Honeywell

Interpret I/O Link Communication

L5694
UCN

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Table of Contents

Figures and Tables

Acronyms

AI .... Analog Input
AO .... Analog Output
APM .... Advanced Process Manager
APMM .... Advanced Process Manager Module
DO .... Digital Output
EEPROM .... Electrically Erasable Programmable Read Only Memory
FIFO .... First In First Out
FTA .... Field Termination Assembly
HLAI .... High Level Analog Input
I/0 .... Input/Output
IOP .... Input Output Processor
LCN .... Local Control Network
PID .... Proportional plus Integral plus Derivative
PM .... Process Manager
PMM .... Process Manager Module
RAM .... Random Access Memory
ROM .... Read Only Memory
SOE .... Sequence of Events
UCN .... Universal Control Network

References

Publication Title	Publicatio n Number	Binder Title	Binder Number
For R5xx :			
Universal Control Network Guidelines	UN20-500	Installation/UCN	TPS 3041
HPM Implementation Guidelines	HP12-500	Implementation/HPM-1	TPS 3066-1
APM Implementation Guidelines	AP12-500	Implementation/APM-1	TPS 3042-1
PM Implementation Guidelines	PM12-500	Implementation/PM-1	TPS 3040-1
HPM Control Functions and Algorithms	HP09-500	Implementation/HPM	TPS 3066-1
APM Control Functions and Algorithms	AP09-500	Implementation/APM	TPS 3042-1
PM Control Functions and Algorithms	PM09-500	Implementation/PM	TPS 3040-1
For R4xx:			
UCN Guidelines	UN20-400	Installation/UCN	TPS 2041
APM Implementation Guidelines	AP12-400	Implementation/APM	TPS 2042-1
PM Implementation Guidelines	PM12-400	Implementation/PM	TPS 2040-1
APM Control Functions and Algorithms	AP09-400	Implementation/APM	TPS 2042-2
PM Control Functions and Algorithms	PM09-400	Implementation/PM	TPS 2040-2

Introduction

Module Overview

About this module	This course module describes I/O Link communication, with a particular focus on IOP redundancy. The course module is intended for engineers, system administrators, and technicians who want a better understanding of how the I/O Link communicates.
Prerequisites	Previous experience using UCN Status displays and familiarity with IOP types is required to complete this course module.
Objectives	Given an HPM, APM, or PM with redundant IOPs, interpret I/O Link communication concepts and redundant IOP operating characteristics.
Sample test items	This course module's Criterion Test includes the following items: • Describe briefly the role of the I/O Link Supervisor. • Given a redundant output IOP and a US with the node's Detail Status display, perform the following: – switch between a primary and secondary IOP, – identify the indications of bias, and – monitor any synchronization activity.

I/O Link Communication

Communication Overview

Introduction

This section first describes I/O Link communication concepts, which helps you understand some terminology (such as IOL Supervisor) and IOP display results (particularly redundant IOPs). With a better understanding of I/O Link concepts, you can more effectively manage and troubleshoot your system.

Another communication channel

Consider the I/O Link as a communication network that interfaces solely to the Process Manager. The I/O Link communication network uses a Honeywell proprietary protocol, transferring data at 375 kbits/second. The devices that reside on the I/O Link are of two types, master and slave. For example, an AO IOP is a slave device, while an I/O Link Interface is always a master.

Three functional levels

In addition to the two types of devices (master and slave), three levels of functionality exist in I/O Link devices

1. Supervisor—which oversees the flow of I/O Link traffic and monitors the health of the network,
2. Initiator—which initiates unsolicited transactions,
3. Responder—which responds to unsolicited transactions.

A slave device is always a responder; it does not initiate communication on the I/O Link. A master device can become an initiator or supervisor; a master device initiates communication on the I/O Link.

Cable communication overview

Cable communication has the following operating characteristics:

- Information is transmitted on both cables, but received on one.
- I/O Link devices listen on the best channel (ear).
- I/O Link devices automatically swap to the best cable, dependent on the device’s view of the I/O Link.
- Cables swap periodically every one minute to ensure both cables are OK. Devices automatically switch back to original cable if cable problems are found on swapped cable.
- Up to 40 IOP primaries, 40 IOP secondaries, and 2 I/O Link Interfaces can reside on an I/O Link (82 total).
- Originally introduced for local cabinet use, the I/O Link supports remote I/O through the use of fiber optic extenders.

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Overview of cable swap algorithm

Table 1 summarizes the overall cable error effects on periodic cable swapping. The total error count for a cable must be less than 10, otherwise periodic cable swapping is disabled.

Table 1 Periodic Cable Swap Disabling

	Error	Silence	Total Error Count
Cable A	Cable A errors	Cable A silence	must be < 10
Cable B	Cable B errors	Cable B silence	must be < 10

Token passing

While token passing occurs on the I/O Link, the IOPs do not accept or hold the token. In effect, the I/O Link Interface passes the token to itself. Although this sounds unusual, this does provides security for master devices, because if the master device cannot hear its own token, the device removes itself from the I/O Link.

I/O Link Access for Control Point Execution

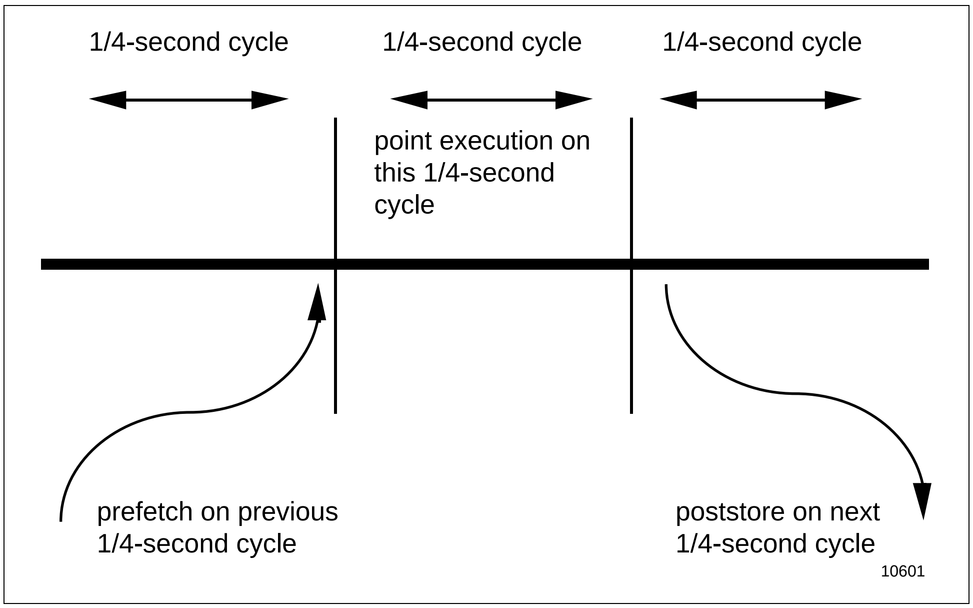
I/O Link access and control point execution

I/O Link parameters are prefetched and poststored; for example, during regulatory control point execution. In the example of a PID control point (refer Figure 1), the following occurs:

- Prefetch PV from the AI (APM and PM only)
- Process the PID control point
- Poststore the output to the AO.

In cases where digital input and digital outputs are used, no prefetch or poststore action is required before the point's execution cycle. Digital input and digital outputs are scanned separately every 1/4 second and cached in the Communication Processor. When a digital composite requires a digital input, the input is retrieved from cache (a demand I/O Link access is not required before point execution).

Figure 1 Prefetch and Poststore Cycles



I/O Link Operating Characteristics

I/O Link rules of operation

Several analogies sum up I/O operation characteristics:

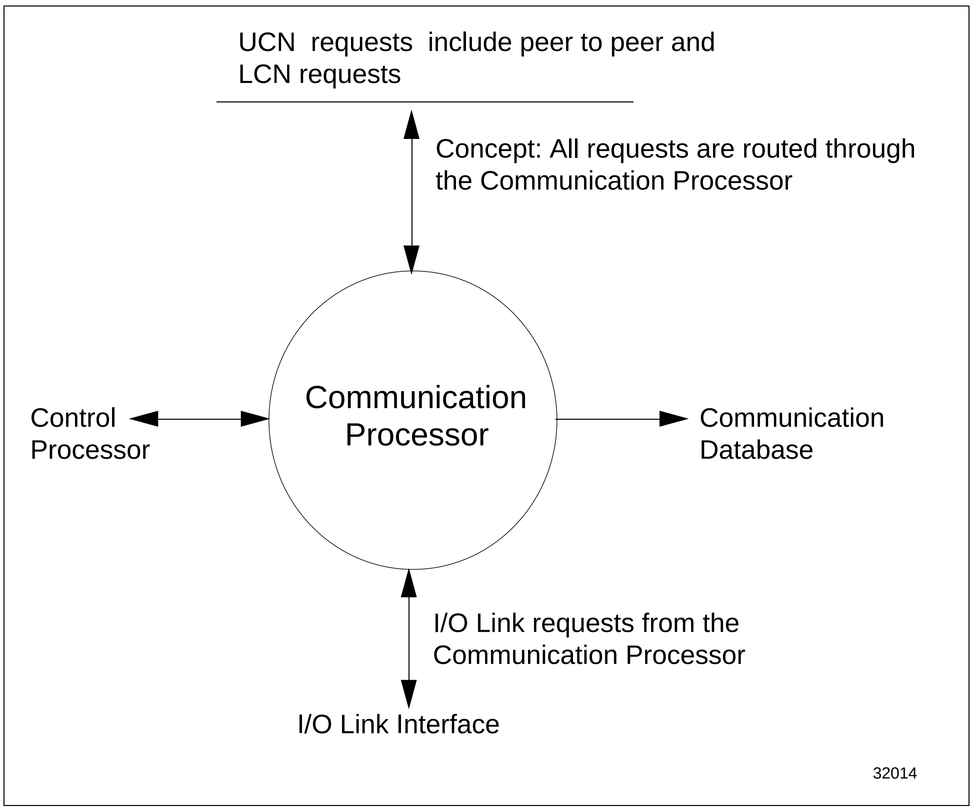
- "The Communication Processor works like a Post Office."
- "Once you are on the I/O Link train, you own it."
- "Anything in the box has higher priority that anything outside the box."

These analogies help explain I/O Link operating characteristics.

Post Office analogy

To understand I/O Link operating characteristics requires a brief review of the HPMM/APMM/PMM Communication Processor. The Communication Processor can be thought of as a Post Office, which routes requests to the proper destination. All UCN requests (for example, peer-to-peer and LCN requests) for parameters are routed through the Communication Processor. Additionally, a Control Processor request for an I/O Link parameter is also routed through the Communication Processor.

Figure 2 Communication Processor Routes Requests



Summary

In layman terms, "all roads go through the Communication Processor."

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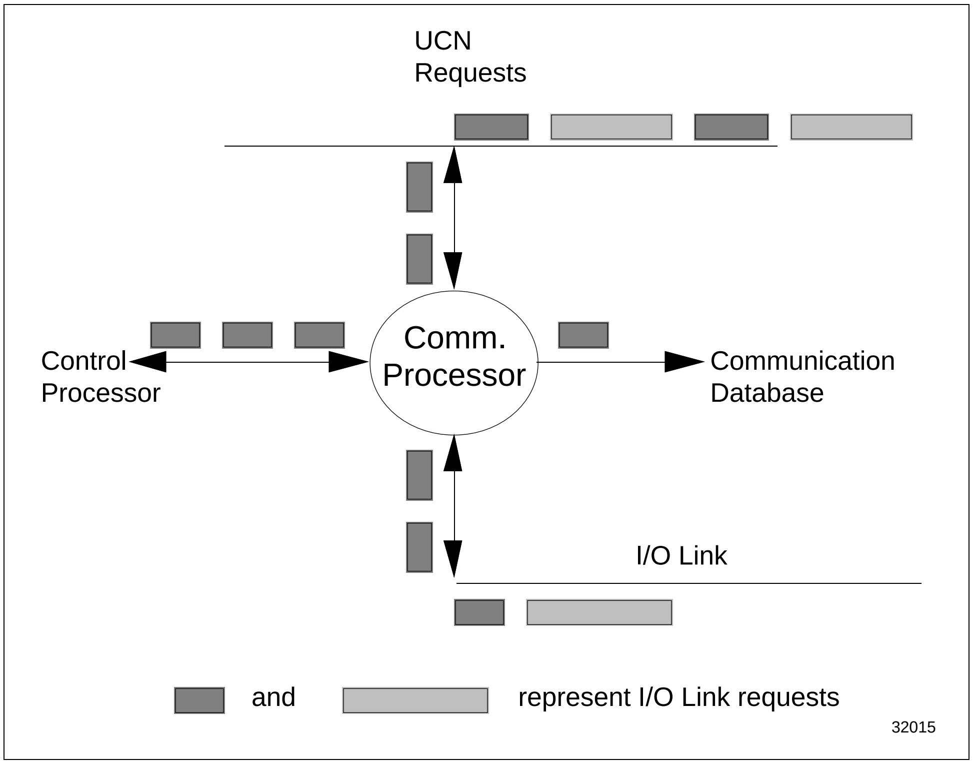
I/O Link train analogy

Most of the time, I/O Link access occurs without any problems, the Communication Processor routes requests to the I/O Link Interface; however, consider what can happen if an unusually heavy UCN request occurs. If a very large transaction gets on the I/O Link train, the transaction "owns the train." A large transaction means that other transactions are now held up. The Control Processor, for example, may be expecting data from the Communication Processor. If the Control Processor cannot get the data it was waiting for within a certain amount of time, the Control Processor reports an I/O Link overrun.

Figure 3 Transactions on I/O Link Analogy



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Box priorities

Requests from within the UCN node (Control to I/O, for example) have a higher priority than requests from outside the UCN node (LCN request, for example). If a request from inside the box and outside the box get to the Communication Processor at the same time, those within the box have priority.

Analogy summary

The analogies described earlier illustrate that when monitoring I/O Link overruns, the Communication Processor CPUFREE values are a good indication of whether it is keeping up with requests. The requests to the Communication Processor include I/O, control, and UCN requests.

I/O Link Supervisor

The I/O Link Supervisor is sometimes referred to in publications and some diagnostic codes, leading to the question “What is the I/O Link Supervisor?” The I/O Link Supervisor is an application task that runs in the Communication Processor. Every 5 seconds the task runs, scanning all IOPs on the I/O Link (even when the IOPs are in IDLE). Because the I/O Link Supervisor runs in the Communication Processor, you could say the “Communication Processor owns the I/O Link.”

Supervisor functions

The I/O Link Supervisor “supervises” I/O Link health, including checking whether

- IOPs are responding
- IOPs are OK
- configuration is correct (example: AI installed, but configured as DO)
- any new IOPs are added to the I/O Link
- correct redundant pairs installed
- FTA connections present
- databases synchronized in redundant IOP pairs

Additionally the I/O Link Supervisor commands a cable swap every one minute.

I/O Link Overruns

I/O Link overrun indication

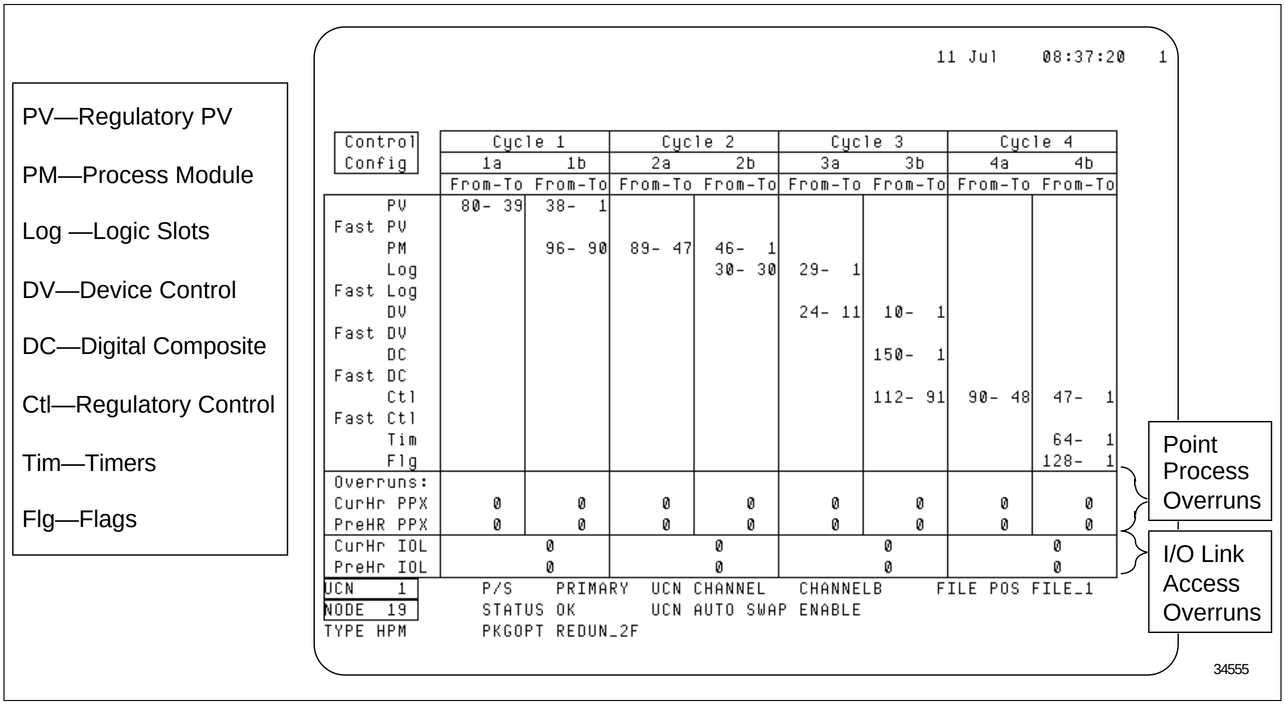
Two different I/O Link overrun indications may occur, depending on the conditions:

- an I/O Link overrun occurs, but no I/O Link overrun soft failure occurs.
- an I/O Link overrun occurs and an I/O Link overrun soft failure occurs.

Overrun and no soft failures

If I/O Link overruns are occurring (in the schedule display of Figure 4) with no soft failures reported, the cause is typically a transient load. Because of this, no troubleshooting action is required.

Figure 4 Schedule Fields



Overruns with soft failures

When soft failures occur (Figure 5), closer examination of possible causes is needed. Your troubleshooting technique should look at the amount of control the UCN node is performing. You can check the following:

- Is the Communication Processor loaded down, in the 5 to 10% range? If so, find out why the CPUFREE is low by checking
  - amount of peer-to-peer to I/O
  - amount of US requests to one UCN node
  - AM requests
- Writes are more expensive than reads to the I/O Link.

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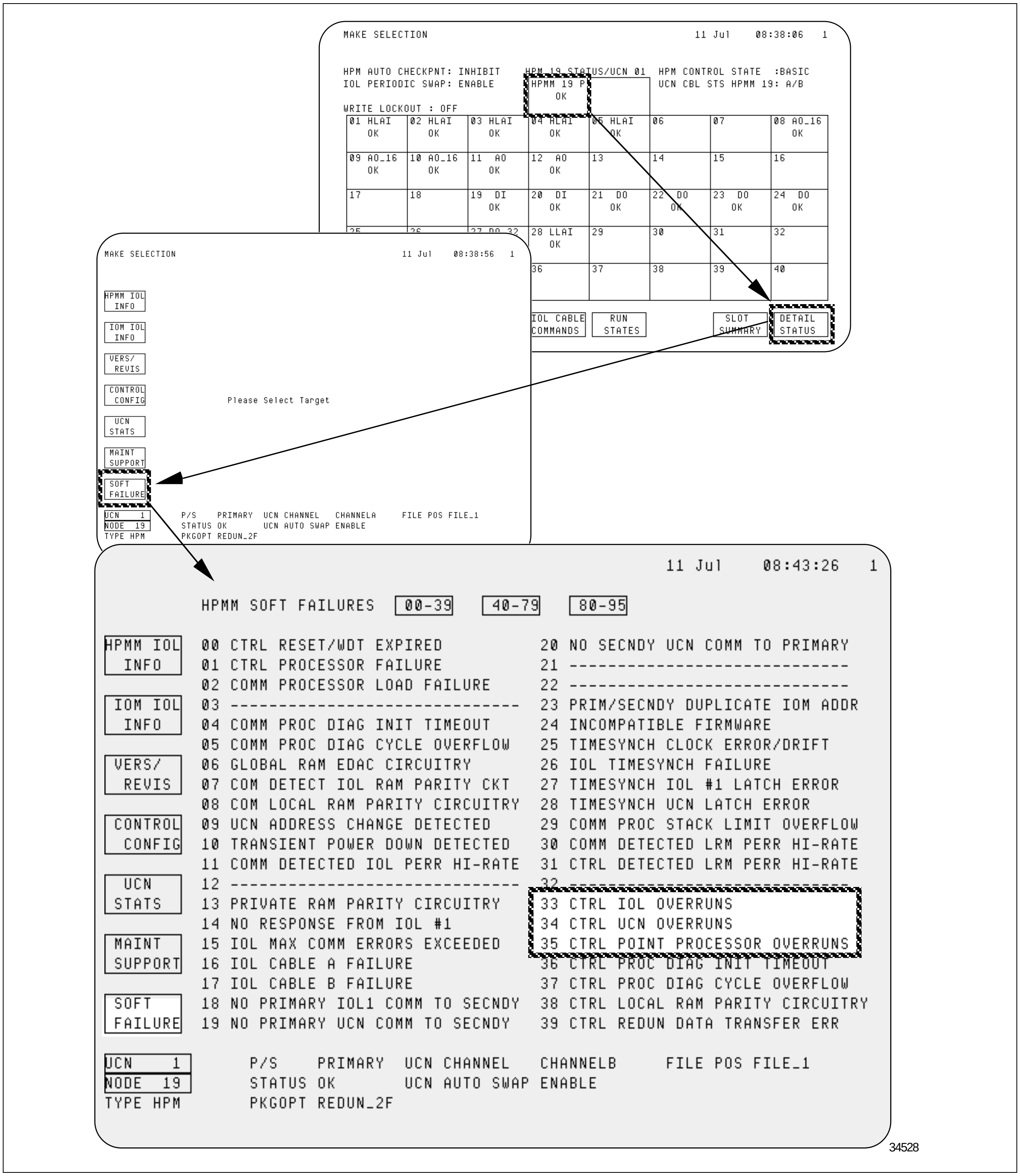
Locations

Figure 5 shows where the soft failure overrun indications are annunciated.

Figure 5 Overrun Symptoms Locations



HPM I/O Link Unit Calculation Sheet

Description

The amount of available I/O Link bandwidth for I/O scanning per second is divided into 1000 units called Link Units (LUs). A Link Unit is roughly equivalent to one read or one write parameter per second.

A Link Unit calculation form is provided for you to calculate the total number of Link Units consumed per second by HPM IOP scanning and by point processing that accesses the IOPs.

You could easily create a form for the PM and APM also. The only difference from the HPM is that you have to keep track of all the AI prefetches. Because of the HPM PV scanning enhancement, you don't have to keep track of AI prefetches for the HPM.

Guidelines

When completing the Link Unit Calculation Sheet, take the following rules into consideration:

- HPM AI, DO, and DI PV connections (including point status and alarms) are scanned and therefore are not counted in the point processing section of the sheet.
- IOP scan times are fixed at 1/4 second (except the LLMUX scan time is 1/2 second and the scan time for Serial Interface (SI) IOPs is configurable). AOs are not scanned.
- Digital Composite and Device Control Outputs change only when commanded. The resulting DO connection load can be estimated from the maximum number of commanded state changes per second.

ATTENTION

ATTENTION—To prevent I/O Link overruns, the total LUs consumed per second should not exceed 1000.

REFERENCE—Refer to the *HPM Control Functions and Algorithms* manual for more information on the LU Calculation Sheet.

Continued on next page

Link Unit calculation sheet

PV and Event Status Scan

I/O Module	# IOPs		LUs		
AO, AO16, SI	______	X	2	=	______
DI, DISOE, DI24V	______	X	9	=	______
DO, DO32	______	X	7	=	______
LLAI, PI	______	X	14	=	______
LLMUX	______	X	20	=	______
HLAI, SDI, STI	______	X	22	=	______
Each secondary IOP*	______	X	2	=	______
			Subtotal		______

Point Processing & SI Scan

Type	# Pts.		LUs		
CL prefetches	______	X	1	=	______
CL poststores	______	X	4	=	______
AO connections (.25s)	______	X	8	=	______
AO connections (.5s)	______	X	4	=	______
AO connections (1s)	______	X	2	=	______
DO connections (.25s)	______	X	4	=	______
DO connections (.5s)	______	X	2	=	______
DO connections (1s)	______	X	1	=	______
SI Array Point Scan (.25s)	______	X	16	=	______
SI Array Point Scan (.5s)	______	X	8	=	______
SI Array Point Scan (1s)	______	X	4	=	______
SI Array Element Write (.25s)	______	X	4	=	______
SI Array Element Write (.5s)	______	X	2	=	______
SI Array Element Write (1s)	______	X	1	=	______
			Subtotal		______

UCN Parameter Access

Type	# Pts.		LUs		
Read (.5s)	______	X	2	=	______
Read (1s)	______	X	1	=	______
Write (.25s)	______	X	16	=	______
Write (.5s)	______	X	8	=	______
Write (1s)	______	X	4	=	______
			Subtotal		______

Total	=		**LUs**
Max	=	1000	**LUs**

*Redundant IOP

Continued on next page

Link Unit calculation example

The example system uses the following hardware:

IOP Type	No. of IOPs
AI	6
AO (8 slot)	12
DI	5
DO (16 slot)	5
LLMUX	4
SI	2
Total IOPs	**36**

The example system has the following connection types and the number of connections given below.

Connection Type	No. of Connections
AO	80 @ 1 sec.
DO	30 @ 1 sec.
CL Writes/sec.	40
SI Array Scanning	35 arrays @ 1 sec.
SI Writes	15 per second
Peer-to-Peer Reads	50 per second
Peer-to-Peer Writes	30 per second

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Link Unit calculation example, continued

An example of a completed calculation sheet is shown below. This example shows the LU calculations for an acceptable system configuration.

PV and Event Status Scan

I/O Module	# IOPs		LUs		
AO, AO16, SI	14	X	2	=	28
DI, DISOE, DI24V	5	X	9	=	45
DO, DO32	5	X	7	=	35
LLAI, PI	0	X	14	=	0
LLMUX	4	X	20	=	80
HLAI, SDI, STI	6	X	22	=	132
Each secondary IOP*	0	X	2	=	0
			Subtotal		320

Point Processing & SI Scan

Type	# Pts.		LUs		
CL prefetches	0	X	1	=	0
CL poststores	40	X	4	=	160
AO connections (.25s)	0	X	8	=	0
AO connections (.5s)	0	X	4	=	0
AO connections (1s)	80	X	2	=	160
DO connections (.25s)	0	X	4	=	0
DO connections (.5s)	0	X	2	=	0
DO connections (1s)	30	X	1	=	30
SI Array Point Scan (.25s)	0	X	16	=	0
SI Array Point Scan (.5s)	0	X	8	=	0
SI Array Point Scan (1s)	35	X	4	=	140
SI Array Element Write (.25s)	0	X	4	=	0
SI Array Element Write (.5s)	0	X	2	=	0
SI Array Element Write (1s)	15	X	1	=	15
			Subtotal		505

UCN Parameter Access

Type	# Pts.		LUs		
Read (.5s)	0	X	2	=	0
Read (1s)	50	X	1	=	50
Write (.25s)	0	X	16	=	0
Write (.5s)	0	X	8	=	0
Write (1s)	30	X	4	=	120
			Subtotal		170

Total	=	995	**LUs**
Max	=	1000	**LUs**

*Redundant IOP

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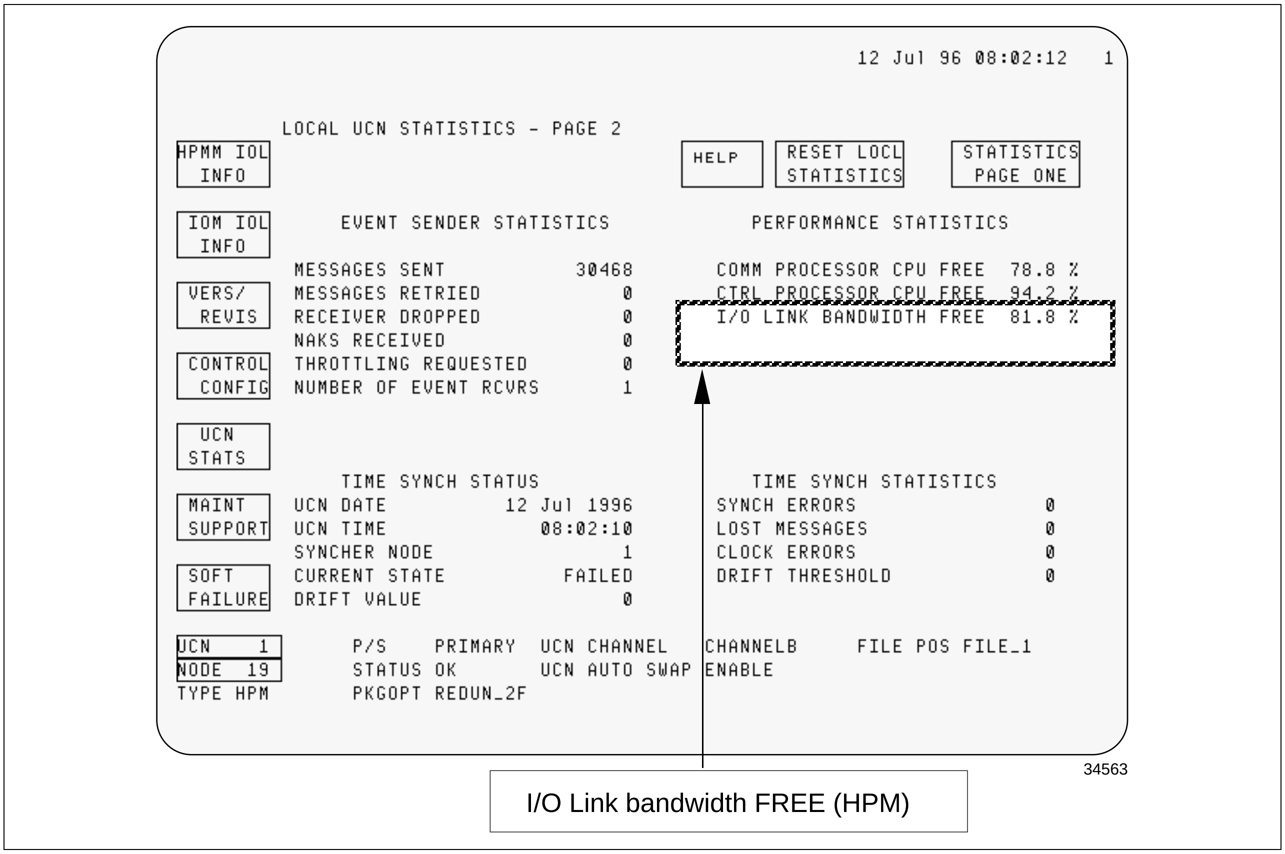
I/O Link bandwidth indication

For the HPM, an I/O Link metering mechanism monitors and reports the percentage of remaining I/O Link bandwidth.

Page 2 of the Local UCN Statistics display indicates the remaining I/O Link bandwidth.

Figure 6 Local UCN Statistics Display (NIM)



IOP Redundancy

IOP Redundancy Overview

Introduction

To meet customers' demands for ever more stringent guarantees of defect-free operations when using control equipment, IOP redundancy is provided as part of the HPM, APM, and PM design.

Design concept

IOP redundancy is summarized as follows:

- The IOP redundancy is one-on-one, which allows either the A or B IOP to be the acting primary
- Primary and redundant modules are identical.
- Primary and secondary IOPs can be located in any physical I/O slot
- Database support is provided in the following fashion
  - Databases of a redundant IOP pair are automatically synchronized following the introduction of the redundant IOP
  - Databases are kept in synch by an "eavesdropping " and verification process that the data reached both the primary and redundant IOP.
  - Synchronization of databases is periodically checked
- Failover support is provided in the following fashion
  - Circuits that perform failover are periodically checked.
  - Failover will result when a primary module can not communicate on the I/O link but the redundant can. If both primary and secondary IOPs fail to communicate on the IO Link, failover will not happen.
  - Failover does not interrupt data access nor does it cause loss of alarms
  - IOP failover is transparent to the operator's view of the process and control functions executing in the UCN node or AM. Communication on the I/O link are delayed less than 50 msec

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Introduction

When redundant IOPs are used, two concepts to become familiar with are

- Synchronization
- Bias

Synchronization explanation

Before a redundant IOP can perform its role as a backup, the redundant IOP must get a copy of the primary IOP's database. The process is called synchronization, and indications in the node Status display provide synchronization status. When a letter S appears in the display, the message means either

- Synchronization is taking place (a warning indicated by a yellow S.), or
- Synchronization has failed (an error indicated by a red S.)

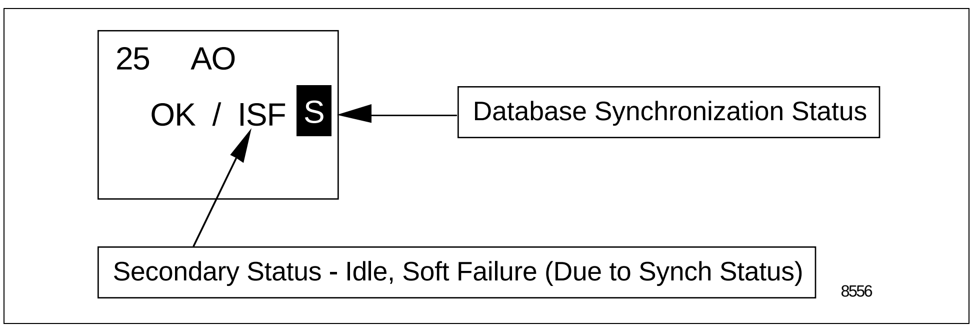
Synchronization warning

The yellow S, which indicates a warning, appears during a startup of the secondary IOP. The warning is a transitional state. During the time the yellow S appears, the HPMM, APMM, and PMM is directing the transfer of the primary's database to the secondary.

Synchronization failed

The red S, which indicates the database of the secondary is not the same as the primary's, means the secondary IOP is not able to provide backup to the primary IOP. The HPMM, APMM, and PMM was unable to talk to the secondary IOP, or failed in its attempt to synchronize the secondary. This state could occur because of a hardware failure or an I/O Link failure.

Figure 7 Synchronization Indications



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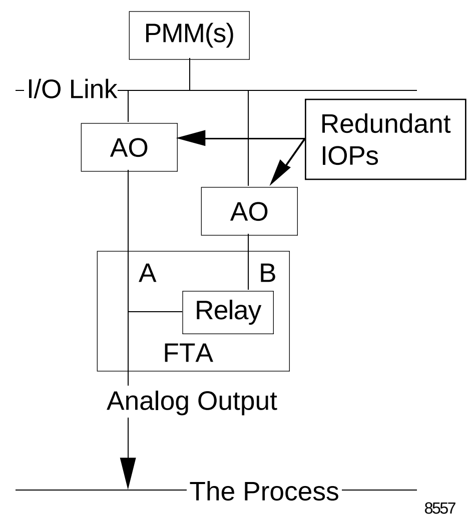
Bias explanation

When redundant analog output IOPs are used, one Analog Output IOP "gets to see the FTA screw terminals," while the other Analog Output IOP can only see them when a biased relay is energized. Figure 8 shows this relationship. The IOP module cabled to the A connector, because it can "see" the FTA screw terminals, is called the preferred primary and is unaffected by removal of the switching relay The IOP module cabled to the B connector is called the preferred secondary.

Figure 8 A and B IOP Cabling Summary



Bias indications

A letter B appears in the node Status displays indicating the biased relay is energized and the preferred primary (which is the IOP cabled to the A connector) is not controlling the process. The letter B means you are "operating against the bias." An easier way to remember what the letter B means is that you are operating on the "Backup" IOP connected to the B connector. Honeywell recommends operating on the preferred primary (cabled to A) after you have corrected any redundant IOP malfunction.

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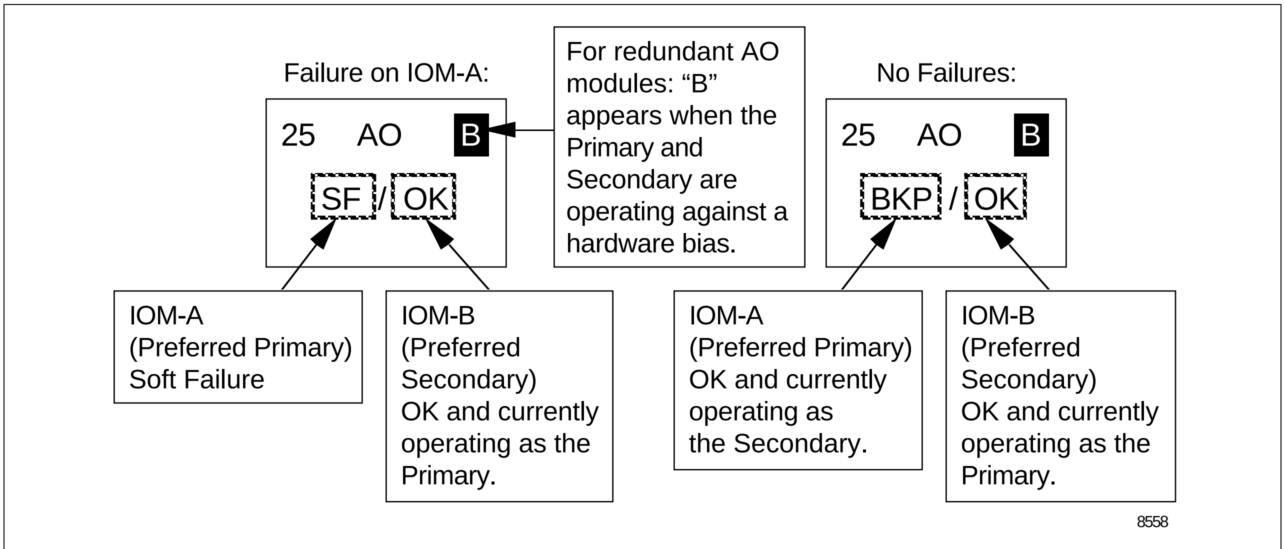
Bias display fields

Figure 9 shows where the bias indications are seen.

Figure 9 Bias Indications in Status Display



What's next

The discussion of the following pages provides more detail about how IOP redundancy works

IOP Theory of Operation

Background

I/O Processor Redundancy adds to the security and system availability by supporting an optional one-on-one redundant partner for each I/O module where redundancy is required. Redundancy is accomplished mainly through software. The addition of switching circuitry is added if the IOP requires it, as in analog output IOPs.

Parallel connections

The approach to I/O Redundancy is to parallel-connect inputs to input type IOPs and to switch IOP output drivers for output type IOPs. Each IOP of a redundant pair maintains a synchronized database and processes its signals in parallel. Field connections are wired to a single FTA and are then distributed by FTA cables to the appropriate IOP pair.

Failover automatic

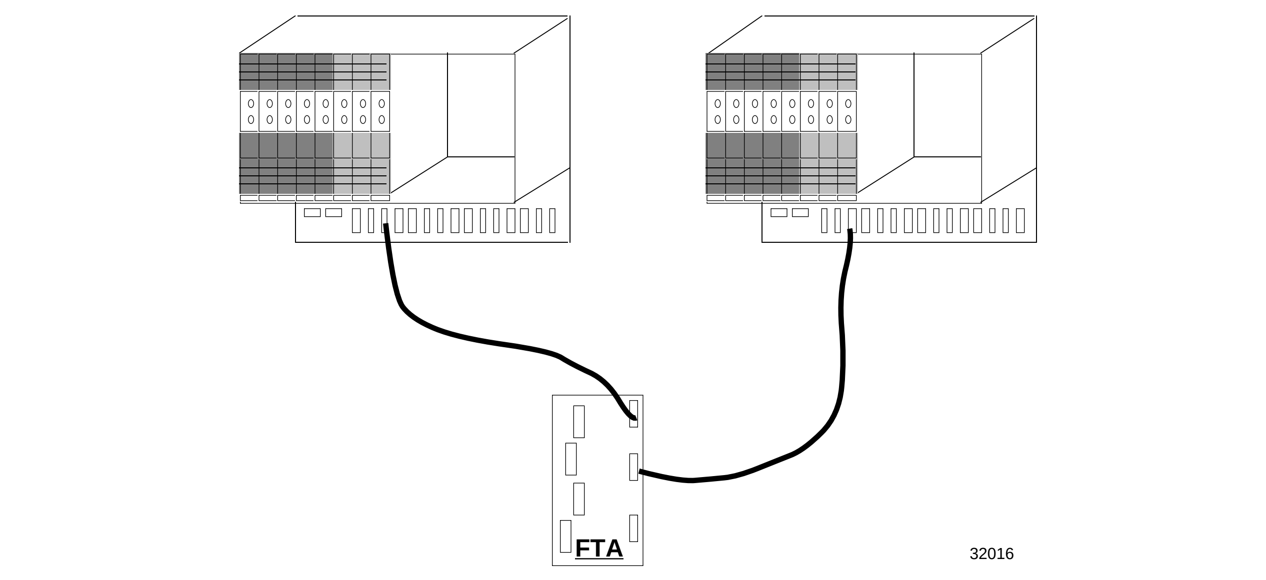
Failover happens automatically as a result of a detectable failure of the primary by the redundant partner or the HPMM, APMM, or PMM. The redundancy system is tested periodically on line without disturbing the process.

IOP Hardware Architecture

Introduction

A redundant I/O Subsystem (Figure 10) consists of two IOPs, a redundancy Field Termination Assembly (FTA) and two FTA cables. The primary IOP and its redundant partner are identical modules.

Figure 10 IOP Redundancy Connection



Common IOP Redundancy Functions

Background

There are three key operational concepts common to all modules:

1. initial synchronization,
2. on-line redundancy maintenance,
3. and failure detection and processing.

Eavesdropping

To obtain initial synchronization and on-line maintenance, a common method of eavesdropping is used.

Eavesdropping means that the Secondary module receives all writes initiated by a master (HPMM, APMM, or PMM) and directed to the Primary, and acts upon these writes in the same way as the Primary.

The eavesdropping process includes the following:

- The master node writes a parameter to the Primary module and receives an acknowledgment back from the Primary.
- The Secondary eavesdrops the write in the same sequence as the Primary receives it and enacts the same change to its database as the Primary.

Initial synchronization

Initial IOP synchronization is the process by which a redundant partner is added to an on-line system. Once the HPMM, APMM, or PMM knows that the configuration matches the hardware, it initiates the initial synchronization:

- Freezes the Primary's and Secondary's ability to process incoming write messages while permitting write messages to be queued for later processing. This freeze ensures that the database does not get modified as it is transferred.
- When the freeze is successful, it commands the primary to "dump" its database
- If all checks prove to be successful, it marks the IOP partners as a synchronized redundant pair.

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On-line redundancy maintenance

On-line redundancy maintenance is the process by which

- synchronization of the redundant pair is maintained and checked, and
- diagnostics are performed to prove the availability of each partner as well as any hardware used to support redundancy.

Data synchronization maintenance is provided with an eavesdrop scheme similar to that used in initial synchronization. The secondary eavesdrops all write messages to its primary IOP, and acts to update its database based on those writes.

The HPMM, APMM, or PMM sends write messages only to the primary; the secondary records the change requests directly.

Failover detection

IOP failover detection and processing occurs when a primary detects a failure or fails. Failover is directed jointly by the IOPs and the HPMM, APMM, or PMM:

- The secondary IOP constantly tests a signal called Backup Request (BUPREQ+) routed through the FTA from the primary that indicates the primary's health.
- If the secondary IOP is in synch and receives a backup request, it performs a failover initialization of its database and places a status available to the HPMM, APMM, or PMM.
- The HPMM, APMM, or PMM gives the logical address of the IOP pair to the secondary, making it the primary.

Analog Output IOP Redundancy

Description

Each AO IOP has eight analog output channels that normally send output current to control the valves. Each current is sent through a switching element on the FTA so that either the A IOP channels or the B IOP channels are to common, thus allowing only currents from one of the IOPs to reach the terminals.

When a fault is detected, the eight outputs from AO IOP A are shunted to common and the eight outputs from AO IOP B reach the field device.

Periodically a diagnostic is run to check the ability of the relay switches to operate.

How AO is switched

The AO relay is energized by the Primary IOP, turning off an open collector transistor connected to the Backup Request (BUPREQ+) line.

A hard failure (such as watch dog timeout) or a soft failure (such as output current out of calibration) can operate the open collector transistor under hardware or firmware control. For example, removing power or removing the Primary IOP from the system has the same effect as turning off the open collector transistor.

In a similar manner the Secondary IOP normally keeps its open collector transistor connected to its Backup Request (BUPREQ+) turned on. If the secondary IOP detects a fault, it turns its open collector transistor off, which inhibits the primary from transferring control to a faulty Secondary.

In addition, two status signals are generated by the redundant FTA. One is an output from the FTA that signals the health of the A IOP to the B IOP . The other is an output from the FTA that signals the health of the B IOP to the A IOP.

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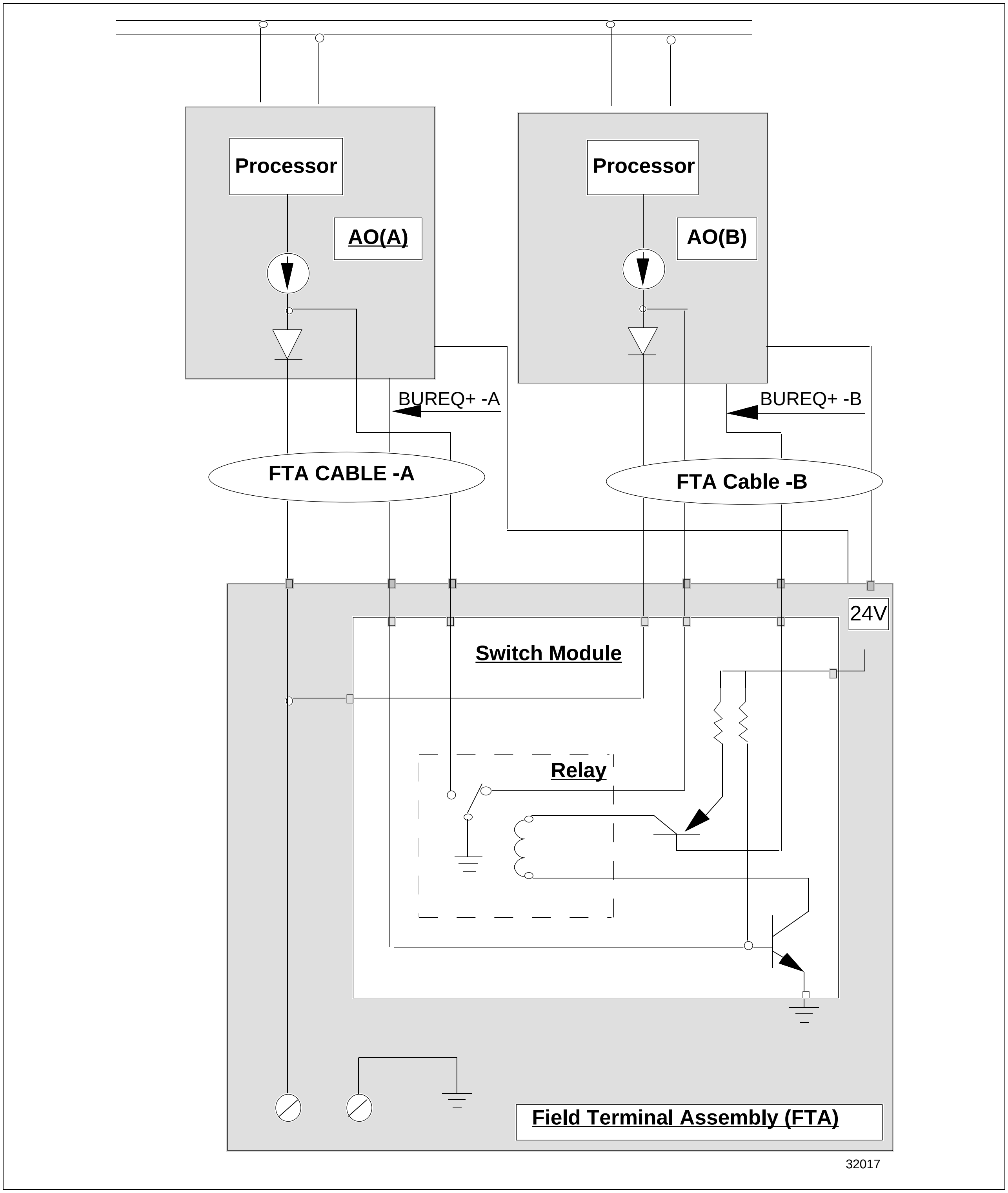
Analog Output IOP Redundancy, Continued

Figure 11 AO Redundancy



Analog Input IOP Redundancy

Introduction

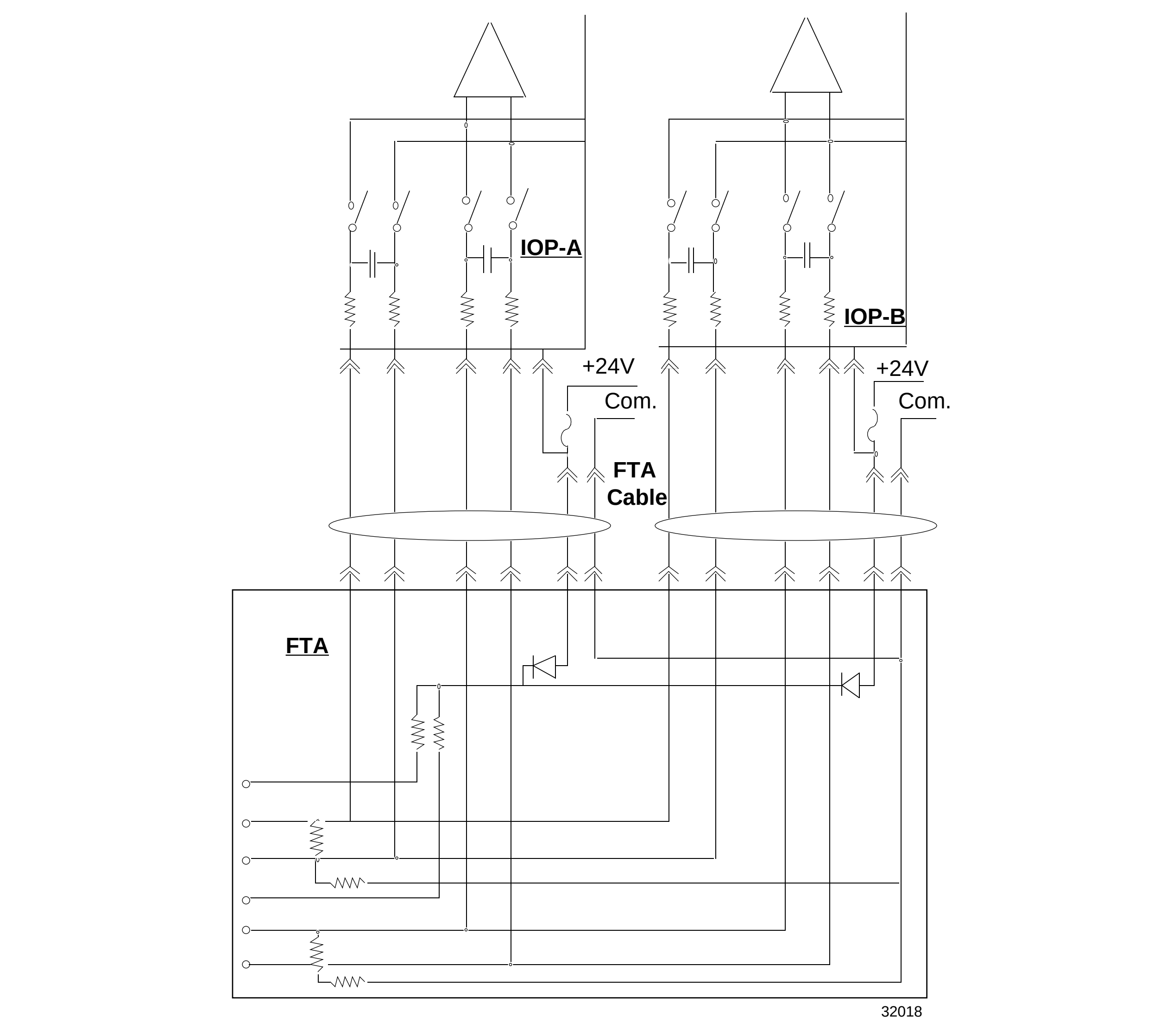
The High Level Analog Input (HLAI) I/O Redundancy System is composed of two HLAI IOPs and an HLAI redundancy FTA. Refer to Figure 11 for the following description.

Redundancy architecture

The HLAI uses parallel wiring of inputs. Sufficiently high value resistors are used in series with each input to limit fault propagation from the primary IOP to the secondary IOP.

Backup request and switch signals are routed through the FTA cables and the redundant FTA. The signals are used to signal each IOP of the health of its partner and to test cabling.

Figure 12 AI Redundancy



IOP Failover Causes

Causes

IOP failover from a primary to a secondary occurs only when a pair is synchronized and both IOPs are functional. There are four cases that can cause failover:

- IOP hard failure,
- IOP soft failure,
- IOP loss of FTA, and
- loss of communication on the IOL.

Hard failure

The most basic cause of IOP failover is if the a primary dies because of hard failure. Hard failure could be caused by

- a diagnostically detected fault, such as ROM or RAM failure,
- be a catastrophic fault such as microprocessor failure or address line fault.
- pulling a live primary or simply removing power from it.

A hard failure of a Primary IOP is sensed by the HPMM, APMM, or PMM through a no response on the IOL

Loss of FTA

An IOP that loses its FTA posts a soft failure and, if synchronized, requests backup. Loss of FTA is the highest priority soft failure; therefore, if the secondary has the FTA but also has a soft failure it is awarded primary relationship by the PMM.

A command to swap from an IOP with an FTA to one without an FTA is blocked by the PMM.

Loss of communication

If a Primary IOP loses IOL communications (dual cable fault or IOL-related hardware fault at primary), and the Secondary is able to communicate, failover occurs.

Continued on next page

Soft failure backup

HPMM, APMM, or PMM gives each IOP a set of soft failures that, upon occurrence, should cause a primary to enact failover.

Backup for soft failures works as follows,

- If a primary gets a soft failure and it has a partner that is synchronized, it requests backup.
- The HPMM, APMM, or PMM arbitrates which IOP is better, for each may have a soft failure.
- Once the primary relationship issue is resolved, the redundant partners automatically resynchronize, so that an IOP with a soft failure can still function as a backup in case the primary fails.

Soft failures causing backup

These soft failure conditions cause a synchronized primary to attempt failover to its secondary:

OUTPUT

- Output Failure
- Output Loopback Circuit Failure
- AO Output Buffer Failure
- AO/DO Write Enable Failure

INPUT

- Input Failure
- Multiple Input Failure
- PV Validation Diagnostic Failure
- SOE Clock Failure
- SOE Counter Failure

SECONDARY

- Other Processor Failed
- Bad Secondary Regulator
- Secondary Latch Register Failure

GENERAL

- FTA Missing
- On Board Reference Point Failure
- IOP Not Calibrated or EEPROM Error
- R210 IOP Used in a Redundant Pair
- Mailbox RAM Failure
- Private RAM Failure
- Hardware FIFO Failure
- Data Path Failure/Timeout

Directions

DIRECTIONS—This is the end of this module.

Use your course map to

- Get your course manager to sign off this module.
- Choose your next eligible module.

If you have a question

- Ask your course manager.