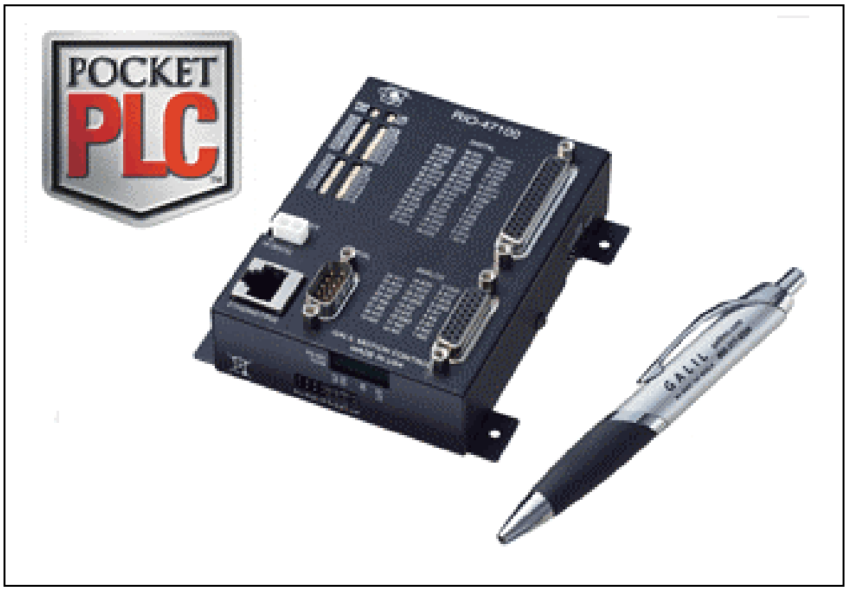

Galil RIO Pocket PLC
And Mach3 ModBus
Installation and Programming

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4/28/2009

Introduction

The Galil RIO controller allows a user to add Analog and Digital I/O points to a machine controller. There is an embedded programming language that enables the user to configure the controller to handle almost any automation task.

The Mach3 controller software allows a user to control multiple axis machines with an industry standard
g-code input method.

This manual identifies the settings and methods of communicating between them.

RIO configuration

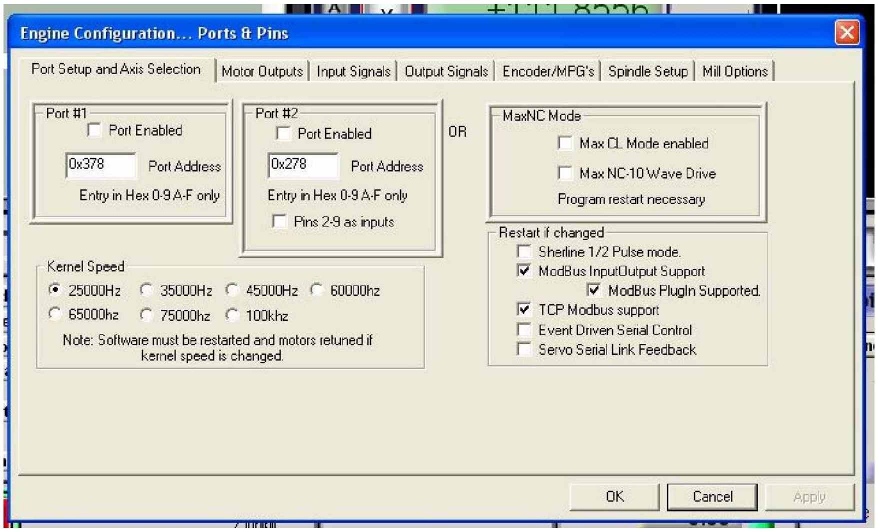
The RIO needs to have an I/P address saved to its onboard memory to allow Ethernet communications. Use the free Galil-tools program. Downloaded from: www.galilmc.com
I found it convenient to set the I/P address of my controller to 192.168.1.4
You may choose other settings that may better fit your network. The I/P configuration is explained in the RIO manual.

It is also necessary to set MV to 0 and MI to 1 for the purposes of this setup. Save these settings using the BN (burn) command.

Mach3 configuration
Step #1

Mach3 needs to know that we are going to use ethernet ModBus protocol to communicate with the RIO.

The first settings are made in the Config -> Ports and Pins dialog box.



Port #1
□ Port Enabled
0x378 Port Address
Entry in Hex 0-9 A-F only

Port #2
□ Port Enabled
0x278 Port Address
Entry in Hex 0-9 A-F only
□ Pins 2-9 as inputs

OR

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

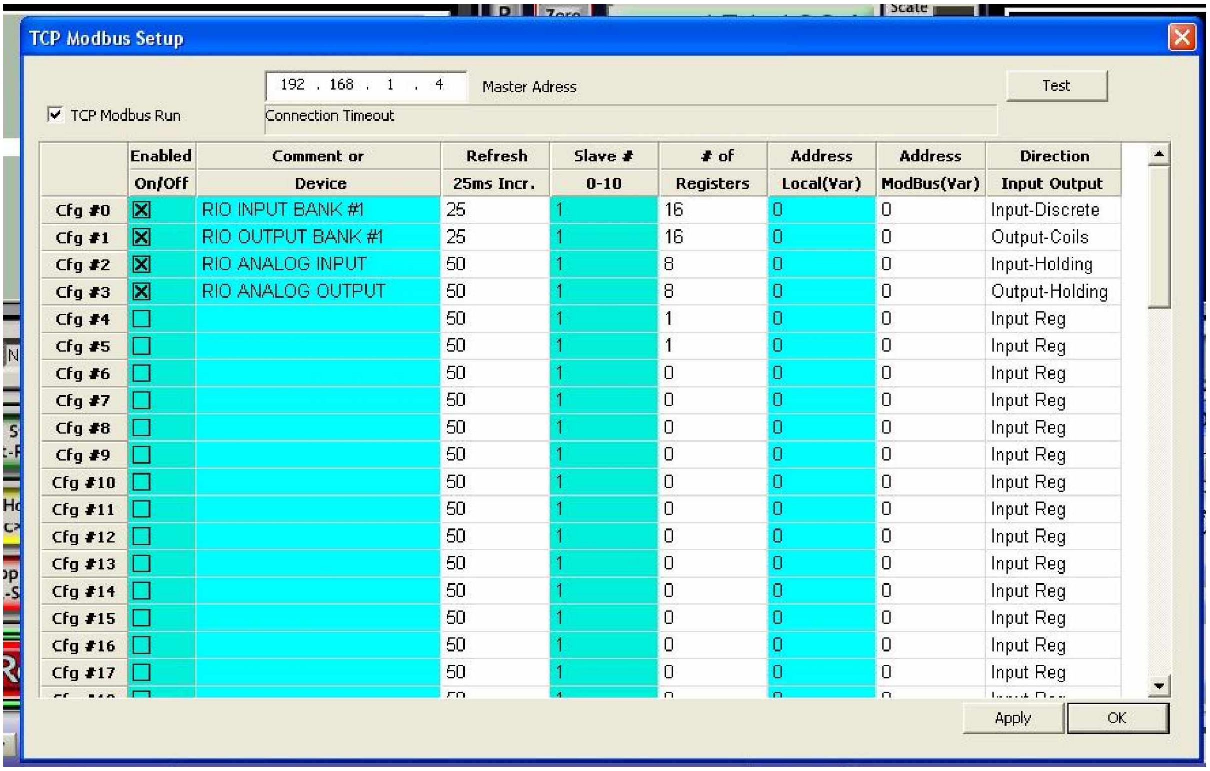
Kernel Speed
● 25000Hz ○ 35000Hz ○ 45000Hz ○ 60000hz
○ 65000hz ○ 75000hz ○ 100khz
Note: Software must be restarted and motors retuned if kernel speed is changed.

Restart if changed
□ Sherline 1/2 Pulse mode.
☑ ModBus InputOutput Support
☑ ModBus PlugIn Supported.
☑ TCP Modbus support
□ Event Driven Serial Control
□ Servo Serial Link Feedback

Settings that need to be checked here are:
ModBus InputOutput support:
ModBus PlugIn Supported:
TCP ModBus support:

You need to exit and restart Mach3 after checking these configuration boxes!

Mach3 configuration
Step #2



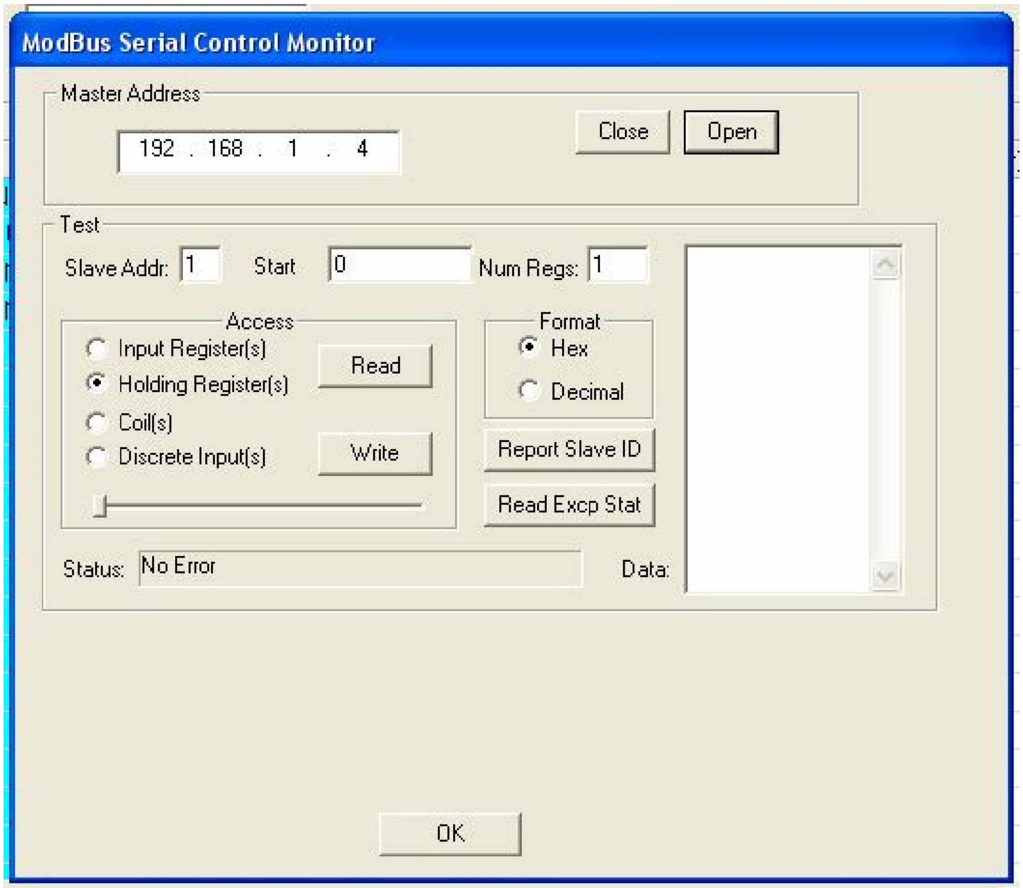
192 . 168 . 1 . 4 Master Adress

☑ TCP Modbus Run

Connection Timeout

	Enabled	Comment or	Refresh	Slave #	# of	Address	Address	Direction
	On/Off	Device	25ms Incr.	0-10	Registers	Local(Var)	ModBus(Var)	Input Output
Cfg #0	☒	RIO INPUT BANK #1	25	1	16	0	0	Input-Discrete
Cfg #1	☒	RIO OUTPUT BANK #1	25	1	16	0	0	Output-Coils
Cfg #2	☒	RIO ANALOG INPUT	50	1	8	0	0	Input-Holding
Cfg #3	☒	RIO ANALOG OUTPUT	50	1	8	0	0	Output-Holding
Cfg #4	□		50	1	1	0	0	Input Reg
Cfg #5	□		50	1	1	0	0	Input Reg
Cfg #6	□		50	1	0	0	0	Input Reg
Cfg #7	□		50	1	0	0	0	Input Reg
Cfg #8	□		50	1	0	0	0	Input Reg
Cfg #9	□		50	1	0	0	0	Input Reg
Cfg #10	□		50	1	0	0	0	Input Reg
Cfg #11	□		50	1	0	0	0	Input Reg
Cfg #12	□		50	1	0	0	0	Input Reg
Cfg #13	□		50	1	0	0	0	Input Reg
Cfg #14	□		50	1	0	0	0	Input Reg
Cfg #15	□		50	1	0	0	0	Input Reg
Cfg #16	□		50	1	0	0	0	Input Reg
Cfg #17	□		50	1	0	0	0	Input Reg

After restarting Mach3, you'll need to setup the communications configurations for the 4 RIO functions that we will use for data transfer. You need to go to the Function Cfg's -> Setup TCP Modbus dropdown menu to get to the above screen. Please be sure to enter all data as shown above. Be especially careful to set the direction choices exactly as shown here.



ModBus Serial Control Monitor

Master Address: 192 . 168 . 1 . 4

Test

Slave Addr: 1 Start 0 Num Regs: 1

Access
○ Input Register(s)
● Holding Register(s)
○ Coil(s)
○ Discrete Input(s)

Format
● Hex
○ Decimal

Status: No Error

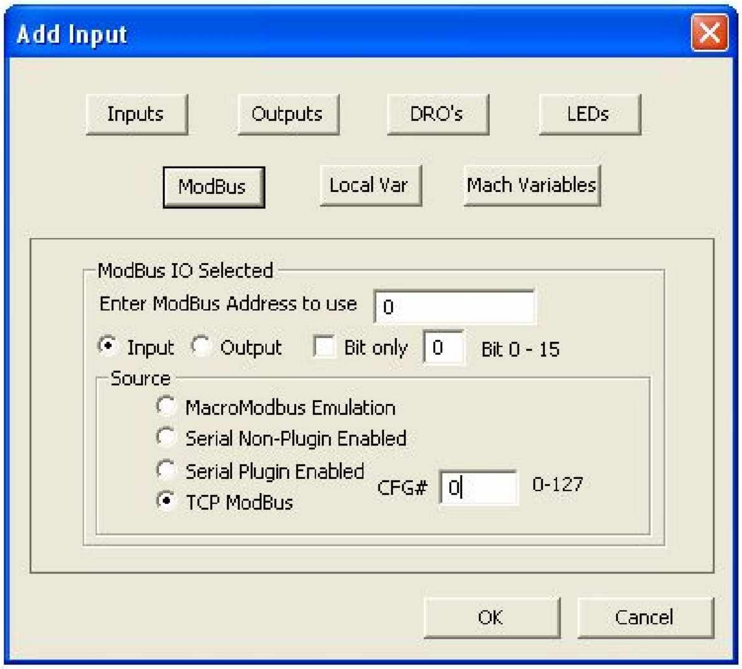
Click the “Test” button and the above screen appears. You can then enter the I/P address of the RIO controller. Set the slave address to 1 and click on the “Open” button. If the Rio is powered on and connected by an ethernet crossover cable or by two straight ethernet through cables and a switch, you should see the “No Error” response in the status box. If you get an error, please recheck power and Ethernet connections as well as making sure that the RIO I/P address is correct. “OK” returns you to the prior screen.

Check again that the I/P address is correct and check the TCP ModBus Run checkbox. Mach and the RIO are now able to communicate with each other.

Mach3 configuration
Step #3

Mach3 uses “brain” files to assign the Modbus I/O to Mach friendly variables. There are several good documents that describe ”brains” programming in detail. Please see http://www.machsupport.com/videos/ for an example of brains programming.

Digital Input programming



ModBus IO Selected

Enter ModBus Address to use: 0

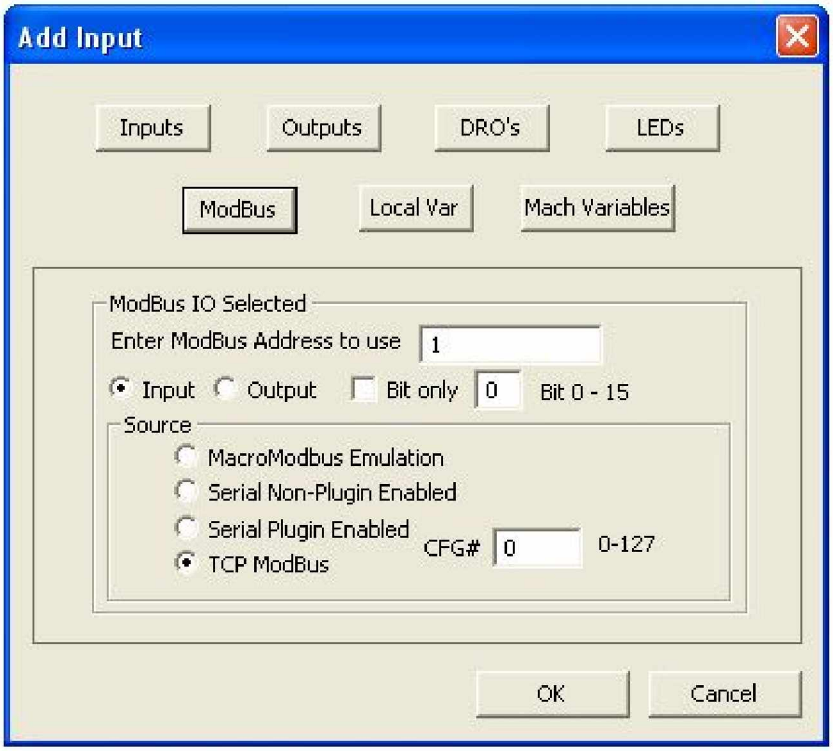
● Input ○ Output □ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 0 0-127

When in the “Brain” editor selecting the + brings up the above dialog box. Here we are configuring a digital input as input 0 on the RIO. Notice that the ModBus address of 0 is used and the Input checkbox is checked. Do NOT check the Bit only and Bit 0-15 boxes as they do not work properly in Mach3. The above configuration is the only one that has been found to work correctly. Check the TCP ModBus box and CFG# 0 which is the input configuration from the first screen in step #2. Clicking “OK” enters an input into the Brain files as the first entry of a ladder rung.



ModBus IO Selected

Enter ModBus Address to use: 1

● Input ○ Output □ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation

○ Serial Non-Plugin Enabled

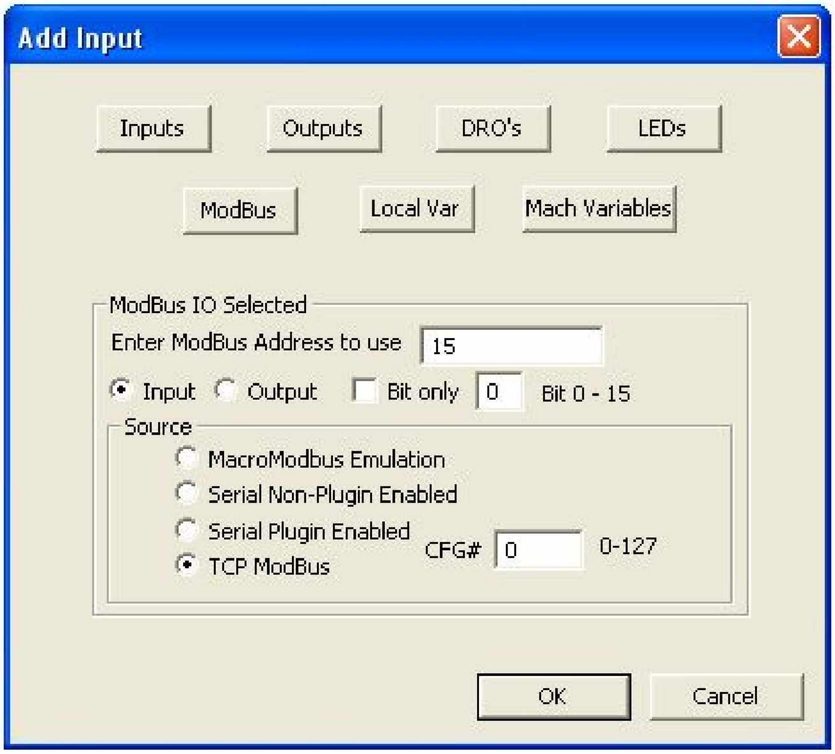
○ Serial Plugin Enabled

● TCP ModBus

CFG# 0 0-127

The above screen shows the configuration for RIO input# 1.

It is the same as the previous screen except for the ModBus address, which has now been set to 1. All other settings are the same as for input#0.



ModBus IO Selected

Enter ModBus Address to use 15

● Input ○ Output □ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 0 0-127

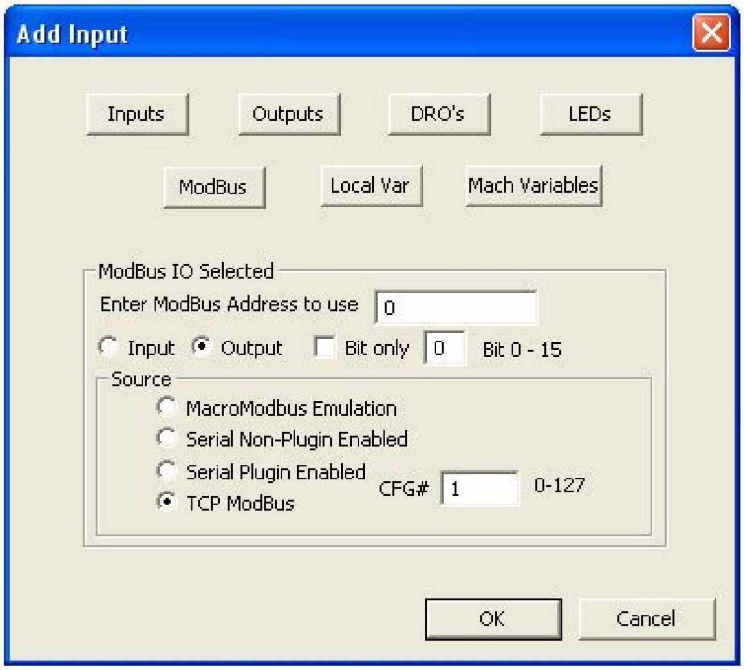
The above screen shows the configuration for RIO input# 15.

It is the also the same as the previous screen except for the ModBus address, which has now been set to 15. All other settings are the same as for input#0.

For all other Digital inputs, follow the above scheme except enter the RIO input number for the ModBus address.

Mach3 configuration
Step #4

Digital Output programming



ModBus IO Selected

Enter ModBus Address to use: 0

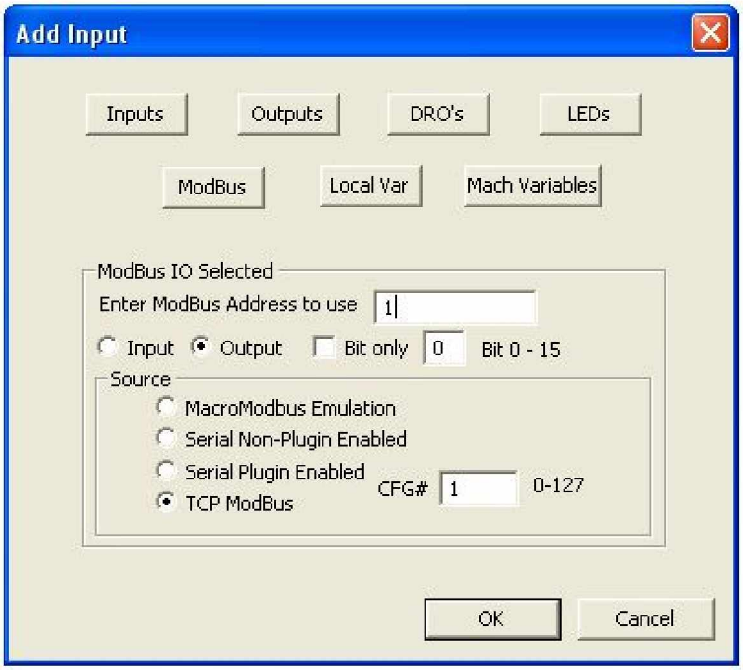
○ Input ● Output □ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 1 0-127

When in the “Brain” editor selecting the _|_ brings up the above dialog box. Here we are configuring a digital output as output 0 on the RIO. Notice that the ModBus address of 0 is used and the Output checkbox is checked. Do NOT check the Bit only and Bit 0-15 boxes as they do not work properly in Mach3. The above configuration is the only one that has been found to work correctly. Check the TCP ModBus box and CFG# 1 which is the output configuration from the first screen in step #2. Clicking “OK” enters an output into the Brain files as the last entry of a ladder rung.



ModBus IO Selected

Enter ModBus Address to use 1

○ Input ● Output ☐ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation

○ Serial Non-Plugin Enabled

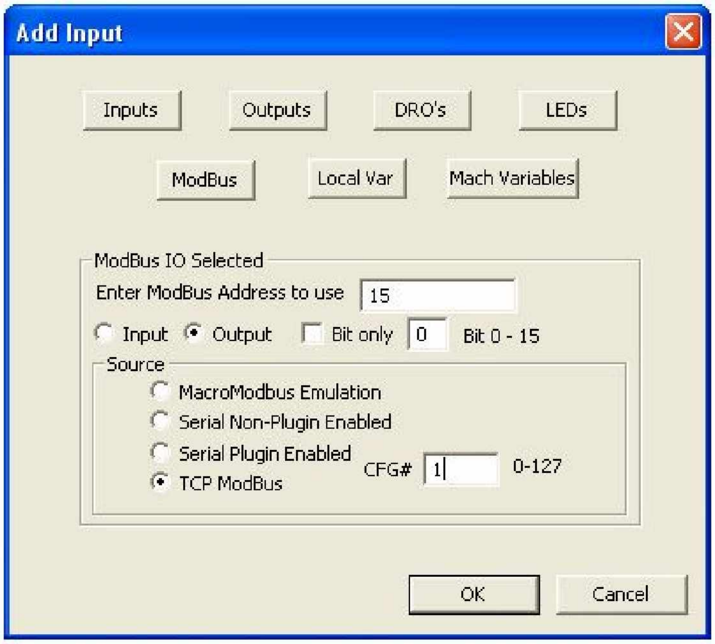
○ Serial Plugin Enabled

● TCP ModBus

CFG# 1 0-127

The above screen shows the configuration for RIOoutput# 1.

It is the same as the previous screen except for the ModBus address which has now been set to 1. All other settings are the same as for output#0.



ModBus IO Selected

Enter ModBus Address to use 15

○ Input ● Output □ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 1 0-127

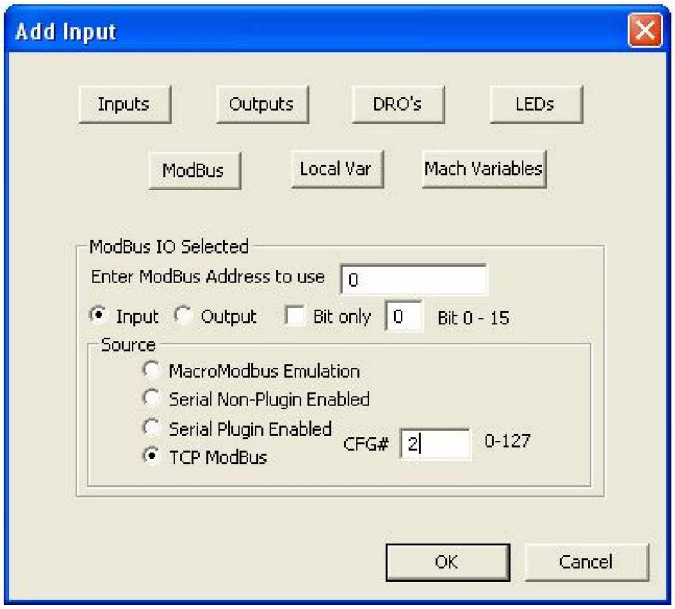
The above screen shows the configuration for RIO output# 15.

It is the also the same as the previous screen except for the ModBus address which has now been set to 15. All other settings are the same as for output#0.

For all other Digital outputs, follow the above scheme except enter the RIO input number for the ModBus address.

Mach3 configuration
Step #5

Analog Input programming



ModBus IO Selected

Enter ModBus Address to use 0

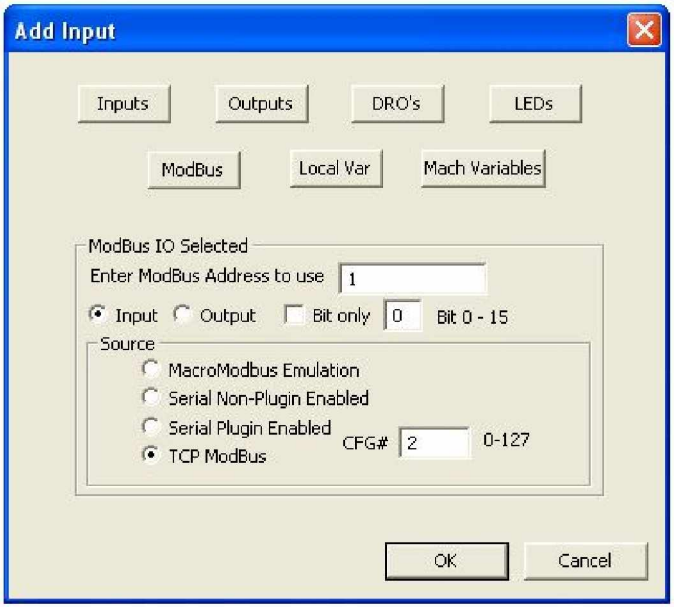
● Input ○ Output ☐ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 2 0-127

When in the “Brain” editor selecting the + brings up the above dialog box. Here we are configuring an analog input as input 0 on the RIO. Notice that the ModBus address of 0 is used and the Input checkbox is checked. Do NOT check the Bit only and Bit 0-15 boxes as they do not work properly in Mach3. The above configuration is the only one that has been found to work correctly. Check the TCP ModBus box and CFG# 2 which is the analog input configuration from the first screen in step #2. Clicking “OK” enters an input into the Brain files as the first entry of a ladder rung.



ModBus IO Selected

Enter ModBus Address to use 1

● Input ○ Output □ Bit only 0 Bit 0 - 15

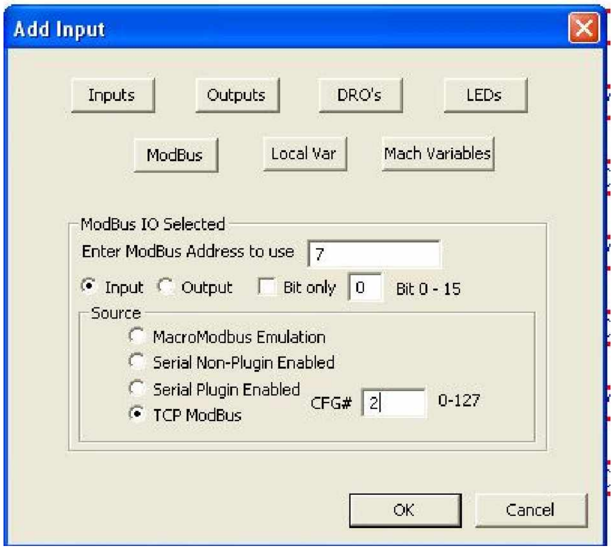
Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 2 0-127

The above screen shows the configuration for RIO analog input# 1.

It is the same as the previous screen except for the ModBus address which has now been set to 1. All other settings are the same as for analog input#0.



ModBus IO Selected

Enter ModBus Address to use 7

● Input ○ Output ☐ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 2 0-127

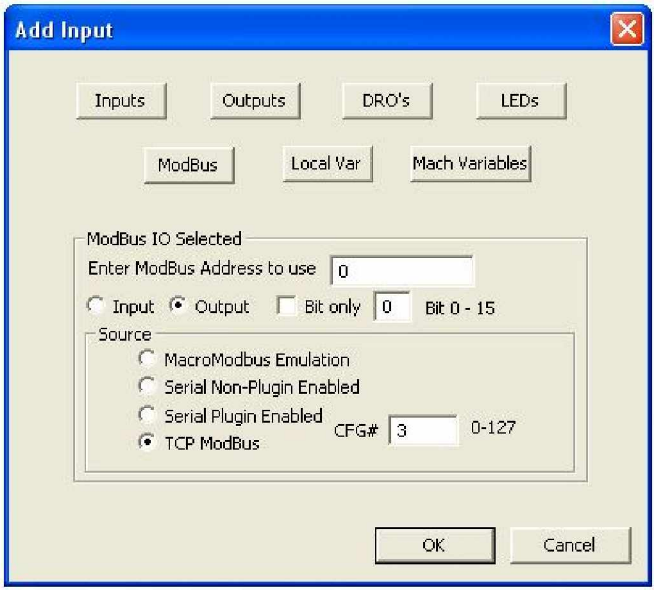
The above screen shows the configuration for RIO analog input# 7.

It is the also the same as the previous screen except for the ModBus address which has now been set to 7. All other settings are the same as for analog input#0.

For all other analog inputs, follow the above scheme except enter the RIO analog input number for the ModBus address.

Mach3 configuration
Step #6

Analog Output programming



ModBus IO Selected

Enter ModBus Address to use: 0

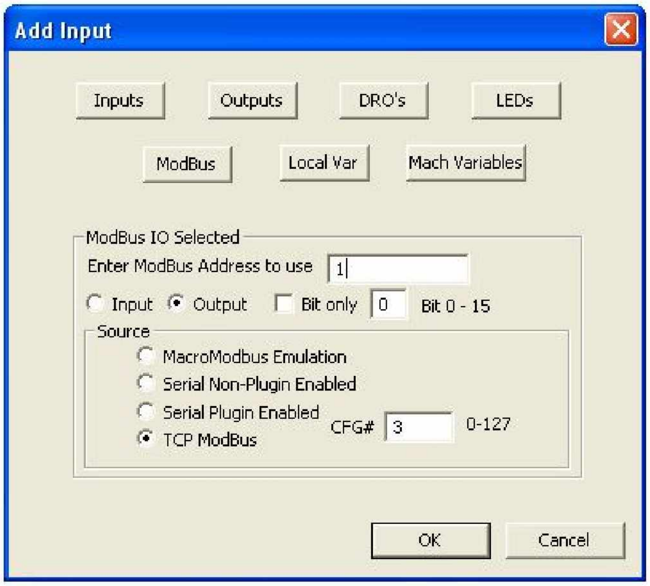
○ Input ● Output □ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 3 0-127

When in the “Brain” editor selecting the _|_ brings up the above dialog box. Here we are configuring an analog output as output 0 on the RIO. Notice that the ModBus address of 0 is used and the Output checkbox is checked. Do NOT check the Bit only and Bit 0-15 boxes as they do not work properly in Mach3. The above configuration is the only one that has been found to work correctly. Check the TCP ModBus box and CFG# 3 which is the output configuration from the first screen in step #2. Clicking “OK” enters an output into the Brain files as the last entry of a ladder rung.



ModBus IO Selected

Enter ModBus Address to use 1

○ Input ● Output □ Bit only 0 Bit 0 - 15

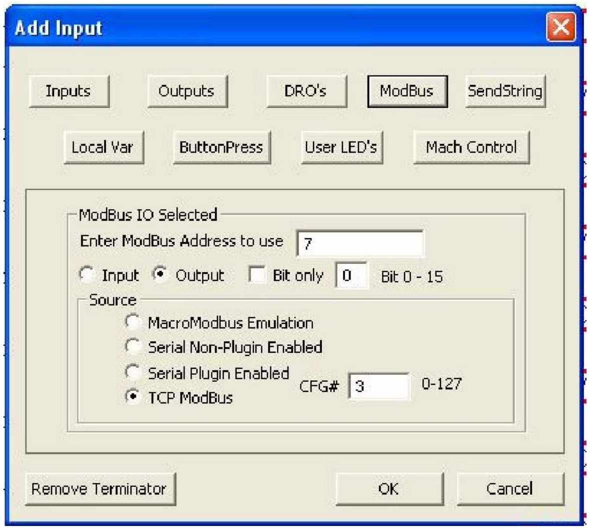
Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled
● TCP ModBus

CFG# 3 0-127

The above screen shows the configuration for RIO analog output# 1.

It is the same as the previous screen except for the ModBus address which has now been set to 1. All other settings are the same as for analog output#0.



ModBus IO Selected

Enter ModBus Address to use 7

○ Input ● Output ☐ Bit only 0 Bit 0 - 15

Source

○ MacroModbus Emulation
○ Serial Non-Plugin Enabled
○ Serial Plugin Enabled CFG# 3 0-127
● TCP ModBus

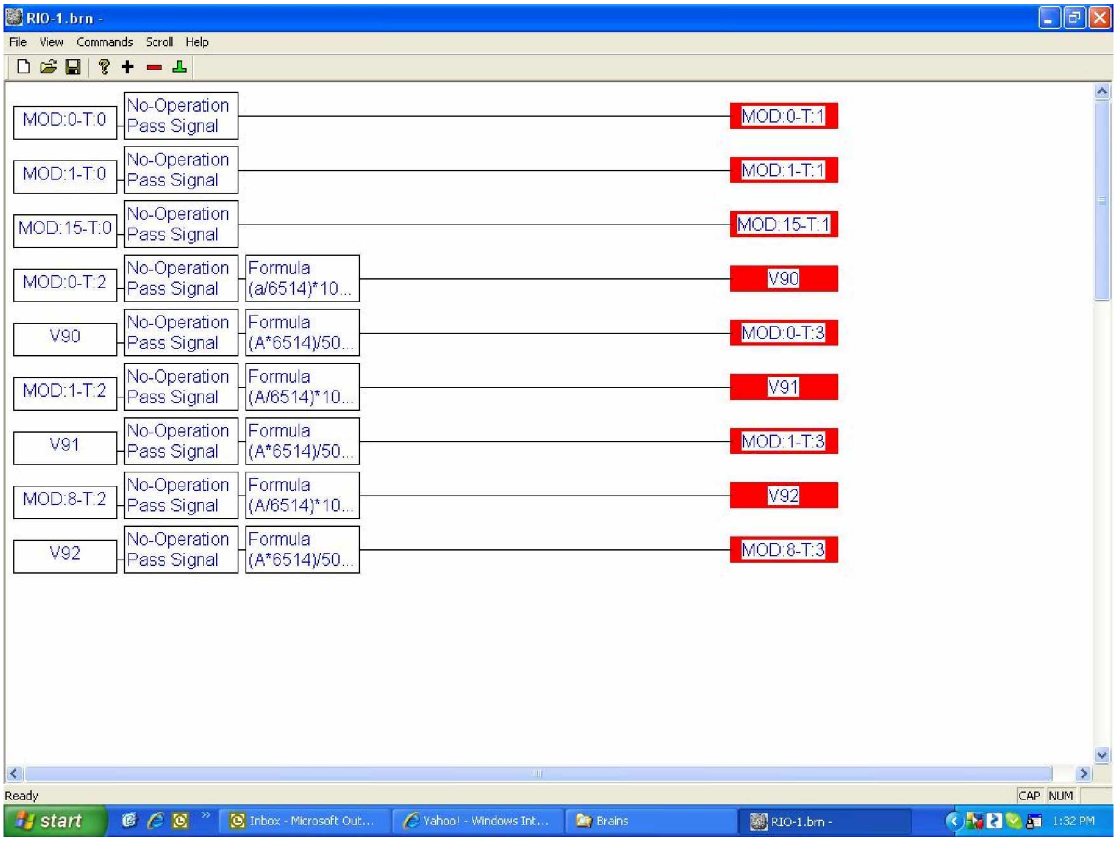
The above screen shows the configuration for RIO analog output# 7.

It is the also the same as the previous screen except for the ModBus address which has now been set to 7. All other settings are the same as for analog output#0.

For all other analog outputs, follow the above scheme except enter the RIO analog output number for the ModBus address.

Mach3 configuration
Step #7

Brain File Programming



MOD:0-T:0	No-Operation Pass Signal		MOD:0-T:1
MOD:1-T:0	No-Operation Pass Signal		MOD:1-T:1
MOD:15-T:0	No-Operation Pass Signal		MOD:15-T:1
MOD:0-T:2	No-Operation Pass Signal	Formula (a/6514)*10...	V90
V90	No-Operation Pass Signal	Formula (A*6514)/50...	MOD:0-T:3
MOD:1-T:2	No-Operation Pass Signal	Formula (A/6514)*10...	V91
V91	No-Operation Pass Signal	Formula (A*6514)/50...	MOD:1-T:3
MOD:8-T:2	No-Operation Pass Signal	Formula (A/6514)*10...	V92
V92	No-Operation Pass Signal	Formula (A*6514)/50...	MOD:8-T:3

The above screen shows the sample brain file RIO-1.brn. It is showing the use of RIO digital inputs directly driving RIO digital outputs using the above configuration schemes. Of course, any Mach3 brain object may be substituted in place of either input or output to accomplish whatever task the user desires.

Also shown are RIO analog inputs driving local variables through a no-op block and a formula block. The no-op blocks are necessary in the second spot to convert real number results from prior calculations into integers for later processing. A function block will not operate on a real number when it is in the first spot. Placing the no-op second converts the real number to an integer which can then be processed by the function block. In this instance, we are converting the RIO integer count input for the analog value to its DC voltage representation. IE to 4.9800 volts when the input is a count of 32572 or full scale. V90 thus has a value equal to the analog voltage input to the RIO. We then use V90 as an input and convert back to a count which drives the RIO analog output at 65520 counts or full scale, giving an analog output from the RIO of 4.9800 volts. This is also shown for RIO analog inputs 2 & 7 respectively. We have thus taken an input of 4.98 volts, input it to Mach3, saved the value as 4.98 volts, reconverted it to an integer value and written it back to the RIO which outputs 4.98 volts.

Needless to say, the RIO can also execute programs which are saved in the RIO memory. Examples of these types of programs are routines for automatic tool-changers and the use of analog output laser probes for part measurement.

The RIO is an extremely adaptable controller, which when mated with the machine control abilities of Mach3 CNC controller software, makes the construction of intelligent, affordable machine systems possible.

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