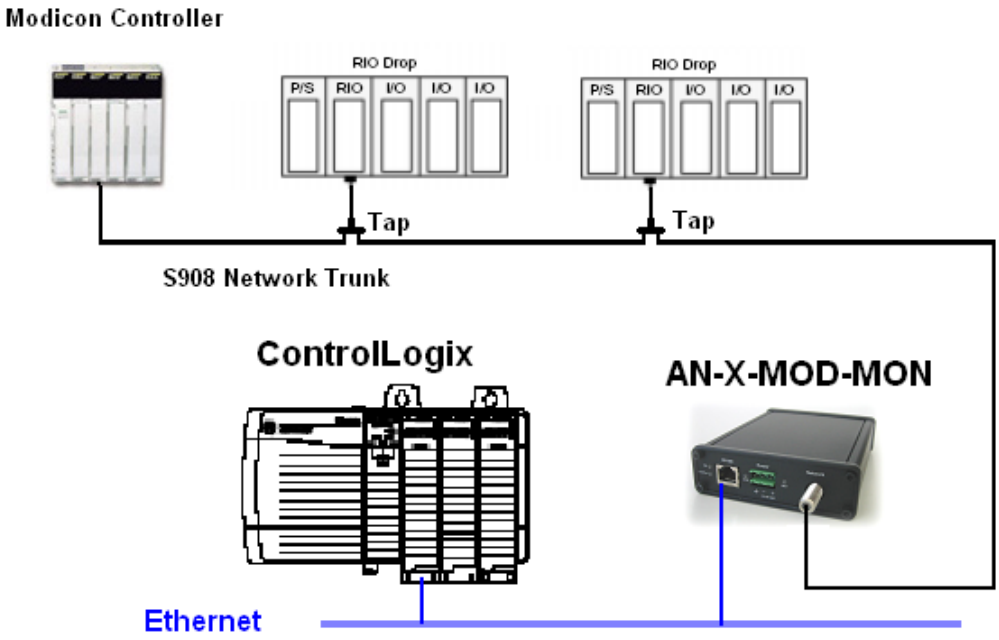
AN-X2 Application Note

Using AN-X2-MOD-MON to upgrade a control system



This application note describes an approach to upgrading control systems that results in minimal risk and downtime.

To perform a control system upgrade:

- Convert existing ladder logic to Logix
- Capture the old controller's I/O configuration
- Create a control program in the ControlLogix that writes its outputs to a ControlLogix array tag
- Have Logix ghost the old controller by sending it live inputs and outputs from the existing controller and comparing its outputs to the existing controller's outputs

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- Develop and run HMIs, SCADA etc. while in monitor mode
- Swap in the new controller, test and be able to swap back to the old controller if required

Once the new control system's functionality has been verified, the old I/O can be replaced a little at a time with modern I/O as time and funding permit.

As an example, this application note describes in detail how to replace a Modicon controller with a ControlLogix processor and AN-X2-MOD-MAS.

It describes a simple network consisting of two drops. Drop 1 is an 800 series drop; drop 2 is a Quantum drop.

It assumes that you will use the same AN-X hardware for both monitor and master, changing one to the other by downloading firmware.

Before you begin…

Select IP addresses and Ethernet host names for the module as master and as monitor. The IP addresses must be different since RSLogix 5000 does not allow two modules in the same I/O configuration to have the same IP address.

If you are adding the module to an existing network, consult the network administrator first to obtain IP addresses and other network parameters.

All the details for setting the IP address are in the AN-X2-MOD-MON manual.

In this example, we'll use 192.168.1.14 for the monitor and 192.168.1.15 for the master.

We'll use names AnxModMon and AnxModMas for the AN-X module in RSLogix 5000.

WARNING!

Do not connect or disconnect the AN-X module while the existing Modicon control system is running!

Connecting the AN-X2-MOD-MAS and AN-X2-MOD-MON to the S908 Network

The hardware for the AN-X2-MOD-MAS and AN-X2-MOD-MON contains built-in termination.

When you connect the AN-X2-MOD-MAS to the network, it usually replaces a Modicon master and no wiring changes are necessary.

When you connect the AN-X2-MOD-MON to the network, you can't connect it just like any other node. There's a loss of about 14 dB through a tap to each drop, so if the AN-X were connected as a drop, there would be a loss of at least 28 dB in the signal from other drops to the AN-X2-MOD-MAS, as well as any attenuation along the cables.

The AN-X2-MOD-MON should be located at the end of the network trunk. Remove the terminator previously at the end of the network trunk.

If it isn't practical to connect the AN-X2-MOD-MON to the end of the network trunk, it can be connected using a Modicon trunk splitter. Refer to the Modicon Remote I/O Cable System Planning and Installation Guide for details.

WARNING! The use of more than one splitter as a branching device on the RIO network is never permitted.

If you remove an AN-X2-MOD-MON from the S908 network, make sure the network is properly terminated after you remove it.

Step 1: Set up the AN-X2-MOD module as monitor

Set the IP address of the module to the address you've chosen for monitor operation. In this example, the monitor IP address is 192.168.1.14

Give the AN-X a meaningful hostname. This name will also be used when we configure the module in RSLogix 5000. In this example, we'll name the module AnxModMon.

Use the web interface to access the AN-X and select *Administration/AN-X Configuration*. Change the IP address and hostname.

Check that the firmware selected is AN-X2-MOD-MON.

Click SUBMIT to accept the changes and restart the AN-X.

Step 2: Autoconfigure the AN-X2-MOD-MON

Whenever the Modicon master starts up, it sends configuration (traffic cop) information based on its current I/O configuration. The AN-X2-MOD-MON captures this traffic cop data and uses it to build an I/O configuration file.

At startup, the Modicon master also sends parameter data to Quantum drops. Typical parameter data includes timeout data, channel configurations for analog modules, and so on. The AN-X2-MOD-MON captures this parameter data and adds it to the remote I/O configuration so that it can later be used by the AN-X2-MOD-MAS.

First clear out any previous configuration stored in the AN-X2-MOD-MON.

From the web interface, select *Automation Network/Modicon S908 I/O Network Configuration*. Click the *Clear Heard Configuration* button. When AN-X is done, click the *configuration page* link to return to the main configuration page.

Now stop and start the Modicon master. The AN-X2-MOD-MON captures the configuration traffic on the network.

Click *Auto-configure Network*. The AN-X2-MOD-MON builds a configuration from what it has captured.

It also builds a default ControlLogix configuration that maps the Modicon I/O data to scheduled connections in the ControlLogix.

Use the web interface to view and store the remote I/O and ControlLogix configurations it generated, as well as the alias tags.

First select *Automation Network/View Configuration Files.*

To view the remote I/O configuration, click *AN-X2-MOD-MON RIO Network Configuration File.*

To view the ControlLogix configuration, click *AN-X2-MOD-MON ControlLogix Configuration File.*

To view the alias tags, click *AN-X2-MOD-MON Ethernet/IP ControlLogix I/O Data Tags.*

To save these files, right click on each link and select *Save Target As...* from the menu. Save the monitor tags as we will need them later.

Here's an example of a remote I/O configuration generated by AN-X after an autoconfiguration:

```
;QTS AN-X2-MOD-MON Auto Configuration Utility
;Copyright (c) 2005 Quest Technical Solutions
;Auto Config Mod Mon File - Version 4.2.4
Drop=1,
;HoldTime=3
,Rack=1
,,Slot=4,Type=B804
,,Slot=5,Type=B805
,,Slot=6,Type=B863
EndDrop
Drop=2,
;HoldTime=3
,Rack=1
,,Slot=1,Type=CPS_114_xx
,,Slot=2,Type=CRA_93x_00
,,Slot=3,Type=DDI_353_00
,,Slot=4,Type=DDO_353_00
,,,,CfgLen=2,0x0000,0x0000
,,Slot=5,Type=ACI_030_00
,,,,CfgLen=1,0x0001
,,Slot=6,Type=ACO_020_00
,,,,CfgLen=6,0x8001,0x5555,0x0000,0x0000,0x0000,0x0000
EndDrop
```

Figure 1 Remote I/O Configuration

Things to note

The remote I/O configuration lists the modules the AN-X2-MOD-MON captured in the configuration that was sent on the network, by drop, rack and slot.

For example, the line

```
,,Slot=4,Type=B804
```

indicates that drop 1 slot 4 contains a B804 module.

The line

```
,,Slot=3,Type=DDI_353_00
```

indicates that drop 2 rack 1 slot 3 contains a DDI 353 00 module.

AN-X appends a list of supported 800 series and Quantum modules to the end of the I/O configuration file.

Comments start with a semicolon. Some comments have been removed for clarity.

The lines

```
,,Slot=4,Type=DDO_353_00
,,,,CfgLen=2,0x0000,0x0000
```

indicate that the DDO_353_00 module has two words of configuration data, both with value 0x0000. (The leading 0x indicates a hexadecimal number.)

Here's an example of a ControlLogix configuration generated by AN-X:

```
;QTS AN-X2-MOD-MON Auto Configuration Utility
;Copyright (c) 2005 Quest Technical Solutions
;Auto Config Ethernet/IP File - Version 4.2.4
ClxName,AnxModMon
ClxPrefix,MOD_
ClxPrefixOut,MOD_MONOUT_
; ---- Modicon Inputs ----
ClxSlot,0
DataInput   ; Inputs to ControlLogix
  0,DropErr
  2,d1s5_Inp,d01s5_Inp
  3,d1s6_Inp,d01s6_Inp
  7,d2s3_Inp,d02s3_Inp
  9,d2s5_Inp,d02s5_Inp
; ---- Modicon Monitored Outputs ----
 18,d1s4_Out,d01s4_Out
 19,d2s4_Out,d02s4_Out
 21,d2s6_Out,d02s6_Out
;The following lines map Diagnostics into ClxSlot 15
ClxSlot,15
DataOutput
  0,DiagCtl   ; Len=1 Set Bit 0 to clear diagnostic counters
DataInput  ; Inputs to ControlLogix
  0,DiagCtrs
 15,d1ModHlth
 20,d2ModHlth
;Module Status Byte for Quantum Only
 25,d2ModSts,  3
;ControlLogix Connection Statistics
 30,ConnStats0
```

Figure 2 ControlLogix Configuration

The ControlLogix configuration shows where the I/O data is mapped in the ControlLogix.

Things to note

In this example, data is mapped to generic modules in slots 0 and 15. Data for each slot starts with a line that consists of the keyword ClxSlot and the slot number.

AN-X2-MOD-MON packs all the inputs together, then all the monitored outputs. All the I/O data, both inputs and outputs, are mapped to input data in the ControlLogix.

The line

```
2,d1s5_Inp,d01s5_Inp
```

means that the input data for the module at drop 1 slot 5 is mapped to the ControlLogix inputs at offset 2 in connection 0, and has the associated alias name d01s5_Inp.

AN-X2-MOD-MON maps diagnostic data to slot 15. It includes the diagnostic counters, module health bits, module status data for Quantum drops, and statistics for the ControlLogix connections.

Step 3: Configure the AN-X2-MOD-MON in the ControlLogix

To the ControlLogix processor the AN-X2-MOD-MON looks like a 17 slot rack with an ENBT/A module in slot 16 and generic modules in slots 0 to 15.

When you autoconfigure the AN-X2-MOD-MON, it maps the Modicon I/O data into the input data for the generic modules in the ControlLogix. You add scheduled connections to those generic modules to read the S908 data from the AN-X.

By default, the AN-X2-MOD-MON maps I/O data into the generic modules in slots 0 to 14. It maps diagnostic counters and other status information to the generic module in slot 15.

In the example in Figure 2, the "ClxSlot" lines indicate where the data for each generic module starts. Since this is a small I/O configuration, all the I/O data fits into the input data for slot 0. The diagnostic data is mapped to the input data for slot 15.

To configure the AN-X2-MOD-MON, add an ENBT/A module to the I/O configuration at the AN-X2-MOD-MON IP address (192.168.1.14). Configure the ENBT for slot 16 and give the ENBT the same name as the hostname of the AN-X (AnxModMon).

Add generic modules for each slot we want to create a connection to, in this case slots 0 and 15.

Refer to the appendix for detailed instructions.

Step 4: Configure the AN-X2-MOD-MAS in the ControlLogix

To the ControlLogix processor the AN-X2-MOD-MAS looks like a 17 slot rack with an ENBT/A module in slot 16 and generic modules in slots 0 to 15.

When you autoconfigure the AN-X2-MOD-MAS, it maps the Modicon I/O data into the input and output data for the generic modules in the ControlLogix. You add scheduled connections to those generic modules to read and write the S908 data.

By default, the AN-X2-MOD-MAS maps I/O data into the generic modules in slots 0 to 14. It maps diagnostic counters and other status information to the input data for the generic module in slot 15.

To configure the AN-X2-MOD-MAS, first add an ENBT/A module to the I/O configuration at the AN-X2-MOD-MAS IP address (192.168.1.15). Configure the ENBT

for slot 16 and give the ENBT the same name as the hostname of the AN-X (AnxModMas).

Add generic modules for each slot we want to create a connection to, in this case slots 0 and 15.

Refer to the AN-X2-MOD-MAS user manual for detailed instructions.

Step 5: Check that you can see the I/O data

With the Modicon controller in run mode, check that you can see the input and output data.

In the ControlLogix configuration file, the line

```
2,d1s5_Inp,d01s5_Inp
```

indicates that the input data for the module in drop 1 slot 5 (a B805) starts at offset 2.

The line

```
19,d2s4_Out,d02s4_Out
```

indicates that the output data for the module in drop 2 slot 4 (a DDO 353 00) starts at offset 19.

Use the ControlLogix configuration and RSLogix 5000 to verify that you can see input and output data for all the modules on your network. Some modules may have both input and output data.

Step 6: Import tags into RSLogix 5000

Use the tag import facility in RSLogix 5000 to import the file you saved. RSLogix 5000 must be offline when you import tags.

Before you import any tags, create the temporary array tag which is where the new control program writes while in moniotor mode. The tag name is the AN-X2-MOD-MON hostname, in this example AnxModMon, appended with TempOut, or AnxModMonTempOut. The first array index is the number of the highest connection needed to hold the data, but must be at least 1. The second array index is 250.

Therefore we must create the array AnxModMonTempOut[1,250]

Import the monitor alias tags.

When we switch the AN-X over to master mode, we will import the master alias tags so that the control program uses the master inputs and writes to the master outputs, not the temporary array tag.

Download the program and verify that you can use the alias tags to access the input, output and diagnostic data.

For the B804 module, there are two aliases

```
ALIAS,"","MOD_MONOUT_d01s4_Out","B804","","AnxModMon:0:I.Data[18]"
```

```
ALIAS,"","MOD_d01s4_Out","16-OUT B804","","AnxModMonTempOut[0,18]"
```

The first alias points to the monitored output data from the Modicon master, in ControlLogix input data. The second alias points to a ControlLogix array tag, AnxModMonTempOut, which is where the new control program writes.

The name MOD_d01s4_Out points to the array tag in the monitor. You write your control program using this name. When you import the master alias tags and overwrite the monitor tags, the name now points to the real Modicon output instead of the array tag.

Step 7: Monitor the existing control system in the ControlLogix

Monitor the running process and confirm that you can observe all the I/O data, both inputs and outputs, using the imported tags.

TIP: Always remember that 800 series drops send their inputs only when the inputs change. You can force the 800 series adapters to update all inputs if you stop and start the existing Modicon controller.

Step 8: Create the new control program

Create the ladder logic to read the inputs and control the outputs and write the output values to the array tag in the ControlLogix, using the imported monitored tags.

Step 9: Compare the new system with the old

Both the old and new systems receive the same inputs.

Compare the outputs from the new system with the outputs from the old.

There will be slight variations in timing due to differences in processor scan time, I/O scan time, rounding and truncation in analog values, and so on, which you will have to account for in the comparison.

For discrete I/O, you can use timers or counters to measure the time that the outputs from the old and new systems differ and confirm that the differences remain small.

For analog I/O, confirm that the difference between the new and old values remains within whatever limit you choose to be acceptable.

TIP: HMI's, SCADA etc can run with the new controller with live data while in monitor mode.

Step 10: Change the AN-X from monitor to master

If you are using the same AN-X hardware for the master as you used to monitor the old system:

- disconnect the Modicon master and ensure the network is properly terminated
- change the IP address of the AN-X

- change the AN-X hostname to AnxModMas
- select the master firmware in the AN-X web interface
- autoconfigure the master
- manually download the remote I/O configuration from the monitor. This step ensures that any parameter data the Modicon controller was sending to remote drops is duplicated by the AN-X2-MOD-MAS
- import the master alias tags into RSLogix 5000 so that the ControlLogix obtains its inputs from the master inputs, not from the monitored inputs, and writes to the real outputs, not the array tag. There will be warnings as the master alias tags overwrite the monitor alias tags that refer to the ControlLogix array tag.

For example, for the B804 module, in the monitor there are two aliases

```
ALIAS,"","MOD_MONOUT_d01s4_Out","B804","","AnxModMon:0:I.Data[18]"
```

```
ALIAS,"","MOD_d01s4_Out","16-OUT B804","","AnxModMonTempOut[0,18]"
```

The first alias points to the monitored output data from the Modicon master, in ControlLogix input data. The second alias points to a ControlLogix array tag, AnxModMonTempOut, which is where the new control program writes.

The alias in the master is

```
ALIAS,"","MOD_d01s4_Out","B804","","AnxModMas:0:O.Data[1]"
```

In the monitor, the name MOD_d01s4_Out points to the array tag. You write your control program using this name. When you import the master alias tags and overwrite the monitor alias tags, the name now points to the real Modicon output instead of the array tag.

Step 11: Switch over

When you're convinced that the new system duplicates the functionality and timing of the existing system, you can switch over.

If you've missed something and run into problems, you can easily change back to the old system, since the I/O and field wiring are unchanged.

Over time, you can replace the Modicon I/O a bit at a time.

The advantages of this approach…

- the new system is tested before you install it
- it results in minimum downtime and lost production. Install the new system during scheduled shutdowns.
- I/O and field wiring are unchanged so you can easily back out of the change until the new control program is working correctly
- HMI's SCADA and other data collection can be run with live data from the new controller with no risk while the AN-X is in monitor mode.

Some troubleshooting tips…

Use the diagnostic counters to monitor network communication.

Monitor the Modicon diagnostics (drop errors, module status, module health bits, diagnostic counters) to check for problems with I/O modules and drops.

If you run into problems with I/O or ControlLogix connections, check the AN-X logs for detailed information on the likely cause.

References

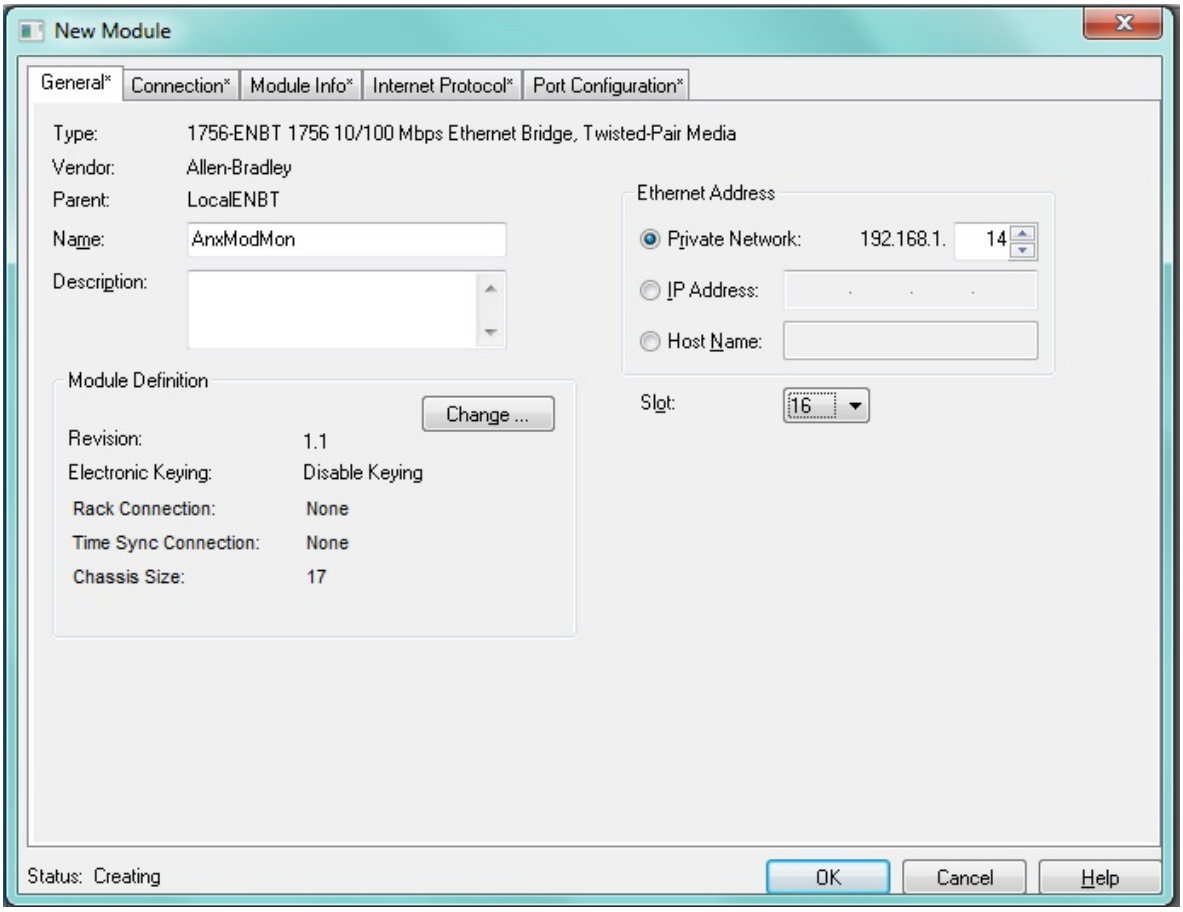
- AN-X2-MOD-MON User's Guide
- AN-X2-MOD-MAS User's Guide

Appendix: AN-X2-MOD-MON ControlLogix configuration

To configure the AN-X2-MOD-MON in RSLogix 5000:

Add the adapter

Add an ENBT/A to the Ethernet adapter in the ControlLogix rack. This will represent the AN-X. Give it the IP address you chosen for the monitor (in this example 192.168.1.14).



Set the name to match the AN-X hostname in the AN-X2 configuration, in this example, AnxModMon.

Set the *Comm format* to *None*.

Set the *Chassis Size* to 17 and the slot to 16.

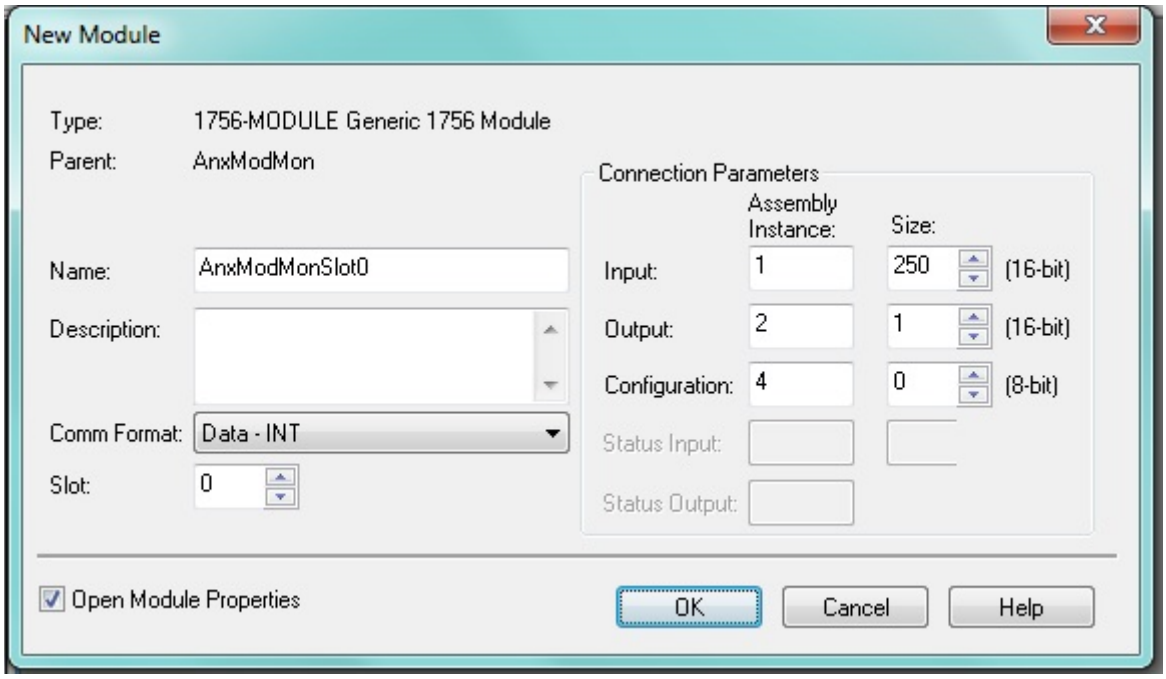
Set the *Electronic Keying* to *Disable Keying*.

Click *Finish>>*

Add generic modules to represent slots

Right click on the ENBT you just added and add as many generic modules as required by the remote I/O configuration. In this example, we'll add a generic module in slot 0 for the I/O data and a generic module in slot 15 for the diagnostics.

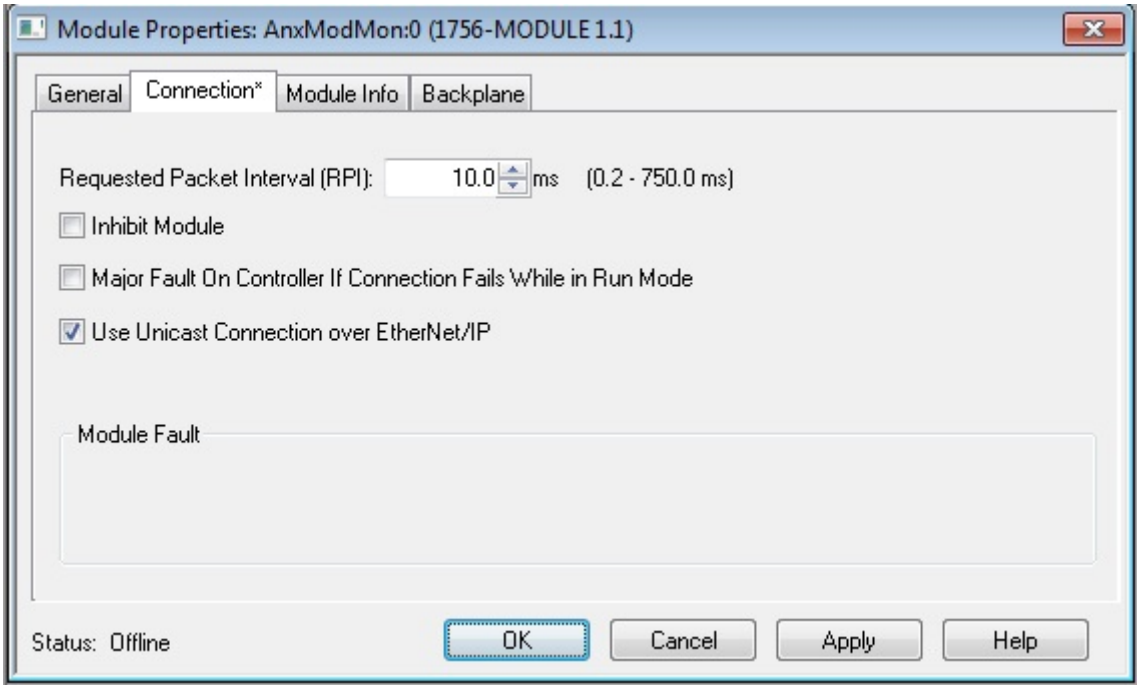
Right click on the ENBT you just added and select *Add Module*. From the list, select a module of type *1756-MODULE, Generic 1756 Module*.



Set the parameters as shown. Even though there's no output data, we have to set the Output Size to 1 since RSLogix 5000 won't accept a size of 0.

Click *Next* >

Set the RPI for the connection and click *Finish* >>



Repeat these steps for slot 15. The only differences will be that the slot number will be 15 instead of 0 and the RPI can be much longer (for example, 500 ms) for the diagnostic connection.