AN-X Technical Note

Controller Redundancy with the AN-X-MOD-MAS

This technical note describes how to implement controller redundancy with the AN-X-MOD-MAS. This is "soft" redundancy since it depends on logic in the ControlLogix processors to switch.

Introduction

Version 2.2.1 and above of the firmware for the AN-X-MOD-MAS includes features to make it easy to enable and disable AN-X I/O scanners.

One ControlLogix and AN-X is designated the primary and acts as the scanner; the other is designated the secondary and acts as a backup.

Each ControlLogix processor maintains scheduled connections to one AN-X module. The ControlLogix processors communicate with each other by means of scheduled data (over ControlNet, Ethernet or over the backplane) or by means of MSG instructions over some other network. If the primary ControlLogix decides there is a problem, it takes its AN-X offline and signals the backup to take over.

The backup AN-X constantly monitors the S908 network. When it becomes the primary, it has the current state of inputs, drop status, etc. Each ControlLogix processor has access to current I/O data from the S908 network.

The backup AN-X listens to the S908 network when it is told to go online as a scanner. It waits for 10 ms of silence on the network before it takes over. It does not start scanning if it hears another master already online.

There have been changes and additions to the ControlLogix configuration file to support redundancy. No changes are required to the S908 I/O Configuration file.

The firmware is backwards compatible. Existing applications do not need to be modified.

Requirements

- 2 AN-X-MOD-MAS modules
- firmware version 2.2.1 or above

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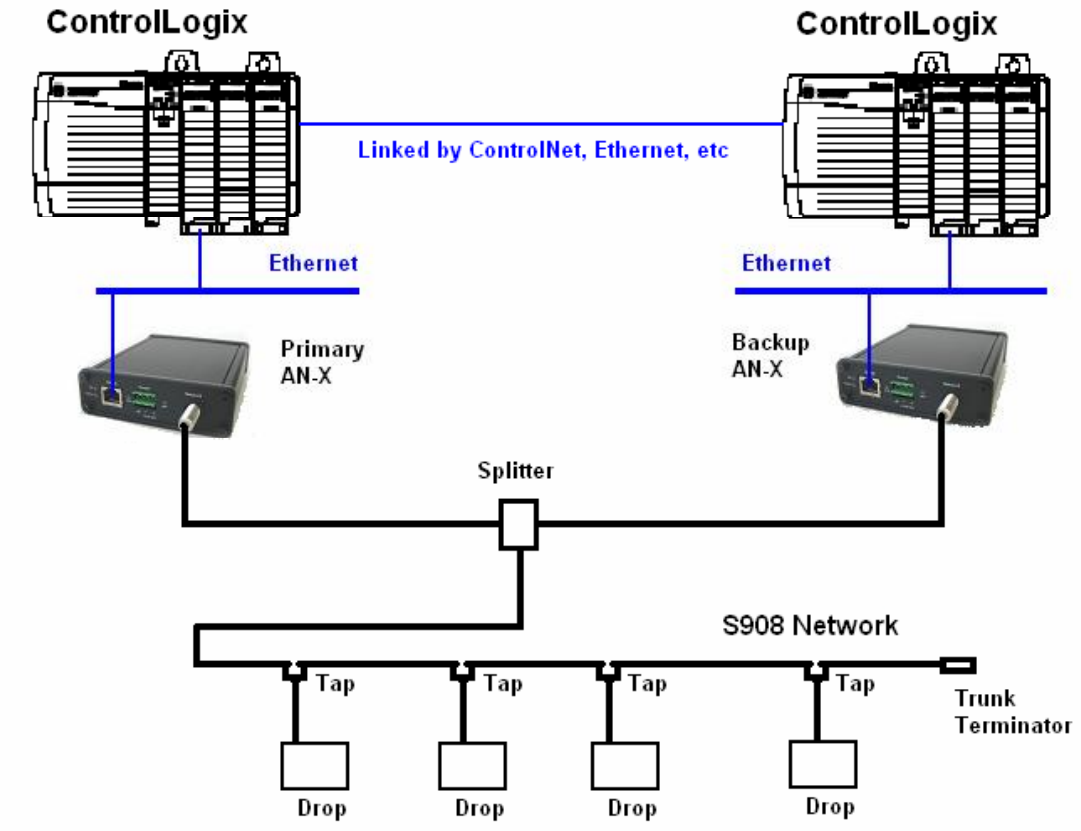
Cabling

Using the Modicon Redundancy Terminator Kit

You can use the Modicon Redundancy Terminator Kit to connect to the S908 network.

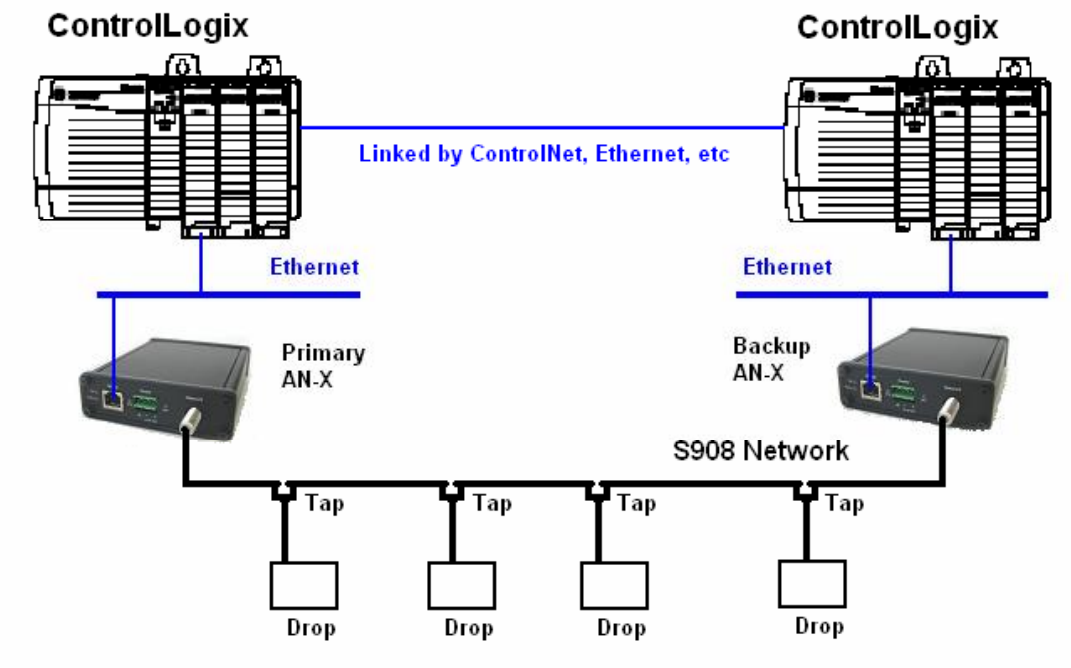
The AN-X module has built-in termination. Do not use the inline terminators in the cable from the AN-X module to the splitter from the kit.

Do not disconnect either AN-X module from the splitter since that also removes the termination.



Without the Redundancy Terminator Kit

The AN-X modules should be located at the physical ends of the network trunk. The AN-X modules have built-in termination so no additional termination is required on the network trunk.



ControlLogix Ethernet Configuration File

There have been changes and additions to the ControlLogix configuration file to support redundancy.

Parameter	Description
RedundEna, RedundPrefix	New parameter RedundEna Must be included at the beginning of the ControlLogix configuration file RedundPrefix is used to create aliases for certain data
RedundCtl	New parameter, must be mapped to the output data for the connection to slot 0
ScanSts	New parameter, can be mapped to the input data for any connection
LongInput	New parameter Forces 800 series drops to send inputs on every scan

RedundEna

Include a line with the RedundEna parameter, followed by a comma and a unique name for the AN-X at the start of the ControlLogix configuration file.

The AN-X uses the RedundPrefix when it generates aliases for elements that are unique to each AN-X module, such as diagnostics.

RedundCtl

Map RedundCtl to the output data for the connection to slot 0 in the AN-X.

RedundCtl consists of a single 16-bit word. Only bit 0 is used. To set an AN-X to act as the scanner, set bit 0 to 1. To set an AN-X to act as a backup, set bit 0 to 0.

If the configuration file contains RedundEna, you must map RedundCtl.

ScanSts

ScanSts is an array of 5 INTs that contain information about the current operation. Only the first 3 are used.

Offset	Description
0	Scan state, 0=idle, 1=monitor, 2=scanning, 3=scan halted
1	Scan counter, increments at the start of each scan
2	Init counter, increments whenever a drop is reinitialized
3	not used
4	not used

Map ScanSts to input data for any connection.

By default, when you perform an autoconfiguration, AN-X maps ScanSts to the connection to slot 15, but comments out the mapping.

LongInput

Most 800 series drops send inputs only when the inputs change. You can force 800 series drops to send inputs on every scan by including the LongInput parameter in the ControlLogix configuration file. That way, when you switch between AN-X modules, you can be sure that the backup has the latest inputs.

ClxName

The ClxName is used in the address part of the aliases for elements that are unique for each AN-X, such as diagnostics. It is usually set equal to the Ethernet host name.

Aliases

The AN-X-MOD-MAS creates aliases that can be imported into RSLogix 5000.

Criteria for Switching between AN-X Modules

The ControlLogix processor maintains connections to both AN-X modules. It can monitor data on both AN-X modules and can switch between them based on:

- diagnostic counters
- drop error table
- module health bits

Procedure

Configuration

1. Connect both AN-X modules to the S908 network
2. Autoconfigure the primary AN-X module. Create both remote I/O and ControlLogix configuration files.
3. Upload the ControlLogix configuration to the computer and edit it.
4. Uncomment the RedundEna line and add a prefix that uniquely identifies the AN-X.
    - Uncomment the RedundEna line and add a prefix that uniquely identifies the AN-X.
    - Map RedundCtl to connection 0. The autoconfiguration maps it to outputs to the connection to slot 0 but comments it out.
    - Map RedundSts to the inputs for any connection. The autoconfiguration maps it to outputs to the connection to slot 15 but comments it out.
    - Include the LongInput option.
5. Save the modified file and upload it to the primary AN-X.
6. Autoconfigure the secondary (backup) AN-X module. Create both remote I/O and ControlLogix configuration files.

7. Upload the ControlLogix configuration to the computer and edit it.
   - Uncomment the RedundEna line and add a prefix that uniquely identifies the AN-X.
   - Map RedundCtl to connection 0. The autoconfiguration maps it to outputs to the connsection to slot 0 but comments it out.
   - Map RedundSts to the inputs for any connection. The autoconfiguration maps it to outputs to the connsection to slot 15 but comments it out.
   - Include the LongInput option.
8. Save the modified file and upload it to the secondary (backup) AN-X.
9. Upload the alias files from each AN-X and save them. Import them into RSLogix 5000.

Create the ControlLogix applications

1. Add logic to set the AN-X as scanner or as backup
2. Add logic to disable the scanner and signal the backup to take over

Switchover

To switch between AN-X modules:

1. Set RedundCtl on the backup AN-X to 1. The backup AN-X will not go online while it ses the primary AN-X as master on the network.
2. Set RedundCtl on the primary AN-X to 0. The backup AN-X will now become master on the S908 network.

When you turn on the RedundCtl bit for an AN-X-MOD-MAS module, it waits for 10 ms of silence on the network before it starts scanning as master.

WARNING!!! If the RedundCtl bits on both AN-X modules are on, only one will act as master. However, if the bits are set on both AN-X modules and the current master is disconnected from the S908 network, even for a very short period, the backup will take over. When the module that was disconnected comes online, both modules will be master on the S908 network. YOUR APPLICATION MUST ENSURE THAT THE RedundCtl BITS ARE BOTH ON ONLY DURING SWITCHOVER!

Other factors to consider…

Do not use the ScanModProg parameter if you are using redundancy.

Do not set the RedundCtl bits on both primary and backup AN-X modules at the same time, except during switchover.

When you modify the ControlLogix configuration file and add elements, the mapped data may become larger than the maximum for a connection, especially for large I/O networks or for networks with many analog modules. It may be necessary to change some of the mappings. Also, when you add elements, the offsets in the comments generated by the autoconfiguration will no longer be correct.

Make sure the mappings in the ControlLogix configurations in both AN-X modules are the same. Each AN-X module cannot check the configuration in the other AN-X module.

LEDs

When the AN-X-MOD-MAS is used in redundant mode, the network LED is green when scanning, orange when monitoring and red when there has been an error or during switchover.

Sample Application

In this example, the S908 network consists of two drops: drop 4 is a Quantum drop; drop 5 is an 800 series drop.

Remote I/O Configuration files

The S908 remote I/O configuration files must be the same for both AN-X modules

```
Drop=4,
,Rack=1,
,,Slot=1,Type=CPS_114_xx,;Addr=d4s1,Inp=00,Out=00,AC PS 115/230V 10A
,,Slot=2,Type=CRA_93x_00,;Addr=d4s2,Inp=00,Out=00,RIO DROP S908
,,Slot=3,Type=DDI_353_00,;Addr=d4s3,Inp=04,Out=00,DC IN 24V 4x8
,,Slot=4,Type=DDO_353_00,;Addr=d4s4,Inp=00,Out=04,DC OUT 24V 4x8
,,,,CfgLen=2,0x0000,0x0000
,,Slot=5,Type=ACO_020_00,;Addr=d4s5,Inp=00,Out=08,AN OUT 4CH CURR
,,,,CfgLen=6,0x8001,0x5555,0x0000,0x0000,0x0000,0x0000
,,Slot=6,Type=ACI_030_00,;Addr=d4s6,Inp=18,Out=00,AN IN 8CH UNIPOLAR
,,,,CfgLen=1,0x0001
EndDrop

Drop=5,
,Rack=1,
,,Slot=2,Type=B810,;Addr=d5s2,Inp=00,Out=01,8-OUT ISO B810
,,Slot=3,Type=B863,;Addr=d5s3,Inp=08,Out=00,REG 4 CH IN B863
,,Slot=4,Type=B804,;Addr=d5s4,Inp=00,Out=02,16-OUT B804
EndDrop
```

ControlLogix Configuration Files

The mappings in the files must be the same. Usually both ControlLogix processors will be running identical control programs.

Primary AN-X

```
RedundEna,MODA  ; Enable Redundant configuration and specify Redund Prefix
LongInput       ; Force drops to send all inputs on every scan
ClxName,ANXA
ClxPrefix,MOD
ClxSlot,0
```

```
DataOutput ; ,<ClxBaseTag> Outputs from ControlLogix
,RedundCtl  ; Redundancy Control
,d4s4,d04s4_Out,; DDO_353_00 DC OUT 24V 4x8
,d4s6,d04s6_Out,; ACO_020_00 AN OUT 4CH CURR
,d5s2,d05s2_Out,; B810 8-OUT ISO B810
,d5s3,d05s3_Out,; B804 16-OUT B804
DataInput ; ,<ClxBaseTag> Inputs to ControlLogix
,DropErr
,d4s3,d04s3_Inp,; DDI_353_00 DC IN 24V 4x8
,d4s5,d04s5_Inp,; ACI_030_00 AN IN 8CH UNIPOLAR
,d5s4,d05s4_Inp,; B863 REG 4 CH IN B863
;The following lines map Diagnostics into ClxSlot 15
ClxSlot,15
DataInput ; ,<ClxBaseTag> Inputs to ControlLogix
,DiagCtrs, ;
,ScanSts  ; S908 Scan Status
,d4ModHlth,;
,d5ModHlth,;
;Module Status Byte for Quantum Only
,d4ModSts, ;
;ControlLogix Connection Statistics
,ConnStats0, ;
```

Secondary (Backup) AN-X

```
RedundEna,MODB  ; Enable Redundant configuration and specify Redund Prefix
LongInput       ; Force drops to send all inputs on every scan
ClxName,ANXB
ClxPrefix,MOD
ClxSlot,0
DataOutput ; Outputs from ControlLogix
,RedundCtl  ; Redundancy Control
,d4s4,d04s4_Out,; DDO_353_00 DC OUT 24V 4x8
,d4s6,d04s6_Out,; ACO_020_00 AN OUT 4CH CURR
,d5s2,d05s2_Out,; B810 8-OUT ISO B810
,d5s3,d05s3_Out,; B804 16-OUT B804
ataInput ; Inputs to ControlLogix
,DropErr
,d4s3,d04s3_Inp,; DDI_353_00 DC IN 24V 4x8
,d4s5,d04s5_Inp,; ACI_030_00 AN IN 8CH UNIPOLAR
,d5s4,d05s4_Inp,; B863 REG 4 CH IN B863
;The following lines map Diagnostics into ClxSlot 15
```

```
ClxSlot,15
DataInput ; <ClxBaseTag> Inputs to ControlLogix
,DiagCtrs, ;
,ScanSts  ; S908 Scan Status
,d4ModHlth,;
,d5ModHlth,;
;Module Status Byte for Quantum Only
,d4ModSts, ;
;ControlLogix Connection Statistics
,ConnStats0, ;
```

Ladder Logic

A sample ladder logic application is appended.

The scanner uses scheduled data between ControlLogix processors to signal the backup to take over. The backup acknowledges the transfer of control, again using scheduled data.

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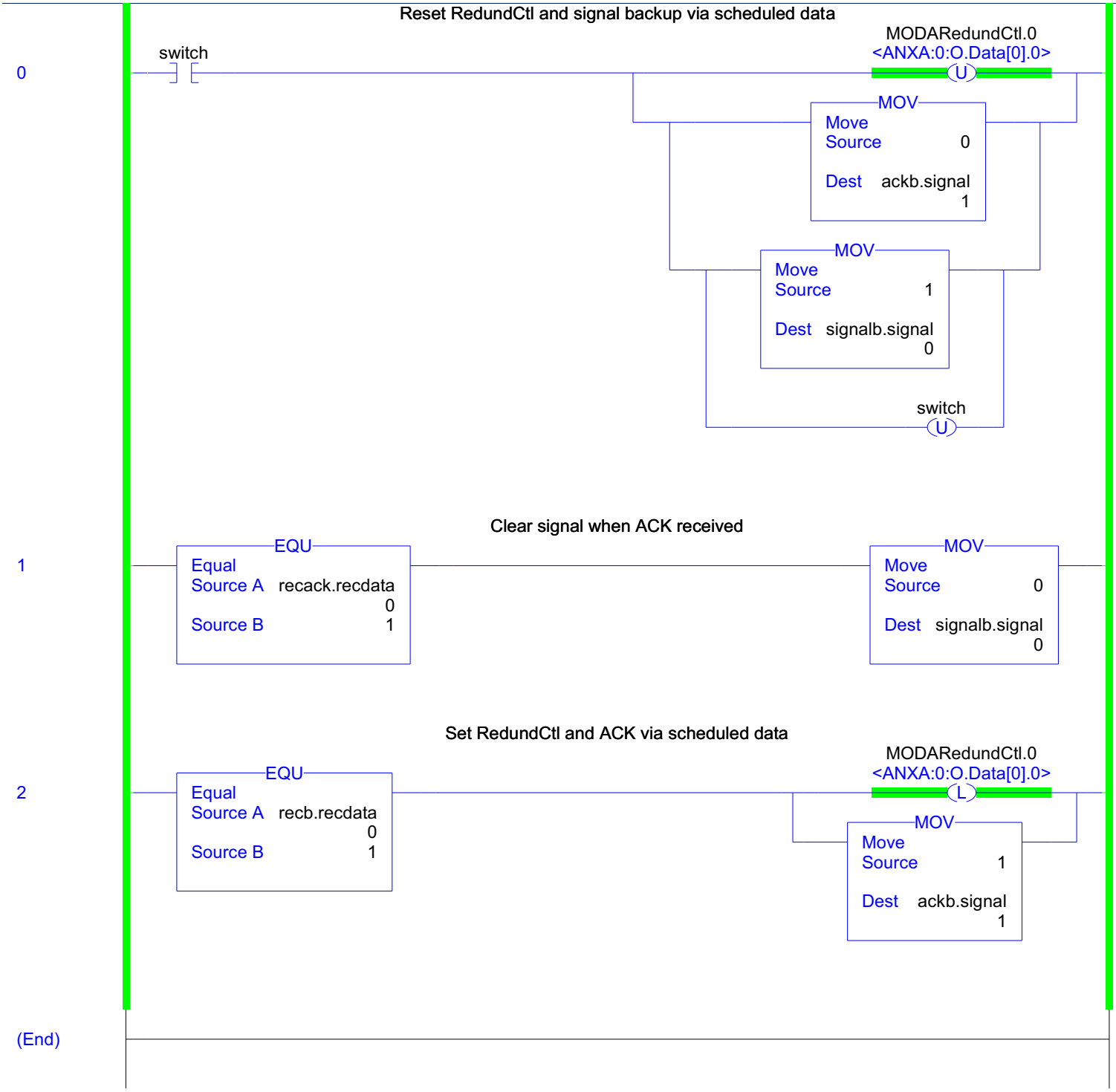
Reset RedundCtl and signal backup via scheduled data
0
switch
MODARedundCtl.0
<ANXA:0:O.Data[0].0>
U
MOV
Move
Source 0
Dest ackb.signal
1
MOV
Move
Source 1
Dest signalb.signal
0
switch
U
Clear signal when ACK received
1
EQU
Equal
Source A recack.recdata
0
Source B 1
MOV
Move
Source 0
Dest signalb.signal
0
Set RedundCtl and ACK via scheduled data
2
EQU
Equal
Source A recb.recdata
0
Source B 1
MODARedundCtl.0
<ANXA:0:O.Data[0].0>
L
MOV
Move
Source 1
Dest ackb.signal
1
(End)

Tag Name	Type	Description
⊞-ANXA:0:C	AB:1756_MODULE:C:0	
⊞-ANXA:0:I	AB:1756_MODULE_INT_500Bytes:I:0	
⊞-ANXA:0:O	AB:1756_MODULE_INT_496Bytes:O:0	
⊞-ANXA:15:C	AB:1756_MODULE:C:0	
⊞-ANXA:15:I	AB:1756_MODULE_INT_500Bytes:I:0	
⊞-ANXA:15:O	AB:1756_MODULE_INT_496Bytes:O:0	
switch	BOOL	
⊟-signalb	mysend	
⊞-signalb.signal	INT	
⊞-recb	myreceive	
⊞-ackb	mysend	
⊞-recack	myreceive	
⊞-MODARedundCtl	INT	
⊞-MODd04s4_Out_0	INT	DDO_353_00
⊞-MODd04s4_Out_1	INT	DDO_353_00
⊞-MODd04s6_Out_0	INT	ACO_020_00
⊞-MODd04s6_Out_1	INT	ACO_020_00
⊞-MODd04s6_Out_2	INT	ACO_020_00
⊞-MODd04s6_Out_3	INT	ACO_020_00
⊞-MODd05s2_Out	INT	B810
⊞-MODd05s3_Out	INT	B804
MODAd04_CommError	BOOL	
MODAd05_CommError	BOOL	
⊞-MODd04s3_Inp_0	INT	DDI_353_00
⊞-MODd04s3_Inp_1	INT	DDI_353_00
⊞-MODd04s5_Inp_0	INT	ACI_030_00
⊞-MODd04s5_Inp_1	INT	ACI_030_00
⊞-MODd04s5_Inp_2	INT	ACI_030_00
⊞-MODd04s5_Inp_3	INT	ACI_030_00
⊞-MODd04s5_Inp_4	INT	ACI_030_00
⊞-MODd04s5_Inp_5	INT	ACI_030_00
⊞-MODd04s5_Inp_6	INT	ACI_030_00
⊞-MODd04s5_Inp_7	INT	ACI_030_00
⊞-MODd04s5_Inp_8	INT	ACI_030_00
⊞-MODd05s4_Inp_0	INT	B863
⊞-MODd05s4_Inp_1	INT	B863
⊞-MODd05s4_Inp_2	INT	B863
⊞-MODd05s4_Inp_3	INT	B863
⊞-MODAScanSts	INT	
⊞-MODAScanCtr	INT	
⊞-MODAInitCtr	INT	
MODd04s1_Health	BOOL	CPS_114_xx
MODd04s2_Health	BOOL	CRA_93x_00
MODd04s3_Health	BOOL	DDI_353_00
MODd04s4_Health	BOOL	DDO_353_00
MODd04s5_Health	BOOL	ACI_030_00

Tag Name	Type	Description
MODd04s6_Health	BOOL	ACO_020_00
MODd05s2_Health	BOOL	B810
MODd05s3_Health	BOOL	B804
MODd05s4_Health	BOOL	B863
⊞-MODd04s2_1_StsBytes	INT	CRA_93x_00 / CPS_114_xx
⊞-MODd04s4_3_StsBytes	INT	DDO_353_00 / DDI_353_00
⊞-MODd04s6_5_StsBytes	INT	ACO_020_00 / ACI_030_00