Logic Manager
Implementation Guidelines

LM12-500

Honeywell

Implementation
Logic Manager

Logic Manager Implementation Guidelines

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About This Publication

This publication summarizes the Logic Manager (LM) implementation process, guides you to procedures and references you need to implement LMs, describes LM operational considerations in implementing and using redundant LMs, and defines the UCN Node points and Node Specific points you must build for each LM.

This publication supports TDC 3000X software release 500.

Change bars are used to indicate paragraphs, tables, or illustrations containing changes that have been made to this manual effective with Release 500. Pages revised only to correct minor typographical errors contain no change bars.

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INTRODUCTION
Section 1

This introduction summarizes the Logic Manager implementation tasks, lists publications that you will refer to implement Logic Managers, and describes implementation dependencies.

1.1 SUMMARY OF LOGIC MANAGER IMPLEMENTATION TASKS

While most information in this publication relates to Logic Manager (LM) functions, LM data points, and LM operating considerations, other implementation activities must also be completed to make the LM functional. The Engineering Personality activities listed below may be affected by the implementation of an LM or must be used to implement an LM.

See subsection 1.2 for references to instructions for each of these activities.

Activities named in `THIS TYPEFACE` are activated by targets on the Engineering Personality Main Menu.

- `UNIT NAMES`—The process units defined for each LM data point are established in this activity.
- `AREA NAMES`—The area name and descriptor for any units with LM points that are assigned to an area are established in this activity.
- `LCN NODES`—All LCN nodes are defined in this activity, including the Network Interface Modules (NIMs) that provide the interface to the Universal Control Network(s) (UCNs) on which the LMs reside.
- `VOLUME CONFIGURATION`—The NIM checkpoint volume, &8np, and the CL/PM sequences and LM ladder logic volume, &9np, are established in this activity. Volume &8np must have adequate storage space to accommodate the LM checkpoint data plus space to accommodate all other devices on all of the Universal Control Networks (UCNs) in this system. Volume &9np must have adequate space to accommodate all ladder logic programs and all CL/PM sequences.
- `APPLICATION MODULE`—Any AM points that are members of a control strategy that includes LM points are built in this activity. Connections to the LM points are defined in `tagname.parameter` form.
- `NETWORK INTERFACE MODULE`—The UCN point which defines to the UCN where an LM resides, and the node-specific points that define the nodes on that UCN, including the NIM and the LM, are built in this activity. Also, the LM data points are built in this activity.
- `PICTURE EDITOR`, `FREE FORMAT LOGS`, `BUTTON CONFIGURATION`—Any of pictures, logs, and buttons built by these activities can access LM points, once the points are built and loaded.

- HM HISTORY GROUPS—LM data point values for which continuous history is to be collected are defined in this activity, by assigning them to specific HM history groups.

- AREA DATA BASE—This activity defines how and where data for data points, including LM data points are used and displayed in a given process area. The area database is the database loaded into a Universal Station, so that database defines the process area monitored and controlled through the US.

- Control Language (CL)—A Control Language that runs on an LM is not available, however, CL/AM and CL/PM programs can access LM parameter values. CL/MC programs cannot access LM parameter values.

- Ladder Logic Programming—This is accomplished through the Loader Terminal port on the LM's Processor card file front panel. The 623-60 MS-DOS Loader, which provides an interface and software that are installed in an MS-DOS-compatible personal computer.

NOTE

Recommended or required ladder logic program lines are defined in this publication in the following subsections: 2.2.2, 2.3.6, 2.5, and 3.1.6.

1.2 REFERENCES

- UNIT NAMES and AREA NAMES

  Network Form Instructions in the *Implementation/Startup and Reconfiguration - 1* binder.

  Network Data Entry in the *Implementation/Startup and Reconfiguration - 1* binder.

- VOLUME CONFIGURATION—Section 7 of the *Engineer's Reference Manual*.

- APPLICATION MODULE

  Application Module Control Functions in the *Implementation/Application Module - 1* binder.

  Application Module Algorithm Engineering Data in the *Implementation/Application Module - 1* binder.

  Application Module Parameter Reference Dictionary in the *Implementation/ Application Module - 2* binder.

  Data Entity Builder Manual in the *Implementation/Startup and Reconfiguration - 1* binder.

- NETWORK INTERFACE MODULE

  Logic Manager Control Functions in the *Implementation/Logic Manager* binder.

  Logic Manager Parameter Reference Dictionary in the *Implementation/Logic Manager* binder.

  Data Entity Builder Manual in the *Implementation/Startup and Reconfiguration - 1* binder.

- PICTURE EDITOR, FREE FORMAT LOGS, BUTTON CONFIGURATION

  Instructions for these activities are in the *Implementation/Engineering Operations 1* and - *2* binders.

- HM HISTORY GROUPS

  HM History Group Form Instructions in the *Inplementation and Engineering Operations* - *1* binder.

  Data Entity Builder Manual in the *Implementation/Startup and Reconfiguration - 1* binder.

- AREA DATA BASE

  Area Form Instructions in the *Implementation/Startup and Reconfiguration - 1* binder.

  Data Entity Builder Manual in the *Implementation/Startup and Reconfiguration - 1* binder.

- <u>Control Language (CL)</u>

  CL/AM publications in the *Implementation/Application Module* - *3* binder.

  CL/PM publications in the *Implementation/Process Manager* - *2* binder.

  CL/APM publications in the *Implementation/Advanced Process Manager* - *2* binder.

  Data Entity Builder Manual in the *Implementation/Startup and Reconfiguration - 1* binder.

- <u>Ladder Logic Programming</u>

  623-60 MS-DOS Loader User Manual

> **NOTE**
>
> Recommended or required ladder logic program lines are defined in this publication in the following subsections: 2.2.2, 2.3.6, 2.5, and 3.1.6.

1.3 LM IMPLEMENTATION DEPENDENCIES

Figure 1-1 shows which Logic Manager implementation tasks depend on information entered in other tasks. This figure does not necessarily dictate the order in which the tasks must be completed, but it does show all dependencies that must be satisfied before the LM can be fully operational.

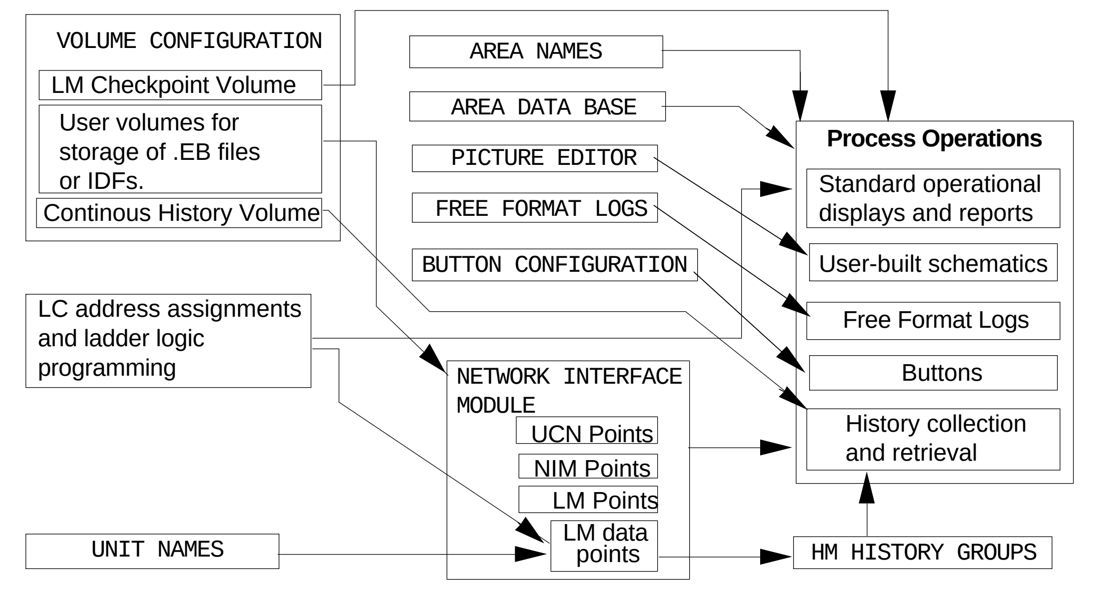


Figure 1-1 — Logic Manager Implementation Dependencies

LM OPERATIONAL CONSIDERATIONS
Section 2

This section describes operational characteristics of the Logic Manager that you should consider as you implement your LM(s).

2.1 THE LOGIC MANAGER SUBSYSTEM

The Logic Manager is unlike other TDC 3000X process-connected subsystems because users can program ladder logic in the LM to do quite sophisticated process data acquisition and control. In addition to Universal Stations, there is another human interface to the LM—the Loader Terminal that is used to view, build, and change the ladder logic. Further, the ladder logic can be changed, even while the LM is on-line, monitoring and controlling the process.

Figure 2-1 is a conceptual diagram of a Logic Manager subsystem. On that figure, note that the LM consists of these main functional blocks:

- The I/O System to which the process field wiring is connected, and which contains appropriate signal conditioning and signal conversion circuitry.
- The Control Processor Module (CPM), which executes the ladder logic program and stores data.
- The Logic Controller, which is a Processor Card file with at least a power supply and a Control Processor Module.
- The Logic Manager Module (LMM), which provides the interface between the UCN and the Control Processor Module and stores the LM's data points.

The I/O subsystem, the CPM, and when present, the Loader Terminal, combine to form a Logic Controller System (LCS).

Note that the ladder logic can be in the path between the data points and the I/O subsystem, therefore, the ladder logic can alter the effect of outputs from a Universal Station and it can alter raw input data from the process. It is not possible to view the ladder logic or its effect from a US, therefore, unless the operators understand what the ladder logic is doing, they can be confused.

It is also possible to use the LCS portion of the LM (the CPM and I/O subsystem) to acquire data from the process and send outputs to the process without building corresponding data points, in which case, US operators would have no way of monitoring or controlling these operations.

2.2 LOGIC MANAGER OPERATING MODES

The Logic Controller's operating modes are controlled by a keyswitch on the front of the Parallel Link Driver Module (PLDM). Those modes and their effect on functions of the LMM are defined in Table 2-1.

In addition, when the keyswitch is in the RUN/PROGRAM or DISABLE positions, the Logic Controller can be placed in the Software Program mode by a loader terminal.

The effects of the modes on the Logic Controller are as described under subsections 2.2.1 through 2.2.5.

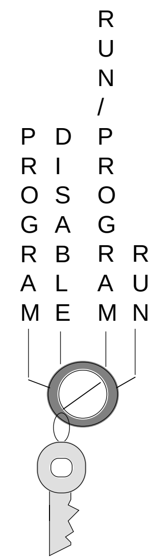


Table 2-1 — Effect of Logic Controller Modes on LMM Actions

	LC Modes			
LMM Actions Allowed	**Program**	**Disable**	**Run/Program**	**Run**
LC Download	Disable	Enable	Enable	Disable
LC Upload	Enable	Enable	Enable	Enable
Transition to IDLE	Automatic	Automatic	Yes	Yes
Transition to RUN	No	No	Yes	Yes

NOTE

"Download" refers to restoring the Logic Manager checkpoint data or ladder logic program from a History Module or removable medium to the Logic Manager.

"Upload" refers to saving the Logic Manager checkpoint data or ladder logic program onto a History Module or removable medium.

"Automatic" means that when the LCS goes to the Program or to the Disable mode, the LMM status, as shown on the status displays, goes to IDLE, automatically.

"No" means that a command from a US cannot cause the LMM status to go to the indicated status (IDLE or RUN).

"Yes" means that a command from a US can cause the LMM status to go to the indicated status (IDLE or RUN).

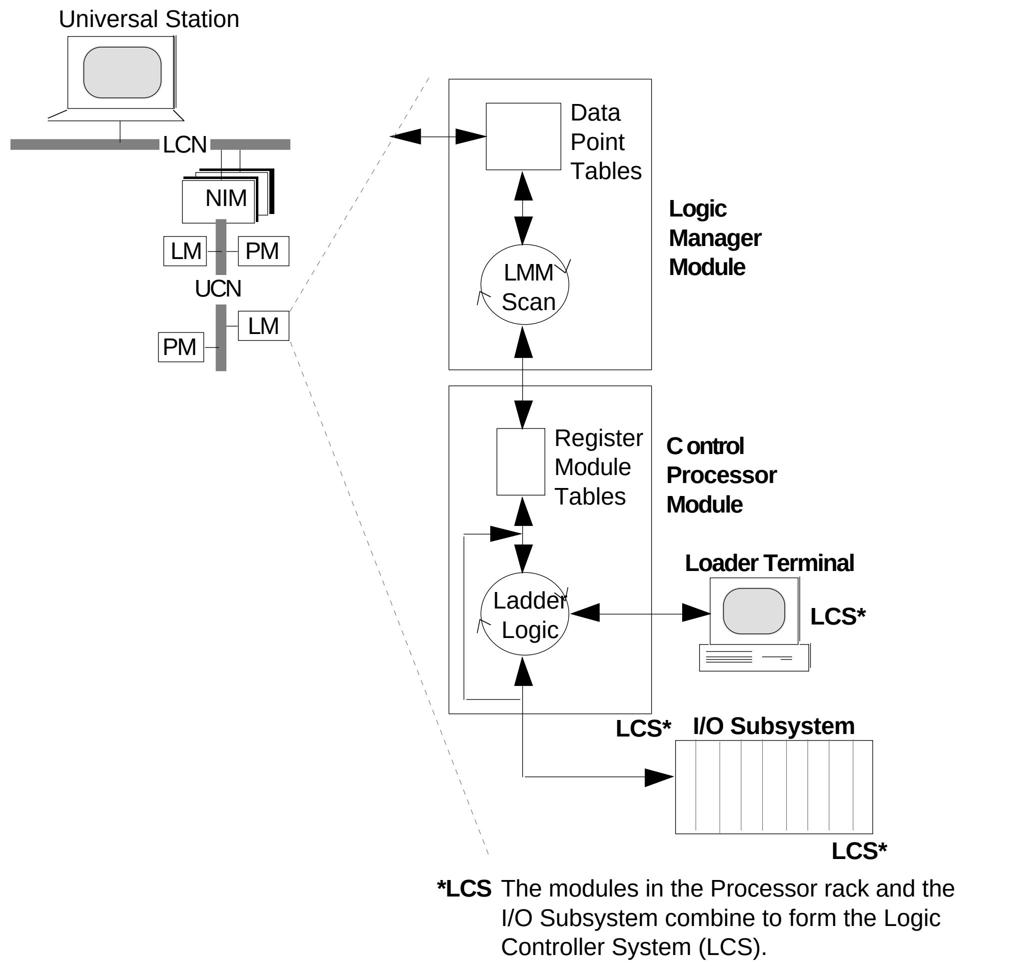


Figure 2-1 — Conceptual Diagram, Logic Manager Subsystem

2.2.1 Run Mode

This is the Logic Controller's principal operating mode. In this mode, the ladder logic program scan operates, thus executing the program. While the Logic Controller is in the Run mode (or the Run/Prog mode), the RUN LED on the Processor card file's Parallel Link Driver Module (PLDM) is on and the scan-loss timer is active.

When the Logic Controller first enters the Run mode, it executes a retentive command which sets all nonretentive outputs (0 to 4095) to the off state. Retentive outputs retain the state they were in during the last scan just before the Logic Controller was last taken out of the Run mode.

After this retentive scan is complete, the ladder logic scan begins by verifying that an Input Scan Status (ISS) instruction is in the first ladder logic memory location. While the input status is being collected from the I/O subsystem, the Logic Controller looks for card faults. If any are detected, fault information is stored in the System Status Table.

The ladder logic program scan continues from the second memory location, and on, until either an End of Memory instruction or a Return to Beginning of Program instruction is encountered. Either instruction causes the program scan to repeat. The Return to Beginning of Program instruction can be inserted by a user through a loader terminal. The End of Memory instruction is automatically entered by the loader terminal as the ladder logic program is loaded into the Processor memory.

The following switches on the Parallel Link Driver Module (PLDM) affect operations in the Run mode (for more information about Logic Manager switch settings, refer to the *Logic Manager Site Planning* manual in the *System Site Planning* binder and *Logic Manager Installation* manual in the *Implementation/Logic Manager - 1* binder):

- <u>SW1, Scan Loss Timer Interval</u>—Selects the time out interval (0 to 140 milliseconds), or disables the scan-loss timer.

- <u>SW2 switch 4, Enable/Disable Force Command</u>—When this switch is closed (on), contacts can be forced.

- <u>SW2 switch 5, Enable/Disable Data Change</u>—When this switch is closed (on), timer and counter data in the Register Module can be changed.

- <u>SW2 switch 7, Clear Outputs on Scan Loss</u>—If the scan-loss timer times out, I/O subsystem outputs can be cleared.

The scan-loss timer detects failures of the ladder logic to execute within the time specified by SW1 on the PLDM. If the timer times out before it is reset at the end of a ladder logic program scan, the scan stops and outputs are cleared or frozen as specified by the setting of SW2 switch 1 on the Parallel I/O Module (PIOM). Because some valid ladder logic programs can exceed the timer interval, the SW1 switch 1 on the PLDM can be closed (on) to disable the timer.

CAUTION

Some of the self-diagnosis built into the Processor is disabled when the scan-loss timer is disabled.

2.2.2 Run/Prog Mode

In this mode, the Logic Controller operates as in the Run mode, but, if enabled by SW2 on the Parallel Link Driver Module (PLDM), ladder logic program changes are enabled. In addition to program changes, if enabled by SW2 on the PLDM, the loader terminal can force element-status changes. For more information about Logic Manager switch settings, refer to the *Logic Manager Site Planning* manual in the *System Site Planning* binder and *Logic Manager Installation* manual in the *Implementation/Logic Manager* binder.

While the Logic Controller is in the Run/Prog mode (or the Run mode), the RUN LED on the Parallel Link Driver Module (PLDM) is on and the scan-loss timer is active.

Augmented Run Mode Programming (ARMP) is available when the keyswitch is in the RUN/PROGRAM position, SW2 switch 6 on the PLDM is closed (on), and the Loader Terminal is in the Program mode.

NOTE

Ladder-logic program changes in the Run/Program mode temporarily increase the ladder logic scan time by up to 20 milliseconds.

When the Loader Terminal is placed in the Program mode this message is displayed on the terminal screen:

```
       620 IN RUN MODE:
CAUTION: RUN MODE PGM ENABLED
Output bit(s) will remain in last state
if DELETED or ADDRESS CHANGED
```

You can then do any of the following:

- Edit a Line—An existing program line can be edited as usual. When the changes are complete, press <INSERT> and <ENTER>. This message appears:

  ```
               WARNING!
  RUN mode programming enabled! ENTER to
  execute;  Any key to cancel<<<
  ```

  If you are entering or deleting a line, this additional message appears:

  ```
               WARNING
  Loader is not monitoring line status!
  ```

  Press <ENTER> to complete the process. A "busy" message flashes when the line edit function is being executed. When this message disappears, line monitoring resumes.

- Insert and Load a Line—A new logic line can be inserted between existing lines (INSERT, Pg Dn) or at the end of the program (ENTER). These operations are similar to the edit line process. The actual operation is initiated by again pressing <ENTER>.

- Delete a Line—The currently displayed line can be deleted from the program by pressing DEL, Pg Dn. The caution and warning messages mentioned above are displayed. Be sure that the line terminator, if it is a coil, is OFF prior to the delete operation. A Send Out, likewise, should be set to zero. The delete is then initiated by pressing <ENTER>.

- Sequencers—Sequencers of 80 steps or fewer can be inserted, loaded or deleted using normal Run mode methods. Sequencers with more than 80 steps cannot be deleted as a whole. The only way to delete such sequencers is to delete individual steps until there are 80 steps or fewer, at which time the entire sequencer can be deleted. Multiple step editing of sequencers greater than 80 steps is also prohibited.

- Guidelines for making program changes in Run/Prog mode:

  - Remember that scan times can increase by as much as 20 ms.

- When you add a new subroutine, add the SUB instruction first, then the JSR. Likewise, when you add new jumps, add the EOS first, then the NSKR.

- When you delete a subroutine, delete the JSR first, then the SUB. When deleting jumps, delete the NSKR first, then the EOS.

- Do not overwrite a SUB or EOS with another SUB or EOS. Delete the old instruction before you add the new instruction.

- Judge carefully the consequences of adding or deleting sequencer steps. For example, adding a step before the active step makes the sequencer appear to be moving back a step. Deleting a step before the active step makes the sequencer appear to be moving forward a step. The step number register must be adjusted to agree with the new number of steps.

- If Load or Unload Sequencer instructions are used, take care if the target sequencer is deleted. In this case, the Load/Unload instruction would operate on the next sequencer in the program.

- If a power loss occurs during a RUN mode programming operation, it could cause a “write in progress” failure. This causes the Processor to shut down, and the only recovery is to reload memory.

- When inserting or adding a new section of program:

    Insert an EOS with an unused reference number such as 999.

    Ahead of the EOS 999, insert a false NSKR line as in the following example:

    (990 is never true or is forced OFF)

```
990
+-]/[-+---+---+---+---+---+---+---+---+-NSKR
999
```

    Insert new program lines between the NSKR and EOS lines.

    Review the new program lines for errors.

    Delete the NSKR line.

    Delete the EOS line.

2.2.3 Program Mode

In this mode, you can load or change the Logic Controller’s ladder logic program, but the program scanner is not running, so the program is not executed. The RUN LED on the Parallel Link Driver Module (PLDM) is off.

In the Program mode, a signal is sent to the I/O System that allows I/O card files to be selected to freeze or to clear outputs. If on the Parallel Link Driver Module (PLDM), switch 4 on SW2 (the force-enable switch) is closed (on), output contacts can be forced. Timer and counter data that is stored in the Register Module can be changed regardless of the position of switch 5 on SW2 (the data-change-enable switch) because the Logic

Controller is already in the Program mode. For more information about Logic Manager switch settings, refer to the *Logic Manager Site Planning* manual in the *System Site Planning* binder and *Logic Manager Installation* manual in this *Implementation/Logic Manager* binder.

The PROGRAM mode forces the Logic Manager to the IDLE state.

2.2.4 Software Program Mode

If the LCS is in the Run/Program mode or the Disable mode, a Loader Terminal can make a request to place the LCS in the Software Program mode [SW2 switch 6 on the PLDM must be closed (on)]. The request for this mode is made through the Loader Terminal's mode-change auxiliary menu. The Logic Controller goes to the Software Program mode after execution of the current ladder logic scan is complete. This feature is particularly useful when you are debugging the program and need to make extensive changes.

When the Software Program mode request is removed, the Logic Controller returns to the original mode, after it successfully executes the retentive scan and self diagnosis.

The SOFTWARE PROGRAM mode forces the Logic Manager to the IDLE state.

2.2.5 Disable Mode

The Logic Controller is placed in the DISABLE mode by the keyswitch or by the absence of any other mode. If the Logic Controller does not detect a selected mode, it enters the DISABLE mode by default. In this mode, the ladder logic program is executed but outputs to the process are not updated.

When the Logic Controller is in the DISABLE mode it scans through the ladder logic program, executing the instructions as it would for normal machine control operation. This involves collecting field input status, deriving solutions and posting the outputs in the Output Status Table. As outputs are updated in the Output Status Table, they are sent to the I/O Control Module to update field outputs. At the same time the hardware on the Parallel Link Driver Module sends a power fail signal to the I/O system. Outputs are cleared or held in the last state as defined by SW2 switch 1 on the PIOM in each I/O card file. The outstrobe for updating the I/O is held disabled, which prevents I/O output updating.

The DISABLE mode forces the Logic Manager to the IDLE state.

2.3 SERIAL I/O FUNCTIONS

2.3.1 Application of Power to the Serial I/O Subsystem

The serial I/O subsystem is serviced asynchronously from the Logic Controller scan. Each Serial Link Module (SLM) operates as the master for the I/O card files connected to it. The SLMs derive their power from the Processor card file backplane to ensure orderly power-up and power-down sequences for the SLM and each channel that it operates.

When power is applied to the system, each SLM clears its I/O status tables, serial I/O status table, PUSH/PULL data and card faults. The SLM then queries each SIOM to determine channel addressing. The SLMs read the SIOM input, output, PUSH and PULL data, and determine the selected I/O responses to system mode changes and system faults.

The SLMs and SIOMs also perform a self-diagnostic check at this time. A status ready bit is set in the SLM serial I/O status table when all the input/PULL data has been received from the SIOMs. An SLM will not transmit output data to a SIOM until all input data has been received. When the status ready bit is set, the SLM permits SIOMs to write their I/O data to the SIOM backplanes, commencing normal service of each I/O channel.

NOTE

Because it is possible for power to be applied to the Logic Controller and for it to begin operation before the serial link has finished its configuration process, you must place the lines shown in the Ladder Logic Diagnostic under subsection 2.3.6 at the beginning of your ladder logic program. These lines cause the program to return to the beginning of program (RBP) until the input/PULL data ready bits are set. Until these lines are implemented, you can avoid this problem by applying power while the keyswitch is in the PROGRAM position and then switch to the RUN mode once the serial system is operating.

2.3.2 Serial I/O Operating Sequence

The normal sequence of operation of a serial I/O channel is as follows:

1. The SLM output RAMs are continuously updated by the Logic Controller during the Logic Controller scan.
2. The SLM input RAMs are read during the input status scan.
3. The SLM services each I/O card file in the order of their addresses on the link by transmitting the card file's output/PUSH data to the SIOM.
4. Each Serial I/O Module (SIOM) (non-redundant 621-9940) responds to its message from the SLM by immediately transmitting its card file input/PULL data to the SLM.
5. The SIOM writes its output/PUSH data to the I/O backplane.
6. The SLM writes the SIOM input/PULL data to its input RAMs.

2.3.3 Serial I/O Status Information

SIOM on-line, off-line and link status is continually updated and maintained at the Serial Link Module (SLM). This serial I/O status information is accessed by using the PULL instruction for addresses 2040 to 2047 in the Logic Controller. This feature precludes the use of any PUSH/PULL or discrete I/O card in the I/O slot occupied by addresses 2040 to 2047. Because the Logic Controller must also be a 2K system in order to obtain the serial status information, LMs are so configured. Table 2-2 shows register addresses and corresponding bit locations for the available serial status information.

- SIOM Off-Line Flag—This bit is OFF (0) when all SIOMs are on-line. When an SIOM is taken off-line this bit is turned ON (1). The bit remains set until all off-line SIOMs have been brought back on-line or the SLM has been reset or card file power has been cycled.

- Input/Pull Data Ready—This bit is used during power-up and switchover to show that each link's input and PULL data has been collected at the SLM. This bit is ON during normal operation. When the input and PULL data is not available, then this bit is OFF. On power-up or when a link is shutdown, causing a switchover, this bit is cleared and remains cleared until all of the data is retrieved.

- All SIOMs Active on Redundant Link—This is used with redundant Logic Manager systems to indicate the status of a backup link. It is ON when all the SIOMs are on-line and communicating on the backup link. It turns OFF when one or more SIOMs drop off-line on the backup side. This bit does not cover SIOMs that are already off-line on the lead (primary) port or on both the lead and the backup ports.

- Starting Address of SIOM Off-Line—This register contains the starting address of the card file for an SIOM that has gone off line. When more than one SIOM is off-line only the first SIOM to go off-line is posted. When it is brought back on-line, the next off line SIOM address is reported. This register contains a valid address only when the SIOM off-line flag bit is ON.

- Number of SIOMs On-Line—This register contains the number of SIOMs currently on line.

Table 2-2 — Serial I/O Status Information

Register Address	Bit Number	Channel	Description
2040	0	1	SIOM Off-Line Flag
	1	1	Input/Pull Data Ready (IPDR)
	2	1-2	RCM/SLM #1 Handshake Bit (see 3.1.7)
	3	1	All SIOMs Active on Redundant Link
	4	2	SIOM Off-Line Flag
	5	2	Input/Pull Data Ready (IPDR)
	6	1-2	SLM #1 Lead/Backup Status
	7	2	All SIOMs Active on Redundant Link
	8	3	SIOM Off-Line Flag
	9	3	Input/Pull Data Ready (IPDR)
	10	3-4	RCM/SLM #2 Handshake Bit
	11	3	All SIOMs Active on Redundant Link
	12	4	SIOM Off-Line Flag
	13	4	Input/Pull Data Ready (IPDR)
	14	3-4	SLM #2 Lead/Backup Status
	15	4	All SIOMs Active on Redundant Link
2041	0-15	1	Starting Address of Off-Line SIOM
2042	0-15	2	Starting Address of Off-Line SIOM
2043	0-15	3	Starting Address of Off-Line SIOM
2044	0-15	4	Starting Address of Off-Line SIOM
2045	0-15	1	Number of SIOMs On-Line
2046	0-15	2	Number of SIOMs On-Line
2047	0-7	3	Number of SIOMs On-Line
2047	8-15	4	Number of SIOMs On-Line

2.3.4 Serial I/O Resetting and Restarting

The remote serial I/O design allows you to make DIP-switch selections on SIOMs of any drop of a multidrop configuration to be taken off-line (intentionally or unintentionally) without interrupting the operation of the remaining drops on the serial link. Several restart options are available to restart a drop that has been taken off-line. The serial I/O system can be reset by turning Logic Manager power off and then on or by shorting the reset terminals on the SLM. Either of these actions will cause the SLM to go through its "power up" sequence, including self-test and link configuration. For more information on switch settings, refer to the *Logic Manager Site Planning* manual in the *System Site Planning* binder and *Logic Manager Installation* manual in the *Implementation/Logic Manager - 1* binder.

You can elect to restart an off-line drop by one of the following methods:

- Short the SLM restart terminals starting all off-line SIOMs. Communication with on-line links continues uninterrupted.
- Start the off-line SIOM only by shorting its reset terminals.
- Start the off-line SIOM only by turning SIOM power off and then back on. It could take several seconds before the SIOM is brought on-line, depending on when during the serial I/O scan a card file (SIOM) is restarted.
- Restart the SLM by pushing a value to its Restart register (see Section A.4).

If the entire serial I/O System is shutdown, we recommend that you turn Logic Manager power off and then back on or short the SLM reset terminals. Either of these methods initiates the self-diagnostic start-up routines. This ensures a complete system reset.

2.3.5 Serial I/O Fault Detection

The serial I/O System employs several on-line fault-detection routines to ensure proper link operation. These routines are executed after all SLMs and SIOMs have successfully passed their self-diagnostic tests. DIP switches on the SIOM can be set to select subsystem behavior in the event of a fault. For more information about switch settings, refer to the *Logic Manager Site Planning* manual in the *System Site Planning* binder and *Logic Manager Installation* manual in the *Implementation/Logic Manager* binder.

Each SIOM (in conjunction with any output modules housed in the I/O card file) diagnoses I/O card file backplane output card faults or bus faults. The SIOM transmits the fault information to the SLM. The SLM enters the most significant I/O card address for the faulted address into the I/O card fault table. You can set switches on the SIOM to clear or freeze I/O at the card file (through DIP switch settings) if a card fault occurs.

Each message transmitted by an SLM or SIOM contains a Cyclic Redundancy Check Character (CRCC) to ensure transmission validity.

If an error is detected in the message initiated by the SLM, the following actions take place:

1. The SIOM aborts its response to the SLM.
2. The SLM recognizes the SIOM failure to respond and retransmits the message to the SIOM.

3. If the retransmitted SLM message is accepted, the SIOM responds with a new input and PULL data message.

4. If the retransmitted SLM message contains an error, the SIOM again aborts its response to the SLM. The SLM ceases communication with the affected SIOM and sends a message to the next SIOM on the link. The affected SIOM takes itself off-line and its input/PULL data is cleared from the SLM status table. The SLM link fault indicator comes on. The outputs in the affected SIOM's card file are cleared or frozen, depending on the SIOM's DIP switch settings.

Once SLM/SIOM communication has been established, if an SLM does not receive a message from a polled SIOM in an allotted time period, the SLM times out. If the CRCC comparison reveals an error in a SIOM transmitted message or the SLM times-out, the following responses occur:

1. The SLM retransmits the message to the SIOM.
2. The SIOM responds to the retransmitted message by transmitting its input and PULL data message.
3. If the SIOM response is accepted by the SLM, the SLM proceeds to send the next message to the next SIOM on the link.
4. If the second response contains an error, or the SLM times-out a second time, the SLM ceases communication with the affected SIOM and sends a message to the next SIOM on the link. The affected SIOM takes itself off-line and its input/PULL data is cleared from the SLM status table. The SLM fault indicator comes on. The outputs in the affected SIOM's card file are cleared or frozen, depending on the SIOM's DIP switch settings.

For data communication errors, the SLM immediately attempts to retry communications with the affected SIOM as explained above. If data communication to or from a SIOM is corrupted on both the initial and retry communication attempts, the associated SIOM is shut down. The number of retries per I/O scan before a link is shut down is determined by the number of card files per link, as follows:

Number of Card files Per Link	Number of Retries
1	1
2	2
3-16	2

2.3.6 Serial I/O Ladder Logic Program Considerations

- The serial I/O scan is asynchronous to (not synchronized with) the Processor scan.

- Send outs to real serial I/O addresses must be on a 16-point I/O address boundary (i.e., 15, 31, etc.)

- At the beginning of the system ladder logic program, logic to monitor serial I/O status is required if fault conditions are to be detected by the Logic Manager Module and alarmed at the Universal Station. The recommended logic for nonredundant Logic Managers is presented on the next few pages. See subsection 3.1.6 for logic for a redundant LM. A detailed description of the logic can be found in Appendix A.

LADDER LOGIC DIAGNOSTIC FOR NONREDUNDANT LOGIC MANAGER

NOTE

With the exception of real I/O addresses 2040 through 2047, the LCS addresses used in this example are arbitrary.

Line #1 — Turn coil 2045 OFF.

```
                                                      SERIOOK
                                                      2045
-- -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --    (U)   -- -- -- --
```

Line #2 — Pull serial status bits and send to monitor register. Use this register for monitoring only.

```
      Serial status                                   Serial status
      bit register                                    bits (monitor)
      SerStat                                         StatBit
      2040                                            3066
-- -- [PUL] -- -- -- -- -- -- -- -- -- -- -- -- -- -- (S2) -- -- -- --
        1                                               0
```

Line #3 — Perform divide by 256 operation on serial status register 2047 to split out upper and lower 8 bits. Store quotient (upper 8 bits) in number of SIOMs on-line, ch. 4.

```
                  # SIOMs
                  on-line,
                  chs. 3 & 4
                  #SIOM34
                  2047                               8049
-- -- ]K2 [ -- -- [PUL] -- [ / ] -- -- [K2] -- -- -- (PSH)--
       0            1                  256             2
```

Line #4 — Store remainder (lower 8 bits) as number of SIOMs on-line on ch. 3.

```
                                                  # of SIOMs
                                                  on-line, ch. 3
                                                  # SIOM3
      8049                                        8047
-- -- [B2] -- -- -- -- -- -- -- -- -- -- -- -- -- (S2) -- -- --
       0                                            0
```

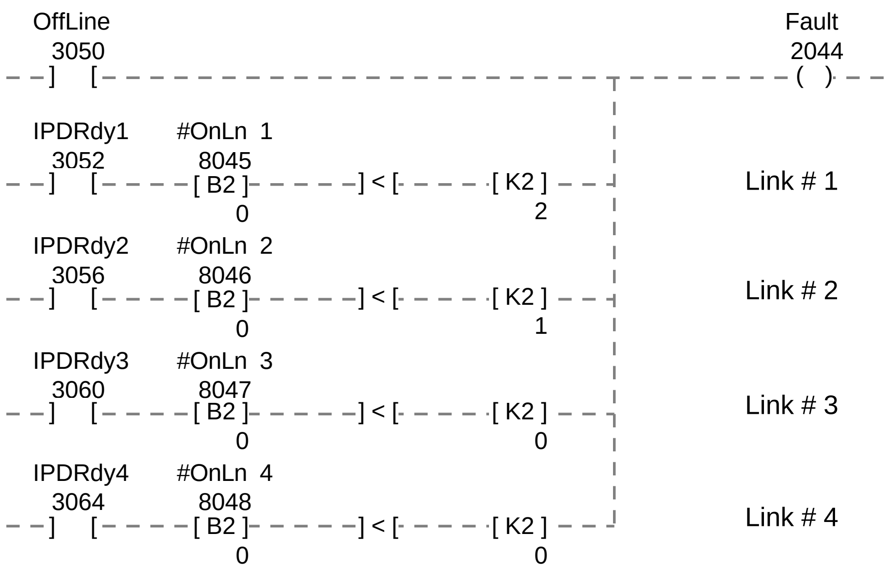
Line #5 — Obtain and store the number of SIOMs on-line for chs. 1 & 2.

```
     #SIOM2                                        #SIOM2
     2046                                          8046
-- -- [PUL] -- -- -- -- -- -- -- -- -- -- -- -- -- (PSH) --
       2                                             2
```

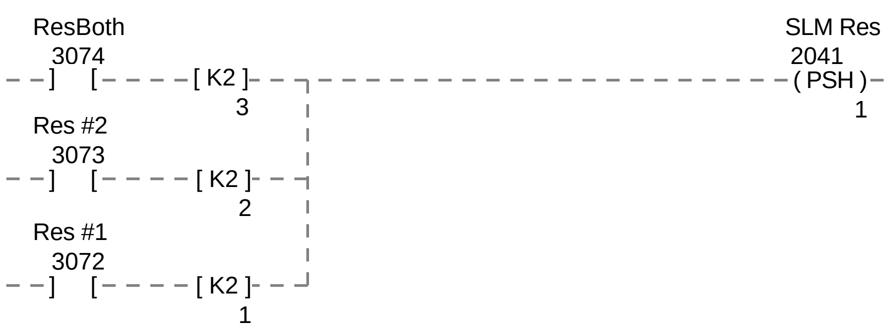
continued on next page

Line #6 — Check SIOM off-line flags. Set output bit if any flag is true.

Line #7 — Compare actual number of active SIOMs with expected number of SIOMS on all links. Set output bit if mismatch occurs or if offline flag is on. Adjust constant to match the number of SIOMs wired on each link.

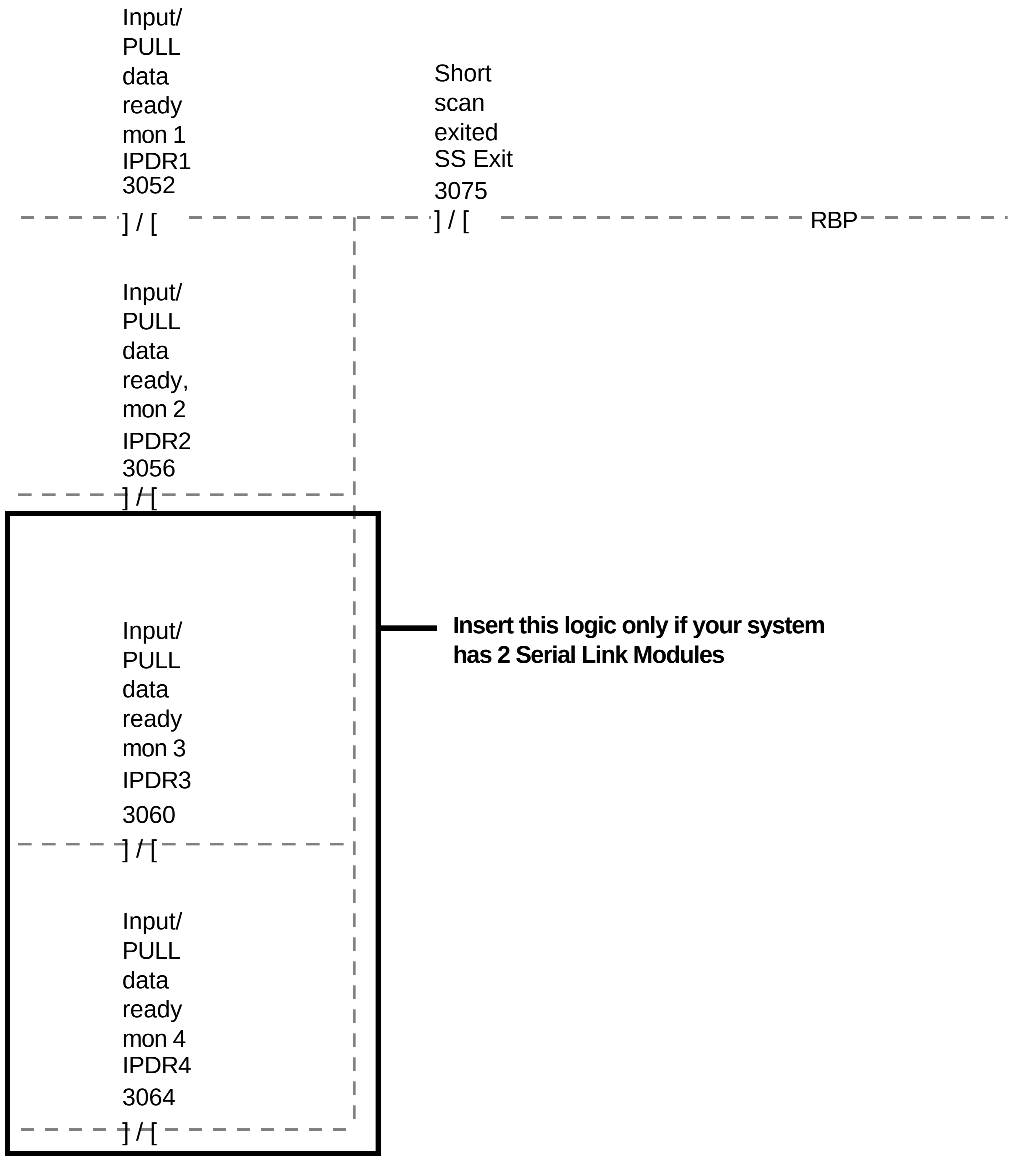


Line #8 — Set 3074 to restart both SLMs or set 3073 to restart SLM 2 or set 3072 to restart SLM 1.

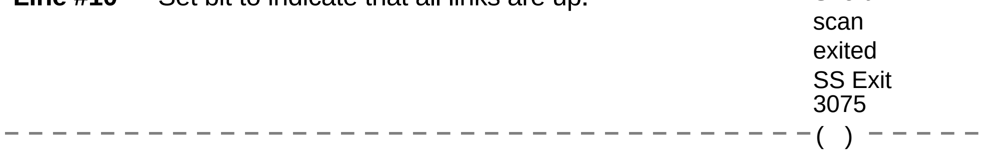


continued on next page

Line #9 — Delay execution of ladder logic program until all links have been brought on-line. After all links have come up, continue to execute the program, even if a link shuts down. DO NOT PROGRAM IPDR BITS FOR UNUSED CHANNELS.



Line #10 — Set bit to indicate that all links are up.



Line #11 — Turn coil 2045 ON.

12155

2.4 PARALLEL I/O FUNCTIONS

The Parallel I/O System consists of one or more I/O card files connected to the Parallel Link Driver Module (PLDM) in the Processor card file in a point-to-point (daisy-chain) configuration. Communication takes place over a parallel bus of multiconductor cables connecting the PLDM in the Processor card file and the Parallel I/O Modules (PIOMs) in the I/O card files. Bus activity between I/O card files and the PLDM in the Processor card file is controlled by the Processor through the I/O Control Module and Parallel Link Driver Module.

2.4.1 Ladder Logic Line Required for Parallel I/O

For LMs that employ parallel I/O, you must use the following ladder logic line at the beginning of the program. This line sets register 2045 (Table 2-2), which the LMM monitors to determine that the ladder logic program is running. Until this register is set, the LM remains in a Part Fail state.

```
                                                       2045
Line 1 ---------------------------------------(L)----
```

2.4.2 Parallel I/O Operating Sequence

1. The Input Status Scan (ISS) instruction is automatically inserted in the first word of memory and can also be placed by users at other points in the control program. During ISS, the processor momentarily stops solving the control program to update the Input Status Table.

2. During ISS, the processor systematically generates I/O module address data which is transmitted to all PIOMs on the parallel channel.

3. The PIOMs decode the address data and in turn generates card selection signals to all I/O cards in the I/O card file.

4. After an input module receives a card selection signal, the data at each input is latched on the input module.

5. Immediately after the card selection signal is received, an in-strobe is applied to the module which allows the information to be transmitted to the processor’s Input Status Table.

6. Each I/O module is successively selected and then strobed. All output modules strobed during input status scan are read as zero or OFF. At this point, output modules are queried for card faults. The processor can store the location of up to eight card faults. The most significant address of the faulted I/O module is stored in the System Status Table.

7. By the end of the Input Status Scan, the status of all inputs is recorded in the Input Status Table. All outputs are recorded as zero or OFF in the Input Status Table.

8. The processor then begins program execution. As output instructions are solved, the status of the output module is placed in the Output Status Table.

9. The processor also generates the address data and output status to the I/O system, the PIOMs decode the address information and select the appropriate output module.

10. After the output module is selected, a specific output command is sent to the module, followed by the outstrobe command that allows the output to turn ON or OFF, as dictated by the output command.

11. The Processor also performs a diagnostic function with every output command. When an output is solved, not only is the address data and output status sent to the I/O system, but also the complement of the output status information. These two groups of data are transmitted to appropriate output modules on separate data lines. At the output module, a comparison between the data and its complement is made. If a miscompare occurs, signifying a module or I/O bus fault, the output module sets a fault flag. This flag is read by the Processor during Input Status Scan. The address of the faulted module is then posted in the System Status Table.

2.4.3 Parallel I/O Shutdown Conditions

If any of the following occurs, the Parallel I/O subsystem stops operating:

- When the Processor is in the Program or Disable modes, a power failure signal is sent to all PIOMs in the I/O card files. When they receive this signal, the PIOMs either turn off all outputs or hold outputs in their last state (as selected by PIOM DIP switch settings) until the power failure signal is removed.

- When any I/O card file power supply detects that the ac input is below 85 volts in 115 Vac operation, or 190 volts in 230 Vac operation, for a time period greater than 11.5 ms, that power supply sends a power failure signal to all other I/O card files as well as to the Processor. This causes the PIOMs to clear or freeze outputs and causes the Logic Manager to halt operation.

- When the processor card file power supply detects a low AC line voltage. A power failure signal is sent to the I/O system and the processor. The Logic Manager halts operations and the PIOMs clear or freeze outputs in their card files.

- PIOMs can be individually selected to recognize output module faults occurring in their card files. If faults are to be recognized or acted upon, the PIOM clears or freezes outputs in its card file only.

2.5 ENHANCED DIAGNOSTIC MODULE FUNCTIONS

Each Logic Manager I/O card file includes a 621-0021R Enhanced Diagnostic Module (EDM). This module is installed in the left-most slot in each card file and, therefore, assumes the lowest eight addresses in the I/O card file.

The EDM detects and aids in diagnosing problems with I/O bus data and control lines that the system diagnostic tests cannot detect. It also has a watchdog timer that can detect a Logic Controller scan loss. When the EDM detects a malfunction, it actuates a set of form C contacts that can be used to remove power from an output module. A terminal board on the EDM front panel provides connections to these contacts.

Use of information from the EDM to diagnose malfunctions is provided in *Logic Manager Service*, which is in the *LM Service* binder. Such diagnosis requires a block of logic in the ladder logic program for each EDM in the LM. The block of logic is <u>only</u> required in parallel I/O systems. Serial I/O systems do not require this logic.

Also, it is remotely possible that ladder logic program execution could take longer than the time set for the EDM watchdog timer (the timer can be set for 200 ms, 490 ms, 1.75 sec., or 4.5 sec., (redundant Logic Managers require that the EDM timer be set for 4.5 seconds) as described in *Logic Manager Service*); therefore, you may need to place a pair of timer-reset lines at one or more places in your program to reset the timer before it times out and actuates the EDM relay. The ladder logic lines are as follows and are only required in parallel I/O systems:

<u>Block to support EDM diagnosis:</u>

This example applies to an EDM at addresses 88 through 95. Adjust the address for the PULL instruction according to the actual addresses assumed by the EDM in each I/O card file.

```
           95                                                   600
Line n    +--[PUL]-----------------------------------------------(S2)--

           600    599    598    597    596    597    594    593    601
Line n+1  +-[ ]----[ ]----[ ]----[ ]----[ ]----[ ]----[ ]----[ ]--+-( )-
          | Data   Data   Data   Data  Data   Data   Data   Data  |
          | Bit    Bit    Bit    Bit    Bit    Bit    Bit    Bit  |
          |  7      6      5      4      3      2      1      0   |
          |                                                       |
          | 592    591     590  589    588    587    586    585   |
          +-[ ]----[ ]----[ ]----[ ]----[ ]----[ ]----[ ]----[ ]--+
           Relay  Relay  Output  Bad  PSH/PUL Input   Data   ICD
          Trigger Coil   Test  Access Address Test     PUL  Detect
          Output Monitor
```

<u>Watchdog reset lines:</u>

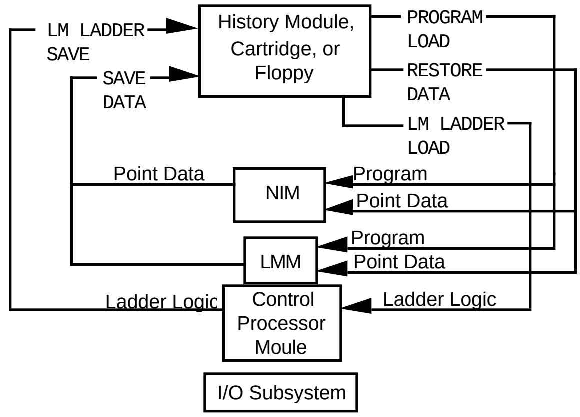
This example applies to an EDM at addresses 88 through 95. Adjust the address for the output coil according to the actual addresses assumed by the EDM in each I/O card file.

```
                                         95
Line m         --------------------------(U)--

                                         95
Line m+1       --------------------------(U)--
```

2.6 SAVING AND RESTORING LOGIC MANAGER INFORMATION

The five targets at the bottom of the UCN Status display save and restore NIM and Logic Manager information as indicated in this diagram.



The functions of each of the five commands is as follows:

- PROGRAM LOAD—Loads the NIM and LMM software personality image from the &UCN volume on an HM, or from a cartridge or floppy, to the NIM and the selected LMM(s) in the selected Logic Manager(s).

- RESTORE DATA—Restores point data stored in the &8np checkpoint volume on an HM, or from a cartridge or floppy, to the NIM and the LMM(s) in the selected Logic Manager(s). For more information on checkpointing, refer to Section 21 of the *Engineer's Reference Manual* in the *Implementation/Startup & Reconfiguration - 2* binder.

- SAVE DATA—Saves point data in the NIM and the LMM(s) in the selected Logic Manager(s) into the &8np checkpoint volume on an HM, or onto a cartridge or floppy. This target requests a "demand" checkpoint. Automatic checkpointing may also save this data at the established automatic checkpoint interval for this system. For more information on checkpointing, refer to Section 21 of the *Engineer's Reference Manual* in the *Implementation/Startup & Reconfiguration - 2* binder.

- LM LADDER LOGIC LOAD—Loads the ladder logic program image stored in the &9np sequence/ladder logic volume on an HM, or from a cartridge or floppy, through the NIM to the Control Processor Module in the selected Logic Manager(s). The file extension is PO.

- LM LADDER LOGIC SAVE—Saves the ladder logic program in the processor(s) in the Selected Logic Manager(s) into the &9np sequence/ladder logic volume on an HM, or onto a cartridge or floppy.

Note that checkpoint saving and restoring and saving and restoring of ladder logic are separate operations, and that ladder logic images are not stored automatically. Also note that ladder logic programs cannot be changed through Universal Stations—they can only be changed through Loader Terminals connected to a Logic Manger's Control Processor Module.

2.6.1 LM Status and Ladder Logic Loading

Detailed instructions for displaying LM status, loading and saving data, and other LM operations are provided in the *Process Operations Manual*.

To successfully load the ladder logic from the LCN into the Logic Manager, the following conditions must be met:

- The selected LM must be shown on the LM Detail Status display as `PREF` (preferred/primary).
- The LM must be `IDLE`.
- The Logic Controller must not be write protected. (Switch on RCM)
- The LM's key switch must be in either RUN/PROGRAM or the DISABLE position.
- If the LM is a redundant LM, the secondary LM must be in the `BACKUP mode`.

If the selected LM is a member of a redundant pair and its status is shown on the LM Detail Status display as `NON_PREF`, swap the primary and secondary <u>so that the preferred LM is the primary</u>.

After you initiate the loading of the ladder logic, the LM status can go through several states, but when the loading operation is complete, its status is normally shown as `IDLE` (primary), `BACKUP` (secondary), and `LOADED`. In the event of a soft failure of an LM, in addition to `LOADED`, the status might also be shown as `PF_IDLE` or `BKUP_PF`. If the error DB_INVALD appears, reload the checkpoint file (RESTOREDATA).

2.6.2 Maintenance of Consistent NIM and LM Databases

It is possible to create inconsistent NIM and LM databases through misuse of the point loading, checkpointing, and deleting functions. These inconsistencies can cause valid connections between points to appear to operators to be invalid.

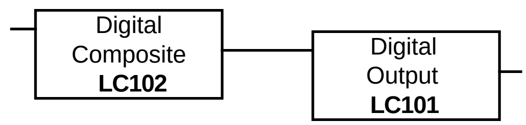
Here are three scenarios that can cause inconsistent, mismatched data in the NIM and LM:

- (1) Save NIM and LM checkpoint data. (2) Use the Data Entity Builder to build and load points in the LM. (3) Before the new LM database is saved in the checkpoint files, shut down and reload the NIM, using the unmodified checkpoint as the data source (the LM data is not restored, so it still has data for the new points, but the NIM does not).

- (1) Use the Data Entity Builder to build and load points in the LM. (2) Save NIM and LM checkpoint data. (3) Use the DEB to delete a point (this removes it from the LM and NIM databases). (4) Restore the LM database, using the checkpoint data which still has the point that was deleted (the NIM database was not restored, so the LM has data for the point that was deleted but the NIM does not).

- (1) With the NIM's LOADSCOP parameter containing NIMAndPM, use the DEB to build and load LM points (2) Change the NIM's UCN Node Configuration entity so that LOADSCOP contains NIMOnly, then delete a point (the delete affects the NIM, only; the LM still has data for the point).

As an example of the confusion that can be caused by NIM/LM database mismatches, consider the LM points in this sketch. LC102 is a digital composite point with an output connection to digital output point LC101. Any of the three scenarios described above could cause the NIM to loose the tag name for LC102. An operator at a Group or Detail display is not able to see any information about LC102. Even more confusing, the input to LC101 may change and its output state may follow, even though there is no apparent input. This is because the connection is operating properly in the LMM, but due to the mismatch in NIM and LMM databases, the operator can't see LC102.



To avoid database mismatches, follow these recommendations:

- When you use the Data Entity Builder to load and to delete points, do so while UCN Node Configuration parameter LOADSCOP in the NIM contains NIMAndLM. If you need to change it to NIMOnly, be sure to change it back as soon as possible.

- Keep only one version of each of the checkpoints for each NIM/LM combination. If you have to have differing versions, be aware that the NIM and LM checkpoints in different versions may not match.

- Immediately after you load or delete points in an LM, use the SAVE DATA target on the UCN Status display to update the checkpoint.

2.7 NIM PROCESSING LOAD

The following paragraphs describe methods for estimating Network Interface Module loading and assessing the results of your estimates. Subsequent paragraphs describe the implementation of a second NIM (or NIM pair) on a UCN, to share the processing load.

Table 2-3 provides an example of a NIM processing-load estimate for the NIM in a performance cluster with one LM on the UCN, three Universal Stations (one displaying schematics), one History Module, and one enhanced (68020-based) Application Module, (for more information about a performance cluster, refer to Section 23 in the *Engineer's Reference Manual*).

2.7.1 Estimating NIM Processing Load

The NIM load estimate is calculated by multiplying the value you entered in the Number column by the factor in the Load Factor column, entering the results in the Induced Load column, and adding the values in the Induced Load column. In this example, the total induced load is 335, which is 33.5% of the maximum load allowed for a NIM.

Table 2-3 — NIM Processing Load Estimator

Load Sources	Units to be entered in Number column	Number	Load Factor	Induced Load
PM /LM Induced Load				
PMs and LMs on UCN	Number of PMs and LMs on the UCN	1	10	10
US Induced Load				
Universal Stations	Number principally accessing this NIM	3	15	45
Schem. Displays on those USs	Number principally accessing this NIM	1	30	30
HM Induced Load				
History Modules	Number principally accessing this NIM	1	30	30
Checkpointing	Number of HMs checkpointing this NIM	1	70	70
AM and CG Induced Loads				
AMs with 68020 microprocessor	Number principally accessing this NIM	1	150	150
AMs with 68000 microprocessor	Number principally accessing this NIM	0	95	0
Computer Gateways	Number principally accessing this NIM	0	60	0
			Total Induced Load:	**335**
			Maximum Allowable Load:	**1000**
			% of maximum allowable load:	**33.5%**

You should make such an estimate for each NIM in your system. Count redundant node pairs (NIMs, AMs, PMMs, LMs) as one. The load factor for schematic displays is based on a schematic with 250 parameters that is principally accessing this NIM (four-second update interval). The AM load factor is based on a fully-loaded AM accessing data from this NIM.

If you have several NIMs, you might consider using a spread sheet on a personal computer to do your calculations. Table 2-3 is a copy of a Microsoft Excel® spread sheet prepared on a Macintosh® computer.

2.7.2 Assessment of NIM Processing Load

The following are the NIM processing-load categories:

- A NIM whose total induced load is 750 (75%) or less can be expected to perform as specified under all actual system-use conditions.

- If the total induced load is between 750 and 1000 (75% to 100%), the NIM load is marginally acceptable, and display of information from this NIM and its reporting of events may occasionally be sluggish, especially during a process upset or a peak load such as multiple point loading.

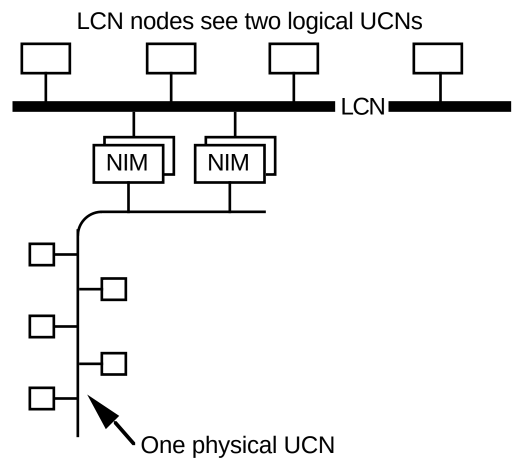
- If the total induced load is above 1000 (100%), the NIM should be considered overloaded, and should a failover to the backup NIM or some other system upset occur, the view to the process may be temporarily lost.

2.7.3 Use of a "Remote" NIM to Share Processing Load

An additional NIM (redundant NIM pair) can be added to the UCN and the LCN to share the processing load with another NIM. To use such a NIM you must adhere to certain rules for point assignments and operational practices.

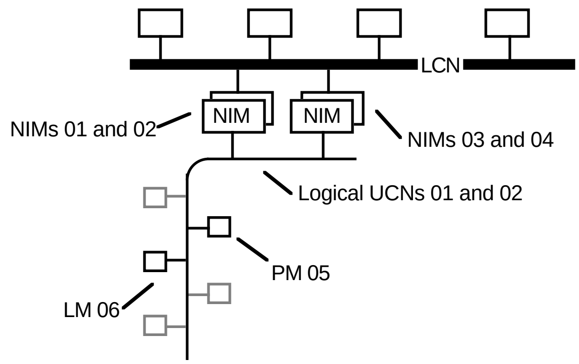
2.7.3.1 Implementation of Two Logical Process Networks

From the LCN viewpoint, the two NIMs (redundant NIM pairs) are on separate process networks, even though they are connected to the same physical UCN. The first NIM (configured as ThisNIM) is assigned to process network n (n is in a range from 1 to 20; each UCN and each Data Hiway is one process network) and the second NIM (configured as RemotNIM) is assigned to process network n+1. The assignment of the network numbers is arbitrary, but consistent, logical assignment simplifies operating practices.



The NIMs to be configured as ThisNIM and RemotNIM and their process networks must first be defined in the NCF through the Engineering Personality's `LCN NODES` activity. Then, all of the UCN nodes, including the NIMs, are defined on both process networks by building UCN entities (NIM points) and Node Specific entities (box points) (for more information about this activity, refer to Section 4). In the UCN Node entities, about half of the nodes on each process network are configured with NODEASSN = ThisNIM and the remainder with NODEASSN = RemotNIM. Each node assigned as ThisNIM on process network n is assigned as RemotNIM on n+1, and each node assigned as ThisNIM on process network n+1 is assigned as RemoteNIM on network n.

For example, for the UCN node numbers in this sketch, you would build the following UCN node and node-specific entities:



Node	UCN	UCN Entity Name	NODEASSN	Node Specific Ent. Name
NIM 01	01	$NM01N01	ThisNIM	N/A
NIM 02	01	$NM01N02	ThisNIM	N/A
NIM 03	01	$NM01N03	RemotNIM	N/A
NIM 04	01	$NM01N04	RemotNIM	N/A
PM 05	01	$NM01N05	ThisNIM	$NM01B05
LM 06	01	$NM01N06	RemotNIM	$NM01B06
NIM 01	02	$NM02N01	RemotNIM	N/A
NIM 02	02	$NM02N02	RemotNIM	N/A
NIM 03	02	$NM02N03	ThisNIM	N/A
NIM 04	02	$NM02N04	ThisNIM	N/A
PM 05	02	$NM02N05	RemotNIM	$NM02B05
LM 06	02	$NM02N06	ThisNIM	$NM02B06

As you build process points to reside on the two logical UCNs, assign approximately equal numbers of points to each UCN (parameter NTWKNUM), but take care to assign points that use peer-to-peer communication to the same UCN (peer-to-peer communication is through connections from points in one UCN node to points in other nodes on the same UCN).

2.7.3.2 Operational Considerations for Two Logical Process Networks

Use of the SAVE DATA target to checkpoint data from the UCN nodes and the restoration of checkpoint data to the nodes can be accomplished only from the UCN Status display for the process network the nodes are assigned to (NODEASSN = ThisNIM). If you try from the wrong display, a “node assignment” error message appears. If some of the points in a UCN node are assigned to process network n and others are assigned to process network n+1, you will have to use SAVE DATA twice, once from each UCN Status display.

For automatic checkpointing to save all data, it must be enabled through the UCN Status displays for both process networks.

Alarming, message transfers, and event-initiated processing are handled by the NIMs and no special operational considerations are required.

2.7.3.3 Functional Relationships of Two Logical Process Networks

Successful implementation and use of two NIMs and logical process networks that share processing loads is more likely if you understand the relationships described here.

The relationships of the two NIMs (or two pairs of redundant NIMs) and the two logical process networks are established through UCN Node configuration. Also, UCN Node configuration assigns nodes on the UCN to one network or the other. The content of each LM and PM is defined in Node Specific configuration. For more information about these activities, refer to Section 4.

The relationships of PMs and LMs to the NIMs are defined in the UCN node point parameter NODEASSN, which contains either ThisNIM or RemotNIM. Two UCN node entities are configured for each UCN node, one on each process network. The PM's or LM's points are processed by the NIM on the process network for which the PM or LM NODEASSN value is ThisNIM.

UCN nodes configured with NODEASSN = RemotNIM appear on the UCN Status display for the process network associated with the NIM that is not processing their points, even though they don't logically belong to that network. The boxes for UCN nodes that logically belong to a process network are green and the boxes for nodes that logically belong to the other process network are yellow.

Because process points are assigned to a process network as the points are built, a PM or LM can contain points that belong to one network and other points that belong to the other network. A point's database resides partly in the PM or LM and partly in the NIM that has the same process network assignment as the point.

Consider this checkpointing example for process networks 1 and 2: When the data for a PM or LM is checkpointed, all point data for the PM or LM is saved in the checkpoint directory for process network 1, but the NIM-resident data for the points assigned to network 2 is not saved until another checkpoint operation saves the data for network 2 in the directory for that network.

2.8 BATTERY BACKUP CONSIDERATIONS

Both the LMM and the LM Power Supply Module (PSM) contain lithium batteries that serve to maintain memory content in the absence of primary power. The LMM's battery backs up its internal memory and the PSM's battery backs up the Logic Controller Memory Module and Register Module.

During the shipment of these modules and when they are stored, the batteries may be protected from discharge by an insulating wafer. These wafers must be removed for normal operation.

While the batteries provide reliable backup of the memories in the absence of primary power, you should not consider that they absolutely assure the retention of data in the memories.

Battery failure causes a SOFTFAIL status to appear at the Universal Station.

If the LMM memory is corrupted a checksum error is detected. If the memory in the Logic Controller's Memory Module or Register Module is corrupted, the PASS indicator on the affected module should be off and the TESTING indicator on the Processor Module remains on continuously (the TESTING indicator flickers, unless the Logic Controller has failed or is repeatedly executing a short loop through the ladder logic program). Corruption of any LM memory causes the LM to fail.

REDUNDANT LOGIC MANAGERS
Section 3

A Redundant Logic Manager system consists of two identically configured LM Processor card files, each of which contains a Redundancy Control Module (RCM). Both LMs are connected to a common I/O Subsystem and the RCMs are linked to each other by a data cable and through the UCN. Any option module, including the LMM, that resides in the Processor card file must also be redundant (one each in each Processor card file). Redundant systems are normally configured using serial I/O. Redundant LMs with serial I/O are shown in Figure 3-1.

NOTE

1. Redundant Logic Managers with parallel I/O are not supported.
2. Adding redundancy to a Logic Manager lengthens the program scan time. The amount of time added to the program depends on the scan time of the program without redundancy. The minimum scan time for any control program in a redundant system is 48 ms. Control programs that are normally (without redundancy) longer than this minimum scan time are lengthened by 14 ms.

   Total program scan time must not exceed 250 ms because of the RCM watchdog timer.

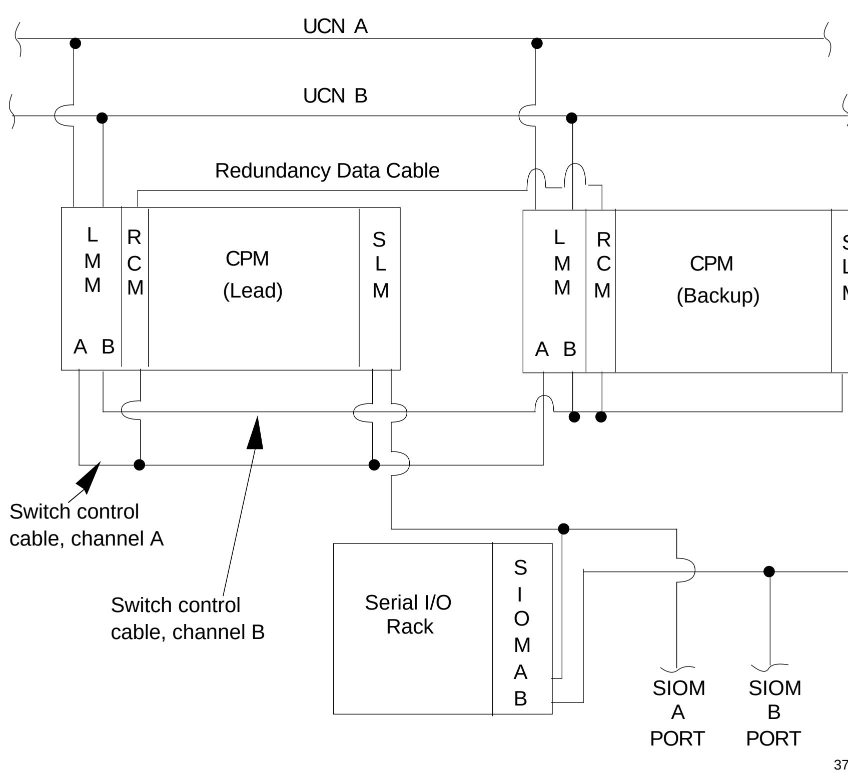


Figure 3-1 — Redundant LMs with Serial I/O

3.1 OPERATION OF REDUNDANT LMMs

If a failure occurs in the lead (primary) LM, the RCMs initiate an orderly switchover of the I/O Subsystem to the backup LM. The backup LM is updated prior to every scan with a copy of the lead Processor's input and output status and register data to ensure identical program execution by the backup, should a switchover occur.

3.1.1 Synchronization of Lead and Backup LMMs

In a redundant LM, the database in LMM in the backup LM is continuously updated from the lead (primary) LMM, through the RCMs and over the UCN (updating over the UCN is sometimes referred to as “flushing”). This means that both LMMs must be operating, therefore, both must have been loaded with their software personality images. This is accomplished using the `PROGRAM LOAD` target on the UCN Status display. Instructions for loading LMMs are in the *Process Operations Manual.*

With the primary LMM loaded and operating (`RUN` status on the UCN Status display), just after the backup LMM is loaded with the personality image, it is synchronized by receiving a copy of the database from the lead Logic Manager. Before the backup LMM received the database, its status shows as `NOSYNCH`. When it is synchronized, its status goes to `SYNCH`. If synchronization is not completed, it is retried up to three times. If that fails, you can force up to three more synchronization attempts by giving the primary LM a RUN STATES command (STARTUP or IDLE) from the UCN Status display. Either of these commands will trigger synchronization, regardless of the existing primary mode.

3.1.2 Operation During a Switchover (See NOTE on next page)

If a switchover (failover) from the lead LM to the backup occurs, all outputs are held frozen until all input, output, PULL and PUSH data is gathered. Once all of the serial I/O data is gathered, the Input/PULL Data Ready bit is set (for more information, refer to Section 2, Table 2-2), and the SIOMs are released to write new output data. Initially, the new lead SLM does not have valid I/O data, and it must obtain all input, output, PULL and PUSH data. One I/O scan gathers the input data, then another I/O scan transfers the output and PUSH data. The Input/PULL Data Ready bit clears (0) to indicate to the first ISS instruction that data is not available. Thus, the ladder logic program or a communication module can determine that the input data is not valid, and can take appropriate action; for example, a ladder-logic line can cause a return to the beginning of the program (RBP) until data is ready.

WARNING

Input Scan Instructions: Use of the user-programmed ISS instruction is not permitted in redundant controllers. The ISS instruction will:

cause each controller to temporarily suspend control program execution while they update their respective Input Status Tables, and,

initiate an additional database transfer from the lead to backup controller after the Input Status Tables have been updated.

This can sufficiently increase total scan time causing the scan loss watchdog timers to timeout.

CAUTION

Address 4112 (do not use this address in a redundant LM)

A user programmable switchover function allows the control program of the lead controller to generate a switchover command to the back up controller. This is done by programming a **Transition ON contact** to a coil addressed as **4112**.

When the coil is energized it is read by the lead RCM which sends a message to the backup RCM. This message instructs the backup RCM to generate a lead request command to the lead RCM at the next RCM-to-RCM database transfer operation.

This operation has the same effect as pressing the **Lead Request** pushbutton on the backup RCM when the function is enabled.

The switchover operation initiated via address **4112** is **level sensitive**. Address **4112** **must** be de-energized after switchover is initiated. If it is not, the controllers will bounce between lead and backup operating states as long as address **4112** is on. The **Transition ON contact** satisfies this requirement since its state is true/on for only one ladder logic scan after an off-to-on transition.

3.1.3 Ladder Logic Program Changes

If the ladder logic program in the lead LM is changed, to get the changes into the backup LM, change the keyswitch on the backup LM to something other than RUN, then (see warning below) change it back to RUN. This causes the Logic Manager database, including ladder logic to be transferred to the backup Logic Controller. You can also cause the backup LM's database to be resynchronized by using the Detail Status display to shutdown, reload, and restart the backup LM.

WARNING

It you have made an on-line ladder logic change to the primary LM, a period of time is required for a new checksum to be calculated; therefore, to avoid a crash of the backup, wait at least 30 seconds before returning the keyswitch position on the backup LM to RUN.

3.1.4 LM UCN Addresses for Redundant Operation

We recommend that you always assign an odd UCN address for the LMM in the primary LM and an even address for the LMM in the backup LM. This allows a more clear interpretation of the UCN and LM status displays when the LMs are loaded. To load the program image and data in the LMs, load the primary first (odd address) and then load the secondary (even address).

3.1.5 Load Sequence Instruction Not Allowed in Redundant LMs

The Load Sequencer instruction, (`--(LS2)--`) cannot be used in redundant LMs because it can cause unpredictable memory changes and possible differences in the ladder logic in the primary and secondary LMs. In many cases it is possible to use an Indirect Bring In instruction (`--<B2>--`), an Indirect Send-Out instruction (`--(I2)--`), and a block of register transfers to implement a similar function.

3.1.6 Ladder Logic Program Considerations for Redundant LMs

For redundant LMs, some additional logic, as compared to nonredundant LMs, is required at the beginning of the system ladder logic program to monitor Serial I/O status. The recommended logic for redundant Logic Managers is presented on the following pages. See subsection 2.3.6 for the logic required by a nonredundant LM. A detailed description of the logic can be found in Appendix A.

LADDER LOGIC DIAGNOSTIC FOR REDUNDANT LOGIC MANAGER

> **NOTE**
>
> With the exception of real I/O addresses 2040 through 2047, and address 2263, the LCS addresses used in this example are arbitrary.

Line #1 — Turn coil 2045 OFF.

```
                                                              SERIOOK
                                                              2045
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - (U) - - - - - - -
```

Line #2 — Pull serial status bits and send to monitor register. Use this register for monitoring only.

```
     Serial status                                       Serial status
     bit register                                        bits (monitor)
     SerStat                                             StatBit
     2040                                                3066
- - -[PUL]- - - - - - - - - - - - - - - - - - - - - - - -(S2)- - - - - - -
       1                                                   0
```

Line #3 — Perform divide by 256 operation on serial status register 2047 to split out upper and lower 8 bits. Store quotient (upper 8 bits) in number of SIOMs on-line, ch.4.

```
                   # SIOMs
                   on-line,
                   chs. 3&4
                   #SIOM34
                   2047                                   8049
- - ]K2 [- - - - -[PUL]- - [ / ] - - [K2] - - - - - - - - (PSH)-
     0               1                256                   2
```

Line #4 — Store remainder (lower 8 bits) as number of SIOMs on-line on ch.3.

```
                                                    # of SIOMs
                                                    on-line, ch. 3
                                                    # SIOM3
     8049                                           8047
- - -[B2]- - - - - - - - - - - - - - - - - - - - - -(S2)- - - - -
      0                                               0
```

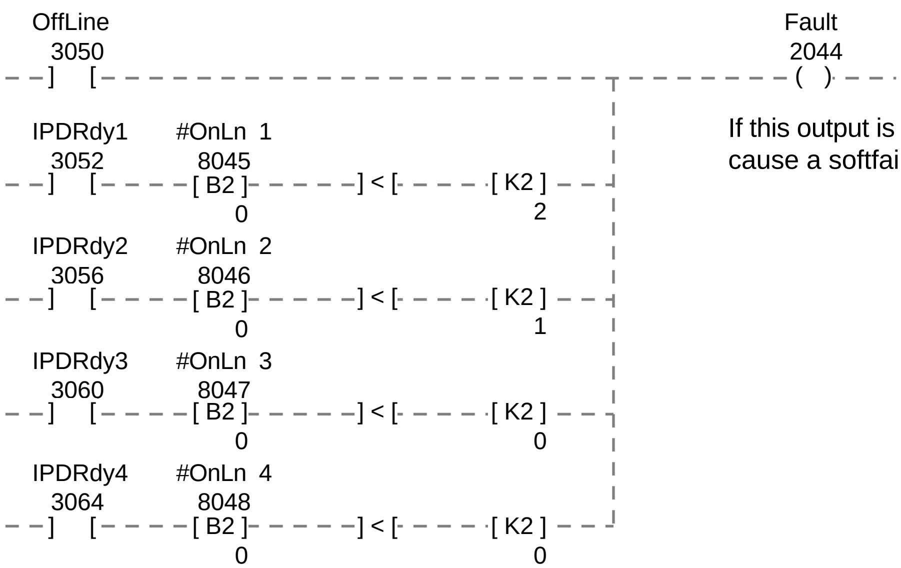
Line #5 — Obtain and store the number of SIOMs on-line for chs. 1 & 2.

```
    #SIOM2                                            #SIOM2
    2046                                              8046
- - [PUL] - - - - - - - - - - - - - - - - - - - - - - (PSH) - -
      2                                                 2
```

continued on next page

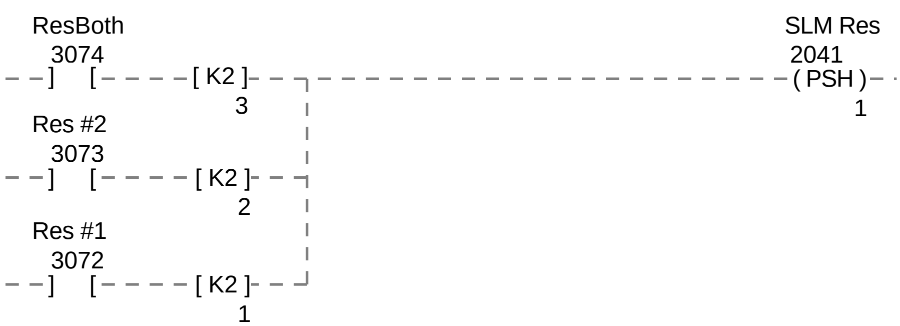
Line #6 — Check SIOM off-line flags. Set output bit if any flag is true.

Line #7 — Compare actual number of active SIOMs with expected number of SIOMS on all links. Set output bit if mismatch occurs or if offline flag is on. Adjust constant to match the number of SIOMs wired on each link.



If this output is on, it will cause a softfail "61."

Line #8 — Set 3074 to restart both SLMs or set 3073 to restart SLM 2 or set 3072 to restart SLM 1.



continued on next page

Line #9 — Compare redundancy status to determine if unit is in backup mode.

```
   Redun                                                                Unit in
   status                                                               backup
   register                                                             mode
   Redstat                                                              Backup
   2263                                                                 2049
-- -[PUL]- - - -[ = ] - - - [K2] - - - - - - - - - - - - - - - - - - - -( )- - - - - -
     1                       3
```

Line #10 — If unit is just becoming backup, perform short scan. This allows last serial link scan to complete on old leader.

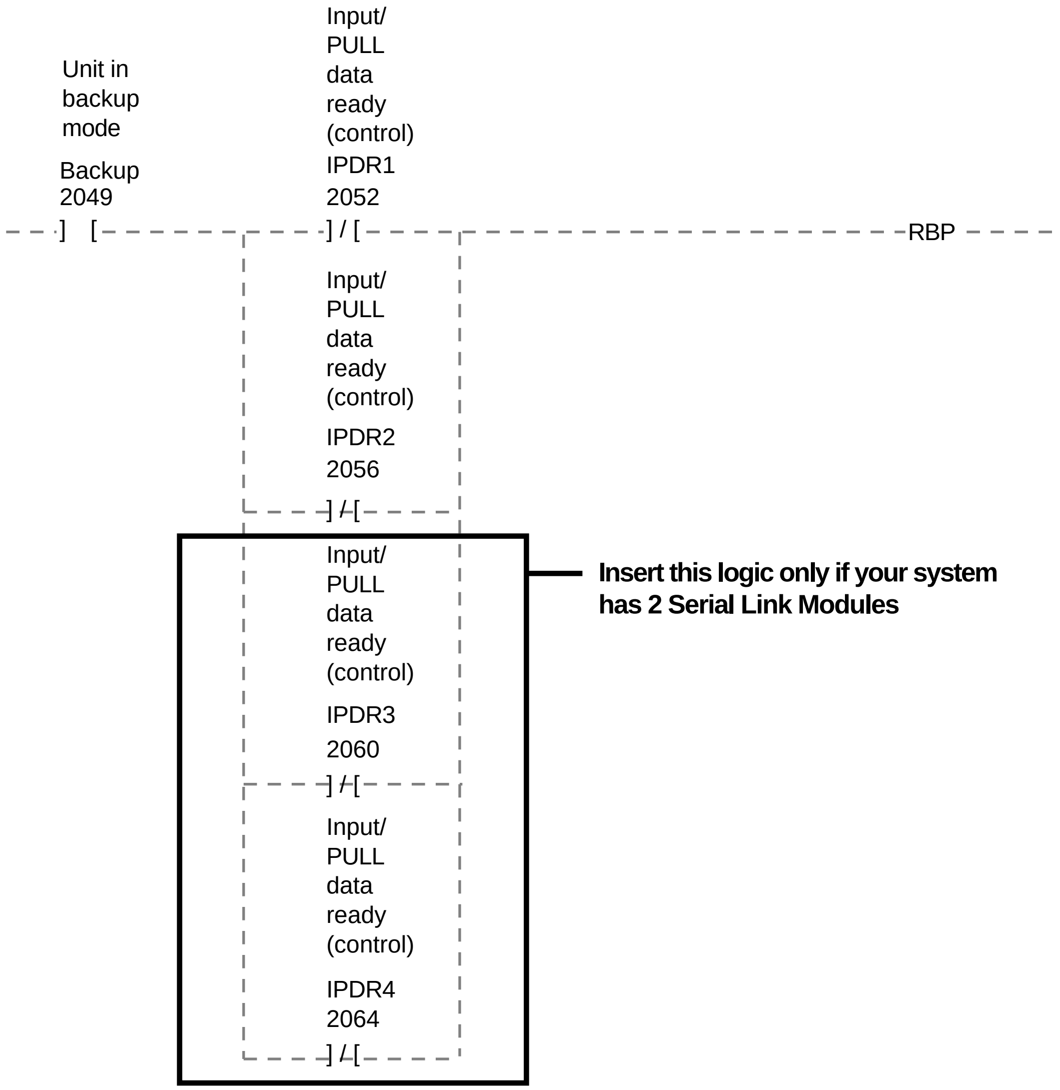
```
   Unit in
   backup
   mode
   Backup
   2049
-- -] /\ [ - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -RBP- - - -
```

Line #11 — If unit is just becoming backup, perform short scan. This allows last serial link scan to complete on old leader.

```
   Unit in
   backup
   mode
   Backup
   2049
-- -] /\ [- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -RBP - - - -
```

continued on next page

Line #12 — If the unit is the backup, and the Input/PULL Data Ready bits for all links are not ON, then short scan. If the unit is the backup, then the IPDRs being monitored are from the lead unit. This effectively holds the backup in short scan until it has completed its final serial link scan, and the new leader has brought all SIOM data up to date. Force OFF or do not program IPDR bits for unused channels.

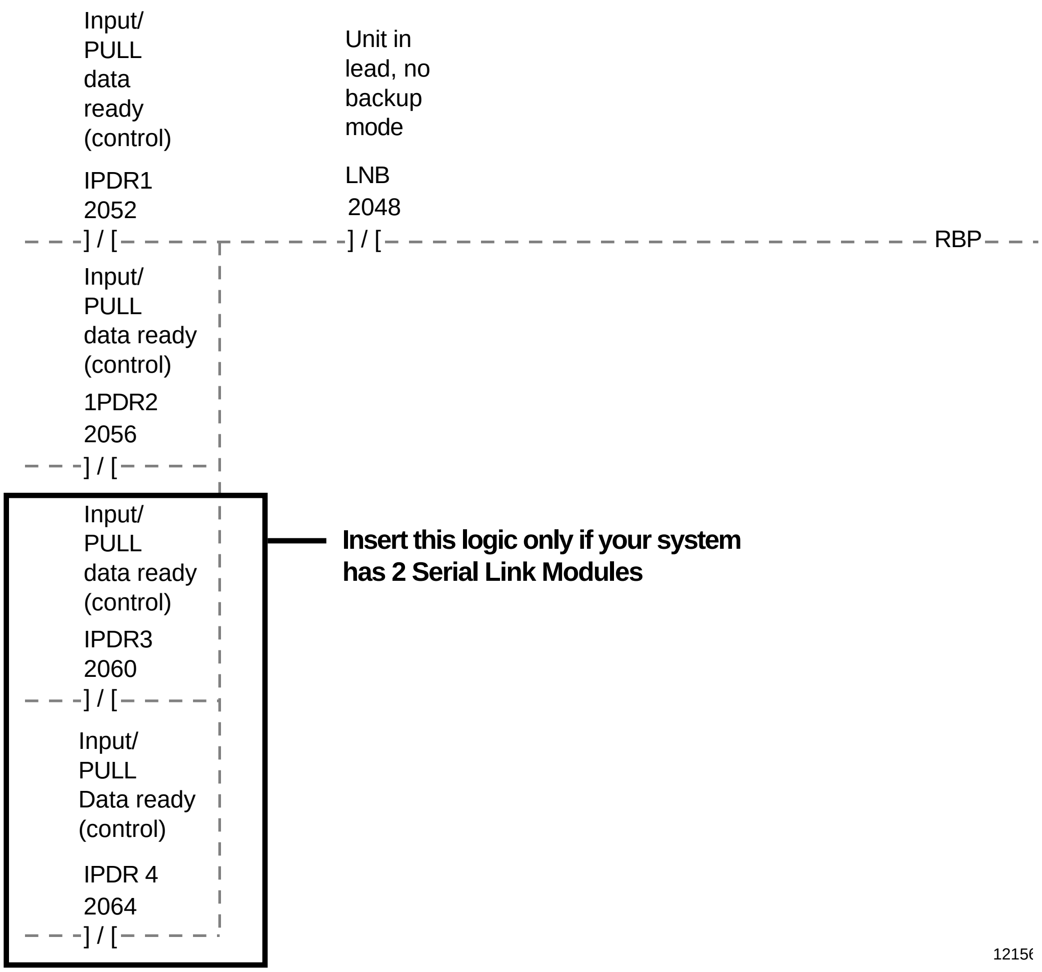


Line #13 — PULL the serial status bits and send them to I/O range to decode. These bits are used to control the link scan; this sendout address should not be the same as in line 2, which is used for monitoring.

continued on next page

Line #14 — The SLM monitors this data and manipulates the IPDR bits according to the data. If the RCM indicates anything other than lead without Backup, the IPDR bits will be turned off at power up, while assuming Lead at redundant switchover, or anytime a communications link is shut down. If the RCM indicates Lead without Backup, the IPDR bits will be turned off only at power up or while assuming the lead at redundant switchover. If a communications link enters the shutdown state, the IPDR bit will remain on.

Line #15 — If any link has shutdown, as indicated by the IPDR bit for that channel being OFF, and the unit is not in the lead, no backup mode, then short scan. This prevents the program from executing if a link has shutdown, unless the unit is LNB. If the unit is LNB, then running without the link is the best you can do. Since the line that controls 2048, the LNB bit, is after this line, this line also functions to keep the user ladder logic program from executing until all links are up and running. Force OFF or don't program IPDR bits for unused channels.



continued on next page

Line #16 — Determine if the unit is in lead, no backup mode.

```
                                                              Unit in
     Redun                                                    lead, no
     status                                                   backup
     register                                                 mode
     redstat                                                  LNB
     2263                                                     2048
-- -[PUL]-- ]=[- - --[K2] --------------------------------------( )-----------
       1                1
```

Line #17 – Turn coil 2045 ON.

```
                                                              SERIOOK
                                                               2045
-----------------------------------------------------------    (L)   -------
```

If 2045 is not on, it will cause softfail "52."

3.1.7 SLM Handshaking and Status Bits

The following functions are built-in and require no user programming.

Four of the bits in register 2040 are reserved for RCM/SLM handshaking and to indicate RCM/SLM status (for more information about serial I/O status refer to Table 2-2 in Section 2). These bits are:

2040, bit 2—RCM/SLM handshaking bit, SLM #1
2040, bit 10—RCM/SLM handshaking bit, SLM #2
2040, bit 6—Lead/backup status bit, SLM #1
2040, bit 14—Lead/backup status bit, SLM #2

The RCMs and SLMs exchange the handshaking bits continuously, each verifying that the other is operating. The RCM and SLM use a combination of PUSHes, PULLs, and outputs to verify that the SLM's I/O bus lines are operating properly. If an SLM does not change its handshaking bit within an internally-specified time, and if the SLM involved is the lead SLM, the RCM initiates a switchover.

The RCMs and SLMs use the lead/backup bits to arbitrate which are the leaders and which are backups. If the lead RCM determines that its SLM no longer indicates that it is the leader, it initiates a switchover. If the new lead SLM does not acknowledge the lead request within a specified time, the new lead RCM declares a serial I/O fault, initiates a switchback, and disconnects from the other RCM.

3.1.8 Removal of Power from a Redundant LM

If the power is removed from either the lead (primary) Logic Controller or the backup Logic Controller, the serial I/O link goes through an orderly shutdown which is similar to that for a nonredundant system.

If the backup LC loses power, the SIOMs are no longer updated over the backup link. The lead link remains active, and the SLM clears the corresponding All SIOMs active on Redundant Link bit in the serial I/O status table (Table 2-2 in Section 2).

If the lead LC loses power, the RCMs note the change and select the backup LC as the new lead LC. The serial I/O subsystem switches communication to the backup link and shuts off communication on the former lead link.

3.1.9 Mode Changes in Redundant LMs

When the keyswitch on the backup Logic Controller is placed in the PROGRAM or DISABLE positions, communication over the lead link continues, but output and PUSH data are no longer updated in the backup LC.

Placing the primary Logic Controller keyswitch into PROG or DISABLE causes an <u>immediate</u> clearing of <u>all</u> I/O, followed by a switchover. For this reason, if it is necessary to place the primary Logic Controller into PROG or DISABLE, first use the SWAP PRIMARY target on the UCN Status display or the Lead Select switch on the backup Logic Controller to force the lead to the backup controller. THEN change the keyswitch on the original primary unit.

3.1.10 Resetting and Restarting Redundant LMs

If the lead (primary), backup, or both communication ports of an SIOM should go off line, the corresponding SIOM channel is taken off-line. If it is the lead SIOM that goes off line, the RCM switches to the backup Logic Controller.

Either serial I/O subsystem (if it has no faults) can be restarted by turning off power to the LC and then turning it back on. They can also be restarted by temporarily connecting a jumper between the Reset terminals on the SLM. When a serial I/O subsystem is thus restarted, it comes up as the backup, and the link that is already operating continues as the lead link. In addition, the link can be restarted by pushing a value to the SLM restart register (see section A.4).

You can reset an SIOM on the backup link by connecting a jumper between the Reset terminals on the backup SLM. This resets all SIOMs on the backup link. Turning power off and then back on at the card file with the off-line SIOM port, also resets both the lead and backup SIOMs.

3.1.11 Fault Detection in Redundant LMs

You may find it helpful to look at Figure 3-1 as you read the following.

3.1.11.1 Card-Fault Information

The RCM sends card-fault (board-fault) information from the lead (primary) Logic Controller to the backup LC. The backup RCM does not transmit such information, but does acknowledge card-fault messages from the lead RCM.

3.1.11.2 Error in a Message From and To the Backup Logic Controller

If an SIOM detects a error in a message from the backup LC, it does not acknowledge that message, and this causes the LC to repeat the message. If the second message is accepted, the SIOM responds with an acknowledge message. However, if the second message also has an error, the backup LC's SLM stops communicating with the affected SIOM. In this situation, the lead link and its SIOM port are unaffected—Input/PULL data is still transferred from the lead LC to the backup and output/PUSH data remains unaffected. The Active LED on the affected port on the SIOM goes off and the Backup SLM Link Fault LED comes on. The All SIOMs Active on Redundant Link bit (Table 2-2 in Section 2) is cleared.

If the backup SLM detects an error in a message from an SIOM, the affected serial I/O link behaves as described in the preceding paragraph.

3.1.11.3 Error in a Message From and To the Lead Logic Controller

If an SIOM detects a message error from the lead LC, it does not acknowledge the message and the lead LC's SLM sends it again. If the second message has an error, the lead SLM stops communicating with the SIOM and the SIOM goes off-line. Communication on the backup link is unaffected but the Input/PULL Data Ready bit (Table 2-2 in Section 2) for the affected channel is cleared. The RCMs continues to transfer all input and register data from the lead LC to the backup LC, but there is no input data for the addresses of the affected card file. The backup LC's SLM continues to send messages to the affected card file over the backup link, but this data is not output because it is from the backup LC. On the affected SIOM, the Port Active LED for the affected port goes off, both Lead LEDs on the SIOMs turn off, and the SLM Link Fault LED comes on.

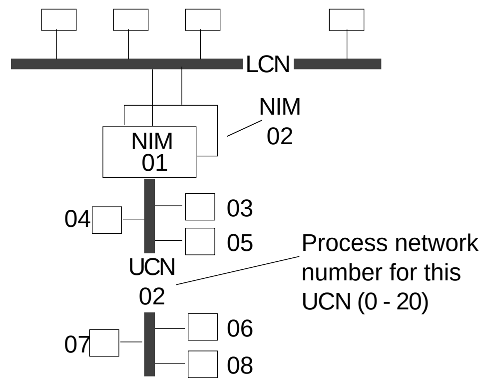
If the lead SLM detects an error in a message from an SIOM, the serial I/O link behaves as described in the preceding paragraph.

When an SIOM goes off-line, its output and PUSH data are frozen long enough to determine if switchover should occur. If switchover does occur, it is bumpless. If it does not occur within a predetermined time, the output and PUSH data are either frozen in the last state or cleared, as determined by switch settings on the SIOM (for more information about Logic Manager switch settings, refer to the *Logic Manager Site Planning* manual in the *System Site Planning* binder and *Logic Manager Installation* manual in this *Implementation/Logic Manager* binder).

Switches on the SLM can be set up to cause switchover when an SIOM or an entire link goes off-line. To effect such a switchover, the ladder logic program must have the lines shown under subsection 3.1.6.

BUILDING UCN POINTS AND NODE-SPECIFIC POINTS
Section 4

A UCN point must be built for each node on a UCN, including each NIM, each LM, and each PMM, including any redundant partners. Also, you must build a node-specific point for each LM and each PMM on the UCN. The UCN and LCN points are reserved entities (see subsection 2.1 of the *Data Entry Builder Manual* for more information about reserved entities). These entities must be built and loaded before data points can be loaded into the nodes on the UCN.



These entities are built with the Data Entity Builder. After you select `NETWORK INTERFACE MODULE` on the Engineering Main Menu, select the `UCN NODE CONFIGURATION` and `NODE SPECIFIC CONFIGURATION` picks to access the Parameter Entry Displays (PEDs) used to build them. For information about the values to be entered refer to the *Logic Manager Parameter Reference Dictionary* in this *Implementation/Logic Manager* binder.

For the UCN example in the sketch above, the following reserved entities would be built:

UCN Node	UCN Point	Node-Specific Point
NIM, UCN node no. 1	$NM02N01	N/A
NIM, UCN node. no. 2	$NM02N02	N/A
LM (or PMM), node no. 3	$NM02N03	$NM02B03
.	.	.
.	.	.
.	.	.
LM (or PMM), node no. 8	$NM02N08	$NM02B08

In the example above, NIM 01 and NIM 02 are partners in a redundant node pair. The LMs (or PMMs) can also be paired as redundant partners (for more information, see Section 3) or they can be independent. A UCN point and a node-specific point must be built for each LM and PMM, including all redundant partners.

DESCRIPTION OF LADDER LOGIC DIAGNOSTIC PROGRAM
Appendix A

This appendix presents a detailed explanation of the diagnostic coding that should be inserted at the beginning of every ladder logic program in a Logic Manager with a serial I/O system. ***See subsections 2.3.6 (nonredundant LM) and 3.1.6 (redundant LM) for the program itself.***

A.1 I/O ON-LINE INDICATOR

Internal coil 2045 is used to notify the Logic Manager Module of the ladder logic program status. Line 1 of the diagnostic program turns this coil OFF. The last line of the diagnostic (Line 11 for nonredundant systems and Line 16 for redundant systems) turns the coil back ON, indicating that the I/O is now on-line.

A.2 SERIAL STATUS REGISTERS (Table A-1)

Information on the serial I/O system is available through the Serial I/O Status Registers. This block of eight registers is located at addresses 2040–2047 in real I/O. Since the Serial I/O Status Registers are used by the serial I/O system, you cannot place I/O cards in these addresses, and should not use them for any purpose other than serial I/O status. Note that the serial system does not allow any card file that is configured to contain addresses 2040–2047 to be brought on-line.

The information in these registers is shown in Tables A-1 and A-2, and is discussed in the following paragraphs. Lines 1 through 8 of the program, which are the same for redundant and nonredundant systems, use the information in these registers to provide the information to the LMM for the Detail Status displays.

A.2.1 Serial Status Bits Register

The program first PULLs the Serial Status Bits Register, and sends its data to control I/O ending at 3064. Doing this saves the register's contents.

A.2.2 Starting Address of SIOM Off-Line Registers

Table A-1 — Serial Status Registers

Register	Example Program Address	Channel	Description
2040	8040	1 - 4	Serial Status bits (see Table A-2)
2041	8041	1	Starting Address of SIOM Off-Line
2042	8042	2	Starting Address of SIOM Off-Line
2043	8043	3	Starting Address of SIOM Off-Line
2044	8044	4	Starting Address of SIOM Off-Line
2045	8045	1	Number of SIOMs On-Line
2046	8046	2	Number of SIOMs On-Line
2047	8047-8048	3 - 4	Number of SIOMs On-Line*

* Bits 0-7 of Register 2047 contain the number of SIOMs on-line for channel 3.
Bits 8-15 of Register 2047 contain the number of SIOMs on-line for channel 4.

Table A-2 — Register 2040 Serial Status Bits (Ladder Logic is shown in 3.1.6)

Bit	Example Program Address Monitor/Control	Channel	Description	Normal State
0	3051/2051	1	SIOM Off-Line Flag	OFF
1	3052/2052	1	Input/Pull Data Ready (IPDR)	ON
4	3055/2055	2	SIOM Off-Line Flag	OFF
5	3056/2056	2	Input/Pull Data Ready (IPDR)	ON
8	3059/2059	3	SIOM Off-Line Flag	OFF
9	3060/2060	3	Input/Pull Data Ready (IPDR)	ON
12	3063/2063	4	SIOM Off-Line Flag	OFF
13	3064/2064	4	Input/Pull Data Ready (IPDR)	ON

Table A-3 — Error Codes

Value	Error Condition
10,000	Too many retries within a single serial link scan
20,000	Transmitter failure detected by SLM
30,000	Channel was shut down by other channel

On the detailed status displays, it should be noted that error codes may be placed in the Starting Address of SIOM Off-Line register to indicate why a channel was shut down. These error codes, which are outside the normal I/O range, are placed in the register if a problem occurs that was not the fault of a specific SIOM. The error codes shown in Table A-3 are in decimal. Note that when these errors occur, all communications on the channel cease, the SIOM Off-Line Flag is set and the proper value is displayed. Also note that a SIOM that has not come on-line since the last SLM reset or power cycle, does not go off-line; therefore, it does not cause the SIOM Off-line Flag to be set, or the Starting Address of SIOM Off-line register to change. However, the ladder logic will detect a mismatch in the number of SIOMS on line and will set the Serial Fault output, causing a soft fail.

A.2.3 Number of SIOMs On-Line

Lines 3 and 4 of the example program are used to separate the high- and low-order bits of 2047, which contains the number of SIOMs on-line for both channels 3 and 4. The division by 256 ($100) places the number of channel 3 SIOMs in the remainder (8047) and the number of channel 4 SIOMs in the quotient (8048). Line 5 obtains the number of SIOMS on-line for channels 1 and 2.

The number of SIOMs that should be present on each link are compared with the actual number in the Number of SIOMs On-Line register. Line 7, which performs this function, conditions the comparison with the Input/PULL Data Ready bits for the respective channels to make sure that the comparison is not performed until the links are configured and running. The user should adjust the constants in these lines to match the number of SIOMs installed on each link of the system.

A.3 SERIAL STATUS BITS

A.3.1 SIOM Off-Line Flag

These bits are used to indicate if any SIOM that has been on-line, on a particular channel, has gone off-line. Line 6 tests these bits and sets the output bit if any SIOMS go off line.

A.3.2 Input/PULL Data Ready Bits (IPDR)

These bits are used to inform the system that the data available from the SLM is valid. These bits are turned off by the SLM at reset or power-up and remain off until the link configuration process is complete and the SLM has obtained input and PULL data from all of the card files on the associated link. The use of these bits in nonredundant and redundant systems is explained further in the applicable programming sections in the example program.

A.3.3 RCM/SLM Handshake Bits

Each of these bits is associated with a single SLM. Bit 2 is associated with the SLM that is set as SLM #1. This is done by setting SW6 on the module to OFF.

When used in redundant configurations with Redundancy Control Modules (RCMs), these bits are used by the SLM to tell the RCM that it is still active and functioning. The bits, which are turned ON by the SLM, are read by the RCM, which turns them OFF. For this reason, they will appear to toggle in the user program. If the RCM sees the bits remain static for more than 0.5 second, it assumes that the SLM has faulted and can no longer update the bits. If this occurs, the RCM annunciates a Serial Link Fault (Flash Code 11), and initiates an immediate switchover to the backup.

In nonredundant systems, the bit is initially turned ON by the SLM, and since there is no RCM to turn the bit OFF, it remains ON continuously.

A.3.4 All SIOMs Active on Redundant Link (ASARL)

In a nonredundant system these bits have no use. In a redundant system, these bits indicate if the SIOMs on the same link of the other controller are all active. The bit will be ON if the starting address of every active SIOM on the associated link on this controller is active (on-line) in the other controller. Basically, this information can be used to tell if the redundant links are running correctly by examining the status bits in the lead unit.

It should be noted that the ASARL bits are undefined if there is no redundant link (nonredundant system), or if there are no SIOMs active on this channel on this logic controller. Also note that if an SIOM is currently off-line on one channel, it is not possible to tell if the SIOM's other port is on-line or not.

A.3.5 SLM Lead/Backup Status

Each of these bits is associated with a single SLM. Bit 6 is associated with the SLM that is set as SLM #1. This is done by setting SW6 on the module to OFF.

In redundant systems, this bit reflects the state of the input of the RCM Lead Select Cable on the SLM's front connector. A "1" is used to indicate an active lead select condition, indicating this SLM is in the lead. If, for any reason, the status of this bit and the leadership state of the RCM in the card file disagree, the RCM annunciates a Serial Link Fault (flash code 11) and initiates a switchover if necessary. The most common cause of this type of problem is the Lead Select Cable being removed from either the SLM or the RCM.

In nonredundant systems, this bit is initialized to the OFF state.

A.4 RESTARTING A SERIAL LINK

The user has the option of restarting a serial link from the ladder logic program or an option module. This can be done only in the RUN or RUN/PROGRAM mode. It is not effective in the DISABLE or PROGRAM mode. Restarting a serial link is done by PUSHing a value to 2041, the SLM Restart Register. Restarts performed from this register have the same effect as shorting the restart terminals on the SLM: Any links that were shutdown are restarted, and any card files that were taken off-line by the SLM will be retried.

Line 8 allows the user to set FORCEs to perform serial link restarts. Forcing 3074 restarts both links, while forcing 3073 or 3072 restarts SLMs 2 or 1, respectively. Since the value needs only to be PUSHed once, and since it automatically clears when the PUSH is stopped, these forces should be cleared as soon as possible after using them. Also note that forcing contacts in one logic controller of a redundant pair does not affect the other logic controller unless a program download occurs.

Alternatively, if option modules are used in the system, the user may restart the links by performing a PUSH from the option card. In the case of the HIM, it is possible to restart only the lead unit of a redundant system. Note that if a value is read back from the address, it will be the value of Starting Address of SIOM Off-line for Link 1.

A.5 NONREDUNDANT SYSTEM PROGRAM LOGIC

Line 9 of the example program in subsection 2.3.6 is required for orderly start-up of the logic controller system. On system start-up, the serial system brings card files on-line one at a time. Running the program with only some card files on-line could potentially cause unexpected operation. To prevent the program from executing until the system has completed its link configuration routines, the line looks at the Input/PULL Data Ready bits to determine if all links have become active, and to see if the processor has executed the remainder of the program yet. The user must be sure to either force OFF or remove, from the line, any IPDR bits for unused channels. The logic line prevents execution of the program until all links have become active. The logic controller remains in this state, referred to as "short scan," until all links have become active. Once all links have become active, the program begins executing all lines. Upon executing line 10, the program sets a bit that indicates that the logic controller has progressed past the short scan state. If a serial link fault should occur after this point, causing the IPDR for the associated channel to go OFF, the logic controller continues to scan the entire program.

If the user desires to perform a reset of the SLM and to have a synchronous system restart (i.e., the program does not execute until all links have restarted), then the normally closed contact 3075 on line 9 should be forced ON (closed) before the reset is attempted. Once the user observes all IPDR bits to be ON again, the force should be cleared.

A.6 REDUNDANT SYSTEM PROGRAM LOGIC

Line 9 of subsection 3.1.6 performs a comparison to determine if the unit is in the backup state. This information is used in lines 10 and 11 to control the program scan of the backup unit.

Line 10 is used to prevent the remainder of the user program from executing in the backup for one scan after a switchover. After that scan has completed, line 11 causes the program to short scan one more time. These two short scans ensure that the new backup logic controller has had its register and I/O table data updated from the new lead unit. Once this has occurred, line 12 controls program execution. In a backup unit, this line will prevent full program scan until all Input/PULL Data Ready Bits from the lead unit have come ON, which does not occur until all SIOMs have switched-over.

Basically, the short scanning in the backup immediately after switchover ensures that the new backup unit will not alter the I/O while the new lead is attempting to take control of the SIOMs. This operation is necessary to assure that the switchover is bumpless; that is, that no points unexpectedly change states during switchover. For this reason, it is critically important that this switchover program be installed in all redundant Logic Manager systems with serial I/O. The following points should also be understood about the switchover program:

1. The addresses used to decode the serial I/O bits for monitoring purposes on line #2 must not be used to control the switchover. The addresses used to control the switchover should be those decoded on line 13, and must be decoded after the serial switchover control line 12. Otherwise, the user program in the new backup uses its own serial status, and not the status of the new leader, to control the scan. Doing this allows the backup to scan and potentially cause I/O changes while the new lead is attempting to gain control of the SIOMs (data "bumps").

2. The user should force OFF or not program the IPDR bits for unused channels on serial switchover lines, 12 and 15. Note that if forces are used, they must also be forced in the backup or a program download must occur to the backup.

Line 13 PULLs and decodes the serial status bits in the logic controller. Since this line occurs after the serial switchover control line, the switchover control line always uses the IPDR bits from the current running lead.

Line 14 is used to monitor the status of the RCM and cause an action within the SLM. The SLM monitors this data and manipulates the IPDR bits according to the data. If the RCM indicates **anything** other than **Lead without Backup,** the IPDR bits will be turned off at power up, while assuming Lead at redundant switchover, or any time a communications link is shut down. If the RCM indicates **Lead without Backup,** the IPDR bits will be turned off only at power up or while assuming the lead at redundant switchover. If a communications link enters the shutdown state, the IPDR bit will remain on.

Line 15 is used to cause a short scan in a logic controller that does not have all of its links currently ready. This line causes the program to short scan after power-up, SLM reset, or switchover until the links are configured and the IPDR bits for all channels indicate that the data is current and accurate. After link configuration, the line will prevent a short scan if any of the serial links shut down and the unit is in the lead with no backup (LNB) mode.

Line 16 is used to determine if the unit is in the LNB state, for use in Line 15. The LNB flag is not set until after line 15, to force a short scan after power-up until the links have been configured.

LM RECOVERY PROCEDURES
Appendix B

B.1 RECOVERY PROCEDURES

There are two partners in a redundant Logic Manager configuration. A preferred and nonpreferred. Each is contained it its own rack or cardfile and communicates with the Redundancy Control Module (RCM) and the Serial Link Module (SLM) in its own rack via local cabling. A data cable also connects the RCMs in the preferred and nonpreferred Logic Managers. The cable is used to pass data between the Lead (primary) and the Backup (secondary) Logic Managers.

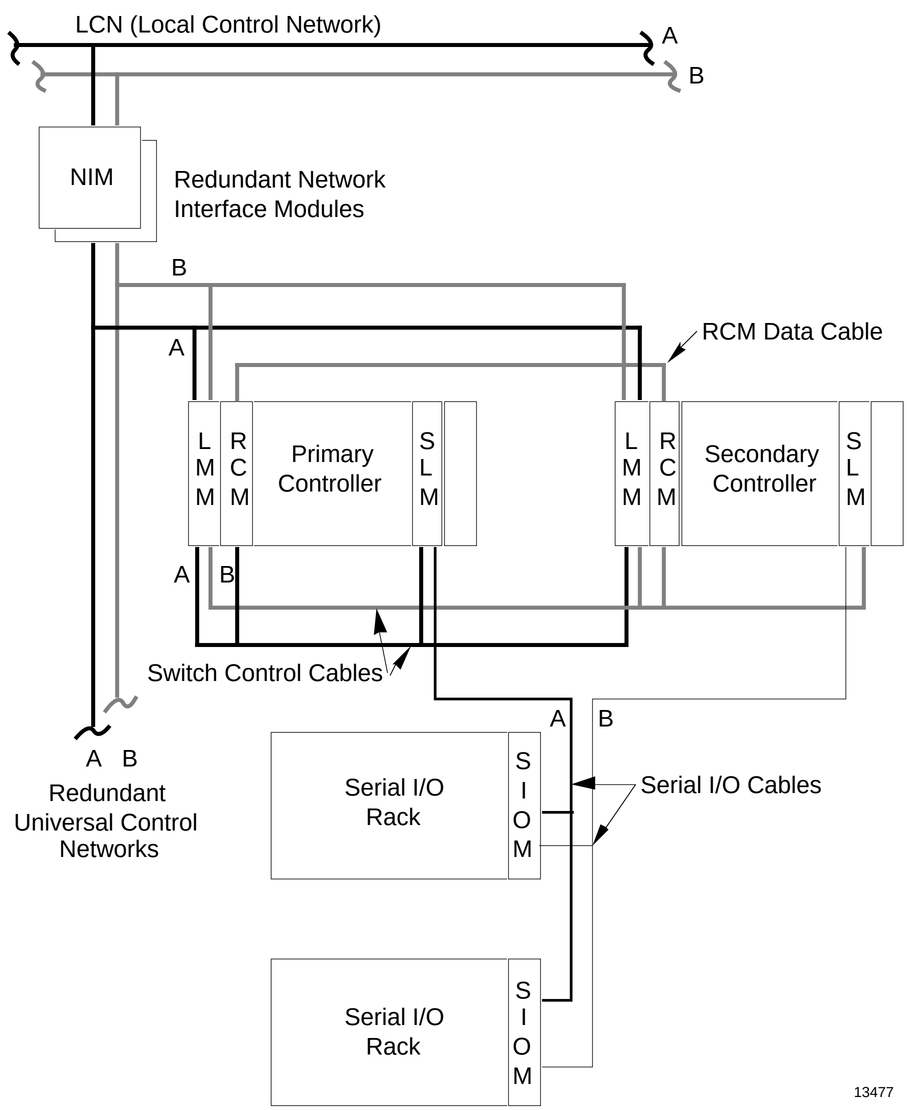


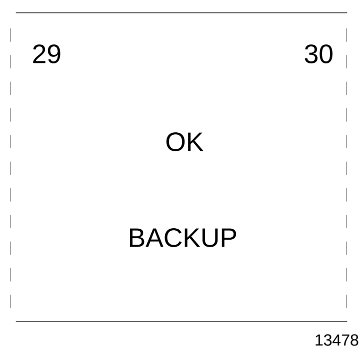
Figure B-1 — Redundant Logic Manager Configuration

The preference is to refer to the Logic Managers as preferred and nonpreferred and serves several purposes. **(Preferred and nonpreferred are physical devices. OK always equals the lead controller (preferred to nonpreferred).)**

1. Rack identification (versus right/left, top/bottom, etc.)
2. Startup default (resolves contention during simultaneous startup)
3. Failure default (if partners lose contact with each other..who takes over?)
4. Control preference (one way Relay Ladder Transfer; sensitivity to I/O link faults).

A normal running LM displays a UCN status box containing the LM designation and numbers in the upper left and right corners with the terms "OK" and "Backup" in cyan. Typically, the preferred LM is the Lead (or Primary) LM. This means it has control of the process and the ladder logic in its logic controller is running things. The LM in the Backup (or Secondary) position is usually the nonpreferred LM and it is standing by waiting to take over the Lead (Primary LM). For various reasons, the nonpreferred may be in the lead (the lead light will be lit on its RCM and its associated LM is displayed as "OK" on the UCN).

The lead LM always takes the lower, odd node number and the backup LM takes the higher, even node number. This is true even when the non-preferred LM is the lead.



In the example above, LM29 is the Lead LM; it may be the preferred or the nonpreferred controller. The three ways to determine which LM is in the lead are:

1. Request the detail display for the LM on the UCN status display.
2. Physically look at the units to see which has the lead light on.
3. Check the ladder logic status bits. Address

B.2 SWAPPING LMs FROM THE UNIVERSAL STATION

WARNING

DO NOT SWAP LMs immediately after an on-line programming change. From the LM Detailed Displays, you must check MEMORY USED and CHECKSUM values before and after the on-line change. Once the “new” checksum is displayed, the nonpreferred controller will have the old checksum and must be changed, using the controller's keyswitch. The programming change must be tested prior to performing the keyswitch operation on the non-preferred LM. **DO NOT SWAP** until both the preferred and nonpreferred displays reflect the new MEMORY USED (if size changed) and CHECKSUM values. Be patient! A large program will require several minutes to update its checksum.

To change the lead LM, first determine which LM is in the lead by the detail display of the UCN status display and that BOTH LMs are OK (showing OK/BACKUP and that both their memory and checksums agree). Next, select either of the LMs and the RUN STATES target, then the SWAP PRIMARY target, and ENTER.

The complete transition from one LM to the other may appear to take up to 5 seconds to finish. It actually takes place in a few milliseconds at the PLC, varies at the serial I/O depending on the link configuration, and less than a second for the Logic Manager Module. The original lead LM gives up the lead (must relinquish the lower, odd address); the outputs are held in their present state and the ladder logic is suspended; the original backup LM takes the lower-numbered address and the backup function as soon as it can reinitialize itself, clear its database, and resynchronize with the new lead (usually 2 minutes at this time). The status changes to OK/BACKUP again and the detail will indicate the LMs are back in "SYNCH." The memory used and the checksums should be the same as they were before the swap.

Failure to return to the OK/BACKUP state (for example, returning to OK/NOSYNC) is an indication that the partner RCMs or LMMs have found a fault or are having trouble synchronizing. The LMMs will limit synchronization retries to 2 attempts so as not to continually burden the primary. Maintenance procedures are required in this case.

B. 3 CLEARING LINK FAULTS

If the preferred system experiences a serial link fault, the preferred controller will automatically switch I/O control to the nonpreferred controller in a bumpless manner. The nonpreferred controller will continue to control all operating serial I/O racks. If a link fault occurs, it is wise to collect failure information and to diagnose the fault before beginning system fault recovery procedures.

IMPORTANT - THE SERIAL LINK MODULES (SLMs) interpret the power cycling of an I/O rack as a link fault. The preferred LM is pinned to failover, leaving its RCM in a fault state (11 flashes of its front panel LED). The preferred LMM does its normal failover reinitialization, including clearing its database, and then waits for the opportunity to resynch with the new primary. The nonpreferred LM, now the primary, also sees such a fault, but it is pinned to tolerate it and continue running. Recovery from this situation requires a power cycle of the preferred LM. This clears the SLM fault and reinitializes the preferred RCM.

B.4 GATHERING OF FAILURE INFORMATION

If a link fault occurs, the affected controller's RCM module pass LED will strobe a repeated pattern of 11 blinks to indicate a serial link fault. Also, the affected SLM module will illuminate its link fault led(s). The affected SIOM(s) active LEDs will turn off.

Since the TDC 3000^{X} System is collecting information from the "LEAD" controller, which is the nonpreferred unit after a link fault occurs, it is necessary to connect a 623-MS-DOS loader to the failed (preferred) unit to collect failure information. The necessary information can be collected by observing the relay ladder logic that is programmed at the beginning of memory in the logic controller. The relay ladder logic is known as the short scan relay ladder logic and is described in subsection 3.1.6.

B.4.1 Serial Fault Recovery

After the diagnostic information is collected, it will be necessary to correct the fault identified.

The cause of the failover should be established prior to attempting a SWAP PRIMARY and the failover condition must be cleared. It will be necessary to look at the LEDs on both the primary and the backup to ensure that no link faults or RCMs off-line are the cause. If either of these conditions are present, they **MUST** be cleared according to the procedure that follows:

In order to reset the preferred controller's SLM and RCM, power must be cycled to the controller. Upon power up, the preferred controller will re-establish its RCM and serial links. The preferred controller will power up in the backup mode. Once the preferred is operational and the TDC 3000X Universal Station LM detail display indicates the lead and backup LMs are "SYNCHED" and memory and checksum values agree, a swap primary operation can be performed.

Observe the Logic Manager UCN Display from the Universal Station; touch the affected LM node primary, and after it is highlighted, touch the DETAIL DISPLAY, it should display Primary and NON-PREF and SYNCH. If all these conditions are observed, touch the UCN node box at the lower left side to return to the UCN status display. Touch the LM node twice, slowly, and touch the DETAIL DISPLAY on the lower right side, the display should read secondary and PREF and SYNCH, if they do, return to the UCN display and touch the LM node once, touch RUN STATES; SWAP PRIMARY and enter. The swapover to the primary may take a few seconds to indicate; however, if the DETAIL DISPLAY is touched, the Primary and PREF will be observed and the NOSYNCH will be displayed in RED for potentially a couple of minutes, this is a normal diagnostic procedure. The UCN Status display may show PARTFAIL as the Primary and OFFNET or NOSYNCH as the BACKUP; this is normal and will be restored to OK and BACKUP within a couple of minutes. If the Primary processor is DETAILED, it should read PRIMARY and PREF and SYNCH, if it does not, do not attempt the procedure again, CALL HONEYWELL TAC AT 800-822-7673.

B.5 CLEARING CARD FAULTS

When data is sent to individual output modules, four bits of actual data are sent along with four bits of complemented data. A comparator on each digital output module then compares the data and sets the card fault latch should a miscompare occur.

While card faults are intended to indicate possible I/O backplane corruption, the card fault latch can also be tripped by severe inductive noise. In either case, the card fault LED of the affected module will be illuminated.

Output module faults can occur to both the lead and backup controller's serial links. No switchover is attempted when a card fault occurs. SIOM modules collect the address of the faulted card and report the address to the lead processor. The lead RCM passes card fault information to the backup controller.

SIOMs can optionally be dipswitch selected to recognize or ignore card faults. If selected to recognize card faults, the SIOM will take action to freeze or clear the outputs in the associated I/O rack (based on another SIOM dipswitch selection) in the event of a card fault. Regardless of the recognize/ignore setting, the card fault information will be collected and passed to the lead processor.

Card fault recovery procedure for "R" version SIOMs;

Should a card fault occur, it is necessary to reseat or replace the I/O module showing the fault. To reset the card fault latch on a faulted module, the module must be removed from the rack and reinstalled.

In order to clear a card fault:

1. By-pass/jumper all necessary outputs on the affected module's terminal block.

2. Toggle the 621-9938R SIOM switch on the module front panel to the freeze position. This will freeze backplane communications to the rack.

NOTE

While the SIOM is in the freeze mode, the SIOM rack fault LED will flash and the SLM link fault LED will illuminate. While in the freeze state, a card fault address of the EDM's most significant address will be reported to the process (if an EDM exists). The card fault does not cause the link to shutdown even though the SLM link fault LED is on. The EDM SCAN LED will de-energize after 4.5 seconds if its dipswitches have been set properly for redundant serial I/O operation. If the EDM contacts are used, they should be jumpered during this procedure.

3. Remove and replace the affected module(s) after the SIOM rack fault LED begins to flash.

4. Toggle the 621-9938R SIOM switch to the run position.

NOTE

The SIOM rack fault and SLM link fault LEDs will de-energize and the EDM scan LED will energize. Also, the card fault information reported to the processor will clear.

5. Remove all by-pass jumpers to resume normal operation.

B.6 MAKING LADDER LOGIC CHANGES

Switch settings in the preferred LM's RCM allows the ladder program to be downloaded to the nonpreferred LM. The nonpreferred LM cannot download its ladder program to the preferred LM. It is necessary to make ladder programming changes in the preferred LM. Additional information is contained in subsection B.7.

Minor changes (one or two lines or a couple of contacts or coils) can be done in the preferred (when in the lead) by putting the PLDM switch in the RUN/PROG position and entering the modifications via the MS-DOS loader. With the WARNING below in mind, when the programmer is satisfied with the changes and the preferred controller has completed its memory checksum calculation (checksum calculation time = [number of memory words used/12] times scan time of controller) the keyswitch on the nonpreferred LM (in BACKUP) can be cycled from RUN (or RUN/PROG) to PROG and back to RUN to download the changes to the nonpreferred LM.

WARNING

DO NOT SWAP LMs immediately after an on-line programming change. From the LM Detailed Displays, you must check MEMORY USED and CHECKSUM values before and after the on-line change. Once the "new" checksum is displayed, the nonpreferred controller will have the old checksum and must be changed using the controller's keyswitch. **DO NOT SWAP** until both the preferred and nonpreferred displays reflect the new MEMORY USED (if size changed) and CHECKSUM values. Be patient! A large program will require several minutes to update its checksum.

For more significant changes or major modifications, use the following procedure:

The lead is swapped to the nonpreferred LM and the MS-DOS loader is connected to the **Loader** port of the controller in the preferred LM. The keyswitch on the preferred is turned to the PROG position and the changes are entered. After the programmer is satisfied with the changes, he must return the keyswitch to the RUN position. When the relay ladder logic checksum has been updated, the new program can be tested by **placing the preferred LM into the Run mode** and swapping **the lead** back to the preferred LM. The new ladder logic will take effect. Should a problem occur in the program or with the new logic, the programmer can initiate a swap to the redundant partner (the nonpreferred) which still contains the unmodified program **after the two units are "SYNCHED."**

Once the program is tested and the programmer is satisfied with the operation of the revised control logic, he can transfer it to the nonpreferred by cycling the keyswitch on the nonpreferred LM from RUN (or RUN/PROG) to PROG and back again. Again, do not cycle the nonpreferred LM's keyswitch until the checksum has been updated. Remember, the checksum is not updated until the keyswitch has been changed from RUN to PROG and back to RUN.

B.7 RESTORING THE PREFERRED LM

Should it ever be necessary to restore the preferred LM when the nonpreferred is in the lead, there are two ways to accomplish this. First you can connect an MSDOS loader to the nonpreferred and save the program in the nonpreferred to disk. The loader can be connected to the preferred and the program loaded into the preferred LM. The second way is that you must turn the power off to the preferred LM; remove its RCM card and temporarily set its dipswitch to allow downloading from the lead LM. The RCM is reinserted; the preferred is powered up and the keyswitch on the preferred is cycled from RUN (or RUN/PROG) to the PROG position and back. After the program has been uploaded, the LM is powered off; the RCM switch is reset and the preferred is powered up again with the new program.

Note: Do not remove ANY LM batteries during this operation.

B.8 RESTORING THE NONPREFERRED LM

The nonpreferred LM can be restored by reloading the LM personality; the checkpoint data is copied from its redundant (preferred) partner. The ladder logic can be obtained by cycling the nonpreferred keyswitch. If the system is off-line, the ladder logic can be obtained by putting the preferred LM in IDLE and reloading the ladder logic to the preferred LM; this also loads it to the nonpreferred LM when it has the LM personality already loaded.

You may copy the ladder logic from the preferred and then idle the preferred and reload ladder logic from NET to restore ladder logic in the nonpreferred. (Copy or save ensures that the current operating ladder logic is loaded.)

Appendix C – Expanded Diagnostics

C.1 Overview

Section contents

These topics are covered in this section:

Background

The Expanded Diagnostics are provided in two forms:

- Expanded Run-Time Diagnostics, which—
  - add two test routines to the on-line diagnostics performed during ISS (memory word zero—MWZ) at the beginning of each scan, and
  - are executed automatically whenever firmware V.R 3.0 is installed in the 620-0080 Processor Module; and
- Expanded Serial I/O Diagnostics, which—
  - test the validity of the serial I/O control lines and data bus between the controller and the serial I/O system,
  - can be enabled or disabled, and
  - require that firmware V.R 3.0 is installed in the 620-0080 Processor Module and firmware V.R 2.3 is installed in the 621-9939 Serial Link Module.

CAUTION

CAUTION—Special considerations apply when resetting an SLM with the Expanded Serial I/O Diagnostics enabled. For specific information and recommended procedures, refer to:

- Subsection C.3—*Expanded Serial I/O Diagnostics, SLM Reset Considerations*

C.2 Expanded Run-Time Diagnostics

Introduction

The Expanded Diagnostics (ED) incorporate firmware that allows the Processor Module (PM) to perform additional checks during run time. Run time is when the controller is actually scanning and executing the ladder logic control program.

Register module diagnostics

Expanded diagnostics include a check of the 620-0056 Register Module (RM) to make sure that simultaneous writes do not occur to the multiple databases on the RM resulting in a corrupted data table. Prior to the expanded run-time diagnostics there was a possibility that if a decoder chip on the RM failed, data could be improperly written to more than one of the following areas:

- I/O Status Table registers,
- Data Register Table registers, and
- System Status Table registers.

System control module diagnostics

A second area of expanded diagnostics includes a check of the 620-0054 System Control Module (SCM) to verify that the contact logic unit on this module is properly decoding programmed single bit relay ladder logic operations.

Effect on scan time

The Expanded Run-Time Diagnostics are executed during MWZ of every scan. They alone will add 3 msec to 5 msec to the scan time during MWZ. The execution of both the Expanded Run-Time Diagnostics and Expanded Serial I/O Diagnostics will not cause MWZ to exceed 10 msec in a controller with no option modules.

Option modules, such as the RCM, require a window on the processor rack backplane during MWZ where they carry-out their communication functions. This window will add additional milliseconds to MWZ, and therefore the controller's scan time.

System requirements

To take advantage of the Expanded Run-Time Diagnostics, it is required that the single controller in a nonredundant configuration, and both redundant controllers in a redundant configuration include:

- 620-0080 Processor Module(s) (PM) with firmware V.R 3.0 or higher,
- 620-0056 4K x 4K Register Module(s) (RM), and
- 620-0085 2048 I/O Control Module(s) (IOCM).

ATTENTION The Expanded Serial I/O Diagnostics also require the 621-9939 Serial Link Module(s) (SLM) to include firmware V.R 2.3 or higher.

Continued on next page

C.2 Expanded Run-Time Diagnostics, Continued

CAUTION

CAUTION—Processor Modules with firmware V.R 3.0 are not compatible with the 620-0055, 2K x 2K Register Modules. Should this combination of modules be placed in a 620-35 Logic Controller, the PM will fail its Expanded Diagnostics.

All 620-0080 PM modules will ship from the factory firmware revision V.R 3.0. PM modules ordered as spares or replacements will include parts and instructions to down-grade the PM to V.R 2.6 should a specific installation not require the Expanded Diagnostics.

REFERENCE—For additional information regarding:

- Expanded Serial I/O Diagnostics, refer to—
  - Subsection C.3—*Expanded Serial I/O Diagnostics*; or
  - Instruction Sheet—*621-9939 Serial Link Module (SLM) V.R 2.3 Expanded Diagnostics*
    Form 6654-S138

C.3 Expanded Serial I/O Diagnostics

Introduction

The Expanded Serial I/O Diagnostics provide an optional level of testing for the serial I/O system by checking:

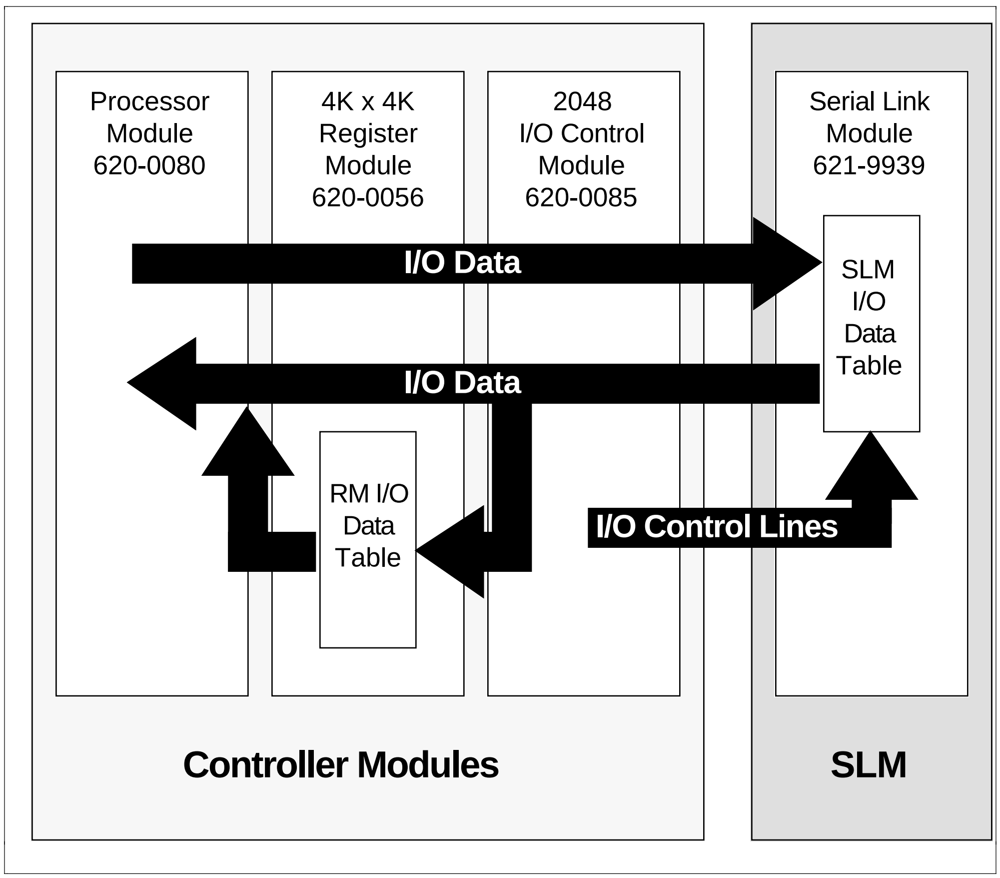
- the function of the controller's and SLM's I/O control circuitry and lines for proper operation, and
- the I/O data bus for lines that may be stuck high, low, or are experiencing interline shorts.

This is done by passing I/O data patterns over the processor rack backplane from the controller to the SLM, which are then reflected back for verification. These "hand-shake" I/O data patterns are not user information, but test patterns designed for this specific use.

Illustration

Figure C-1 illustrates Expanded Serial I/O Diagnostics paths.

Figure C-1 Expanded Serial I/O Diagnostics Paths



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Opting to use the expanded serial I/O diagnostics

The Expanded Serial I/O Diagnostics are optional because of their effect on system operation. When enabled, these diagnostics

- require an additional 48 real I/O addresses be reserved for use by the diagnostic routines, and
- increase control program scan time during MWZ.

If these two actions are unacceptable, the Expanded Serial I/O Diagnostics can be disabled.

CAUTION

CAUTION—Special considerations apply when resetting an SLM with the Expanded Serial I/O Diagnostics enabled. Refer to *SLM Reset Considerations* in this section for more information.

SLM reset considerations

CAUTION Do not reset an SLM by momentarily shorting terminals 18 and 19 together when the Expanded Serial I/O Diagnostics are enabled. Doing so will cause the Processor Module to fail its Expanded Run-Time Diagnostics and exit the Run mode.

Nonredundant Logic Controllers

- Should the Expanded Run-Time Diagnostics fail:
  - the SLM will perform a power up sequence,
  - the PM's Expanded Run-Time Diagnostics will fail,
  - the PM will exit the Run Mode of Operation, and
  - each I/O rack will Freeze or Clear depending on its individual PIOM/SIOM settings.

Redundant Logic Controllers

- Should the Expanded Run-Time Diagnostics fail in a Lead Controller with back-up:
  - the SLM will perform a power up sequence,
  - the PM's Expanded Run-Time Diagnostics will fail,
  - the PM will exit the Run Mode of Operation, and
  - the Back-Up Controller will assume lead with no back-up status.
- Should the Expanded Run-Time Diagnostics fail in a Lead Controller with no back-up (failed, off-line, etc.):
  - the system will react as a non-Redundant Controller as described above.

In lieu of using the reset terminals on the SLM, power-cycle the PM for the rare instance an SLM needs to be reset.

Continued on next page

Address usage

The serial I/O system automatically reserves real I/O addresses 2040 through 2047 to post the status of the serial I/O system. An additional 48 real I/O addresses (1992 through 2039) are required for expanded serial I/O diagnostic exchanges when these serial diagnostic routines are enabled. These addresses are used for expanded handshake (aka: heart-beat) routines between the SLM and the controller modules.

- SLM #1 is assigned addresses 2016 through 2039—
  - if SLM #1 is not used in the system, then these addresses may be used for real I/O functions.
- SLM #2 is assigned addresses 1992 through 2015—
  - if SLM #2 is not used in the system, then these addresses may be used for real I/O functions.

CAUTION

CAUTION—Do not assign addresses 1992 through 2039 to real I/O points when the Expanded Serial I/O Diagnostics are enabled.

The serial I/O system automatically reserves real I/O addresses 2040 through 2047 for use by the standard Serial I/O Status Table. During system start-up, the serial I/O system will not permit any rack configured for this address range to come on-line. This is done to prevent real I/O data from overwriting serial status data.

As indicated, the expanded serial I/O diagnostics require the use of real I/O addresses 1992 through 2039 for test pattern storage. Unlike addresses 2040 through 2047, these addresses are not automatically “locked-out” by the serial I/O system. No “lock-out” exists simply because the expanded serial I/O diagnostics are optional and are only executed when the Processor Module is properly configured to do so. Otherwise, these addresses can be used for real I/O functions.

Enabling the expanded serial I/O diagnostics

The Expanded Serial I/O Diagnostics are configured (enabled/disabled) through jumper W5 located on the Processor Module’s circuit board and require that an additional 48 real I/O addresses be reserved for SLM use. These diagnostics are in addition to the SLM’s standard self-test diagnostic routines.

Continued on next page

C.3 Expanded Serial I/O Diagnostics, Continued

SLM status information

The status of each SLM is automatically posted in the controller's System Status Table. This information is available by Pulling SST address 3125 (8-bit SST addresses 3124 and 3125—SLM 1) and address 3127 (8-bit SST addresses 3126 and 3127—SLM 2). Table C-1 lists the information that can be found in these SST addresses.

Table C-1 SLM Statuses

Data	Status	Definition
0	SLM Not Present	This data value indicates: • the processor rack does not include a 620-0085 2048 IOCM; • this SLM is not present in the processor rack; or • this SLM, if present, is not active.
255	SLM Present, Not Tested	This data value indicates that this SLM does not include firmware V.R 2.3 or higher, and is therefore not capable of performing the Expanded Serial I/O Diagnostics.
16384	SLM Diagnostics Passed	This data value indicates the Expanded Serial I/O Diagnostic routines have and are currently passing for this SLM.
32768	SLM Diagnostics Failed	This data value indicates that the Expanded Serial I/O Diagnostic routines have failed for this SLM.

System requirements

To take advantage of the Expanded Serial I/O Diagnostics, it is required that the single controller in a nonredundant and both controllers in a redundant configuration include:

- 620-0080 Processor Modules with firmware V.R 3.0 or higher,
- 620-0056 4K x 4K Register Module(s) (RM),
- 620-0085 2048 I/O Control Module (IOCM), and
- 621-9939 Serial Link Modules with firmware V.R 2.3 or higher.

ATTENTION

ATTENTION—When incorporated with a 620 Redundant Control System, an SLM failure detected by the expanded serial I/O diagnostics will be identified as a host controller fault by the RCM, which will strobe "7."

REFERENCE—For additional information regarding:

- Expanded Run-Time Diagnostics, refer to:
  - Subsection C.2—*Expanded Run-Time Diagnostics*; or
  - Instruction Sheet—*620-0080 V.R 3.0 Expanded Diagnostics* Form 6654-S137

LOGIC MANAGER APPLICATION NOTES
LM001
Appendix D

This appendix presents an explanation of Logic Manager configuration with regard to performance.

D.1 PREFACE

The Logic Manager Module operates within the Honeywell 620 LCS as a UCN interface. From the UCN viewpoint, its major tasks could be summarized as follows:

- Parameter Access
- Point Processing
- Peer-to-Peer data transfer

In a simplified sense, to allow for maximum flexibility with respect to LM applications, each of these tasks is designed to operate as if it were the only significant task. In other words, each assumes that the available LMM processing power and memory is fully available (excluding overhead) for that task to utilize. If one task is operating at maximum capacity, the others must be configured/utilized to a point well below their maximum capacities.

Although some limitations are checked and conveyed to the Engineer during configuration, it is impractical or impossible to warn of all potential conflicts at system configuration time. The Engineer, therefore, must take some responsibility for seeing that the LMM is not overloaded.

This application note is intended to enhance one's understanding of this performance balancing situation.

D.2 POINT PROCESSING

The LMM's Point Processing software is the major consumer of LMM memory and processing resources. The management of the Point Processor's use of LMM resources is explained through the concept of "Point Mix." In short, each point configured is expected to consume a given unit of processing power. When the sum of the processing units for the mix of points exceeds 2800 Processing Units (PUs), the LMM will reject the Point Mix.

The *Logic Manager Control Functions* manual discusses the subject of Data Point Mix is detail. From the Universal Station, the Point Mix (or Box Configuration) is configured under the NODE SPECIFIC CONFIGURATION menu (under NETWORK INTERFACE MODULE on the SYSTEM MENU).

Specifications:

Maximum Processing Units: 2800

Clarification: The fact that N points are allocated through the Box Configuration does not mean that N points will be burdening the Point Processor. Only configured, active points are actually processed.

WARNING

The later configuration and activation of unused points could push a heavily loaded LMM into an OVERRUN situation.

WARNING

Box Configuration with the NIM configured for NIMONLY could lead to an oversized Point Mix. Only the LMM (not the NIM), actually checks the Point Mix.

WARNING

If the LMM is configured to fully utilize its 2800 PUs, then other tasks, such as Parameter Access, will be forced to stay within their low end limits. If there is a need to collect large quantities of data over the UCN, then the total number of Processing Units may have to be reduced.

Recommendation: When configuring the Point Mix, limit the number of Points to what is needed, including future expansion, plus a safety margin. This will help prevent growth into an OVERRUN situation.

D.3 LOGIC CONTROLLER LCN CONNECTORS

Due both to memory and overhead limitations, the LMM limits the number of connections to the Logic Controller. The greater the number of connections, and the more disjointed the connections, the greater the overhead burden to the LMM.

Specification:

Maximum Logic Controller connections: 2000
Maximum Logic Controller connections in 4096-8191 range: 500

WARNING

Fully utilizing the available connections places additional burden on the LMM to collect data, particularly with regard to connections above the 4095 barrier. This in turn leaves fewer processing resources for other tasks.

Recommendation: Except for Numerics, avoid upper memory (4196-8191) connections and lower memory (0-4195) register accesses where possible. Both of these read accesses are very time consuming.

Recommendation: Group lower memory accesses within 16-bit boundaries. The more contiguous the group, the better. The LMM's Logic Controller interface will collect 16 contiguous bits almost as fast as it collects an isolated individual bit.

Recommendation: Flags and numerics are in a sense free with respect to processing resources. The data is gathered from the Logic Controller using the most efficient means available to the LMM and there is little or no Point Processing involved. With the exception of the first 128 flags, the processing associated with these points is only done when a parameter request is received.

D.4 PARAMETER ACCESS

While the LMM is processing points and servicing its overhead requirements, it also monitors its UCN interface for Parameter Access (Read/Write) requests. The extent to which the LMM can service these requests is a function of its processing load. Likewise, an excessive quantity of Parameter Access requests tends to interfere with the Point Processing and overhead operations.

Specification:

Maximum Parameter Access Requests: 400/second.
Maximum Parameter Write Requests: 50/second.

Clarification: These parameter accesses include those from the Operator Station(s), History Module(s), Application Module(s), other UCN nodes, etc. The LMM does have some capacity to queue these requests, but only to the extent its buffers allow.

Clarification: The 400 total/50 write limits assumes the LMM is operating at full Point Processing capacity (2800 PUs). Lightening the load elsewhere, i.e., fewer PUs, will free the LMM to support a heavier Parameter Access load.

WARNING

Point Processing Overruns will result if the LMM is forced to service an excessive quantity of Parameter requests.

Recommendation: Reducing the LMM burden in other ways will free processing time for parameter access, a reduced point mix, for example

Recommendation: Avoid Parameter Write requests, such a Peer-to-Peer pushes. The data checking which precedes the acceptance of a write request, although intended to protect the node, consumes a relatively large amount of processing power in comparison to read requests.

Recommendation: Pack booleans and pass them by way of Analog Output Points. This can reduce up to 16 booleans to a single UCN parameter.

Recommendation: Avoid schematics unnecessarily laden with parameters, or at least be aware of multiple USs each accessing a large quantity of parameters. When such schematics exist, system testing should involve all USs viewing the target node(s) at one time, to verify the parameter access load will not overburden the node(s).

D.5 PEER-TO-PEER COMMUNICATION

The LMM supports Peer-to-Peer data transfers through its Logic (Linkage) Point. In order to manage the impact of Peer-to-Peer communications on the LMM processor, the Logic Point is allocated a very large number of PUs (200). No where near that much is needed to actually process the point, but it does reserve the necessary resources the LMM needs to service the UCN transactions involved.

Specification:

Maximum UCN PUSH (Output) connections per 1/2 sec LMM scan: 45
Maximum UCN PULL (Input) connections: 50

Clarification: More than 45 output (PUSH) connections can be configured, as long as only 45 are enabled per 1/2 scan, i.e., a multiplexing scheme. Input (PULL) connections, however, are limited to 50, i.e., they cannot be multiplexed.

Clarification: The fact that 14 Logic Points are allowed, each with 12 channels, does not mean the 14 X 12 UCN connections are possible.

Recommendation: Pack booleans and pass them by way of Numeric Points. This can reduce up to 16 booleans to a single UCN parameter. Packing and unpacking must be done by the respective device's user program (e.g., Ladder Logic).

TIP: 620 LCS BRING-IN and SEND-OUT instructions will move 16 contiguous booleans to and from a word, respectively.

Recommendation: If a large number of UCN output (PUSH) connections are required (over the limits above), the user could make use of the LOENBL(x) parameters to multiplex data transfers. Such a multiplexing algorithm would have to be implemented in Ladder Logic. Again, input (PULL) connections cannot be multiplexed.

Recommendation: Distribute the Peer-to-Peer tasks to all UCN nodes involved. This obviously distributes the load, but also offers greater robustness.

Recommendation: Considering the LMM's limit on Parameter Write requests, using the LMM to PULL data serves to circumvent this limit. Pushes from other nodes will work against that limit.

D.6 PERFORMANCE MEASUREMENTS

The Performance Parameter available on the APM are not available on LM. Future implementation in unplanned.

Beginning with LMM PI 30.11, there were 13 parameters made available through the UCN for monitoring LMM performance. To access any of these parameters, however, the user must reserve a corresponding number of Analog Output points, and then configure those AO points to connect to the following Logic Controller addresses. Configure the points for PNTFORM=FULL and OPTDIR=DIRECT. Leave all other parameters at their default values.

4000 Average Total Parameter Requests
4001 Instantaneous Total Parameter Requests per second
4002 Minimum Total Parameter Requests per second
4003 Maximum Total Parameter Requests per second

4004 Average Read Parameter Requests per second
4005 Instantaneous Read Parameter Requests per second
4006 Minimum Read Parameter Requests per second
4007 Maximum Read Parameter Requests per second

4008 Average Write Parameter Requests per second
4009 Instantaneous Write Parameter Requests per second
4010 Minimum Write Parameter Requests per second
4011 Maximum Write Parameter Requests per second

4012 Number of Scans Accumulated

To reset the parameters, issue a write by way of the AO point. The value written is insignificant.

Clarification: Contrary to what the LC address may suggest, these parameters do not actually reside within the Logic Controller. These addresses serve only to trigger the AO Point Processor to fetch these internal variables.

Recommendation: If an application could potentially stray into a performance overload situation, the implementation of these points is strongly recommended. Without them, Honeywell TAC and Engineering can only speculate on a performance problem based on sometimes hard-to-gather configuration data.

LOGIC MANAGER APPLICATION NOTES
LM002
Appendix E

This appendix presents an explanation of Logic Manager Sync Diagnostics and Performance Statistics on the MAINT Display.

E.1 INTRODUCTION

Within the set of DETAIL displays provided for the Logic Manager is a display entitled Maintenance Support. This display is called by the target MAINT SUPPORT. This display was intended to supply information during a failure situation, but is essentially unused during normal operation. This schematic displays 106 bytes of information, only two of which are used during this normal period of operation.

This document describes how some of the remaining 104 bytes will be used in the latest LM Personality releases. There are four major fields of data being presented.

- Sync Diagnostics
- Timer Diagnostics
- Number of PLC Connections
- Parameter Access Statistics

Each will be described with respect to its Purpose, Description, Interpretation, and Operational Considerations.

E.2 SYNC DIAGNOSTICS

E.2.1 Purpose

Logic Manager may encounter synchronization problems in rare instances. The information available by sync diagnostics aids the user in determining what conditions are leading to this phenomenon.

E.2.2 Description

The Sync Diagnostic data contains the status of the most recent sync operation, whether or not it succeeded. The data field is located in columns 00-07 on the first line on the MAINT SUPPORT Display.

```
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

SS RR TT TT EE II NN NN 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00
----D0----- ----D1----- ----D2----- ----D3-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----D4----- ----D5----- ----D6----- ----D7-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----A0----- ----A1----- ----A2----- ----A3-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----A4----- ----A5----- ----A6----- ----A7-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

SS Resulting **status** of the sync operation. See the **Interpretation** section.

RR Number of **(re)tries** the sync operation attempted before it succeeded or failed. Set by the diagnostic process (DiM) upon receiving a Sync Complete or Abort signal from the syncing processing (MPD).

TTTT The **time** the most recent sync operation took to complete (in 10 ms tick counts). Set by diagnostic process (DiM) upon receiving a Sync Complete or Abort signal from the syncing process (MPD). Internally, the *system_time* variable is used to calculate this time.

EE **Error** code indicating why the sync operation failed. Dependent on the type of failure. See the **Interpretation** section.

II **Index** of the data record or sync command related to the sync failure. See the **Interpretation** section.

NNNN Additional data, usually a **number**, pertaining to the sync operation failure. See the **Interpretation** section.

E.2.3 Interpretation

The following is a list of the various sync operation results plus a discussion on variables.

Status (SS)		Interpretation
80		Sync operation completed successfully.
	RR	Number of tries.
	TTTT	Execution time, most recent operation (10 ms ticks).
	EE	Number of messages retried at the application layer.
	II	Not used (00).
	NNNN	Total number of packets.
81		UCN message error (either command or data message).
	RR	Number of tries.
	TTTT	Execution time, most recent operation (10 ms ticks).
	EE	Message request status variable 'reqstat' of the UCN call record.
	II	If a command message, the command code. (xx_PMCMD).
82		Sync command message error.
	RR	Number of tries.
	TTTT	Execution time, most recent operation (10 ms ticks).
	EE	Returning parameter access error (xx_PASTAT).
	II	Sync command code (xx_PMCMD).
	NNNN	Number of packet message.
83		Data packet message error.
	RR	Number of tries.
	TTTT	Execution time, most recent operation (10 ms ticks).
	E	Returning parameter access error (xx_PASTAT) of the offending checkpoint record.
	II	Index of the offending checkpoint record number.
	NNNN	Number of packet message.

E.2.4 Operational Considerations

The LMM is programmed to retry synchronization 3 times, after which a START command is needed to reset the retry counter before additional sync attempts will occur.

If the LMM is not synchronizing, it is necessary to capture the sync data before another sync attempt gets underway. This can be done by an attentive Operator with his/her finger on the "PRINT DISP" button of the Universal Station's keyboard.

E.3 TIMER SELF-TEST DIAGNOSTICS

E.3.1 Purpose

Logic Manager performs a periodic test of its hardware. A problem had been encountered with the testing of the LMM's 82C54 timer chip. The test itself was susceptible to a flaw in the implementation of the chip or a flaw in the chip itself, an issue which remains open. The end result was an LMM failure. The test has since been rewritten to provide a tolerance to the flaw.

It should be emphasized that the flaw IN NO WAY interferes with the normal use of the chip. Only the original diagnostic test was susceptible, not the rest of the software.

This set of Timer Self-Test Diagnostics is intended to aid the user in understanding the potential error and to describe how to interpret the test data.

E.3.2 Description

The Timer Self-Test Diagnostic data contains the status of the most recent reads of the 82C54's T1 timer. The field is located under the 00-03 columns of the third line of the MAINT SUPPORT Display.

```
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

AA AA BB BB 00 00 00 00 00
----D0----- ----D1----- ----D2----- ----D3-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----D4----- ----D5----- ----D6----- ----D7-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----A0----- ----A1----- ----A2----- ----A3-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----A4----- ----A5----- ----A6----- ----A7-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

AAAA First read (of 2) of the 82C54's T1 timer. This value should be in the range of 0 to 0597 (hex).

BBBB Second read (of 2) of the 82C54's T1 timer. This value should be in the range of 0 to 0597 (hex).

Note: The self-test routine looks for a change between readings.

E.3.3 Interpretation

One may see what appears to be a value that is out of range, but is actually a reversal of the high and low bytes. Such "flipped" readings do NOT impact normal operation, since the LMM uses these timers to generate interrupts and does not actually read them (as does the diagnostic test). It is this reversal that caused a problem with the earlier self-test software.

E.3.4 Operational Considerations

None. In general, these two variables can be ignored.

E.4 PLC CONNECTION COUNT

E.4.1 Purpose

Logic Manager has periodically encountered failures that are theorized to be caused by an excessive number of PLC connections. Data transactions with the PLC are time consuming, particularly those in the 4096-8191 range. The LMM places a limit on these connections in order to manage its CPU budget. It is theorized that certain portions of the software may not be adequately resolving conflicts with this limit, causing failures. The actual cause(s) of such failures remains under investigation, but in the interim, a mechanism is needed to help the user understand when this limit is being approached.

This PLC Connection Count data is intended to aid the user in understanding the data.

E.4.2 Description

The PLC Connection Count is located in the 06 and 07 columns on the third line of the MAINT SUPPORT Display.

```
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 CC CC 00
----D0----- ----D1----- ----D2----- ----D3-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----D4----- ----D5----- ----D6----- ----D7-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----A0----- ----A1----- ----A2----- ----A3-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
----A4----- ----A5----- ----A6----- ----A7-----
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
```

CCCC Number of PLC Connections.

E.4.3 Interpretation

Must not exceed 2000, and should be well below 2000. 1800 or less is suggested.

E.4.4 Operational Considerations

The LMM's internal demand for PLC information contributes to these limits. Therefore, the user's portion of these connections (PLCADDR, CCSRC, and other PLC connection parameters) must fall below these limits.

	Recommended Limits	
	LMM Limit	User Limit
Total PLC connection:	2000	1800
PLC Connections in 4096-8191 range:	500	500

E.5 PARAMETER ACCESS STATISTICS

E.5.1 Purpose

Logic Manager, like all UCN nodes, is sensitive to an excessive number of parameter read or write requests. Knowing where the limits are can be difficult. APM offers its so-called PERFORMANCE STATISTICS. LM, however, does not yet support that set of statistics, and may never do so due to its current limitations on CPU resources.

Beginning with LM PI 30.11, thirteen (13) Parameter Access Statistics were offered, but required Analog Output points configured to PLC Addresses 4000-4012.

This set of Parameter Access Statistics offers that same information, but without the need to configure AO points.

E.5.2 Description

The Parameter Access Statistics are located in the Data Register (Dx) and Address Register (Ax) fields of the MAINT SUPPORT Display. Each takes the four bytes of its respective Register field.

```
00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00
-------D0------- ------D1-------- -------D2-------- ------D3-------
 AVG TOTAL  INST TOTAL  MIN TOTAL  MAX TOTAL
-------D4------- ------D5-------- -------D6------- -------D7-------
 AVG READS  INST READS  MIN READS  MAX READS
--------A0------- -------A1-------- --------A2-------- ------A3--------
 AVG WRITES INST WRITES  MIN WRITES  MAX WRITES
------ A4------- ------A5--------- ------A6--------- -----A7--------
# SCANS ACC 00 00 00 00 00 00 00 00 00 00 00 00
```

AVG TOTAL	Average Total Parameter Access Requests/sec.
INST TOTAL	Instantaneous Total Parameter Access Requests/sec.
MIN TOTAL	Minimum Total Parameter Access Requests/sec.
MAX TOTAL	Maximum Total Parameter Access Requests/sec.

AVG READS	Average Total Parameter Read Requests/sec.
INST READS	Instantaneous Total Parameter Read Requests/sec.
MIN READS	Minimum Total Parameter Read Requests/sec.
MAX READS	Maximum Total Parameter Read Requests/sec.
AVG WRITES	Average Total Parameter Write Requests/sec.
INST WRITES	Instantaneous Total Parameter Write Requests/sec.
MIN WRITES	Minimum Total Parameter Write Requests/sec.
MAX WRITES	Maximum Total Parameter Write Requests/sec.

E.5.3 Interpretation

All Parameter Statistics are on a "per second" basis.

Total and Read Requests should be limited to 400 unless Processing Unit reduction allows for a higher limit.

Write Requests should be limited to 50, again unless Processing Unit reduction allows for a higher limit.

E.5.4 Operational Considerations

To reset the statistics, at least one AO point is required. The following point parameter configurations are suggested:

PLCADDR = 4000
PNTFORM = FULL
OPTDIR = DIRECT

Any write to this point will clear all 13 parameters.

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