

i3



**INDUSTRIAL
CONTROL DIRECT**
A BSD Industrial Company



Intelligent Control Station

Hardware Manual



Think **inside the box**

PREFACE

This manual explains how to use all models types of the i^3 Controller.



WARRANTY AND LIMITATION OF LIABILITY

IMO Precision Controls Ltd. warrants to the original purchaser that the i^3 module is free from defects in material and workmanship under normal use and service. The obligation of IMO under this warranty shall be limited to the repair or exchange of any part or parts which may prove defective under normal use and service within three (3) years from the date of purchase, such defect to be disclosed to the satisfaction of IMO after examination by IMO of the allegedly defective part or parts. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED INCLUDING THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR USE AND OF ALL OTHER OBLIGATIONS OR LIABILITIES AND IMO NEITHER ASSUMES, NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IMO, ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF THIS i^3 module. THIS WARRANTY SHALL NOT APPLY TO THIS i^3 module OR ANY PART THEREOF WHICH HAS BEEN SUBJECT TO ACCIDENT, NEGLIGENCE, ALTERATION, ABUSE, OR MISUSE. IMO MAKES NO WARRANTY WHATSOEVER IN RESPECT TO ACCESSORIES OR PARTS NOT SUPPLIED BY IMO. THE TERM "ORIGINAL PURCHASER", AS USED IN THIS WARRANTY, SHALL BE DEEMED TO MEAN THAT PERSON FOR WHOM THE i^3 module IS ORIGINALLY INSTALLED. In no event, whether as a result of breach of contract, warranty, tort (including negligence) or otherwise, shall or its suppliers be liable of any special, consequential, incidental or penal damages including, but not limited to, loss of profit or revenues, loss of use of the products or any associated equipment, damage to associated equipment, cost of capital, cost of substitute products, facilities, services or replacement power, down time costs, or claims of original purchaser's customers for such damages.

To obtain warranty service, return the product to your distributor with a description of the problem, proof of purchase, post paid, insured and in a suitable package.

ABOUT PROGRAMMING EXAMPLES

Any example programs and program segments in this manual or provided on accompanying diskettes are included solely for illustrative purposes. Due to the many variables and requirements associated with any particular installation, IMO Precision Controls Ltd. cannot assume responsibility or liability for actual use based on the examples and diagrams. It is the sole responsibility of the system designer utilizing the i^3 module to appropriately design the end system, to appropriately integrate the i^3 module and to make safety provisions for the end equipment as is usual and customary in industrial applications as defined in any codes or standards which apply.

Note: All programming examples shown in this manual or in tutorials are for illustrative purposes only. Proper machine operation is the sole responsibility of the system integrator.

INSIDE THE CONTROLLER.....	7
CHAPTER 1: SAFETY / COMPLIANCE.....	8
1.1 SAFETY WARNINGS AND GUIDELINES	8
1.2 GROUNDING.....	8
1.3 CE COMPLIANCE	8
CHAPTER 2: INTRODUCTION	10
2.1 VISUAL OVERVIEW	10
2.1.1 Where to Find Information	11
2.1.2 Four main types of information are covered in the manual.....	11
2.1.3 Manual Index.....	11
2.1.4 Table Of Figures.....	11
2.2 CONNECTIVITY	12
2.3 FEATURES	12
2.4 REQUIRED AND SUGGESTED ACCESSORIES.....	13
2.5 USEFUL DOCUMENTS AND REFERENCES.....	13
CHAPTER 3: MECHANICAL INSTALLATION.....	14
3.1 OVERVIEW	14
3.2 MOUNTING REQUIREMENTS.....	14
3.2.2 MOUNTING PROCEDURES (INSTALLED ON DIN RAIL)	15
3.3 MOUNTING ORIENTATION.....	15
3.3.1 Mounting Clip	15
3.3.2 Mounting Orientation	16
3.4 PANEL CUT-OUT.....	16
3.5 DIMENSIONS	17
3.6 FACTORS AFFECTING PANEL LAYOUT DESIGN AND CLEARANCES	17
3.6.1 Clearance / Adequate Space	17
3.6.2 Grounding	18
3.6.3 Temperature / Ventilation	18
3.6.4 Orientation.....	18
3.6.4 Orientation.....	18
3.6.5 Noise	18
3.6.6 Shock and Vibration.....	18
3.6.7 Panel Layout Design and Clearance Checklist.....	18
CHAPTER 4: ELECTRICAL INSTALLATION.....	20
4.1 GROUNDING DEFINITION	20
4.2 GROUND SPECIFICATIONS.....	20
4.3 HOW TO TEST FOR ACCEPTABLE GROUND.....	20
4.4 PRIMARY POWER PORT.....	21
CHAPTER 5: SERIAL COMMUNICATIONS.....	22
5.1 OVERVIEW	22
5.2 PORT DESCRIPTIONS	22
5.3 WIRING.....	22
5.4 RS-485 TERMINATION	23
5.5 RS-485 BIASING	23
5.6 I3 CONFIGURATOR PROGRAMMING VIA SERIAL PORT	23
5.7 LADDER-CONTROLLED SERIAL COMMUNICATION.....	23
5.8 EXTRA SERIAL COMMUNICATION PROTOCOLS	23
CHAPTER 6: CAN COMMUNICATIONS.....	25
6.1 OVERVIEW	25
6.2 PORT DESCRIPTION.....	25
6.3 CAN (NET1) PORT WIRING	25
6.4 I ³ CONFIGURATOR PROGRAMMING VIA CAN.....	25
6.5 LADDER-CONTROLLED CAN COMMUNICATION.....	25
6.6 USING CAN FOR I/O EXPANSION (NETWORK I/O).....	25

CHAPTER 7: COMMUNICATION OPTIONS.....	27
7.1 OVERVIEW	27
7.2 EMBEDDED ETHERNET (I3C12Z/*****-SEHF ONLY)	27
7.2.1 Ethernet Module Protocols and Features.....	27
7.2.2 Ethernet System Requirements.....	27
7.2.3 Ethernet Module Specifications	27
7.2.4 Ethernet Module Configuration.....	27
7.3 ETHERNET COM MODULE (I3-E) OPTION	30
7.4 MODEM COM MODULE (I ³ -M) OPTION	30
CHAPTER 8: REMOVABLE MEDIA.....	33
8.1 OVERVIEW	33
8.2 MICRO SD CARDS	33
8.3 MICRO SD FILE SYSTEM.....	33
8.4 USING THE REMOVABLE MEDIA MANAGER.....	33
8.5 USING REMOVABLE MEDIA TO LOG DATA	34
8.6 USING REMOVABLE MEDIA TO LOAD AND SAVE APPLICATIONS	34
8.7 USING REMOVABLE MEDIA TO VIEW AND CAPTURE SCREENS.....	34
CHAPTER 9: GENERAL I/O.....	36
9.1 OVERVIEW	36
9.2 REMOVING THE I/O COVER.....	36
9.3 MODEL AND I/O OVERVIEW	37
9.4 SOLID-STATE DIGITAL OUTPUTS	37
9.5 RELAY OUTPUTS.....	38
9.6 DIGITAL INPUTS	39
9.7 ANALOGUE INPUTS	39
9.8 UNIVERSAL ANALOGUE INPUTS.....	39
9.9 ANALOGUE OUTPUTS.....	39
CHAPTER 10: HIGH SPEED I/O (HSC / PWM).....	42
10.1 OVERVIEW	42
10.2.1 Frequency	42
10.2.2 Totalize.....	42
10.2.3 Pulse	43
10.2.4 Quadrature.....	43
10.3 HSC FUNCTIONS REGISTER MAP.....	46
10.4 PULSE WIDTH MODULATION (PWM) FUNCTIONS	46
10.4.1 Normal.....	46
10.4.2 PWM	46
10.4.3 HSC (High Speed Counter).....	47
10.4.4 Stepper Function	47
10.5 PWM FUNCTIONS REGISTER MAP.....	48
Example 1.....	48
Example 2.....	48
Example 3.....	48
Example 4.....	48
10.7 STP EXAMPLES.....	48
Example 1.....	48
Example 2.....	49
Example 3.....	49
CHAPTER 11: SYSTEM SETTINGS AND ADJUSTMENTS.....	50
11.1 SYSTEM MENU - OVERVIEW	50
11.2 SYSTEM MENU – NAVIGATION AND EDITING.....	51
11.3 SYSTEM MENU – DETAILS	52
CHAPTER 12: USER INTERFACE	59
12.1 SCREEN NAVIGATION	59
12.2 LADDER BASED SCREEN NAVIGATION	59
12.3 USING EDITABLE SCREEN OBJECTS	59
CHAPTER 13: REGISTERS.....	62

13.1 REGISTER DEFINITIONS.....	62
13.2 USEFUL %S AND %SR REGISTERS	63
13.3 REGISTER MAP FOR i^3 I/O	65
13.4 RESOURCE LIMITS	66
CHAPTER 14: CONFIGURATOR SETUP	67
14.1 OVERVIEW	67
14.2 CONFIGURATOR STATUS BAR	67
14.3 ESTABLISHING COMMUNICATIONS	67
14.4 MODELS SUPPORTED.....	69
14.5 CONFIGURATION.....	69
14.6 DIGITAL INPUT / HSC CONFIGURATION.....	69
14.7 DIGITAL OUTPUT / PWM CONFIGURATION	70
14.8 ANALOGUE INPUT CONFIGURATION	71
14.9 ANALOGUE OUTPUT CONFIGURATION.....	72
CHAPTER 15: MAINTENANCE.....	74
15.1 FIRMWARE UPDATES	74
15.2 BACKUP BATTERY	74
15.2.2 Battery Replacement	74
CHAPTER 16: TROUBLESHOOTING / TECHNICAL SUPPORT.....	76
16.1 CONNECTING TO THE i^3	76
16.1.1 Connecting Troubleshooting Checklist (serial port – MJ1) Programming.....	76
16.1.2 Connecting Troubleshooting Checklist (USB Port - Mini B) Programming (i^3 C only)	76
16.2 LOCAL CONTROLLER AND LOCAL I/O	77
16.2.1 Local I/O Troubleshooting Checklist	77
16.3 iCAN NETWORK.....	77
16.3.1 iCAN Network Troubleshooting Checklist	77
16.4 REMOVABLE MEDIA	78
16.5 SCREEN.....	78
16.6 TECHNICAL SUPPORT CONTACTS.....	78
INDEX	80
TABLE OF FIGURES:.....	81
IMO UK.....	82
IMO FRANCE	82
IMO ITALY	82
IMO CANADA	82

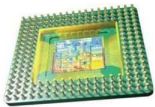
FIRST STEP of ANY TASK: DATASHEET

Each i^3 unit is sent with a datasheet in the box. The datasheet is the first document you need to refer to for model-specific information such as pin-outs, jumper configuration, see the datasheets attached to it. Visit our website to obtain updates to datasheets, user documentation, and a range of extra tutorials for programming assistance.

QUICK START	INSTALLATION	PROGRAMMING	TROUBLESHOOTING
Safety / Compliance page 8	Safety / Compliance page 8	Safety / Compliance page 8	Safety / Compliance page 8
Introduction page 10	Introduction page 10	Introduction page 10	Introduction page 10
	Mechanical Installation page 14	System Settings page 50	Maintenance page 74
	Electrical Installation page 20	Configuration page 67	Troubleshooting page 76
	Serial Comm page 22	User Interface page 59	
	CAN Comm page 25	Removable Media page 33	
	Communication Options page 27	General I/O page 36	
	General I/O page 36	High Speed I/O page 42	
Registers page 62			

Inside the Controller...

CPU



A Powerful 32-bit Microprocessor
Scanning around the speed of 1ms per Kstep

Memory

<p>1MB Graphical Memory 1023 User Screens with up to 50 objects per screen including bitmaps, animations and custom fonts</p>		<p>Up to 2GB MicroSD Log data periodically, back-up user program, download user program from MicroSD</p>
<p>256KB Program Memory Massive capacity for optimal usage of advanced languages such as Structured Text</p>	<p>256KB Internal Flash User-upgradeable firmware unlocking new features without returning hardware</p>	

Screens



Option A:
Monotone 128x64 Pixel Graphical Screen with 10 Programmable Function Keys



Option B:
Monotone 160x128 Pixel Graphical Touch Screen with 4 Programmable Function Keys



Option C:
32K Colour 320x240 Pixel Graphical Touch Screen with 5 Programmable Function Keys

Inputs and Outputs

Up to 4 Analogue Inputs, Options of mA, V, Thermocouple, PT100

4 High Speed Pulse Inputs, up to 10Khz

Up to 24 Digital Inputs, PNP or NPN



Option for 2 Analogue Outputs mA, V

Option for 2 Pulse outputs (up to 65Khz)

Option for 6 Relay Outputs or up to 16 Transistor Outputs

Communication

Up to 3 Ports (i3A & i3B, i3C can have 3 ports + 2 USB + Ethernet)



Port 2 - RS232/RS485 20+ protocols including Modbus, DF1, GeFanuc

Port 1 - RS232/RS485 Add option card to convert to Ethernet
Or add card to convert to GSM Modem for SMS, GSM and GPRS data.

Port 3 (CAN) - Link other i³ controllers or extra I/O. (CANopen firmware upgrade available)

CHAPTER 1: SAFETY / COMPLIANCE

1.1 Safety Warnings and Guidelines

When found on the product, the following symbols specify:

- a. All applicable codes and standards need to be followed in the installation of this product.
- b. For I/O wiring (discrete), use the following wire type or equivalent: Belden 9918, 18 AWG or larger.

Adhere to the following safety precautions whenever any type of connection is made to the module.

- a. Connect the green safety (earth) ground first before making any other connections.
- b. When connecting to electric circuits or pulse-initiating equipment, open their related breakers. Do not make connections to live power lines.
- c. Make connections to the module first; then connect to the circuit to be monitored.
- d. Route power wires in a safe manner in accordance with good practice and local codes.
- e. Wear proper personal protective equipment including safety glasses and insulated gloves when making connections to power circuits.
- f. Ensure hands, shoes, and floor is dry before making any connection to a power line.
- g. Make sure the unit is turned OFF before making connection to terminals. Make sure all circuits are de-energized before making connections.
- h. Before each use, inspect all cables for breaks or cracks in the insulation. Replace immediately if defective.

1.2 Grounding

Grounding is covered in various chapters within this manual.

1.3 CE Compliance

To check for compliance and updates, visit our website at: www.imopc.com



Warning: Consult user documentation.



Warning: Electrical Shock Hazard.

WARNING: To avoid the risk of electric shock or burns, always connect the safety (or earth) ground before making any other connections.

WARNING: To reduce the risk of fire, electrical shock, or physical injury it is strongly recommended to fuse the voltage measurement inputs. Be sure to locate fuses as close to the source as possible.

WARNING: Replace fuse with the same type and rating to provide protection against risk of fire and shock hazards.

WARNING: In the event of repeated failure, do not replace the fuse again as a repeated failure indicates a defective condition that will not clear by replacing the fuse.

WARNING: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

NOTES

CHAPTER 2: INTRODUCTION

2.1 Visual Overview

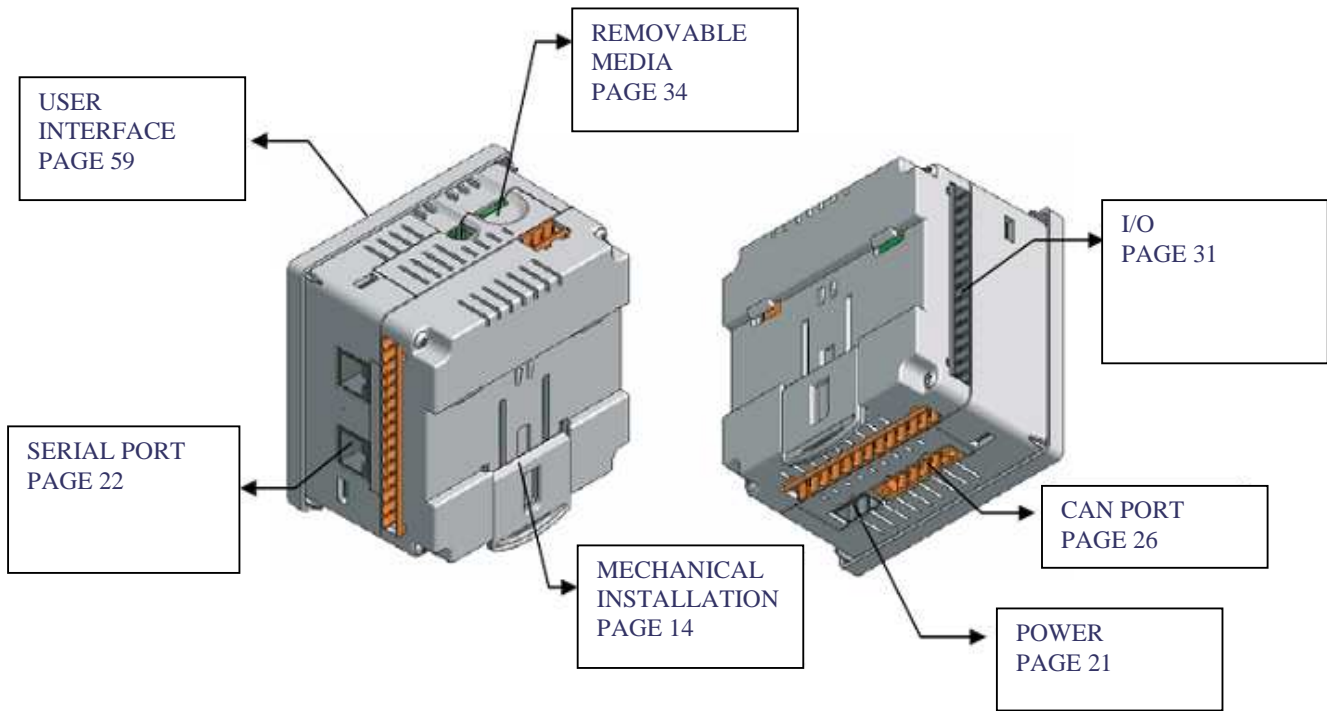
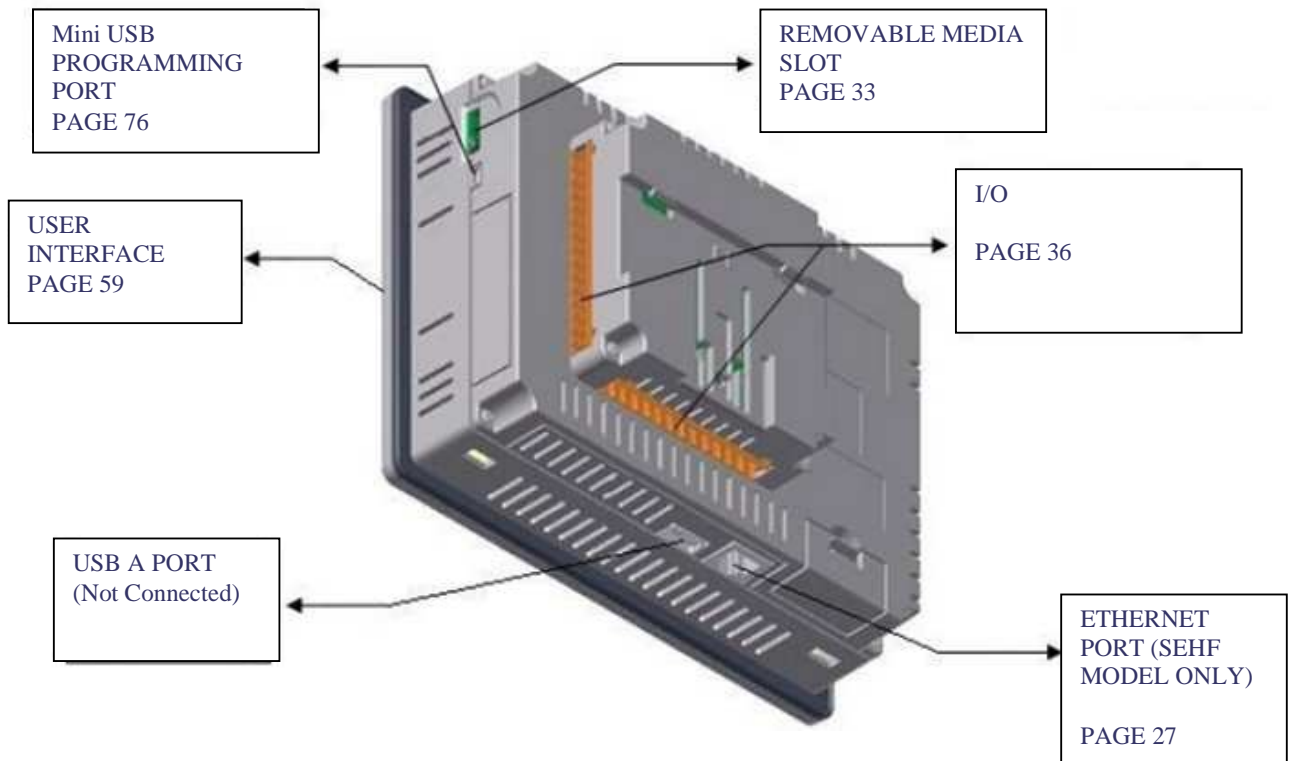
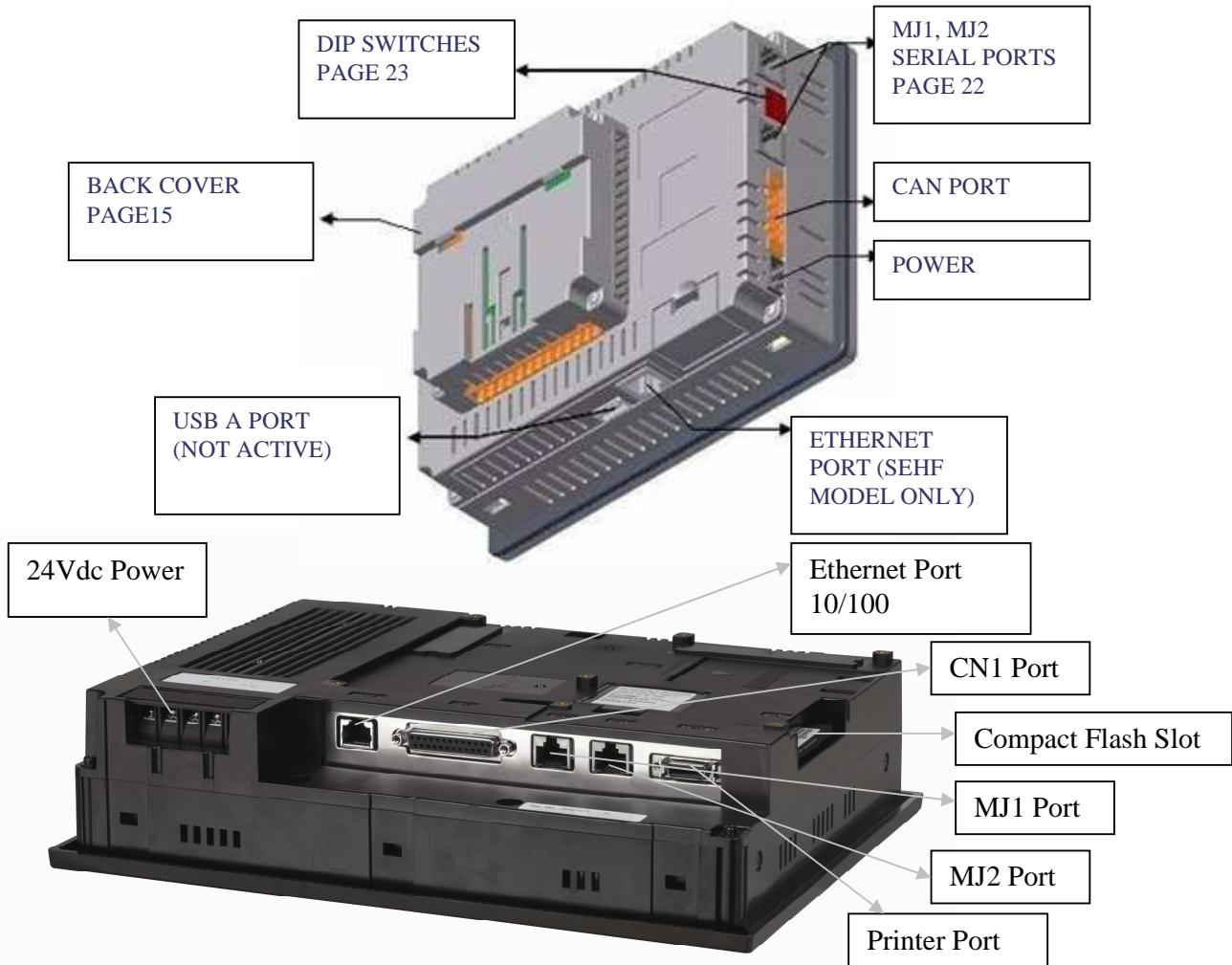


Figure 2.1 – Visual Overview





2.1.1 Where to Find Information

a. In-Box Docs - These are the first documents you need to refer to for key information related to specific *i*³ models. (A datasheet is provided in the box with your unit.) The datasheets for all *i*³ models are attached to the back of this manual on our website, and they are also available individually on the web. Datasheets contain pin-outs, jumper settings and other model specific information.

b. User Manual -This manual provides general information that is common to *i*³ models and can be downloaded from our web. Visit our website, at <http://www.imopc.com/> to obtain user documentation and updates.

c. Tutorial – A range of tutorials are available for download off the website under the *i*³ product section at <http://www.imopc.com/>.

2.1.2 Four main types of information are covered in the manual.

- a. Safety and Installation guidelines / instructions (Mechanical and Electrical)
- b. Descriptions of hardware features (Serial ports, Removable Media, Communication Options, etc.)
- c. Configuration and Use of the *i*³
- d. Maintenance and Support

2.1.3 Manual Index

[Index](#)

Major topics of interest may be found in the [Index](#) towards the end of this manual.

2.1.4 Table Of Figures

[Table of Figures](#)

Location of important drawing, illustrations (etc) may be found in the [Table of Figures](#).

2.2 Connectivity

The i^3 has excellent capabilities for connecting to a variety of devices. The diagram below shows some examples of devices that can be easily connected.

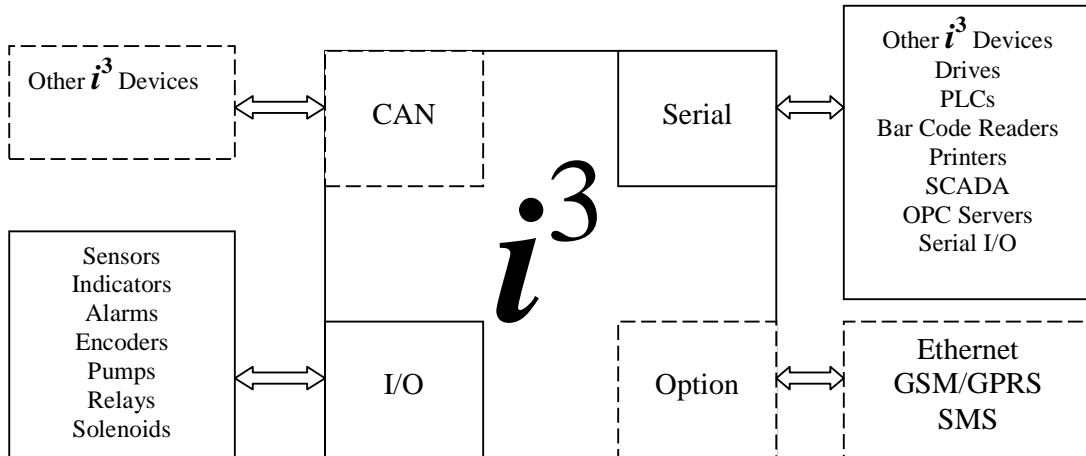


Figure 2.3 – Visual Overview of Types of Devices that can be connected to i^3 (A,B,C)

2.3 Features

An i^3 is an all-in-one industrial control device. It combines control, user interface, I/O and networking into a single, integrated package. Unique features of the i^3 include:

- Choice of: Bright, 32768 colour 800x600px(15", 12", 10", 8") 320x240px(5.7") graphical touch sensing LCD display, 160x128px(3.5") Monotone touch display, and 128x64px(2.25") Monotone screen with 10 programmable function keys.
- Display of complex graphical objects including trends, gauges, meters and animations
- Advanced control capabilities including floating point, multiple auto-tuning PID loops and string handling capabilities
- Removable media for up to two gigabytes of storage of programs, data logging or screen captures
- i CAN networking port for communication with remote I/O, other controllers or PCs
- USB networking port for communication with PCs and programming of controller
- Configurable serial protocols for communication to drives, PLCs, or other serial peripherals
- Full featured, built-in I/O including high resolution analogue, thermocouple, RTD, high speed counters, PWM outputs and relays (depending upon the i^3 model used)
- i^3 Configurator programming software that allows all aspects of the i^3 to be programmed and configured from one integrated application
- Optional communication add-on modules that allow additional capabilities such as Ethernet or modems

2.4 Required and Suggested Accessories

The following list contains a *sampling* of required and suggested *i*³ accessories. Visit our website to view updates on new products and accessories.

<i>Table 2.1 – i³ Accessories</i>	
Part Number	Description
<i>i</i> ³ -E	10/100 Ethernet option kit - field installable. Kit includes all parts necessary for internal installation within the <i>i</i> ³ case, including a deeper plastic back cover adapted for Ethernet operation.
<i>i</i> ³ -MA	GSM Modem for SMS, GSM/GPRS data communication, with antenna.
<i>i</i> ³ PC45	Programming Cable, 9-pin female (PC) to RJ-45 (<i>i</i> ³) - 6 feet.
PC501	USB to RS-232 adapter.

Note: The *i*³ is not shipped with a programming cable in the box. To obtain a programming cable, order *i*³PC45.

2.5 Useful Documents and References

The following information serves as a *general* listing of IMO integrated controller products and other references of interest with their corresponding manual numbers. Visit our website to obtain user documentation and updates.

<i>Table 2.2 – i³ Reference Documents</i>	
NAME	DESCRIPTION
<i>i</i> ³ Datasheet	For selecting models and remote I/O
In-Box-Docs	Supplied with each model, providing set-up and wiring information
Hardware Manual	This document
Tutorials	Various documents showing how to configure and program
Application Guides	Various documents showing recently used applications

CHAPTER 3: MECHANICAL INSTALLATION

Note: Each i^3 unit is sent with a datasheet in the box. **The datasheet is the first document you need to refer to for model-specific information related to i^3 models such as pin-outs, jumper settings, and other key installation information.** The web version of this manual has all of the i^3 datasheets attached to it. Visit our website to obtain datasheets, user documentation, and updates.

3.1 Overview

The mechanical installation greatly affects the operation, safety and appearance of the system. Information is provided to mechanically install the unit such as cut-out sizes, mounting procedures and other recommendations for the proper mechanical installation of the unit.

3.2 Mounting Requirements

3.2.1 Mounting Procedures (Installed in a Panel Door)

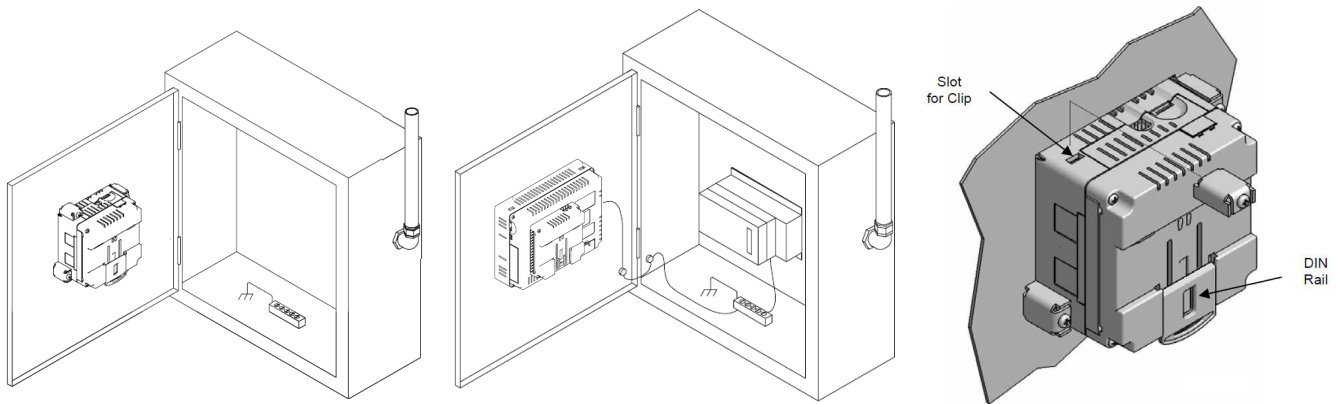


Figure 3.1 – Panel Mounting of an i^3

Once the panel design has been completed using the criteria and suggestions in the following sections, use the following steps to panel mount the i^3 .

1. Remove all connectors from the i^3 unit.
2. Make sure the gasket is installed on the i^3 and is free from dust and debris. Check that the corners of the gasket are secure.
3. Pass the unit through the panel.
4. Insert the each of the four (4) mounting clips into the slots in the i^3 case. One clip should be installed on each corner. Lightly tighten each screw so the clip is held in place.
5. Tighten the screws on the clips such that the gasket is compressed against the panel.

3.2.2 Mounting Procedures (Installed on DIN Rail)

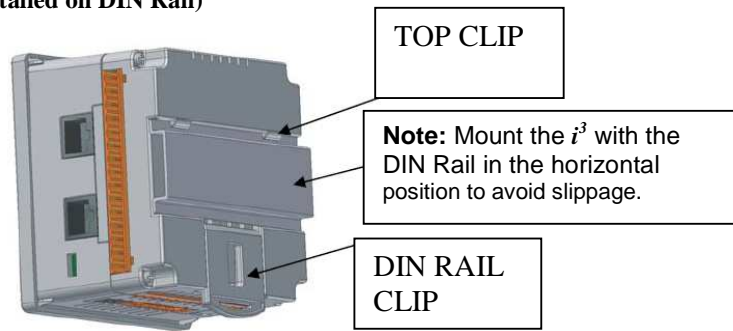


Figure 3.2 – DIN Rail Mounting of the i^3

The i^3 is designed to clip onto standard 35 millimeter DIN rail. If your installation requires liquid or dust protection, make sure the i^3 is placed in an appropriate sealed panel when mounting on DIN rail. Use the following steps to mount the i^3 on DIN rail.

1. Move the DIN rail clip to the lower position.
2. Clip the “Top Clips” on the top of the DIN rail.
3. Press the unit into place and press the DIN rail clip up. A small flat-head screwdriver can be used in the slot of the DIN rail clip if clearance is an issue.

Note: The DIN rail connection does not provide an earth ground. Refer to CHAPTER 4 for proper grounding information.

3.3 Mounting Orientation

3.3.1 Mounting Clip

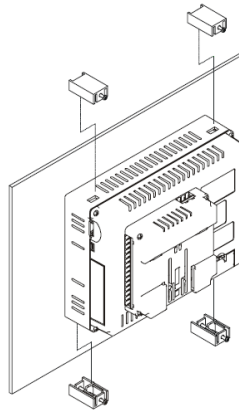


Figure 3.2 – i^3 with Mounting Clips

3.3.2 Mounting Orientation

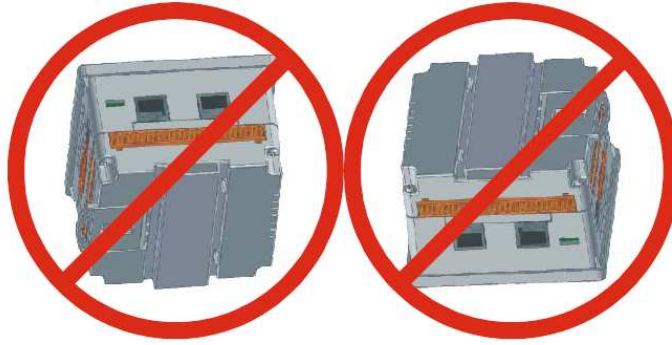


Figure 3.3 – Orientation

NOTE: There are NO orientation restrictions on the *i*³. However, the above orientation provides for optimum readability of the screen and ease of use of the keypad.

3.4 Panel Cut-Out

For installations requiring NEMA4X liquid and dust protection the panel cutout should be cut with a tolerance of ± 0.005 " (0.1 mm).

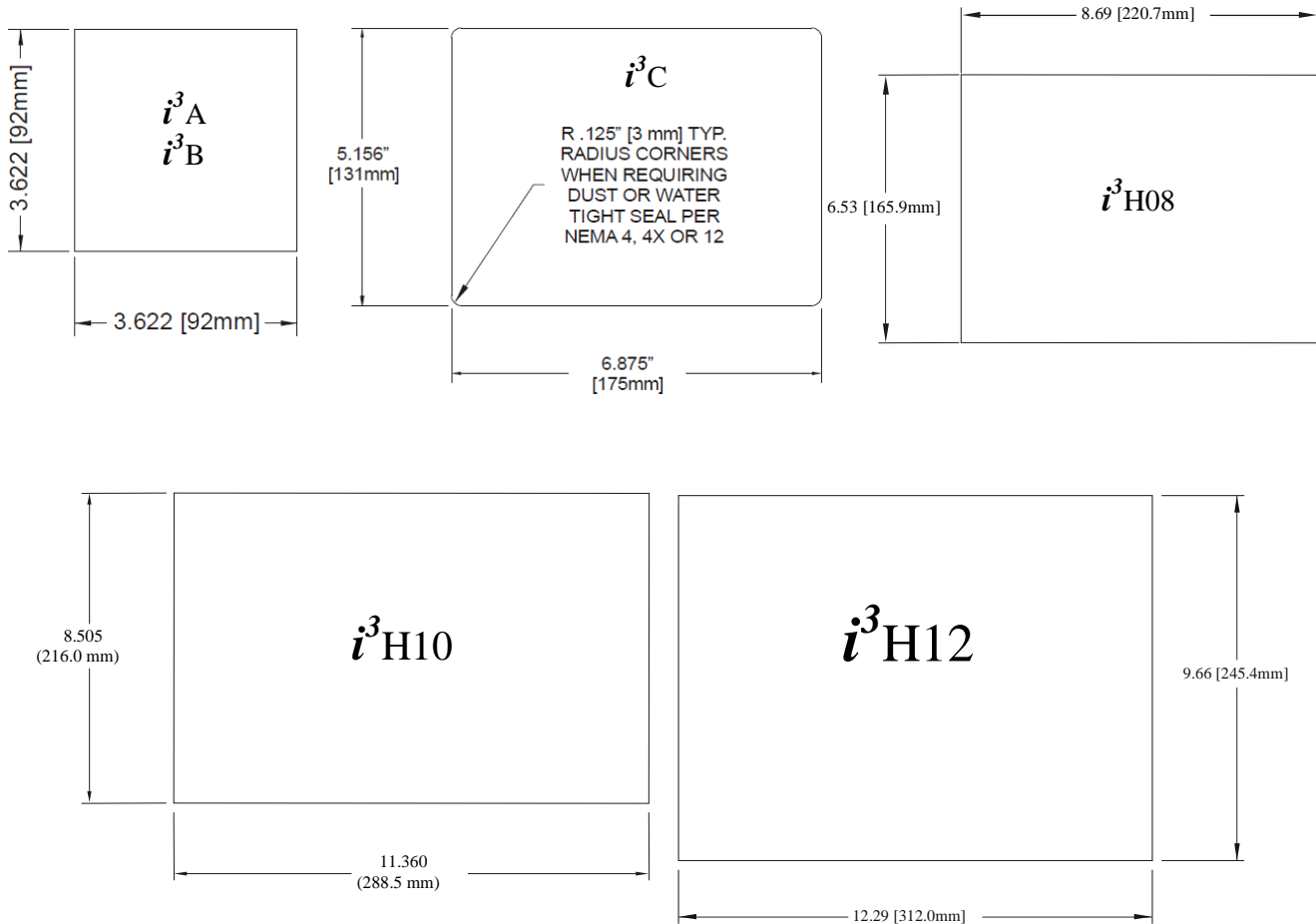


Figure 3.4 – Panel Cutout Tolerances

3.5 Dimensions

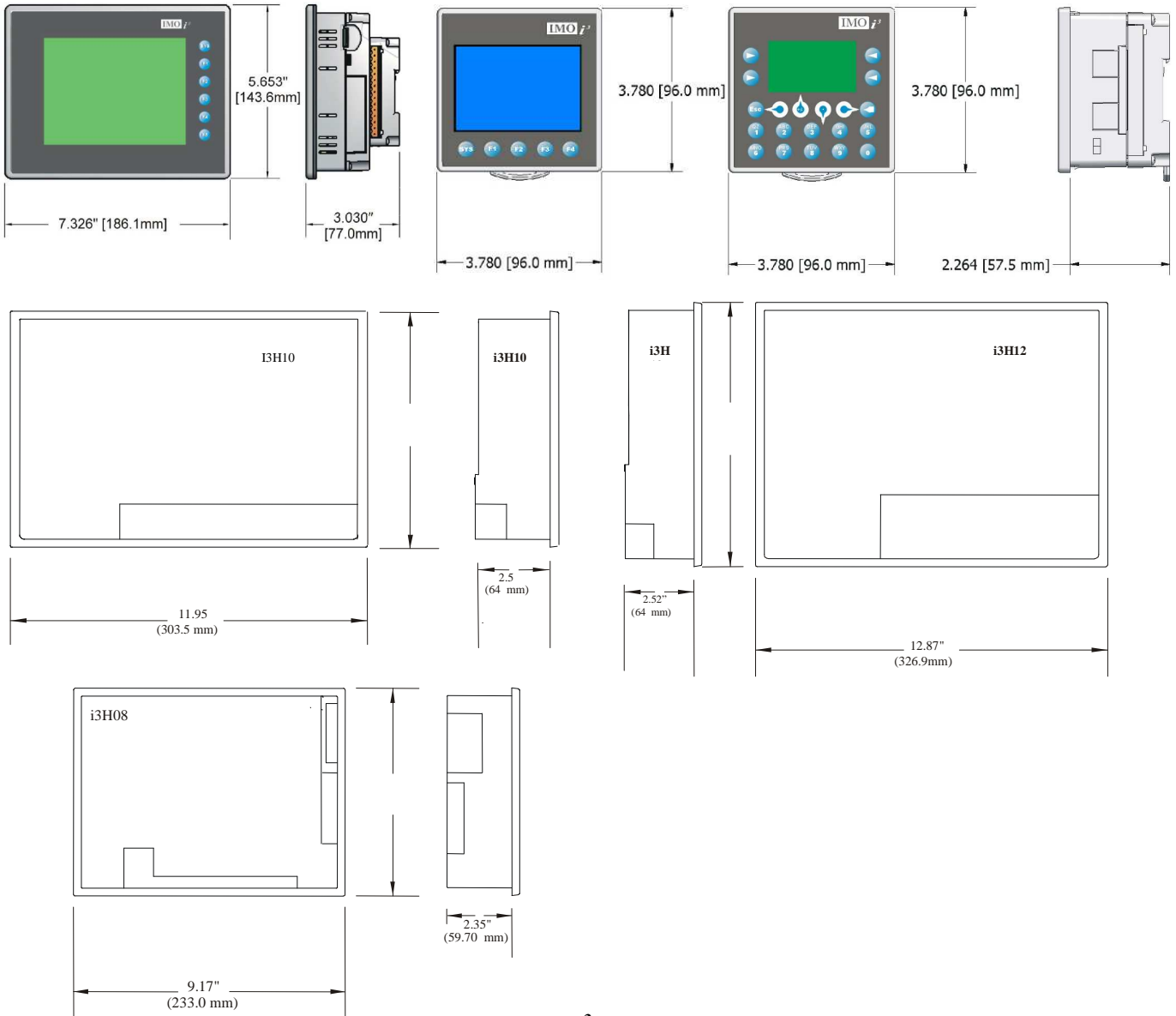


Figure 3.5 – *i*³ Dimensions

3.6 Factors Affecting Panel Layout Design and Clearances

The designer of a panel layout needs to assess the requirements of a particular system and to consider the following design factors.

3.6.1 Clearance / Adequate Space

Install devices to allow sufficient clearance to open and close the panel door.

Minimum Distance between base of device and sides of cabinet	2 inches (50.80mm)
Minimum Distance between base of device and wiring ducts	1.5 inches (38.10mm)
If more than one device installed in panel box (or on door): Minimum Distance between bases of each device.	4 inches between bases of each device (101.60mm)
When door is closed: Minimum distance between device and closed door (Be sure to allow enough depth for the <i>i</i> ³ .)	2 inches (50.80mm)

3.6.2 Grounding

Panel box: The panel box needs to be properly connected to earth ground to provide a good common ground reference.

Panel door: Tie a low impedance ground strap between the panel box and the panel door to ensure that they have the same ground reference.

3.6.3 Temperature / Ventilation

Ensure that the panel layout design allows for adequate ventilation and maintains the specified ambient temperature range. Consider the impact on the design of the panel layout if operating at the extreme ends of the ambient temperature range. For example, if it is determined that a cooling device is required, allow adequate space and clearances for the device in the panel box or on the panel door.

WARNING: It is important to follow the requirements of the panel manufacturer and to follow all applicable electrical codes and standards.

WARNING: Be sure to meet the ground requirements of the panel manufacturer and also meet applicable electrical codes and standards.

3.6.4 Orientation

When panel-mounted, there are no orientation restrictions on the i^3 .

3.6.5 Noise

Consider the impact on the panel layout design and clearance requirements if noise suppression devices are needed. Be sure to maintain an adequate distance between the i^3 and noisy devices such as relays, motor starters, etc.

3.6.6 Shock and Vibration

The i^3 has been designed to operate in typical industrial environments that may inflict some shock and vibration on the unit. For applications that may inflict excessive shock and vibration please use proper dampening techniques or relocate the i^3 to a location that minimizes shock and/or vibration.

3.6.7 Panel Layout Design and Clearance Checklist

The following list provides highlights of panel layout design factors:

___ Meets the electrical code and applicable standards for proper grounding, etc.?

___ Meets the panel manufacturer's requirements for grounding, etc.?

___ Is the panel box properly connected to earth ground? Is the panel door properly grounded? Has the appropriate procedure been followed to properly ground the devices in the panel box and on the panel door?

___ Are minimum clearance requirements met? Can the panel door be easily opened and closed? Is there adequate space between device bases as well as the sides of the panel and wiring ducts?

___ Is the panel box deep enough to accommodate the i^3 ?

___ Is there adequate ventilation? Is the ambient temperature range maintained? Are cooling or heating devices required?

___ Are noise suppression devices or isolation transformers required? Is there adequate distance between the base of the i^3 and noisy devices such as relays or motor starters? Ensure that power and signal wires are not routed in the same conduit.

___ Are there other requirements that impact the particular system, which need to be considered?

NOTES

CHAPTER 4: ELECTRICAL INSTALLATION

Note: Each i^3 unit is sent with a datasheet in the box. **The datasheet is the first document you need to refer to for model-specific information related to i^3 models such as pin-outs, jumper settings, and other key installation information.** The web version of this manual has all of the i^3 datasheets attached to it. Visit our website to obtain datasheets, user documentation, and updates.

4.1 Grounding Definition

Ground: The term **Ground** is defined as a conductive connection between a circuit or piece of equipment and the earth. Grounds are fundamentally used to protect an application from harmful interference causing either physical damage such as by lightning or voltage transients or from circuit disruption often caused by radio frequency interference (RFI).

4.2 Ground Specifications

Ideally, a ground resistance measurement from equipment to earth ground is 0 ohms. In reality it typically is higher. IMO recommends *less than* fifteen (15) ohms resistance from our equipment to ground. Resistance *greater than* twenty-five (25) ohms can cause undesirable or harmful interference to the device.

4.3 How to Test for Acceptable Ground

In order to test ground resistance, a Ground Resistance Tester must be used. A typical Ground Resistance Meter Kit contains a meter, two or three wire leads, and two ground rods. Instructions are supplied for either a two-point or three-point ground test. **Figure 4.1** shows a two-point ground connection test.

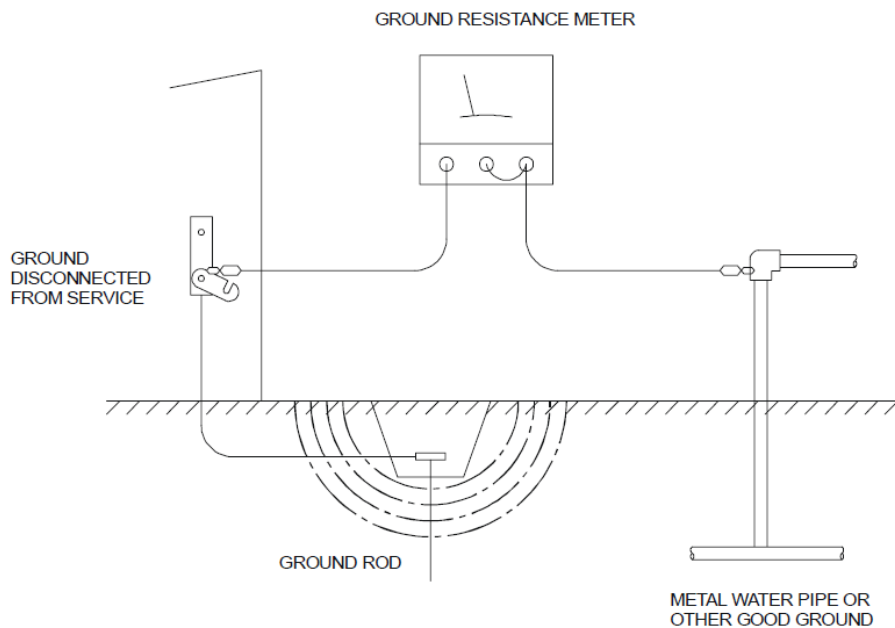


Figure 4.1 – Two Point ground connection test

4.4 Primary Power Port

<i>Table 4.1 – Primary Power Port Pins</i>		
Pin	Signal	Description
1	GND	Frame Ground
2	0V	Input power supply ground
3	+24V	Input power supply positive voltage

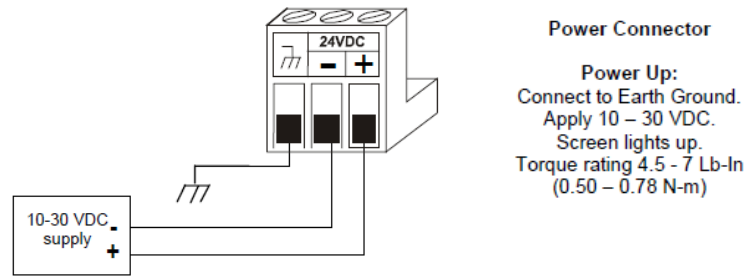


Figure 4.2 - Power Connector (Primary Power Port)

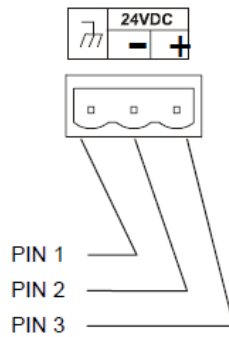


Figure 4.3 – Primary Power Port As Viewed Looking at the *i*³

CHAPTER 5: SERIAL COMMUNICATIONS

5.1 Overview

All *i*³ models provide two serial ports, which are implemented with 8-pin modular RJ45 connectors, and are labeled **MJ1** and **MJ2**. The MJ1 serial port is normally used for *i*³ programming by connecting it to the COM port of a PC running *i*³ Configurator. In addition, both MJ1 and MJ2 can be used for application-specific communication, using a variety of standard data exchange protocols.

5.2 Port Descriptions

The MJ1 serial port contains both a half-duplex RS-485 interface and an RS-232 interface with RTS/CTS handshaking. **Note: MJ1 shares its serial port with the optional COM module, so when an optional Ethernet or Modem COM module is installed and active, the MJ1 connector is inactive.**

The MJ2 serial port contains both a full-duplex RS-485 interface and an RS-232 interface with no handshaking. Both the MJ1 and MJ2 RS-485 interfaces provide switched termination and bias resistors internally.

5.3 Wiring

Figure 5.1 along with Table 5.1.0, Table 5.1 and Table 5.2 show how the MJ1 and MJ2 serial port pins are assigned.

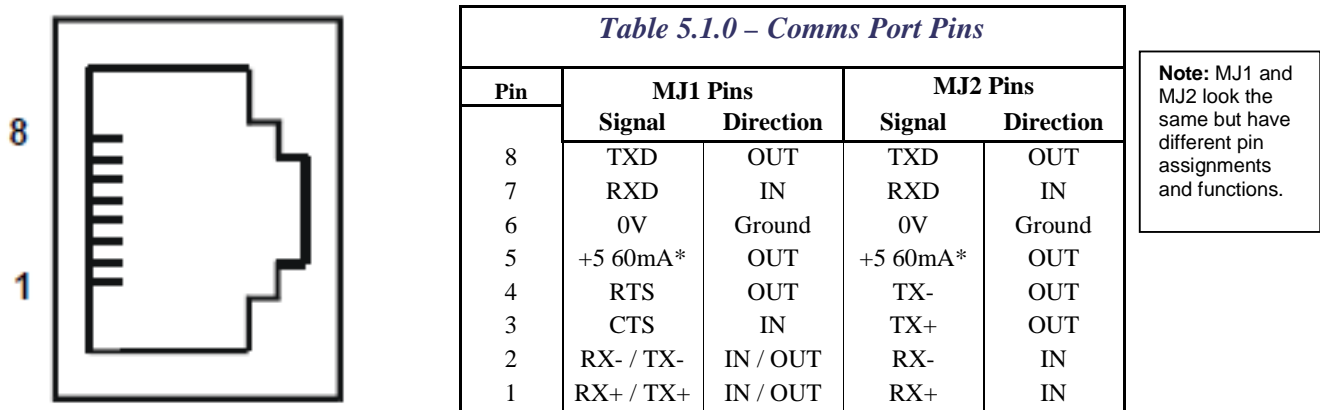


Figure 5.1 – MJ Serial Port Connector

Pin	Signal	Signal Description	Direction
1	RX/TX+	RS-485 Receive/Transmit Positive	In/Out
2	RX/TX-	Receive/Transmit Negative	In/Out
3	CTS ¹	RS-232 Clear to Send	Out
4	RTS ¹	RS-232 Request to Send	In
5	+5*	+5 VDC 60mA max	Out
6	0V	Ground	-
7	RD ¹	RS-232 Receive Data	In
8	TD ¹	RS-232 Transmit Data	Out

Pin	Signal	Signal Description	Direction
1	RX+	RS-485 Receive Positive	In
2	RX-	RS-485 Receive Negative	In
3	TX+	RS-485 Transmit Positive	Out
4	TX-	RS-485 Transmit Negative	In
5	+5*	+5 VDC 60mA max	Out
6	0V	Ground	-
7	RD ¹	RS-232 Receive Data	In
8	TD ¹	RS-232 Transmit Data	Out

Pin #	Signal	Pin #	Signal
1	FG	14	+RTS
2	TXD	15	Not Used
3	RXD	16	Not Used
4	RTS	17	-RTS
5	CTS	18	-CTS
6	Not Used	19	+CTS
7	SG	20	Not Used
8	Not Used	21	Not Used
9	+5V	22	Not Used
10	0V	23	Not Used
11	Not Used	24	+RD
12	+SD	25	-RD
13	-SD		

¹Signals are labeled for connection to a DTE device
 * +5 on *i*³ A Rev E and later, present on all revisions *i*³ B and *i*³ C.

Examples

<i>MJ2 - Full Duplex Mode</i>		
Pin	MJ2 Pins	
	Signal	Direction
8	-	-
7	-	-
6	0V	Ground
5	-	-
4	TX-	OUT
3	TX+	OUT
2	RX-	IN
1	RX+	IN

<i>MJ2 - Half Duplex Mode</i>		
Pin	MJ2 Pins	
	Signal	Direction
8	-	-
7	-	-
6	0V	Ground
5	-	-
4	-	-
3	-	-
2	TX-/RX-	IN/OUT
1	TX+/RX+	IN/OUT

* +5 on *i*³A Rev E and later, present on all revisions *i*³B and *i*³C.

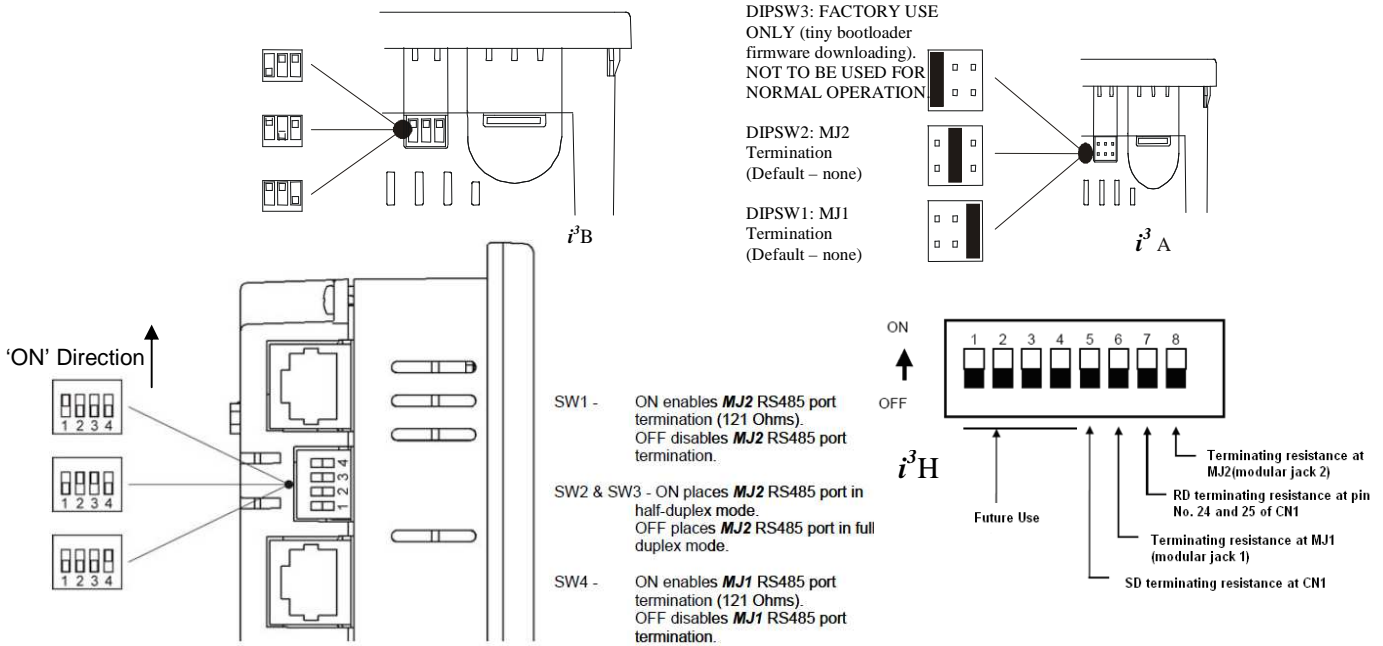


Figure 5.2.0 – MJ *i*³ Serial Port Connectors and DIP Switches for RS-485 Port Termination

5.4 RS-485 Termination

Proper RS-485 termination minimizes reflections and improves reliability. Both serial ports allow an internal RS-485 termination resistor to be placed across pins 1 and 2 by DIP Switch Setting. Only the two devices physically located at the endpoints of the RS-485 network should be terminated.

5.5 RS-485 Biasing

RS-485 biasing passively asserts a line-idle state when no device is actively transmitting, which is useful for multi-drop RS-485 networking. Both serial ports allow internal RS-485 bias resistors to be switched in, pulling pin 1 up to 3.3V and pulling pin 2 down to ground. The Set Serial Ports item in the System Menu can be used to enable RS-485 biasing. Also, an application graphics screen that writes to %SR164 can do the same thing. Setting %SR164.1 enables MJ1 biasing and setting %SR164.2 enables MJ2 biasing. If biasing is used, it should be enabled in only one of the devices attached to the RS-485 network.

5.6 *i*³ Configurator Programming via Serial Port

The *i*³ MJ1 serial port supports *i*CAN Programming Protocol, but MJ2 does not. If a PC COM port is connected to the *i*³ MJ1 serial port, *i*³ Configurator can access the *i*³ for programming and monitoring.

5.7 Ladder-Controlled Serial Communication

Using Serial Communication function blocks, both MJ1 and MJ2 support Generic, Modbus Master and Modbus Slave Protocols. In addition, external modems can be connected and accessed using Init, Dial and Answer Modem function blocks.

5.8 Extra Serial Communication Protocols

Both MJ1 and MJ2 also support protocols such as IMO G-Series Link, Allen Bradley DF1, *i*CAN Master, GE Fanuc SNP and Modbus Master.

NOTES

CHAPTER 6: CAN COMMUNICATIONS

Note: For additional CAN information, refer to the CAN Tutorial on our website.

6.1 Overview

All *i*³C, *i*³B models provide a CAN networking port, which is implemented with a 5-pin connector. The connector is labeled **NET1**. Two models of the more basic *i*³A model provide a CAN networking port.

Like the MJ1 serial port, the NET1 port can be used for *i*³ programming by connecting it to the CAN port of a PC running *i*³ Configurator. The NET1 port also allows the *i*³ to exchange global data with other *i*³ controllers.

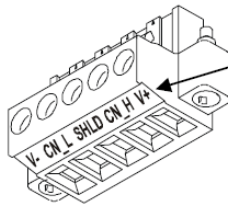
Two protocols are available for the CAN port – iCAN (IMO's own protocol) and CANopen. Due to the large memory requirement of CANopen a special firmware must be downloaded into the *i*³ before operation, select the CANopen option from the firmware update wizard in *i*³ Configurator. For further instruction on CANopen, see the CAN Tutorial on the website.

6.2 Port Description

The *i*³ NET1 port implements the ISO 11898-2 physical layer and the CAN 2.0A data link layer standards. Also, since the NET1 port is powered by an internal isolated power supply, external CAN power is not required.

6.3 CAN (NET1) Port Wiring

CAN Connector
Use the CAN Connector when using *i*CAN network.
Torque rating 4.5 – 7 Lb-In
(0.50 – 0.78 N-m)



Note: The V+ connection is not required on the *i*³. The *i*³ network port is self-powered. Supporting devices can require this connection, and this pin can be used to land the extra wire required for those devices.

Figure 6.2 - NET1 Port Connector

Table 6.1 - NET1 Port Pin Assignments

Pin	Signal	Signal Description	Direction
1	V-	CAN Ground	-
2	CAN_L	CAN DATA LOW	In/Out
3	SHIELD	Shield Ground	-
4	CAN_H	CAN DATA HIGH	In/Out
5	NC	Not Connected	-

6.4 *i*³ Configurator Programming via CAN

The NET1 port supports *i*CAN Programming Protocol. If a PC has a CAN interface installed (via PCI card or USB), and the PC CAN port is connected to the *i*³ NET1 port, *i*³ Configurator can access the *i*³ for programming and monitoring.

In addition, the *i*³ supports single-point-programming of all *i*³ that are connected to a CAN network. If the PC COM port is connected to the *i*³ MJ1 serial port, the *i*³ can act as a pass-through gateway allowing *i*³ Configurator to access all *i*³ devices that are attached to the CAN network.

6.5 Ladder-Controlled CAN Communication

Using Put and Get Network Words function blocks, the NET1 port can exchange digital and analogue global data with other *i*³ attached to the CAN network.

In addition, Put and Get Network Heartbeat function blocks allow nodes on the CAN network to regularly announce their presence and to detect the presence (or absence) of other nodes on the network.

6.6 Using CAN for I/O Expansion (Network I/O)

Connecting Network I/O devices to the NET1 port, allows the *i*³ I/O to be economically expanded and distributed. A variety of Modules is available for this purpose. **Note:** These special *i*CAN remote I/O devices are not currently stocked under IMO's range of Smart I/O. Therefore these must be manufactured to order.

NOTES

CHAPTER 7: COMMUNICATION OPTIONS

7.1 Overview

To supplement the built-in MJ1 and MJ2 serial ports, additional communication options are available. This is accomplished by installing a COM module internal to the *i*³ controller.

*7.1.1 MJ1 shares its serial port with the optional COM module, so when an Ethernet or Modem COM module is installed and active, the MJ1 connector is inactive (this does not apply to embedded Ethernet models). Internal to the *i*³, there is a CPU board, and up to two installed modules. All models have an I/O module in Slot 1 and could have a user-installed COM module in Slot 2. This chapter briefly describes both the Ethernet and Modem COM module options. For detailed information regarding these modules, please refer to the individual documents provided with the modules.*

7.2 Embedded Ethernet (i3C12Z/*****-SEHF ONLY and all i3H models)

Note: Embedded Ethernet provides enhanced functionality compared to the Ethernet expansion option.

7.2.1 Ethernet Module Protocols and Features

The following table describes the Ethernet Module Protocols and features supported by the i3C.

Protocol / Feature	Protocol / Feature Description
ICMP Ping	Internet Control Message Protocol
EGD (Peer)	GE Fanuc Ethernet Global Data
SRTP Server	GE Fanuc Service Request Transfer Protocol
iCAN TCP Server	IMO iCAN over Ethernet
Modbus TCP Slave	Modbus over Ethernet
Ethernet / IP Server	ODVA CIP over Ethernet
FTP Server	File Transfer Protocol
HTTP Server	HyperText Transfer Protocol (Web Server)

7.2.2 Ethernet System Requirements

Full Ethernet functionality requires:

1. PC running *i*³ Configurator Software Version 8.8 with upgrade or later (for configuration).
2. *i*³C controller with onboard Ethernet port.
3. FTP & HTTP protocols.

7.2.3 Ethernet Module Specifications

Speeds	10 BaseT Ethernet (10-Mbps)
	100 BaseTx Fast Ethernet (100-Mbps)
Modes	Half or Full Duplex
Auto-Negotiation	Both 10/100-Mbps and Half/Full Duplex
Connector Type	Shielded RJ-45
Cable Type (Recommended)	CAT5 (or better) UTP
Port	Auto MDI/MDI-X

7.2.4 Ethernet Module Configuration

Note: The following configuration is required for all applications regardless of the protocols used. Additional configuration procedures must be performed for each protocol used. To configure the Ethernet Module, *i*³ Configurator Software to perform the following steps:

1. On the main *i*³ Configurator screen, select the **Controller** menu and its **I/O Configure** sub-menu to open the I/O Configuration dialog (Figure 7.2.1)
2. If configuring a different *i*³ Model than the one shown in the I/O Configuration dialog, click on the topmost **Config** button, select the desired *i*³ Model, and then click **OK**.

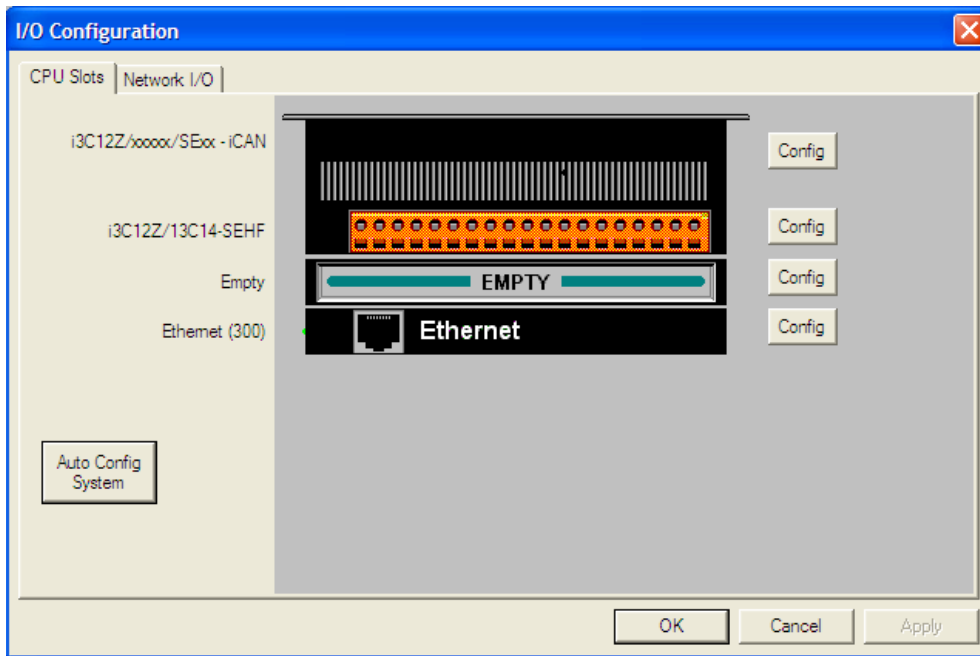


Figure 7.2.1 – I/O Configuration Dialog

3. Click the **Config** button to the right of the Ethernet Module, and then select the Module Setup tab, revealing the Ethernet Module Configuration dialog as shown in figure 7.2.2

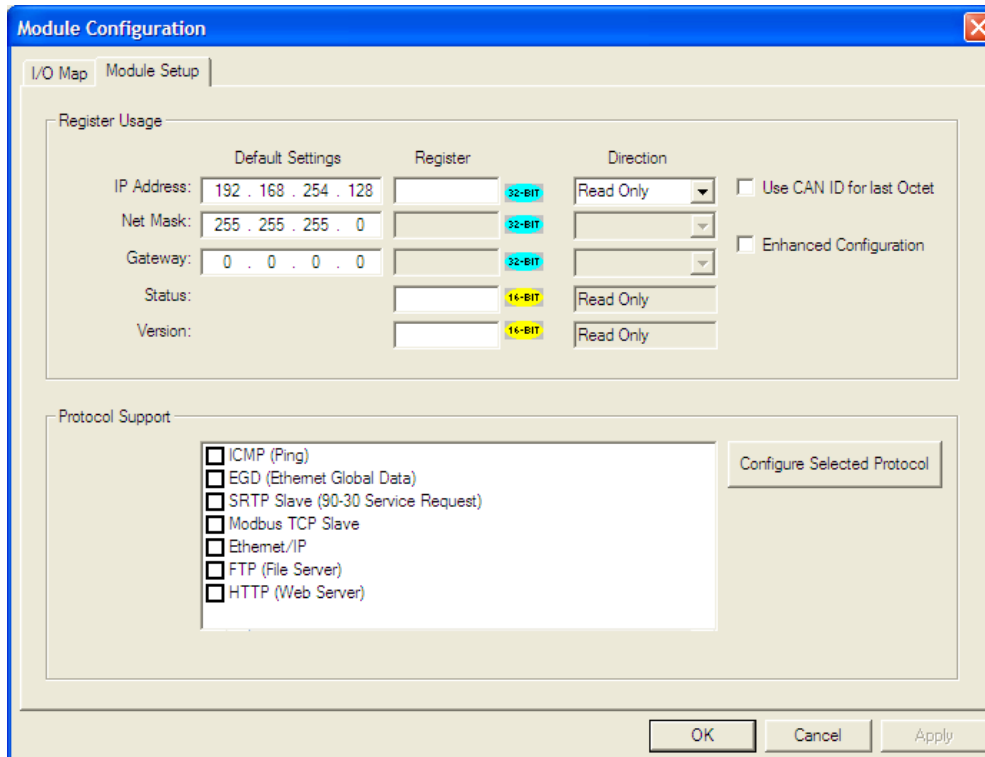


Figure 7.2.2 – Ethernet Module Configuration

4. Configure the Ethernet Module parameters as follows:

IP Address: Enter the static IP Address for the Ethernet Module being configured.

Note: IP Addresses are entered as four numbers, each ranging from 0 to 255. These four numbers are called octets and they are always separated by decimal points.

Net Mask: Enter the Net Mask (sometimes called Subnet Mask) being used by all nodes on the local network. Typical local networks use Class C IP Addresses, in which case the low octet (rightmost number) is used to uniquely identify each node on the local network. In this case, the default Net Mask value of 255.255.255.0 should be used.

Gateway: Enter the IP Address of a Gateway Server on the local network that allows for communication outside of the local network. To prevent the Ethernet Module from communicating outside the local network, set the Default Gateway IP Address to 0.0.0.0 (the default setting).

Status Register: Enter an i^3 Register reference (such as %R100) to indicate which 16-bit i^3 register will have the Ethernet Status word written to it. Table 7.2 shows how this register value is formatted and explains the meaning of each bit in the Status Word.

Table 7.2 - Ethernet Status Word Register Format

High Byte								Low Byte							
Bit 16	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
0	0	Dup	Spd	0	Rx	Tx	Link	TCP Connections							
Status Bit(s)		Status Indication						Status Values							
								Minimum		Maximum					
0		Reserved						Always 0							
Dup		Link Duplex (Auto-Negotiated)						0 = Half Duplex		1 = Full Duplex					
Spd		Link Speed (Auto-Negotiated)						0 = 10 MHz		1 = 100 MHz					
Rx		Receive State						0 = Inactive		1 = Active					
Tx		Transmit State						0 = Inactive		1 = Active					
Link		Link State						0 = Down		1 = Up					
TCP Connections		Total Number of Active TCP Connections (i CAN, SRTTP, Modbus, EIP, FTP, HTTP)						0		40					

Version Register: Enter an i^3 Register reference (such as %R101) to indicate which 16-bit i^3 register will have the Ethernet Firmware Version written to it. The value stored in the Version Register is: (Ethernet Firmware Version * 100). For example, for Ethernet Firmware Version 4.30, the Version register will contain 430.

Ethernet Module Register Usage - Standard Configuration

To perform Standard Configuration, simply leave the Enhanced Configuration checkbox unchecked. In this case, **Net Mask** and **Gateway** cannot be assigned to i^3 registers, while **IP Address**, **Status** and **Version** must be assigned to i^3 registers. Note that the assigned IP Address register's **Direction** can be set to **Read only** or **Read / Write**. If the register is Read only, the Default IP Address becomes the unit's IP Address and is loaded into the assigned register, where it can be read by the application. (Note: In this case, the low octet of the IP Address can be replaced with the unit's CAN Network ID, by checking the **Use CAN ID for last Octet** checkbox.)

If the register is Read / Write, the application should write an IP Address to the assigned register, and this value will then be the unit's IP Address. (In this case, the Default IP Address is used only if communication is lost during an I/O configuration download; otherwise the Default IP Address is ignored.)

Ethernet Module Register Usage - Enhanced Configuration

To perform Enhanced Configuration, first check the Enhanced Configuration checkbox. In this case, **IP Address**, **Net Mask**, **Gateway**, **Status** and **Version** can all be optionally assigned to registers. By default, the register edit boxes are empty indicating that no registers are assigned.

As with the IP Address register (described in the Standard Configuration section above), Net Mask and Gateway register **Directions** can be set to **Read Only** or **Read / Write**.

Ethernet Module Register Usage – General

For the Status and Version registers (if configured), the Direction settings are always Read Only.

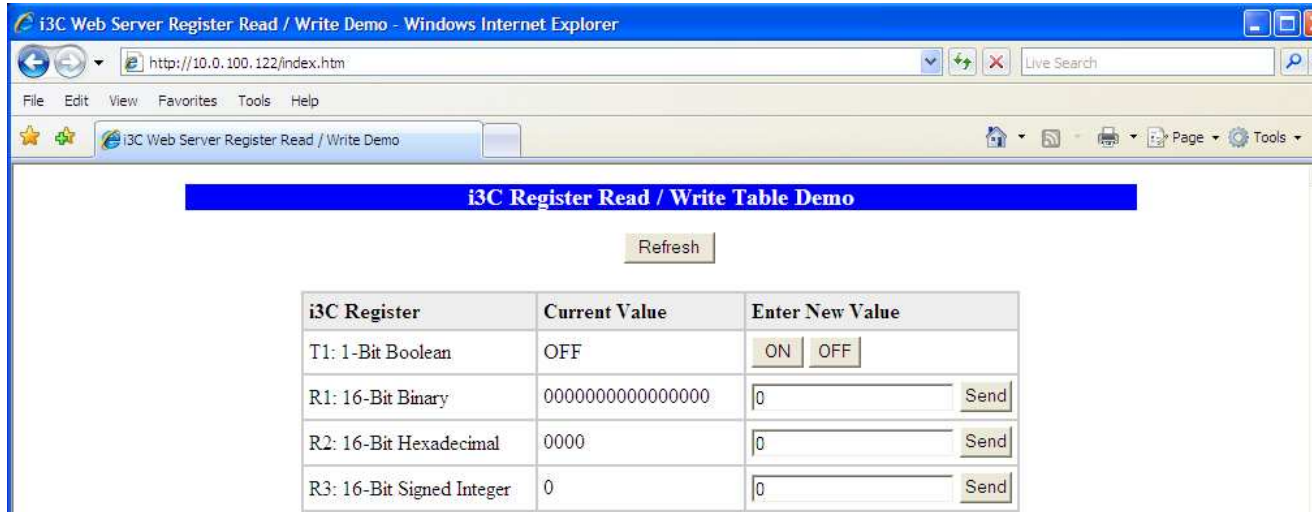
The **Use CAN ID for last Octet** checkbox does not affect Net Mask, Gateway, Status or Version configuration.

Ethernet Module Protocol Configuration

The Protocol Support area contains a list of all the protocols supported by the platform being configured. To activate a protocol, check its checkbox.

For protocols that require additional configuration, click on a listed protocol to select it and then click the Configure Selected Protocol button. This will open a new dialog with configuration options for the selected protocol.

If HTTP (Web Server) is configured, please note that a Micro SD card must be present in the unit for this function. Configure your web pages using any compatible editor (MS Word, MS Publisher etc) to generate the .HTM files. Copy these to the Micro SD card root directory. Open Internet Explorer, type the IP address of the unit into path including the file name i.e. In this case <http://10.0.100.122/index.htm>



For detailed information on individual protocol configuration refer latest version of *i*³ Ethernet(300) Tutorial.

7.3 Ethernet COM Module *i*³-E Option (All Models)

An Ethernet COM module can be installed to allow *i*³ Configurator programming of an *i*³ over a Local Area Network or over the Internet. In addition, the IMO OPC Server can be installed on a PC to allow other standard PC applications (such as database and spreadsheets programs) access to *i*³ register data.

The Ethernet COM module supports 10 BaseT (10 MHz) and 100 BaseTx (100 MHz) as well as both half and full duplex communication. Both the connection speed and the duplex are auto-negotiated. Although the physical connection between the Ethernet COM Module and the Local Area Network is done using a standard Ethernet cable (CAT5 or better with RJ45 modular plug), a **Serial Port Tunnel** protocol is employed that makes the Ethernet COM Module appear as a serial port to *i*³ Configurator or OPC Server software running on the PC. On the *i*³ end of the Serial Port Tunnel, the Ethernet COM module should be properly configured using the *i*³ System Menu. This configuration consists of making Ethernet the Default Programming Port and setting its target IP Address, Net Mask and optionally the Gateway IP Address. The Gateway IP Address is required if the *i*³ will be accessed from outside the Local Area Network (e.g. the Internet).

On the PC end of the Serial Port Tunnel, the PC should be connected to the Local Area Network (or to the Internet).

After installing and configuring the Ethernet COM module, *i*³ Configurator or OPC Server software should be set up to communicate to one of the “virtual” serial ports, at which point they should function as if a “real” PC serial port was connected to the *i*³ **MJ1** serial port.

7.4 Modem COM Module *i*³-M Option (All Models)

A Modem COM module can be installed to allow *i*³ Configurator programming over a GSM/GPRS network. In addition, the application ladder program can take control of the modem for application specific modem communication.

To enable *i*³ Configurator programming via a dial-up network, the Modem COM module should first be configured as the Default Programming Port, using the *i*³ System Menu (see CHAPTER 11). Doing this puts the Modem COM module in auto-answer mode, so *i*³ Configurator can call the *i*³ via a remote modem.

To program the ladder application to communicate via the Modem, standard *i*³ Configurator Serial and Modem function blocks can be used.

Note: The SMS functionality of the modem works only when the GSM/GPRS data stream is disconnected. The two functions cannot operate simultaneously.

	GSM Data Communication	GPRS Data Communication
SIM Card	Data/Fax services must be enabled. This usually requires a one-off payment to the service provider, creating a second phone number for data services, leaving SMS and voice for the other.	Requires Static or Private IP address. Static IP – unsecured. Private IP – secured via VPN. Specialist service providers can offer these services with global coverage.
SMS Messaging	Can be used when Dial-up connection is disconnected and idle for a timed period.	Can be used when data is idle for a timed period.
Costing	After the one-off set-up charge, data is usually charged per Megabyte.	There is usually an initial set-up fee, then a monthly rental for IP address, and data is usually charged per Gigabyte.
Recommended usage	Occasional Dial-ups for quick fault finding/remote support, or uploading small amounts of data from the <i>i</i> ³ controller.	Always on data connection, suitable for Data-logging through SCADA/OPC Server, remote fault finding, uploading of large amounts of data from the <i>i</i> ³ Controller.
Advantages	Easy initial set-up. Up to 9600bps data rate.	Up to 38400bps data rate. Much lower cost per data packet. Always-on connection, no dial-up just a network/internet connection required.
Limitations	Making program changes or downloading programs remotely should be done with extreme caution! Any software connecting to the modem must have dial-up capability.	Making program changes or downloading programs remotely should be done with extreme caution! Supports only one incoming or outgoing connection at one time.

For diagrams to better understand the differences between GSM/GPRS connections please see below.

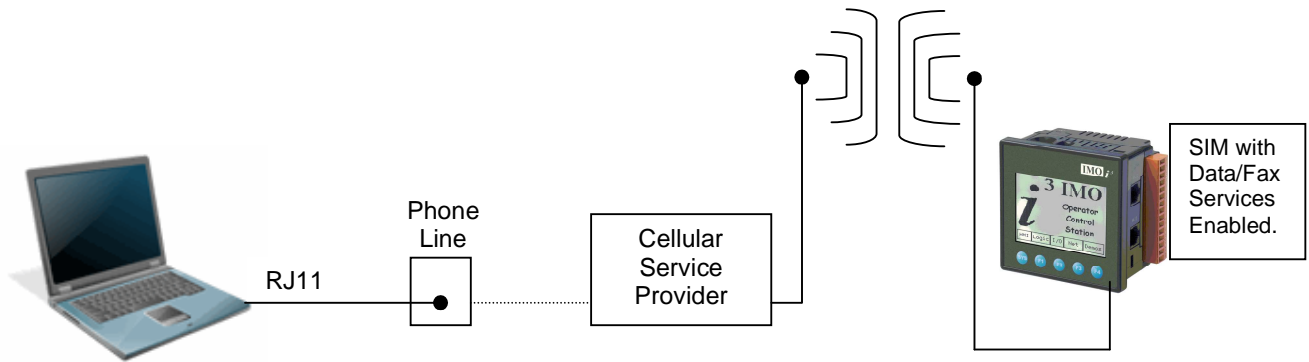


Figure 7.3.1 – GSM Data

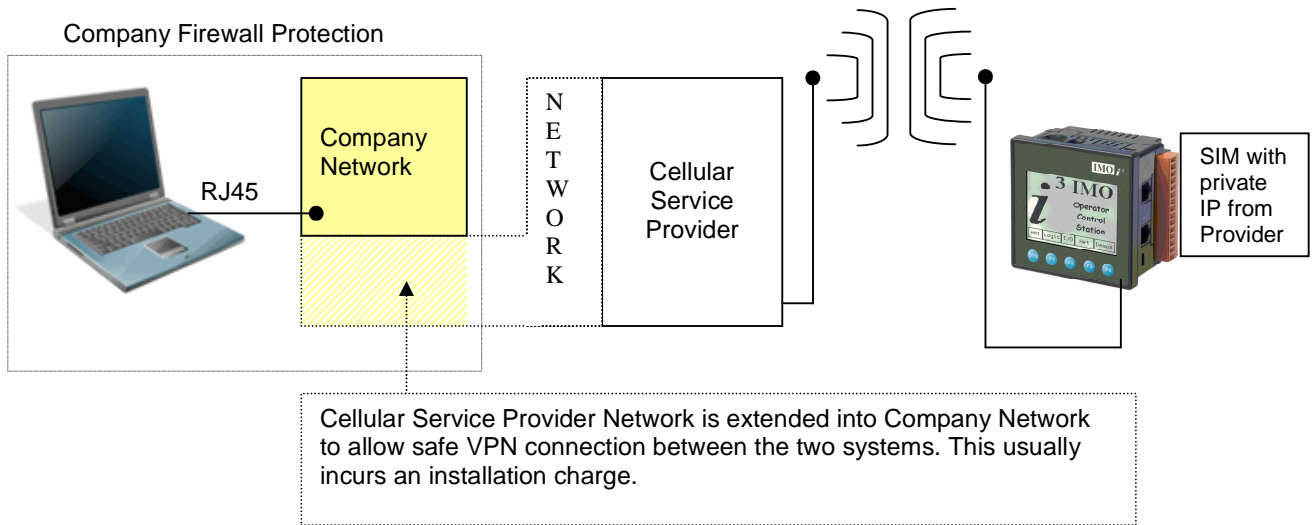


Figure 7.3.2 – GPRS Data (Private IP)

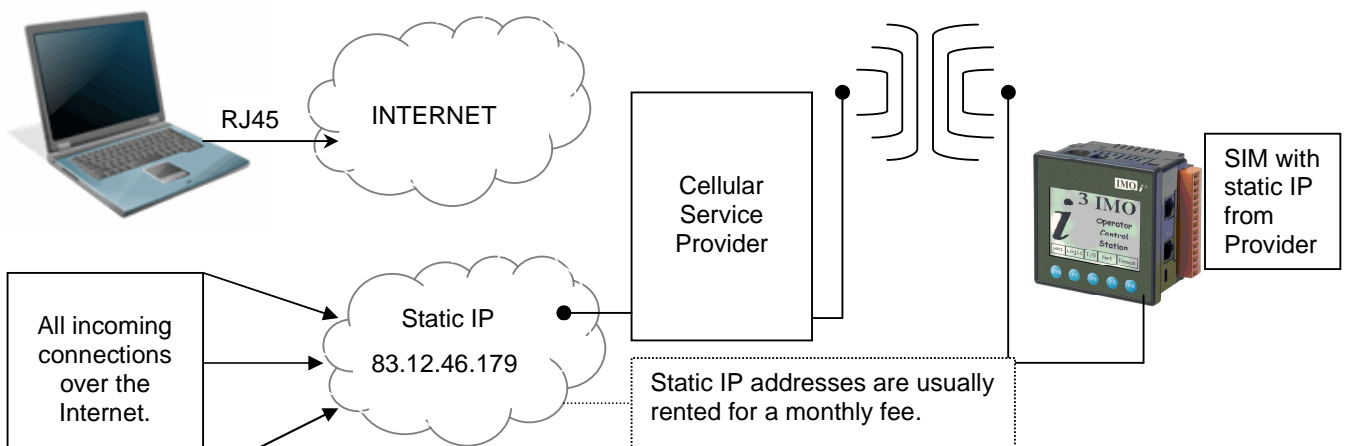


Figure 7.3.3 – GPRS Data (Static IP)

CHAPTER 8: REMOVABLE MEDIA

8.1 Overview

All *i*³C, *i*³B and *i*³A(F) models provide a Removable Media slot, labeled **Memory Card**, which supports standard Micro SD (IMO Recommends using SanDisk™ media only) Flash memory cards. Micro SD cards can be used to save and load applications, to capture graphics screens and to log data for later retrieval.



Figure 8.1 – Removable Micro SD Memory Card Slot

8.2 Micro SD Cards

When the Micro SD card format was introduced, it was originally called TransFlash. Cards labeled either Micro SD or TransFlash from SanDisk™, with up to 2 GB of Flash memory are compatible with the *i*³ Memory slot. The Memory slot is equipped with a “push-in, push-out” connector and a Micro SD card can be safely inserted into the Memory slot whether the *i*³ power is On or Off. *To install a Micro SD card:* Align its 8-pin gold edge connector down, facing the front of the *i*³ unit as shown in **Figure 8.2**; then carefully push it all the way into the Memory slot. Ensure that it clicks into place.

To remove the Micro SD card: Push down on the top of the card gently to release the spring.



Figure 8.2 – Installing Removable Memory Card

8.3 Micro SD File System

The Micro SD Memory slot uses the PC-compatible FAT16 File System. This means that a PC, with a Micro SD-compatible card reader, can read files that have been written by the *i*³ and can write files that can be read by the *i*³.

However, the *i*³ does not support long filenames, but instead implements the 8.3 filename format.

This means that all file and directory names must consist of up to 8 characters, followed by an optional dot, and an optional extension with up to 3 characters.

Directories and sub-directories can be nested up to 16 levels deep as long as each pathname string does not exceed 147 characters. FAT16 also supports no more than 512 files per folder or 65535 files on the entire disk.

8.4 Using the Removable Media Manager

The Removable Media Manager is an interactive *i*³ screen that performs the following functions:

- a. Display number of total and free bytes

- b. Browse file and directory lists
- c. Delete files and directories
- d. Format a Micro SD card
- e. Load and save application programs
- f. View screen capture bitmaps

The Removable Media Manager can be accessed via the System Menu or by using *i*³ Configurator to place a Removable Media Manager object on an application graphics screen.

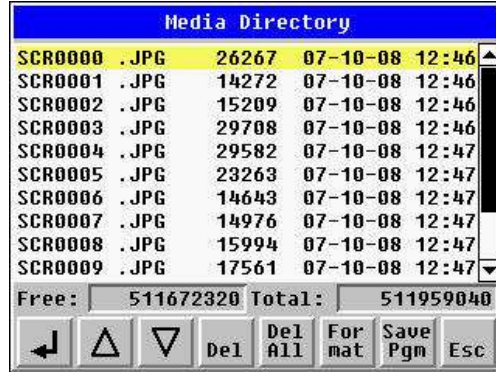


Figure 8.3 – *i*³ Removable Media Submenu (*i*³C menu shown)

8.5 Using Removable Media to Log Data

Using Read and Write Removable Media function blocks, an application ladder program can read and write *i*³ register data in the form of comma-delimited files, with a .CSV extension. These files are compatible with standard database and spreadsheet PC programs. In addition, an application ladder program can use Rename and Delete Removable Media function blocks to rename and delete files.

8.6 Using Removable Media to Load and Save Applications

A special file type, with a .PGM extension, is used to store *i*³ application programs on Micro SD. To load an application from Micro SD to the *i*³, use the Removable Media Manager (open the Removable Media Manager in the System Menu) to find and highlight the desired .PGM file, and then press the Enter key. [Enter]

To save an application from the *i*³C to Micro SD, open the Removable Media Manager in the System Menu and press the Save Pgm [Save Pgm] function key. The application will be saved in a file called **DEFAULT.PGM** in the Micro SD root directory.

Note: Saving an application to Micro SD can only be done from the Removable Media System Menu and is not available on a Removable Media Manager object that was placed on an application graphics screen by *i*³ Configurator. *i*³ Configurator can also save an application directly to a Micro SD card, which is plugged into the PC's Micro SD compatible card reader by selecting the Export to Removable Media item on the *i*³ Configurator File menu.

8.7 Using Removable Media to View and Capture Screens

The *i*³ File System uses bitmap files with the .BMP (.bmp) extension to store *i*³ graphic screen captures.

To view a captured *i*³ screen, use the Removable Media Manager to find and highlight the desired .BMP file, and then press Enter. To capture an *i*³ screen, turning on the assigned **Screen Capture Control Register** will capture the current *i*³ graphics screen and write it to the Micro SD card using the assigned **Screen Capture Filename**. Before capturing an *i*³ screen, *i*³ Configurator must first be used to assign a **Screen Capture Control Register** and **Filename** in the application. To do this, first open the Graphics Editor by selecting the **View / Edit Screens** item on the *i*³ Configurator **Screens** menu. Next select the **Screen Capture** item of the Graphics Editor Config menu and then enter a **Control Register** and **Filename**.

NOTES

CHAPTER 9: GENERAL I/O

Note: Each i^3 unit is sent with a datasheet in the box. The datasheet is the first document you need to refer to for model-specific information related to i^3 models such as pin-outs, jumper settings, and other key installation information. The web version of this manual has all of the i^3 datasheets attached to it. Visit our website to obtain datasheets, user documentation, and updates.

9.1 Overview

The i^3 is a compact unit that contains high density, very versatile I/O. Using the I/O properly requires wiring to the proper terminals, configuring jumpers inside the i^3 unit and configuring i^3 Configurator properly. This section will offer some tips and suggestions to configure the I/O properly. For the register mapping of the I/O, refer to the [Index](#) at the end of this manual for the pages referencing register mapping.

9.2 Removing the I/O Cover

Some I/O configurations require jumper settings to be changed inside the i^3 unit. Examples of these settings are setting positive or negative logic on digital inputs or setting current or voltage on analogue inputs. Each i^3 I/O jumper is set to a factory default. Refer to the data sheet for your i^3 model to find the default setting to determine if a jumper change is necessary for your application. To remove the I/O cover of the i^3 , remove the four (4) Phillips screws from the I/O back. It may help to place the i^3 unit face down on a clean work surface. Once the four screws are removed the I/O cover can be lifted straight off.

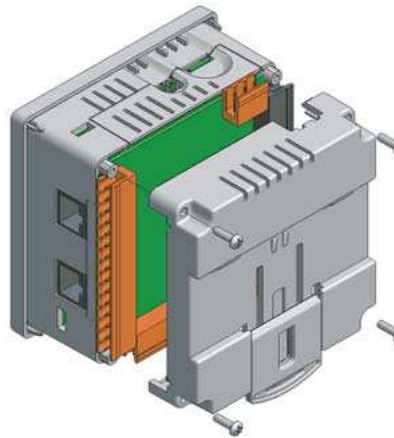


Figure 9.1 – Removing the I/O Cover

WARNING: Power, including I/O power *must be removed* from the unit prior to removing the back cover. Failure to do so could result in electrocution and/or damage to equipment.

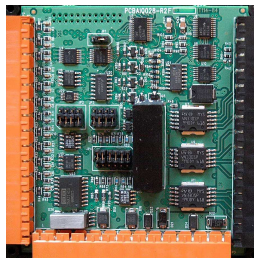


Figure 9.2 – I/O Cover Removed (sample I/O board)

Once the back is removed the jumper selection can be changed. The jumper settings are documented on each data sheet using a diagram such as Figure 9.4 below and a description of the jumper settings.

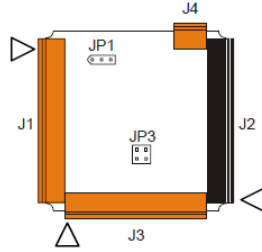


Figure 9.4 – Example Jumper Diagram

To re-install the cover, place the I/O cover back on the unit.

Place the screw back into the hole and turn the screw slowly counter clockwise until it clicks into the threads. This prevents the screw from being cross-threaded. Now turn the screw clock-wise until the cover is firmly secured. Repeat this process for all four (4) screws.

9.3 Model and I/O Overview

<i>Table 9.1 – I/O and Model Overview Model</i>						
Model	Solid State Digital Outputs	Relay Outputs	Digital Inputs	Analogue Input(s)	Universal Analogue Inputs	Analogue Outputs
i3A12X/10A01-SOO		6	12	1		
i3A12X/10B04-SCH	12		12	2		
i3A12X/10D03-SCH		6	12	4		
i3B12Y/10D03-SCHF		6	12	4		
i3C12Z/10D03-SCHF		6	12	4		
i3A12X/20B05-SOH	16		24	2		
i3B12Y/20B05-SCHF	16		24	2		
i3C12Z/20B05-SCHF	16		24	2		
i3A12X/13C14-SOH	12		12		2	2
i3B12Y/13C14-SCHF	12		12		2	2
i3C12Z/13C14-SCHF	12		12		2	2

Table 9.1 shows the different types of I/O included with the various i³ models. Specific specifications, jumper settings and wiring diagrams can be found on the in-box data sheets. Descriptions and applications of the different type of I/O can be found below. Models without in-built I/O are also available, ask at IMO. For a full details please see page 41.

9.4 Solid-State Digital Outputs

Solid-state digital outputs are generally used to activate lamps, low voltage solenoids, relays and other low voltage and low current devices.

Note: The digital outputs used on the i³ are “sourcing” outputs. This means the output applies a positive voltage to the output pin when turned ON. When turned off, the output applies approximately zero volts with respect to the I/O ground.

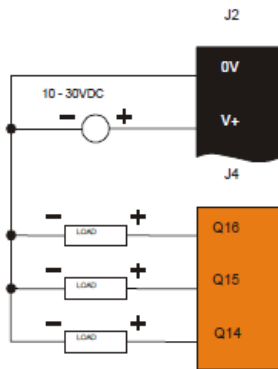


Figure 9.5 – Typical Output Wiring

The digital outputs used in the i^3 have electronic short circuit protection and current limiting. While these electronic protections work in most applications, some application may require external fusing on these outputs. The digital outputs in the i^3 are typically controlled via %Q bits in the register mapping. Some of the outputs are designed for high-speed applications and can be used for PWM or frequency output applications. Please see the data sheet and the chapter on High Speed I/O for additional information. When the controller is stopped the operation of each output is configurable. The outputs can hold the state they were in before the controller stopped or they can go to a predetermined state. By default digital outputs turn off. For more information on stop state see the [Index](#) to find pages referencing i^3 Configurator settings. The digital outputs feature an output fault bit. %I32 will turn on if any of the outputs experience a short circuit, over-current or the output driver overheats.

9.5 Relay Outputs

Relay outputs are designed to switch loads that typically have high voltage or current requirements or require isolation that relays provide.

Note: The design of the i^3 does not require external coil power for the relays to function. The relays will activate anytime the i^3 is powered.

There are several factors that should be considered when using relays.

Relay Life – Relays are mechanical devices that have a long but limited life. Typically, switching more current limits the life of relays. Please check the data sheets at the end of this manual for expected relay life.

Current / Temperature De-Rating – Products containing relays often have total current limits based on the ambient temperature of the application. Please see the product data sheet for current / temperature de-rating information for relays.

Fusing – External fusing is generally required to protect the relays, devices and wiring from shorts or overloads.

WARNING: To protect the module and associated wiring from load faults, use external (5 A) fuse(s) as shown. Fuses of lower current or fusing for the entire system need to be in place to assure the maximum current rating of the unit is not exceeded.

WARNING: Connecting high voltage to any I/O pin can cause high voltage to appear at other I/O pins.

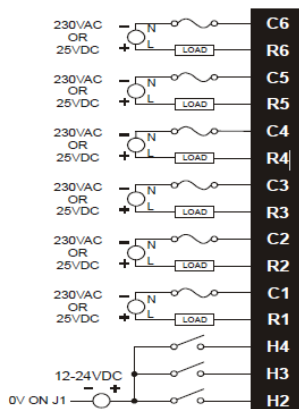


Figure 9.6 - Relay Fusing

Protection for Inductive Loads – Inductive loads can cause reverse currents when they shut off that can shorten the life of relay contacts. Some protective measures need to be determined by an engineer. Below you will find recommendations that will work for many applications. If you have additional questions on protection from inductive load, consult an application engineer or IMO Technical Support.

DC Loads – General purpose diode (IN4004) in reverse bias across the load.

AC Load – MOV (Harris V140xxx for 120V, V275xx for 220V)

Output State on Controller Stop

When the controller is stopped the operation of each output is configurable. The outputs can hold the state they were in before the controller stopped or they can go to a predetermined state. By default relay outputs turn off. For more information on stop state see the [Index](#) for i^3 Configurator settings pages.

9.6 Digital Inputs

Note: Refer to the datasheet for i^3 model you are using for details on jumper settings.

Note: The digital inputs on the i^3 are designed for low voltage DC inputs. The inputs are designed to support both positive and negative input modes. The mode is set by a jumper setting and by a parameter in i^3 Configurator. All the inputs on the unit must be configured to the same mode.

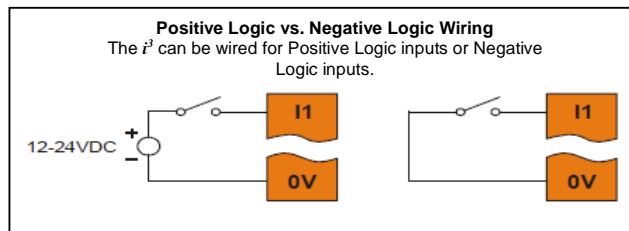


Figure 9.7 – Positive and Negative Inputs

In positive logic mode a positive voltage applied to the input will turn the input. The internal design of this mode is basically a resistor from the input to I/O ground. This mode is sometimes called sourcing. In negative logic mode, connecting the input to the I/O ground or zero volts will turn the input on. The internal design of this mode is basically a resistor from the input to the positive I/O voltage (usually 12 or 24 volts). This mode is sometime called sinking. Some of the digital inputs may support high-speed input functional such as counting or frequency measurement.

9.7 Analogue Inputs

Note: See the data sheet for the i^3 model you are using for jumper settings and see the appropriate page in this manual (see [Index](#)) for details on how to use i^3 Configurator to configure the digital filtering.

The analogue inputs on the i^3 allow voltage or current measurement from a variety of devices. The voltage or current mode is set through jumpers on the unit and settings in i^3 Configurator. Each channel can be separately configured for voltage or current mode. The analogue inputs have a digital filter that can be used to filter electrical noise that may be unavoidable in some installations. The downside to digital filtering is the inputs will respond more slowly to sudden changes in the actual input.

9.8 Universal Analogue Inputs

Note: See the data sheet for the i^3 model you are using for jumper settings and see the appropriate pages in this manual (see [Index](#)) for details on how to use i^3 Configurator to configure the digital filtering.

The universal analogue inputs provide a high resolution, very flexible interface for a variety of analogue inputs. These inputs include voltage, current, thermocouple, RTD and millivolt. Each channel can be configured separately using jumpers and configuration settings in i^3 Configurator.








Like the standard analogue inputs, these inputs have a digital filter that can be used to filter electrical noise that may be unavoidable in some installations. The downside to digital filtering is the inputs will respond more slowly to sudden changes in the actual input.

9.9 Analogue Outputs

Note: Refer to the datasheet for i^3 model you are using for details on jumper settings.

The analogue outputs on i^3 devices provide high-resolution voltage or current outputs. The voltage or current selection is controlled with jumpers and configuration settings in i^3 Configurator. Note that each channel can be separately configured for voltage or current mode.

When the controller is stopped the operation of each output is configurable. The outputs can hold the state they were in before the controller stopped or they can go to a predetermined value. By default analogue outputs are set to a value of zero. For more information on Stop State, refer to the appropriate pages (see [Index](#)) for the configuration chapter for i^3 Configurator settings.

	Part Number	Base Unit					I/O Options				Communication Options					
		Screen	Power	Colour	Keys	MicroSD Card* (up to 2GB)	Digital Inputs (10 - 30VDC)	Digital Outputs (0.5A)	Relay Outputs	Analogue Inputs	Analogue Outputs	Serial Ports	CAN Port	Native Ethernet	GSM Modem**	Ethernet Expansion**
	ENTRY LEVEL i3A12X/10A01-SOO	128x64 F Key	10-30V DC	2	20	SOOF*	12		6 (3A)	1x 10bit (V/mA)				i3-MA	i3-E	
	i3A12X/10B04-SCH	128x64 F Key	10-30V DC	2	20	SCHF*	12	12		2 x 10bit (V/mA)	2	1		i3-MA	i3-E	
	i3A12X/10D03-SCH	128x64 F Key	10-30V DC	2	20	SCHF*	12		6 (3A)	4 x 10bit (V/mA)	2	1		i3-MA	i3-E	
	i3A12X/20B05-SOH	128x64 F Key	10-30V DC	2	20	SOHF*	24	16		2 x 10bit (V/mA)	2			i3-MA	i3-E	
	i3A12X/13C14-SOH	128x64 F Key	10-30V DC	2	20	SOHF*	12	12		2x 14bit(TC/RTD/V/mA) 2x12bit V/mA	2			i3-MA	i3-E	
	i3B12Y/10D03-SCHF	160x128 Touch	10-30V DC	2	5	Y	12		6 (3A)	4 x 10bit (V/mA)	2	1		i3-MA	i3-E	
	i3B12Y/20B05-SCHF	160x128 Touch	10-30V DC	2	5	Y	24	16		2 x 10bit (V/mA)	2	1		i3-MA	i3-E	
	i3B12Y/13C14-SCHF	160x128 Touch	10-30V DC	2	5	Y	12	12		2x 14bit(TC/RTD/V/mA) 2x12bit V/mA	2	1		i3-MA	i3-E	
	i3C12Z/10D03-SCHF	320x240 Touch	10-30V DC	32768	6	Y	12		6 (3A)	4 x 10bit (V/mA)	2	1	SEHF*	Y	i3-MA	i3-E
	i3C12Z/20B05-SCHF	320x240 Touch	10-30V DC	32768	6	Y	24	16		2 x 10bit (V/mA)	2	1	SEHF*	Y	i3-MA	i3-E
	i3C12Z/13C14-SCHF	320x240 Touch	10-30V DC	32768	6	Y	12	12		2x14bit(TC/RTD/V/mA) 2x12bit V/mA	2	1	SEHF*	Y	i3-MA	i3-E
All models of i3 Controller are available without in-built I/O if not required, please ask automation@imopc.com																
Remote I/O (Modbus & iCAN)   	iOS/M04IPX-D1		10-30V DC							4x RTD (0.01C)				1		
	iOS/M08ICX-D1		10-30V DC							8x 16bit mA				1		
	iOS/M08IVX-D1		10-30V DC							8x 16bit V				1		
	iOS/M08ITX-D1		10-30V DC							8x TC (0.01C)				1		
	iOS/M04OXA-D1		10-30V DC								4x 14bit V/mA			1		
	iOS/M08OXV-D2		24V DC								8x 14bit V			1		
	iOS/M08BDR-D1		10-30V DC				4 NPN		4 (2A)					1		
	iOS/M12IDX-D1		10-30V DC				12 NPN							1		
	iOS/M12BDD-D2		24V DC				4 NPN	4 NPN						1		
	GSL-DT4A		24V DC				16 (24VDC)		16					1		
	GSL-RY2A		24V DC						16 (2A)					1		
	GSL-D24A		24V DC				32 (24VDC)							1		
	GCL-A21-A		24V DC							12x 14bit V/mA			1			
	GCL-AT1-A		24V DC							8x 14bit V/mA	4x 14bit V/mA			1		
	GCL-DT4A		24V DC				16 (24VDC)		16					1		
GCL-RY2A		24V DC						16 (2A)					1			
GCL-D24A		24V DC				32 (24VDC)							1			
	SMT-CD-R20	16x4 Chars	24V DC	2	4		8		8 (8A)	4x 12bit V			2			
	SMT-CD-AR20	16x4 Chars	24V DC	2	4		8		8 (8A)	4x 12bit V	2x 12bit V***		2			

*Replace Part Number Suffix

*** Via Exansion Module

** Modem and Ethernet card should be ordered seperately

CHAPTER 10: HIGH SPEED I/O (HSC / PWM)

10.1 Overview

In addition to the compliment of simple analogue and digital I/O, several of the i^3 I/O modules support High Speed Counting (HSC) I/O functions and may also support Pulse Width Modulation (PWM) Output functions. The HSC functions include: frequency, totalizing, pulse width and Quadrature measurement. The PWM functions include: traditional PWM (with variable rate and duty) and a stepper (limited functionality) with variable acceleration and deceleration rates. To determine function availability, refer to the associated model's Specification/Installation sheet (Digital DC Input/Output sections).

This chapter describes the operation of these high level I/O functions. For configuration details of these functions, see i^3 Configurator settings.

10.2 High Speed Counter (HSC) Functions

On units that support the HSC, four dedicated inputs are available than can be configured for one of four modes of operation. Those modes are Frequency, Count (totalize), Pulse width or period (pulse) and Quadrature measurement. For some modes, more than one HSC input may be consumed. The measurement value is provided to ladder in a %AI register (see mapping below).

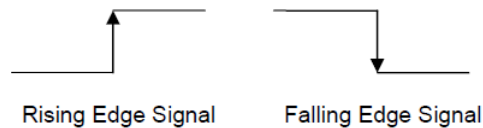
Note: While the high-speed input circuitry has a resolution of 1 μ s, measured edge transitions must not occur faster than 100 μ s for accurate measurements. Keep in mind that pulse width measurements utilize both the rising and falling edges of the waveform, thus the pulse width must exist longer than 100 μ s. Note that the edge polarity selection in the mode parameter for totalize and pulse width functions (Digital/HSC Input Configuration) assume Positive Logic regardless of the associated I/O board's jumper setting for the *Digital DC inputs polarity*. If Negative logic is configured when using these functions, the opposite edge polarity must be selected in the mode parameter.

10.2.1 Frequency

In frequency mode, the frequency of the input signal is written to the accumulator in terms of Hertz (cycles/second). When using frequency mode, four update selections are provided which specify the width of the sample window. Note that selecting a shorter sample window provides a quicker measurement (faster response) but lowers the frequency accuracy (resolution) and increases the minimum frequency measurement limit.

10.2.2 Totalize

In totalize mode, the accumulator is simply incremented each time the input transitions in a specific direction. Totalize mode is configurable to specify the edge (rising or falling) on which the accumulator is incremented.



Three different options are available to reset the current count. They are:

- Configured reset value
When configuring the Totalize function, a value may be specified under the *Counts per Rev* column. When the totalizer accumulator reaches this value - 1, the accumulator will reset to zero on the next count. Specifying zero for this value allows the totalizer to count through the full 32-bit range before resetting.
- Ladder control
Setting registers %Q17-20 reset HSC1-4 (respectively) with no additional configuration. When these registers are asserted, the associated totalizer accumulator is reset and held at zero (level sensitive). *See also Section 10.6.*
- Direct digital input control (HSC1 and HSC2 only)
HSC3 (%I11) and HSC4 (%I12) may be configured as hardware digital reset signals for HSC1 and HSC2 (respectively). To enable these inputs as reset signals, specify the type as *Totalize Reset* (note that the corresponding Totalize HSC must be previously configured before this option is available). The direct digital reset controls are edge sensitive with the edge polarity configurable.

Maximum direct digital reset latency is 100 μ s.

The totalize function also supports an option which compares the current accumulator value with a supplied Preset Value (PV), which is provided through a %AQ, and drives a physical digital output based on the that comparison.

- This option (available for HSC1 and HSC2 only) drives Q1 or Q2 output point (respectively) once the associated totalizer accumulator reaches (or exceeds) the PV value. To enable this function, the corresponding PWM function output (Q1 or Q2) must be configured for *HSCx Output*.

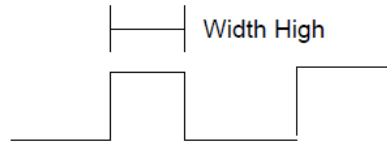
Note that Q1 and Q2 are PWM function outputs that may be configured independently as one of the following: standard digital output, PWM, HSCx or stepper output.

Preset values may be modified during run-time. A preset value of zero disables (resets) the totalizer compare function output causing the output to remain low.

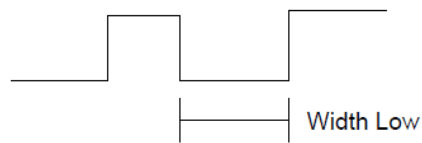
10.2.3 Pulse

In pulse mode, the high-speed input can measure the width or period of a pulse stream in one of four modes and provides a continuous indication of the last sampled value.

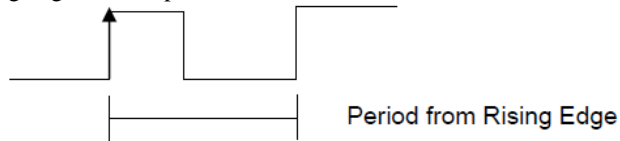
Width High 1 μ s Counts – In this sub-mode the accumulator value will contain the number of 1 μ s counts the pulse is high.



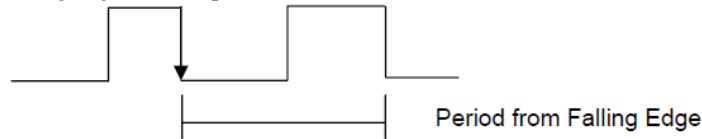
Width Low 1 μ s Counts - In this sub-mode the accumulator value will contain the number of 1 μ s counts the pulse is low.



Period Rising Edges 1 μ s Counts – In this sub-mode the period of the input signal is reported in one (1) μ s units. The period measurement will start on the rising edge of the input.



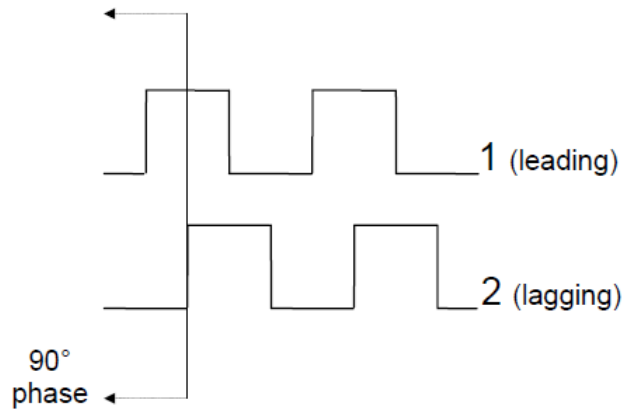
Period Falling Edges 1 μ s Counts – In this sub-mode the period of the input signal is reported in one (1) μ s units. The period measurement will start on the falling edge of the input.



10.2.4 Quadrature

Two HSC inputs are consumed for each of the two possible Quadrature counters. For example, selecting Quadrature mode for HSC 1 will use HSC inputs 1 and 2, which correspond to A and B Quadrature signals. Therefore, HSC 1 and 3 may be configured for Quadrature input. Alternately, HSC 3 may be configured to reset HSC1 (Quadrature) count on a marker input. Quadrature mode works much like the totalizer except the accumulator will automatically increment or decrement based on the rotation phase of the two inputs. See the following example for more details. Quadrature inputs are typically used for reporting the value of an encoder.

Two modes are available for Quadrature that select whether the accumulator counts up or down when the phase of input 1 leads input 2. Check your encoder's documentation to determine the output form it uses or try both modes to determine if the encoder counts up when expected.



Using the above waveforms and a HSC input configuration of “Quadrature” - “1 leads 2, count up,” the accumulator will count up when 1 is rising and 2 is low, 1 is high and 2 is rising, 1 is falling and 2 is high, and when 1 is low and 2 is falling. This results in 4 counts per revolution. So in order to determine the number of cycles, the accumulator would have to be divided by 4.

Three different options are available to reset (or set) the current count:

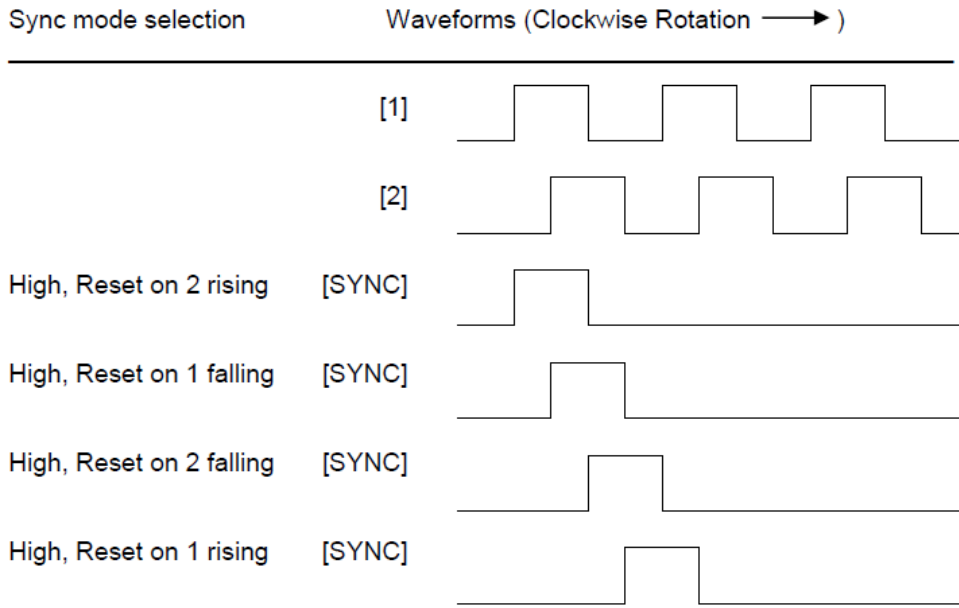
- **Configured *Counts per Rev* value**
When configuring the Quadrature function, a value may be specified under the *Counts per Rev* column. When rotation produces an increasing count, the Quadrature accumulator resets to zero on reaching the *Counts per Rev* count. Alternately, when rotation produces a decreasing count, the Quadrature accumulator is set to *Counts per Rev - 1* on the count following zero. Specifying zero for this value allows the totalizer to count through the full 32-bit range before resetting. For example if your encoder outputs 1024 counts per revolution, the value of 1024 can be entered into the configuration for *Counts per rev*. This will result in a counter that produces counts in the range of 0 to 1023.
- **Ladder control**
Setting registers %Q17 or Q19 resets Quadrature (HSC) 1 or Quadrature (HSC) 3 (respectively) with no additional configuration. Setting registers %Q18 or Q20 sets Quadrature (HSC) 1 or Quadrature (HSC) 3 (respectively) to *Counts per Rev - 1*.
- **Direct digital input control (HSC3) [Marker]**
When HSC input 1 and 2 are used for Quadrature inputs, an additional choice of marker input becomes available for HSC input 3. The marker input is typically part of an encoder or motion system that signals when a cycle of motion is complete. When the marker input is triggered, the accumulator is reset to zero or to *Counts per rev - 1* based on rotation direction. Marker reset operation is enabled when HSC3 is configured for *Marker* type. Once selected, one of several modes is available for marker operation. These modes can be sub-divided into two groups of marker operation.

Asynchronous modes ignore the Quadrature inputs and reset the Quadrature accumulator to zero on the configured edge (rising, falling or both). These are the most common settings used. When configuring, asynchronous mode selections are prefixed with the word *Async*.

Synchronous modes synchronize the reset (or set) to the selected Quadrature input and the selected marker polarity. Figure 10.1 below indicates which mode to select based on the markers timing diagram. Consult the documentation provided with your encoder to determine the marker pulse timing.

Note that the Marker input is sampled within 50 microseconds of the associated Quadrature edge. It is left to the user to determine if this meets the time constraints of the measured drive.

Note that if the Marker input pulse consecutively spans more than one of the specified edges, Quadrature-decoding operation is unpredictable.



*While not displayed in this figure, modes for low level (inverse logic) are also supported for each state.

Figure 10.1 – Sync pulse mode illustration

The accumulator is reset to zero on the specified edge if rotation is clockwise (as shown in figure 10.1 above). However, if rotation is reversed, the accumulator is alternately set to *Counts per rev* - 1 on that same physical edge. When direction is reversed, that same physical edge is seen (by the internal decoder) as having the opposite edge polarity as shown below.

Mode	Direction	A (HSC1)	B (HSC2)	Marker (HSC3)	Reset Value
Async, Reset on rising edge				Rising	0
Async, Reset on falling edge				Falling	0
Async, Reset on both edge				Both	0
High, Reset on 1 rising	Clockwise	Rising		High	0
“	Counter	Falling		High	CPR - 1
Low, Reset on 1 rising	Clockwise	Rising		Low	0
“	Counter	Falling		Low	CPR - 1
High, Reset on 1 falling	Clockwise	Rising		High	CPR - 1
“	Counter	Falling		High	0
Low, Reset on 1 falling	Clockwise	Rising		Low	CPR - 1
“	Counter	Falling		Low	0
High, Reset on 2 rising	Clockwise		Rising	High	0
“	Counter		Falling	High	CPR - 1
Low, Reset on 2 rising	Clockwise		Rising	Low	0
“	Counter		Falling	Low	CPR - 1
High, Reset on 2 falling	Clockwise		Rising	High	CPR - 1
“	Counter		Falling	High	0
Low, Reset on 2 falling	Clockwise		Rising	Low	CPR - 1
“	Counter		Falling	Low	0

10.3 HSC Functions Register Map

Register Frequency Totalize Pulse Quad

Register	Frequency	Totalise	Pulse	Quad
%AI5-6		HSC1 (function) Accumulator		Quad 1 Acc
%AI7-8		HSC2 (function) Accumulator		
%AI9-10		HSC3 (function) Accumulator		Quad 2 Acc
%AI11-12		HSC4 (function) Accumulator		
%AQ1-2		HSC1 Preset		
%AQ3-4		HSC2 Preset		
%Q17		Clear HSC1		Clear Quad 1
%Q18		Clear HSC2		Set Quad 1
%Q19		Clear HSC3		Clear Quad 2
%Q20		Clear HSC4		Set Quad 2

10.4 Pulse Width Modulation (PWM) Functions

On units that support the PWM, two dedicated outputs are available that can be configured for one of four modes of operation. Those modes are Normal, PWM, HSC (count = PV) and Stepper.

10.4.1 Normal

When either Q1 or Q2 is configured for Normal operation, the digital output registers %Q1 and %Q2 drives that respective output.

10.4.2 PWM

When either Q1 or Q2 is configured for PWM, the PWM function drives that respective output. Both PWM channels may be individually enabled; however, when both PWM outputs are enabled, both share the same output frequency (with the low going pulses synchronized). Otherwise, each PWM pulse width can be independently adjusted.

PWM requires three parameters (%AQs) to be set for operation. These parameters may be set at run-time.

- Prescale Count

The Prescale (%AQ5-6) count sets the resolution of the internal counter used for generating the PWM output. The (Prescale count + 1) is a divisor applied to a 16MHz clock that drives the internal PWM counter. For the highest resolution PWM output, this value should be set as low as possible (0 provides a 1/16 micro second resolution). Both the Period and Duty cycle (pulse width) are based on *counts* of the internal PWM counter.

The frequency of the PWM output is calculated using the following formula:

$$\text{Frequency} = \frac{(\text{PrescaleCount} + 1) \times \text{PeriodCount}}{16,000,000}$$

- Period Count

This value (%AQ7-8) sets the period of the output signal by specifying the number of internal PWM counter *counts* before the cycle is reset (larger count results in a smaller frequency). The duration of each *count* is determined by the prescaler value. This parameter affects the Period of both PWM outputs.

See the previous formula to see how the prescale and period counts create an output frequency.

For example, setting the PWM for 1 μs resolution (prescale=15), and a period count of 20,000 would result in a 50 Hz output.

- Duty Cycle Count

This value (PWM1: %AQ1-2, PWM2: %AQ3-4) sets the width of the output signal by specifying the number of internal PWM counter *counts* that the output is maintained high. The duration of each *count* is determined by the prescaler value. Each PWM channel has its own duty cycle count parameter.

Setting the period count to 1000 and the duty cycle count to 500 results in a duty cycle of 50 percent. Changing just the duty cycle count to a value of 250 results in a duty cycle of 25 percent.

At controller power-up or during a download, the PWM output is maintained at zero until both the Period (count) and the Duty cycle (count) are loaded with non-zero values. When the controller is placed in stop mode, the state of the PWM outputs is dependent on the *PWM State on Controller Stop* configuration. This configuration allows for either hold-last-state or specific prescale, period and duty cycle counts. Specifying zero for either the period or duty causes the PWM output to remain low during stop mode.

Note that the nominal output driver turn-on-time delay (to reach 50% output) is 25 microseconds. Therefore, this limitation should be considered when determining both the minimum pulse width and the duty cycle accuracy of the application.

10.4.3 HSC (High Speed Counter)

When either Q1 or Q2 is configured for HSC operation, HSC1 or HSC2 totalize functions are extended to allow respective direct output control based on a comparison of the current count and a preset value (PV). See totalize in the HSC section above for more information.

10.4.4 Stepper Function

When Q1 is configured for Stepper, the stepper function is enabled at the Q1 output. Only one stepper function and output is available.

Note that when Q1 is configured for stepper operation, Q2 operation is limited to direct digital output.

The Stepper requires five parameters (%AQs) to be set for operation. These parameters may be set at run-time but are 'latched' when the stepper is commanded to start.

Start Frequency (cycles per second)

This value (%AQ1) sets the frequency for the first cycle during the acceleration phase and the frequency of the last cycle during the deceleration phase. When an acceleration or deceleration count is specified, the Start Frequency must be greater than 0 and must not exceed the run frequency or an error is generated.

Run Frequency (cycles per second)

This value (%AQ2) sets the frequency for the last cycle during the acceleration phase, the consistent frequency during the run phase, and the frequency of the first cycle during the deceleration mode. The Run Frequency must be greater than 0 and must not exceed 5000 cycles/sec. or an error is generated.

Acceleration Count

This value (%AQ3-4) sets the number of cycles to occur within the acceleration phase. The frequency of the cycles within this mode will vary linearly between the specified Start and Run frequency. The Accel count must not equal 1 or an error is generated. Setting this value to zero disables this phase.

Run Count

This value (%AQ5-6) sets the number of cycles to occur within the run phase. The frequency of the cycles within this mode is constant at the specified Run frequency. The Run count may be any value. Setting this value to zero disables this phase.

Deceleration Count

This value (%AQ7-8) sets the number of cycles to occur within the deceleration phase. The frequency of the cycles within this phase will vary linearly between the specified Run and Stop frequency. The Decel count must not equal 1 or an error is generated. Setting this value to zero disables this phase.

The stepper provides two Boolean registers to provide stepper status

Ready/Done

A high indication on this register (%I30) indicates the stepper sequence can be started (i.e. not currently busy).

Error

A high indication on this register (%I31) indicates that one of the analogue parameters specified above is invalid or the stepper action was aborted before the operation was complete. This register is cleared on the next start command if the error was corrected.

The stepper requires one discrete register (%Q1) to control the stepper action. Setting this register starts the stepper cycle. This register must remain set to complete the entire cycle.

Clearing this register before the cycle is complete aborts the step sequence and sets the error bit.

Note that setting the PLC mode to Stop while the stepper is in operation causes the stepper output to immediately drop to zero and the current stepper count to be lost.

Note that stepper output level may cause damage or be incompatible with some motor driver inputs. Consult drive documentation to determine if output level and type is compatible.

10.5 PWM functions register map

Register	PWM	HSC	Stepper
%AQ1	PWM1 Duty Cycle (32-bit)	HSC1 Preset Value	Start Frequency
%AQ2			Run Frequency
%AQ3	PWM2 Duty Cycle (32-bit)	HSC2 Preset Value	Accel Count
%AQ4			(32-bit)
%AQ5	PWM Prescale (32-bit)		Run Count
%AQ6			(32-bit)
%AQ7	PWM Period (32-bit)		Decel Count
%AQ8			(32-bit)
%Q1			Run
%I30			Ready/Done
%I31			Error

10.6 PWM Examples

All of the PWM examples use the following formula:

$$\text{Frequency} = \frac{(\text{PrescaleCount} + 1) \times \text{PeriodCount}}{16,000,000}$$

Example 1

To get a 50% Duty Cycle @ 10 kHz waveform on PWM1:

Set %AQ1-2 = 50 (duty cycle count)
 Set %AQ5-6 = 15 (prescale count)
 Set %AQ7-8 = 100 (period count)

Example 2

To get a 50% Duty Cycle on PW1 and 90 % Duty Cycle on PWM2 @ 1 kHz waveform:

Set %AQ1-2 = 500 (duty cycle count)
 Set %AQ3-4 = 900 (duty cycle count)
 Set %AQ5-6 = 15 (prescale count)
 Set %AQ7-8 = 1000 (period count)

Example 3

To turn PWM 1 output ON all the time

Set %AQ1-2 = Same value as AQ7-8 (duty cycle count)
 Set %AQ5-6 = Any value (prescale count)
 Set %AQ7-8 = Non-Zero value (period count)

Example 4

To turn PWM 1 output OFF all the time

Set %AQ1-2 = 0 (duty cycle count)
 Set %AQ5-6 = Any value (prescale count)
 Set %AQ7-8 = Any value <or> 0 (period count)

10.7 STP Examples

Example 1

10,000,000 steps control sequence

The following example starts at 2.5 kHz and ramps up to 5 kHz during the first 1,000,000 steps. Then, it runs at 5 kHz for the next 8,000,000 steps. Finally during the last 1,000,000 steps it slows to a stop.

Set %AQ1 = 2500 (Hz) {Start Frequency}
 Set %AQ2 = 5000 (Hz) {Run Frequency}
 Set %AQ3-4 = 1000000 (Steps) {Accel Count}
 Set %AQ5-6 = 8000000 (Steps) {Run Count}
 Set %AQ7-8 = 1000000 (Steps) {Decel Count}

Example 2

5,000,000 steps control sequence

The following example starts at 0.5 kHz and ramps up to 1 kHz during the first 2,000,000 steps. Then, it runs at 1 kHz for the next 2,000,000 steps. Finally during the last 1,000,000 steps it slows to a stop.

Set %AQ1 = 500 (Hz) {Start Frequency}

Set %AQ2 = 1000 (Hz) {Run Frequency}

Set %AQ3-4 = 2000000 (Steps) {Accel Count}

Set %AQ5-6 = 2000000 (Steps) {Run Count}

Set %AQ7-8 = 1000000 (Steps) {Decel Count}

Example 3

6,000,000 steps control sequence

The following example starts at 50 Hz and ramps up to 250 Hz during the first 150,000 steps. Then, it runs at 250 Hz for the next 5,500,000 steps. Finally during the last 350,000 steps it slows to a stop.

Set %AQ1 = 50 (Hz) {Start Frequency}

Set %AQ2 = 250 (Hz) {Run Frequency}

Set %AQ3-4 = 150000 (Steps) {Accel Count}

Set %AQ5-6 = 5500000 (Steps) {Run Count}

Set %AQ7-8 = 350000 (Steps) {Decel Count}

Note: The highest usable frequency is 65 KHz for the PWM output.

CHAPTER 11: SYSTEM SETTINGS AND ADJUSTMENTS

11.1 System Menu - Overview

The *i³* has a built-in System Menu, which lets the user view System Settings and make adjustments.

To start the System Menu, either press the SYSTEM key (*i³B* and C Models), press the ↓ and ↑ keys simultaneously (*i³A*), or set %SR3 to 1, which will display the Main Menu.

Then use the ↓ and ↑ (Up Arrow or Down Arrow) keys to select a **Main Menu** item and press **Enter** (Return Arrow) to display the item's Sub-Menu.

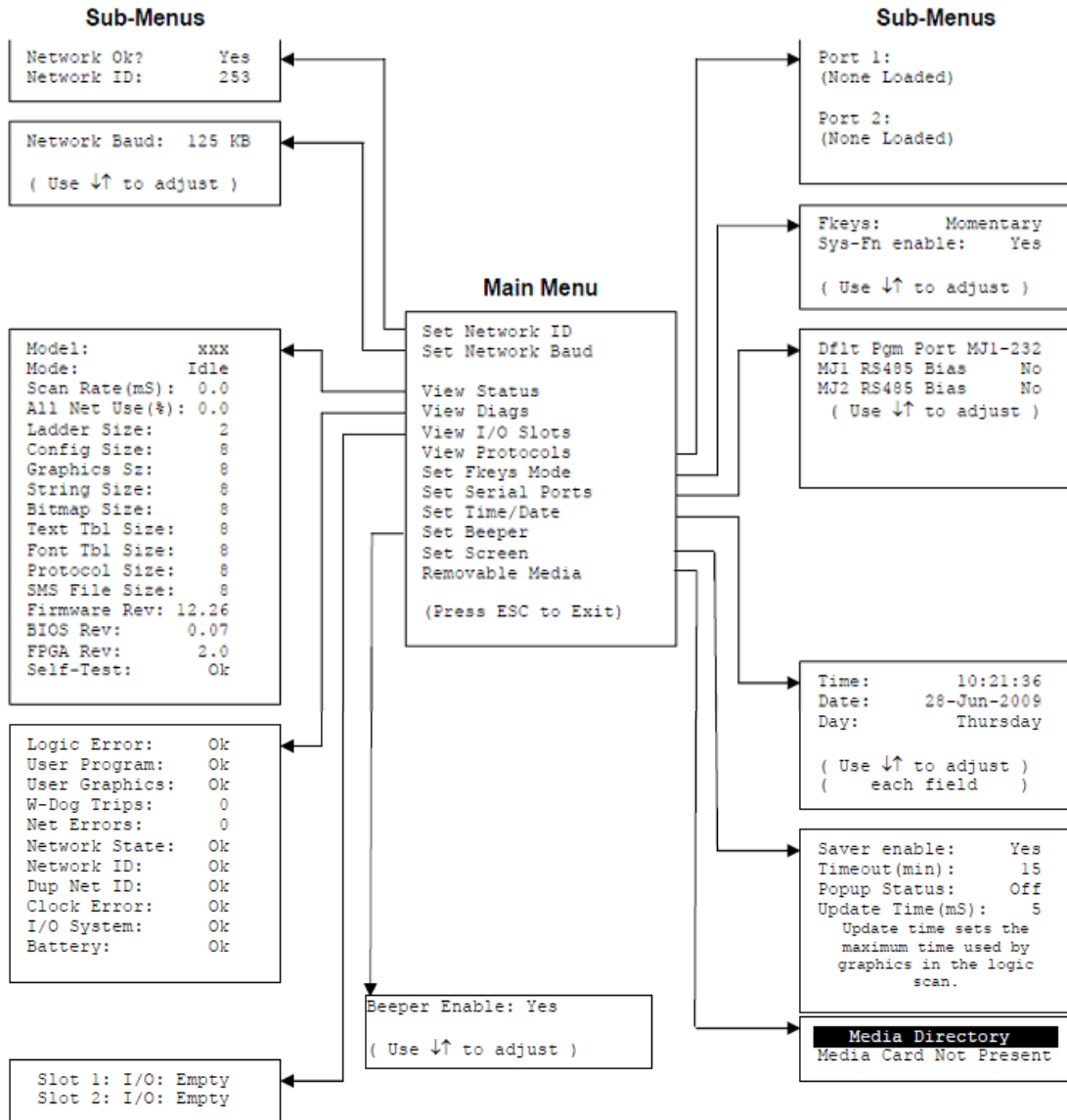


Figure 11.1 – System Menu (*i³C*)



Figure 11.2 – System Menu (i³C) Screenshot

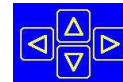
11.2 System Menu – Navigation and Editing

As mentioned above, the System Menu is started by pressing the System key on the i³C. Next, Press **ESC** to exit the System Menu, or use the **↑** to select an item and press **Enter** to display the item's Sub-Menu.

A Sub-Menu generally shows a list of System Settings and their values. After opening a Sub-Menu, if any of its System Settings are editable, the first System Setting that can be edited is highlighted. If desired, the **↓** and **↑** keys can be used to select a different System Setting to be edited.

At this point, either press **ESC** to exit the Sub-Menu (returning to the Main Menu) or press **Enter** to edit the highlighted System Setting. If **Enter** is pressed, the System Setting's value will be highlighted, indicating that it is ready to be modified.

When modifying a System Setting's value, use either the arrow keys (**←** **→** **↓** **↑**) or the

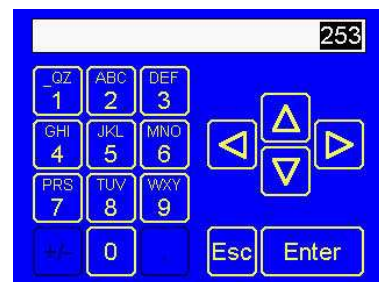


numeric keys, or the appropriate touch screen icons to select a new value.

The arrow keys are used to edit System Settings that have just a few possible values. Each time the arrow key is pressed, a new possible value is displayed. When the desired value appears, press the **Enter** key to save it, otherwise press the **ESC** key to cancel the edit.

The numeric keys are normally used to enter numeric System Settings.

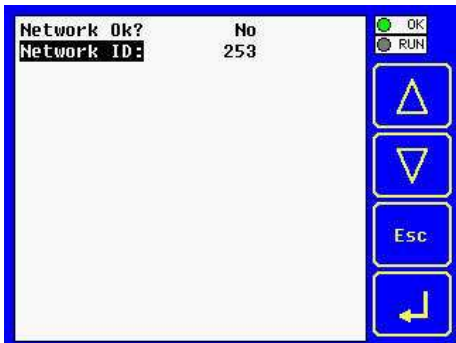
In addition, to edit a single numeric digit, use the **←** or **→** key to select the digit and then either press a numeric key or use **↓** or **↑** to modify the digit. In any case, after entering the new desired value, press the **Enter** key to save it; otherwise press the **ESC** key to cancel the edit.



11.3 System Menu – Details

The following sections describe each of the Sub-Menus in detail.

Set Network ID

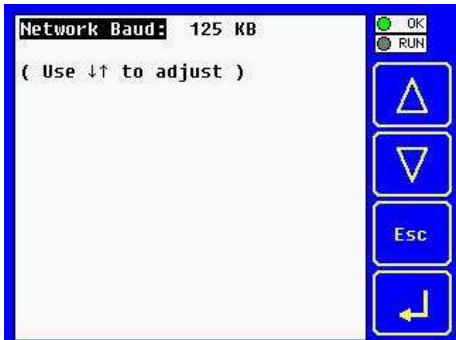


This Sub-Menu displays two System Settings of which only **Network ID** is editable.

Network Ok? Yes = NET1 connected to a CAN network and functioning properly
No = Not ready to communicate on CAN network

Network ID: 1 to 253 = This node's *i*CAN Network ID; must be unique on network

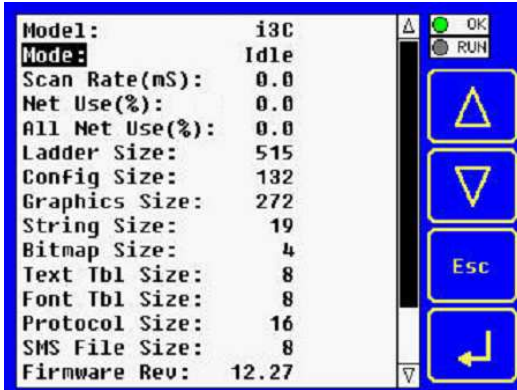
Set Network Baud



The Network Baud Sub-Menu only appears for *i*³ models that have CAN ports (XE1xx). This Sub-Menu displays just one System Setting and it is editable.

Network Baud? 125 KB = 125 KBaud CAN network
250 KB = 250 KBaud CAN network
500 KB = 500 KBaud CAN network
1 MB = 1 MBaud CAN network

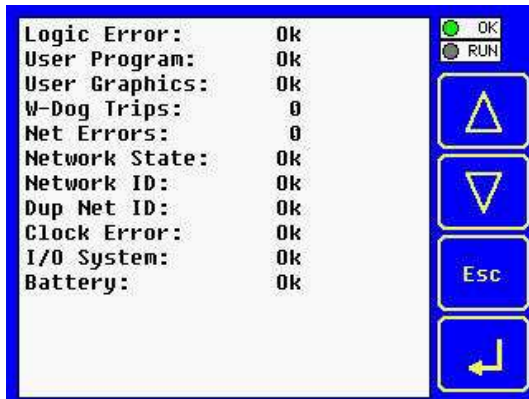
View i^3 Status



The View Status Sub-Menu displays up to 17 System Settings. Only the **Mode** System Setting is editable.

Model:	Model number of this i^3 unit
Mode:	Idle = i^3 is in Idle mode DoIO = i^3 is in Do I/O mode Run = i^3 is in Run mode
Scan Rate(mS):	0.0 = i^3 is not in Run mode 0.1 to 999.9 = Average number of mS for each ladder scan
Net Use %:	0.0 to 100.0 = CAN network bandwidth % used by this i^3 node
All Net Use %:	0.0 to 100.0 = CAN network bandwidth % used by all nodes
Ladder Size:	x = Number of bytes in application ladder program
Config Size:	x = Number of bytes in application I/O configuration
Graphics Size:	x = Number of bytes in application graphic screens
String Size:	x = Number of bytes in application string table
Bitmap Size:	x = Number of bytes in application bitmaps
Text Tbl Size:	x = Number of bytes in application text tables
Font Tbl Size:	x = Number of bytes in application font tables
Protocol Size:	x = Number of bytes in application downloaded protocols
SMS File Size:	x = Number of bytes in application SMS protocol configuration
Firmware Rev:	xx.yy = Current firmware version
BIOS Rev:	x.yz = Current CPLD (Complex Programmable Logic Device) version
FPGA Rev:	x.y = Current FPGA (Floating Point Gate Array) version
Self-Test:	Ok = All power-on self-tests passed Fault = One or more power-on self-tests failed

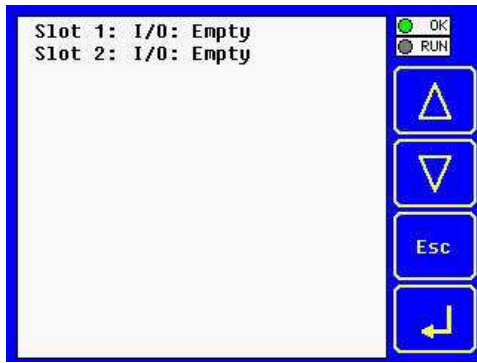
View Diags



The View Diags Sub-Menu displays up to 14 System Diagnostics, none of which are editable. The first two System Diagnostics are critical. If any of them indicate a Fault condition, the i^3 will not enter or remain in Run mode, and the problem must be investigated and corrected.

Logic Error:	Ok = All executed ladder instructions are legal for loaded firmware Fault = A ladder instruction not supported by firmware was found
User Program:	Ok = Ladder program and I/O configuration loaded successfully Fault = Ladder program or I/O configuration not loaded or load failed The last nine System Diagnostics are informational. If any of them indicate a Warning condition, the i^3 can still enter and remain in Run mode, but the problem should be investigated and corrected.
User Graphics:	Ok = Application graphics objects loaded successfully Fault = Application graphics objects not loaded or load failed
W-Dog Trips:	0 = Watchdog timer has not tripped since the last power-up x = Number of times watchdog timer has tripped
Net Errors:	0 = No CAN network bus-off errors have occurred x = Number of CAN network bus-off errors that have occurred
Network State:	Ok = At least one other node was found on the CAN network Warning = No other nodes were found on the CAN network
Network ID:	Ok = This node's CAN Network ID is in the range 1 to 253 Warning = This node's CAN Network ID was out of range at power-up
Dup Net ID:	Ok = This node's Network ID is unique on the CAN network Warning = This node's Network ID is duplicated in another node
Clock Error:	Ok = Time and date have been set Warning = Time and date need to be set
I/O System:	Ok = I/O configuration matches the installed I/O and COM modules Warning = I/O configuration needs updating to match installed modules
Battery:	Ok = Backup battery operating properly Warning = Backup battery needs to be replaced

View I/O Slots



The View I/O Slots Sub-Menu displays two System Settings, both of which are not editable.

Internal to the *i*³, there is a CPU board, and up to two installed modules. All other models have an I/O module and can have a user-installed COM module.

Depending on which I/O module is installed and which I/O module has been configured by *i*³ Configurator, one of the following six System Settings should appear for Slot 1:

Slot 1: I/O: Empty = No I/O module installed or configured

Slot 1:*Unsupported = Unsupported I/O module installed

Slot 1:-I/O Missing = No I/O module installed but an I/O module is configured

Slot 1:+I/O: i3xyy = yy I/O module installed but no I/O module configured

Slot 1:?I/O: i3xyy = yy I/O module installed but another I/O module configured

Slot 1: I/O: i3xyy = yy I/O module installed and configured properly

Depending on the COM module that is installed and the COM module that has been configured by *i*³ Configurator, one of the following six System Settings appears for Slot 2:

Slot 2: I/O: Empty = No COM module installed or configured

Slot 2:*Unsupported = Unsupported COM module installed

Slot 2:-I/O Missing = No COM module installed but a COM module is configured

Slot 2:+I/O: XzC = z COM module installed but no COM module configured

Slot 2:?I/O: XzC = z COM module installed but another COM module configured

Slot 2: I/O: XzC = z COM module installed and configured properly

View Protocols



The View Protocols Sub-Menu displays two System Settings, neither of which are editable. As mentioned in 0, both the MJ1 (Port 1) and MJ2 (Port 2) serial ports support downloadable protocols. To assign a downloadable protocol to an *i*³ serial port, select the **Protocol Config** item in *i*³ Configurator's Program menu and then setup a protocol for Port 1 or Port 2 (or both). In the View Protocols Sub-Menu, the currently downloaded protocol, if any, and its version number are displayed for both Port 1 and Port 2.

Port 1:

Protocol name = **(None Loaded)** or name of the protocol assigned to MJ1

Protocol version = Blank or version of the protocol assigned to MJ1

Port 2:

Protocol name = **(None Loaded)** or name of the protocol assigned to MJ2

Protocol version = Blank or version of the protocol assigned to MJ2

Set Fkeys Mode



The Set Fkeys Sub-Menu displays two System Settings, both of which are editable.

Fkeys: Momentary = %K1-10 bits go On & Off as F1-F10 are pressed & released.
Toggle = %K1-10 bits toggle each time F1-F10 are pressed

SYS_Fn enable: Yes = Reset and all clear system functions enabled
No = Reset and all clear system functions disabled

Set Serial Ports



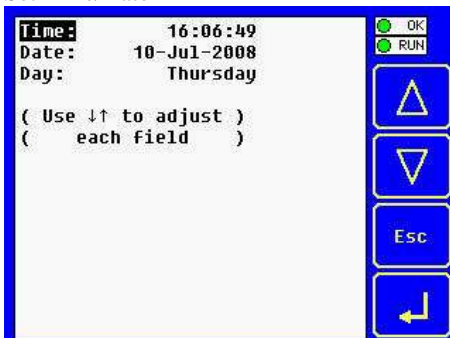
The Set Serial Ports Sub-Menu displays three System Settings, all of which are editable, and one optional item. For the **Dflt Pgm Port** System Setting, only MJ1-232 can be selected, unless a Modem *i*³-M, or Ethernet *i*³-E module is installed.

Dflt Pgm Port: MJ1-232 = MJ1 RS232 port is the default programming port
Enet = Ethernet COM module is the default programming port
GSM = Modem COM module configured for dial-up programming
GPRS = Modem COM module configured for always-on data communication

MJ1 RS485 Bias: No = MJ1 RS485 bias resistors are not switched in
Yes = MJ1 RS485 bias resistors are switched in

MJ2 RS485 Bias: No = MJ2 RS485 bias resistors are not switched in
Yes = MJ2 RS485 bias resistors are switched in

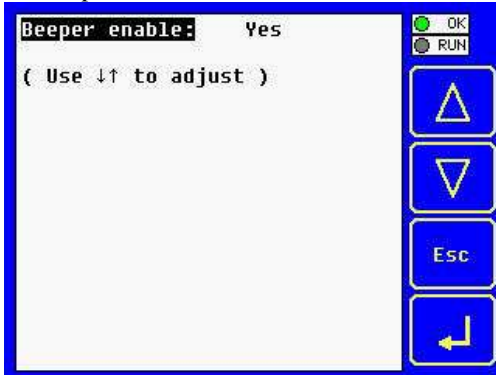
Set Time/Date



The Set Time/Date Sub-Menu displays three System Settings. **Time** and **Date** are editable, and **Day** is automatically calculated from the **Date** setting. Note that **Time** and **Date** are split into three editable fields each. Use ← or → to select a field and then use ↓ or ↑ to edit the field.

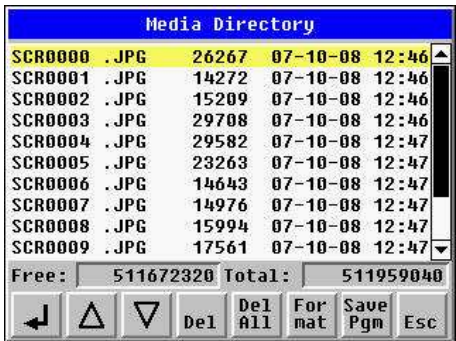
Time: 16:09:49 = Current time (hours:minutes:seconds in 24-hour format)
Date: 10-Jul-2008 = Current date (day-month-year)
Day: Thursday = Current day of week calculated from the Date setting

Set Beeper



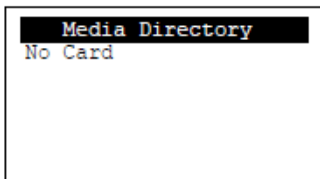
The Set Beeper Sub-Menu displays one System Setting, which is editable **Beeper enable: Yes (default)**= Enables beeper **No** = Disables beeper (does NOT affect ladder access)

Removable Media

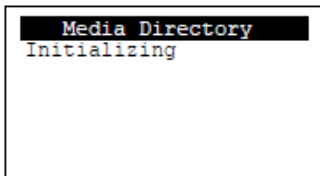


The Removable Media Sub-Menu displays the Removable Media Manager. After selecting Removable Media from the Main Menu, one of four Sub-Menu screens will appear:

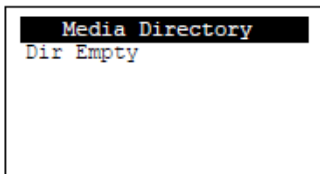
If a directory name is highlighted, pressing **Enter** will switch to that directory showing its files and subdirectories. In a sub-directory, highlighting .. (dot dot) and pressing **Enter** will move up one directory.



= No Micro SD card has been installed in the Memory slot

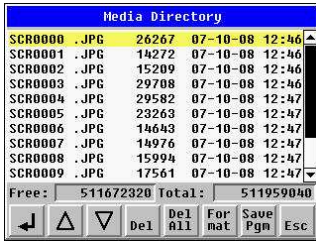


= Micro SD card is installed, but it is still initializing

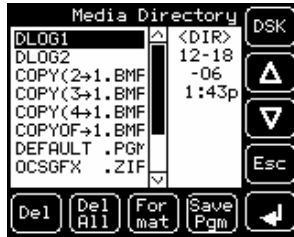


= Micro SD card is installed and initialized, but contains no files

*i*³C

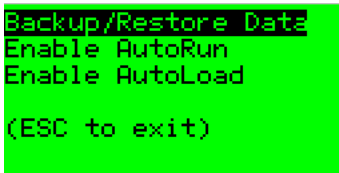


*i*³B



= Micro SD card is installed and initialized, and it contains files

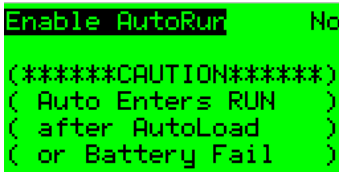
Failsafe Menu



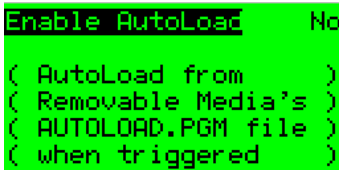
Failsafe functions are available in Firmware V12.42 or later. This feature controls how the *i*³ reacts in the event of a memory corruption.



1. Backup/Restore option saves %R table from battery-backed RAM into internal Flash memory. This allows Setpoints / Values to be saved for later restoration. Beware: after restoring the registers, the *i*³ must reboot to write the values back to battery-backed RAM.



2. The Enable AutoRun is linked to the AutoLoad function. Enabling this allows the *i*³ controller to put itself into 'RUN' mode without input from an operator after an AutoLoad has completed correctly.



3. The Enable AutoLoad requires a MicroSD card to be present in the Removable Media slot at all times. The card must also contain a program entitled "AUTOLOAD.PGM". This program should be correct program for the application. On the event of a memory corruption/error, the *i*³ firmware will automatically load this program back into memory (and run it if AutoRun is enabled).

CHAPTER 12: USER INTERFACE

12.1 Screen Navigation

The screen navigation on the i^3 is quite flexible. Basic methods will be described here. Control programming can be used to create complex screen navigation techniques.

One form of screen navigation is the **Jump Screen** graphics object. This object is typically tied to a soft key. Pressing the soft key will switch to the screen that is programmed.

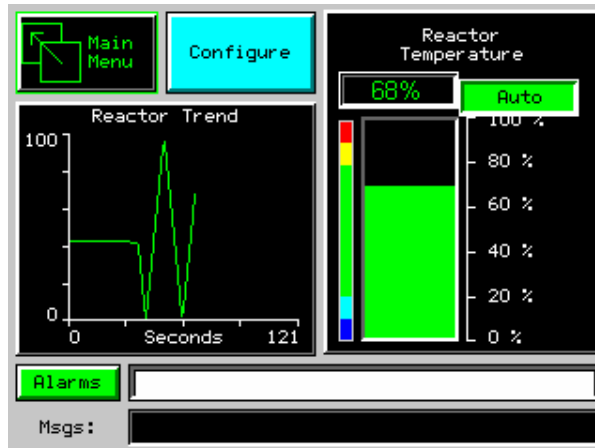


Figure 12.1 – Typical Screen Jump Object (i^3C)

Screen jumps can also be triggered on other keys or based on control logic for more advanced applications. To allow the operator to change screens, a **screen jump object** is generally used. This object may be visually **represented as a button** (responding to touch) or remain invisible and logically tied to an i^3 register. An optional system ICON may be configured for display along with the legend, which aids in identifying the object as one that causes a screen change.

12.2 Ladder Based Screen Navigation

Ladder logic can use several techniques to control screen navigation. Coils can be tied to %D registers to make them screen coils. These coils have two modes, switch and alarm. If the ladder program energizes an alarm display coil, the screen associated with this coil is displayed and overrides the normal user screens. This is designed to show alarm conditions or to display other ladder-detected events.

When the text coil is de-energized, the previous screen that was being viewed before the alarm is returned.

The switch display coil switches to the associated screen when it is energized. Once it is de-energized the screen remains until switched by the user or ladder.

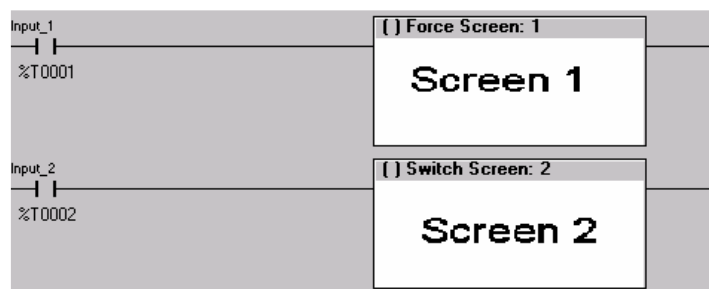


Figure 12.2 – Force and Switch Coils in Ladder Programming

There is also a system register that can be used for control based screen navigation. %SR1 can be read to determine the current screen or written to change the current screen.

Refer to the help in i^3 Configurator for more information on control-based screen navigation.

12.3 Using Editable Screen Objects

When a screen contains editable objects, one of the objects will be selected by default. Selected objects will be outlined with a dotted line. The arrow keys can be used to navigate the editable objects and allow selection of an object to edit. When the object to be edited is selected press **Enter**. This enters the objects editing mode.

The most common editable object is the numeric object.

The value chosen by the operator cannot exceed the minimum or maximum set by the user program. If the user tries to exceed the maximum point or enter a value below the minimum point, the value does not change.

The most common editable object is the numeric object. To edit, touch the object and pop-up keypad will appear to allow editing the value.

For addition information on a specific object please see the on-line help in *i*³ Configurator.

Beeper Acknowledgement

The *i*³ contains an internal beeper that provides an audible acknowledgment when an operator touches a graphic object that accepts touch input. When the graphical object is enabled, a short 5ms tone is emitted. When the graphical object is disabled, a longer 100mSec tone is emitted to enounce that graphical object is not currently accepting the touch input.

If beep acknowledgement is not desired, the beeper function can be disabled from the system menu.

Note: If the *i*³ displays >>>>> in a numeric field, the value is too big to display in the field or is above the maximum for an editable field. If the *i*³ displays <<<<< in a numeric field, the value is too small to display or is below the minimum for an editable field.

NOTES

CHAPTER 13: REGISTERS

13.1 Register Definitions

When programming the i^3 , data is stored in memory that is segmented into different types. This memory in the controller is referred to as registers. Different groups of registers are defined as either bits or words (16 bits). Multiple registers can usually be used to handle larger storage requirements. For example 16 single bit registers can be used to store a Word or two 16 bit registers can be used to store a 32-bit value. Below is a list of the type of registers found in the i^3 .

%AI Analogue Input

16-bit input registers used to gather analogue input data such as voltages, temperatures, and speed settings coming from an attached device.

%AQ Analogue Output

16-bit output registers used to send analogue information such a voltages, levels or speed settings to an attached device.

%AIG Global Analogue Input

Specially defined 16-bit input registers that come from the network.

%AQG Global Analogue Output

Specially defined 16-bit output registers that go to the network.

%D Display Bit

These are digital flags used to control the displaying of screens on a unit that has the ability to display a screen. If the bit is SET, the screen is displayed.

%I Digital Input

Single-bit input registers. Typically, an external switch is connected to the registers.

%IG Global Digital Input

Specially defined single-bit inputs that come from the network.

%K Key Bit

Single-bit flags used to give the programmer direct access to any front panel keys appearing on a unit.

%M Retentive Bit

Retentive single-bit registers.

%Q Digital Output

Single-bit output registers. Typically, these bits are connected to an actuator, indicator light or other physical outputs.

%QG Global Digital Output

Specially defined single-bit outputs that go to the network.

%R General Purpose Register

Retentive 16-bit registers.

%S System Bit

Single-bit bit coils predefined for system use.

%SR System Register

16-bit registers predefined for system use.

%T Temporary Bit

Non-retentive single-bit registers.

13.2 Useful %S and %SR registers

Register	Description
%S1	Indicate First Scan
%S2	Network is OK
%S3	10mS timebase
%S4	100mS timebase
%S5	1 second timebase
%S6	I/O is OK
%S7	Always ON
%S8	Always OFF
%S9	Pause 'n Load soon
%S10	Pause 'n load done
%S11	I/O being forced
%S12	Forcing is enabled
%S13	Network I/O is OK
%S16	Ethernet COM module is OK

Register	Name	Description	Min Val	Max Val
%SR1	USER_SCR	Current User Screen Number	1	1023
%SR2	ALRM_SCR	Current Alarm Screen Number (0=none)	0	1023
%SR3	SYS_SCR	Current System Screen Number (0=none)	0	14
%SR4	SELF_TEST	Bit-Mapped Self-Test Result	0	65535
%SR5	CS_MODE	Control Station Mode (0=Idle, 1=Do I/O, 2=Run)	0	2
%SR6	SCAN_RATE	Average Scan Rate (/ 10)	-	1000
%SR7	MIN_RATE	Minimum Scan Rate (/ 10)	-	1000
%SR8	MAX_RATE	Maximum Scan Rate (/ 10)	-	1000
%SR9-10	EDIT_BUF	Data Field Edit Buffer	0	2 ³² -1
%SR11-12	LADDER_SIZE	Ladder Code Size	2	256K
%SR13-16	Reserved	-	-	-
%SR17-18	IO_SIZE	I/O Configuration Table Size	16	127K
%SR19-20	NET_SIZE	Network Configuration Table Size	34	1K
%SR21-22	SD_SIZE	Security Data Table Size	-	-
%SR23	LADDER_CRC	Ladder Code CRC	0	65535
%SR 24-25	Reserved	-	-	-
%SR26	IO_CRC	Configuration Table CRC	0	65535
%SR27	NET_CRC	Network Configuration Table CRC	0	65535
%SR28	SD_CRC	Security Data Table CRC	0	65535
%SR29	NET_ID	This Station's Primary Network ID (iCAN)	1	253
%SR30	NET_BAUD	Network Baud Rate (CsCAN) (0=125KB; 1=250KB; 2=500KB; 3=1MB)	0	3
%SR31	NET_MODE	Network Mode (0=network not required; 1=networkrequired; 2=network optimized; 3=network required and optimized)	0	3
%SR32	LCD_CONT	LCD Display Contrast setting	0	255
%SR33	FKEY_MODE	Function Key Mode (0=Momentary; 1=Toggle)	0	1
%SR34	SERIAL_PROT	RS232 Serial Protocol Mode (0=Firmware Update (RISM); 1=CsCAN; 2=Generic(Ladder- Controlled); 3=Modbus RTU; 4=Modbus ASCII)	0	4
%SR35-36	SERIAL_NUM	This Station's 32-bit Serial Number	0	2 ³² -1
%SR37	MODEL_NUM	This Station's Binary Model Number	0	65535
%SR38	ENG_REV	Firmware Rev Number (/ 100)	0	9999
%SR39	CPLD_REV	BIOS Rev Number (/ 100)	0	255
%SR40	FPGA_REV	FPGA Image Rev Number (/ 10)	0	255
%SR41	LCD_COLS	Vertical Pixel Count	-	-

%SR42	LCD_ROWS	Horizontal Pixel Count	-	-
%SR43	KEY_TYPE	Keypad Type	-	-
%SR44	RTC_SEC	Real-Time-Clock Second	0	59
%SR45	RTC_MIN	Real-Time-Clock Minute	0	59
%SR46	RTC_HOUR	Real-Time-Clock Hour	0	23
%SR47	RTC_DATE	Real-Time-Clock Date	1	31
%SR48	RTC_MON	Real-Time-Clock Month	1	12
%SR49	RTC_YEAR	Real-Time-Clock Year	1996	2095
%SR50	RTC_DAY	Real-Time-Clock Day (1=Sunday)	1	7
%SR51	NET_CNT	Network Error Count	0	65535
%SR52	WDOG_CNT	Watchdog-Tripped Error Count	0	65535
%SR53-54	BAD_LADDER	Bad Ladder Code Error Index	0	65534
%SR55	F_SELF_TEST	Filtered Bit-Mapped Self-Test Result	0	65535
%SR56	LAST_KEY	Key Code of Last Key Press or Release	0	255
%SR57	BAK_LITE	LCD Backlight Dimmer Register 0 = 0% On; 25=25% On; 100-255 = 100% On	0	255
%SR58	USER_LEDS	User LED Control / Status	0	65535
%SR59-60	Reserved	-	-	-
%SR61	NUM_IDS	This Station's Number of Network IDs	1	253
%SR63	SS_BASE	Smart I/O Base Selector	0	7
%SR64	SS_STATUS	Smart I/O Base Status	0	2
%SR65-76	SS_INFO_1	SmartStack I/O Module #1 Information Structure	-	-
%SR77-88	SS_INFO_2	SmartStack I/O Module #2 Information Structure	-	-
%SR89-100	SS_INFO_3	SmartStack I/O Module #3 Information Structure	-	-
%SR101-112	SS_INFO_4	SmartStack I/O Module #4 Information Structure	-	-
%SR113-114	GOBJ_SIZE	Graphics Object Table Size	8	256K
%SR115-116	GSTR_SIZE	Graphics String Table Size	8	128K
%SR117-118	GBMP_SIZE	Graphics Bitmap Table Size	4	256K
%SR119-120	GTX_T_SIZE	Graphics Text Table Size	8	128K
%SR121-122	GFNT_SIZE	Graphics Font Table Size	8	256K
%SR123-124	PROT_SIZE	Protocol Table Size	16	64K
%SR125	GOBJ_CRC	Graphics Object Table CRC	0	65535
%SR126	GSTR_CRC	Graphics String Table CRC	0	65535
%SR127	GBMP_CRC	Graphics Bitmap Table CRC	0	65535
%SR128	GTX_T_CRC	Graphics Text Table CRC	0	65535
%SR129	GFNT_CRC	Graphics Font Table CRC	0	65535
%SR130	PROT_CRC	Protocol Table CRC	0	65535
%SR131-163	Reserved		-	-
%SR164.3		Enable Automatic Restore Operation (Fail Safe)		
%SR164.4		Enable Backup (Fail Safe System)		
%SR164.5		Enable AUTORUN (Fail Safe)		
%SR164.6		Enable AUTOLOAD (Fail Safe)		
%SR164.7		Clear Backup trigger bit		
%SR164.8		Create Backup trigger bit		
%SR164.9		MAKE_CLONE trigger bit		
%SR164.10		LOAD_CLONE trigger bit		
%SR165-174	Reserved			
%SR175	Removable Media	Current Removable Media interface status	0	6
%SR176-177	Removable Media	Indicates free space on the Removable Media card	0	231
%SR178-179	Removable Media	Indicates the total card capacity in bytes	0	231
%SR180	Reserved		-	-
%SR181	ALM_UNACK	Unacknowledged Alarm (high bit indicates which group #)		
%SR182	ALM_ACT	Active Alarm (high bit indicates which group #)		
%SR183	SYS_BEEP	System Beep Enable (0=disabled; 1=enabled)		

%SR184	USER_BEEP	Software configurable (0=OFF; 1=ON)		
%SR185	SCR_SAVER	Screen Saver Enabled (0=disabled; 1=enabled)		
%SR186	SCR_SA_TM	Screen Saver Time in minutes (delay)		
%SR187	NET_USE	Average Net Usage of all units on the CAN network		
%SR188	NET_MIN	Minimum Net Usage of all units on the CAN network		
%SR189	NET_MAX	Maximum Net Usage of all units on the CAN network		
%SR190	NT_TX_AVG	Average Net Usage of this unit		
%SR191	NT_TX_MIN	Minimum Net Usage of this unit		
%SR192	NT_TX_MAX	Maximum Net Usage of this unit		

For additional information on system bits and registers, refer to the help file found in i^3 Configurator.

13.3 Register Map for i^3 I/O

<i>Table 13.3 – I/O Register Map</i>	
Registers	Description
%I1 to %I24	Digital Inputs
%I25 to %I31	Reserved
%I32	Output Fault
%Q1 to %Q16	Digital outputs
%Q17	Clear HSC1 accumulator to 0
%Q18	Totalizer: Clear HSC2 Quadrature 1-2: Accumulator 1 Reset to max – 1
%Q19	Clear HSC3 accumulator to 0
%Q20	Totalizer: Clear HSC4 Quadrature 3-4: Accumulator 3 Reset to max – 1
%Q21 to %Q32	Reserved
%AI1 to %AI4	Analogue inputs
%AI5, %AI6	HSC1 Accumulator
%AI7, %AI8	HSC2 Accumulator
%AI9, %AI10	HSC3 Accumulator
%AI11, %AI12	HSC4 Accumulator
%AQ1, %AQ2	PWM1 Duty Cycle
%AQ3, %AQ4	PWM2 Duty Cycle
%AQ5, %AQ6	PWM Prescale
%AQ7, %AQ8	PWM Period
%AQ9 to %AQ14	Analogue outputs

Note: Not all i^3 models contain the I/O listed in this table.

13.4 Resource Limits

<i>Table 13.4 – Resource Limits</i>	
Resource	Value
%S	13
%SR 192	192
%T 2048	2048
%M 2048	2048
%R 9999	9999
%K 10	10
%D 1023	1023
%I 2048	2048
%Q 2048	2048
%AI 512	512
%AQ 512	512
%IG 64	64
%QG 64	64
%AIG 32	32
%AQG 32	32
Network Ports	<i>i</i> CAN (Optional depending on model.)
Controllers Per Network	253
Keypad	20 keys (10 fn keys and 4 soft keys)
Display	320x240 LCD Backlit, 32768 Colour
Screen Memory	2 MB
User Screens	1023
Data Fields	Per User Screen 50
Ladder Code	256 k

CHAPTER 14: CONFIGURATOR SETUP

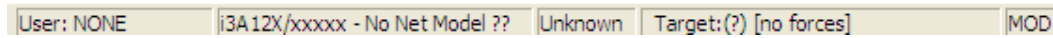
14.1 Overview

The i^3 hardware is programmed with a Windows based PC application called i^3 Configurator. This application can be used to program, configure, monitor and debug all aspects of the i^3 unit.

Please see the on-line help provided with i^3 Configurator for additional details.

14.2 Configurator Status Bar

When the i^3 is connected to a PC using i^3 Configurator software a Status Bar appears at the bottom of the screen. The i^3 Configurator Status Bar can be used to determine if communications have been established between the i^3 and the i^3 Configurator program. Components of the i^3 Configurator Status Bar are explained below.



Equal Indicator – indicates whether the current program in i^3 Configurator is equal to the program stored in the Target Controller.

- If *Equal*, the program in i^3 Configurator is the same as the program stored in the Target Controller.
- If *Not Equal*, the program in i^3 Configurator is not the same as the program stored in the Target Controller.
- If *Unknown*, there may have been a change since the last time the program in i^3 Configurator was compared to the Target Controller.

Communications Status - indicates the current status of the “pass through” Connector.

- **Local: xx** – indicates the Network ID of the i^3 .
 i^3 to which the Configurator program is physically connected through its serial port. It can serve as a pass through device to other nodes on the network.
- **Target: yy(R)** – indicates the Network ID of the device with which the Configurator program is exchanging data.

Note: The **Local** unit and **Target** unit can be the same unit or they can be separate units.

The following are status indicators:

- (R) – Running
- (D) - Do I/O
- (I) – Idle
- (?) – i^3 Configurator is not communicating with the remote unit.
- [no forces] – indicates no I/O has been forced.

Message Line -

The contents of these messages are context sensitive. The Message line can be empty.

Current User -

indicates who is logged (for security purposes).

Controller Model - Network (Model Confirmation)

- **Controller Model** indicates the controller model for which the program in i^3 Configurator is configured.
- **Network** indicates the type of network that the program in i^3 Configurator expects to use (e.g., iCAN).
- **(Model Confirmation)** provides the following indications:
 - **(Model=)** - the actual Target Controller matches the configured Controller Model and Network.
 - **(Model Not=)** – the actual Target Controller does not match the configured Controller Model and Network.
 - **(Model ?)** – there may have been a change since the last time the Target Controller was compared to the configured Controller Model and Network.

File Modified Indicator - indicates that the file in the selected window has been modified but has not been saved.

14.3 Establishing Communications

The preferred method of communicating between the Configurator and an i^3 is via USB port. The i^3 C can communicate with Configurator using USB to USB, USB to serial adapters, serial port communications via MJ1 Port, Ethernet (with an Ethernet adapter board), CAN (*i*CAN) or modems. For communications other than USB or the MJ1 port please refer to the manual shipped with the communications adapter hardware being used for programming.

To communicate with the i^3 C via USB you will need the automated driver installed, included in i^3 Configurator software install V8.8 onwards:

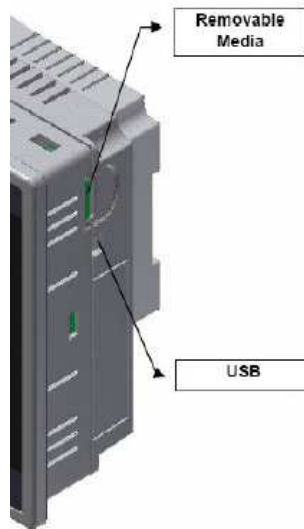


Figure 14.1 – Front Panel and USB Programming Connector

The PC will detect a new device has been plugged into the USB port.

Next, configure i^3 Configurator to use the correct communications port. This can be done using the **Tools |**

Editor Options | Communication Port dialog in i^3 Configurator. In order to find the Comm Port number that the i^3C is using, go to the PC's Control Panel and System, System Properties, Hardware.

Next, go to the PC's Device Manager and Ports.

Note that, in this example, the i^3C is on COM3. This COM number may vary from PC to PC.

Now that you know which COM port the i^3C is plugged to, go to i^3 Configurator, Tools, Editor Options, Communications Port and choose the correct COM port (in this example Com 3).

If communications are successful, the target indicator should show the mode of the controller **Target: yy(R)** as shown in the status section [above](#) in this chapter, section [i³ Configurator Status Bar](#).

If the controller is not communicating you may need to set the target ID of the controller in i^3 Configurator or on the unit. The **Target ID** allows directing communications to a particular unit when multiple units are connected via an i CAN network. Units without i CAN network ports respond to any network ID and do not require the ID to be configured.

To check or change the ID on the i^3 , press the system menu key.

The first item in the menu is **Set Network ID**. Pressing **Enter** allows you to view or modify the ID of the unit.

To change the Target ID of i^3 Configurator use the **Controller | Set Target Network ID** dialog.

14.3.1 Communicating via MJ1 Serial Port

Start by configuring i^3 Configurator to use the correct communications port. This can be done using the Tools | Options | Communication Port dialog in i^3 Configurator.

Next connect the PC's serial port to the port labeled MJ1 on the i^3 .

If communications are successful, the target indicator should show the mode of the controller Target: yy(R) as shown in the status section [above](#).

If the controller is not communicating you may need to set the target ID of the controller in i^3 Configurator or on the unit. The Target ID allows directing communications to a particular unit when multiple units are connected via an i CAN network. Units without i CAN network ports respond to any network ID and do not require the ID to be configured.

To check or change the ID on the i^3 , press the UP and DOWN keys simultaneously, or on the i^3B / i^3C press the SYS button to enter the system menu. The first item in the menu is Set Network ID.

Pressing Enter allows you to view or modify the ID of the unit.

To change the Target ID of i^3 Configurator use the Controller | Set Target Network ID dialog.

14.4 Models supported

The i^3 Configurator supports all models and options offered in the i^3 line. For the latest version of i^3 Configurator or compatibility information, contact Technical Support.

14.5 Configuration

An overview of configuration:

- (1) Start the configuration by selecting the **Controller | I/O Configure** menu item.
 - (2) If the i^3 is connected to the PC press the **Auto Config System** button to automatically detect the Base model, I/O and any communication options.
 - (3) If the i^3 is not connected press the **Config** button to the right of the top of the unit. This allows the base CPU to be selected.
 - (4) Select either i^3 **iCAN** or i^3 **No Net** from the type drop down box.
 - (5) Once the type of i^3 is selected, the model # drop down box will provide the i^3 model numbers from which to choose from.
 - (6) Once the i^3 CPU is selected, press **OK** to exit the dialog and configure the I/O that is present in the first slot.
 - (7) The I/O configure dialog (Specifically the **Module Setup** tab) provides 4 buttons to configure all of the I/O. Go through each area of I/O and configure it.
 - (8) Once done configuring the I/O OK out of configuration dialogs.
- Configuring the i^3 I/O has four main portions that are covered in this chapter. For additional information on I/O, refer the chapters covering General I/O or High Speed I/O in this manual.

The four areas of I/O configuration are:

- Digital in / HSC
- Digital out / PWM
- Analogue in
- Analogue out

14.6 Digital Input / HSC Configuration

The following figure illustrates the **Digital Input / HSC Configuration** dialog.

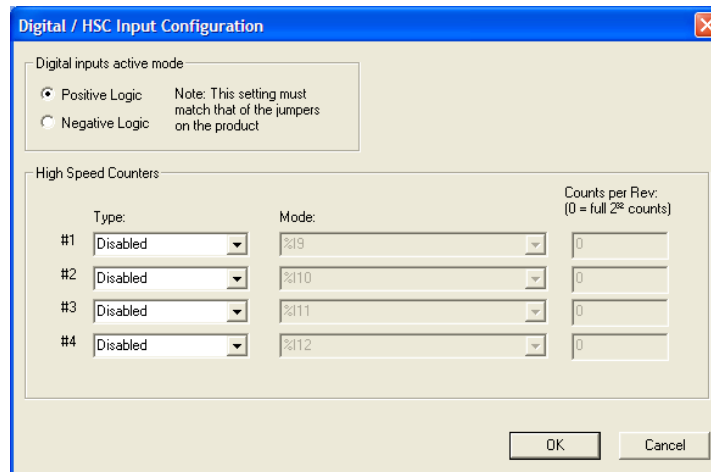


Figure 14.2 – Digital Input / HSC Configuration Dialog

The Active mode group box allows the user to select if inputs are active high (Positive logic) or active low (Negative logic). It is important that this setting match what the jumper settings are on the hardware.

The High-Speed Counters group box contains all of the windows that are used for configuring the 4 available high-speed counters on the i^3 . In configuring a counter, the user needs to set the type, mode, and counts per rev.

The type drop down includes the following options:

- Disabled
- Frequency
- Totalize
- Pulse
- Quadrature
- Marker (Only available in counter #3 if counter #1 is set to Quadrature.)

The mode drop-down items are set according to the type selection. The **Counts Per Rev.** window is enabled/disabled according to the type selection as well. The following table shows what is available with each type selection.

<i>Table 14.2.1- Count Per Rev</i>		
Type	Mode	Counts Per Rev.
Disabled	Grayed out. Displays %lx to indicate to the user that the input devoted to the high speed counter is just dumb I/O, and its location RELATIVE to the I/O map	Grayed out
Frequency	Enabled. Contains the following: 1 sec. 100 msec. 10 msec. Scan resolution	Grayed out
Totalize	Enabled. Contains the following: Rising edge Falling edge	Enabled. Value can be 0 → 0xffffffff (Hex)
Pulse	Enabled. Contains the following: Width high, 1µsec. Counts Width low, 1µsec. Counts Period rising edges, 1µsec. Counts Period falling edges, 1µsec. Counts	Grayed out
Quadrature	Enabled. Contains the following: 1 leads 2, count up 1 leads 2, count down	Enabled. Value can be 0 → 0xffffffff (Hex)
Marker	Enabled. Only available in counter #3 and only when counter #1 is set to quadrature. Contains the following: Async, reset on rising edge Async, reset on falling edge Async, reset on both edges High, reset on 1 rising Low, reset on 1 rising High, reset on 1 falling Low, reset on 1 falling High, reset on 2 rising Low, reset on 2 rising High, reset on 2 falling Low, reset on 2 falling	Grayed out

14.7 Digital Output / PWM Configuration

The following figure illustrates the **Digital Output / PWM Configuration** dialog.

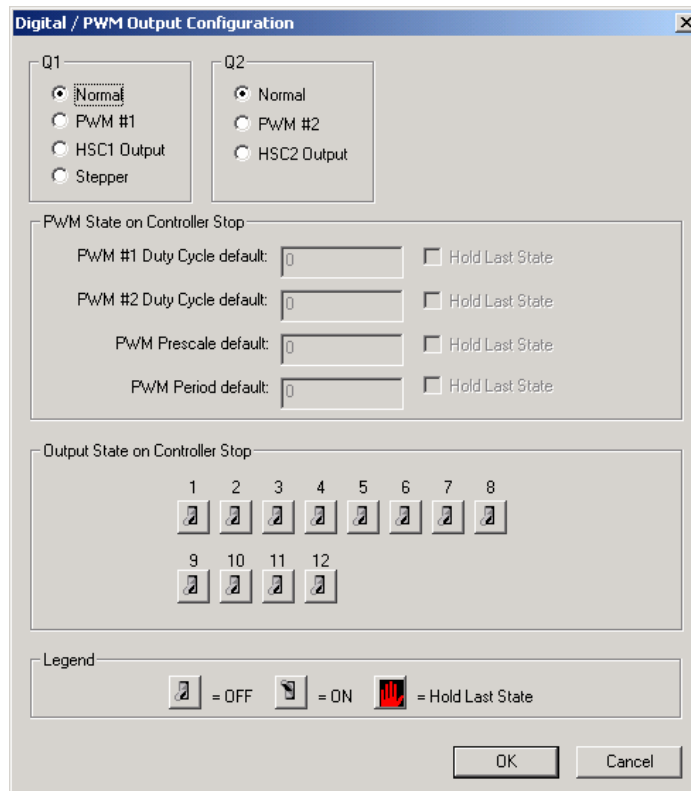


Figure 14.3 – Digital Output / PWM Configuration Dialog

The **Q1** and **Q2** group boxes allow the user to specify the operation of the multi-function outputs. The **PWM State On Controller Stop** group box contains items that allow the user to specify how the PWM outputs behave when the controller is stopped. These items can either hold their value or default to some value when the controller is stopped.

Note that the PWM outputs are set to the OFF state at power-up and during program download and remain in that state until the unit is placed in RUN

The **Output State On Controller Stop** group box contains items to allow the user to specify how the remaining digital outputs behave when the controller is stopped. These items can either hold their value or default to some value when the controller is stopped.

14.8 Analogue Input Configuration

The following figure illustrates the **Analogue Input Configuration** dialog.

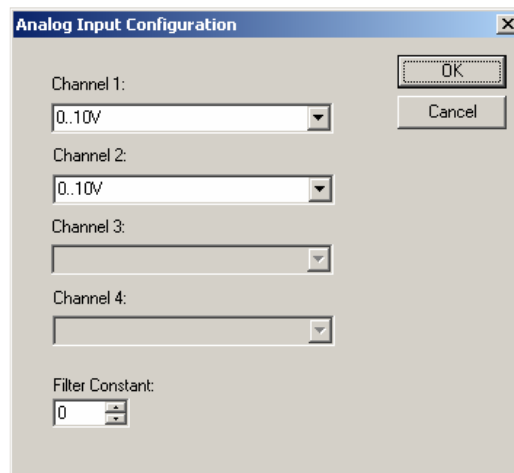


Figure 14.4 – Analogue Input Configuration Dialog

The **Channel x** drop down windows allow the user to specify the mode for each analogue input to operate. The **Channel x** drop down windows are enabled/disabled according to which model is being configured. All of the models have the following modes available:

- 0..10V
- 0..20mA
- 4..20mA

On all 13C14 models, channels 3 and 4 also have the following modes available:

- 100mV
- PT100 DIN RTD, 1/20°c
- Type J Thermocouple, 1/20°c
- Type K Thermocouple, 1/20°c
- Type N Thermocouple, 1/20°c
- Type T Thermocouple, 1/20°c
- Type E Thermocouple, 1/20°c
- Type R Thermocouple, 1/20°c
- Type S Thermocouple, 1/20°c
- Type B Thermocouple, 1/20°c

The **Filter Constant** provides filtering to all channels.

14.9 Analogue Output Configuration

The following figure illustrates the **Analogue Output** Configuration dialog.

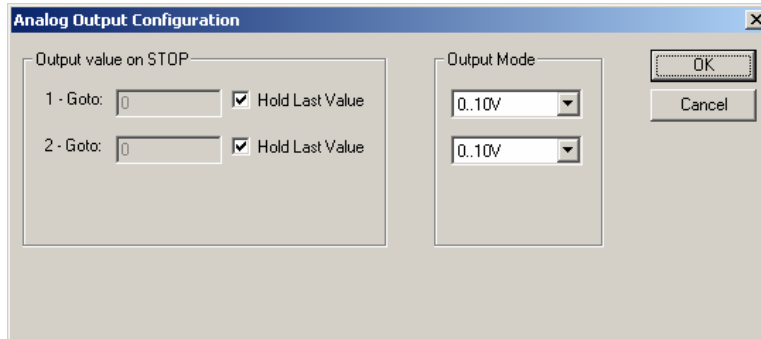


Figure 14.5 – Analogue Output Configuration Dialog

The **Output value on Stop** group box contains items that allow the user to specify how the analogue output channels behave when the controller is stopped. The outputs can either hold their value or default to a value when the controller is stopped. The **Output Mode** group box allows the user to select the operating modes for each of the analogue outputs. The modes include the following:

- 0..10V
- 0..20mA
- 4..20mA

NOTES

CHAPTER 15: MAINTENANCE

15.1 Firmware Updates

The i^3 products contain field upgradeable firmware to allow new features to be added to the product at a later time. Firmware updates should only be performed when a new feature or correction is required.

Steps for updating the firmware:

1. Establish communication between i^3 Configurator and the controller using a direct serial connection to MJ1.
2. Make sure your application is available on your PC or upload the application.
3. Make sure the machinery connected to the i^3 is in a safe state for firmware update (see warning above).
4. Start the firmware update by selecting File | Firmware Update Wizard.
5. The correct product type should be selected, if it is not select the type of controller from the drop down list and press the OK button.
6. Press the start button
7. Wait for the firmware update to complete.
8. If there is a communication failure check the cable, connections and comm. port setting and try again.
9. Firmware updates typically delete the user applications to ensure compatibility. You will need to reload your application.
10. Test the operation of the equipment with the new firmware before returning the i^3 system to an operation mode.

15.2 Backup Battery

The i^3 contains a run-time battery monitor that checks the voltage of the internal lithium battery.

This battery is used to run the real-time clock and maintains retentive registers when power is disconnected.

Under normal conditions the battery in the i^3 should last 7 to 10 years. Higher operating temperatures or variations in batteries may reduce this time.

15.2.1 Indications the battery needs replacing

The i^3 indicates the battery is low, failed or missing in a variety of ways. At power-up, an error message is displayed indicating the low or missing battery. The user program can monitor the battery using %SR55.13. This bit will turn on if the battery is low or missing. The system menu also contains a battery status message under the diagnostics sub-menu (see the chapter on System Settings and Adjustments).

Warning: Firmware updates are only performed when the equipment being controlled by the i^3 is in a safe, non-operational state. Communication or hardware failures during the firmware update process can cause the controller to behave erratically resulting in injury or equipment damage. Make sure the functions of the equipment work properly after a firmware update before returning the device to an operational mode.

15.2.2 Battery Replacement

The i^3 uses a coin lithium battery available from IMO Precision Controls Ltd.

Below are the steps to replace the battery.

1. Make sure the user program and any data stored in retentive memory is backed up.
2. Disconnect all power from the i^3 unit including I/O power.
3. Remove the battery cover.
4. Note there are two connectors (X1 and X2) in the battery compartment that can accommodate the battery connector.
5. Plug the new battery into the empty connector (X1 or X2) before removal of the old battery.
6. Remove the old battery.
7. Dispose of the old battery properly; see the above warning on disposal regulations.
8. Place the battery cover back on the unit.
9. Apply power to the unit. Check that the battery error is no longer reported. If the unit still reports the error, remove the battery immediately and contact Technical Support.



Figure 15.1 – Back Cover - Replacing the back-up battery

Warning: Disposal of lithium batteries must be done in accordance with federal, state, and local regulations. Be sure to consult with the appropriate regulatory agencies *before* disposing batteries. In addition, do not re-charge, disassemble, heat or incinerate lithium batteries.

Warning: Do not make substitutions for the battery. Be sure to only use the authorized part number to replace the battery.

WARNING: Lithium Batteries may explode or catch fire if mistreated
Do not recharge, disassemble, heat above 100 deg.C (212 deg.F) incinerate, or puncture.
Battery Cover

CHAPTER 16: TROUBLESHOOTING / TECHNICAL SUPPORT

Provides commonly requested **troubleshooting information and checklists** for the following topics.

- Connecting to the *i*³ controller
- Local controller and local I/O
- *i*CAN Network
- Removable media

In the event that this information is not what you need, please contact Technical Support at the locations indicated at the end of this chapter.

16.1 Connecting to the *i*³

The Configurator software connects to the local controller automatically when the serial connection is made. The status bar below shows an example of a successful connection. This status bar is located in the bottom right hand corner of the Configurator window.

In general the **Target** number should match the **Local** number. The exception to this is when the controller is being used as a "pass through" unit where other controllers on an *i*CAN network could be accessed through the local controller.

Determine connection status by examining feedback next to **Local & Target** in the status bar of *i*³ Configurator.

Local: ###

If a number shows next to **Local** then communication is established to the local controller.

Local: No Port

The Configurator software is unable to access the COM port of the PC. This could mean that *i*³ Configurator is configured for a COM port that is not present or that another program has control of the COM port. Only one *i*³ Configurator window can access a port at a time. Subsequent instances of *i*³ Configurator opened will indicate No Port.

Local: No Com

The Configurator software has accessed a PC COM port, but is not communicating with the controller. This typically occurs when the controller is not physically connected.

Local: ???

Unknown communication error. Close *i*³ Configurator, power cycle the controller and reopen with a blank project. Check Local.

Target: #(I,R,D) If I (idle), R (run), or D (do I/O) shows next to **Target number** then communication is established to the target controller.

Target: #(?) Communication is not established to the target controller. Check node ID of controller and set Target to match. Make sure **local** connection is established.

16.1.1 Connecting Troubleshooting Checklist (serial port – MJ1) Programming

1. Programming and debugging must use MJ1.
2. Controller must be powered up.
3. Assure that the correct COM port is selected in the Configurator software. Tools/Editor Options/Communications Port.
4. Assure that a straight through (non null modem) serial cable is being used between PC and controller port MJ1.
5. Check that a Loaded Protocol or ladder is not actively using MJ1. Taking the controller out of run mode from the System Menu on the controller will make MJ1 available to *i*³ Configurator.
6. Make sure the COM port of the PC is functioning. An RS-232 serial loopback and Microsoft HyperTerminal can determine positively if the COM port is working. Or connect to an alternate device to determine if the port is working.
7. Successful communications with USB-to-serial adapters vary. If in doubt, IMO Precision Controls Ltd. offers a USB to serial adapter.
8. *i*³ units without Ethernet or Modem must use MJ1 or the Mini B USB Port for programming and debugging (if USB present). If Ethernet is installed it can be selected as the programming port. The selection is made in the controller's System Menu. If there are difficulties connecting, make sure that the default programming port is set correctly with the connection method being attempted.

16.1.2 Connecting Troubleshooting Checklist (USB Port - Mini B) Programming (*i*³C only)

1. Programming and debugging must use Mini B USB Port or MJ1.
2. Controller must be powered up.
3. Assure that the correct COM port is selected in *i*³ Configurator: Tools/Editor Options/Communications Port.
4. Be sure that the USB cable is connected between the PC and controller and check the Windows Device Manager to find out if the USB driver is properly installed and which port it set itself up on.

5. Make sure the USB port of the PC is functioning and/or connect to an alternate device to determine if the port is working.
6. *i*³ units without Ethernet or GSM Modem must use the Mini B USB Port or MJ1 for programming and debugging. If Ethernet is installed it can be selected as the programming port, as can the GSM modem once the modem set-up has been downloaded into the *i*³ through *i*³ Configurator (for complete information on setting up the GSM modem, please download the *i*³ SMS-GSM-GPRS tutorial from the website). The selection is made in the controller's System Menu. If there are difficulties connecting, make sure that the default programming port is set correctly with the connection method being attempted.

16.2 Local Controller and Local I/O

The system menu provides the following status indications that are useful for troubleshooting and system maintenance.

- Self-test results, diagnostics.
- RUN and OK status
- Network status and usage
- Average logic scan rate
- Application memory usage
- Loaded firmware versions
- Loaded protocols
- Removable media access

To view the system menu, press the System key.

16.2.1 Local I/O Troubleshooting Checklist

1. Verify the controller is in RUN mode.
2. Check diagnostics to insure controller passed self-tests.
View diags in System Menu or in *i*³ Configurator, click; Controller/Diagnostics
3. Check data sheets to insure proper wiring.
4. Insure that hardware jumpers and software configuration for I/O match.
5. Check data sheets for voltage and current limits.
6. Take ladder out of the picture. From *i*³ Configurator set controller to "Do I/O" mode. In this mode inputs can be monitored and outputs set from a data watch window in *i*³ Configurator without interference from the ladder program. Some I/O problems are only a result of a mistake in the ladder program.

WARNING: Setting outputs ON in Do I/O mode can result in injury or cause machinery to engage in an unsafe manner depending on the application and the environment.

16.3 iCAN Network

For complete information on setting up an *i*CAN network, refer to the *i*³ CAN Tutorial by visiting our.

Network status, node ID, errors, and baud rate in the controller system menu are all in reference to the *i*CAN network. These indications can provide performance feedback on the *i*CAN network and can also be used to aid in troubleshooting.

16.3.1 iCAN Network Troubleshooting Checklist

1. Use the proper Belden wire type or equivalent for the network as specified in MAN0799.
2. The *i*³ does not provide 24VDC to the network. An external voltage source must be used for other devices such as Smart I/O.
3. Check voltage at both ends of the network to insure that voltage meets specifications of attached devices.
4. Proper termination is required. Use 121-ohm (or 120-ohm) resistors at each end of the network. The resistors should be placed across the CAN_HI and CAN_LO terminals.
5. Measure the resistance between CAN_HI and CAN_LO. If the network is properly wired and terminated there should be around 60 ohms.
6. Check for duplicate node ID's.
7. Keep proper wires together. One twisted pair is for V+ and V- and the other twisted pair is used for CAN_HI and CAN_LO.
8. Make sure the baud rate is the same for all controllers on the network.
9. Assure shields are connected at one end of each segment -- they are not continuous through the network.
10. Do not exceed the maximum length determined by the baud rate and cable type.
11. Total drop length for each drop should not exceed 6m (20 feet). A drop may include more than one node. The drop length adds to the overall network length.
12. Network should be wired in "straight line" fashion, not in a "star" pattern.
13. In applications requiring multiple power supplies, make sure the V- of all supplies is connected together and to earth ground at one place only.
14. In some electrically noisy environments it may be necessary to add repeaters to the network.

Repeaters can be used to add additional nodes and/or distance to the network and protect the signal against noisy environments.

16.4 Removable Media

16.4.1 Basic Troubleshooting

Description	Action
<i>i</i> ³ does not read media card.	The media card should be formatted with the <i>i</i> ³ .
<i>i</i> ³ will not download project file.	Make sure the project file is saved as a compiled .pgm file and not an uncompiled .csp file. In addition to file must be .pgm, the file's I/O configuration must match the <i>i</i> ³ configuration for it to download.

16.5 Screen

Description	Action
<i>i</i> ³ screen will not light.	<ol style="list-style-type: none"> 1. Check external jumper/DIP switch is not set for tiny bootloader upgrade. See page 23. 2. Check %SR57 is not set to 0. Move a value between 1-255 into the register to turn the backlight on.
Screen function becomes too slow when large ladder program is used	<ol style="list-style-type: none"> 1. On larger programs, use Sub-Calls and Jump functions to optimize program scan time. See Basic Operation Tutorial for more details. 2. In Display editor, select Config ->Display Setting and increase this time to balance processor time dedicated between Ladder scan and HMI function.
Incorrect user screen shown from ladder screen-call.	Ensure only one ladder-activated screen call is active at any moment in time. Screen calls are only enacted at the end of the ladder scan. If multiple call are active during the scan, only the last one read will be enacted.

16.6 Technical Support Contacts

For manual updates and assistance, contact Technical Support at the following locations:

NOTES

INDEX

Accessories	13	%AQG.....	62, 66
Communication	22	%D.....	59, 62, 66
CANopen.....	25	%I.....	62, 66
Embedded Ethernet	27	%IG	62, 66
Ethernet	12, 13, 22, 27, 30, 56, 63, 67, 76, 77	%K.....	62, 66
GPRS.....	30	%M.....	62, 66
GSM.....	30	%Q.....	38, 62, 66
iCAN	25, 52, 66, 67, 68, 69, 76, 77	%QG.....	62, 66
MJ1.....	22, 23, 25, 27, 30, 55, 56, 67, 68, 74, 76, 77	%R.....	62, 66
MJ2.....	22, 23, 27, 55, 56	%S	62, 63, 66
SMS.....	13, 30, 31, 53	%SR.....	62, 63, 66
Web Server.....	27	%T	62, 66
Configurator..	12, 22, 23, 25, 30, 34, 36, 38, 39, 40, 42, 55, 59, 60, 65, 67, 68, 69, 74, 76, 77	Removable Media.....	6, 11, 33, 34, 57, 78
Dimensions	17	SanDisk	33
GENERAL I/O	36	Safety	8
Fusing.....	38	CE Compliance	8
Jumper	37	Grounding.....	8, 18, 20
Model Overview.....	37	SYSTEM SETTINGS.....	50
Relay.....	37, 38	Failsafe Menu.....	58
Solid-State.....	37	Removable Media	57
High Speed Counter.....	42, 47	Set Beeper	57
Frequency	42, 46, 47, 48, 49, 69	Set Fkeys Mode.....	56
Pulse	42, 43, 46, 69	Set Network Baud	52
Quadrature.....	42, 43, 44, 65, 69	Set Network ID.....	52
Totalize.....	42, 46, 69	Set Serial Ports	56
INSTALLATION	6, 14, 20	Set Time/Date.....	56
Power.....	21	View Diags.....	54
REGISTERS	62	View I/O Slots.....	55
%AI	42, 62, 66	View i ³ Status.....	53
%AIG	62, 66	View Protocols	55
%AQ.....	42, 62, 66	Troubleshooting.....	76, 77
		Where to Find Information	11

Table of Figures:

Figure 2.1 – Visual Overview.....	10
Figure 2.3 – Visual Overview of Types of Devices that can be connected to i³ (A,B,C).....	12
Figure 3.1 – Panel Mounting of an i³	14
Figure 3.2 – DIN Rail Mounting of the i³	15
Figure 3.2 – i³ with Mounting Clips.....	15
Figure 3.4 – Panel Cutout Tolerances	16
Figure 3.5 – i³ Dimensions.....	17
Figure 4.1 - Two-Point Ground Connection Test.....	20
Figure 4.1 – Two Point ground connection test.....	20
Figure 4.2 - Power Connector (Primary Power Port)	21
Figure 4.3 – Primary Power Port As Viewed Looking at the i³	21
Figure 5.1 – MJ Serial Port Connector	22
Figure 5.2.0 – MJ i³ Serial Port Connectors and DIP Switches for RS-485 Port Termination	23
Figure 6.2 - NET1 Port Connector	25
Figure 7.2.1 – I/O Configuration Dialog	28
Figure 7.2.2 – Ethernet Module Configuration	28
Figure 7.3.1 – GSM Data.....	32
Figure 7.3.2 – GPRS Data (Private IP).....	32
Figure 7.3.3 – GPRS Data (Static IP).....	32
Figure 8.2 – Installing Removable Memory Card.....	33
Figure 8.3 – i³ Removable Media Submenu (i³C menu shown).....	34
Figure 9.1 – Removing the I/O Cover	36
Figure 9.2 – I/O Cover Removed (sample I/O board).....	36
Figure 9.4 – Example Jumper Diagram.....	37
Figure 9.5 – Typical Output Wiring	38
Figure 9.6 - Relay Fusing	38
Figure 9.7 – Positive and Negative Inputs.....	39
Figure 10.1 – Sync pulse mode illustration	45
Figure 11.1 – System Menu (i³C).....	50
Figure 11.2 – System Menu (i³C) Screenshot	51
Figure 12.1 – Typical Screen Jump Object (i³C).....	59
Figure 12.2 – Force and Switch Coils in Ladder Programming	59
Figure 14.1 – Front Panel and USB Programming Connector	68
Figure 14.2 – Digital Input / HSC Configuration Dialog	69
Figure 14.3 – Digital Output / PWM Configuration Dialog.....	71
Figure 14.4 – Analogue Input Configuration Dialog	72
Figure 14.5 – Analogue Output Configuration Dialog.....	72
Figure 15.1 – Back Cover - Replacing the back-up battery	75

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