MAC VALVES, INC.

DOCUMENT NUMBER

TITLE: Troubleshooting Manual for MI/O-67 Manifold

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Troubleshooting Manual
For
MI/O-67 Serial Manifold

1.   System Overview

The MI/O-67 is a highly configurable valve driver system with the options of a wide variety of modules which allows the machine builder to interface directly the valves, sensors, and other outputs to a master controller. This controller can run any of the five general protocols of the EtherNet family (EtherNet /IP, Profinet, EtherCat, PowerLink, or Modbus TCP).

For the purposes of this manual, referring to "EtherNet" will be calling out the industrial protocol, not computer to computer protocol. There are differences between the two.

This manual will address some of the challenges the operator could encounter during system start-up and operation. It is broken down into various areas to guide the operator during problems. Because each protocol and its software are different in look and approach, they are talked about separtely.

2.   General IP Addresses

A.   Overview

All the protocols in the EtherNet family are based on the 32-bit number arranged in 4 octets. They look something like: 192.168.1.25 for example. You cann't use the same IP Address twice on the same network.

Depending on the controller type, there will be an error if there are two nodes sharing an IP Address. Regardless of type, this will not allow the network to come online.

B.   IP Config Tool

This tool will allow the user to set the IP Address of the MI/O-67.

First thing, the IP Configuration Tool must be downloaded to your computer. From the link below, go to "Software" (about 2/3 the way down on the page), locate "IPConfig – Utility for module TCP/IP configuration" and select "download" to the right.

https://www.anybus.com/support/file-doc-downloads/compactcom-40-series-specific/?ordercode=AB6674

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Once it is downloaded, select "IPConfig" under apps and the software will start. You do not need to set the subnet mask or addressing on the computer at this point, just have the MI/O-67 physically connected to the same network.

A window will appear which looks like **Figure 1**.

Figure 1 IPConfig Front Page
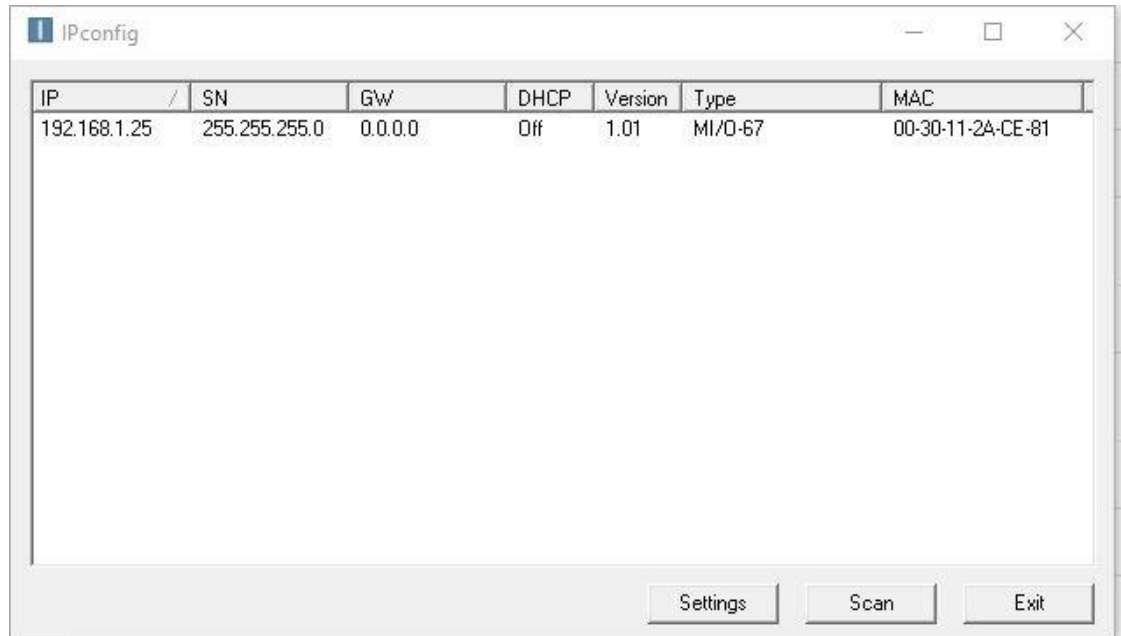
From this page, you will notice there is one node connected, (if more than one node is found, they will also appear here). It has IP Address 192.168.1.25, subnet mask of 255.255.255.0, DHCP is off, Version 1.01, Type is MI/O-67, and the MAC ID is 00-30-11-2A-CE-81.

If you would like to change any of these or the come up as 0's, then double click on the note in question and an second screen will appear which is shown in **Figure 2.**

Figure 2 IPConfig Tool Settings
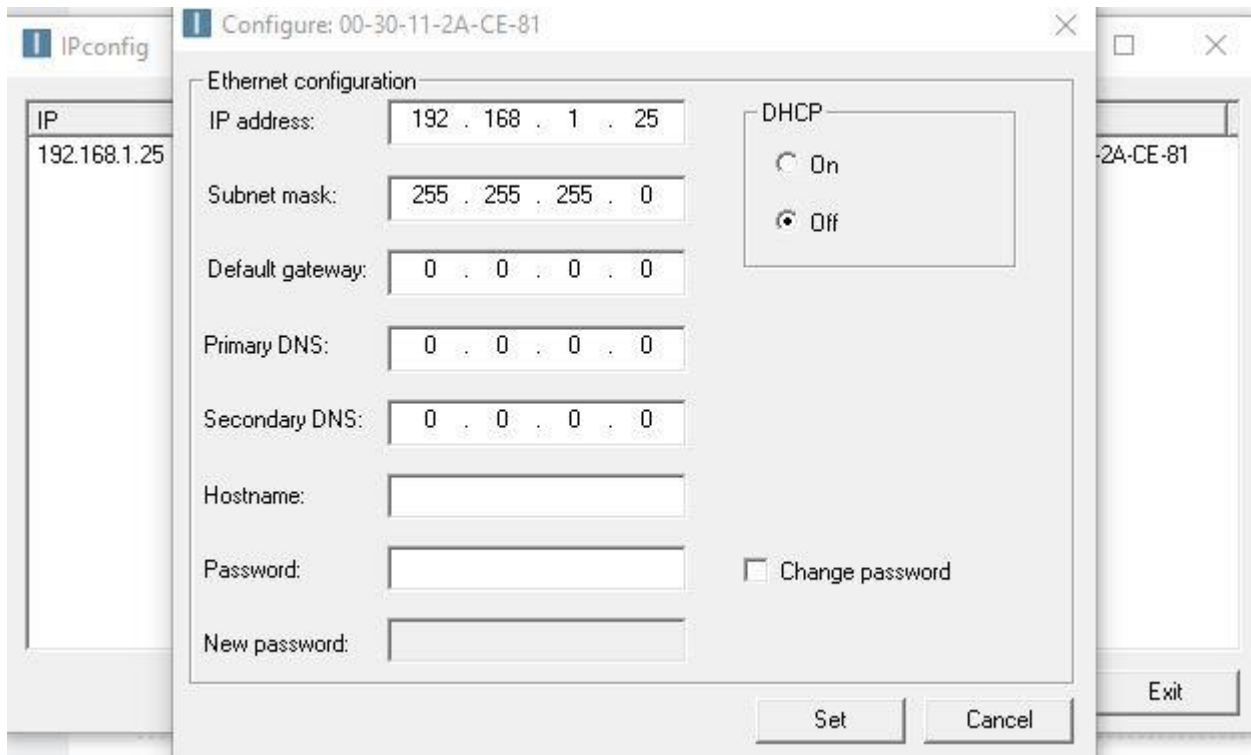
From this screen, you can set any of the values shown. For most networks, the DHCP should be in the "Off"state. Otherwise, the node will, when powered up, grab the next available IP address and not necessarily the desired one. Select "Set" and the information is transferred to the MI/O-67.

C. Web Configurator Tool

The next tool available for offline troubleshooting is the Web Configurator Tool. This tool is embedded into the Comms Module and can be used to check out the stack health, operate valves and outputs, and test inputs.

The first thing that has to be done to use this tool is to set the computer up on the same subnet mask as the MI/O-67 being tested. For our example, we are using an independent computer (from the PLC). Also, note, the PLC can not be running while using this system. Unlike the PLC which is a Class 1 connection, this tool is a Class 3. This means any changes to the software (ie operating a valve, testing a sensor) but be manually refreshed.

The first step is to use the Control Panel and set the IP Address and Subnet Mask to match up to the MI/O-67. If this is already done, skip to **i.**

Figure 3 Computer Control Panel App

.
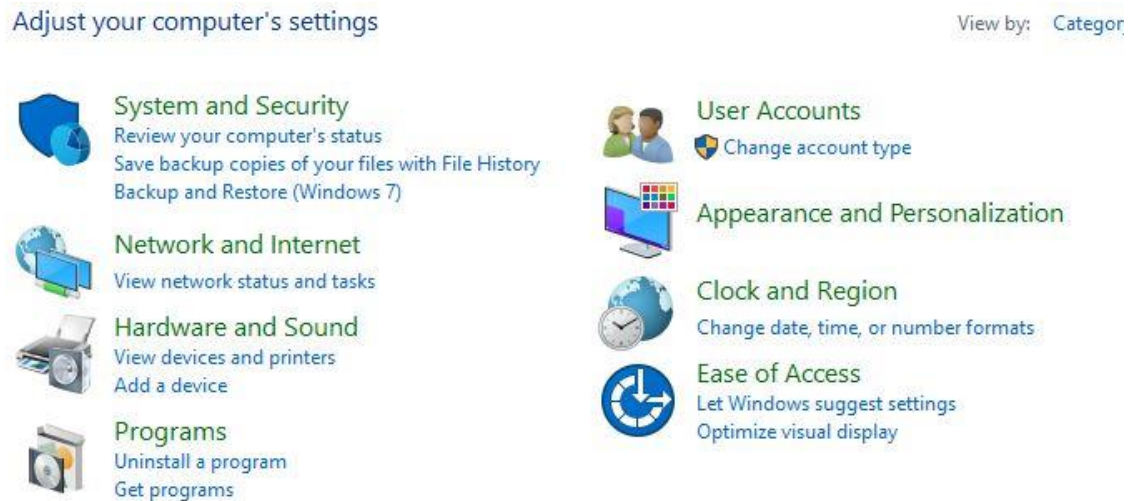
Select "Network and Sharing Center"

Figure 4 Network and Sharing Center
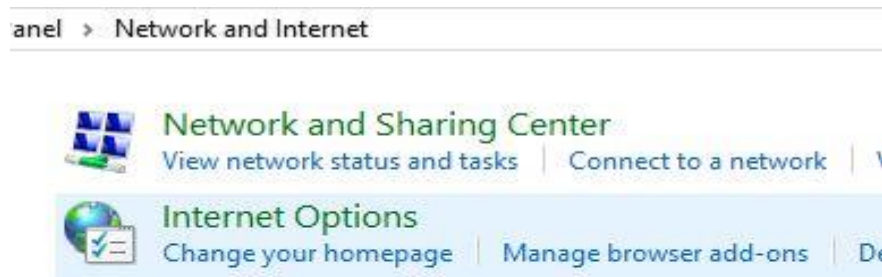
Select "Change adapter settings" in left column

Figure 5 Adapter Set-Up
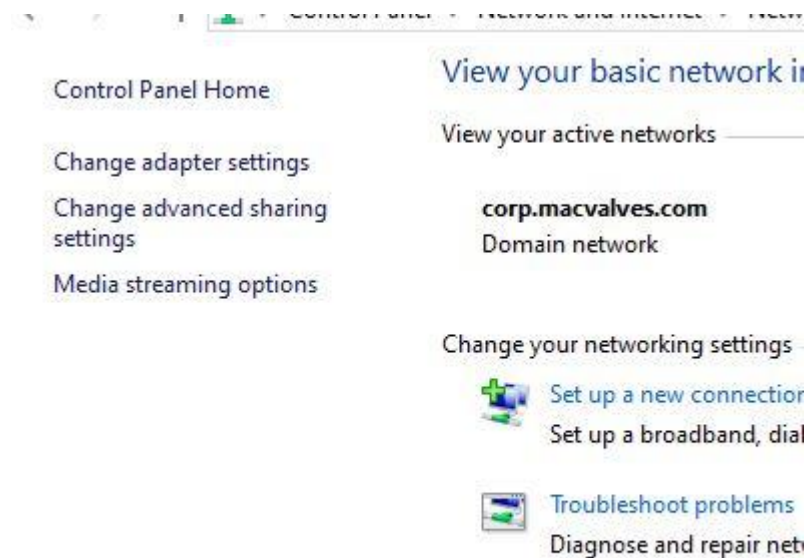
Select "Internet Protocol Version 4 (TCP/IPv4)" as shown in **Figure 6**.

Figure 6 EtherNet Card Set-Up
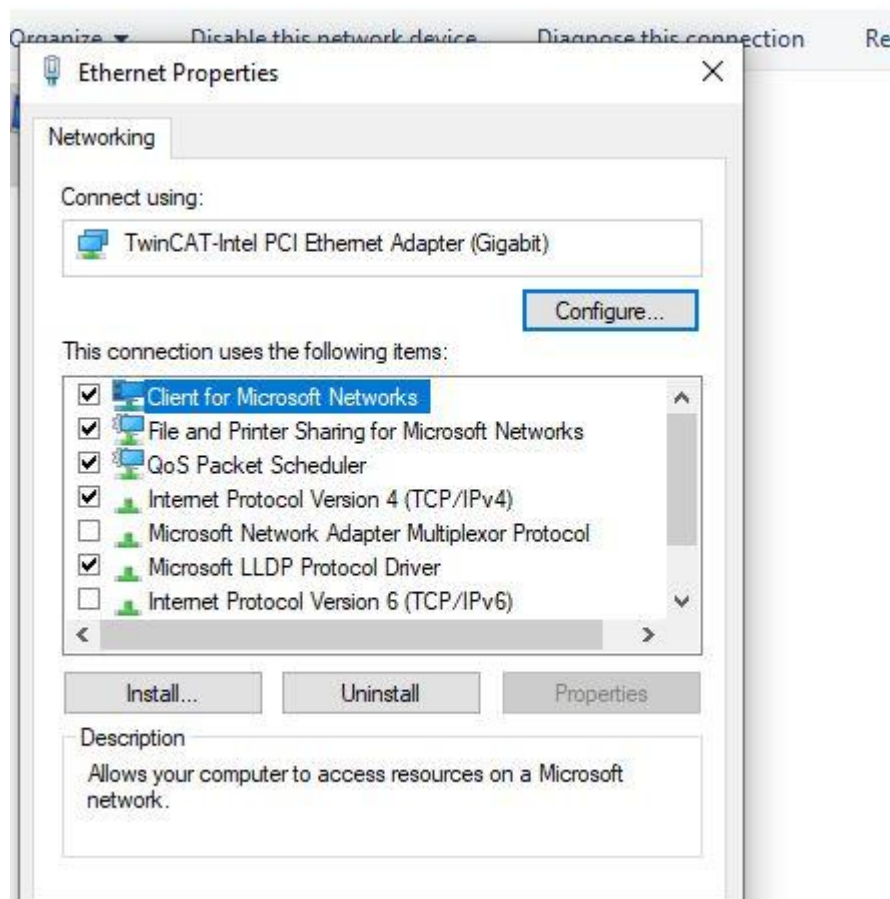
Select "Use the following IP address:". Then type in the IP Address for the computer ensuring it

will be on the same subnet mask as the MI/O-67. From there type in the subnet mask. In our example in Figure x, since the MI/O-67 is using 192.168.1.25, we can not use that address so we selected 192.168.1.50 because we know it is not reserved or being used. The subnet mask will force the local net to only listen to addresses in the last octet. The first three octets have to match to make this connection valid.

Figure 7 Setting Local Network IP Address
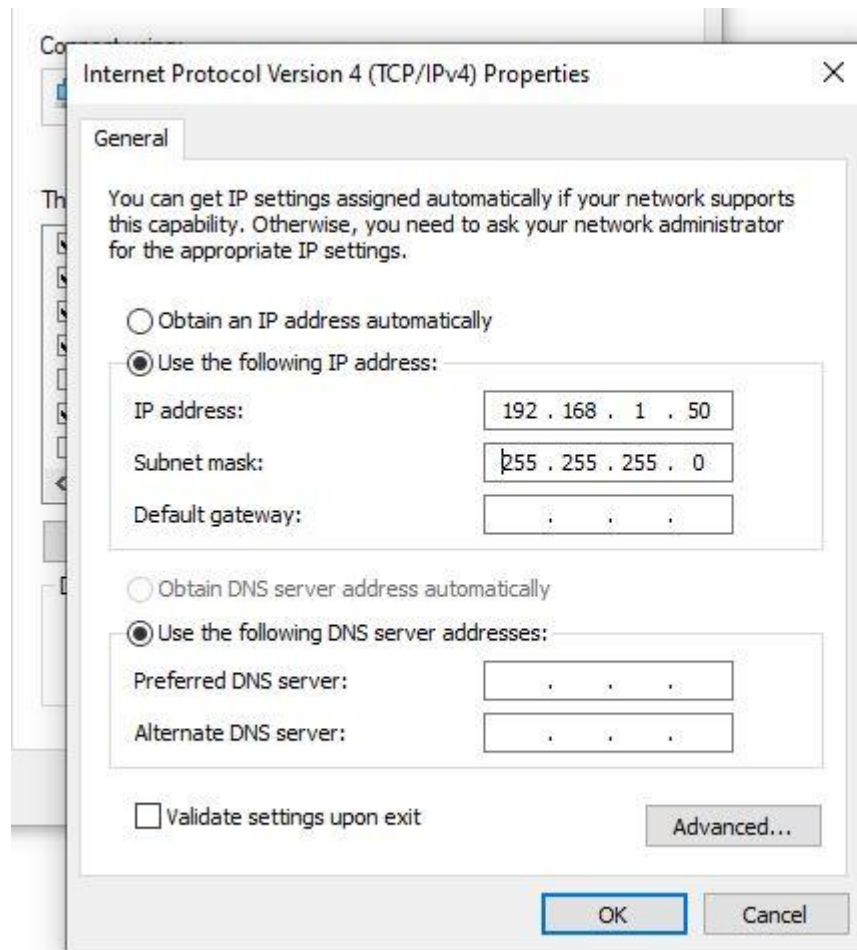
The computer is now ready to start using the Web Configurator Tool.

i.   WebConfig Overview Page

To invoke the Web Configurator Tool, start the Chrome explorer and type in the IP address (192.168.1.25 in our case) for the MI/O-67. The screen shown in **Figure 8** will appear.

One thing to note when using the WebConfig tool, the computer has to be compatible with the protocol of the MI/O. For example, if the computer is not set up for EtherCat, then the tool will not be usage.

Figure 8 WebConfig Overview Page

On this page, you can see the basis interface information under "Communications Module Details". Below that, the specifics for the modules. Here, we only have a Comms Module connected which has serial number 0xA03D9F58, it is hardware version 1.0.0, and software version 1.1.16.

The WebConfig tool is a Class 3 connection so manual refreshing of data whether it is inputs or outputs will be required.

ii.　　WebConfig Tool Status Page

Figure 9 WebConfig Status Page

By selecting "Status" in the left column, the page shown in **Figure 9** will appear. After refreshing (blue buttons on the right side of the page), the Device Flags will appear. In this case, everything is normal and there are no errors to report. If there was a faulty module, they this page would show that. The Device Error Flag portion will also direct you to the problem area.

Figure 10 WebConfig Control Page

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Figure 11 WebConfig Network Page

The next area of the tool that can help in troubleshooting or pre-testing I/O is located in the "I/O Data" section of the software.

In this section, all inputs and outputs on the stack and be operated and monitored. The

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tool is a Class 3 connection so changing an output will require refreshing prior to it going to the stack and toggling a sensor on the stack will require refreshing prior to reading it on the Web Config page.

Also, the data is in Binary Coded Decimal format. Refer to Table 1 for a conversion chart for inputs and outputs.

Table 1 Binary Code Decimal Conversion

Decimal Value	Channel															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4	--	--	x	--	--	--	--	--	--	--	--	--	--	--	--	--
8	--	--	--	x	--	--	--	--	--	--	--	--	--	--	--	--
16	--	--	--	--	x	--	--	--	--	--	--	--	--	--	--	--
32	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--	--
64	--	--	--	--	--	--	x	--	--	--	--	--	--	--	--	--
128	--	--	--	--	--	--	--	x	--	--	--	--	--	--	--	--
256	--	--	--	--	--	--	--	--	x	--	--	--	--	--	--	--
512	--	--	--	--	--	--	--	--	--	x	--	--	--	--	--	--
1024	--	--	--	--	--	--	--	--	--	--	x	--	--	--	--	--
2048	--	--	--	--	--	--	--	--	--	--	--	x	--	--	--	--
4096	--	--	--	--	--	--	--	--	--	--	--	--	x	--	--	--
8192	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--	--
16384	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x	--
32768	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	x

This conversion will be needed for the next part.

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Figure 12 WebConfig I/O Data Page

Shown in **Figure 12**, is the I/O Data section of the WebConfig Tool where the valves can be operated from. The sequence to operate a valve is find the valve channel (here is it the first solenoid) convert that number(s) (if more than one) to decimal (see Table 1), if it is the first 16 solenoids, place that number in Instance 55040:0 and hit "Set" button. If it is the next 16 solenoids, place that number in Instance 55040:1 and hit "Set" button. The command will echo back in Instance 54784 Device Inputs.

Figure 13 WebConfig Overview Page

In **Figure 13** above, the stack which is connected has three Digital I/O Modules, the first being configured as an output module, the next two has PNP input modules. They all have Version 1.1.16 on their firmware. This is one way to judge the basis health of the stack in the case it does not connect to the PLC. If the modules that are on the stack do not appear on this list, then the backplane of that module is not functioning properly and must be replaced. It is also important to note that when a module needs to be physically added or subtracted from the stack, the power should be off. Changing the modules with the power on could damage them.

Figure 14 WebConfig Module I/O Data Page (Inputs)

From the stack configuration shown **in Figure 13**, we are running a test for the health of some of the input channels on one of the input modules (module 3 in this case). Channels 5 and 6 (on Connector 3) and Channel 7 (on Connector 4) or active. A Refresh is required to update the date. Shown in Instance 16416:0 is the decimal valve of 112. This works out as a value of 16 for Channel 5, 32 for Channel 6, and 64 for Channel 7 (112 = 16 +32 + 64).

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Figure 15 WebConfig I/O Data Page (Outputs)

If the module which needs to be tested is an output device, then they will be operated under the Module Output section of the I/O Data page. Shown in **Figure 15**, are the three Digital I/O modules on the test stack for their output areas. If the modules were configured as outputs, they Instances 20480, 20496, and 20512 will operate those channels.

Figure 16 WebConfig Device Configuration Data Page

Shown in **Figure 16** is the Device area of the tool. Here is where any special configurations can be set such as the Open Load Detect or the EtherNet signal default values. Shown is the set up to test the continuity of all of the valve channels (value FF FF FF FF in Instance 55297) and operating the first six solenoids in the event of EtherNet failure (value 3F in Instance 55296). Our test stack has three double solenoid valves.

Shown in **Figure 17** is the result of a test whereas the three A solenoids are operated (Channels 1, 3, 5 for a value of 21) and all the channels have the open load detection enabled. Shown in Instance 54764:4,5,6,7 are the values of 65472, 65535,65535, and 65535. We have good connections to the three double solenoid valves (Channels 1-6). Thus a valve of Channel 1 =1, Channel 2 = 2, Channel 3 =4, Channel 4 = 8, Channel 5 = 16, Channel 6 = 32 becomes 1 + 2 + 4 +8 + 16 + 32 =63. Then 65535 -32 = 65472 which tells us that there is nothing connected to the last 26 Channels. This is a good way to check the continuity of the stack.

Figure 17 WebConfig I/O Data With Configuration Example

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Figure 18 WebConfig Topology Page

Another area where you can check the stack configuration is located in the "Topology" section of the tool. Shown in **Figure 18** is the test stack with three Digital I/O modules configured for PNP input mode.

Also above is shown the serial numbers, IDs, and hardware and software version levels.

2. Power Wiring and Connectors

A. Connectors - Power

The MI/O-67 has two paths for power. There are also two options for power connectors for this product. The power connector located on the top of the MI/O-67 Comms Module. The pin-out for the five pin connector is shown in **Figure 19**. The pin-out for the four pin connector is shown in **Figure 20**.

If it is desired to add or subtract modules from the stack, *it is very important to remove all the power prior to connecting or discounting the modules. Failure to do this could result in module damage.*

There are two separate power systems on the power connector. The first is the +24VDC required for the valves. The largest current a single valve can consume is 500mA. Since there can be up to 32 valves, it is important that the power supply be able to supply the 8.0A which would be required to energize a fully loaded system. The second being the power required for the electronics. Also, it is possible to run the electronics independent of the valves. If it is desirable to keep the electronics "awake," while the valve power is off, then two separate power supplies will be necessary. By disconnecting the valve power supply and keeping the electronics supply active, the node will stay online but the valves will not operate. Please note that it is also important to make a connection to the Earth.

As far as the Electronics and I/O power is concerned; it depends on the number of modules and the load on each module. For starters, the Comms Module will draw about 140mA. The Digital I/O will draw 60mA without loads (sensors). The Analog Voltage Module will draw 115mA (assuming all outputs are full on). The Analog Current Module will draw 130mA (assuming all outputs are full on). The Power Plus Module will draw 50mA. The maximum capacity for the electronics power line is also 8.0A. Refer to the Power Handling Section (10) for the load calculations.

There is an excel tool available for current calculations.

Figure 19 Power Connector, 5 Pin, Pin-Out
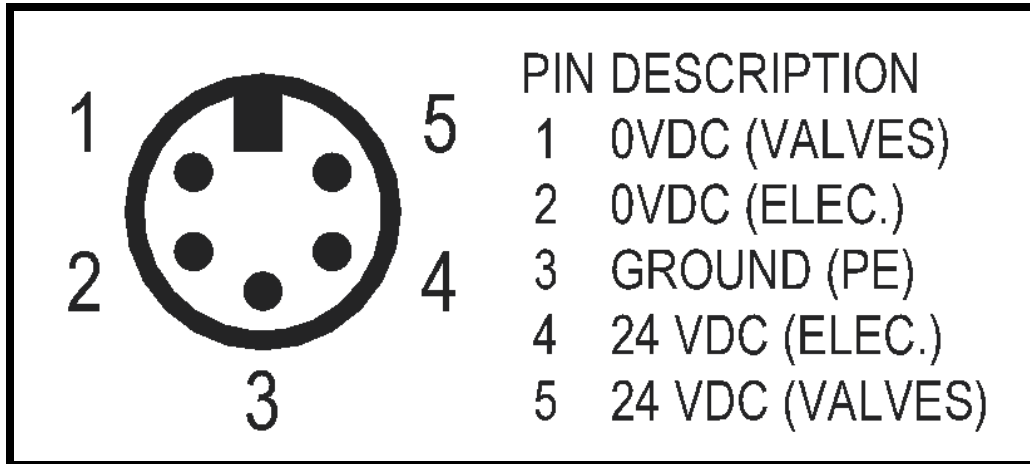
The MI/O-67 system has two power paths for the valves and the modules as shown in **Figure 1** in Section 1.A. In addition to that, the Power Plus Module uses an external power connector to operate the valves connected to that module.

Figure 20 Power Connector, 4 Pin, Pin-Out
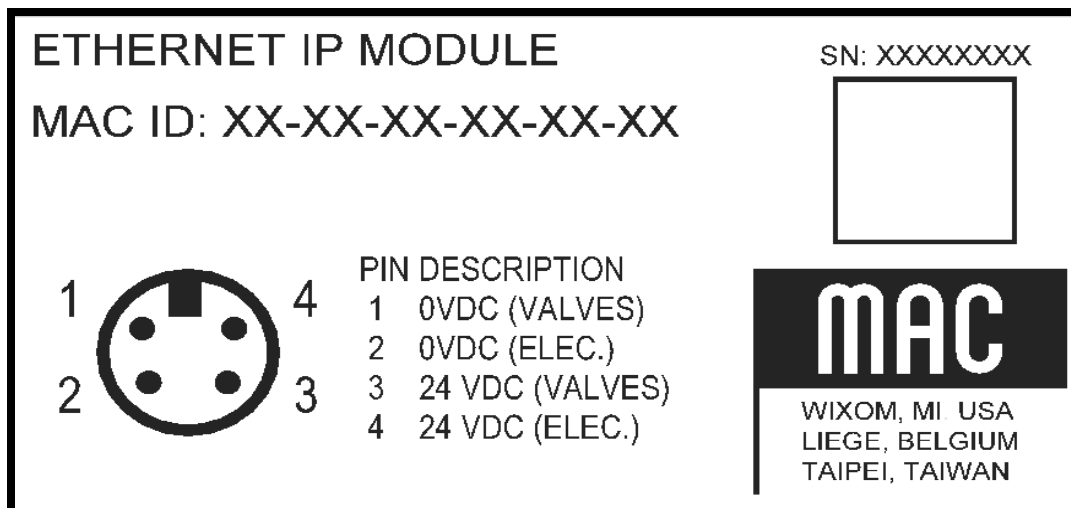
a. Valve Power

The first power system is for the valves on the stack. It is isolated from the electronics power and thus can be separately disconnected if desired. It can pass up to 8A at 24VDC maximum. To calculate the total power for the valve line, use the following formula:

Total Current (Amps) = Number of Valves x (Valve Wattage/24) +0.4A ≤ 7.6 Amps.

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If there are valves of different wattages on the stack then each group of wattages must be added up separately. Thus:

Total Current (Amps) = [Number of Valves (Wattage1) x (Valve Wattage1/24)] + [Number of Valves (Wattage2) x (Valve Wattage2/24] + [Number of Valves (Wattage3) x (Valve Wattage3/24] + [Number of Valves (Wattage4) x (Valve Wattage4/24)] …..etc.

Note: Valve wattage must be $\leq$ 12 watts per channel at 24VDC.

b. Electronics Power

There is an isolated power line which also can handle up to 8 Amps at 24VDC. This line is used for the EtherNet electronics, module electronics, and the electronics (but not the outputs) of the Power Plus Module.

c. Comms Module

The Comms Module will consume 140mA from the 8A total. Thus, for additional modules, and assuming there is 8A available at the connector, the first module will have 7.86A maximum to work with.

d. Analog Module, Current

The Analog Module can operate 4 channels of 4-20mA outputs at the same time. If all the channels are running at maximum output the module will consume 130mA from the electronics power allotment per module.

e. Analog Module, Voltage

Like the Analog Current Module above, the Analog Voltage Module has four channels which can output 10V at a maximum of 16mA per channel. This module will consume, at maximum output, 115mA per module from the electronics power allotment.

f. Digital I/O Module

The modes of the Digital I/O Module must be considered when calculating the module's current draw.

If the module is run completely as an output unit, then the total current draw will be 60mA (for the module) + (number of channels used up to 16 x current load of the outputs). For example, if there are 16 outputs at 250mA per device, then the current draw will be 60mA + (16 x 250mA) = 4.06A. Care must be taken with this module because the individual channel maximum outputs are 0.5A and if the unit is loaded down to the maximum (16 x 0.5A) it is possible to completely load the entire stack and take the EtherNet off line.

If the module is used only as an input unit, then the draw of the sensors must be taken into account. This works out as 60mA for the module and then the current draw of each sensor x the number of sensors on the module. For example, if there are 16 Hall Effect proximity sensors on the module and each sensor draws 2mA, then the total current draw for the module will be 60mA + (16 x 2mA) = 92mA total.

Using the module as a combination input/output module will require using input and output current calculations plus the module current draw (60mA).

g. Power Plus Module

The Power Plus Module can operate up to 12 0.5A loads (valves, outputs, etc.). However, this power does not come from the electronics total. The module itself draws 100mA. The load power comes from an isolated source by way of the min connector on the module's top.

h. Power Distribution

The stack's power distribution is shown in **Figure 11**. The Electronics power handles all the module electronics plus the I/O electronics for the Digital and Analog I/O Modules. This is routed through the backplane along with the CAN control signals. The stack valve power comes from the Comms Module power. The Power Plus Module has a separate source for its loads.

Figure 21 Stack Power Distribution

1. Valve Pwr on Stack Only
If this pwr is E-stopped, you lose valve stack pwr only. The node remains alive along with all the modules
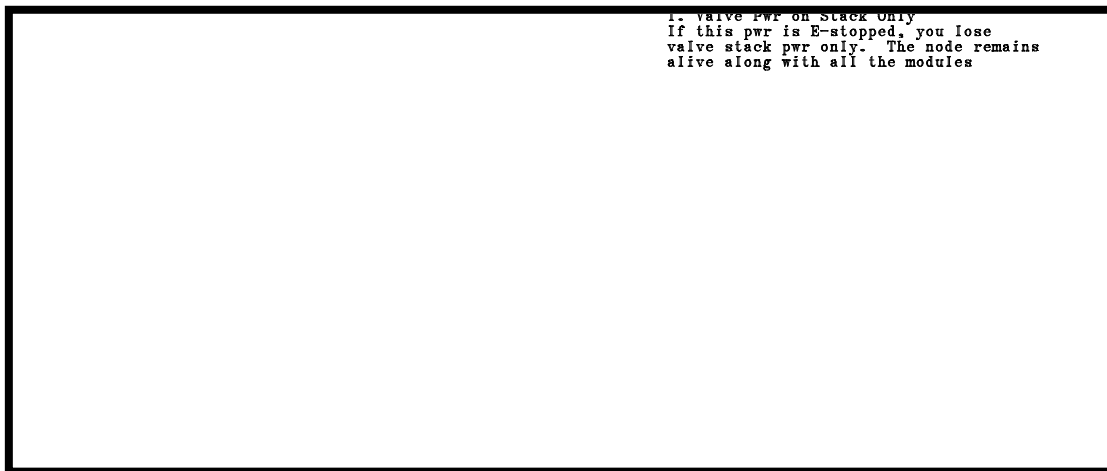
## B.	Power Troubleshooting Chart

### a.	Symptom

MI/O does not connect to the Master PLC

### b.	Cause/Cure

Verify the electronics power to the Comms Module. If the power is OK, check the IP Address and subnet mask. The LEDs on the Comms Module will light up whether the IP Address is set correctly or not. It just needs power for the unit to start searching for an EtherNet line.

### c.	Symptom

Valves do not operate

### d.	Cause/Cure

No valve power, check wiring to main power connector, check power supply. Also, check if there is a power cut-off switch used and functioning.

If you are attempting to operate it by way of the Web Configurator, check the power cable.   If you are using the PLC, check the power cable and configuration table.

Also note that if the valve power is not available, a latched error will appear in the code to the PLC. Refer to the I/O table for the Protocol User's Manual on how to reset this bit.

Stack Valve Operation

A.   Configuration

The protocols are all different in how to set the stack configuration into the PLC. For example, EtherNet I/P is shown below. ProfiNet and EtherCat configures automatically.

If the stack has only valves and no additional modules, then the primary configuration will start with setting the configuration byte C.Data[0] = 16#00 as shown in **Figure 22.**

Figure 22 Configuration for Comms Module Only Stack

If additional functions such as Open Load Detection or EtherNet Fault are required, refer to Section 11.

B.   Valve Operation

The valves on the stack or broken down in four bytes of output. The first solenoid (Valve 1, Solenoid A) start with O:[2].0, as shown in **Figure 23**. **Figures 24, 25, and 26** show examples of other output channels on the stack.

Figure 23 Valve 1, Solenoid A Output Location

Figure 24 Solenoid 8 Output Location

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Figure 25 Solenoid 16 Output Location

Figure 26 Solenoid 32 Output Location

Table 2 Stack Valve Output Bit Assignment

Byte	Description
O:Data[2].0	Valve Channel 0, Valve 1, Solenoid A
O:Data[2].1	Valve Channel 1 (Valve 1, Solenoid B if double or Valve 2 Solenoid A if single)
O:Data[3].0	Valve Channel 8
O:Data[3].7	Valve Channel 16
O:Data[4].0	Valve Channel 17
O:Data[4].7	Valve Channel 24
O:Data[5].0	Valve Channel 25
O:Data[5].7	Valve Channel 32

Note: the valve channel assignment is based on the number of solenoids, not the number of valves due to the possibility of having a stack with both single and double solenoid valves on it.

3. Analog Module Wiring and Connectors (Configurable Type)

A. Connectors

The four connectors for these modules on the top of the MI/O-67 are shown in **Figure 27**. The pin outs can be found in **Figure 28**.

The pin out for each connector is dependent on whether it is configured as an Output or Input.

Each module has four channels on four different connectors. The modules themselves are either 0-10V I/O or 4-20mA I/O.

The function of each connector (whether it is an input or output)

Figure 27 Analog I/O Module, Configurable Type
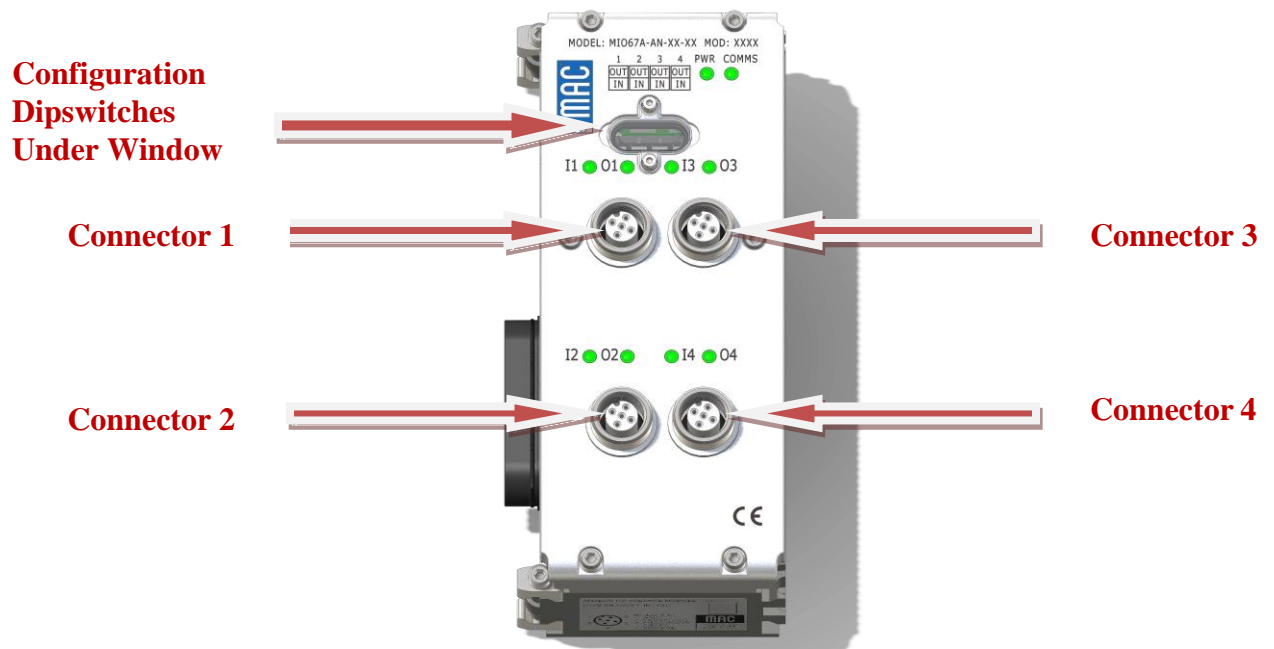
Figure 28 Analog Module (Configurable) Pin-Out

ANALOG I/O CURRENT MODULE   SN:

CONFIGURABLE IN / OUT

PIN DESCRIPTION
1   24 VDC
2   0-20mA (IN / OUT)
3   0 VDC / 0 VDC (OUT)
4   0 VDC (IN)
5   GROUND (PE)

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ANALOG I/O VOLTAGE MODULE   SN:

CONFIGURABLE IN / OUT

PIN DESCRIPTION
1   24 VDC
2   0-10VDC (IN / OUT)
3   0 VDC / 0 VDC (OUT)
4   0 VDC (IN)
5   GROUND (PE)

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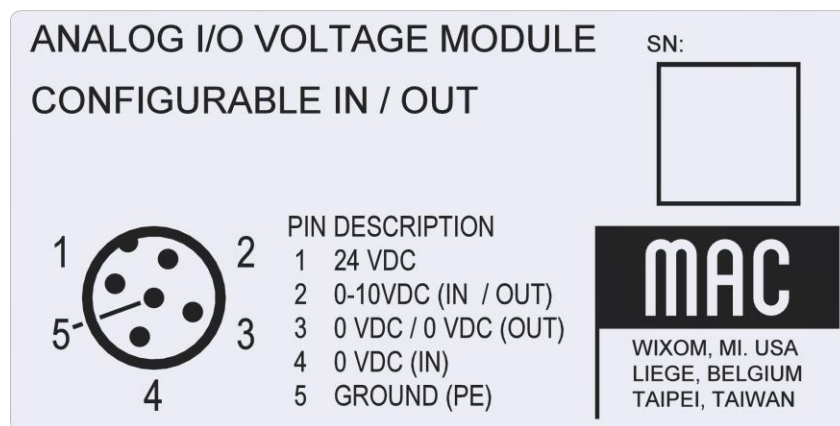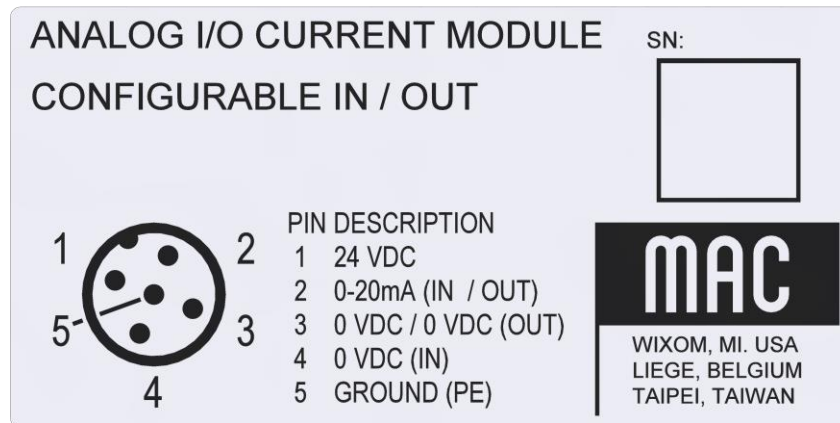
As shown in **Figure 28**, depending on how the connectors are configured sets the pin-out for that connector. For example, if you have a 0-10V module and you configure a connector to act as an output, then Pin 2 is the Positive output and Pin 3 is the Negative Output along with the common for the 24VDC. If you have a 4-20mA module and you configure a connector to act as an Input, then Pin 2 is the Positive input and Pin 4 is the Negative Input.

B. Module Configuration

Each connector on the module can be configured as an Analog Output or an Analog Input. The type depends on whether you have an Analog Current Module, an Analog Voltage Module.

The configuration is done by way of the four dipswitches under the window on the module near the top as shown in **Figure 27**.

Figure 29 Dipswitch Configuration

```
"ON" =    ⱽ
Switch Position
for Inputs
```

The controller must also be configured. This is done in the configuration table for the controller. The module's type is loaded in according to Table 2 below where Byte X is the first byte of this module and so on.

If there was only one module on the stack, Byte X would be Byte 2. If the Digital I/O module was the second module of a two module stack, then Byte X would be Byte 6. The values below are given in hex format. This will also be discussed in the Byte Definition, Configuration Section 9-A.

Table 3 Analog Module Configuration

Analog Current Module

Byte X   16#91

Byte X+1   16#01

Byte X+2   16#0c

Byte X+3   16#82

Analog Voltage Module

Byte X   16#91

Byte X+1   16#01

Byte X+2   16#0c

Byte X+3   16#81

C.   Indicator LEDs

Each connector has two LEDs near them. The LEDs are solid green when the everything is running normally. They will change to red when there is either an overvoltage (for the current module) or overcurrent (for the voltage module) fault.

4. Analog Module Wiring and Connectors, Non-Configurable Type

A. Connectors

The four connectors for these modules on the top of the MI/O-67 are shown in **Figure 29**. The pin outs can be found in **Figure 30**.

Each module has four channels on four different connectors. The modules themselves are either 0-10V I/O or 4-20mA I/O.

Figure 30 Analog I/O Module, Non-Configurable Type
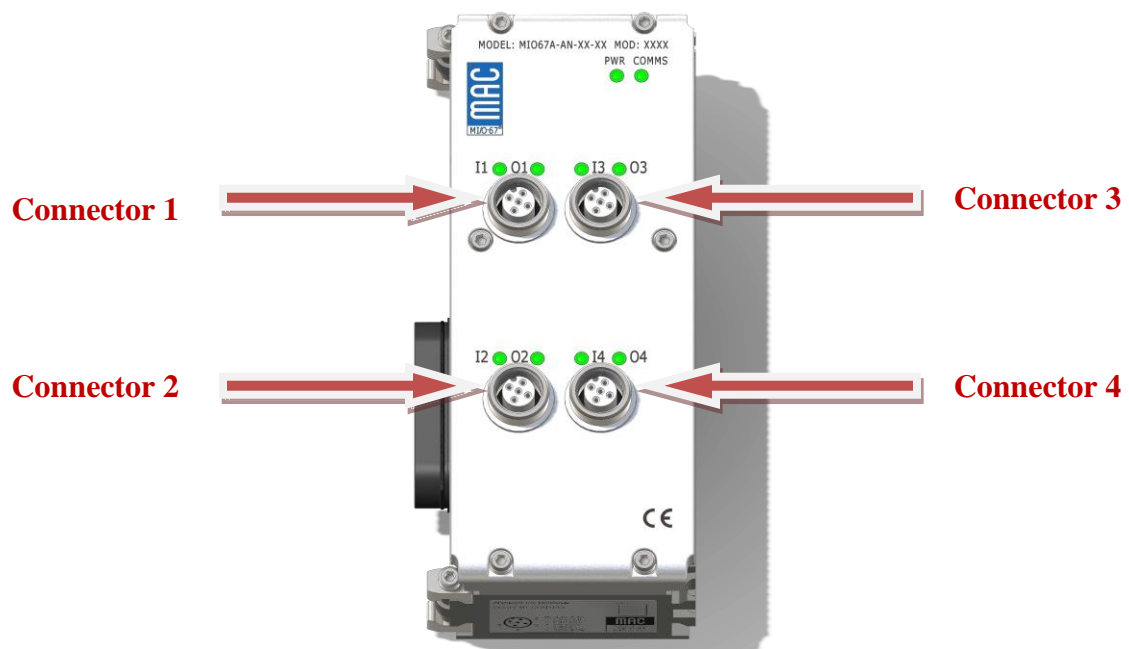
Figure 31 Analog I/O Pin-Out

PIN DESCRIPTION
1   0-20 mA (OUT)
2   0 VDC (OUT)
3   0-20 mA (IN)
4   0 VDC (IN)
5   GROUND (PE)

PIN DESCRIPTION
1   0-10 VDC (OUT)
2   0 VDC (OUT)
3   0-10 VDC (IN)
4   0 VDC (IN)
5   GROUND (PE)
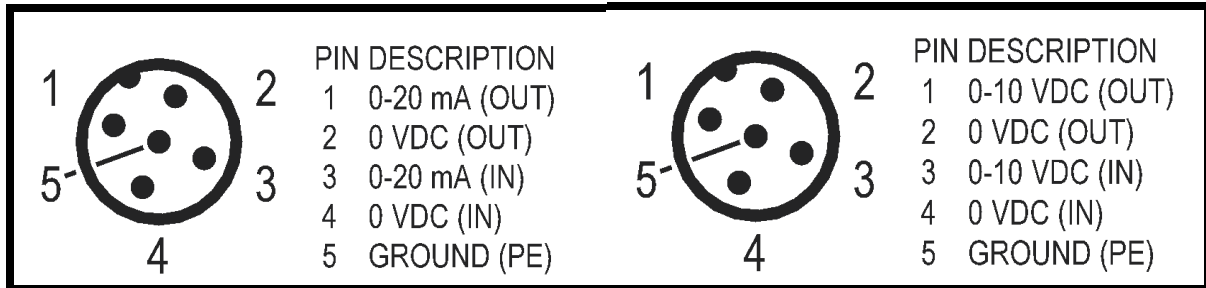
B.   Module Configuration

The controller must also be configured. This is done in the configuration table for the controller. The module's type is loaded in according to Table 3 below where Byte X is the first byte of this module and so on.

If there was only one module on the stack, Byte X would be Byte 2. If the Digital I/O module was the second module of a two module stack, then Byte X would be Byte 6. The values below are given in hex format. This will also be discussed in the Byte Definition, Configuration Section 9-A.

Table 4 Analog Module Configuration

Analog Current Module
Byte X   16#91
Byte X+1   16#01
Byte X+2   16#0c
Byte X+3   16#82

Analog Voltage Module
Byte X   16#91
Byte X+1   16#01
Byte X+2   16#0c
Byte X+3   16#81

C.   Indicator LEDs

Each connector has two LEDs near them. The LEDs are solid green when the everything is running normally. They will change to red when there is either an overvoltage (for the current module) or overcurrent (for the voltage module) fault.

5.   Digital I/O Module Connectors and Configuration

A.   Connectors

The eight connectors for these modules on the top of the MI/O-67 are shown in **Figure 32**. The pin outs can be found in **Figure 33**.

Each module has sixteen channels on the eight different connectors. The module can be configured for sixteen inputs, sixteen outputs, or eight inputs and eight outputs. Also shown in **Figure 32** is the window for access to the mode selector dipswitches. More about that later.

The schematic representation is shown in **Figure 34.**

Figure 32 Digital I/O Module

Configuration Dipswitches Under Window

Connector 1, See Figures 33 and 34

Connector 2

Connector 3

Connector 4

Connector 5

Connector 6

Connector 7
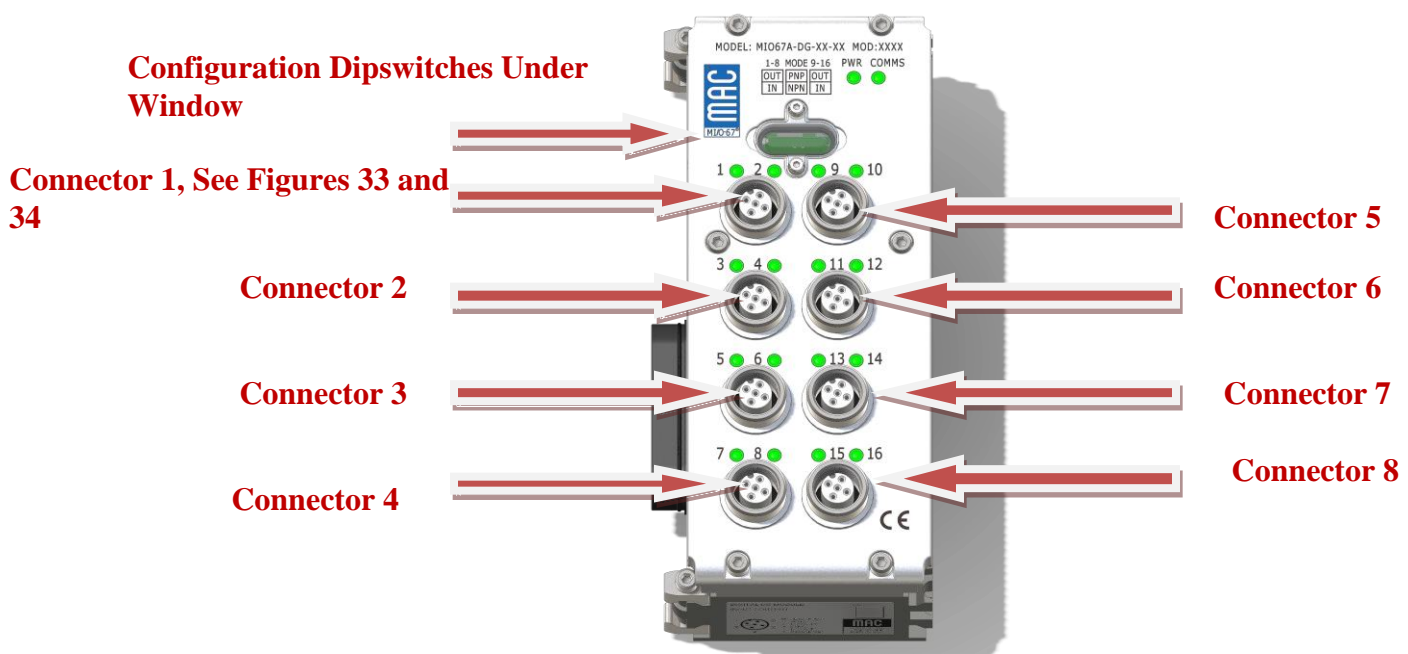
Connector 8

Figure 33 Digital I/O Pin-Out, Connectors 1-8 Typical

PIN DESCRIPTION
1 24 VDC
2 IN 2 / OUT 2
3 0 VDC
4 IN 1 / OUT 1
5 GROUND (PE)
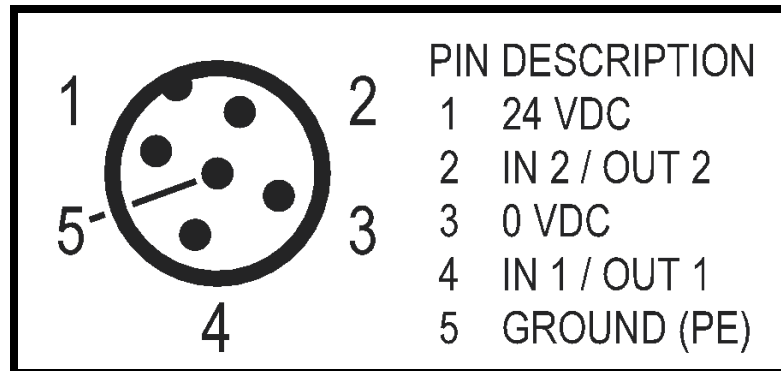
Figure 34 Sensor/Load Wiring
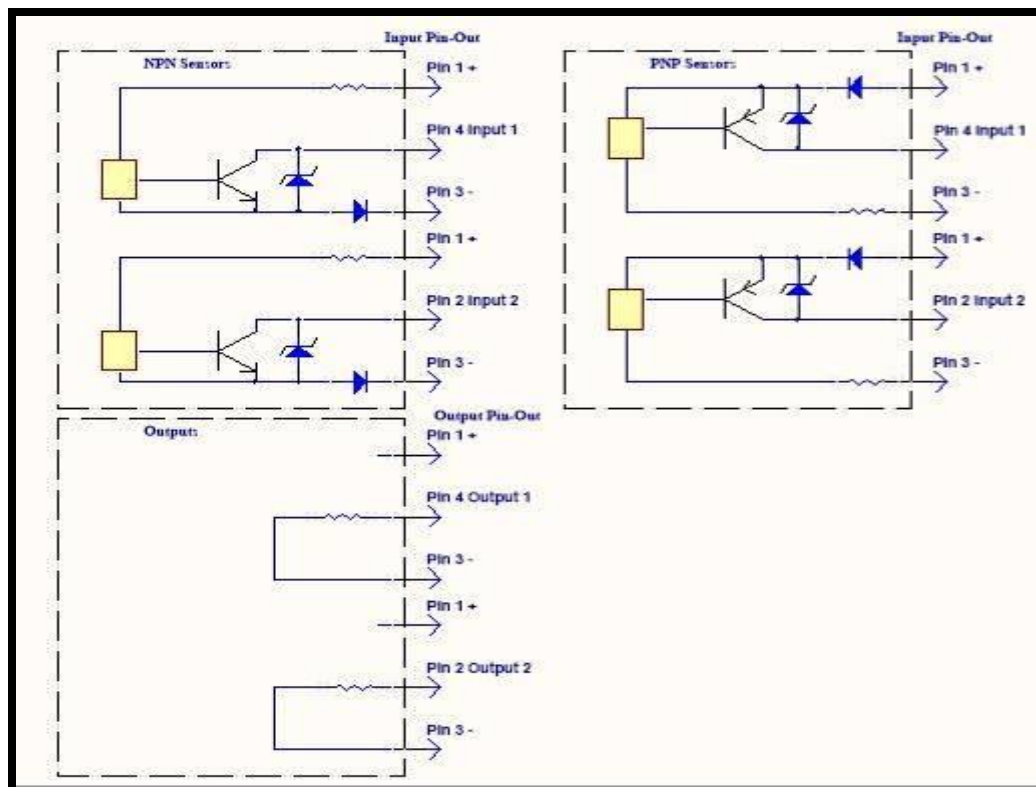
B.　Dipswitch Configuration

The module is broken down into two banks of 8 points. The left 4 connectors are considered Bank A and the right 4 connectors are considered Bank B. The dipswitches shown in **Table 3** will set the bank function of being either input or output connectors for these modules. The pin outs can be found in **Figure 22**.

Figure 35 shows the dipswitches for the module (located under the window near the top of the module). Note, the "ON" or 1 position is for the switch to be in the "UP" position (closer to the edge of the module), and the "OFF" or 0 position in the "DOWN" position.

Figure 35 Digital I/O Dipswitch Position
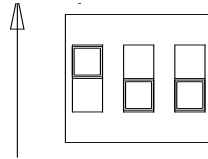
Each module has sixteen channels on the eight different connectors. The module can be configured for sixteen inputs, sixteen outputs, or eight inputs and eight outputs. For the inputs, along with setting the banks, you can also set whether they are for NPN or PNP sensors. The table below shows the dipswitch settings.

Left to Right as shown in **Table 3**, where 0 = off position (dipswitch position away from top edge of board) and 1 = on position (dipswitch position is closer to top edge of board) for the switches:

MAC Valves, Inc.　　　　　　　　　　　　　　　　　　　　Phone: (248)624-7700
30569 Beck Rd.　　　　　　　　　　　　　　　　　　　　　Fax: (248)624-0549
Wixom, MI 48393

Table 3 Dipswitch Position

Dipswitch			Bank A	Bank B
A	**B**	**C**		
0	0	0	Input/NPN	Input/NPN
0	0	1	Input/NPN	Output
0	1	0	Input/PNP	Input/PNP
0	1	1	Input/PNP	Output
1	0	0	Output	Input/NPN
1	0	1	Output	Output
1	1	0	Output	Input/PNP
1	1	1	Output	Output

C.   Module Configuration

Each position of the dipswitch will have a unique configuration. Since the location of the configuration is dependent on where the module is in the stack, in the table below Byte X is the first byte of this module and so on.

If there was only one module on the stack, Byte X would be Byte 2. If the Digital I/O module was the second module of a two module stack, then Byte X would be Byte 6. The values **Table 4** are given in hex format.

Table 4 Digital I/O Configuration Data

Dipswitch				
A	**B**	**C**		
0	0	0	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03
			Byte X+3	16#70
0	0	1	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03
			Byte X+3	16#71
0	1	0	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03
			Byte X+3	16#72
0	1	1	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03

			Byte X+3	16#73
1	0	0	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03
			Byte X+3	16#74
1	0	1	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03
			Byte X+3	16#75
1	1	0	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03
			Byte X+3	16#76
1	1	1	Byte X	16#91
			Byte X+1	16#01
			Byte X+2	16#03
			Byte X+3	16#77

D.   Indicator LEDs

There are two LEDs for each connector on the module. Each LED is for one channel whether it is used as an input or an output. If the module is set up as inputs, the LED will illuminate when the sensor (using normally open point of view) closes. This will cause the bit associated with that channel to toggle high. If the module is set up as outputs, then each time the channel output is toggle high, the LED will illuminate.

6.   Power Plus Module

A.   Connectors

This module will have six connectors (twelve outputs total, two outputs per connectors) for external valve operation plus an external power connection.

MAC Valves, Inc.
30569 Beck Rd.
Wixom, MI 48393
http://www.macvalves.com/   Page 45 of 79

Phone: (248)624-7700
Fax: (248)624-0549

Figure 36 Power Plus Module
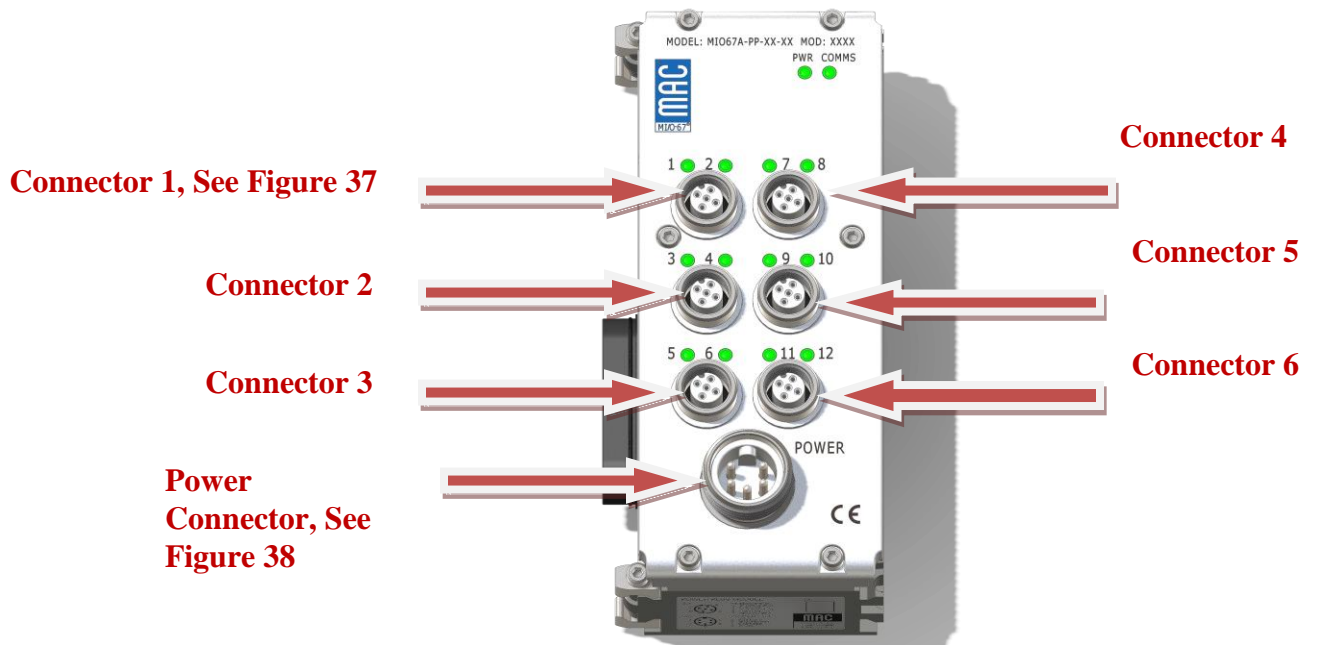
B.   Wiring

Shown below in **Figure 37**, are the load connections to drive a valve or other 12W or less loads on the Power Plus Module. Each connector has two outputs. There are six M12 connectors for a total of twelve outputs per module.

The power to operate the electronics of the module comes from the Comms Module Electronics power. The load power comes from the mini connector on the module and is wired according to **Figure 27**. The outputs cannot be operated without power from the mini connector. If this power is absent, the channel LEDs will be solid red and an error message will be sent to the PLC.

Figure 37 M12 Load Connections
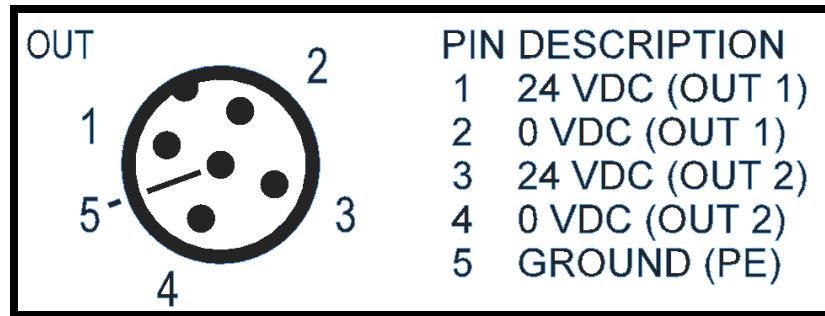
Figure 38 Mini Power Connector Pin-Out
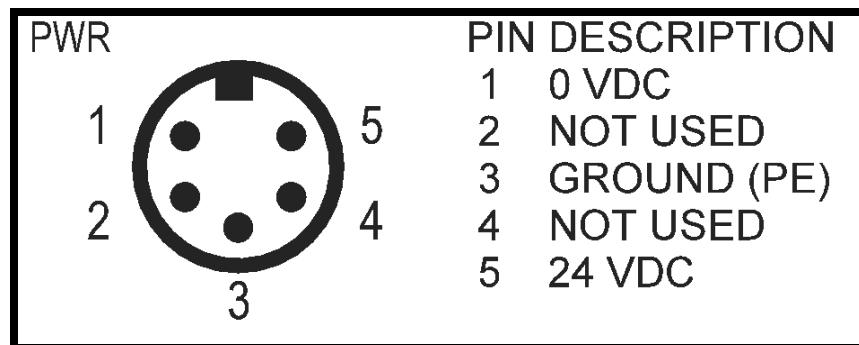
C.   Indicator LEDs

Each connector has two LEDs near them. The LEDs are solid green when the change is active (driving an output load). If there is no output power to the module, the LEDs will be solid red.

7. Network Connection

A. Connectors – EtherNet I/P

There are two EtherNet I/P connectors shown in **Figure 1**. The one on the left is Port 1; the one on the right is Port 2. If you are connecting this in a standard "drop" type configuration where one port is used, either Port 1 or Port 2 can be connected without any other configuration. If a DLR system is going to be used, both ports will be used.

8. Operation Example – Rockwell PLC

The following are some screen shots typical of a Rockwell PLC and what the MI/O-67 will look like in the system.

First, load in the EDS file into the system memory and add a slave onto the scanner string. In this case, the name used is: MIO_67_25.

Next, select the desired IP Address. In this example, we used: 192.168.1.25.

Select the disabled the keying and set it as Exclusive Owner. These can be set using the "change" key shown in the figure below. Also the Private Network Address is set to: 192.168.1.25. This is shown below.

Figure 39 Module Name, Keying, IP Address
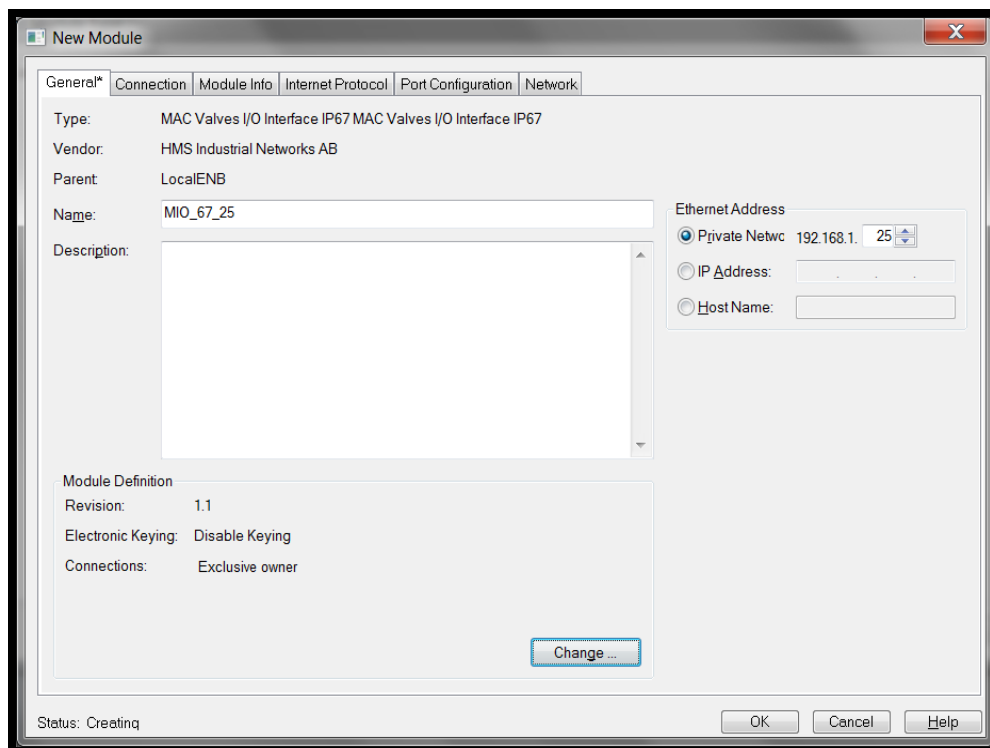
Next, go to the Controller Tags on the tree on the left and select the name you chose for the slave. This can be seen in the below screen shot.

There are three groups of tags: C (configuration), I (Input), O (Output).

The configuration must be set for the number of functional modules on the stack excluding the Comms Module, select the C pull down and follow the example below.

Figure 40 Configuration, Input, Output Bytes
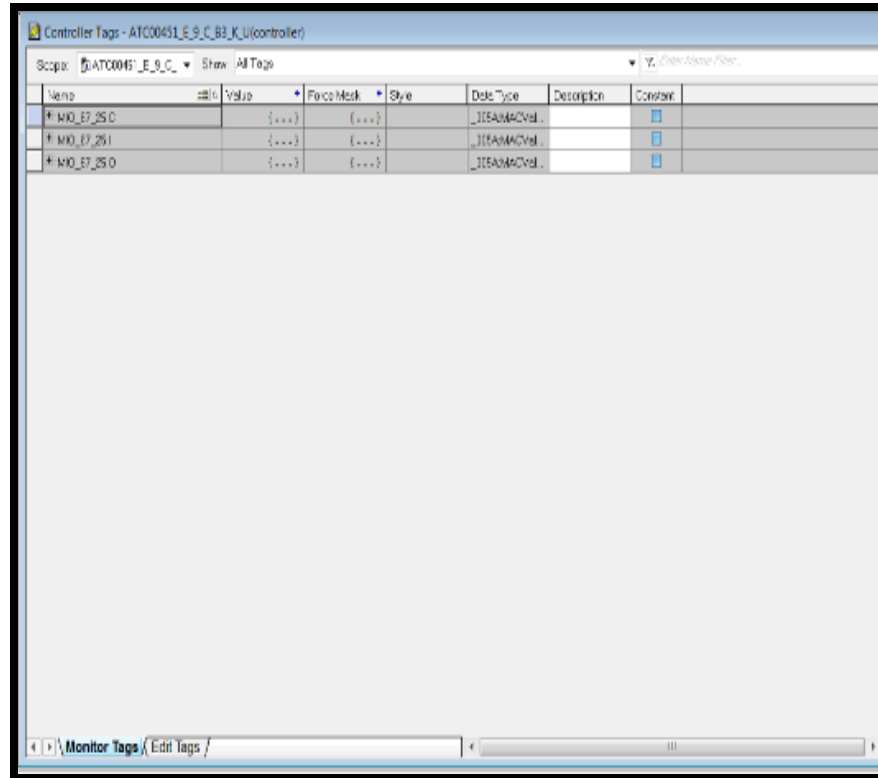
Configuration Example

1. Using the example above, select MIO_67_25C in the Controller Tags table.
2. If there are no modules connected to the Comms Module, byte 0 and 1 should both be 0x00.
3. If there are modules connected, then byte 0 should be 0x0y (number of modules) 0x01 for 1 module, 0x02 for 2 modules…etc. and byte 1 should be 0x00. Up to twelve modules can be configured here. If you have just the Comms Module, set the two bytes to 0x00.
4. Next, each module has a 4 byte code which must be entered in order right to left (starting with the first module connected to the Comms Module).   **Figure 1** is an example of 1 module (Analog Module Voltage) on the stack.
5. The codes are:
   a. Digital I/O= 0x91, 0x01, 0x03, 0x80
   b. Analog Module (Current)= 0x91, 0x01, 0x0c, 0x82
   c. Analog Module (Voltage)=0x91, 0x01, 0x0c, 0x81
   d. Power Plus Module=0x91,0x01,0x03,0x84
6. In the module numbering scheme, module 1 is directly touching the Comms Module, module 2 is to the left from module 1.
7. For a three module stack (right to left from the Comms Module, Analog Module Current, Analog Module Voltage, Digital I/O), the configuration will look like:
   a. Byte 0 = 0x03
   b. Byte 1= 0x00

c. Byte 2= 0x91
d. Byte 3= 0x01
e. Byte 4= 0x0c
f. Byte 5= 0x82
g. Byte 6=0x91
h. Byte 7= 0x01
i. Byte 8= 0x0c
j. Byte 9= 0x81
k. Byte10= 0x91
l. Byte11= 0x01
m. Byte12=0x03
n. Byte13= 0x80

Figure 41 Configuration Example, 1 Module, Analog I/O Voltage

8. To operate a valve on the stack, go to MIO_67_25O. There the valves are in bytes 2,3,4,5. Below in **Figure 31**, valve 1, solenoid A is being operated. Data(2) 16#01 is shown as 16#01 (0x01).

Figure 42 Valve Operation Example

9. Below in **Figure 32**, valve 1, solenoid A, valve 16 solenoid B, and valve 24 solenoid B (assuming all single solenoids) are is being operated. Data(2) 16#01, Data(3) 16#80, and Data(4) 16#80 are shown.

Figure 43 Valve Operation Example

10. The open circuit/short circuit detection will be viewable using the MIO_67_25:I in our example. To engage this function, the output channels must be configured for Open Circuit Detection and not active. For the Short Circuit Detection, the function is on when the output channels are active. The Open Circuit Detection will appear in Bytes 2, 3, 4, and 5 and for Short Circuit Detection, in Bytes 6, 7, 8, and 9. In **Figure 33** below, we are operating outputs 25-32 without valves (and is configured) and it shows an open circuit on all of these channels (Data(5) 16#ff). More about configuration later.

Figure 44 Valve Diagnostics Example

9.   Byte Definitions

The overall system will produce 210 Bytes, consume 210 Bytes, and use 190 Bytes for configuration. The break down and description of the bytes are below. Note; [User Name] is the name assigned to the stack during configuration. C means you are in the configuration section, and Data is the bytes for configuration. The data number below is given in Hex format. Also, this is written in Rockwell Logix layout. Other systems could be slightly different in format but the data locations and values will be the same.

A.   Configuration

The Configuration Table is broken down into two sections. The first section (Bytes 0-49) is the module definition section. If modules are used, then information is required to be entered into this area. If not, then these are all a value of 16#00.

The second section (Bytes 50-190) is used for special features to be loaded into the controller for each module. These include (for the Comms Module for example) Open Load Detection, Output Reaction for Network Faults, etc.

[User Name]:C.Data

[User Name]:C.Data(0)   Byte 0   Defines number of modules on the
                                                                                 Stack from 0-12

Examples: 4 modules would be: **[User Name]:C.Data(0)   16#04**
                 2 modules would be: **[User Name]:C.Data(0)   16#02**

[User Name]:C.Data(1)   Byte1   Reserved for future

[User Name]:C.Data(2)   Byte2   First byte of first module (closest
                                                                                 to Comms Module ID

--------**0 modules (Comms Module only) would be:**
[User Name]:C.Data(2) 16#00

-------- **>0 modules regardless of type would be:**
[User Name]:C.Data(2) 16#91

[User Name]:C.Data(3)   Byte3   Second byte of first module ID
-------**0 modules (Comms Module only) would be:**
[User Name]:C.Data(3) 16#00

------- **>0 modules regardless of type would be:**
[User Name]:C.Data(3) 16#01

[User Name]:C.Data(4)   Byte4   Third byte of first module ID
--------**0 modules would be:**
[User Name]:C.Data(4) 16#00

-------- **>0modules according to the following list:**
For:
-------Digital I/O= 16#03
-------Analog, Current= 16#0C
-------Analog, Voltage= 16#0C
-------Power Plus= 16#03
          Thus for example, an Analog, Current Module being the first
module after the Comms Module:
          [User Name]:C.Data(4)   16#0C
          For a Digital I/O Module:
          [User Name]:C.Data(4)   16#03
[User Name]:C.Data(5)   Byte5   Fourth byte of first module ID
--------**0 modules (Comms Module only) would be:**
[User Name]:C.Data(5)   16#00
Note if there are no modules in the stack all other configuration data bytes will
be **[User Name]:C.Data(x)   16#00**

---------- **>0 modules, this byte is according to the following list:**
For:

    ----Digital I/O, All Input, NPN= 16#70
    ----Digital I/O, Bank A Input, NPN—Bank B Output =16#71
    ----Digital I/O, All Input, PNP Polarity =16#72
    ----Digital I/O, Bank A Input, PNP—Bank B Output =16#73
    ----Digital I/O, Bank A Output—Bank B Input, NPN =16#74
    ----Digital I/O, All Output =16#75
    ----Digital I/O, Bank A Output—Bank B Input, PNP =16#76
    ----Digital I/O, All Output =16#77
    (Note, 16#75 and 16#77 can be used interchangeability)
    ----Analog, Current= 16#82
    ----Analog, Voltage= 16#81
    ----Power Plus= 16#84

      For example, an Analog, Current Module being the first module after the Comms Module:
      [User Name]:C.Data(5) 16#82

    Each additional module will follow this pattern every four bytes. Thus, if you have a Digital I/O Module located next to the Analog, Current Module used in the above examples, the configuration for the next four bytes would look like:
    [User Name]:C.Data(6) 16#91
    [User Name]:C.Data(7) 16#01
    [User Name]:C.Data(8) 16#03
    [User Name]:C.Data(9) 16#80

  Remember to configure byte(0) with the correct number of modules, otherwise the PLC will not recognize the bytes with the additional modules. The Comms Module is not counted in this number.

  The maximum number of modules that can be on a stack for configuration purposes is 12. Next, there are a number of default conditions that can be set for the valves and the modules. This information is loaded in the configuration table starting at **[User Name]:C.Data(50).**

  The basic layout for the stack valves and the modules follow this pattern:
    [User Name]:C.Data(x) 16#yy (Where yy= module number starting with 1, closest to Comms Module and increasing as you move away up to 12, or FF/FE reserved for the valve stack)
    [User Name]:C.Data(x+1) 16#yy (Where yy= configuration action
      0=No action
      1=Read configuration data from module
      2=Restore and read configuration

3=Reserved
4=Write configuration data to module
5=Write configuration data to module
 And store to non-volatile
6=Reserved
7=Reserved
8=Store configuration
9-255=Reserved

[User Name]:C.Data(x+2) 16#yy (Where yy=configuration data of indexed
Module) where,

Digital Module
[User Name]:C.Data(x+2) 16#yy For Network Faults:
[User Name]:C.Data(x+3) 16#yy Byte(x+2) channels 0-7
Byte(x+3) channels 8-15
Where 0 = Hold last state in idle
         1 = Apply configured value in
                Bytes (x+3) and (x+4).
[User Name]:C.Data(x+3) 16#yy Idle Values:
[User Name]:C.Data(x+4) 16#yy Byte(x+3) channels 0-7
Byte(x+4) channels 8-15
Where 0 = Digital Output Low
         1 = Digital Output High
[User Name]:C.Data(x+5) 16#yy (Where yy=configuration data of indexed
Module)
[User Name]:C.Data(x+6) 16#yy (Where yy=configuration data of indexed
Module)
[User Name]:C.Data(x+7) 16#yy (Where yy=configuration data of indexed
Module)
[User Name]:C.Data(x+8) 16#yy (Where yy=configuration data of indexed
Module)
[User Name]:C.Data(x+9) 16#yy (Where yy=configuration data of indexed
Module)

a.   Comms Module

For the **Comms Module** and Valve Stack, the configuration will start at
Data(50). Note: the configuration data does not have to start with the Comms
Module, just start at Data(50). All configurations are 10 bytes in length.
[User Name]:C.Data(50)   16#FF   Indexing bytes 0-7 on the Comms Module
[User Name]:C.Data(51)   16#yy   Action 04 or 05 from above
[User Name]:C.Data(52)   16#yy   Valve Drivers 1-32 where the LSB is
valve driver 1. Data(52) = valves 1-8
                Data(53) = valves 9-16
                Data(54) = valves 17-24
                Data(55) = valves 25-32

`   **[User Name]:C.Data(53)**   **16#yy**   For the bytes 52-55,
                                                    0=Hold last state during network fault

[User Name]:C.Data(54)   **16#yy**   1=Apply fault value below

[User Name]:C.Data(55)   **16#yy**

[User Name]:C.Data(56)   **16#yy**   Fault Values 1-32 where the LSB is
                                                    valve driver 1.   Data(56) = valves 1-8
                                                                             Data(57) = valves 9-16
                                                                        Data(58) = valves 17-24
                                                                        Data(59 = valves 25-32

`   **[User Name]:C.Data(57)**   **16#yy**   For bytes 56-59,
                                                    0=De-energize valve during fault

[User Name]:C.Data(58)   **16#yy**   1=Energize valve during fault

[User Name]:C.Data(59)   **16#yy**

[User Name]:C.Data(60)   **16#FE**   Indexing bytes 8-15 on the Comms
                                                  Module

[User Name]:C.Data(61)   **16#yy**   Action 04 or 05 from above

[User Name]:C.Data(62)   **16#yy**   Valve Drivers 1-32 where the LSB is
                                                  valve driver 1.

`   **[User Name]:C.Data(63)**   **16#yy**   0=Open-load detection Off

[User Name]:C.Data(64)   **16#yy**   1=Open-load detection On

[User Name]:C.Data(65)   **16#yy**

[User Name]:C.Data(66)   **16#yy**   Reserved

`   **[User Name]:C.Data(67)**   **16#yy**   Reserved

[User Name]:C.Data(68)   **16#yy**   Reserved

[User Name]:C.Data(69)   **16#yy**   Reserved

b.   Analog Module, Current

 [User Name]:C.Data(70)   **16#yy**   Indexing for module 1-12

[User Name]:C.Data(71)   **16#yy**   Action from list above

[User Name]:C.Data(72)   **16#**yy   Default Setting (bits 0-3)

0 = Hold the analog output's last state   1 = Zero analog output, Channels 1-4.

[User Name]:C.Data(73)   **16#yy**   Reserved

[User Name]:C.Data(74)   **16#yy**   Reserved

[User Name]:C.Data(75)   **16#yy**   Reserved

[User Name]:C.Data(76)   **16#yy**   Reserved

`   **[User Name]:C.Data(77)**   **16#yy**   Reserved

[User Name]:C.Data(78)   **16#yy**   Reserved

[User Name]:C.Data(79)   **16#yy**   Reserved

c.   Analog Module, Voltage

[User Name]:C.Data(70)   **16#yy**   Indexing for module 1-12
[User Name]:C.Data(71)   **16#yy**   Action from list above
[User Name]:C.Data(72)   **16#**yy   Default Setting (bits 0-3)
0 = Hold the analog output's last state 1 = Zero analog output, Channels 1-4.
[User Name]:C.Data(73)   **16#yy**   Reserved
[User Name]:C.Data(74)   **16#yy**   Reserved
[User Name]:C.Data(75)   **16#yy**   Reserved
[User Name]:C.Data(76)   **16#yy**   Reserved
`   **[User Name]:C.Data(77)**   **16#yy**   Reserved
[User Name]:C.Data(78)   **16#yy**   Reserved
[User Name]:C.Data(79)   **16#yy**   Reserved

d.   Power Plus Module

[User Name]:C.Data(70)   **16#yy**   Indexing for module 1-12
[User Name]:C.Data(71)   **16#yy**   Action from list above
[User Name]:C.Data(72)   **16#yy**   Valve Drivers 1-8 where the LSB is
                  valve driver 1.
[User Name]:C.Data(73)   **16#yy**   Valve Drivers 9-12 where the LSB is
                   valve driver 9.
                  0=Hold last state during network fault
                  1=Apply value from below
[User Name]:C.Data(74)   **16#yy**   Fault Valve Drivers 1-8
[User Name]:C.Data(75)   **16#yy**   Fault Valve Drivers 9-12
                  0=De-energize valve
                  1=Energize valve
[User Name]:C.Data(76)   **16#yy**   Open Load Detection Drivers 1-8
`   **[User Name]:C.Data(77)**   **16#yy**   Open Load Detection Drivers 9-12
                  0=Open Load Detection Off
                  1=Open Load Detection On
[User Name]:C.Data(78)   **16#yy**   Reserved
[User Name]:C.Data(79)   **16#yy**   Reserved

e.   Digital I/O Module

Note, this is only for the outputs of the module if configured as such.

[User Name]:C.Data(70)   **16#yy**   Indexing for module 1-12
[User Name]:C.Data(71)   **16#yy**   Action from above
[User Name]:C.Data(72)   **16#yy**   Output 1-8 where the LSB is
                  output driver 1.

[User Name]:C.Data(73)   **16#yy**   Output 9-12 where the LSB is
                                                                 output driver 9.
                                                                 0=Hold last state during network fault
                                                                 1=Apply value from below
[User Name]:C.Data(74)   **16#yy**   Fault State 1-8
[User Name]:C.Data(75)   **16#yy**   Fault State 9-12
                                                                 0=De-energize output
                                                                 1=Energize output
[User Name]:C.Data(76)   **16#yy**   Reserved
`   **[User Name]:C.Data(77)**   **16#yy**   Reserved
[User Name]:C.Data(78)   **16#yy**   Reserved
[User Name]:C.Data(79)   **16#yy**   Reserved

Below is an example of the Open Load Detection being set on valve channels 1-32. Note, in this example, there are no Network Fault States configured. If they were desired, then they would start with Byte 60.

Figure 45 Open Load Detection

+ mio25:C.Data[49]	16#00	
+ mio25:C.Data[50]	16#fe	
+ mio25:C.Data[51]	16#04	
+ mio25:C.Data[52]	16#ff	
+ mio25:C.Data[53]	16#ff	
+ mio25:C.Data[54]	16#ff	
+ mio25:C.Data[55]	16#ff	
+ mio25:C.Data[56]	16#00	
+ mio25:C.Data[57]	16#00	

In our example, with Open Load Detect set for solenoids 1-32 on a 10 solenoid valve stack, operating channels 1 and 2, and Solenoid 2 being shorted then the Input Table would read back:

[mio25]:I.Data(2)   **16#03**   Command operating solenoids 1 and 2
[mio25]:I.Data(6)   **16#02**   Short detected on solenoid 2
[mio25]:I.Data(10)   **16#00**   No Open Circuit Detect on solenoids 1-8 (1 and 2 are disabled during channel ON state and solenoids 3-8 or OK)
[mio_25]:C.Data(11)   **16#fc**   Open Circuit Detect found on solenoids 11-16,

solenoids 9 and 10 are OK. This is a 10 solenoid stack so there is nothing connected on solenoid channels 11-16. This fault is normal).

        [User Name]:C.Data(66) **16#yy** Reserved
        [User Name]:C.Data(67) **16#yy** Reserved
        [User Name]:C.Data(68) **16#yy** Reserved
        [User Name]:C.Data(69) **16#yy** Reserved
        [User Name]:C.Data(66) **16#yy** Reserved
        [User Name]:C.Data(67) **16#yy** Reserved
        [User Name]:C.Data(68) **16#yy** Reserved
        [User Name]:C.Data(69) **16#yy** Reserved

      For the **Analog Module, Current/Voltage**

        [User Name]:C.Data(80) **16#yy** Indexing for module 1-12
        [User Name]:C.Data(81) **16#yy** Action from above
        [User Name]:C.Data(82) **16#yy** Setting value for network fault where the LSB is output channel 1. Only the lowest four bits are used
            0=Hold last state during network fault
            1=Zero the analog output
        [User Name]:C.Data(83) **16#yy** Reserved
        [User Name]:C.Data(84) **16#yy** Reserved
        [User Name]:C.Data(85) **16#yy** Reserved
        [User Name]:C.Data(86) **16#yy** Reserved
        [User Name]:C.Data(87) **16#yy** Reserved
        [User Name]:C.Data(88) **16#yy** Reserved
        [User Name]:C.Data(89) **16#yy** Reserved

B.   Inputs

The first byte of the inputs contains the Communications Fault bit. It is labeled in the software as such. If it is a "0", the communications are OK. If it is a "1" then the communications are faulted and must likely cause by a configuration error.

a.   Comms Module

[User Name]:I.Data
[User Name]:I.Data(0)   Byte 0   Backplane Status, Lower Byte
Bit 0: Operational Status   1= All modules on the backplane are operational.
        0= One or more slaves or not operational

Bit 1: Outputs Valid   1= All modules operational and configured module ID list matches detected and all posted configured parameters have been successfully written to the modules.

0= One or more modules are not operational
and/or configured module ID list does not match detected and/or some of the
posted configured parameters have been not be successfully written to the
modules.

Bit 2: Inputs Valid   1= Inputs are valid.

0= One or more modules are not operational
and/or configured module ID list does not match detected and/or some of the
posted configured parameters have been not be successfully written to the
modules.

Bit 3: Topology Valid   1= The configured/written Module ID List
matches the detected list.

0= The configured/written Module ID List does
not match the detected list.

In the example in **Figure 35**, one of the modules was missing. Thus, the
configuration table does not match up with the read back from the modules.
However, the modules that are still there are functioning properly.

Figure 46 Module Missing Fault

Bit 4: Configuration In-Progress   1= Not all requested configuration
parameters have been applied to the backplane yet. During this state the
outputs/inputs are not valid.

0= All download requests to

configuration parameters have been successfully applied.

Bits 5-7: Reserved

[User Name]:I.Data(1)   Byte 1   Backplane Status, Upper Byte
Bit 0: Power Error   1= Backplane power budget has been exceeded.
     0= Power OK

Bit 1: Module Error   1= A backplane module error has been detected.
     0= No backplane module errors detected.

Figure 47 Module Error

Bit 2: Non-Volatile CheckSum Error   1= Parameters stored in non-volatile memory are corrupt. Reloading configuration required.
     0= All non-volatile parameters are consistent with the last stored configuration.

Bit 3: CAN Error Passive   1= CAN controller is in 'Error Passive state.
     0= CAN controller is in 'Error Active' state.

Bit 4: CAN Receive Overrun Error 1= A CAN receive queue overrun event occurred.

0= No overrun has occurred.

Bit 5: CAN Transmit Overrun Error 1= A CAN transmit queue overrun event occurred.

0= No overrun has occurred.

Bit 6: CAN Bus-off Error   1= CAN bus-off error occurred.
0= No bus-off errors have occurred.

Bit 7: External (I/O) Error   1 = (Latched) at least one external error condition is present. These include faults on physical I/O (short/open valve driver, over temperature, etc.), Comm/Power faults with driver chips…etc.
0= No faults

Figure 48 Input Table Showing External Fault

Note: to reset this fault, toggle [User Name]:O.Data[0] Byte 0. An example of this would be used if the power to the stack valves is turned off.

Figure 49 External I/O Fault Reset

Figure 50 Normal Operation

[User Name]:I.Data(2)	Byte 2	Valve Stack Output Mirror Solenoids 1-8
[User Name]:I.Data(3)	Byte 3	Valve Stack Output Mirror Solenoids 9-16
[User Name]:I.Data(4)	Byte 4	Valve Stack Output Mirror Solenoids 17-24
[User Name]:I.Data(5)	Byte 5	Valve Stack Output Mirror Solenoids 25-32
[User Name]:I.Data(6)	Byte 6	Valve Stack Short Circuit Detect Solenoids 1-8

[User Name]:I.Data(7)	Byte 7	Valve Stack Short Circuit Detect Solenoids 9-16
[User Name]:I.Data(8)	Byte 8	Valve Stack Short Circuit Detect Solenoids 17-24
[User Name]:I.Data(9)	Byte 9	Valve Stack Short Circuit Detect Solenoids 25-32
[User Name]:I.Data(10)	Byte 10	Valve Stack Open Circuit Detect Solenoids 1-8
[User Name]:I.Data(11)	Byte 11	Valve Stack Open Circuit Detect Solenoids 9-16
[User Name]:I.Data(12)	Byte 12	Valve Stack Open Circuit Detect Solenoids 17-24
[User Name]:I.Data(13)	Byte 13	Valve Stack Open Circuit Detect Solenoids 25-32
[User Name]:I.Data(14)	Byte 14	Valve Stack Open Circuit Enable, Solenoids 1-8
[User Name]:I.Data(15)	Byte 15	Valve Stack Open Circuit Enable, Solenoids 9-16
[User Name]:I.Data(16)	Byte 16	Valve Stack Open Circuit Enable, Solenoids 17-24
[User Name]:I.Data(17)	Byte 17	Valve Stack Open Circuit Enable, Solenoids 25-32

Examples: 0 modules, 23 solenoids on the stack, trying to operate 24 solenoids (1 more than stack total) and having solenoid 1 shorted:

[User Name]:I.Data
[User Name]:I.Data(0)	16#01	Status Lower
[User Name]:I.Data(1)	16#08	Status Upper
[User Name]:I.Data(2)	16#ff	Solenoid Signals 1-8 On
[User Name]:I.Data(3)	16#ff	Solenoid Signals 9-16 On
[User Name]:I.Data(4)	16#ff	Solenoid Signals 17-24 On
[User Name]:I.Data(5)	16#00	Solenoid Signals 25-32 Off
[User Name]:I.Data(6)	16#01	Solenoid 1 Shorted, 2-8 Not Shorted
[User Name]:I.Data(7)	16#00	Solenoids 9-16 Not Shorted
[User Name]:I.Data(8)	16#00	Solenoids 17-24 Not Shorted
[User Name]:I.Data(9)	16#00	Solenoids 25-32 Not Shorted

Note: Valve Channels must be operated to detect a short circuit
[User Name]:I.Data(10)	16#00	Solenoids 1-8 Not Open
[User Name]:I.Data(11)	16#00	Solenoids 9-16 Not Open
[User Name]:I.Data(12)	16#00	Solenoids 17-23 OK, 24 Open
[User Name]:I.Data(13)	16#ff	Solenoids 25-32 Open

Note: Valve Channels must be off to detect an open circuit. Thus even though Channel 24 is open, by operating 17-24, the detection is "turned

off"

[User Name]:I.Data(14)	16#ff	Valve Stack Open Circuit Enable**,** Solenoids 1-8
[User Name]:I.Data(15)	16#ff	Valve Stack Open Circuit Enable, Solenoids 9-16
[User Name]:I.Data(16)	16#ff	Valve Stack Open Circuit Enable, Solenoids 17-24
[User Name]:I.Data(17)	16#00	Valve Stack Open Circuit Enable, Solenoids 25-32

The next input bytes and their functions are related to the type of module connected after the Comms Module. They are set in 16 Byte groups. Thus, the first module will control Bytes 17-33, the second module will control Bytes 34-49, etc. If there is only a Comms Module on the stack, the rest of the input bytes would be: **[User Name]:I.Data(18-210) 16#00.**

However, if there are more modules, then they will look like this:
the locations of the inputs follow the pattern of starting with Data(18) and every 16 bytes thereafter. This is used for illustration purposes. Thus, from the configuration table, Module 1 starts at Data(18), Module 2 starts at Data(34), and Module 3 starts at Data (50)

b.   Analog Module, Current

For the **Analog Module, Current**, assuming it is the first module on the stack after the Comms Module:

[User Name]:I.Data(18)	16#xx	Lower byte, Input 1
[User Name]:I.Data(19)	16#xx	Upper byte, Input 1
[User Name]:I.Data(20)	16#xx	Lower byte, Input 2
[User Name]:I.Data(21)	16#xx	Upper byte, Input 2
[User Name]:I.Data(22)	16#xx	Lower byte, Input 3
[User Name]:I.Data(23)	16#xx	Upper byte, Input 3
[User Name]:I.Data(24)	16#xx	Lower byte, Input 4
[User Name]:I.Data(25)	16#xx	Upper byte, Input 4
[User Name]:I.Data(26)	16#xx	Input Undercurrent Diagnostics

Bit 0 = Input 1, Bit 1 = Input 2, Bit 2 = Input 3, Bit 3 = Input 4
Will trigger when the Input Current is between approx. 0.5-3.6mA
[User Name]:I.Data(26)   16#xx   Input Overcurrent Diagnostics
Bit 4 = Input 1, Bit 5 = Input 2, Bit 6 = Input 3, Bit 7 = Input 4
Will trigger when the Input Current is approx. >22.0mA
[User Name]:I.Data(27)   16#xx   Output Open Loop
Bit 0 = Output 1, Bit 1 = Output 2, Bit 2 = Output 3, Bit 3 = Output 4
Ok = 0, Open Loop Output = 1

[User Name]:I.Data(27)   16#xx   Output Over temperature
Diagnostics
Bit 4 = Output 1, Bit 5 = Output 2, Bit 6 = Output 3, Bit 7 = Output 4
Ok = 0, Over temperature = 1
[User Name]:I.Data(28)   16#xx   Output CRC Diagnostics
Bit 0 = Channel 1, Bit 1 = Channel 2, Bit 2 = Channel 3, Bit 3 = Channel 4
OK = 0, Invalid Comm Data
[User Name]:I.Data(28)   16#xx   Output Comm Diagnostics
Bit 4-7 b0000 when OK, b1111 when any channel has discrete DAC chip
failure
[User Name]:I.Data(29)   16#xx   Reserved
[User Name]:I.Data(30)   16#xx   Reserved
[User Name]:I.Data(31)   16#xx   Reserved
[User Name]:I.Data(32)   16#xx   Reserved
[User Name]:I.Data(33)   16#xx   Reserved

For the range of the inputs to be 0-20mA, the inputs will read as follows (per
connector):

Current (ma)	Upper Byte (hex)	Lower Byte (hex)
0.0	0x00	0x00
1.0	0x00	0xaa
2.0	0x01	0x55
4.0	0x02	0xa3
8.0	0x05	0x52
12.0	0x07	0xfe
16.0	0x0a	0xa7
20.0	0x0d	0x53

c.   Analog Module, Voltage

For the **Analog Module, Voltage**, assuming it is the first module on the stack
after the Comms Module:

[User Name]:I.Data(18)   16#xx   Lower byte, Input 1
[User Name]:I.Data(19)   16#xx   Upper byte, Input 1
[User Name]:I.Data(20)   16#xx   Lower byte, Input 2
[User Name]:I.Data(21)   16#xx   Upper byte, Input 2
[User Name]:I.Data(22)   16#xx   Lower byte, Input 3
[User Name]:I.Data(23)   16#xx   Upper byte, Input 3
[User Name]:I.Data(24)   16#xx   Lower byte, Input 4
[User Name]:I.Data(25)   16#xx   Upper byte, Input 4
[User Name]:I.Data(26)   16#xx   Input Overvoltage Diagnostics
Bit 0 = Input 1, Bit 1 = Input 2, Bit 2 = Input 3, Bit 3 = Input 4

Will trigger when the Input Voltage is >11.2V
[User Name]:I.Data(26)   16#xx   Output Overcurrent Diagnostics
Bit 4 = Input 1, Bit 5 = Input 2, Bit 6 = Input 3, Bit 7 = Input 4
Will trigger when the Input Current is approx. >16.0mA
[User Name]:I.Data(27)   16#xx   Output Thermal Shutdown
Bit 0-3 b0000 when OK, b1111 when any channel is in Thermal Shutdown
[User Name]:I.Data(27)   16#xx   Output Comm Diagnostics
Bit 4-7 b0000 when OK, b1111 when any channel has discrete DAC chip
failure
[User Name]:I.Data(28)   16#xx   Reserved
[User Name]:I.Data(29)   16#xx   Reserved
[User Name]:I.Data(30)   16#xx   Reserved
[User Name]:I.Data(31)   16#xx   Reserved
[User Name]:I.Data(32)   16#xx   Reserved
[User Name]:I.Data(33)   16#xx   Reserved

For 0-10V inputs, the corresponding inputs will read (per connector)

Voltage	Upper Byte	Lower Byte
(volts)	(hex)	(hex)
0.0	0x00	0x00
1.0	0x01	0x98
2.5	0x04	0x01
5.0	0x08	0x00
7.5	0x0c	0x08
10.0	0x10	0x00

d.   Power Plus Module

For the **Power Plus Module**, assuming it is the first module on the stack after
the Comms Module:
 [User Name]:I.Data(18)   16#xx   State (0-7)
0 = Output Off, 1 = Output On. Channels 1-8
[User Name]:I.Data(19)   16#xx   State (0-3)
0 = Output Off, 1 = Output On. Channels 9-12
[User Name]:I.Data(20)   16#xx   Short Circuit (0-7)
0 = No short detected, 1 = Shorted channel (Channels 1-8)
[User Name]:I.Data(21)   16#xx   Short Circuit (0-3)
0 = No short detected, 1 = Shorted channel (Channels 9-12)
[User Name]:I.Data(22)   16#xx   Open Load (0-7)
This is active only when the channel is off (0 state) and the Open_Load
Detection is configured. 0 = No Open load, 1 =Open Load, Channels 1-8.
[User Name]:I.Data(23)   16#xx   Open Load (0-3)
This is active only when the channel is off (0 state) and the Open_Load
Detection is configured. 0 = No Open load, 1 =Open Load, Channels 9-12.

[User Name]:I.Data(24)   16#xx   Open_Load Detect Status (0-7)
0 = Not configured, 1 = Configured, Channels 1-8.
[User Name]:I.Data(25)   16#xx   Open_Load Detect Status (8-12)
0 = Not configured, 1 = Configured, Channels 9-12.
[User Name]:I.Data(26)   16#xx   Reserved
[User Name]:I.Data(27)   16#xx   Reserved
[User Name]:I.Data(28)   16#xx   Reserved
[User Name]:I.Data(29)   16#xx   Reserved
[User Name]:I.Data(30)   16#xx   Reserved
[User Name]:I.Data(31)   16#xx   Reserved
[User Name]:I.Data(32)   16#xx   Reserved
[User Name]:I.Data(33)   16#xx   Reserved

e.   Digital I/O Module

For the **Digital I/O Module**, assuming it is the first module on the stack after the Comms Module and in all input mode:

[User Name]:I.Data(18)   16#xx   Status (0-7)
0 = Input Off, 1 = Input On. Channels 1-8 where Input 1 = Bit 0, Input 2 = Bit 1….etc
[User Name]:I.Data(19)   16#xx   Status (0-7)
0 = Input Off, 1 = Input On. Channels 9-16 (Inputs 9-16)
[User Name]:I.Data(20)   16#xx   Reserved
[User Name]:I.Data(21)   16#xx   Reserved
[User Name]:I.Data(22)   16#xx   Short Circuit Detection
For Inputs, 16#03 = Short on connector 1, 16#0c = Short on connector 2, 16#30 = Short on connector 3, 16#c0 = Short on connector 4
For Outputs, per channel shorts where the LSB = channel 0, MSB = channel 7
[User Name]:I.Data(23)   16#xx   Short Circuit Detection
For Inputs, 16#03 = Short on connector 1, 16#0c = Short on connector 2, 16#30 = Short on connector 3, 16#c0 = Short on connector 4
For Outputs, per channel shorts where the LSB = channel 0, MSB = channel 7
[User Name]:I.Data(24)   16#xx   Reserved
[User Name]:I.Data(25)   16#xx   Reserved
[User Name]:I.Data(26)   16#xx   Reserved
[User Name]:I.Data(27)   16#xx   Reserved
[User Name]:I.Data(28)   16#xx   Reserved
[User Name]:I.Data(29)   16#xx   Reserved
[User Name]:I.Data(30)   16#xx   Reserved
[User Name]:I.Data(31)   16#xx   Reserved
[User Name]:I.Data(32)   16#xx   Reserved
[User Name]:I.Data(33)   16#xx   Reserved

Note, if the Digital Module is split half Outputs and half Inputs, Bank A will be Data(18) and Bank B will be Data (19) Inputs.

C. Outputs

a. Comms Module, Stack Valves

The location of the individual valve solenoids vs the binary/hex byte is as follows:

Solenoid	Byte	Binary	Hex
1	**O.Data(2)**	0000 0001	16#01
2		0000 0010	16#02
3		0000 0100	16#04
4		0000 1000	16#08
5		0001 0000	16#10
6		0010 0000	16#20
7		0100 0000	16#40
8		1000 0000	16#80
9	**O.Data(3)**	0000 0001	16#01
10		0000 0010	16#02
11		0000 0100	16#04
12		0000 1000	16#08
13		0001 0000	16#10
14		0010 0000	16#20
15		0100 0000	16#40
16		1000 0000	16#80
17	**O.Data(4)**	0000 0001	16#01
18		0000 0010	16#02
19		0000 0100	16#04
20		0000 1000	16#08
21		0001 0000	16#10
22		0010 0000	16#20
23		0100 0000	16#40
24		1000 0000	16#80
25	**O.Data(5)**	0000 0001	16#01
26		0000 0010	16#02
27		0000 0100	16#04
28		0000 1000	16#08
29		0001 0000	16#10
30		0010 0000	16#20
31		0100 0000	16#40

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32	1000 0000	16#80

The break down for the Bytes is:

[User Name]:O.Data		
[User Name]:O.Data(0)	Byte 0	CAN control, reserved
[User Name]:O.Data(1)	Byte 1	CAN control, reserved
[User Name]:O.Data(2)	Byte 2	Valve Solenoids 1-8
[User Name]:O.Data(3)	Byte 3	Valve Solenoids 9-16
[User Name]:O.Data(4)	Byte 4	Valve Solenoids 17-24
[User Name]:O.Data(5)	Byte 5	Valve Solenoids 25-32
[User Name]:O.Data(6)	Byte 6	Reserved
[User Name]:O.Data(7)	Byte 7	Reserved
[User Name]:O.Data(8)	Byte 8	Reserved
[User Name]:O.Data(9)	Byte 9	Reserved
[User Name]:O.Data(10)	Byte 10	Reserved
[User Name]:O.Data(11)	Byte 11	Reserved
[User Name]:O.Data(12)	Byte 12	Reserved
[User Name]:O.Data(13)	Byte 13	Reserved
[User Name]:O.Data(14)	Byte 14	Reserved
[User Name]:O.Data(15)	Byte 15	Reserved
[User Name]:O.Data(16)	Byte 16	Reserved
[User Name]:O.Data(17)	Byte 17	Reserved

b.   Analog Module, Current

For the **Analog Module, Current**, assuming it is the first module on the stack after the Comms Module:

[User Name]:O.Data(18)	16#xx	Lower byte, Output 1
[User Name]:O.Data(19)	16#xx	Upper byte, Output 1

Current (mA)	Upper Byte (hex)	Lower Byte (hex)
0.0	0x00	0x00
1.0	0x00	0xaa
2.0	0x01	0x55
4.0	0x02	0xa3
8.0	0x05	0x52
12.0	0x07	0xfe
16.0	0x0a	0xa7
20.0	0x0d	0x53

[User Name]:O.Data(20)	16#xx	Reserved
[User Name]:O.Data(21)	16#xx	Reserved

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[User Name]:O.Data(22)   16#xx   Reserved
[User Name]:O.Data(23)   16#xx   Reserved
[User Name]:O.Data(24)   16#xx   Reserved
[User Name]:O.Data(25)   16#xx   Reserved
[User Name]:O.Data(26)   16#xx   Reserved
[User Name]:O.Data(27)   16#xx   Reserved
[User Name]:O.Data(28)   16#xx   Reserved
[User Name]:O.Data(29)   16#xx   Reserved
[User Name]:O.Data(30)   16#xx   Reserved
[User Name]:O.Data(31)   16#xx   Reserved
[User Name]:O.Data(32)   16#xx   Reserved
[User Name]:O.Data(33)   16#xx   Reserved

For the range of the outputs to be 0-20mA, the outputs will be from
16#00,16#00 (for 0mA) through 16#0D,16#53(for 20mA). If there are more
modules for this type, then they reside on the next 8 bytes in order

c.   Analog Module, Voltage

For the **Analog Module, Voltage**, assuming it is the first module on the stack
after the Comms Module:

[User Name]:O.Data(18)   16#xx   Lower byte, Output 1
[User Name]:O.Data(19)   16#xx   Upper byte, Output 1
[User Name]:O.Data(20)   16#xx   Lower byte, Output 2
[User Name]:O.Data(21)   16#xx   Upper byte, Output 2
[User Name]:O.Data(22)   16#xx   Lower byte, Output 3
[User Name]:O.Data(23)   16#xx   Upper byte, Output 3
[User Name]:O.Data(24)   16#xx   Lower byte, Output 4
[User Name]:O.Data(25)   16#xx   Upper byte, Output 4
[User Name]:O.Data(26)   16#xx   Reserved
[User Name]:O.Data(27)   16#xx   Reserved
[User Name]:O.Data(28)   16#xx   Reserved
[User Name]:O.Data(29)   16#xx   Reserved
[User Name]:O.Data(30)   16#xx   Reserved
[User Name]:O.Data(31)   16#xx   Reserved
[User Name]:O.Data(32)   16#xx   Reserved
[User Name]:O.Data(33)   16#xx   Reserved

For the range of the outputs to be 0-10V, the outputs will read from
16#00,16#00 (for 0V) through 16#10,16#00(for 10V). If there are more
modules on the stack of this type, then they reside on the next 8 bytes in order.

d. Power Plus Module

For the **Power Plus Module**, assuming it is the first module on the stack after the Comms Module:

[User Name]:O.Data(18)	16#xx	Lower byte, Outputs 1-8 (bits 0-7)
[User Name]:O.Data(19)	16#xx	Upper byte, Output 9-12 (bits 0-3)
		(bits 4-7 not used)
[User Name]:O.Data(20)	16#xx	Reserved
[User Name]:O.Data(21)	16#xx	Reserved
[User Name]:O.Data(22)	16#xx	Reserved
[User Name]:O.Data(23)	16#xx	Reserved
[User Name]:O.Data(24)	16#xx	Reserved
[User Name]:O.Data(25)	16#xx	Reserved
[User Name]:O.Data(26)	16#xx	Reserved
[User Name]:O.Data(27)	16#xx	Reserved
[User Name]:O.Data(28)	16#xx	Reserved
[User Name]:O.Data(29)	16#xx	Reserved
[User Name]:O.Data(30)	16#xx	Reserved
[User Name]:O.Data(31)	16#xx	Reserved
[User Name]:O.Data(32)	16#xx	Reserved
[User Name]:O.Data(33)	16#xx	Reserved

e. Digital I/O Module

For the **Digital I/O Module**, output mode, assuming it is the first module on the stack after the Comms Module:
Output 1 would be bit 0, Output 2 would be bit 1…etc

[User Name]:O.Data(18)	16#xx	Lower byte, Outputs 1-8 (bits 0-7)
[User Name]:O.Data(19)	16#xx	Upper byte, Output 9-16 (bits 0-7)
[User Name]:O.Data(20)	16#xx	Reserved
[User Name]:O.Data(21)	16#xx	Reserved
[User Name]:O.Data(22)	16#xx	Reserved
[User Name]:O.Data(23)	16#xx	Reserved
[User Name]:O.Data(24)	16#xx	Reserved
[User Name]:O.Data(25)	16#xx	Reserved
[User Name]:O.Data(26)	16#xx	Reserved
[User Name]:O.Data(27)	16#xx	Reserved
[User Name]:O.Data(28)	16#xx	Reserved
[User Name]:O.Data(29)	16#xx	Reserved
[User Name]:O.Data(30)	16#xx	Reserved
[User Name]:O.Data(31)	16#xx	Reserved
[User Name]:O.Data(32)	16#xx	Reserved
[User Name]:O.Data(33)	16#xx	Reserved

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10. LED Troubleshooting Guide

In the event of difficulties in either operation or installation of the MI/O-67 have a number of fault detection tools available. Along with the short/open detection mentioned above, each module has groups of LEDs which can help to get the manifold online in the event of problems.

A. Comms Module

Below the EtherNet Ports, there are four LEDs. Along the top of the Comms Module are three LEDs.

For NS (Network Status):

State	Description
Off	No Power/No IP Address
Green	Online, 1 or more connections established
Green Flashing	Online, no connection established
Red	Duplicated IP Address, Fatal Error
Red Flashing	Connection timed out

For MS (Module Status):

State	Description
Off	No power
Green	Controlled by a scanner in run mode
Green Flashing	Not configured or scanner in idle mode
Red	Fatal Error
Red Flashing	Recoverable fault, Non-DLR mode: connector time out.

For LS (Link/Activity)

State	Description
Off	No Link/No Activity
Green	Link established, 100mb
Green Flickering	Activity, 100mb
Yellow	Link established, 10mb
Yellow Flickering	Activity, 10mb

For Power:

State	Description
Off	No Power
Green	Power OK

For Comm (Backplane Communications):

State	Description
Off	No power
Green	OK

Green Flashing	Not configured or scanner in idle mode
Red	Fatal Error
Red Flashing	Recoverable fault

For Stat (Backplane Status)

State	**Description**
Off	No Link/No Activity
Green	Run Mode
Green Flashing	Standby Mode

B.   Digital I/O Module

Leds on top right of module:

Com Led-- Red: (CANopen Status, Error Led)

State	**Description**
Off	No error
Single Flash	Warning limit reached (error passive)
Flickering	LSS Config Mode
On	Bus Off/fatal error
Double Flash	Heartbeat timeout error

Com Led-- Green: (CANopen Status, Run Led)

State	**Description**
Single Flash	CANopen stopped state
Flickering	LSS Config Mode
On	CANopen operational state
Blinking	CANopen pre-operational state

PWR Led:

State	**Description**
Green	Power/Application loaded
Green w/Red	
Single Flash	IO Comm failure
Flickering between	
Green and Red	Dip switch state changed
Red	Fatal error in application

IO Led near each M12 connector, 2 ea.:

Input Mode

State	**Description**
Green	NPN-connection is sinking current, PNP-connection is sourcing current.

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Red	Fault on channel
Off	Channel off

Output Mode

Green	Output on
Red	Fault on channel
Off	Channel off

During start up, PWR, IO, and Com Leds will be 0.25sec Green, 0.25sec Red.

C.   Power Plus Module

Leds on top right of module:

Com Led-- Red: (CANopen Status, Error Led)

State	**Description**
Off	No error
Single Flash	Warning limit reached (error passive)
Flickering	LSS Config Mode
On	Bus Off/fatal error
Double Flash	Heartbeat timeout error

Com Led-- Green: (CANopen Status, Run Led)

State	**Description**
Single Flash	CANopen stopped state
Flickering	LSS Config Mode
On	CANopen operational state
Blinking	CANopen pre-operational state

PWR Led:

State	**Description**
Green	Power/Application loaded
Green w/Red	
Single Flash	IO Comm failure
Flickering between	
Green and Red	Dip switch state changed
Red	Fatal error in application

Output Led near each M12 connector, 2 ea:

State	**Description**
Green	Output on
Red	Fault (output power not present)
Off	Output off

During start up, PWR, Output, and Com Leds will be 0.25sec Green, 0.25sec Red.

D.   Analog I/O Module (Voltage and Current)

Leds on top right of module

Com Led-- Red: (CANopen Status, Error Led)

State	Description
Off	No error
Single Flash	Warning limit reached (error passive)
Flickering	LSS Config Mode
On	Bus Off/fatal error
Double Flash	Heartbeat timeout error

Com Led-- Green: (CANopen Status, Run Led)

State	Description
Single Flash	CANopen stopped state
Flickering	LSS Config Mode
On	CANopen operational state
Blinking	CANopen pre-operational state

PWR Led:

State	Description
Green	Power/Application loaded
Green w/Red	
Single Flash	IO Comm failure
Flickering between	
Green and Red	Dip switch state changed
Red	Fatal error in application

During start up, PWR, IO, and Com Leds will be 0.25sec Green, 0.25sec Red.

11. Troubleshooting Chart

Fault	Description
Do valves operate?	
No	Check power to Comms Module
	Check network wiring
	Check network indicator LEDs on Comms Module
	Check network IP Address and Configuration
	Check for correct Bytes to operate valves in PLC Output Table
Do modules operate?	
No	Check configuration in PLC
	If using a Digital I/O Module, check dipswitches on module
	If using a Power Plus Module, check external power
	Check all module for wiring (sensors, loads, etc)
Are you getting faults on Comms Module?	Check the Open Load Diagnostics in PLC and valve set up
Is unit coming online in the PLC network?	
No	Check the IP address and whether the EDS file is loaded

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Warning:

Under no circumstances are MAC Valves to be used in any application or system where failure of the valves or related components to operate as intended could result in injury to the operator or any other person.

- Do not operate outside of prescribed pressure or temperature ranges.
- Air supply must be clean. Contamination of valve can affect proper operation.
- Before attempting to perform any service on valve, consult catalog, P & O sheet, or factory for proper maintenance procedures. Never attempt service with air pressure to valve.
- If air line lubrication is used, consult catalog, P & O sheet, or factory for recommended lubricants.
- Before interfacing the product to any bus or serial system, consult the controller and bus manuals for proper usage.