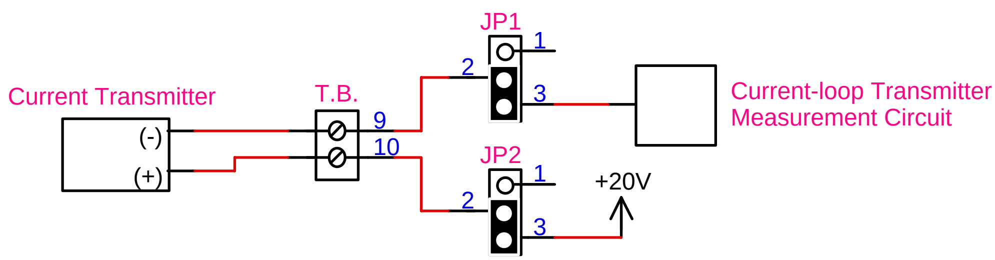


Figure 2.8 *Example wiring and equivalent circuit for interfacing with a 2-wire current transmitter on Universal Analog Input Channel 1.*

3-Wire Current Transmitters

Figure 2.9 shows the jumper placements for all the channels configured to interface with 3-wire current transmitters. The odd headers are set to measure current and the even headers are jumpered to provide a common signal return (ground) to the current transmitters. Refer to Table 2.1 for the channel assignments of the jumper headers.

Figure 2.10 shows the wiring and equivalent circuit of the jumper configurations to interface with a 3-wire current transmitter. Note that the power for the current transmitter ideally would come from a wire from the positive terminal of the power of the node (pin 22) in order to keep the +, -, and signal wires together. This power could also come from a power supply separate from the node.

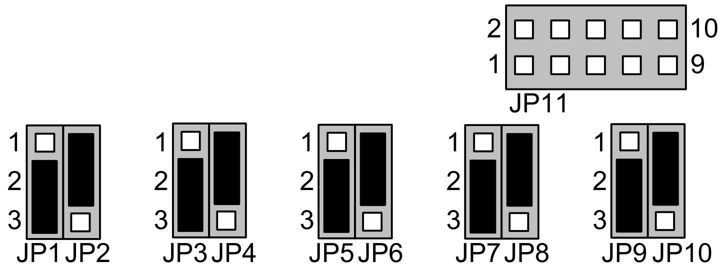


Figure 2.9 *Jumper shunt positions for interfacing with 3-wire current transmitters.*

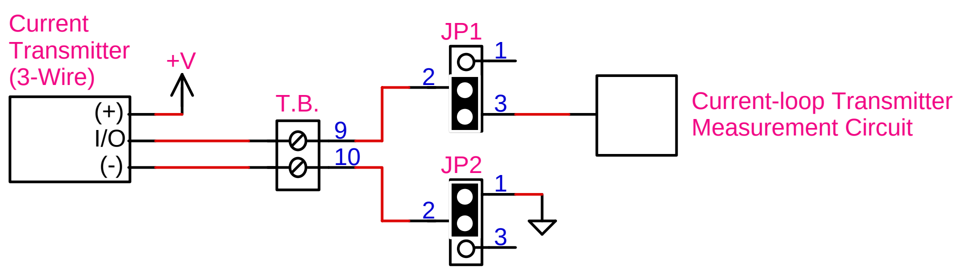


Figure 2.10 *Example wiring and equivalent circuit for interfacing with a 3-wire current transmitter on Universal Analog Input Channel 1.*

2.5 Voltage Measurements

Each Universal Analog Input channel can be individually configured to measure a single-ended voltage of 0-5V or 0-10V (as referenced to signal return/ground).

0-5 Volt Inputs

Figure 2.11 shows the jumper placements for all the channels configured to interface with 0-5 V transducer inputs. The odd headers have their jumpers off which configures the inputs to measure voltage. The even headers are jumpered to provide a signal return (ground) to the transducer. Refer to Table 2.1 for the channel assignments of the jumper headers.

Figure 2.12 shows the wiring and equivalent circuit of the jumper configurations to interface with a 0-5 V transducer.

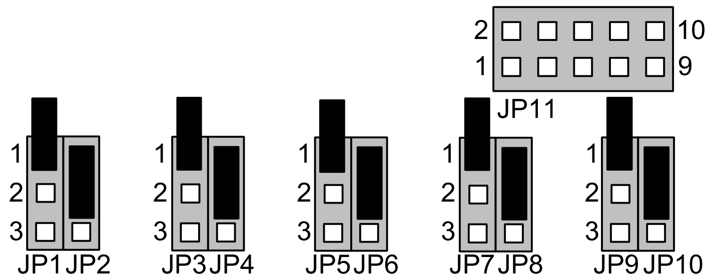


Figure 2.11 *Jumper shunt positions for measuring 0-5 V.*

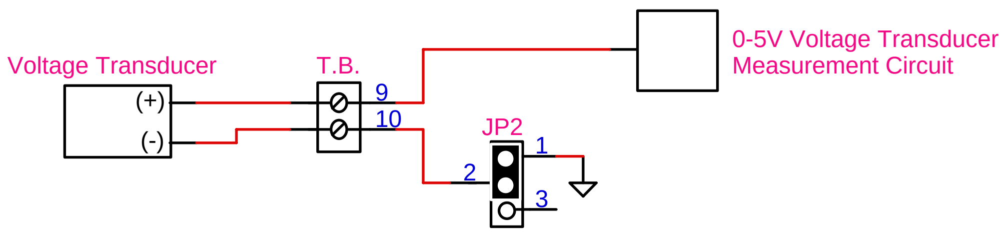


Figure 2.12 *Example wiring and equivalent circuit for interfacing with a 0-5V transducer on Universal Analog Input Channel 1.*

0-10 Volt Inputs

Figure 2.13 shows the jumper placements for all the channels configured to interface with 0-10 V transducer inputs. The odd headers have their jumpers off which configures the inputs to measure voltage. The even headers are jumpered to provide a signal return (ground) to the transducer. The corresponding jumper in JP11 is set to closed. Refer to Table 2.1 for the channel assignments of the jumper headers.

Figure 2.14 shows the wiring and equivalent circuit of the jumper configurations to interface with a 0-10 V transducer.

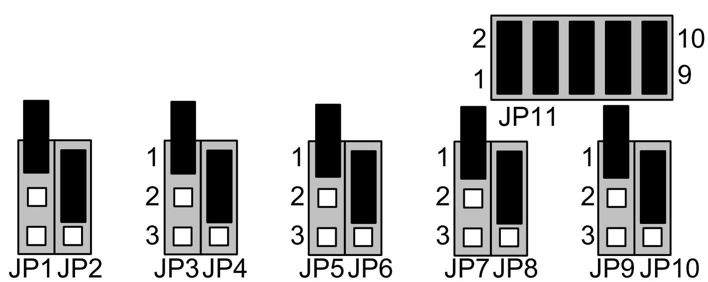


Figure 2.13 *Jumper shunt positions for measuring 0-10 V.*

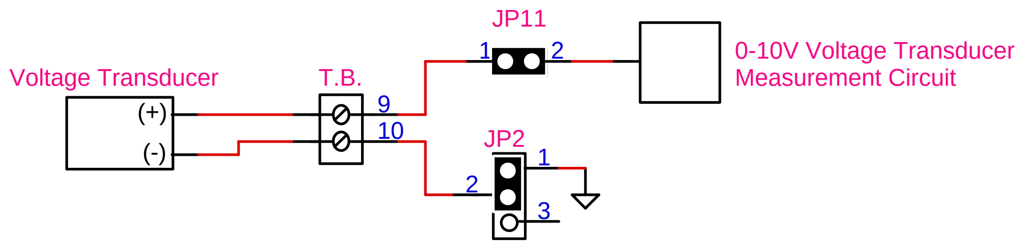


Figure 2.14 *Example wiring and equivalent circuit for interfacing with a 0-10V transducer on Universal Analog Input Channel 1.*

2.6 Dry Contact Switch Inputs

Dry contact switch inputs can be connected to the Digital Inputs or the Universal Analog Inputs. Also, open-collector transistors or TTL signals can be interfaced the same way.

The connections to the digital inputs are shown in Figure 2.4. There are no configuration jumpers needed for connection into the digital inputs.

The Universal Analog Inputs need to be configured to interface with dry contact switch inputs (or equivalent). Figure 2.15 shows the jumper placements for all the channels configured to interface with dry contact switch inputs. Refer to Table 2.1 for the channel assignments of the jumper headers.

Figure 2.16 shows the wiring and equivalent circuit of the jumper configurations to interface with a dry contact switch input (or equivalent).

Figure 2.17 shows the wiring and equivalent circuit of the interface with a dry contact switch input (or equivalent) on a Digital Input channel of which there are seven.

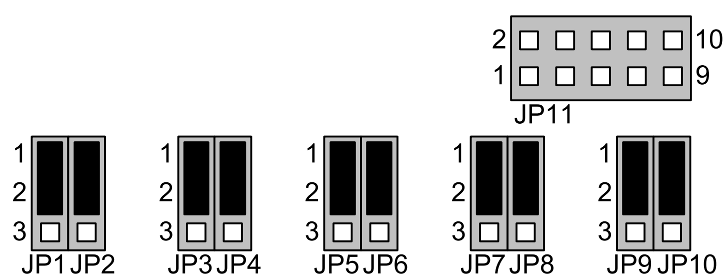


Figure 2.15 *Jumper shunt positions for interfacing with dry contact switches.*

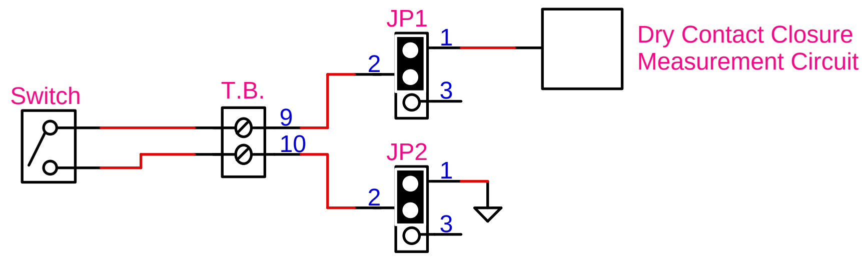


Figure 2.16 *Example wiring and equivalent circuit for interfacing with a dry contact switch on Universal Analog Input Channel 1.*

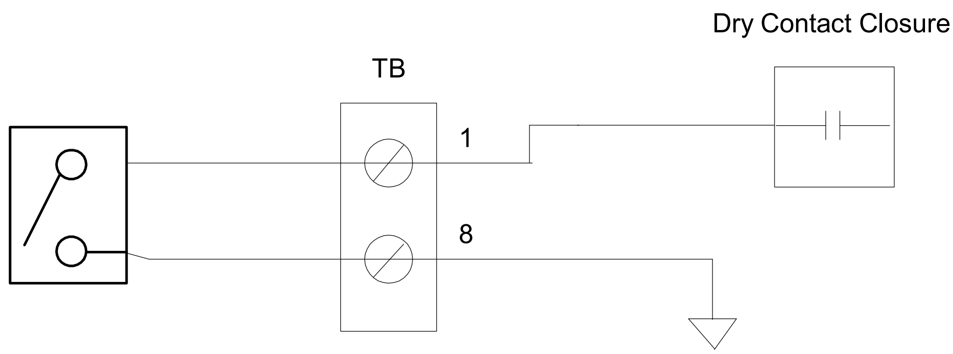


Figure 2.17 *Example wiring and equivalent circuit for interfacing with a dry contact switch on Digital Input Channel 1.*

2.7 Voltage Outputs

The four Analog Outputs on the EC230 controller can be configured for 0-10 volts of output, which is the default.

Figure 2.18 shows the jumper placements for the four analog output channels. Refer to Table 2.1 for the channel assignments of the jumper headers.

Figure 2.19 shows the wiring and equivalent circuit of the jumper configurations to interface with a voltage output.

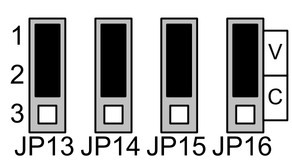


Figure 2.18 *Jumper shunt positions for interfacing with a voltage output.*

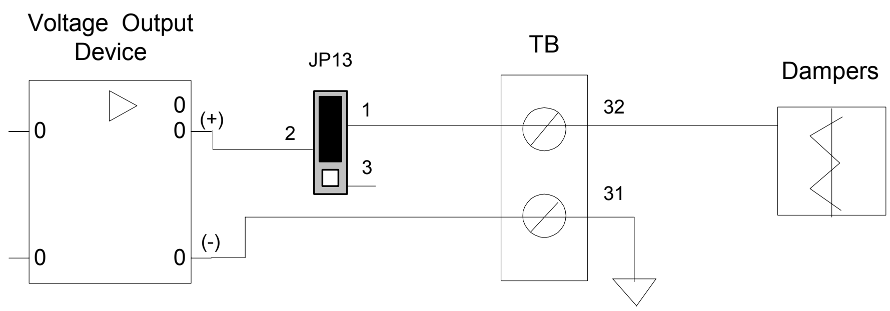


Figure 2.19 *Example wiring and equivalent circuit for interfacing with a voltage analog output on Channel 1.*

2.8 Digital Relay Outputs

The seven Digital Outputs on the EC230 controller are relay outputs that can be connected to Heating, Cooling, Fans, and other Digital Output type devices. There is a shared common for all seven relays.

Figure 2.20 shows the wiring and equivalent circuit of the wiring to a relay output device.

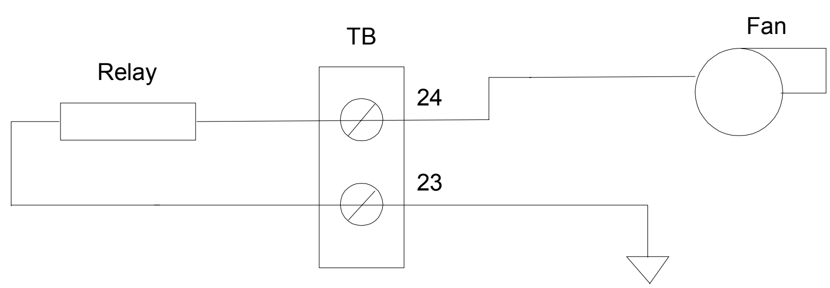


Figure 2.20 *Example wiring and equivalent circuit for interfacing with a digital relay output device on Channel 1.*

3

I/O Functional Profile

This section provides an overview of using the functional profile that comes with your EC230 module.

3.1 Network System Overview

LonWorks systems use “network variables” to enable various devices to communicate with one another. These devices can be Smart Controls modules or products from other companies that use “Standard Network Variable Types”, or SNVTs (pronounced “sni-vets”).

These network variables are like “soft” or terminal blocks. They can be logically “soft wired” or “bound” between devices, just like wires can connect physical terminal blocks. When “soft wired”, information from a transmitting device is received in those device(s) that are soft wired to the transmitting device.

The network variables are logically connected, or “bound”, to other devices with a network management tool such as VisualControl, Newron Systems’ NL-220, Echelon’s LonMaker for Windows, or IEC’s ICELAN G.

3.2 Node Definition

The following information is necessary for defining the node in the network management environments.

Neuron: 3150
Clock rate: 10 MHz
Transceiver: TP/FT-10
System Image Version: see below
Memory Properties:

Memory type: Flash EPROM
Memory size: 56 Kbytes (224 pages)
Sector size: 128
Range: 0-DFFF

Functional Profile

Profile Firmware Version

The firmware version of the profile may be determined by “querying” the node with a network management tool. The network management tool can obtain the node’s program ID string and self-documentation string. The node’s program ID string can contain the LonMark standard program ID (SPID) or the Smart Controls custom part number for the application profile. The node’s self-documentation string will give a brief description of the device.

Smart Controls LonMark Profiles

Every LonMark application has a unique, 16 digit, hexadecimal Standard Program ID defined by the LonMark Interoperability Association with the following format:

FM:MM:MM:CC:CC:UU:TT:NN

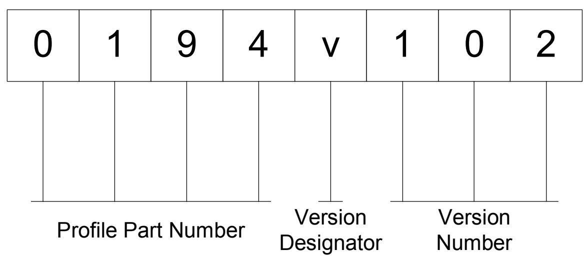
This Program ID is broken down into the following fields:

Letter	Field	Description
F	Format	A 1 hex-digit value defines the structure of the program ID. The upper bit of the format defines the program ID as a standard program ID (SPID) or a text program ID. The upper bit is set for standard program IDs, so formats 8 - 15 (0x8 - 0xF) are reserved for standard program IDs. Program ID format 8 is reserved for LonMark certified devices. Program ID format 9 is used for devices that will not be LonMark certified, or for devices that will be certified but are still in development or have not yet completed the certification process. Program ID formats 10 - 15 (0xA - 0xF) are reserved for future use. Text program ID formats are used by network interfaces and legacy devices and, with the exception of network interfaces, should not be used for new devices.
M	Manufacturer ID	A 5 hex-digit ID that is unique to each LonWorks device manufacturer. The manufacturer ID for Smart Controls is 0:00:0F. The upper bit identifies the manufacturer ID as a standard manufacturer ID (upper bit clear) or a temporary manufacturer ID (upper bit set). Standard manufacturer IDs are assigned to manufacturers when they join the LonMark Interoperability Association, and are also published by the LonMark Interoperability Association so that the device manufacturer of a LonMark certified device is easily identified. Standard manufacturer IDs are never reused or reassigned.
C	Device Class	A 4 hex-digit value identifying the primary function of the device. This value is drawn from a registry of pre-defined device class definitions. If an appropriate device class designation is not available, the LonMark Association will assign one, upon request.
U	Usage	A 2 hex-digit value identifying the intended usage of the device. The upper bit specifies whether the device has a changeable interface. The next bit specifies whether the remainder of the usage field specifies a standard usage or a functional-profile specific usage. The standard usage values are drawn from a registry of pre-defined usage definitions. If an appropriate usage designation is not available one will be assigned upon request. If the second bit is set, a custom set of usage values is specified by the primary functional profile for the device.
T	Channel Type	A 2 hex-digit value identifying the channel type supported by the device's LonWorks transceiver. The standard channel-type values are drawn from a registry of pre-defined channel-type definitions. A custom channel-type is

		available for channel types not listed in the standard registry.
N	Model Number	A 2 hex-digit value identifying the specific product model. Model numbers are assigned by the product manufacturer and must be unique within the device class, usage, and channel type for the manufacturer. The same hardware may be used for multiple model numbers depending on the program that is loaded into the hardware. The model number within the program ID does not have to conform to the manufacturer's model number.

Smart Controls Custom Profiles

The part number for a custom profile has eight characters. The part number consists of four numbers separated by a “v” and then three more numbers. The first four numbers are the actual part numbers that define a particular profile. The “v” is used to signify that the last three numbers are the version numbers of the profile firmware. An example is shown below.



3.3 Network Logical Installation

Network management tools need to have nodes on the network “logically” installed. When the network management tool asks you to install the node or press the service pin, press the black button on the side of the unit labeled **INSTALL**.

This will send a “service-pin” message consisting of the Neuron and Program IDs. This step logically installs the node into the network management tool so the tool can send it addressing information.

3.4 Profile Overview

The functional profile, which is loaded in the node at the factory, provides network variables that allow you to monitor the I/O from the network. The profile also allows you to configure the node.

There are two profiles available for downloading:

1) 0194vXXX (Formerly EC230_L)
2) 0195vXXX (Formerly EC230_S)

XXX is the version number of the application profile.

0194vXXX is the factory default and uses SNVT_lev_disc for the digital network variable types. 0195vXXX uses SNVT_switch for the digital network variable types.

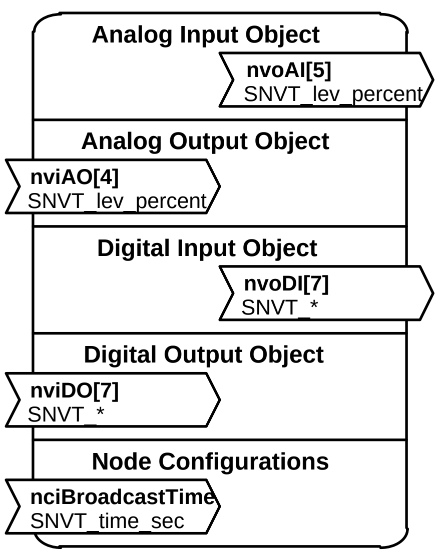
The EC230 has three primary types of network variables to monitor or control devices in the system:

1) network variable outputs (nvo) to monitor the Digital and Analog inputs
2) network variable inputs (nvi) to control the Digital and Analog outputs
3) configuration variables to set the parameters for the profile functional operation

The network variables are described in the next section of this chapter, "Network Variables".

3.5 Network Variables

The following information describes the network variables for the default application profile provided with the EC230. The network variables are graphically depicted below.



nvoAI[5]. Analog input level. 0 V or mA = 0%, 5V or 20mA = 100%. Index[0] = ch. 1, [4] = channel 5.

nviAO[4]. Analog output control. 0% = 0 Volts, 100% = 10V. Index[0] = ch. 1, [3] = channel 4.

nvoDI[7]. Digital input value. On = closed (0V). Index[0] = ch. 1, [6] = channel 7. * - For profile 0194vXXX (EC230_L), SNVT_lev_disc is used. For profile 0195vXXX (EC230_S), SNVT_switch is used.

nviDO[7]. Digital (relay) output control. 'On' activates the outputs (closed). Index[0] = ch. 1, [6] = channel 7. * - For profile 0194vXXX (EC230_L), SNVT_lev_disc is used. For profile 0195vXXX (EC230_S), SNVT_switch is used.

nciBroadcastTime. Time period of sending a single analog and digital input value. If 0, all are transmitted when sampled. The default value for this network variable is 0. The SNVT_time_sec has a resolution of 0.1 seconds and the time period can be incremented by 0.1 seconds.

4

Programming Considerations

This section provides an overview of programming your EC230 product.

4.1 Programming Overview

The application software for your EC230 module is created using NEURON C™ and a tool such as such as VisualControl Graphical Programming from VisualControl, LLC, or a LonBuilder or NodeBuilder from Echelon. You may use any of these tools to develop software for the EC230.

The easiest way to get an EC230 software application up and running using Neuron C is to use the sample code that is on the Product Support Files disk. This disk contains an off-the-shelf software application for measuring current that can easily be modified for translating the measurement to other units. The disk also contains the files with library functions necessary to access the hardware. Please see the documentation (.TXT files) on the disk for details of these files.

Once the software is written, plug the EC230 module into a network connected to your development tool. The tool can automatically download the new code to the EC230 over the network. Please note that this new firmware replaces the firmware that is programmed into the module at the factory.

Smart Controls offers software development services to implement your custom application. Please contact the sales department for details on software products and/or services.

I/O Channel Definitions

When using the library functions, the parameters for the I/O are as follows:

Channel index parameter = Channel number - 1

For example, to read channel 1, the code would be:

```
ec23x_ai_read(0)
```

4.2 Node Definitions

The following information is necessary for defining the node in the network management environments.

Neuron: 3150
Clock rate: 10 MHz
Transceiver: TP/FT-10
System Image Version: see below
Memory Properties:
Memory type: Flash EPROM
Memory size: 56 Kbytes (224 pages)
Sector size: 128
Range: 0-DFFF

Firmware Versions

The System Image firmware is updated from time to time by Echelon. When defining the node, you will need to know what System Image firmware version was loaded at the factory.

To determine the firmware version of your product, use a network management tool to "test" the hardware (methods will vary depending on the tool you are using). This will give the Firmware Version of the System Image loaded at the factory.

4.3 Library Functions

To use the EC230 library functions, the following header file must be declared in the Neuron C file:

```
#include "0205vXXX.inc"
```

where XXX is the current released version number.

Example uses of the functions can be found in the example Neuron C file, “EC_Sampl.nc”.

ec23x_ai_read

This function reads a universal analog input channel.

Declaration (contained in header file) and parameter(s):

unsigned long ec23x_ai_read(unsigned ch_index)

Parameters:

ch_index is the index of the channel. Indices of the channels are defined as follows:

Index = Hardware Channel - 1

Returns:

a 12-bit number (0-4095) representing the analog input.

ec23x_ao_write

This function writes a value to an analog output channel.

Declaration (contained in header file) and parameter(s):

void ec23x_ao_write(unsigned ch_index, unsigned long analog_value)

Parameters:

ch_index is the index of the channel. Indices of the channels are defined as follows:

Index = Hardware Channel - 1

analog_value is a 12-bit number (0-4095) representing the analog output which is scaled to fit the 10-bit D/A.

ec23x_di_read

This function is used to read a digital input channel.

Declaration (contained in header file) and parameters:

unsigned short ec23x_di_read(unsigned short ch_index)

Parameters:

ch_index is the index of the channel. Indices of the channels are defined as follows:

Index = Hardware Channel - 1

Returns:

a "1" if the input is On (shorted to ground) or a "0" if the input is open or high (5 V).

ec23x_di_read_all

This function is used to read a digital input channel. It returns a "1" if the input is OFF (open or high, 5 V); or a "0" if the input is ON (shorted to ground).

Declaration (contained in header file) and parameters:

unsigned short ec23x_di_read_all(void)

Returns:

an 8-bit number representing the states of all the inputs. Bit 7 (MSB) is channel 1. Bit 1 is channel 7. These bits are in the order that most efficiently uses the bit order used by tst_bit, set_bit, and clr_bit.

Example: 0b01111111 (127, or 0x7F) shows that channel 1 is ON (closed).

ec23x_do_enable

This function is used to enable the digital outputs.

Declaration (contained in header file) and parameters:

void ec23x_do_enable(boolean enable)

Parameters:

enable is TRUE to enable the outputs and FALSE to disable them. When the outputs are disabled, they are all OFF (open).

ec23x_do_write

This function is used to write a digital output channel.

Declaration (contained in header file) and parameters:

void ec23x_do_write(unsigned short ch_index, unsigned short state)

Parameters:

ch_index is the index of the channel. Indices of the channels are defined as follows:

Index = Hardware Channel - 1

state is the state of the output. If a “0”, the output will be turned OFF. If greater than 0, the output will be turned ON (shorted to the relay common).

ec23x_do_write_all

This function is used to write to all the digital outputs at once.

Declaration (contained in header file) and parameters:

void ec23x_do_write_all(unsigned short digital_states)

Parameters:

digital_states defines the states of all the outputs. Bit 7 (MSB) is channel 1. Bit 1 is channel 7. These bits are in the order that most efficiently uses the bit order used by tst_bit, set_bit, and clr_bit.

Example: 0b10000000 (128, or 0x80) will turn channel 1 ON (closed).

4.4 Use of Libraries Files with VisualControl, LonBuilder and NodeBuilder

VisualControl Graphical Programming

This Smart Controls product is already set up in VisualControl. No additional action is needed.

LonBuilder

To use a library file with a LonBuilder:

1. Copy the file to C:\LB\IMAGES\VER7. The particular path might be different for your LonBuilder system directory. The subdirectory name (e.g. VER7) corresponds to the latest system image from Echelon.
2. Edit the file c:\lb\images\STDLIBS.LST. Add the ".LIB" file to the list in the file. There should be one library name per line, no blank lines, and no spaces preceding library names.

NodeBuilder

To use a library file with a NodeBuilder:

1. Copy the file to C:\LONWORKS\IMAGES\VER7. The particular path might be different for your system directory. The subdirectory name (e.g. VER7) corresponds to the latest system image from Echelon.

4.5 Conversion to Engineering Units

When measuring voltage or current that needs to be converted from A/D code to engineering units, an easy conversion for linear systems is as follows:

$$EU = \frac{(AD_{IN} - AD_{MIN}) \cdot (EU_{MAX} - EU_{MIN})}{AD_{MAX} - AD_{MIN}} + EU_{MIN}$$

where

- EU is the converted Engineering Unit.
- EU_{MAX} is the value at the full-scale range of the A/D converter.
- EU_{MIN} is the value when the A/D converter reads 0 (if the sensor input does not actually go down to 0, the value must be linearly interpolated at 0V in OR AD_{MIN} must be calculated at this value).
- AD_{IN} is the raw A/D input.
- AD_{MAX} is 4096. If the entire range of the A/D converter is used, (AD_{MAX} - AD_{MIN}) is the full-scale range of the A/D converter (4096 even though the maximum number from the A/D will be 4095).
- AD_{MIN} is the minimum A/D converter value. If the EU_{MIN} is calculated at 0V in, then this number is 0. Otherwise it is the value of the A/D at EU_{MIN}.

For example, to convert to voltage, use the equation:

$$V_{IN} = \frac{AD_{IN} \cdot V_{MAX}}{4096}$$

where:

- V_{IN} is the measured voltage
- V_{MAX} is the maximum voltage input at A/D_{MAX}
- A_{IN} is the raw A/D input
- 4096 is the A/D_{MAX}

To convert to current, use the equation:

$$I_{IN} = \frac{AD_{IN} \cdot I_{MAX}}{4096}$$

where:

- I_{IN} is the measured current
- I_{MAX} is the maximum current input at A/D_{MAX} (20 mA for the ADR110 or ADR112)
- AD_{IN} is the raw A/D input
- 4096 is the full-scale range of the A/D converter

The Programming Support Files disk contains library functions for converting to voltage and current engineering units. See the appropriate .TXT file for a description of the conversion functions.

4.6 Resistance Measurements

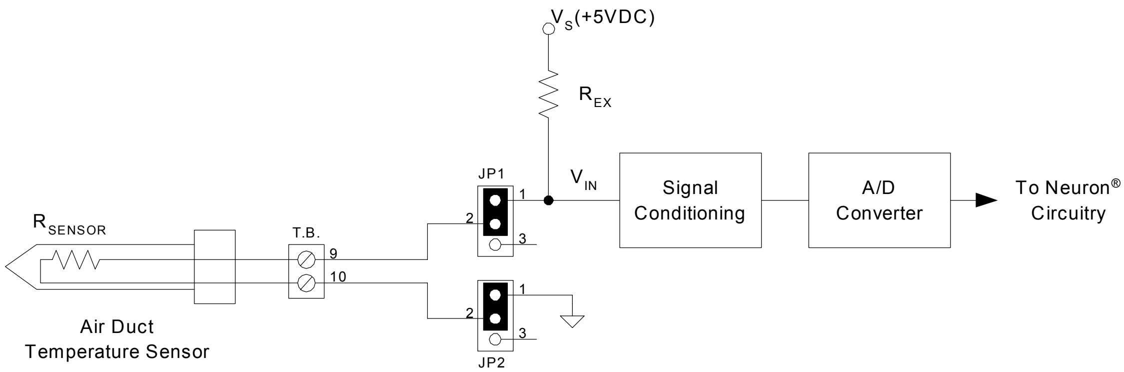


Figure 4.1 Example wiring and equivalent circuit for measuring a resistive sensor on a Universal Analog Input Channel 1.

The use of the Air Duct Temperature Sensor in Figure 4.1 is an example of how a resistance can be used to measure temperature on the EC230. The EC230 measures the voltage input produced from the voltage divider circuit created by the excitation resistor R_{EX} and the sensor resistor R_{SENSOR}. The input voltage V_{IN} is the voltage across R_{SENSOR} and is present at the input terminal block (T.B.). The voltage V_{IN} is proportional to the ambient temperature sensed and is signal conditioned before being applied to the Analog-to-Digital (A/D) converter.

The input voltage V_{IN} can be calculated from the following equation,

$$V_{IN} = \frac{V_S \bullet R_{SENSOR}}{R_{SENSOR} + R_{EX}}$$

where:

- V_{IN} is the voltage input to the A/D converter
- V_S is the stable source voltage (5V)
- R_{SENSOR} is the resistance of the sensor
- R_{EX} is the excitation resistance (10.0KΩ or 1.78KΩ)

The EC230 comes standard to measure the voltage that is produced from a temperature sensor with a 10KΩ nominal resistance at room temperature. The value used for R_{EX} should be 10KΩ when the EC230 has been specified for measuring a sensor with a nominal 10KΩ resistance at room temperature. The EC230 can be optionally specified to measure sensors with a nominal 1KΩ resistance at room temperature. If the EC230 has been specified to measure nominal 1KΩ sensors then the value used for R_{EX} should be 1.78KΩ.

If the resistance of the sensor is not known and the input voltage is known, then the following equation can be used to calculate the resistance of the sensor, R_{SENSOR}.

$$R_{SENSOR} = \frac{R_{EX} \cdot V_{IN}}{V_{MAX} - V_{IN}}$$

For an application program to determine the temperature that is being sensed by the resistive temperature probe, an equation or look-up table will have to be created by the application programmer. The equation or look-up table can be created in software from information or data provided by the manufacturer of the temperature sensor. The equation or look-up table will need the A/D value that is proportional to the input voltage and thus temperature being sensed.

To calculate the digital value for the A/D converter that will be used in the application program, the following equation can be used.

$$A_{IN} = \frac{4096 \bullet R_{SENSOR}}{R_{SENSOR} + R_{EX}}$$

where:

- A_{IN} is the A/D value
- 4096 is the maximum analog-to-digital value
- R_{SENSOR} is the resistance of the sensor
- R_{EX} is the excitation resistance (10KΩ or 1.78KΩ))

Below are two example calculations for determining the A/D value that an application program would receive from the A/D converter to calculate the corresponding measured temperature value.

Example 1

A 10KΩ type III thermistor at a room temperature of 20ºC has a nominal value of 10KΩ. The A/D value would then be calculated as follows:

Using the equation,

$$A_{IN} = \frac{4096 \bullet R_{SENSOR}}{R_{SENSOR} + R_{EX}}$$

$$R_{SENSOR} = 10K\Omega$$
$$R_{EX} = 10K\Omega$$

The equation would then be,

$$A_{IN} = \frac{4096 \bullet 10,000}{10,000 + 10,000}$$

and the analog-to-digital value, A_{IN}, would equal

$$A_{IN} = 2048$$

Example 2

A 1.0KΩ RTD at a room temperature of 20ºC has a nominal value of 1.0KΩ. The A/D value would then be calculated as follows:

Using the equation,

$$A_{IN} = \frac{4096 \bullet R_{SENSOR}}{R_{SENSOR} + R_{EX}}$$

$R_{SENSOR} =$ 1KΩ
$R_{EX} =$ 1.78KΩ

The equation would then be,

$$A_{IN} = \frac{4096 \bullet 1,000}{1,000 + 1,780}$$

and the analog-to-digital value, A_{IN}, would equal

$A_{IN} = 1473$

Note that the value has been rounded to the nearest whole value because of the decimal value being truncated by the A/D converter measurement.

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5

System Design Considerations

5.1 Overview

It is important for the EC230 to be correctly designed into your system for proper functioning. Many aspects of your system design must be taken into account such as power and ground, noise and electromagnetic compatibility, electrostatic discharge, power-up/reset states, and networking.

5.2 Power and Ground

The EC230 uses a fused and protected power circuit for DC power into the module. The power return (ground) is tied directly to the I/O return (ground). The equivalent circuit is shown below. The positive fuse trips in the event of an over-voltage or over-current on the power supply input.

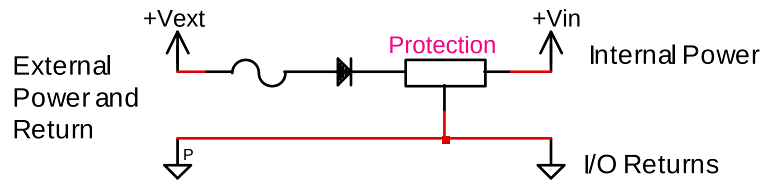

Figure 5.1 *EC230 power supply equivalent circuit.*

Ground Loops

Ground loops are created when the I/O returns (grounds) of multiple sensors, actuators, and/or nodes are connected to a common conductor. Current then flows through this common conductor, which can cause random noise, noise spikes, or other problems.

The common conductor can be a direct wire connection or a subtle conductive path. Care needs to be given to the design of the power supplies and wiring to make sure that sensors or other I/O devices do not cause problems.

Ground loops can be avoided by using isolated sensors and/or by electrically isolating the module.

Electrically Isolating the Module

The communications transceiver is transformer isolated. Therefore, by using a power supply which have returns (ground or negative terminal) that is isolated from the power system ground or by using an AC transformers, the node can be electrically isolated from other nodes on the network. This avoids ground loops between nodes.

5.3 Electromagnetic Compatibility

Even though EC230 modules have been tested for agency approvals, care must be taken on how the module is wired for correct functioning. I/O, power, and network wiring should be routed away from AC power wiring or other noisy cables.

5.4 Electrostatic Discharge

ESD can cause problems with electronics. For the EC230, problems can be in the form of resetting the module or actually damaging it.

EC230 modules have ESD protection on all the I/O, but repeated ESD “hits” can still damage it or reset it.

If the module is connected to a sensor that might slowly build an electrical charge, a 1 MΩ resistor should be tied from the sensor ground to earth ground to allow the static electricity to bleed off.

5.5 Network Considerations

All EC230 modules use LonMark compatible FTT-10A transceivers from Echelon. Up to 64 nodes may be connected to a single network channel. Table 5.1 lists some other network specifications. This information is from Echelon’s FTT-10A Free Topology Transceiver User’s Guide.

Network Wiring:	**Free Topology**		**Bus Topology***
Cable	**Maximum node-to-node distance**	**Maximum total wire length**	**Maximum bus length**
Belden 85102	500 m	500 m	2700 m
Belden 8471	400 m	500 m	2700 m
Level IV, 22AWG	400 m	500 m	1400 m
JY (St) Y 2x2x0.8	320 m	500 m	900 m
TIA Category 5	250 m	450 m	900 m

Table 5.1 *FT-10 Network specifications. * Doubly terminated bus may have stubs of up to 3 meters from the bus to each node.*

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6

Specifications

This section includes the key electrical, environmental, and mechanical specifications for the module.

6.1 Electrical Specifications

Power Supply Input

Voltage range: 19.2-28.8 VAC or 22.8-40 VDC.
Current:

Typical, no outputs on at 25DegC: 75 mA.
Maximum: 260 mA. Conditions:

- All outputs on
- All analog outputs at 10V driving 1 KΩ loads.
- 5 Current transducers all drawing 20 mA each from sensor power
- Power Supply Voltage 24VDC

Protection circuitry:

- Transient overvoltages.
- ESD.

Universal Analog Input Circuits

Five types of Universal Inputs, user configurable:

1) 0-5 Volts
2) 0-10 Volts
3) 0-20 mA Current
4) Resistive sensors
5) Dry contacts (e.g. switches), or TTL compatible inputs

Resolution: 12-bit, no missing codes.

Errors:

Input Setting	Max. Error at 25 °C (F.S. stands for Full Scale)	Temperature Drift
0-5 Volts	±2 LSb ±0.45% F.S.	
0-10 Volts	±2 LSb ±1.45% F.S.	±200 ppm/°C
0-20 mA Current	±2 LSb ±1.45% F.S.	±100 ppm/°C
Resistive sensors	±2 LSb ±1.45% F.S.	±100 ppm/°C

Protection circuitry:

- Overvoltage: indefinite short to 24 VAC/DC.

- Transient overvoltages.
- ESD.

Sensor Power Output (+20V)

Voltage range: 18-21 VDC.
Maximum Current:
Maximum: 120 mA.

Protection circuitry:
- Over-current (will temporarily reset node).
- ESD.

Analog Output Circuits

Errors:

Output Range	Max. Error at 25 °C	Temperature Drift
0-10 Volts	±50mV ±1% F.S.* *F.S. stands for Full Scale	±0.15µV/°C ±140 ppm/°C

- Resolution: 10-bit
- Max Current Output: Voltage Outputs: 16 mA.

Protection circuitry:
- Short: indefinite short to ground.
- Transient overvoltages.
- ESD.

Digital Input Circuits

Normal Voltage Range: 0-5 V.

Protection circuitry:
- Short: indefinite short to 24 VAC/DC.
- Transient overvoltages.
- ESD.

Relay Outputs

Max Current Output: 1 A @ 24 VDC resistive load
Max Voltage: 60 Vpeak.

Protection circuitry:
- Transient overvoltages.
- ESD.

6.2 Environmental Specifications

- Temperature:
  Operating, -25 to 50 °C (inside enclosure)
  Non-operating, -40 to +85 °C
- Humidity:
  Operating, 25-90% Relative Humidity @ 25°C (non-condensing)
  Non-operating, 0-95% (non-condensing)

6.3 Mechanical Specifications

Figure 6.1 shows the dimensions of the enclosure. The integrated mounting clips are designed for the unit to fit onto a 35mm DIN-rail (DIN 50022).

Material flammability rating: UL94-V1.

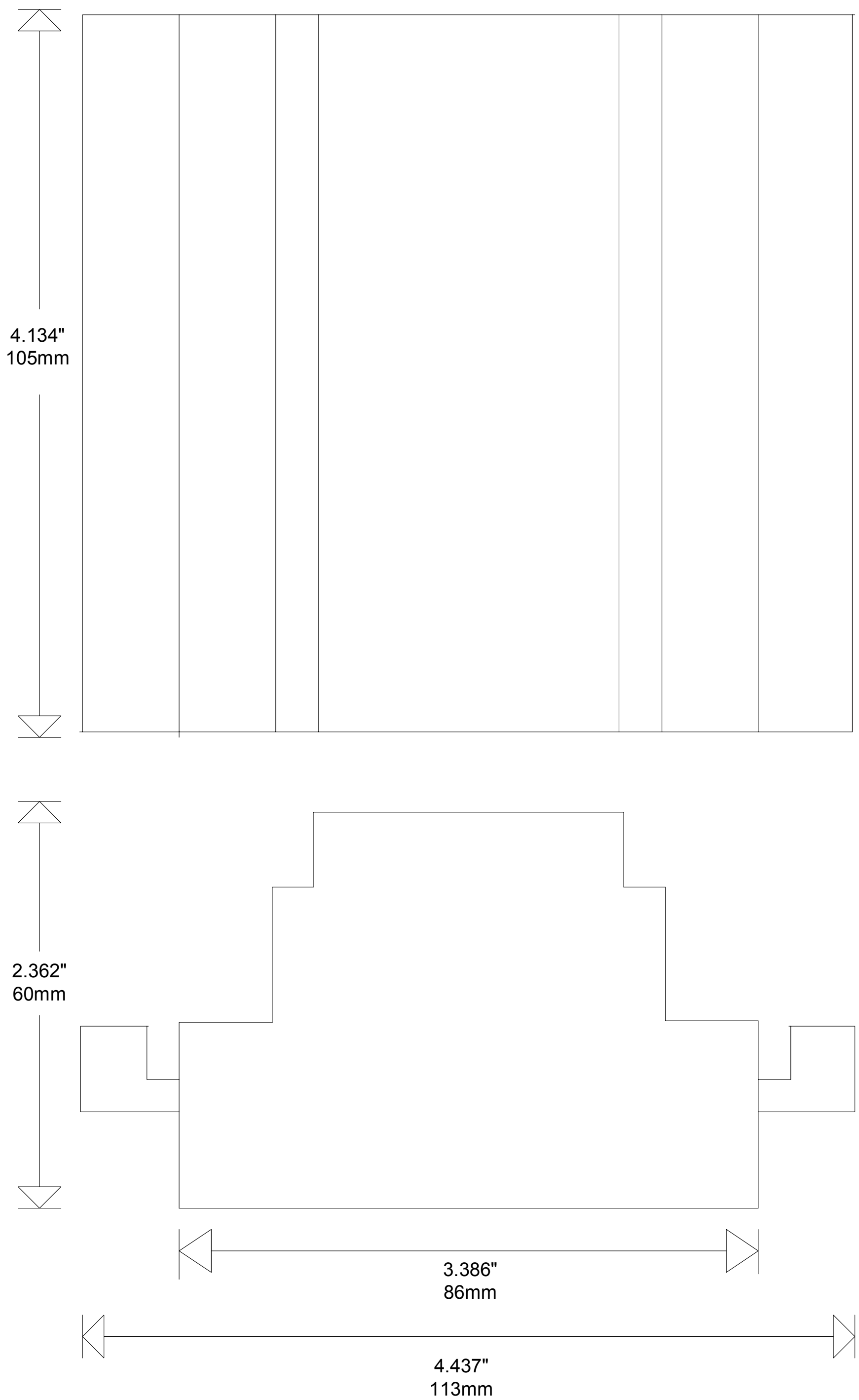

Figure 6.1 *Overall dimensions for the plastic enclosure.*

7

Installation Worksheet

The following page contains an Installation Worksheet. I/O and network connections can be drawn to assist in the physical installation of the module. This sheet may be freely copied as needed.

Jumper Positions for the Installed Module:

Jumper	Channel	Function	Position (circle 1)
JP1	1(+)	0-5/10 V Sensor/DI 0-20mA	Off 1-2 2-3
JP11 1-2		0-5V 0-10V	Off On
JP2	1(-)	Ground +20V	1-2 2-3
JP3	2(+)	0-5/10 V Sensor/DI 0-20mA	Off 1-2 2-3
JP11 3-4		0-5V 0-10V	Off On
JP4	2(-)	Ground +20V	1-2 2-3
JP5	3(+)	0-5/10 V Sensor/DI 0-20mA	Off 1-2 2-3
JP11 5-6		0-5V 0-10V	Off On
JP6	3(-)	Ground +20V	1-2 2-3

Jumper	Channel	Function	Position (circle 1)
JP7	4(+)	0-5/10 V Sensor/DI 0-20mA	Off 1-2 2-3
JP11 7-8		0-5V 0-10V	Off On
JP8	4(-)	Ground +20V	1-2 2-3
JP9	5(+)	0-5/10 V Sensor/DI 0-20mA	Off 1-2 2-3
JP11 9-10		0-5V 0-10V	Off On
JP10	5(-)	Ground +20V	1-2 2-3
JP13	1	0-10V	1-2
JP14	2	0-10V	1-2
JP15	3	0-10V	1-2
JP16	4	0-10V	1-2

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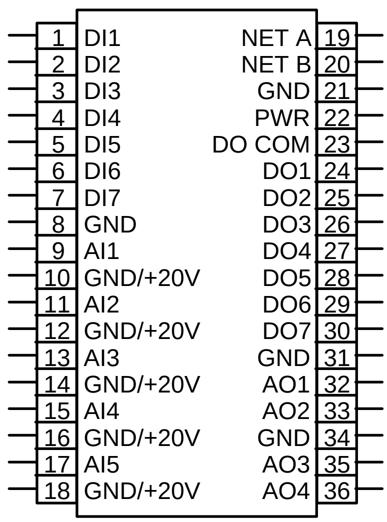
INSTALLATION WORKSHEET

LOCATION/IDENTIFIER _______________________



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Appendix A

Declaration of Conformance

The following page is the Declaration of Conformance for the CE-mark. This sheet may be freely copied as needed.

DECLARATION OF CONFORMITY

according to EN 45014

We, SMART CONTROLS, LLC. located at 10000 St. Clair Ave, Fairview Heights, IL. 62208, U.S.A., declare under our sole responsibility that the product:

Product Name:
Smart I/O EC230

Model Number:
S-EC230-F

to which this declaration relates is in conformity with the standards noted:

EN 50081-1 (1992)	EMC Generic Emission Standard for Residential, Commercial and Light Industrial Environments.
EN 50081-2 (1994)	EMC Generic Emission Standard for Industrial Environments.
EN 50082-1 (1998)	EMC Generic Immunity Standard Residential, Commercial & Light Light Industrial Environments.
EN 50082-2 (1995)	EMC Generic Immunity Standard for Industrial Environments.

Following the provisions of European Directives:

89/392/EEC Machinery Directive
91/368/EEC Amending 89/392/EEC
93/44/EEC Amending 89/392/EEC
89/336/EEC Electromagnetic Compatibility Directive
92/31/EEC Amending 89/336/EEC

Signed,

David Kniepkamp

David Kniepkamp
President
Smart Controls, LLC.