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ModIO™ M100
Modbus Interface Unit
User's Guide

ModIO PCB Rev: 1.2 (aka Rev C)
Firmware Rev: 16
Mach3 Rev: 1.84

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Disclaimer

Feedback

We appreciate any feedback you may have for improvements on this document. Please send your comments to info@homanndesigns.com

Trademarks

Acknowledgements

To get a product like the ModIO to the state that it is now, takes an immense effort. This would not be possible without the help of the following people and others who have helped by beta testing the early versions.

Andy Wander - Andy has taken it upon himself to provide front line support for the ModIO, usually being the first to address questions and problems as they appear on the Yahoo ModIO and Mach User Groups.

Art Fenerty - Art has worked tirelessly, providing a ModIO interface into Mach3. He is always open and responsive to new suggestions and possibilities.

Olivier Adler - Olivier convinced us that ModBus was the way to go for a reliable serial communications protocol. Additionally, he conducted the ModIO RS-485 interface testing, identified a number of required safety features and has always provided valuable feedback.

John Prentice - John has transformed this document from its incomplete draft state into a polished manual. Additionally, behind the scenes John has been a sounding board and a great support during the development of the ModIO.

Steve Blackmore - Steve has always provided sound advice and feedback on various aspects of the ModIO development.

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1 Introduction

Thank you for purchasing Homann Designs' *ModIO™ M100 Modbus interface unit*. The M100 provides a general purpose interface unit with a Modbus RS-232 and RS-485 serial interface for communication with a Modbus Master.

This document is a User's Guide that describes the *ModIO™ M100 Modbus interface unit*. The document contains information on how to use and integrate the board into your own systems.

1.1 Contents

The box received when ordering the *ModIO™ M100 Modbus interface unit*. contains the following:

- The *ModIO™ M100 Modbus interface board*
- A serial cable, DB9-male to 10 pin 2 x 5, 0.1" boxed header , for connecting
- An optional 4x20 Character LCD display for use with the M100.

1.2 Features

Homann Designs' *ModIO™ M100 Modbus interface unit* lets you quickly and simply add additional I/O functionality to your CNC system. The M100 provides the following;

- Serial Communications
  - Modbus Protocol Stack
  - RS-232 Transceiver, and
  - RS-485 Half or Full Duplex Interface
  - RX and TX communications activity indicator LEDs
- Digital I/O
  - 8 Digital 0 - 5 volt logic inputs
  - 8 Digital outputs capable of driving relay coils
  - LED Activity indicators on all inputs and outputs
- Analog Inputs
  - 3 Analog inputs with 0 - 5 volt input
  - 10-bit resolution (1024 steps)
- Quadrature Encoders
  - 2 Manual Pulse Generator (MPG) Quadrature Encoder interfaces
- Character LCD Interface
  - For Hitachi HD44780 (industry standard) controller character displays
  - Up to 4 x 20 character LCD Display.
- Safety Charge Pump
  - Disables outputs when Modbus Communications are interrupted.
- DigiSpeed™ Interface
  - Generates PWM Signals for DigiSpeed™ Motor Speed controller.
- Expansion Module Interface
  - Provides for up to 15 Special purpose Interface expansion boards.
- Power Supply Input
  - +8 to +24 Vdc or +6 to +12Vac via screw terminals or,
  - +8 to +24 Vdc or +6 to +12Vac via 2.1mm Coaxial jack
  - Power indicator LED
- Firmware Upgrades
  - User upgradeable via serial interface.
- Other Features
  - Error indicator LED for ModIO™ and communications errors.
  - 5mm pluggable screw terminals for Digital, Analog I/O and Power connections.
  - Designed to fit into the OKW B6504111 RailTec DIN Rail enclosure.

The ModIO™ can be used with any controlling software supporting the Modbus RS-232 or RS-485 standards. In this manual we will use the Mach3 CNC controller when we need to illustrate the master side of the Modbus interface. A demonstration of Mach3 can be downloaded from : http://www.artsoft.ca should you not already be using it and want to run the setup procedures described in the manual.

2 Quick Start Guide

This section is intended to allow you to set up your new ModIO™ with a single switch and to use Mach3 to read its state and to control one of the output LEDs of the ModIO™. Initially you should use the RS-232 interface, even though you may eventually want to use RS-485. When you have successfully done this you will have experience which will help you understand the information in subsequent chapters.

We cannot too strongly advise you to follow these simple tests if you have not used a ModIO™ before. Its neat appearance belies a large number of configurable facilities. In addition you must ensure that the software in the PC (the master) and the ModIO™ (the slave) are compatibly configured. The serial communications cannot be simply diagnosed with a multi-meter or logic probe in the way that the connections between parallel port and breakout board can. If you do encounter any difficulties then an understanding of what you are aiming to do and a systematic set of testing steps will ensure your success.

This manual contains many diagrams showing interface connections, but if you have difficulty in understanding them you are strongly advised to seek assistance from someone with electronics experience. Incorrect connections could damage the ModIO™ and/or the equipment to which you are interfacing.

2.1 What you need

To get started you need:

- a ModIO™ board
- a toggle or push switch with two flying leads
- a power supply (e.g. wall-wart aka plug-top transformer) delivering 6 to 18 volts AC, or 8 to 24 volts DC via a 2.1 mm coaxial jack
- a lead with a D9 Male connector at one end (the ModIO™) and a D9 Female connector at the computer end
- a PC with a serial (COM) port available and Mach3 installed on it
- and, ideally, an LCD connected to the ModIO™

With the power to PC and ModIO™ switched off connect the ModIO™ to the PC by the serial cable and RS-232 ribbon cable supplied with the ModIO™. This plugs into J7 which is between the two sets of LEDs which face the edge of the board.

If you have the LCD, plug it into J4

Check that the jumpers are in their default positions as shown in figure 2.1 Notice that the jumpers and pins have been highlighted for clarity of illustration.

Switch the hex rotary switch (figure 3.4) to “0” (zero) – This gives the default configuration of all ModIO parameters (e.g. baud rate, slave address etc.).

Plug in the power jack

Turn on the computer and ModIO™ power supply. The green power LED on the ModIO, should light. See figure 3.4. The LCD should display text similar to figure 3.3. – in particular be sure to check that “–DEF” is shown on the bottom line. If it is not then the hex switch is not correctly set.

Next you need to tell Mach3 about your ModIO™.

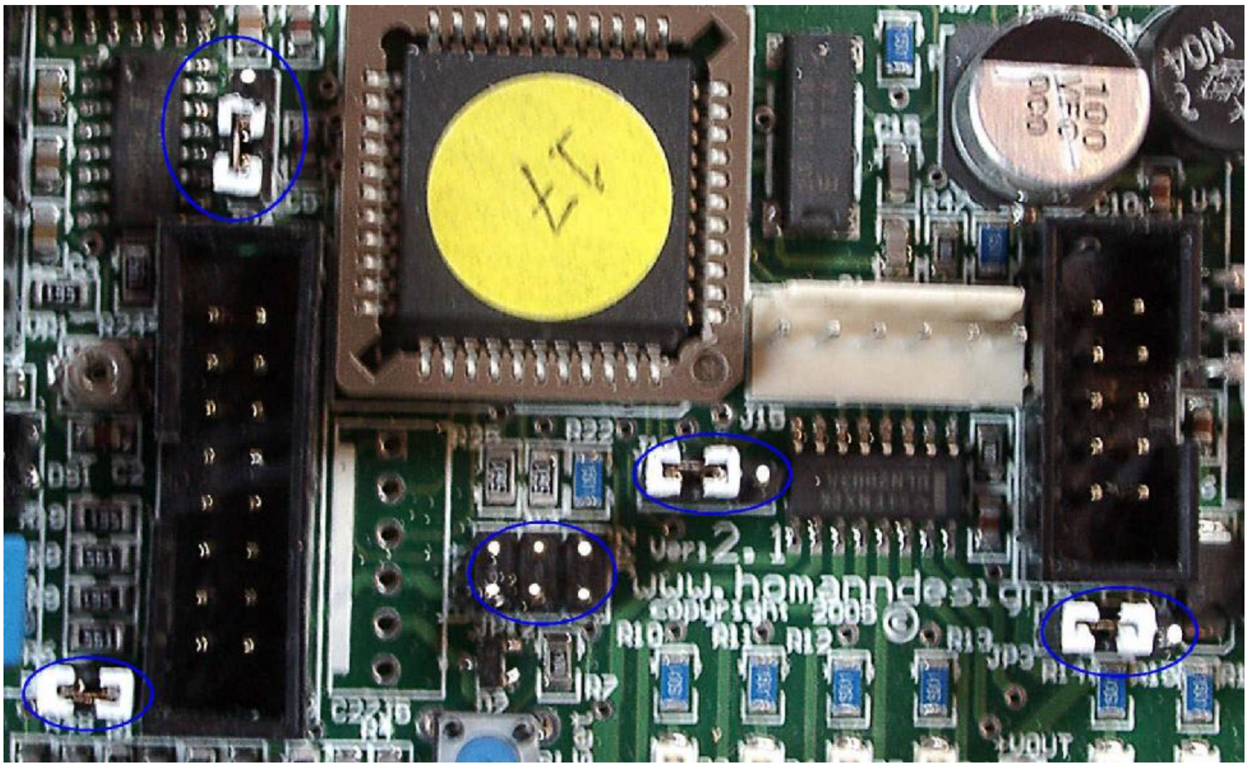


Figure 2.1 – Standard jumpering for use with RS-232

2.2 Configuring Mach3/IV

Double click the Mach3 icon – not Mach3Mill. Click Create Profile. And fill in the new name and highlight that you want it cloned from Mach3Mill. If you have another profile you normally use then you can clone from this. See figures 2.2 and 2.3.

You can either create a new shortcut for your profile (see *Using Mach3Mill* manual) or run Mach3.exe and select from the list of profiles

In this manual we will assume that you are using the standard 1024.set screens. The ModIO™ will however work with any screen set.

If you are testing the ModIO™ on a computer that does not have your machine tool connected to it then you will need to work in the *Offline* mode to be able to clear the EStop condition.

On Config>Ports and Pins, Port Setup & Axis Selection tab, check ModBus Input/Output support. Close Mach3 and reload it with your ModIOTest profile

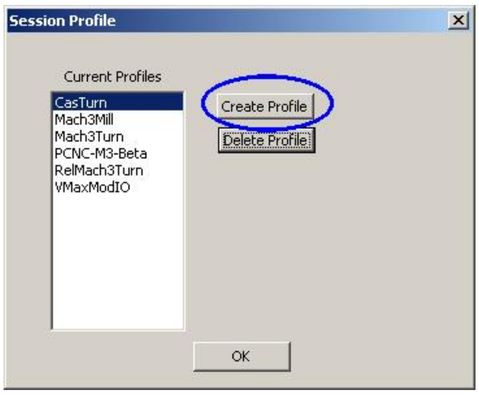


Figure 2.2 – Creating new Profile

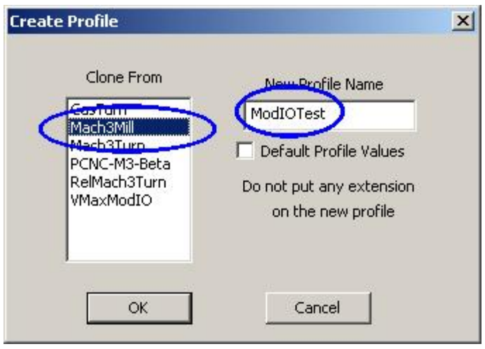
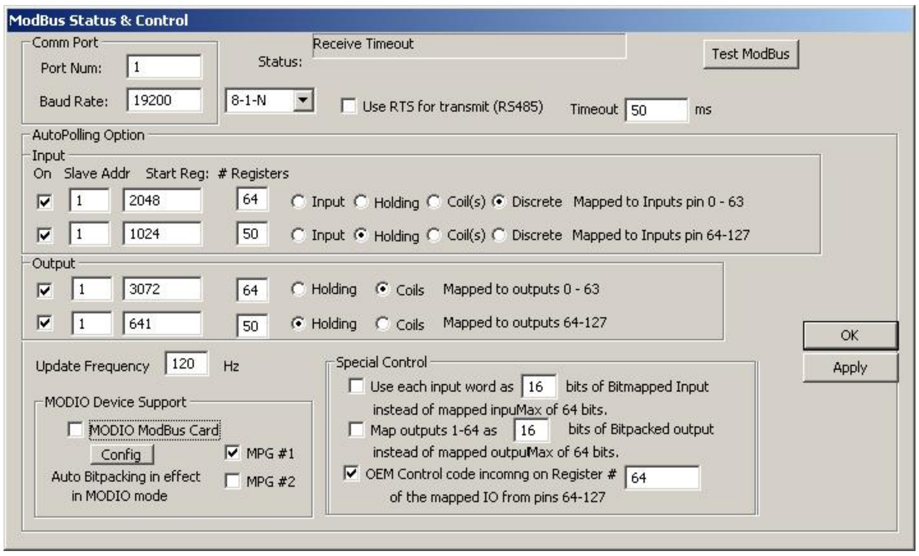


Figure 2.3 – Naming and cloning

Open the dialog from the Config>Setup ModBus Control menu. It will look like figure 2.4


ModBus Status & Control

Comm Port
Port Num: 1
Baud Rate: 19200
8-1-N

Status: Receive Timeout

Test ModBus

[ ] Use RTS for transmit (RS485)
Timeout 50 ms

AutoPolling Option

Input

On	Slave Addr	Start Reg:	# Registers		
[✓]	1	2048	64	Input Holding Coil(s) [✓ Discrete]	Mapped to Inputs pin 0 - 63
[✓]	1	1024	50	Input [✓ Holding] Coil(s) Discrete	Mapped to Inputs pin 64-127

Output

[✓]	1	3072	64	Holding [✓ Coils]	Mapped to outputs 0 - 63
[✓]	1	641	50	[✓ Holding] Coils	Mapped to outputs 64-127

Update Frequency 120 Hz

MODIO Device Support
[ ] MODIO ModBus Card
Config
[✓] MPG #1
[ ] MPG #2
Auto Bitpacking in effect in MODIO mode

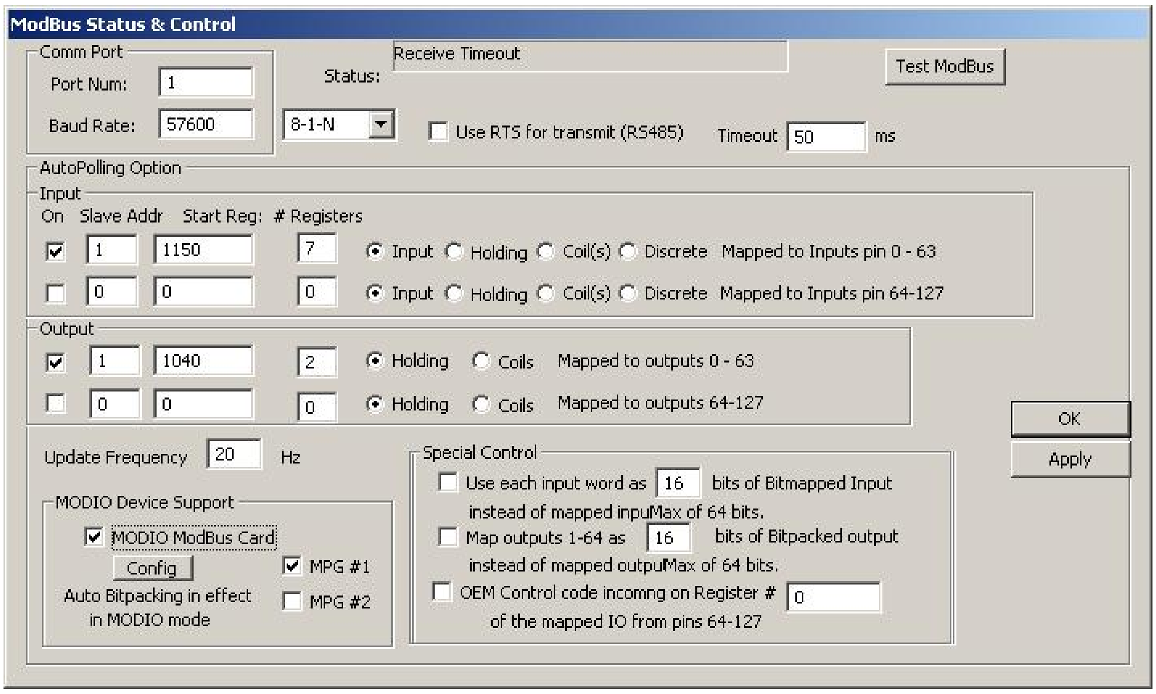
Special Control
[ ] Use each input word as 16 bits of Bitmapped Input instead of mapped inpuMax of 64 bits.
[ ] Map outputs 1-64 as 16 bits of Bitpacked output instead of mapped outpuMax of 64 bits.
[✓] OEM Control code incomng on Register # 64 of the mapped IO from pins 64-127

OK
Apply

Figure 2.4 – A default Modbus configuration in Mach3

This complex looking screen allows Mach3 to be used with virtually any Modbus device – e.g. a custom programmed PLC.

Mach3 is aware of the arrangement of registers in the ModIO™ and will replace this arbitrary configuration with one optimised for ModIO™ when you check the *MODIO ModBus* card checkbox. The screen will then look like figure 2.5.


ModBus Status & Control

Comm Port
Port Num: 1
Baud Rate: 57600
8-1-N

Status: Receive Timeout

Test ModBus

[ ] Use RTS for transmit (RS485)
Timeout 50 ms

AutoPolling Option

Input

On	Slave Addr	Start Reg:	# Registers		
[✓]	1	1150	7	[✓ Input] Holding Coil(s) Discrete	Mapped to Inputs pin 0 - 63
[ ]	0	0	0	[✓ Input] Holding Coil(s) Discrete	Mapped to Inputs pin 64-127

Output

[✓]	1	1040	2	[✓ Holding] Coils	Mapped to outputs 0 - 63
[ ]	0	0	0	[✓ Holding] Coils	Mapped to outputs 64-127

Update Frequency 20 Hz

MODIO Device Support
[✓] MODIO ModBus Card
Config
[✓] MPG #1
[ ] MPG #2
Auto Bitpacking in effect in MODIO mode

Special Control
[ ] Use each input word as 16 bits of Bitmapped Input instead of mapped inpuMax of 64 bits.
[ ] Map outputs 1-64 as 16 bits of Bitpacked output instead of mapped outpuMax of 64 bits.
[ ] OEM Control code incomng on Register # 0 of the mapped IO from pins 64-127

OK
Apply

Figure 2.5 – Mach3 set for ModIO

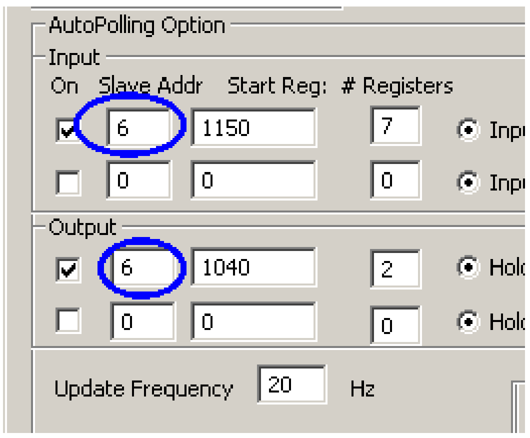
It is assumed that you are plugged into COM1 on your PC. The baud rate and async parameters are set to 57600 and 8-1-N which is the ModIO™ default. Use RTS is only relevant to half-duplex RS-

485 operation and the default serial timeout of 50mS is suitable for all applications.

At this stage the green LED to the left of the RS-232 cable should be giving and intermittent double-flash about every half second. This shows that data is being received by the ModIO™.

The details of the Autopoller are described later in chapter 4. For now, notice only that the Slave Address is set to 1 in Mach3 whereas the ModIO™ default is 6. Change the screen as shown in figure 2.6 and click *Apply*.

When you do this you should notice that the status message *Receive Timeout* at the top of the screen should change to *No Error*. The flashing green LED will speed up and the red one above it will also flash. The red LED shows that the ModIO™ is recognising the received data (because the slave address is correct) and transmitting replies.



AutoPolling Option

Input

On	Slave Addr	Start Reg:	# Registers	
✓	6	1150	7	● Inp
☐	0	0	0	● Inp

Output

On	Slave Addr	Start Reg:	# Registers	
✓	6	1040	2	● Hol
☐	0	0	0	● Hol

Update Frequency 20 Hz

Figure 2.6 – Setting slave address

There is no point in going further if you cannot get the regular red/green flashing when the ModIO™ is connected to your running Mach3. Recheck connections, that the ModIO™ is running the default configuration and that the Config>Setup ModBus Control dialog looks correct.

If all is well you can control your first output device.

2.3 Lighting an LED

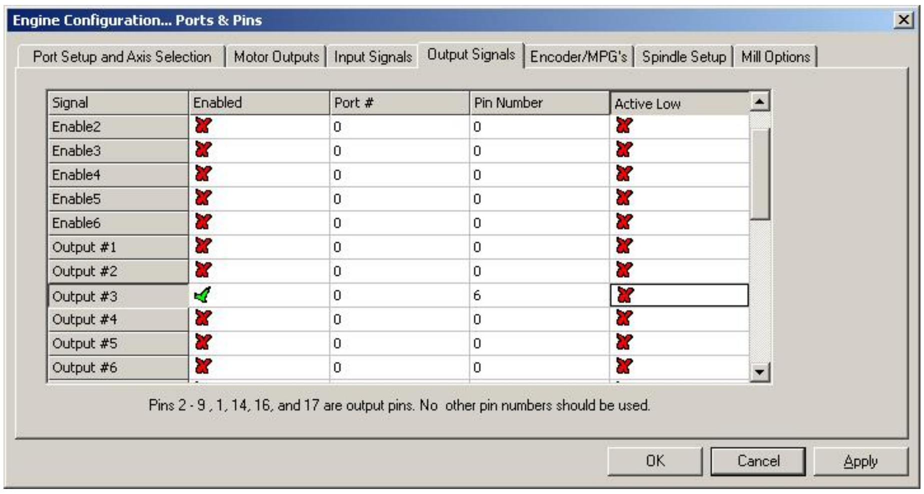
The ModIO™ has 8 digital outputs each with an indicator LED on the board. If the power jack is on the right hand side of the board then these LEDs are above the connector on the bottom edge.

The outputs are numbered 0 to 7 from left to right. These numbers correspond to setting Port 0 “Pins” 0 to 7 in the Config>Ports and Pins, Output Signals tab.

Within Mach3 the outputs which can be controlled from parallel port, ModIO™ or, in MachIV, the GRex are numbered 1 to 20.

Figure 2.7 shows Mach output #3 configured to ModIO™ Discrete Output 6.

Do this on your system and click *Apply*.



Engine Configuration... Ports & Pins

Port Setup and Axis Selection | Motor Outputs | Input Signals | Output Signals | Encoder/MPG's | Spindle Setup | Mill Options

Signal	Enabled	Port #	Pin Number	Active Low
Enable2	✗	0	0	✗
Enable3	✗	0	0	✗
Enable4	✗	0	0	✗
Enable5	✗	0	0	✗
Enable6	✗	0	0	✗
Output #1	✗	0	0	✗
Output #2	✗	0	0	✗
Output #3	✓	0	6	✗
Output #4	✗	0	0	✗
Output #5	✗	0	0	✗
Output #6	✗	0	0	✗

Pins 2 - 9 , 1, 14, 16, and 17 are output pins. No other pin numbers should be used.

OK | Cancel | Apply

Figure 2.7 – Mach Output 3 configured to ModIO discrete output 6

Now if you change the Active Low column for your output you will be able to turn the LED (next to the right end for Discrete Output 6) on and off.

Figure 2.8 shows LED 6 on and figure 2.9 shows the corresponding screen setting.

In practice, of course, an output would be controlled by something like M07/M08 (coolant) or a user macro in Mach3.

You can show this by using Config>Ports and Pins, Spindle tab to set Mach3 output 3 to be the Flood coolant control. Then your LED will turn on if you MDI an M08 or use the Flood coolant button and turn off with an M09.

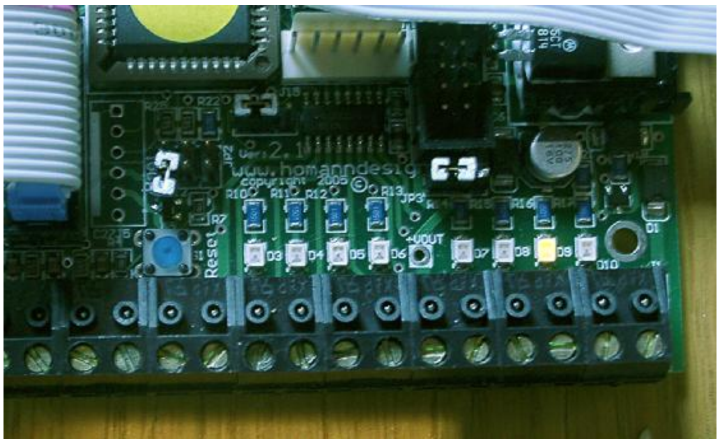
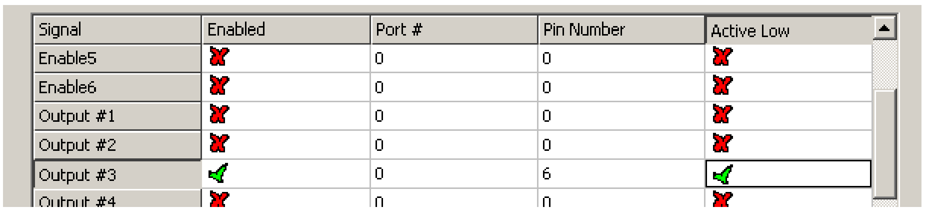


Figure 2.8 – LED 6 is ON

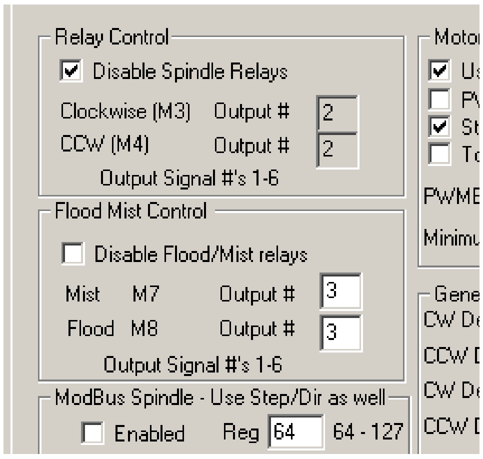


Signal	Enabled	Port #	Pin Number	Active Low
Enable5	✗	0	0	✗
Enable6	✗	0	0	✗
Output #1	✗	0	0	✗
Output #2	✗	0	0	✗
Output #3	✓	0	6	✓
Output #4	✗	0	0	✗

Figure 2.9 – Config for LED 6 to be ON

You might be confused by all the numbering so it is worth summarizing it.

- Every output signal in Mach3 has an internal number (1 to 20)
- In Config>Ports and Pins, Output Signals you link (or map) these to a port and a "pin" number on that port
- ModIO™ ouputs (and inputs come to that) are all referred to as being on Port 0 (zero). Printer ports are 1 and 2.
- The 8 ModIO™ Discrete Outputs are named DOut0 to DOut7 (left to right if the connector is at the bottom as you view the board) and, for example, DOut 6 is what Mach3 thinks is Port 0 Pin 6.



Relay Control
[✓] Disable Spindle Relays
Clockwise (M3) Output # 2
CCW (M4) Output # 2
Output Signal #'s 1-6

Flood Mist Control
[ ] Disable Flood/Mist relays
Mist M7 Output # 3
Flood M8 Output # 3
Output Signal #'s 1-6

ModBus Spindle - Use Step/Dir as well
[ ] Enabled Reg 64 64 - 127

Figure 2.10 – Coolant is ModIO Output 6

And finally:

- The actual outputs are connected to numbered terminals (plugged onto pins) on the ModIO™. So for example the signal DOut 6 is on terminal 16 – sometimes called pin 16. These numbers are defined in Table 3.1

It seems complicated but unfortunately necessary because of the power of the system.

Next you can move on to see how a switch input can be used.

2.4 Sensing a switch closure

Switch off the ModIO™ power and connect a normally open switch between terminals 5 and 8 on the Input side of the ModIO™. These terminals are Ground and input DIn 1 respectively.

Note: Take care not to do this on the output side by mistake.

Switch on the ModIO™ power. When you press the switch the second light from the left (if power jack is on right hand edge of board) should light. If it is on and goes off when switch pressed the you have a normally closed switch by mistake.

The connections are shown in figure 2.11.

Now go to Config>Ports and Pins, Input Signals tab and define input #3, say, to be Port 0 (i.e. the ModIO™) Pin 1 (i.e. Din 1). This is shown in figure 2.12

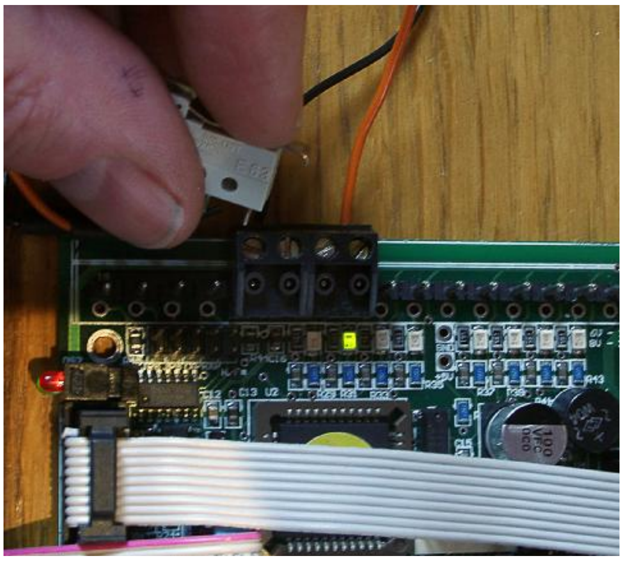
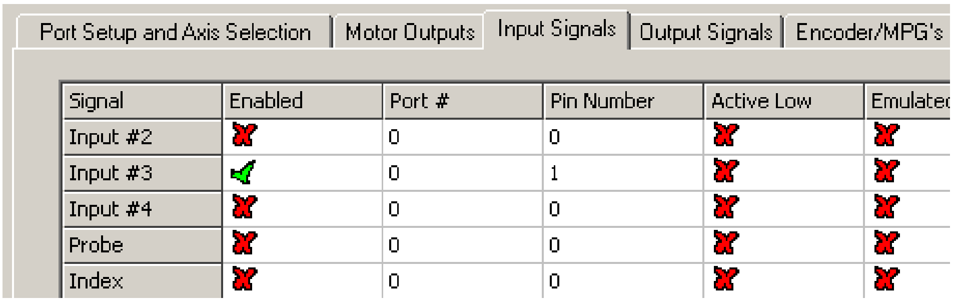


Figure 2.11 – Switch connected to terminals 5 and 8 of Input side of ModIO

When you go to the Mach3 Diagnostics screen you will see Input #3 lighting when you press the switch.



Signal	Enabled	Port #	Pin Number	Active Low	Emulated
Input #2	✗	0	0	✗	✗
Input #3	✓	0	1	✗	✗
Input #4	✗	0	0	✗	✗
Probe	✗	0	0	✗	✗
Index	✗	0	0	✗	✗

Figure 2.12 – Configuring a ModIO input

Note: If you are following very carefully you might spot that we have the switch connected so it pulls the input low when active but did not select Active Low in Config>Ports and Pins. This is a feature (or perhaps more properly bug) of the current release of Mach3.

If your ModIO™ works with these two simple tests then you are in a position to configure it and Mach3 interfaced to an actual machine tool. Congratulations!

The next chapter gives details of all the physical interfaces.

3 Board Description

3.1 Introduction

This section tells you about the mechanical and electrical aspects of the ModIO™ board.

On first reading you probably do not need to read beyond the description of the LEDs and their functions.

3.2 Overview

The board is 82mm x 98 mm excluding wiring space from the screw connectors. The total thickness is approximately 25mm. Figure 3.1 shows the position of the mounting holes.

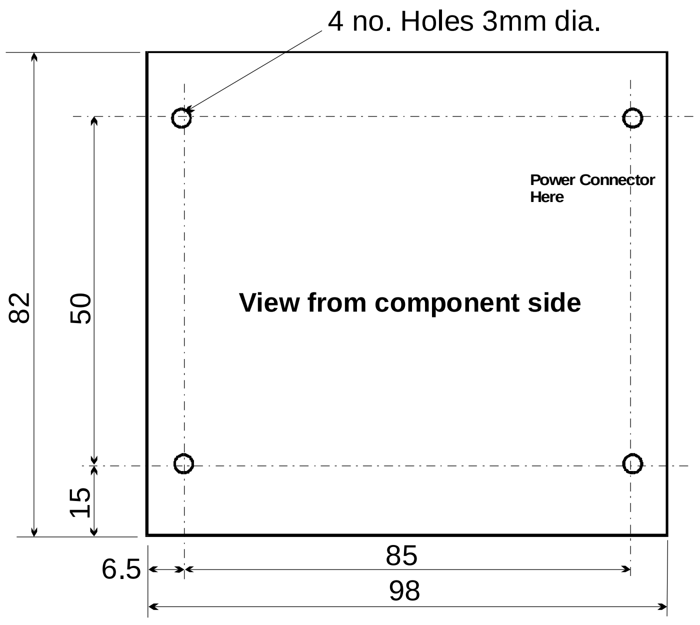


Figure 3.1 – Board outline and fixings

3.3 Connectors

3.3.1 Connector summary

The ModIO™ contains a number of connectors by which the board is interfaced to the PC, your machine tool and its control panel and a power source. The connectors are listed in Table 3.1 below. The location of the connectors is indicated in Illustration 3.2 below.

Connector	*Description*	*Comment*
J1, J10	I/O Connectors	18 Pin pluggable screw connectors
J4	LCD Interface	16 pin 2 x 8, 0.1" IDC header
J6	Expansion Bus	10 pin 2 x 5, 0.1" IDC header
J7	RS-232 Interface	10 pin 2 x 5, 0.1" IDC header
J8	Power Jack	2.1mm Coaxial Power jack
J15	DigiSpeed™ Control	6 Pin Molex 0.1" single row header

Table 3.1 - Connector Summary

3.3.2 I/O Connectors (J1, J10)

The ModIO™ contains 2 connectors for interfacing to the machine tool and its control panel. Each connector (J1 and J10) is made up of 18 pluggable screw terminals. Being pluggable, they may be "lifted off" their pins to aid servicing and installation. The identification of each terminal is listed below in Table 3.2 and Table 3.3 below.

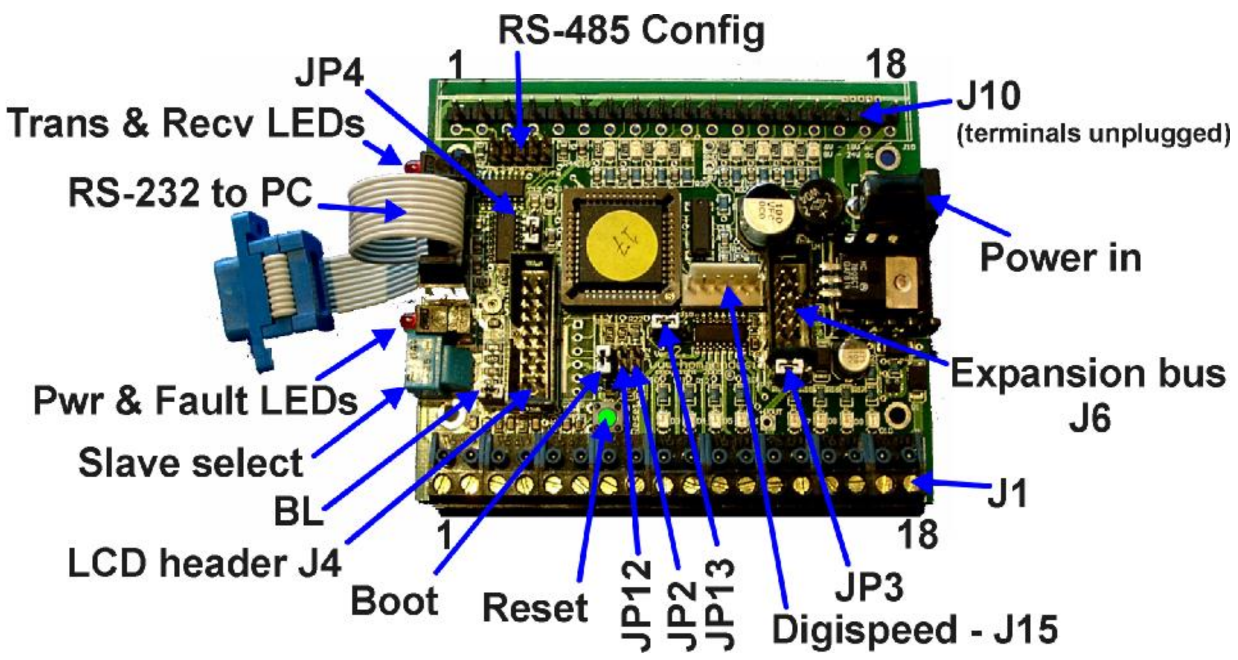


Figure 3.2 – Jumper/Connector Identification

Pin number	*Signal*	*I/O*	*Comment*
1	+5v	-	Power Supply (+5V)
2	Analog 1 Input	I	0-5V Analog Input
3	Analog 2 Input	I	0-5V Analog Input
4	GND	-	Power Supply (GND)
5	Analog 3 Input	I	0-5V Analog Input
6	GND	-	Power Supply (GND)
7	VGnd	-	Connect external VOut supply Ground here
8	+VOut	-	Device supply (VOut) *(It is a power input or output depending on JP3)
9	DOut0	O	Discrete Output Shared with Scanned keyboard column select 0
10	DOut1	O	Discrete Output Shared with Scanned keyboard column select 1
11	DOut2	O	Discrete Output Shared with Scanned keyboard column select 2 Shared with DigiSpeed Direction
12	DOut3	-	Discrete Output Shared with Scanned keyboard column select 3 Shared with optional DigiSpeed Enable
13	+VOut	-	Power Supply (VOut)*

Pin number	*Signal*	*I/O*	*Comment*
14	DOut4	O	Discrete Output Shared with DigiSpeed PWM signal
15	DOut5	O	Discrete Output
16	DOut6	O	Discrete Output
17	DOut7	O	Discrete Output
18	+VOut	-	Power Supply (VOut)* (see pin 3)

Table 3.2 - J1 or J2 I/O Connector (Outputs side)

Pin number	*Signal*	*I/O*	*Comment*
1	RS-485 A+	I/O	RS-485 differential line A+
2	RS-485 A-	I/O	RS-485 differential line A-
3	RS-485 B-	I/O	RS-485 differential line B-
4	RS-485 B+	I/O	RS-485 differential line B+
5	GND	-	Power Supply (GND)
6	+5V	-	Power Supply (+5V)
7	DIn0	I	Discrete Input (0-5V) Shared with Scanned Keyboard data 0
8	DIn1	I	Discrete Input (0-5V) Shared with Scanned Keyboard data 1
9	DIn2	I	Discrete Input (0-5V) Shared with Scanned Keyboard data 2
10	DIn3	I	Discrete Input (0-5V Shared with Scanned Keyboard data 3
11	GND	-	Power Supply (GND)
12	DIn4	I	Discrete Input (0-5V) Shared with DigiSpeed Index Shared with MPG2
13	DIn5	I	Discrete Input (0-5V) Shared with MPG2
14	DIn6	I	Discrete Input (0-5V) Shared with MPG1
15	DIn7	I	Discrete Input (0-5V) Shared with MPG1
16	GND	-	Power Supply (GND)
17	Vac/Vdc	-	Power Supply (VIN)
18	Vac/Vdc	-	Power Supply (VIN)

Table 3.3 - J10 or J12 I/O Connector (Inputs side)

Note:

(a) In this revision of the manual these Data connections have been relabeled from 0 to 7 rather than 1 – 8 to correspond to the bit numberings in DIN and DOUT registers. You do not need to change any existing wiring - this is only a name change.
(b) For the remainder of this manual we will use the identifications J1 and J10 (these should be taken as J2 and J12 on boards equipped with the 5.08mm terminals
(c) Many functions share the DIn and DOut pins with the main discrete input register and discrete output register. The details are given in the individual sections of the manual. The terminology DOUT (and DIN) refers to the actual bits of the discrete output (and input registers) while DOut and DIn refer to the signals whatever their source or destination (e.g. MPG logic, PWM generator, keyboard scanner etc.)

3.4 Jumpers

The ModIO™ also contains a number of jumper that allow the board to be configured. The connectors are listed in Table 4 below. The location of the connectors is indicated in figure 3.2.

Jumpers	***Description***	***Comment***	***Reference***
S2	Slave Id/Default Config	16 position Hex switch	
J13	DigiSpeed™ Enable source	3 Pin 0.1" Jumper	
JP1	Boot Select	2 Pin 0.1" Jumper	See Firmware programming section
JP2	spare	2 Pin 0.1" Jumper	Leave open
JP3	Vout Source	3 Pin 0.1" Jumper	See Discrete Outputs section
JP4	RX Receive Source	3 Pin 0.1" Jumper	See Communications Section
H/F* (JP5)	RS-485 Duplex Select	2 Pin 0.1" Jumper	See Communications Section
RXP (J6)	RS-485 RX Polarity	2 Pin 0.1" Jumper	See Communications Section
JP7	Not used		
JP8	RS-485 A Load	2 Pin 0.1" Jumper	See Communications Section
JP9	RS-485 B Load	2 Pin 0.1" Jumper	See Communications Section
TXP (J10)	RS-485 TX Polarity	2 Pin 0.1" Jumper	See Communications Section
BL (JP11)	LCD Back light	2 Pin 0.1" Jumper	See LCD Section
Default (JP12) JP13	Legacy (was Default Configuration) DigiSpeed enable	2 Pin 0.1" Jumper 3 Pin 0.1" Jumper	Leave open See DigiSpeed interface

Table 3.4 - Jumper Summary

3.5 Power Supply

Power is connected to the ModIO™ via a 2.1mm Co-axial Power Jack (J8), or from Pins 17 and 18 on the I/O Connector strip J10. The power supply can accept AC or DC power and it does not matter whether the connector pin is positive or negative although it is usual for the pin to be the positive pole with a DC supply.

The input voltage should be in the range 8 to 24 volts DC or 6 to 18 volts RMS AC.

Internally the ModIO™ conditions this raw power supply by a full-wave bridge rectifier feeding into a 500mA linear voltage regulator. The heat dissipation of this regulator can cause excessive temperature rise in a small enclosure or when input voltages are at the higher end of the range. The internal supply presents 5volts DC and/or the unregulated (but rectified) raw input to various output terminal. Sufficient power is available for potentiometers, the LCD backlight, a few low power LEDs or relays, etc. but if industrial MPGs or other higher powered devices are to be used then you need to provide your own supply for them with its ground commoned to the ModIO™ ground.

3.6 Reset Switch

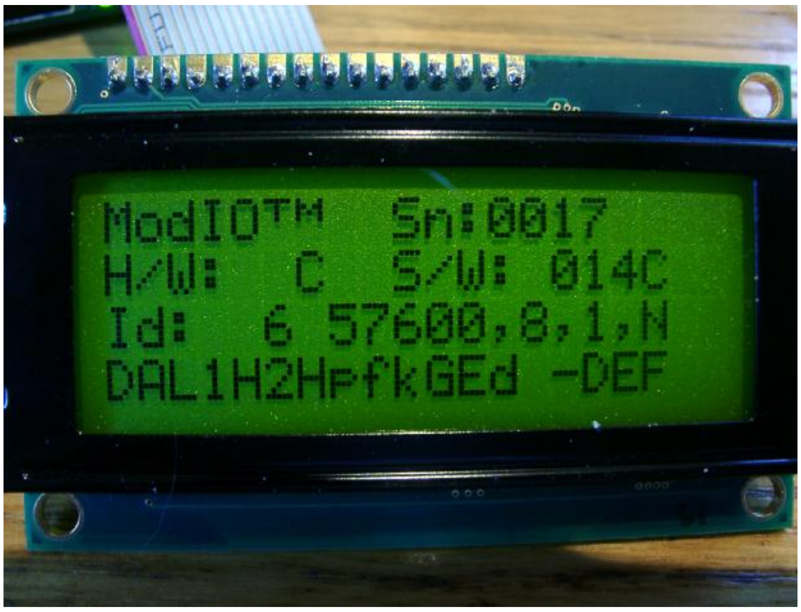
A small push button is mounted on the ModIO™ printed circuit behind output terminal number J1-7. This will reset the ModIO™.

Note: No changes in configuration either by software or jumper take effect until the ModIO™ is reset by this button or by cycling the power off and on. Forgetting to do this is a source of many reports of difficulty in configuring the ModIO™.

3.7 Configurations and Slave address switch

3.7.1 Configuration parameters

The ModIO™ remembers how it is configured in an area of flash memory in the PIC chip. This configuration is updated by writing to registers of the ModIO™. In a Mach3 installation this will generally be done using the Config dialog but can also be done by using the test screen and writing into the numbered registers. If you have an LCD connected then, until you overwrite the screen (e.g. from Mach3) it will display the programmed configuration. In part this is in clear language and in part by letters indicating the state of configurations bits. A capital version of the letter indicates that the feature is Enabled a lowercase letter that it is Disabled.



```
ModIO™   Sn:0017
H/W:   C   S/W: 014C
Id:    6 57600,8,1,N
DAL1H2HpfkGEd -DEF
```

Figure 3.3 – Configuration display on LCD

The following symbols are displayed in this order:

Function	Enabled	Disabled	Notes
Discrete outputs	D	d	J1 Pins 9-12 & 14 - 17

Analog inputs	A	a	J1 Pins 2, 3 & 5
LCD interface	L	*l*	
MPG1	1	m	J10 Pins 14 & 15
MPG1 Hi-res	H	h	
MPG2	2	m	J10 Pins 12 & 13
PWM output for DigiSpeed	P	p	J1 Pin 14
Frequency counter	F	f	J10 Pin 4
Keypad scanner	K	k	J10 Pins 7 – 10 & J1 Pins 9 - 12
Enforce serial interchar gap rules	G	g	
Limit serial error flash to duration of error state	E	e	
ModIO debug mode selected	D	d	**Hardware/firmware debug only.** If enabled it Disables the discrete outputs.
Default parameters in use	-DEF		The LCD **displays** the programmed values. The ModIO (after Reset) **uses** the default ones.

Illustration 3.3 shows a sample screen display.

3.7.2 Slave addressing

Each Modbus device (and with RS-485 there can be many on one "bus") has a *Slave Address* which defines the messages to which it will respond. This is configured by a 16 position miniature rotary switch. See figure 3.4. Position 0 of this switch is reserved to define the Default Configuration.

Note: Changes to the switch do not take effect until after the ModIO™ is reset.

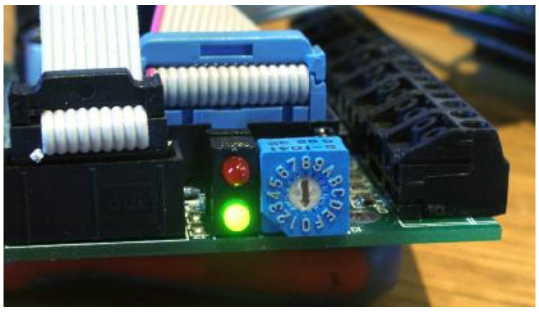


Figure 3.4 – Slave address switch and power LED

Note: It is Highly recommended that you operate the ModIO™ with the default configuration (switch position = 0 selected) until there is a need to alter the unit's configuration and you become confident understanding the operation of the ModIO™.

To enable the Default configuration:

1. Switch the slave address switch to "0"
2. Press the Reset Switch, or cycle the power to the ModIO™.

On Bootup, the ModIO™ will be configured to:

- Modbus Slave address of 6
- Communication settings of 57,600 Baud, 8 bit data, 1 Stop bit, No parity

- LCD Interface Enabled
- Discrete I/O Interface Enabled
- Analog Interface Enabled
- MPG 1 & 2 Enabled (Hi Resolution Mode)
- Limit Error Flash Enabled
- Flash Discrete outputs Disabled
- DigiSpeed™ Interface Disabled
- Debug Interface Disabled

Note: If you have the LCD display connected then it will indicate the configuration currently programmed into the ModIO™ **not** the parameters of the Default configuration that you will be using. This is state is indicated by the characters "-DEF" on the bottom line of the display.

3.8 Status LEDs

3.8.1 Power LED

The green LED on the edge of the board by the Slave Address switch shows that the board has 5 volt power available.

3.8.2 Error LED

The red LED above the Power LED is an "Error Indication". The LED is capable of indicating 2 types of errors:

- Flashing – Modbus Communication Error. Indicates that a error has been detected during serial communications.
- Solid – ModIO™ Internal Error. Indicate an error internally within the Unit. *Selecting an invalid Slave address will cause such an error*

Note: The Modbus Specification requires that once an error is detected, the indicator remains latched until the unit is reset. This feature can be inconvenient when debugging communication errors such as an intermittent fault. The ModIO™ contains a configuration bit, LEF, [b2 in register 102 COMM0] that allows the latching of an error to be disabled. When this bit is 1 the Indicator will extinguish shortly after the error condition is removed.

3.8.3 Transmit/Receive LEDs

The LEDs mounted on the board edge to the left of the RS-232 connector indicate the reception of data by the ModIO™ (green) and transmission of data by it to the PC (red).

Hint: **When Mach3 is running if the green LED flashes but red LED is not flashing then it is almost certain that the values of slave address are configured differently in Mach3 and the ModIO™.**

3.8.4 Pin status LEDs

Each of the 8 discrete outputs and inputs has a surface-mount LED on the board near to its terminal. The LEDs indicate an active (i.e. Lo) state on the corresponding pin.

Note: On first reading you may wish to skip the remainder of this chapter.

3.9 Modbus Communication interface

3.9.1 RS-232 versus RS-485

The ModIO™ contains an RS232 and RS-485 serial interface. Both of these interfaces are used by a single UART on the ModIO™. Therefore only one of the interfaces may be used at any one time.

3.9.2 RS-232 Interface

The connector for this bus is a 10 pin 2 x 5, 0.1" boxed header. The pins and signals for the connector are detailed in Table 3.5 below.

Pin number	*Signal*	*I/O*	*Comment*
1	N/C	-	-
2	N/C	-	-
3	TX Data	O	RS-232 Data transmitted from ModIO
4	N/C	-	-
5	RX Data	I	RS-232 Data Received by ModIO
6	N/C	-	-
7	N/C	-	-
8	N/C	-	-
9	GND	-	Power Supply (GND)
10	N/C	-	-

Table 3.5 - RS-232 Interface Connector

3.9.3 RS-485 interface

The RS-485 interface should be used if connections of longer than 3 metres are required between the ModIO™ and the computer or if it is to be operated in an electrically noisy environment (e.g. with a plasma cutter)

RS-485 allows more than one ModIO™ on the bus (i.e. with different slave addresses) although this is not at present supported by Mach3.

RS-485 can be used with two or four wire connexions. Although both are supported by ModIO™ it is strongly advised not to use the 2-wire option with Mach3. The reason for this is that Windows is not reliable in generating a signal from a Com port to define the direction of information transfer. With 4-wire this is unnecessary as one pair is transmit and the other pair is receive.

The RS-485 signals are connected via pins 1 to 4 on J10 (or J12). The PC end of the connexion will require an RS-232 to RS-485 converter. These are available as standard stock items from electronics and computer suppliers.

The RS-485 mode has various jumpering option as described in Table 3.4

The meaning of these jumpers is as follows:

RX Receive source (JP4)

Should be in position 1-2 for RS-485 communications and position 2-3 for RS-232 communications. If it is in the wrong position then data will not be received from the interface intended.

RS-485 Duplex Select (H/F)

Should only be inserted in the exceptional event of using 2-wire (half duplex) operation

RS-485 Receive polarity (JP6)

Normally open – jumper to invert Mark/Space polarity

RS- 485 A load (JP8)

This jumper should be in for the last (only) ModIO™ on the bus. It terminates the line with a 120R load

RS-485 B Load (JP9)

This jumper should be in for the last (only) ModIO™ on the bus. It terminates the line with a 120R load

RS-485 TX Polarity (JP10)

Normally open – jumper to invert Mark/Space polarity

3.10 Discrete Inputs

The ModIO™ provides 8 Discrete inputs (Din0 to DIn7) which feed the DIN register. Some also are used for the MPGs and the scanned keyboard logic. These are accessed via pins on J10.

They operate as "Active Low". That is, the input device needs to connect the relevant DIn pin to Ground to represent the active state.

Each input contains a pull-up resistor, allowing it to be used with switches or open-collector outputs on MPGs and the like.

Each input is provided with a LED, indicating when the input is active.

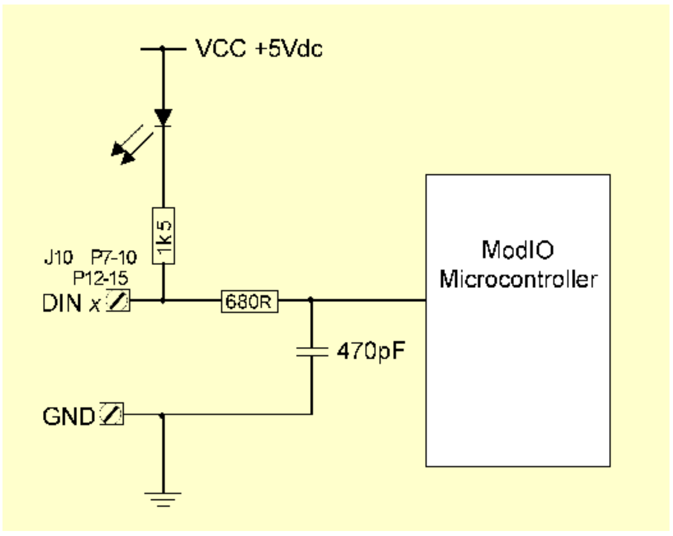


Figure 3.5 - Discrete Input Schematic

If the input is being connected to a switching device other than a passive switch, the voltage from the device should **not** exceed 5 volts DC or the inputs will be damaged.

When state of a Discrete input is accessed by the DIN input register, the register contains a bit for each discrete input. The bit is set "1" when the input is active (i.e. tied to <0.8 volts and LED is illuminated)

The ModIO™ may be configured to disable the discrete inputs and outputs. That said, it would be unusual to have a need to do so. To disable the discretes set bit UDIS (CONFIG<2>) to 0.

3.11 Discrete Outputs

The ModIO™ provides 8 Discrete outputs accessed via the Discrete Output Register (DOUT), the Digispeed feature and the scanned keyboard.

The outputs operates as "Open Collector". That is, the output is pulled near to ground when active.

Devices that are to be controlled need to be connected between the VOut terminal and a particular DOut terminal.

The outputs (0 to 6) use the ULN2003A transistor output driver chip. This driver contains an integral free-wheeling or catch diode, allowing inductive loads such as relay coils to be controlled. The ULN2003A is rated for 500mA per output.

Output & uses a FMMT491 transistor rated at 200mA.

Each output is provided with a LED, indicating when the output is active.

Note: that the ModIO™ power supply is only capable of supplying 500 mA in total. Therefore for high current applications VOut needs to be powered from an external power supply.

There are three sources for supplying power to the Discrete outputs. The source is controlled by Jumper J3, as detailed below;

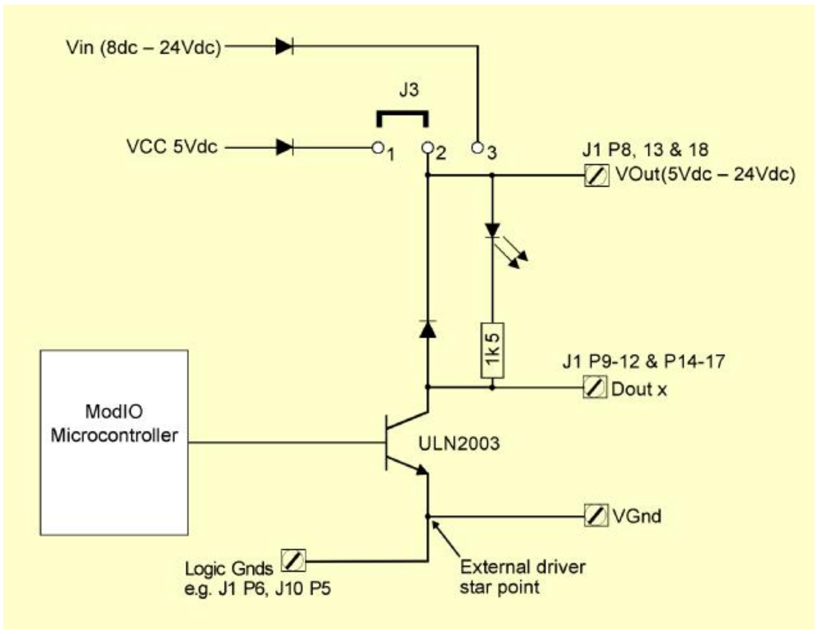


Figure 3.6 - Discrete Output Schematic

1. External supply to VOut Terminal – Remove J3 completely. By removing J3, the VOut terminal is isolated from the rest of the ModIO™ power supply. Power for the devices connected to VOut must be provided externally and is to be connected between a VGnd terminal and the VOut Terminal.
2. VIn Supply – By placing Jumper J3 between pins 2 and 3, Power for VOut is sourced from the VIn power supply. It is tapped into the supply after Vin has been full wave rectified but before it is regulated.
   In this case power can be taken from the VOut terminals but an external supply must not be connected to it.
3. +5V Supply – By placing Jumper J3 between Pins 1 and 2, power for VOUT is sourced from the ModIO™ internal voltage regulator.
   In this case power can be taken from the VOut terminals but an external supply should not normally be connected to it.
   This internal source is not recommended as the power supply has limited capacity.

3.12 Expansion Module Interface

The ModIO™ contains a proprietary expansion bus, based on the I2C serial communication standard. The connector for this bus is a 10 pin 2 x 5, 0.1" boxed header. The pins and signals for the connector are detailed in Table 3.6 below.

Pin number	***Signal***	***I/O***	***Comment***
1	+VOut	-	Power Supply (+VOut)
2	+VOut	-	Power Supply (+VOut)
3	+5V	-	Power Supply (+5V)
4	+5V	-	Power Supply (+5V)
5	GND	-	Power Supply (GND)
6	Clock	O	Expansion Bus Clock
7	GND	-	Power Supply (GND)
8	Data	I/O	Expansion Bus Bidirectional Data
9	GND	-	Power Supply (GND)
10	GND	-	Power Supply (GND)

Table 3.6 - J6 Expansion Bus Connector

3.13 DigiSpeed™ DC Motor Controller Interface

The ModIO™ contains an interface for the Homann DigiSpeed™ DC Motor controller. The connector for this bus is J5, a 6 pin, 0.1” open header. The pins and signals for the connector are detailed in Table 3.7 below.

Pin number	***Signal***	***I/O***	***Comment***
1	GND	-	Power Supply (GND)
2	PWM	O	DigiSpeed™ PWM Signal# Shared with DOut 4
3	Enable	O	DigiSpeed™ Enable Signal Shared with DOut3 or jumpered to GND by JP13
4	Direction	O	Motor Direction Signal Shared with DOut2
5	Index	I	Motor Spindle Index Signal Shared with DIn4
6	+5V	-	Power Supply to Digispeed (+5V)

Table 3.7 - J5, DigiSpeed™ DC Motor Controller Interface Connector

4 ModIO support in Mach3

This chapter gives you details of the way you configure Mach3 for the full range of input and output devices and gives examples of some user code to exploit them.

The Mach3 ModBus interface is subject to a proposal for redesign so information here is limited to that required for use of the current software.

4.1 Introduction to data – the autopoller and macropump

The ModBus interface is a very polite thing. The slave (ModIO™) never speaks until spoken to by the master (the PC). The implication of this is that the PC has to keep asking the ModIO™ what the state of its inputs are.

Mach3 has a buffer, called *Input*, of 128 x 16 bit words for data input to it from the ModBus device and another, called *Output*, of another 128 words of data destined to be sent to the ModBus device. In addition to these buffers is another 40 word buffer used to send data to the LCD.

A task in Mach3 called the AutoPoller runs periodically (by default 20 times per second). The AutoPoller sends data to the ModBus device and reads data from it. It is responsible for any errors in transmission etc. Thus the user just has to put data in *Output* and the LCD buffers and in due course it will go to the ModBus device. Data retrieved by the user from *Input* is the latest version of information from the device.

The first 64 words of *Input* and *Output* are mapped into the port 0 input pins and port 0 output pins respectively. Thus anything that activates or deactivates a pin (e.g. turning on coolant) can change the data in a ModBus device and data from the device can be treated as a limit switch, OEM trigger or virtually anything else that can come in on an input pin.

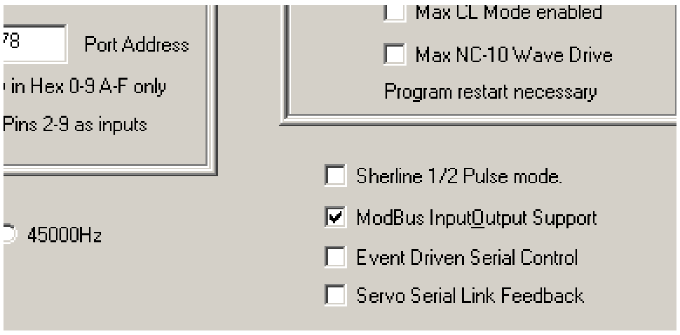
The second 64 words of Input and Output have to be accessed from VB Script code (e.g. in a macro or on a button). This will very often be done in a Macropump macro. This is code run, rather like the AutoPoller, periodically. The difference is that the autopoller does standard things but you write your own MacroPump.

There are endless possibilities for ModBus devices, indeed with a PLC (programmable logic controller) the system designer actually writes code to run in the device. The ModIO™ is not user programmable so Mach3 knows what it does and this makes ModIO™ configuration much simpler than general ModBus configuration. This manual concentrates of the ModIO™ case.

4.2 Configuring Mach communications for a ModIO

In order to use a ModBus device you must check *Use Modbus InputOutput* support on the Config>Ports and Pins, Port Setup and Axis Selection tab. After checking this, close and reload Mach3 with your ModIO profile.

You will then be able to access Config>Setup ModBus Control. This is illustrated in figure 4.2.

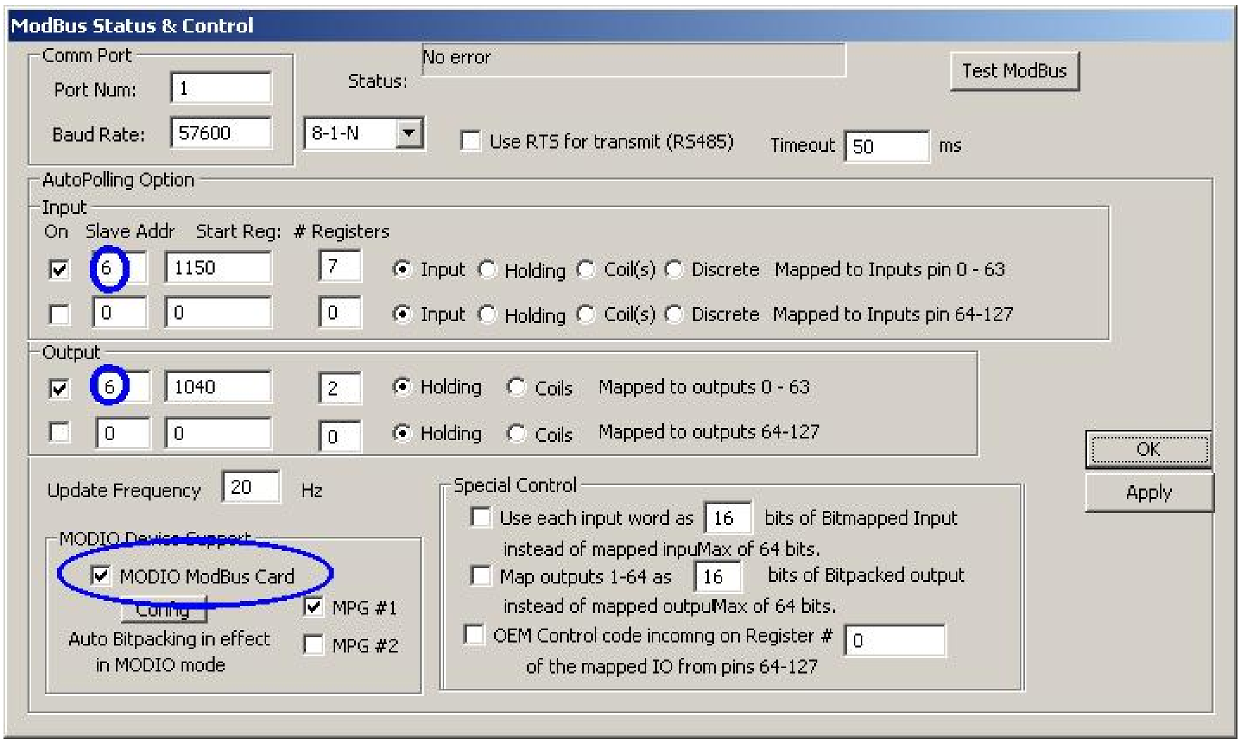


78 Port Address
in Hex 0-9 A-F only
Pins 2-9 as inputs
45000Hz

☐ Max CL Mode enabled
☐ Max NC-10 Wave Drive
Program restart necessary

☐ Sherline 1/2 Pulse mode.
☑ ModBus InputOutput Support
☐ Event Driven Serial Control
☐ Servo Serial Link Feedback

Figure 4.1 – Enabling ModBus support



ModBus Status & Control

Comm Port
Port Num: 1
Baud Rate: 57600
8-1-N
Status: No error
Test ModBus
☐ Use RTS for transmit (RS485)
Timeout 50 ms

AutoPolling Option

Input

On	Slave Addr	Start Reg:	# Registers		
✓	6	1150	7	● Input ○ Holding ○ Coil(s) ○ Discrete	Mapped to Inputs pin 0 - 63
☐	0	0	0	● Input ○ Holding ○ Coil(s) ○ Discrete	Mapped to Inputs pin 64-127

Output

On	Slave Addr	Start Reg:	# Registers		
✓	6	1040	2	● Holding ○ Coils	Mapped to outputs 0 - 63
☐	0	0	0	● Holding ○ Coils	Mapped to outputs 64-127

Update Frequency 20 Hz

MODIO Device Support
☑ MODIO ModBus Card
Config
☑ MPG #1
☐ MPG #2
Auto Bitpacking in effect in MODIO mode

Special Control
☐ Use each input word as 16 bits of Bitmapped Input instead of mapped inpuMax of 64 bits.
☐ Map outputs 1-64 as 16 bits of Bitpacked output instead of mapped outpuMax of 64 bits.
☐ OEM Control code incomng on Register # 0 of the mapped IO from pins 64-127

OK
Apply

Figure 4.2 – Configuring ModBus control

Under MODIO Device Support, check *MODIO ModBus card*. If this was previously unchecked you will notice that many of the values in the dialog box change automatically.

You are initially advised to work with the default ModIO™ configuration. This corresponds to the values set by Mach3 when *MODIO ModBus card* is checked except that you need to alter *Slave Addr* to 6 in the two places indicated in figure 4.2.

The other change that might be required is if you are not using COM1 as the serial port. Set *Port Num* to the *n* in the COM*n*. That you are using.

Do not alter any other values in the dialog – they are there for devices like PLCs.

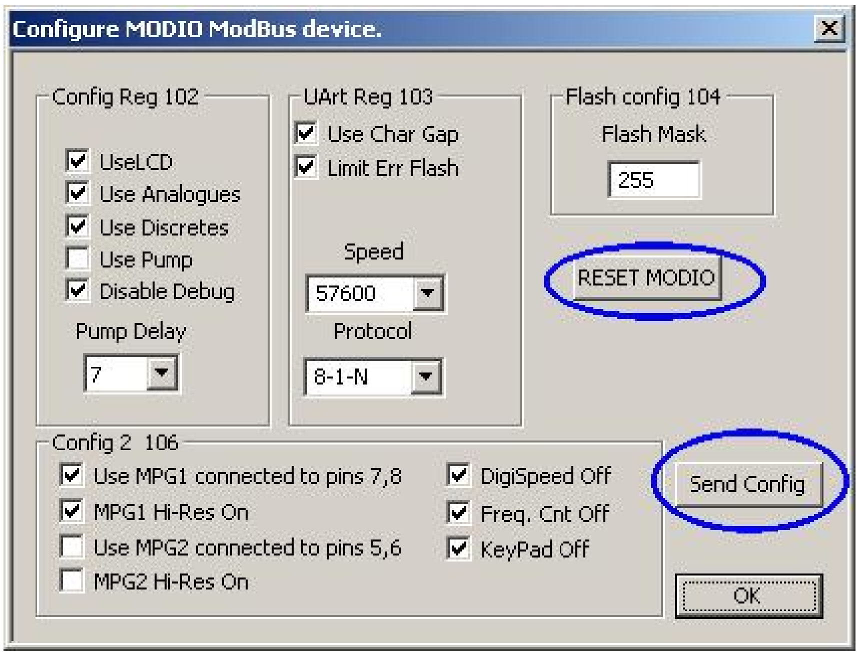
When you have done this, click *Apply* and the red and green LEDs on the left hand side of the RS-232 header (J7) should be flashing rapidly and "No Error" should be indicated in *Status*. If this does not happen revisit the Quick Start guide of chapter 2 and get this going again.

If you click OK the dialog will dismiss but as it is running at the same time as Mach3 will still appear on the task bar. You can re-open it from there or the Mach3 Config menu whenever required.

4.3 Enabling the ModIO interfaces

The default configuration is suitable for many applications. It provides 8 discrete inputs, with the two MPGs enabled in high-res mode (i.e. one cycle of quadrature pulses gives one count) and 8 discrete outputs. The analog inputs are enabled, the LCD interface is enabled. You may however need to change these and may wish to configure the ModIO™ board. This is done by the *Config* button on the ModBus Status & Control dialog which is just below the MODIO ModBus card checkbox. See figure 4.2.

This Config button opens a new dialog as shown in figure 4.3.



Configure MODIO ModBus device.

Config Reg 102
- [✓] UseLCD
- [✓] Use Analogues
- [✓] Use Discretes
- [ ] Use Pump
- [✓] Disable Debug

Pump Delay: 7

UArt Reg 103
- [✓] Use Char Gap
- [✓] Limit Err Flash

Speed: 57600

Protocol: 8-1-N

Flash config 104

Flash Mask: 255

Config 2 106
- [✓] Use MPG1 connected to pins 7,8
- [✓] MPG1 Hi-Res On
- [ ] Use MPG2 connected to pins 5,6
- [ ] MPG2 Hi-Res On
- [✓] DigiSpeed Off
- [✓] Freq. Cnt Off
- [✓] KeyPad Off

Figure 4.3 – Configure ModIO device

Notes:

(a) It is very important to realize that using this dialog displays and reconfigures the ModIO™ hardware. That is to say it rewrites the data in the flash memory of the PIC.

(b) If you are set to default configuration (hex switch position = 0) then this is **not** the configuration actually being used by the ModIO™

(c) Changes to a hardware configuration do not occur until you Reset the ModIO™

(d) If you change some parameters (e.g. baud rate) and forget them then you may find you can no longer communicate with the ModIO™ to further configure it. The default configuration at switch position 0 will get you out of this difficulty. Do not forget you need a Reset after choosing it.

Important note: **Even experienced users can get confused and think that the ModIO™ is not working correctly by forgetting these things**

Some explanation of individual controls in this dialog may be useful:

Headings: The register numbers shown by Mach3 in some of the headings are wrong. See chapter 6 for correct details.

Use Pump: The ModIO™ has built in "charge pump" logic to disable outputs if it seems to have lost contact with the PC. This can cause problems in testing so you may wish to disable the feature. The feature, if globally enabled, can be disabled on an individual output by output basis using bits in register 104 via the Test dialog.

Pump delay: See definition of CONFIG (register 101) for the coding of the pump watchdog delay time.

Use MPG1../Use MPG2….: The screen references to "pins 5, 6" and "pins 7, 8" should read "Input side terminals 14, 15" and ".. Input side terminals 12, 13" - I.e. DIn 6, DIn7 and DIn 4, DIn 5.

Disable Debug: It is vital to leave this checked unless you have specialist debugging experience. If enabled then the discrete outputs are Disabled.

Send config: This button writes the configuration selected to the ModIO™ flash.

RESET MODIO: This button is equivalent to pressing the reset button on the ModIO™ board. It puts a new configuration into use. It is particularly convenient when the ModIO™ is in an enclosure on the machine.

4.4 Configuring Inputs & Outputs

No special action is required. Inputs DIn 0 to DIn 7 appear as Mach3 "input pins" 0 to 7 on Port 0. Outputs DOut 0 to DOut 7 are controlled by "output pins" 0 to 7 on Port 0

4.5 Configuring MPGs

It is convenient to use Port 0 pins 6, 7 or Port 0 pins 4, 5 on the Config>Ports and Pins, Encoders/MPGs tab to record the connections although the MPG mechanism does not involve pulse counting by Mach3 – it is done in the ModIO™.

Ensure that the MPGs are configured within the ModIO™ (figure 4.3)

Check the MPG #1 and, if required, MPG #2 boxes on the Modbus Status and Control dialog (figure 4.2).

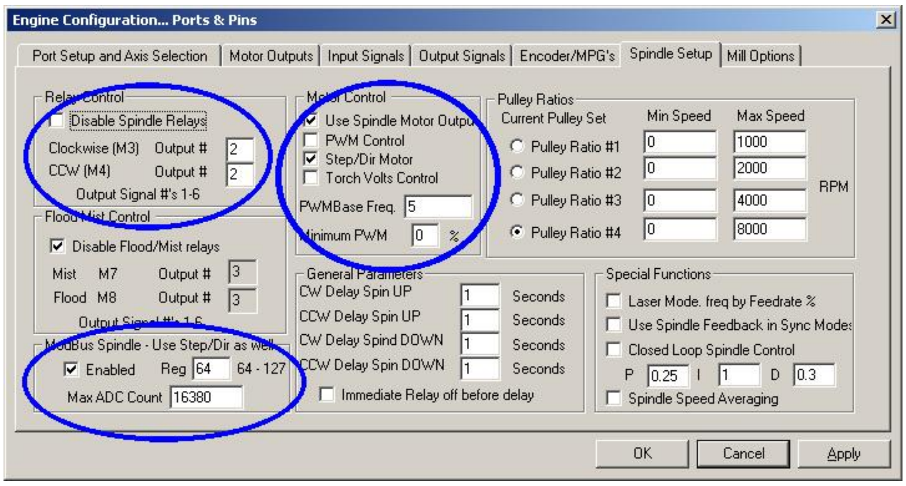
Use the *Cal* button on the jogging flyout in Mach3 to tune the MPGs. Unless a fixed step per detent click is important to you, you should find that Velocity mode is the most responsive way of working.

4.6 Configuring the DigiSpeed spindle control

The ModIO™ has a custom interface to the Homann Designs DigiSpeed. This device connects in place of the potentiometer on VFD and chopper DC speed controllers and allows software control of the spindle speed.

It is supported by Mach3 in the PWM (pulse width modulated) mode.

Enable the interface in the Configure ModIO™ device dialog by unchecking *Digispeed Off*. See figure 4.3. Click Send Config and remember to reset the ModIO™.



Relay Control
- [ ] Disable Spindle Relays
- Clockwise (M3) Output # 2
- CCW (M4) Output # 2
- Output Signal #'s 1-6

Flood Mist Control
- [✓] Disable Flood/Mist relays
- Mist M7 Output # 3
- Flood M8 Output # 3
- Output Signal #'s 1-6

ModBus Spindle - Use Step/Dir as well
- [✓] Enabled Reg 64 64 - 127
- Max ADC Count 16380

Motor Control
- [✓] Use Spindle Motor Output
- [ ] PWM Control
- [✓] Step/Dir Motor
- [ ] Torch Volts Control
- PWMBase Freq. 5
- Minimum PWM 0 %

Pulley Ratios

Current Pulley Set	Min Speed	Max Speed
○ Pulley Ratio #1	0	1000
○ Pulley Ratio #2	0	2000
○ Pulley Ratio #3	0	4000
● Pulley Ratio #4	0	8000

RPM

General Parameters
- CW Delay Spin UP 1 Seconds
- CCW Delay Spin UP 1 Seconds
- CW Delay Spind DOWN 1 Seconds
- CCW Delay Spin DOWN 1 Seconds
- [ ] Immediate Relay off before delay

Special Functions
- [ ] Laser Mode. freq by Feedrate %
- [ ] Use Spindle Feedback in Sync Modes
- [ ] Closed Loop Spindle Control
- P 0.25 I 1 D 0.3
- [ ] Spindle Speed Averaging

Figure 4.4 – Spindle setup

The DigiSpeed uses discrete outputs DOut 3 and DOut 4 (and optionally DOut 2) so you will not be able to use these for other purposes (e.g. a scanned keyboard).

Use Config>Ports and Pins, Spindle Setup tab to configure Mach3 as shown in the ringed parts of figure 4.4.

When the S word is set by G-code to the S DRO equal to the maximum speed for the currently selected pulley then the ModIO™ will output a 100% ON PWM signal giving full input voltage on the motor drive circuit. Similarly id S is half the maximum speed then a 50% PWM signal will be generated.

Configure a Mach3 output signal (#2 in the example above) to be Port 0 Pin 2 (=DOut 2) to control the motor direction.

4.7 Using analog inputs

Analog inputs accept an input voltage from 0 to 5 volts DC. This will often be derived from a potential divider (potentiometer) between the ModIO™ +5 volt rail and ground.

The relevant register is set to a value between 0 (0 volts) and 1023 (5 volts).

Analog1 is in Input[64]
Analog2 is in Input[65]
Analog3 is in Input[66]

The following fragments of code from MacroPumps show how the data can be used in Mach3:

```
' Macropump for setting Feed rate override from a potentiometer on
' Analog3
Option Explicit
Dim fro As Integer

fro = GetInput (66)         ' read Analog3
fro = (fro * 95.0)/1024.0
setDRO 21, fro+5      ' range is now 5 to 100%
```

The idea here is that the full range of the potentiometer sets the feed rate override from 5% (minimum) to 100% (maximum).

This second code supports the schematic in figure 5.7

```
' Macropump for setting Jog Mode thru Analog In1
MPGAxis = GetInput( 64 ) 'analog Input 1 On ModIO
Select Case MPGAxis
Case < 100
      'do nothing
      State = 0
Case < 300
      If GetOEMLED( 14 ) = 0 Then 'If not Set to Continuous Jog Mode
            DoOEMButton( 276 ) 'Set Jog To continuous
      End If
      If State <> 1 Then
            Speak "Continuous"
      End If
      State = 1
Case < 512
      If GetOEMLED( 15 ) = 0 Then 'If not Set to Step Jog Mode
            DoOEMButton( 275 ) 'Set Jog To Step
      End If
      If State <> 2 Then
            Speak "Step"
      End If
      State = 2
Case < 715
      If GetOEMLED( 57 ) = 0 Then 'If not Set to MPG Jog Mode
            DoOEMButton( 327 ) 'set Jog to MPG
      End If
      If GetOEMLED( 59 ) = 0 Then
            DoOEMButton( 185 ) 'set MPG Jog to X
      End If
      If State <> 3 Then
```

```
          Speak "X"
     End If
     State = 3
Case < 920
     If GetOEMLED( 57 ) = 0 Then 'If not Set to MPG Jog Mode
          DoOEMButton( 327 ) 'set Jog to MPG
     End If
     If GetOEMLED( 60 ) = 0 Then
          DoOEMButton( 186 ) 'set MPG Jog to Y
          Speak "Y"
     End If
     State = 4
     Case >= 920
     If GetOEMLED( 57 ) = 0 Then 'If not Set to MPG Jog Mode
          DoOEMButton( 327 ) 'set Jog to MPG
     End If
     If GetOEMLED( 61 ) = 0 Then
          DoOEMButton( 187 ) 'set MPG Jog to Z
          Speak "Z"
     End If
     State = 5
End Select
```

The values such as "100", "300", etc. above are arrived at as follows:

- The Analog input will read the voltage (between 0 and +5V) on its input pin, and convert it to a digital value from 0-1023
- Since we have a 6-position switch, the first position will be "0", the 6th position will be 1023, and each of the positions in between will be 1023/5 greater than the one before it.
- This gives values(rounded to the nearest integer) of:

Position	ExactValue
1	0
2	205
3	409
4	614
5	818
6	1023

To make the switching as reliable as possible, one doesn’t want to look for these exact values, as they might drift slightly. Therefore, the decision is based on numbers between the switch positions.

Position	Mid Value
1	100
2	300

3	511
4	715
5	920
6	1030

So, for instance, any number less than 100 is taken to be a "0", which equates to Position 1. Any number less than 300 is taken to be Position 2.

4.8 LCD Display

The characters are written to the LCD two characters per word. The easiest way to do this is to setup the entire 80 character string in a VB script array and write it to the LCD. The sample below shows code to display the axis DROs, the current measurement mode, the coordinate system, the jog mode and if EStop has occurred.

```
Rem Axis DRO display on ModIO
' Include this as or in Macropump.m1s

Option Explicit
Dim Display As String
Dim SVal As String
Dim iCount As Integer
Dim iBase As Integer
Dim strMode (6) As String  ' supplementary info must be 5 chars exactly in each

Const slave = 6 ' default config
Const NoAxesToDisp = 4  ' max lines on ModIO Reduce if no A

If GetLED (1) Then strMode (0) = " inch" Else strMode (0) = "   mm"
If GetOEMLED (16) Then strMode (1) = "<m/c>" Else strMode (1)  = "     " ' coord
system

If GetOEMLED (83) Then strMode (2) = "     " Else strMode (2) = "NoJog"

If GetLed (0) Then strMode (3) = "EStop" Else strMode (3) = "     "

strMode (4) = "     "  ' not on ModIO LCD of course
strMode (5) = "     "

Display = "" ' initially empty string

For iCount = 0 To NoAxesToDisp - 1
      SVal = Right (" " & Format (GetDro (iCount), "+0.00000;-0.00000"), 8)
                                    ' format the DRO value 8 chars long
      If iCount < 3 Then ' X, Y, Z
            iBase = Asc ("X")
      Else ' A, B, C
            iBase = Asc ("A") - 3
      End If
      Display = Display & " " & Chr (iBase + iCount) & _
             SVal & "     " & StrMode (iCount)
Next iCount

SetModIOString (slave, 0, 0, Display)’ Sends string to the ModIO on next poll
```

4.9 Scanned keyboard

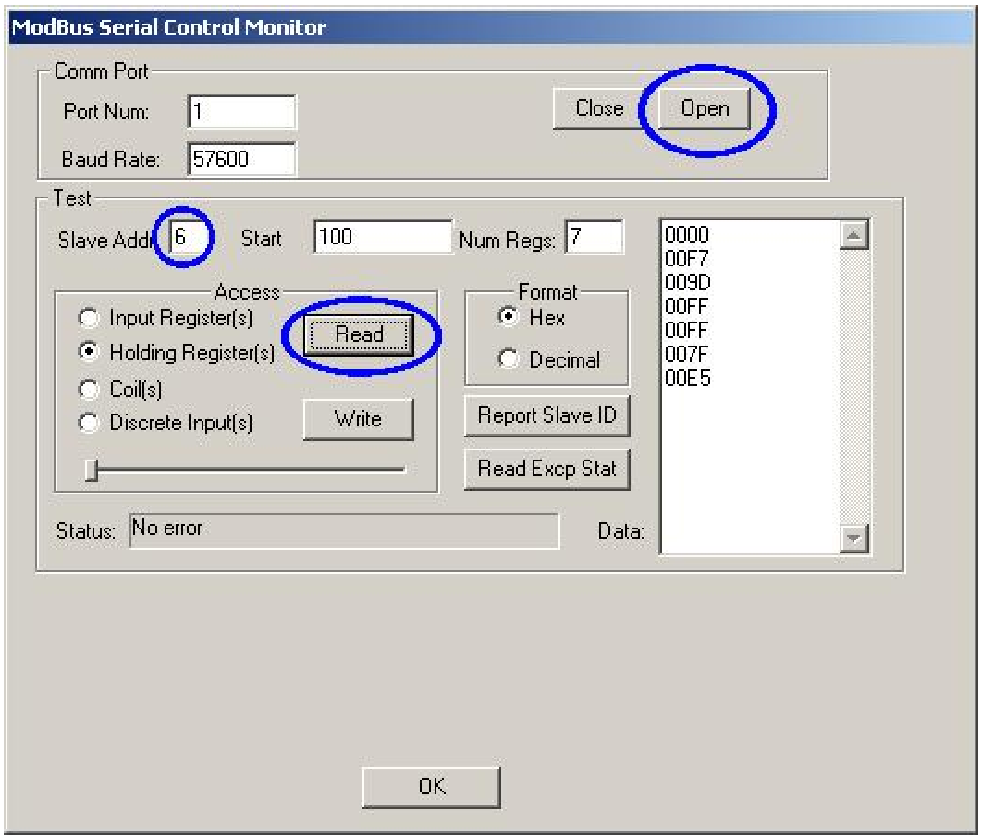
This feature is currently not supported by Mach3

4.10 Frequency measurement

This feature is currently not supported by Mach3

4.11 Testing ModIO from Mach3

It is possible to read and write individual registers of the ModIO™ using the Test dialog. This is



Port Num: 1
Baud Rate: 57600
Slave Addr: 6
Start: 100
Num Regs: 7
Access: Input Register(s) [✓ Holding Register(s)] Coil(s) Discrete Input(s)
Format: [✓ Hex] Decimal
Status: No error
Data:

```
0000
00F7
009D
00FF
00FF
007F
00E5
```

Figure 4.5 – The Test dialog

displayed by the *Test ModBus* button on the ModBus Status and Control. The dialog is shown in figure 4.5

4.11.1 Opening the ModIO for test

The first operations must be to set the, communications parameters if these are wrong, set the ModIO Slave Address (typically 6) and click the *Open* button.

The Status should read *No Error*.

4.11.2 Reading registers

To read one of more ModIO™ registers, enter the start address and number of registers and click *Read*. If an attempt is made to read a non-existent register then a Timeout Error will be reported.

Figure 4.4 shows the Config registers of a typical system.

4.11.3 Writing a register

Data can be written to any register by putting its address and a Num Regs of 1 in the control and typing a new hex value in the list box and clicking *Write*.

This is illustrated in figure 4.6.

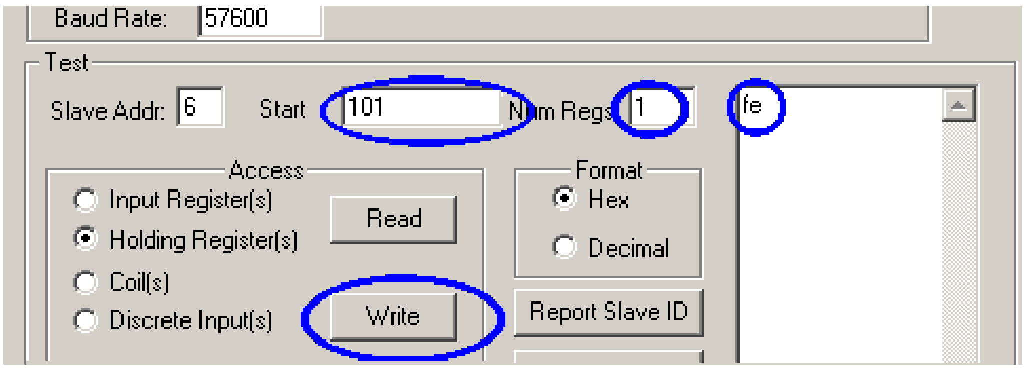

Baud Rate: 57600
Test
Slave Addr: 6
Start 101
Num Regs 1
fe
Access
Input Register(s)
[✓ Holding Register(s)]
Coil(s)
Discrete Input(s)
Format
[✓ Hex]
Decimal

Figure 4.6 – Writing test data

Notes: **If you use this feature to change the ModIO™ configuration do not forget to Reset the ModIO™ so the new configuration is used.**

Do not press *Enter* after typing data into the controls of the test dialog. If you do so it will close as Enter is the shortcut for the *OK* button.

5 Interfacing some typical devices to ModIO

This section describes some possible circuits for interfacing external devices. It does not cover the "standard" interfaces for the DigiSpeed, RS-232, RS-485 etc.

5.1 Output devices

It is very important to consider the options for the VOut supply for external devices. All the outputs on J1 share a common VOut so a single choice must be made.

5.1.1 External LED or lamp

Generally with external lamps you will need a separate VOut power supply. In this case you must remove the JP3 jumper to avoid the external supply back feeding.

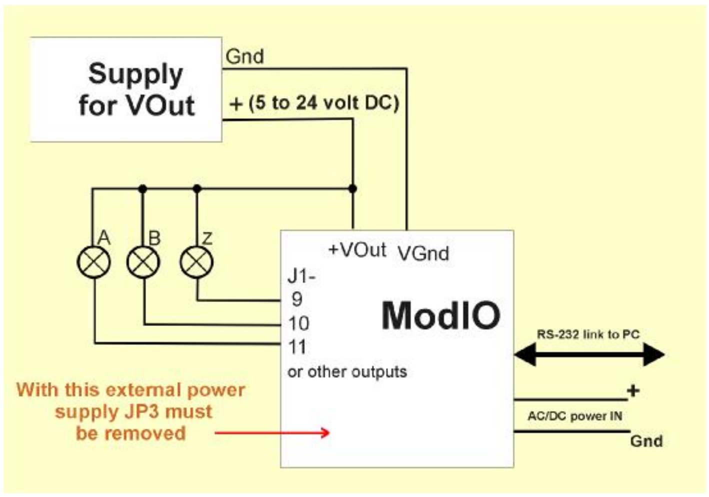


Figure 5.1 – Interfacing external indicators

5.1.2 Relay

External relays can be controlled directly provided they draw no more than the rated 500mA sink current (200mA for Dout7) of the output stages

Catching diodes are built in to the ModIO™ but it does not matter if they are duplicated at the relay terminal. Indeed this would be a good thing if long connecting leads are required to the relay panel.

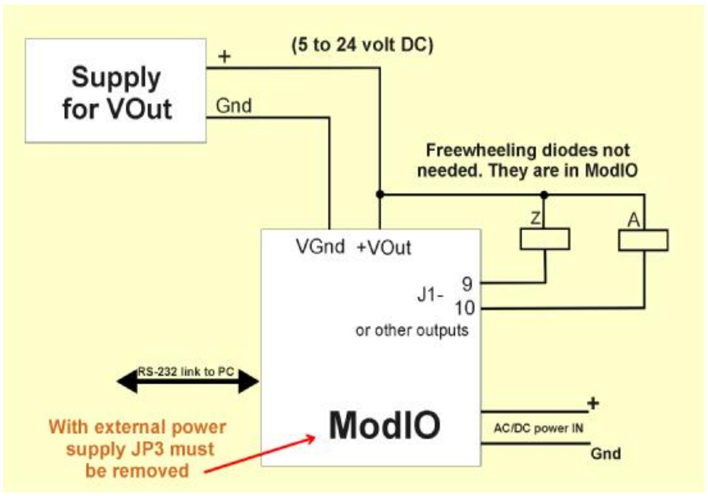


Figure 5.2 – Interfacing relays

Note that the ON voltage on the DOut terminals is about 0.6 to 0.8 volts. Thus if you attempt operation from a 5 volt supply the relay must be specified to pull in at <4.2 volts.

5.1.3 Logic gate (e.g. on VFD invertor)

Warning: Check that the logic ground on any external device is isolated from mains.

It is very important not to exceed the permitted hi input voltage on the logic in the external device. This is typically a little over the Vcc supply voltage of the logic (5.6 volts with TTL).

In practice this means that the ModIO™ VOut should be from the same supply as the logic Vcc. If the external device allows you to provide this supply then you can use the ModIO™ VOut at 5 volts of perhaps the unregulated 8– 24 volt supply (See JP3 for details). Otherwise you will have to take the supply from the external device. This may constrain what else you can drive with the ModIO™ outputs. For a slow signal (like motor on/off or direction of rotation) it is often best to include a low power relay to get isolation.

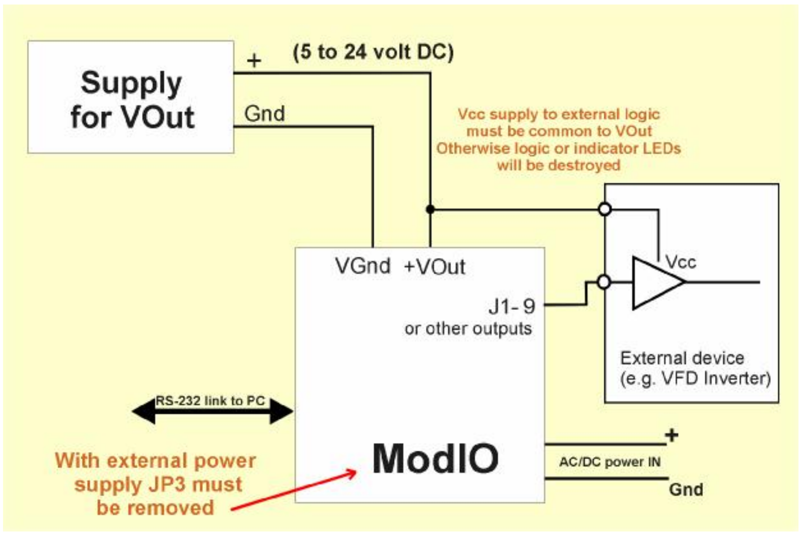

Supply for VOut
+
(5 to 24 volt DC)
Gnd
Vcc supply to external logic must be common to VOut Otherwise logic or indicator LEDs will be destroyed
VGnd +VOut
J1- 9 or other outputs
Vcc
External device (e.g. VFD Inverter)
RS-232 link to PC
With external power supply JP3 must be removed
ModIO
AC/DC power IN
+
Gnd

Figure 5.3 – Driving external logic

5.2 Input devices

5.2.1 Push switches (galvanic contact)

Connect the switch from a DIn terminal to a convenient ground (e.g. J10 pin 5, 11 or 16)

No external pullup resistor is required as one is provided in the ModIO™

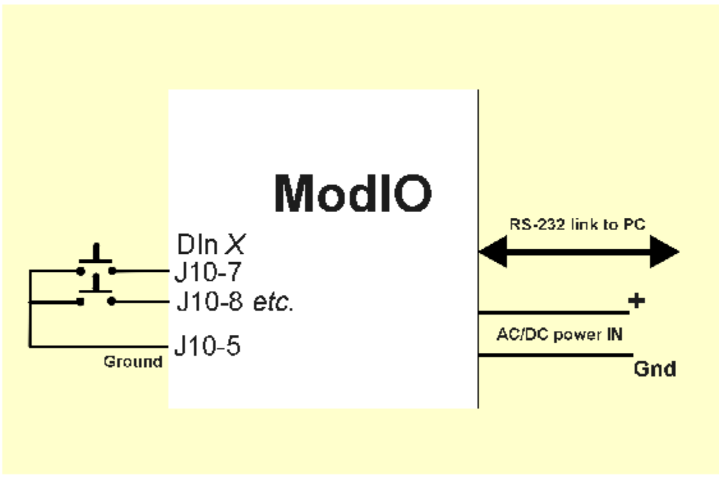


Figure 5.4 – Interfacing switches

5.2.2 From logic gate outputs

Wherever possible use Open Collector output gates in the external equipment. The ModIO™ contains a suitable pullup resistor.

If you have to use totem-pole outputs (i.e. not open-collector gates) then you must ensure that the Vcc of the external logic does not exceed the 5 volt supply of the ModIO™ or its

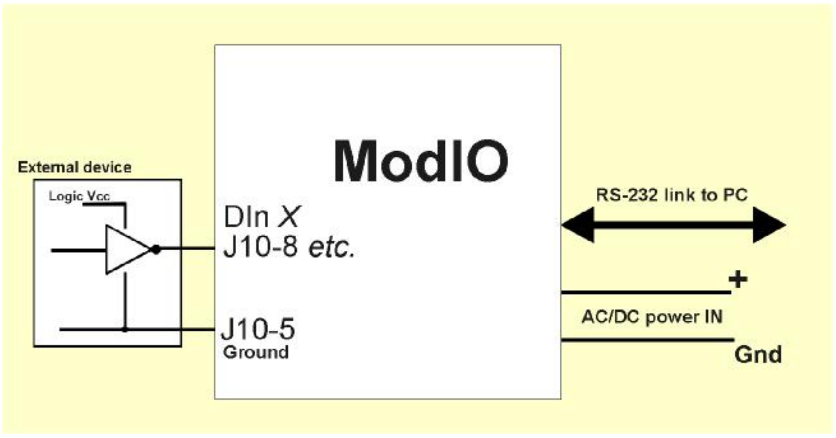


Figure 5.5 – Interfacing inputs to other logic

input gates or indicator LEDs may be damaged.

5.2.3 MPGs

The diagram shows the MPGs being interfaced to the ModIO™.

Ideally you should use MPGs with Open Collector outputs as this avoids the need to co-ordinate power supply voltages.

If you use totem-pole outputs then the Vcc of the MPG must be the same as that of the ModIO™

Many MPGs require more current than can be provided by the ModIO™ and in this case an external supply should be provided (as with MPG2 in this example).

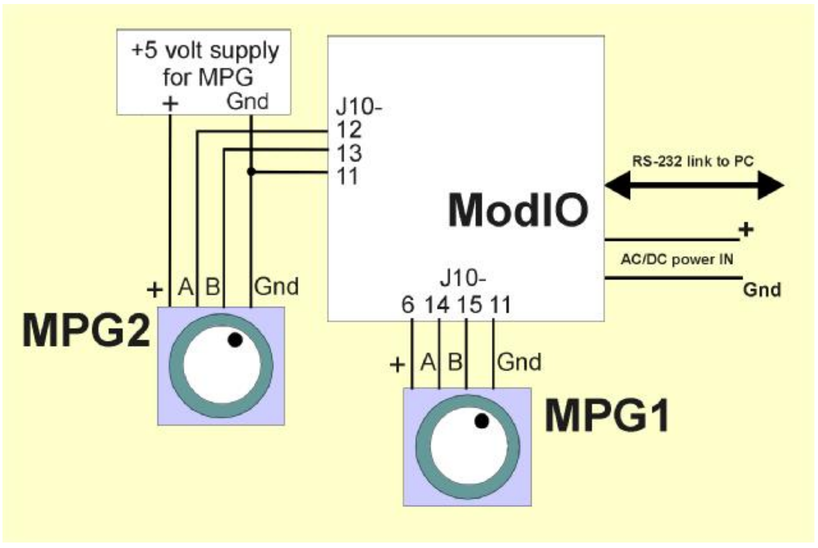


Figure 5.6 – Interfacing MPGs

5.2.4 Rotary potentiometers

See Analog input schematic diagram for details of a rotary potentiometer connection.

5.2.5 Rotary switches as potentiometer

Analog inputs are a very economical way of interfacing controls like axis selectors, step size programming and such like using a rotary switch. Macro code is, of course, needed to convert the voltage levels into actions in Mach3

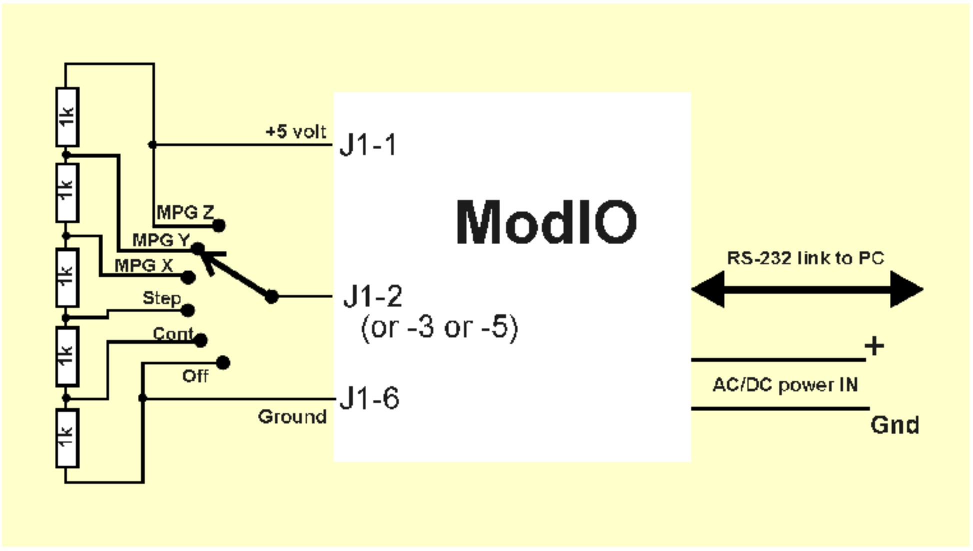


Figure 5.7 – Rotary switch as a potentiometer

6 Register Organization

This chapter is aimed at a user who is going to program a master to drive the ModIO™ or a user who is going to use the Test dialog in Mach3 or MachIV to diagnose problems in a complex installation. It assumes that you have an understanding of binary and hexadecimal numbers as a way of representing bit patterns.

Skip the chapter unless you **have** to use it.

There are three Register blocks in the ModIO™. These Register blocks are;

- ROM REGISTERS
- CONFIG REGISTERS
- RAM REGISTERS

The three blocks are separate and have different functionality. All ModIO™ Registers are 16 bits wide. The bits within a register are organized as "Little Endian". That is bit 0 is the least significant bit (LSB), bit 15 the Most significant (MSB). This is depicted below.

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	Bit 0

Table 6.1 - Register Bit Layout

Register addresses are also 16 bit in length. Valid Addresses are from 0 to 65535.

This is consistent with the Modbus specification.

Note: Although the valid register address range is from 0 – 65535, the actual valid register addresses for the ModIO are dependant on the ModIO firmware you have loaded.

The ModIO™ memory may also be accessed as single bit(s) via the Modbus Discrete input (02) and coil functions (01,05,15). The Address for a bit in a 16 bit register may be calculated by;

Bit Address = (Register Address * 16) + bit number

For example, to access the Limit Error Flash control bit, LEF, Bit 2 of the ModIO™ UART configuration control register Address 102.

LEF bit address = (102 * 16) + 2
= 1634

Table 6.2 shows the memory map for the ModIO™ devices.

Register Block	Address
ROM REGISTERS	0000 0047
Not Used	0048 0099
CONFIG REGISTERS	100 200
Not Used	201 999
RAM REGISTERS	1000 1249

Table 6.2 - ModIO™ Register Block Map

6.1 ROM Register Block

To be defined in a later version of this manual.

6.2 Configuration Register Block

The config register block is implemented as EEPROM memory. This memory is non-volatile and will retain its values once set even when the ModIO™ is powered down. It is used to set-up the ModIO™ Configuration.

Even though the registers in the Config block are 16 bit, only the lower 8 bits of each register are utilized When writing to the Config Block, the upper 8 bits of the register are ignored. When Reading from the Config Block, the upper 8 bits are set to 0.

Additionally, when writing to the Config Block, registers can only be written to one at a time.

The ModIO™ Config Block contains the registers as shown below in table 6.3.

Note: Any changes made to registers in the Config Block will only take effect after pressing the Reset button or after Power Up.

Address	Name

100	ADDRHI
101	CONFIG
102	COMM0
103	FLASH
104	PUMP
105	DEBUG
106	CONFIG2
107	-
	-
	-
	-
	-
	-
	-
	-
250	-

Table 6.3 - Config Block Register Map

6.2.1 100 - ADDRHI: Modbus Unit ID address high nibble

U-1	U-1	U-1	U-1	R/W-1	R/W-1	R/W-1	R/W-1
-	-	-	-	ADDR3	ADDR2	ADDR1	ADDR 0
Bit 7							Bit 0

Bit 7	Unimplemented
Bit 6	Unimplemented
Bit 5	Unimplemented
Bit 4	Unimplemented
Bit 3-0	ADDR3:ADDR0 Modbus Unit ID Address high Nibble. These 4 bits are the high 4 bits of the Modbus Unit ID. The lower 4 bit of the address are determined by the Address jumpers on the ModIO™ board.

Note: It will not often be necessary to use these bits to extend the 16 slave addresses available on the rotary switch.

Legend:		
R = Readable Bit	W = Writable Bit	U = Unimplemented
‘1’ = bit set	‘0’ = bit cleared	‘X’ = bit Unknown

6.2.2 101 - CONFIG: Configuration control register

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
DBEL	PDL2	PDL1	PDL0	UPMP	UDIS	UANA	ULCD
Bit 7							Bit 0

Bit 7 DBEL: Debug Enable Lo
Enable/Disable the ModIO™ Debug interface.
1 = Disable Debug Interface
0 = Enable Debug Interface.

Bit 6-4 PDL2:PDL0 Charge Pump Timeout Delay
000 = 325ms
001 = 650ms
010 = 1.30S
011 = 2.60S
100 = 5.20S
101 = 10.4S
110 = 20.8S
111 = 41.6S

Bit 3 UPMP: Use Pump
Enable/Disable the ModIO™ Charge Pump .
1 = Enable the Safety Charge Pump
0 = Disable the Safety Charge Pump.

Bit 2 UDIS: Use Discretes
Enable/Disable the ModIO™ Discrete I/O interface.
1 = Enable the Discrete IO Interface
0 = Disable the Discrete IO Interface.

Bit 1 UANA: Use Analogs
Enable/Disable the ModIO™ Analog inputs interface.
1 = Enable the Analog Input Interface
0 = Disable the Analog Input Interface.

Bit 0 ULCD: Use LCD
Enable/Disable the ModIO™ Character LCD interface.
1 = Enable the LCD Interface
0 = Disable the LCD Interface.

Legend:		
R = Readable Bit	W = Writable Bit	U = Unimplemented
‘1’ = bit set	‘0’ = bit cleared	‘X’ = bit Unknown

6.2.3 102 - COMM0: UART Configuration Control Register

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	U-1	R/W-1
SPD2	SPD1	SPD0	MD1	MD0	LEF	-	UCG
Bit 7							Bit 0

Bit 7-5	SPD2:SPD0 UART Baud rate control bits 000 = 9,600 Baud 001 = 19,200 Baud 010 = 34,400 Baud 011 = 56,000 Baud 100 = 56,700 Baud 101 = 115,200 Baud 110 = 230,400 Baud 111 = 56,700 Baud
Bit 4-3	MD1:MD0 UART Parity, Stop control bits 00 = 8 data bits, 1 stop bit, odd parity 01 = 8 data bits, 1 stop bit, even parity 10 = 8 data bits, 2 stop bit, no parity 11 = 8 data bits, 1 stop bit, no parity
Bit 2	LEF: Limit Error Flash control bit Limits the time that the error led will flash on detection of an error. 1 = Reset the error led after a few seconds. 0 = Latch the error led once an error is detected
Bit 1	Unimplemented
Bit 0	UCG: Use Character Gap control bit Check when receiving a message that the gap between the received characters is less than 1.5 * character reception time as per the Modbus specification. 1 = Check that the inter-character gap is within limits 0 = Ignore the inter-character timing requirements.

Legend:

R = Readable Bit	W = Writable Bit	U = Unimplemented
‘1’ = bit set	‘0’ = bit cleared	‘X’ = bit Unknown

6.2.4 103 - FLASH: Flash control register

The ModIO™ provides a Discrete Output Flashing Capability. This facility can be enabled on an individual discrete output basis. Output flashing is provided as a mechanism to easily allow the flashing of indicators, such as warning lights, etc.

Enabling/disabling of individual discrete output flashing is controlled by the FLASH configuration register as defined below.

When a bit is cleared, the corresponding Discrete output will flash if the Output is Active.

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
FLD7	FLD6	FLD5	FLD4	FLD3	FLD2	FLD1	FLD0
Bit 7							Bit 0

Bit 7	FLD7: Discrete 7 Flash Disable 1 = Disable flashing output 0 = Enable flashing output
Bit 6	FLD6: Discrete 6 Flash Disable 1 = Disable flashing output 0 = Enable flashing output
Bit 5	FLD5: Discrete 5 Flash Disable 1 = Disable flashing output 0 = Enable flashing output
Bit 4	FLD4: Discrete 4 Flash Disable 1 = Disable flashing output 0 = Enable flashing output
Bit 3	FLD3: Discrete 3 Flash Disable 1 = Disable flashing output 0 = Enable flashing output
Bit 2	FLD2: Discrete 2 Flash Disable 1 = Disable flashing output 0 = Enable flashing output
Bit 1	FLD1: Discrete 1 Flash Disable 1 = Disable flashing output 0 = Enable flashing output
Bit 0	FLD0: Discrete 0 Flash Disable 1 = Disable flashing output 0 = Enable flashing output

Note: Flashing should not be enabled for output pins that are used for the DigiSpeed or scanned keyboard.

Legend:

R = Readable Bit	W = Writable Bit	U = Unimplemented
‘1’ = bit set	‘0’ = bit cleared	‘X’ = bit Unknown

6.2.5 104 - PUMP: Pump Control Register

The ModIO™ provides a Safety Charge Pump facility. The purpose of this facility is to disable selected outputs if communications with the ModBus Master are disrupted. If the Master computer or it's software malfunctions, then the Safety Charge Pump will deactivate those inputs selected to be controlled by the charge pump.

The Charge Pump facility is enabled/disabled by the UPMP bit (CONFIG<3>). If set (default condition) the facility is enabled. If the bit is cleared then the facility is disabled and not used.

The timeout period required to invoke the Safety Charge Pump is controlled by the Charge Pump Delay PDL0-2 (CONFIG<6:4>).

If the Safety Charge Pump is enabled then individual Discrete outputs may be selected to be under the control of the Safety Charge Pump by setting or clearing the corresponding bit in the PUMP configuration register at address 104.

When a bit Set, the corresponding Discrete output will turn off if at least one ModBus message is not received during the timeout delay period.

R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1	R/W-1
CPE7	CPE6	CPE5	CPE4	CPE3	CPE2	CPE1	CPE0
Bit 7							Bit 0

Bit 7	CPE7: Discrete 7 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control
Bit 6	CPE6: Discrete 6 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control
Bit 5	CPE5: Discrete 5 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control
Bit 4	CPE4: Discrete 4 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control
Bit 3	CPE3: Discrete 3 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control
Bit 2	CPE2: Discrete 2 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control
Bit 1	CPE1: Discrete 1 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control

Bit 0	CPE0: Discrete 0 Pump Enable 1 = Enable Pump output control 0 = Disable Pump output control

Register Use Summary

101<15-8>	CONFIG	-	-	-	-	-	-	-	-
101<7-0>	CONFIG	DBEL	PDL2	PDL1	PDL0	UPMP	UDIS	UANA	ULCD
104<15-8>	PUMP	-	-	-	-	-	-	-	-
104<7-0>	PUMP	CPE7	CPE6	CPE5	CPE4	CPE3	CPE2	CPE1	CPE0

Table 6.4 - Registers associated with Safety Charge Pump

Legend:		
R = Readable Bit	W = Writable Bit	U = Unimplemented
‘1’ = bit set	‘0’ = bit cleared	‘X’ = bit Unknown

6.2.6 105 - DEBUG: ModIO™ Debug control register.

R/W-1	U-1	U-1	U-1	U-1	U-1	R/W-1	R/W-1
DBENHI	-	-	-	-	-	COMDBOFF	MPGDBOFF
Bit 7							Bit 0

Bit 7	DBENHI: Debug Enable High bit. Enable/Disable the ModIO™ Debug interface. 1 = Enable the Debug Interface 0 = Disable the Debug Interface.
Bit 6	Unimplemented
Bit 5	Unimplemented
Bit 4	Unimplemented
Bit 3	Unimplemented
Bit 2	DSDBOFF DigiSpeed Debug Screen Control. Enable/Disable the ModIO™ DigiSpeed debug screen 1 = Disable the DigiSpeed Debug screen 0 = Enable the DigiSpeed Debug Screen.
Bit 1	COMDBOFF Communications Debug Screen control. Enable/Disable the ModIO™ Communications debug screen 1 = Disable the Communications Debug screen 0 = Enable the Communications Debug Screen.
Bit 0	MPGDBOFF MPG Debug Screen control. Enable/Disable the ModIO™ MPG debug screen 1 = Disable the MPG Debug screen 0 = Enable the MPG Debug Screen.

Note: You should not normally enable the Debug interface except to investigate a particular problem as in this state the Discrete outputs a disabled, for safety reasons.

Legend:		
R = Readable Bit	W = Writable Bit	U = Unimplemented
‘1’ = bit set	‘0’ = bit cleared	‘X’ = bit Unknown

6.2.7 106 - CONFIG2: Configuration control register 2

R/W-1	R/W-1	R/W-1	U-1	R/W-1	R/W-1	R/W-1	R/W-1
DSOFF	PEROFF	KBOFF	-	UHSE2	UHSE1	UENC2	UENC1
Bit 7							Bit 0

Bit 7 DSOFF: DigiSpeed™ Enable
Enable/Disable the ModIO™ DigiSpeed™ interface.
1 = Disable the DigiSpeed™ Interface
0 = Enable the DigiSpeed™ Interface.

Bit 6 PEROFF: Period Measurement Enable
Enable/Disable the ModIO™ Period Measurement (Frequency) interface.
1 = Disable the Period Measurement Interface
0 = Enable the Period Measurement Interface.

Bit 5 KBOFF: Keyboard Enable
Enable/Disable the ModIO™ 4x4 Keyboard matrix interface.
1 = Disable the Keyboard Interface
0 = Enable the Keyboard Interface.

Bit 4 Unimplemented

Bit 3 UHSE2: Use High Resolution for Encoder 2
Enable/Disable the quadrature edge transition detection.
1 = Count all 4 edge transitions per pulse
0 = Count on 1 transition per pulse only.

Bit 2 UHSE1: Use High Resolution for Encoder 1
Enable/Disable the quadrature edge transition detection.
1 = Count all 4 edge transitions per pulse
0 = Count on 1 transition per pulse only.

Bit 1 UENC2: Use Quadrature Encoder 2
Enable/Disable the ModIO™ Quadrature Encoder Counter 2 interface.
1 = Enable the Encoder 1 Interface
0 = Disable the Encoder 1 Interface.

Bit 0 UENC1: Use Quadrature Encoder 1
Enable/Disable the ModIO™ Quadrature Encoder Counter 1 interface.
1 = Enable the Encoder 1 Interface
0 = Disable the Encoder 1 Interface.

Legend:		
R = Readable Bit	W = Writable Bit	U = Unimplemented
'1' = bit set	'0' = bit cleared	'X' = bit Unknown

6.3 RAM Register Block

The RAM register block is implemented in RAM within the PIC. This area is volatile, and all data is reset to 0 on power up. Each register is 16 bits and may be written to and read from. The access may be single or multiple reads and writes. The access may be on a register or bit basis.

The RAM Register Block is split into two sections, the input section and the output section. The purpose behind this partitioning is for efficiency in reading and writing transactions with the ModIO™. All reads to the ModIO™ may be done with a single Modbus Read Holding Registers Function (03). All writes may be done with a single Write Multiple registers (16). Alternatively, it is possible to read and write with a single function, Read/Write Multiple Registers (23).

The RAM Register Block Map is defined below in Table 6.4.

Address	Name	
1000	LCD Data Area	Output
1039		
1040	DOUT	
1041	SPINSPEED	
	-	
1149	-	
1150	ENCODR1	InputRegisters
1151	DIN	
1152	ANALOG1	
1153	ANALOG2	
1154	ANALOG3	
1155	ENCODR2	
1156	TICKCTR	
1157	PERIOD	
1158	KEYBOARD	
1249	-	

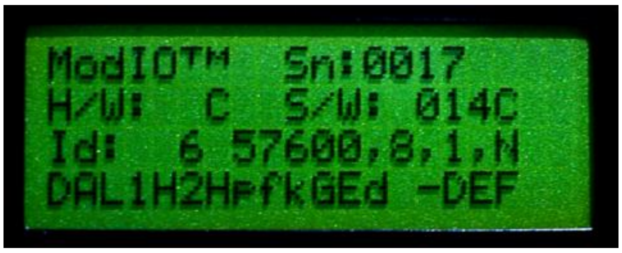
Table 6.4 – RAM registers

6.3.1 1000 - 1039 Liquid Crystal Display Controller registers

The ModIO™ provides a character LCD interface. The interface is for a 4 x 20, 80 Character HD44780 (industry standard) based character LCD.

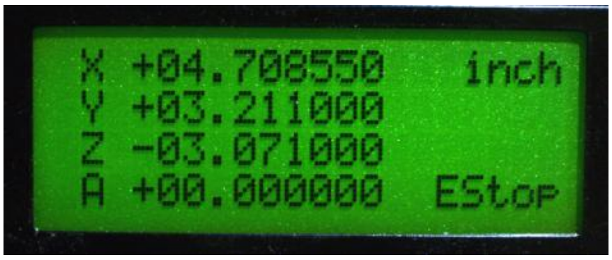
The display is used in two basic modes, Diagnostic Mode and Data Mode. In Diagnostic mode, the information displayed is preformed with the particular display being selected by the debug configuration that is selected.

Although configured for four rows of 20 characters, smaller display sizes may be used.



```
ModIO™  Sn:0017
H/W:  C  S/W: 014C
Id:  6 57600,8,1,N
DAL1H2HPfkGEd -DEF
```

Figure 6.1 – System data in LCD



```
X +04.708550   inch
Y +03.211000
Z -03.071000
A +00.000000  EStop
```

Figure 6.2 – User data in LCD

6.3.1.1 LCD data Registers

The ModIO™ LCD interface provides for a 4x20 character display. Each 16 bit register holds two 8 bit ASCII characters. The LCD registers start at address 1000 and continue through to 1039, forty registers in total. By writing to a register the characters will be displayed on the LCD.

6.3.1.2 LCD Connector Interface

The ModIO™ LCD interface interfaces to the LCD via a standard 16 pin 0.1" IDC Box header J4. Table 6.5 below details the signal connections to the connector. The interface is configured in "4 bit mode".

Power for a LED back light is provided and will provide about 240mA at 5Vdc if other output devices are powered by an independent VOut power supply. Insert jumper B/L to enable the LCD backlight.

If it is vital for additional current to be supplied to the LCD then an external 5Vdc power supply may be used. Consult Homann Designs for details of its connection.

Note: An external current limiting resistor will be required.

The contrast of the LCD is adjusted by trimpot VR1. The trimpot is set at the factory for a standard 4x20 display. It should not . need to be adjusted by the user.

Pin	*Signal*	*I/O*	*Description*
1	Vss	-	Power Supply (GND)
2	Vcc	-	Power supply (+5V)
3	Vee	-	LCD Bias voltage
4	RS	O	Register Select
5	R/W	Gnd	Read/Write. Connected to Gnd
6	E	O	Display Enable
7	DB0	N/C	Not Connected
8	DB1	N/C	Not Connected
9	BD2	N/C	Not Connected
10	DB3	N/C	Not Connected
11	DB4	O	I/O Data Bus Line 6
12	DB5	O	I/O Data Bus Line 6
13	DB6	O	I/O Data Bus Line 6
14	DB7	O	I/O Data Bus Line 7 (MSB)
15	BL+	-	Back light Supply (+5V)
16	BL-	-	Back light Supply (GND)

Table 6.5 - J10, LCD Connector

6.3.1.3 Register Use Summary

The registers used by the LCD interface are listed below in Table 6.6.

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
101<15-8>	CONFIG	-	-	-	-	-	-	-	-
101<7-0>	CONFIG	DBEL	PDL2	PDL1	PDL0	UPMP	UDIS	UANA	ULCD
1000<15-8>	LCD CHAR 02	D7	D6	D5	D4	D3	D2	D1	D0
1000<7-0>	LCD CHAR 01	D7	D6	D5	D4	D3	D2	D1	D0
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...
1039<15-8>	LCD CHAR 80	D7	D6	D5	D4	D3	D2	D1	D0
1039<7-0>	LCD CHAR 79	D7	D6	D5	D4	D3	D2	D1	D0

Table 6.6 - Registers associated with LCD Interface

6.3.2 1040 - DOUT: Discrete Output Register

Each of the Discrete outputs may be controlled by the DOUT register. The register contains a bit for each discrete output as defined in below. The output is made active by setting the bit to "1". When the output is active, the output is pulled to Ground and LED is illuminated.

The ModIO™ may be configured to disable the discrete inputs and outputs. That said, it would be unusual to have a need to do so. To disable the discrete set bit ULCD (CONFIG<2>) to 0.

6.3.2.1 Bit allocation in DOUT

R/W-X	R/W-X	R/W-X	R/W-X	R/W-X	R/W-X	R/W-X	R/W-X
DOUT7	DOUT6	DOUT5	DOUT4	DOUT3	DOUT2	DOUT1	DOUT0
Bit 7							Bit 0

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
-	-	-	-	-	-	-	-
Bit 15							Bit 8

Bit 15 - 8	Unimplemented
Bit 7	DOUT7: Discrete Output 7 (J1/2 - Pin 17 – DOut7) 1 = Input is Active (0V) 0 = Input is Inactive (+VOut)
Bit 6	DOUT6: Discrete Output 6 (J1/2 - Pin 16 – DOut6) 1 = Output is Active (0V) 0 = Output is Inactive (+VOut)
Bit 5	DOUT5: Discrete Output 5 (J1/2 - Pin 15 – DOut5) 1 = Output is Active (0V) 0 = Output is Inactive (+VOut)
Bit 4	DOUT4: Discrete Output 4 (J1/2 - Pin 14 – DOut4) 1 = Output is Active (0V) 0 = Output is Inactive (+VOut)
Bit 3	DOUT3: Discrete Output 3 (J1/2 - Pin 12 – DOut3) 1 = Output is Active (0V) 0 = Output is Inactive (+VOut)
Bit 2	DOUT2: Discrete Output 2 (J1/2 - Pin 11 - DOut2) 1 = Output is Active (0V) 0 = Output is Inactive (+VOut)
Bit 1	DOUT1: Discrete Output 1 (J1/2 - Pin 10 – DOut1) 1 = Output is Active (0V) 0 = Output is Inactive (+VOut)
Bit 0	DOUT0: Discrete Output 0 (J1/2 - Pin 9 –DOut0)

1 = Output is Active (0V)
0 = Output is Inactive (+VOut)

Legend:		
R = Readable Bit	W = Writable Bit	U = Unimplemented
'1' = bit set	'0' = bit cleared	'X' = bit Unknown

6.3.2.2 Discrete Output Safety Charge Pump

The ModIO™ provides a Safety Charge Pump facility. For Discrete Outputs, this facility can be enabled on an individual output basis. When enabled, the output will be disabled if the ModIO™ unit fails to receive a Modbus Request within a user selected timeout period.

See the section on the Safety Charge Pump register 104 for details on using this facility.

Note: If a discrete is disabled by the Safety Charge Pump, it will not be automatically re-enabled once Modbus communication recommences.
The discrete output must be re-activated to turn it back on

6.3.2.3 Register Use Summary

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
101<15-8>	CONFIG	-	-	-	-	-	-	-	-
101<7-0>	CONFIG	DBEL	PDL2	PDL1	PDL0	UPMP	UDIS	UANA	ULCD
103<15-8>	FLASH	-	-	-	-	-	-	-	-
103<7-0>	FLASH	FLD7	FLD6	FLD5	FLD4	FLD3	FLD2	FLD1	FLD0
1040<15-8>	DOUT	-	-	-	-	-	-	-	-
1040<7-0>	DOUT	DOUT7	DOUT6	DOUT5	DOUT4	DOUT3	DOUT2	DOUT1	DOUT0

Table 6.7 - Registers associated with Discrete Outputs

6.4 1041 – SSPEED: PWM for DigiSpeed unit

The ModIO will generate a pulse width modulated output which is presented on the DigiSpeed interface header (J5 Pin 2) and on DOut4

The interface is enabled by bit 7 of CONFIG2 = 0

When the interface is enabled, DOut3 and DOut4 are dedicated to the PWM function and cannot be used as Discrete outputs.

The frequency of this pulse train is 4.75Hz.

The pulse width is controlled by the least significant 10 bits of register 1041 (SSPEED). A value of 0 in this register is 0% of the pulse time being active (hi on J5 pin 2, lo on DOut4). A value of 1024 is 100% of the pulse time active.

DOut3 is used as the Enable signal for the PWM output and optionally the DigiSpeed itself. Its configuration is optimized for this application. The software in the master (e.g. Mach3) should use bit 3 in the DOUT register to turn the PWM signal on and off. DOUT3 = 1 forces the PWM signal to be 0% active (zero speed). DOUT3 = 0 generates the pulse width defined by SSPEED. In addition DOut3 can be connected to the DigiSpeed as an enable via J5 pin 3 or the DigiSpeed enable can be help permanently lo (active) by J(P)13.

DOut2 is presented to the DigiSpeed on J5 pin 4. It can be used to control a contactor to set the direction of spindle rotation. In this case it would be controlled as a discrete output by Mach3

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
105<15-8>	CONFIG2	-	-	-	-	-	-	-	-
105<7-0>	CONFIG2	DSOFF	PEROFF	KBOFF	-	UHSE2	UHSE1	UENC2	UENC1
1040<15-8>	DOUT	-	-	-	-	-	-	-	-
1040<7-0>	DOUT	DOUT7	DOUT6	DOUT5	DOUT4	DOUT3	DOUT2	DOUT1	DOUT0
1041<15-8>	SSPEED	-	-	-	-	-	-	B9	B8
1141<7-0>	SSPEED	B7	B6	B5	B4	B3	B2	B1	B0

Table 6.8 – PWM output register

6.4.1 1050 - Encoder1: MPG Encoder read register

6.4.1.1 Overview

The ModIO™ provides an interface for two MPG (Manual Pulse Generator) inputs. The interface is provided primarily for 100 ppr (pulses per revolution) encoders as found on CNC pendants and controllers.

Note: The MPG interface is *not* designed for high resolution encoders as found on servos, etc. The MPG interface may lose steps if the encoder generates more than 1000 pulses/second.

The MPG interface is enabled by default, but may be controlled via configuration register CONFIG2. Each MPG may be enabled/disabled independently. Additionally, the encoder count for each encoder may be divided by four, if desired.

Each encoder interface generates a 16- bit up down counter which rolls under/over once the 16 bits have been exhausted.

Encoder 1 shares pins 14 and 15 with Discrete inputs DIn 6 and DIn 7.

Register 1156 (TickCtr) give the time in ticks since an MPG register was read. This is used by Mach3 to calculate the speed of rotation of the MPGs

6.4.1.2 Register Use Summary

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
106<15-8>	CONFIG2	-	-	-	-	-	-	-	-
106<7-0>	CONFIG2	DSOFF	PEROFF	KBOFF	-	UHSE2	UHSE1	UENC2	UNC1
1150<15-8>	MPG1	B15	B14	B13	B12	B11	B10	B9	B8
1150<7-0>	MPG1	B7	B6	B5	B4	B3	B2	B1	B0
1155<15-8>	MPG2	B15	B14	B13	B12	B11	B10	B9	B8
1155<7-0>	MPG2	B7	B6	B5	B4	B3	B2	B1	B0
1156<15-8>	TickCtr	B15	B14	B13	B12	B11	B10	B9	B8
1156<7-0>	TickCtr	B7	B6	B5	B4	B3	B2	B1	B0

Table 6.9 - Registers associated with MPG Interface

6.4.2 1151 - DIN: Discrete Input Register

R/W-X	R/W-X	R/W-X	R/W-X	R/W-X	R/W-X	R/W-X	R/W-X
DIN7	DIN6	DIN5	DIN4	DIN3	DIN2	DIN1	DIN0
Bit 7							Bit 0

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0
-	-	-	-	-	-	-	-
Bit 15							Bit 8

Bit 15 - 8	Unimplemented
Bit 7	DIN7: Discrete Input 7 (J10/12 - Pin 15) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)
Bit 6	DIN6: Discrete Input 6 (J10/12 - Pin 14) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)
Bit 5	DIN5: Discrete Input 5 (J10/12 - Pin 13) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)
Bit 4	DIN4: Discrete Input 4 (J10/12 - Pin 12) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)
Bit 3	DIN3: Discrete Input 3 (J10/12 - Pin 10) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)
Bit 2	DIN2: Discrete Input 2 (J10/12 - Pin 9) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)
Bit 1	DIN1: Discrete Input 1 (J10/12 - Pin 8) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)
Bit 0	DIN0: Discrete Input 0 (J10/12 - Pin 7) 1 = Input is Active (0V) 0 = Input is Inactive (+5V)

Legend:

R = Readable Bit	W = Writable Bit	U = Unimplemented
‘1’ = bit set	‘0’ = bit cleared	‘X’ = bit Unknown

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
101<15-8>	CONFIG	-	-	-	-	-	-	-	-
101<7-0>	CONFIG	DBEL	PDL2	PDL1	PDL0	UPMP	UDIS	UANA	ULCD
1151<15-8>	DIN	-	-	-	-	-	-	-	-
1151<7-0>	DIN	DIN7	DIN6	DIN5	DIN4	DIN3	DIN2	DIN1	DIN0

Table 6.10 - Registers associated with Discrete Inputs

6.4.3 1152 , 1153, 1154 – Analog in Registers

6.4.3.1 Overview

The ModIO™ provides three analog to digital (A to D) inputs. These inputs are provided primarily for the connection of potentiometers (either rotary or with switched discrete resistors) for use as variable input devices, such as speed or feed rate control inputs.

The reference voltage for the analog to digital converter is 5V. Therefore the analog voltage inputs are limited to 0 – 5Vdc.

The Analog interface is enabled by default, but may be controlled via the Use Analogs Bit (UANA) of configuration register CONFIG2.

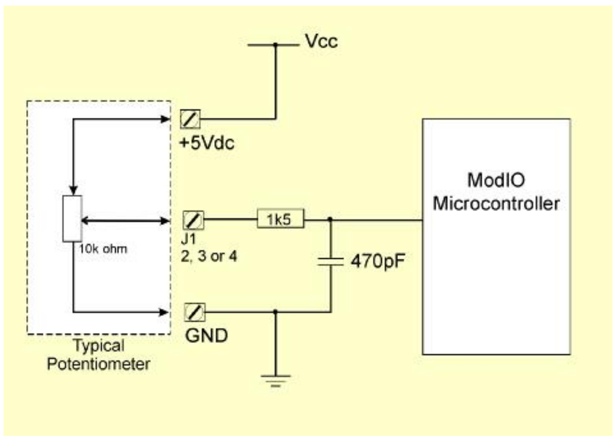


Figure 6.3 - Analog Input Schematic

Each of the three analog to digital converter inputs convert the analog input voltage to a 10 bit variable that ranges from 0 to 1023.

6.4.3.2 Register Use Summary

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
101<15-8>	CONFIG	-	-	-	-	-	-	-	-
101<7-0>	CONFIG	DBEL	PDL2	PDL1	PDL0	UPMP	UDIS	UANA	ULCD
1152<15-8>	ANA1	-	-	-	-	-	-	B9	B8
1152<7-0>	ANA1	B7	B6	B5	B4	B3	B2	B1	B0
1153<15-8>	ANA2	-	-	-	-	-	-	B9	B8
1153<7-0>	ANA2	B7	B6	B5	B4	B3	B2	B1	B0
1154<15-8>	ANA3	-	-	-	-	-	-	B9	B8
1154<7-0>	ANA3	B7	B6	B5	B4	B3	B2	B1	B0

Table 6.11 - Registers associated with Analog to Digital Interface

6.4.4 1155 – Encoder2: MPG Encoder read register

6.4.4.1 Overview

The ModIO™ provides an interface for two MPG (Manual Pulse Generator) inputs. The interface is provided primarily for 100 ppr (pulses per revolution) encoders as found on CNC pendants and controllers.

Note: The MPG interface is *not* designed for high resolution encoders as found on servos, etc. The MPG interface may lose steps if the encoder generates more than 1000 pulses/second.

The MPG interface is enabled by default, but may be controlled via configuration register CONFIG2. Each MPG may be enabled/disabled independently. Additionally, the encoder count for each encoder may be divided by four, if desired.

Each encoder interface generates a 16- bit up down counter which rolls under/over once the 16 bits have been exhausted.

Encoder 2 shares pins 12 and 13 with DIn 4 and DIn 5.

Register 1156 (TickCtr) give the time in ticks since an MPG register was read. This is used by Mach3 to calculate the speed of rotation of the MPGs

6.4.4.2 Register Use Summary

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
106<15-8>	CONFIG2	-	-	-	-	-	-	-	-
106<7-0>	CONFIG2	DSOFF	-	-	-	UHSE2	UHSE1	UENC2	UNC1
1150<15-8>	MPG1	B15	B14	B13	B12	B11	B10	B9	B8
1150<7-0>	MPG1	B7	B6	B5	B4	B3	B2	B1	B0
1155<15-8>	MPG2	B15	B14	B13	B12	B11	B10	B9	B8
1155<7-0>	MPG2	B7	B6	B5	B4	B3	B2	B1	B0
1156<15-8>	TickCtr	B15	B14	B13	B12	B11	B10	B9	B8
1156<7-0>	TickCtr	B7	B6	B5	B4	B3	B2	B1	B0

Table 6.12 - Registers associated with MPG Interface

6.4.5 1156 – TickCtr: Timing register

This register gives the time, in PIC ticks, since an MPG register was read. It is used to estimate the speed of rotation of the MPGs

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
1056<15-8>	TickCtr	D7	D6	D5	D4	D3	D2	D1	D0
1056<7-0>	TickCtr	D7	D6	D5	D4	D3	D2	D1	D0

Table 6.13 - Registers associated with MPG speed measurement

6.4.6 1157 – Period: Spindle speed measurement register

Gives the time in (a unit to be determined) between the latest and penultimate pulses on the Index input of the DigiSpeed interface

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
1057<15-8>	Period	D7	D6	D5	D4	D3	D2	D1	D0
1057<7-0>	Period	D7	D6	D5	D4	D3	D2	D1	D0

Table 6.14 - Register associated with Period measurement

6.4.7 1158 – Keyboard: Scanned inputs register

DOut pins 3 – 0 (J1 terminals 12 to 9) can be arranged to scan 4 possible columns of contacts (e.g. a 4 x 4 switch matrix). DIn pins 3 – 0 (J10 terminals 10 to 7) sense the signal rows.

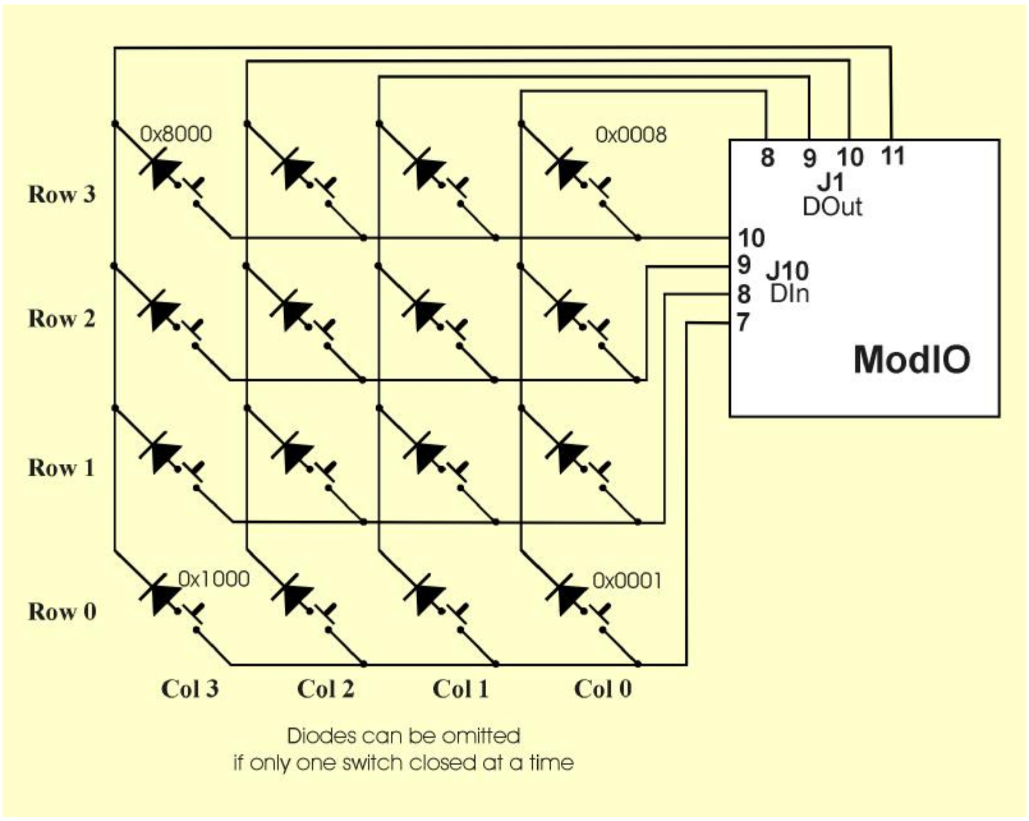


Figure 6.4 – Connections for "Keyboard" matrix

This mode is enabled by bit 5 of CONFIG2 (register 106). When enabled these 4 outputs and 4 inputs are automatically disabled in DOUT (register 1040) and DIN (register 1151).

With a suitable circuit with diodes in series with each switch, the ModIO can sense any simultaneous combination of switch closures so this feature can be used to encode 16 switches for any function not just a keypad. If one switch closure at a time is all that is expected and you do not mind spurious results if several are pressed then the diodes can be omitted.

Address	*Name*	*Bit7/15*	*Bit614*	*Bit5/13*	*Bit6/12*	*Bit3/11*	*Bit2/10*	*Bit1/9*	*Bit0/8*
106<15-8>	CONFIG2	-	-	-	-	-	-	-	-
106<7-0>	CONFIG2	DSOF F	PEROFF	KBOFF	-	UHSE2	UHSE1	UENC2	UNC1
1058<15-8>	Keyboard	C3R3	C3R2	C3R1	C3R0	C2R3	C2R2	C2R1	C2R0
1058<7-0>	Keyboard	C1R3	C1R2	C1R1	C1R0	C0R3	C0R2	C0R1	C0R0

Table 6.15 - Register associated with Scanned Inputs

Key: C*x*R*y* (e.g. C1R2) means bit is set to "1" if switch in Column *x* Row *y* (e.g. Column 1 Row 2) is closed

7 Firmware programming

The processor on the ModIO has flash memory in it which stores the firmware. This can be re-flashed from a PC using the RS-232 serial interface. This is useful for implementing upgrades to the firmware in the field.

This process can only be performed after inserting a jumper (JP1) so cannot be performed accidentally by a user.

If you are encountering difficulties with a ModIO, then re-flashing should only be attempted as a last resort and if you know that the newer version of the firmware that you are installing corrects the sort of symptoms that you have seen. If you have a hardware or communications fault the re-flashing will potentially fail leaving you with an erased PIC and diagnosis will be even harder than with a partly working system.

7.1 Preparation

Insert a jumper on the pins of the boot jumper. See highlight in Figure 7.1.

Reset the ModIO. It will the be running a built in boot-loader awaiting commands from a utility in the PC.

Run the program `P1618QP.exe`

This will display a screen like figure 7.2.

Click *Select* and right click on the baud rate control. Select 57600 as shown in figure 7.3.

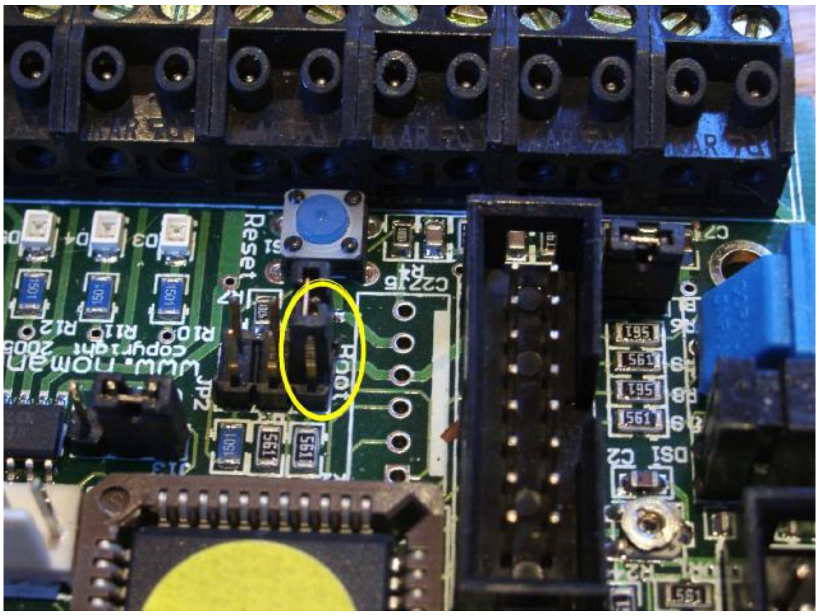


Figure 7.1 – Boot jumper location

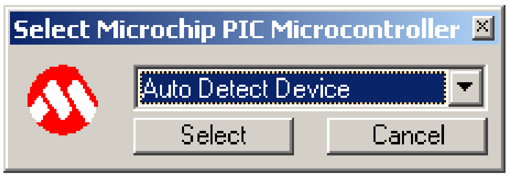


Figure 7.2 – Programming utility

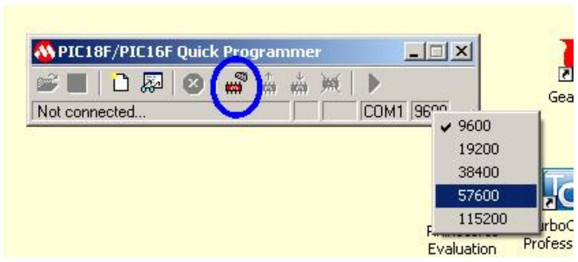


Figure 7.3 – Selecting baud rate

7.2 Connecting to the ModIO and erasing flash

Click the Connect icon on the tool bar. See figure 7.3.

The bootloader should identify the PIC in the ModIO and enable the other icons on the toolbar. Click the Erase Flash icon to erase the ModIO memory.

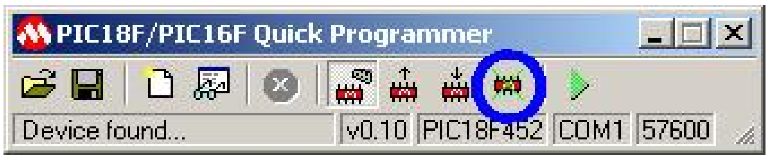


Figure 7.4 – PIC identified and the Erase icon

The PIC flash memory will be cleared. This is most important or the subsequent re-program will fail to give a valid system.

7.3 Programming

Next use the File>Open menu item of open file icon to display a file open dialog. Navigate to the folder where you have stored the firmware hex file – probably downloaded from the ModIO Yahoo! Group.

An example with only one file is shown in figure 7.5. Select the file to use and click *Open*.

Then click the *Write device* icon on the programmer utility.

This is highlighted in figure 7.6.

The programmer will count up the bytes as they are written to the ModIO PIC.

When the write is completed, remove the Boot jumper and Reset the ModIO.

If you have an LCD, you can confirm the version of the current firmware that has been flashed as it is displayed on the initial screen.

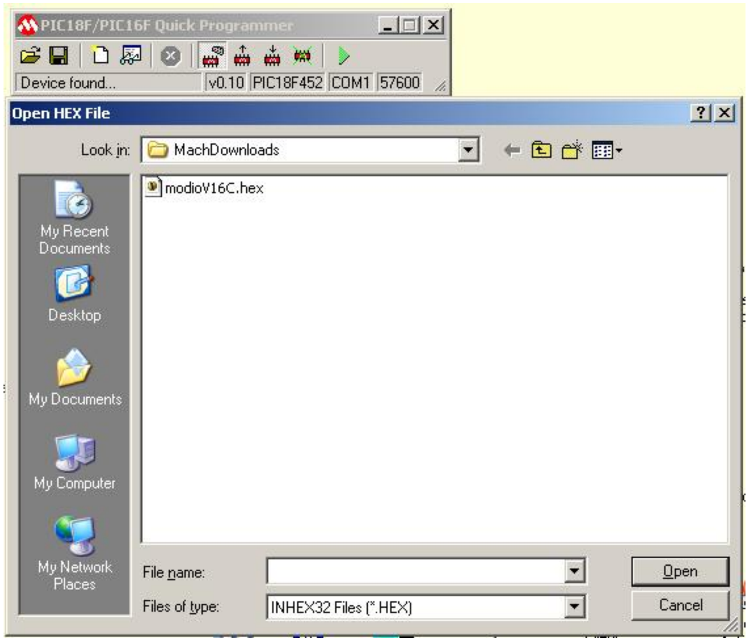


Figure 7.5 – File open dialog for firmware

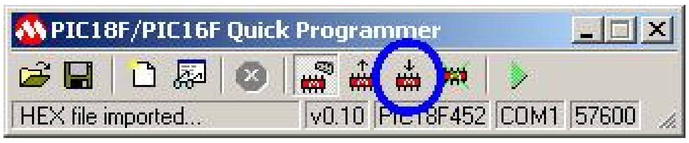


Figure 7.6 – Hex file leaded and the Write device icon

8 Revision data

Version	**Date**	**Change record**
0.92	16 April 2006	Various detailed drafting improvements made after user feedback
0.91	20 March 2006	Initial issue of full manual

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