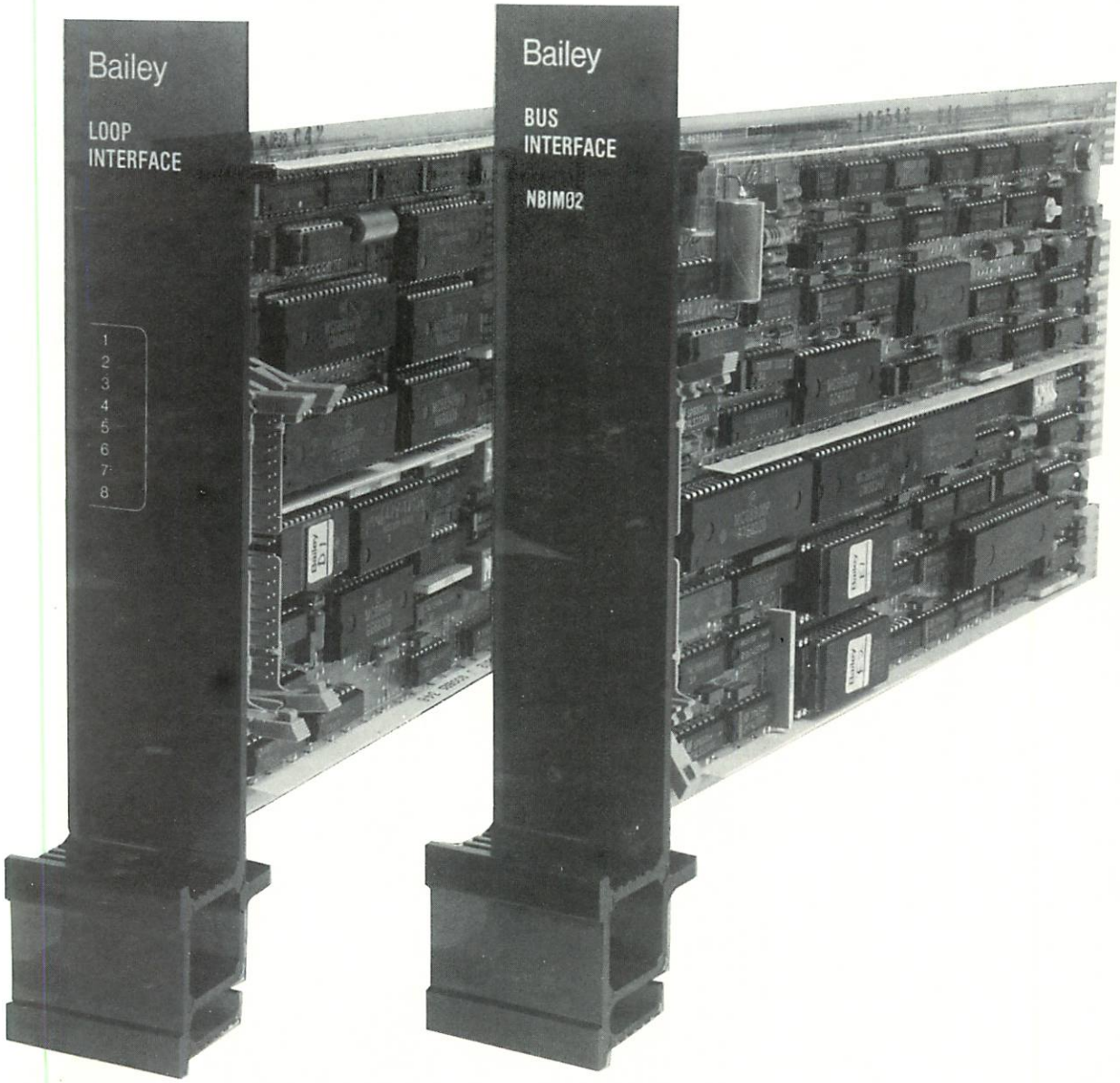
Bailey®
network 90®

Loop Interface/Bus Interface (LIM/BIM)



Product Instruction

E93-908-1

Bailey Controls
Babcock & Wilcox, a McDermott company

WARNING notices as used in this manual apply to hazards or unsafe practices which could result in severe personal injury or death.
CAUTION notices apply to hazards or unsafe practices which could result in minor personal injury or property damage.
NOTES highlight procedures and contain information which assists the operator in understanding the information contained in this manual.

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Preface

This product instruction provides the user with the necessary installation and operating information for the:

LIM01 — basic Loop Interface Module
LIM02 — enhanced Loop Interface Module
BIM01 — basic Bus Interface Module
BIM02 — enhanced Bus Interface Module

NOTE: The BIM02 version has the added functionality of Exception Report packing and a greater point capacity. The LIM02 allows greater distance between nodes.

The following associated hardware is also mentioned:

NKLM01 — cable from LIM to termination unit
NKTM01 — cable from LIM to termination module
NTPL01 — termination unit, plant loop
NIPL01 — termination module, plant loop
NMMU01 — module mounting unit

NOTE: Information concerning cable and termination unit/module installation is explained in detail in Product Instruction E93-911, Termination Unit Manual. Please refer to this document as needed.

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Section 1 — Introduction

General

The Loop and Bus Interface Modules (LIM/BIM) provide the principal communication interface between NETWORK 90 Process Control Units and the Plant Communication Loop (PCL). Information is passed over the Loop to other nodes. A node can be a Process Control Unit (PCU), Management Command System (MCS), Operator Interface Unit (OIU), Plant Loop Gateway (PPG) or Computer Interface Unit (CIU). A maximum of 63 nodes, in any combination, can be on the Loop.

The basic function of the BIM is to gather data from modules and transfer it to the LIM. The basic function of the LIM is to examine the data and transmit it to the assigned destination on the Loop. Detailed theory of LIM/BIM operation is covered in the **Theory of Operation** section of this document.

This document is divided into the following sections:

Theory of Operation — provides an in-depth view of how the LIM/BIM pair work.

Installation — gives step-by-step procedures for preparing the LIM/BIM pair for installation in the PCU.

Operation — provides the user with normal, everyday operating instructions.

Troubleshooting — explains possible error situations and corrective measures; also includes service/replacement information.

How to Use this Manual

Read the introductory material first. Then, proceed to the **Theory of Operation** section to get a fundamental understanding of how the modules work. Next, read the **Installation** section. This should be read thoroughly, and all preparatory steps performed, before putting the modules into operation. After installing the modules, read the **Operation** section to find out what to look for in the normal and abnormal operating modes. Refer to the **Troubleshooting** section if any abnormal situations occur after putting the modules into operation.

Glossary

Common Database	Data shared by LIM/BIM pairs on the Plant Loop.
Exception Report	Information update generated when a point change is greater than a specified significant amount.
Frame	Valid string of bytes on the Plant Loop.
Node	Any drop on the Loop; can be a Management Command System, Operator Interface Unit, Computer Interface Unit, Plant Loop Gateway or Process Control Unit.
Packing	The process of grouping multiple Exception Reports into one message.
Plant Communication Loop	The unidirectional highway for serial data shared by all nodes on the Loop.
Polling Rate	The time interval that the BIM checks the modules for Exception Reports.
Receive Data	Data received by destination PCU.
Synchronization Time	The time it takes for internal circuitry to readjust when a module goes into or comes out of bypass.
Transmit Data	Data sent by one PCU to another.

Specifications

Memory	LIM01: 2K bytes RAM, 2K bytes ROM LIM02: 2K bytes RAM, 4K bytes ROM BIM01: 16K bytes RAM, 16K bytes ROM BIM02: 32K bytes RAM, 16K bytes ROM
Power Requirements	LIM: +5 V dc @ 2.0 amps; 10 watts nominal ±15 V dc @ 80 mA; 1.2 watts nominal BIM: +5 V dc @1.0 amps; 5 watts nominal +15 V dc @ 150 mA; 2.25 watts nominal —15 V dc @ 120 mA; 1.80 watts nominal
System Capability	Maximum of 63 nodes in the system. Any combination of PCU, MCS, OIU, PPG, or CIU.
Communications Rates	500K baud 800 messages/second maximum.
Synchronization Time	100 milliseconds maximum.
Cable Specifications	
Plant Loop	LIM01 = 500 meters (1,640 feet) maximum LIM02 = 2,000 meters (6,561 feet) maximum
Loop Interface	LIM01 = 15 meters (50 feet) maximum LIM02 = 61 meters (200 ft) maximum
Certification	CSA certified for use as process control equipment in an ordinary (non-hazardous) environment.
Environmental	
Ambient Temperature	0°C to 70°C
Relative Humidity	0 to 95% up to 55°C (non-condensing) 0 to 45% at 70°C (non-condensing)
Atmospheric Pressure	Sea level to 3 km

LIM P3 Connections

Pin No.	Signal	Pin No.	Signal
1	Loop 2 In (+)	13	Loop 2 Bypass Control
2	Loop 2 In (—)	14	Cable Shield
3	Cable Shield	A	Cable Shield
4	Loop 1 Out (+)	D	Loop 1 Output (—)
5	Loop 1 Out (+)	E	Loop 1 Out (—)
6	Loop 1 In (+)	F	Cable Shield
7	Loop 1 In (—)	H	Loop 2 Bypass Control
8	Cable Shield	K	Loop 2 Out (—)
9	Loop 2 Out (+)	L	Loop 2 Out (—)
10	Loop 2 Out (+)	M	Cable Shield
11	Cable Shield	S	Cable Shield

BIM P1 Pin Connections

Pin No.	Signal	Pin No.	Signal
1	+5 V dc	7	+15 V dc
2	+5 V dc	8	—15 V dc
3	— open	9	Power Fail Interrupt
4	— open	10	Power Fail Interrupt
5	Common	11	Module Bus
6	Common	12	Module Bus

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE.

Section II — Theory of Operation

General

The Plant Communication Loop is a unidirectional highway for serial data which is shared by all nodes. The Loop Interface Module is the communication interface with the Plant Loop. The Bus Interface Module provides Plant Loop access to the Module Bus where data is being obtained and updated continuously from system instrumentation. Redundant Plant Communication Loop cables carry identical messages.

Startup

When the system is initialized (powered up for the first time), each LIM sends a "broadcast" message informing all other LIMs that it is on-line and ready to receive and transmit messages. Message acknowledgment is not necessary for the broadcast. When a broadcast is received, the LIM sends a "node on-line" (NOL) message to its BIM. Once this process is complete, all LIM/BIM pairs "know" that the PCU is on-line and it can be communicated with.

Message Format

As shown in Figure 1, the message format for system communication is made up of two time-related data frames or groups. The first group is referred to as the header and the second group provides the message data. A time gap exists between the two message groups which is referred to as the V-Time Gap. This gap allows the LIM to process a substantial part of a message before another segment is received.

The header contains the following bytes of information:

0. **Destination PCU —** intended receiver of message; range is 1 to 63.

1. **Source PCU —** sender of message; range is 1 to 63.

2. **Header Data (Frame Sync) —** the LIM uses this byte to insure header/data synchronization on the loop, in the event of noise or other signal degradation.

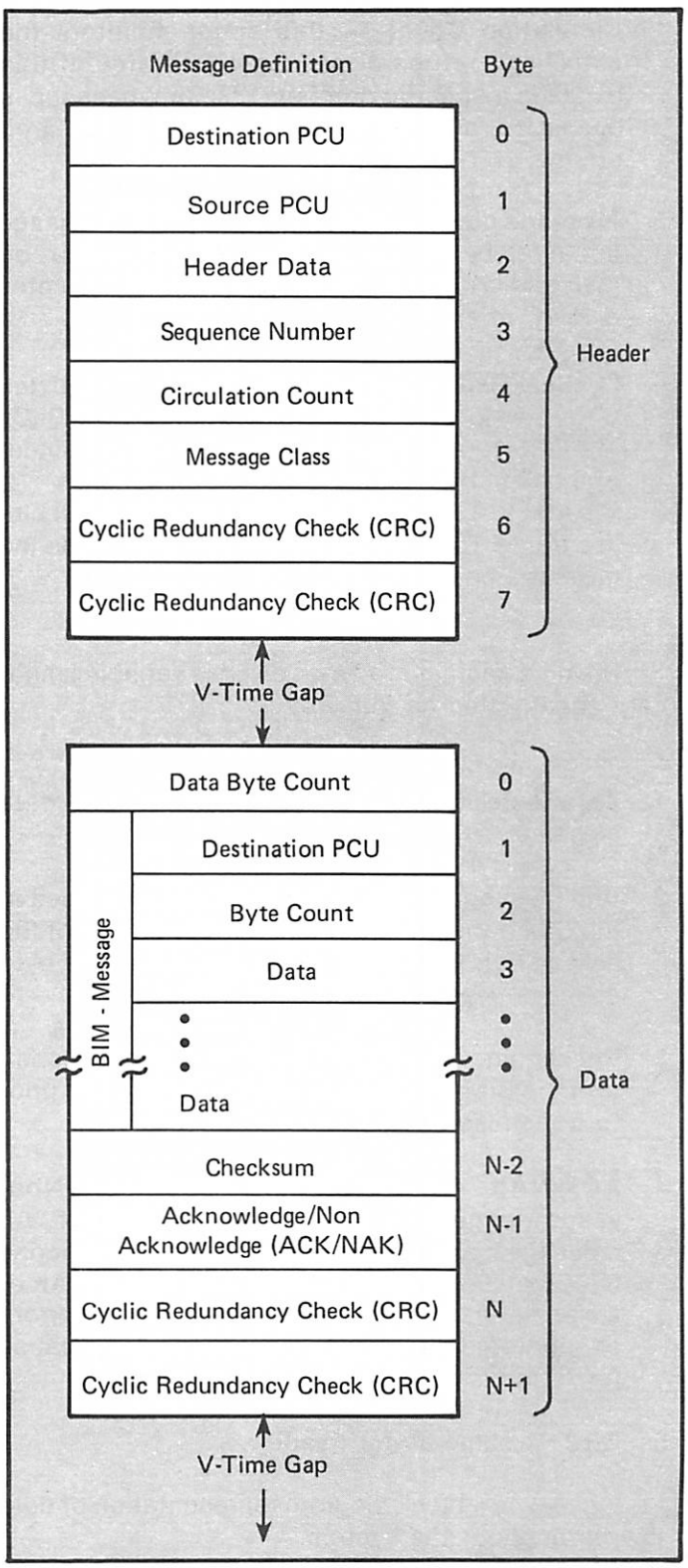

FIGURE 1 — Message Format

3. **Sequence number** — this is the counter in the LIM that indexes in the sequence that messages are transmitted and insures that messages are received in the same order in which they were sent.

4. **Circulation Count** — this count monitors the number of retries a message generates. If this exceeds a specific number (127), the message is discarded, and the destination PCU is declared off-line.

5. **Message class** — indicates the type of message initialized by the source PCU. A 00 indicates a normal, BIM-originated message and an FF indicates a "Hey" message.

6. **Cyclical Redundancy Check (CRC)** — (two bytes wide) developed and checked by hardware (ADLC). The CRC code is the complement of the remainder of a calculation employing the polynomial $x^{16} + x^{12} + x^5 + 1$, where x is the binary value of all bits in a frame. The V-Time Gap follows the CRC in the message header.

The next segment to be received is variable length data constructed as follows:

1. **Data byte count** — the length of the data message.

2. **BIM Message** — the exact message as placed in the BIM transmit buffer and it is composed of the **destination PCU, byte count** and **data.** The byte count is used for check sum computation.

3. **Checksum** — an Exclusive-OR sum developed over the BIM Message, computed by the LIM prior to transmission and again after receipt.

4. **ACK/NAK** — Acknowledgement/Non-acknowledgement of Plant Loop message. All messages are transmitted with a no-response NAK. Valid responses are an ACK, a busy NAK or a no-response NAK. Any other code reflects errors encountered during loop transmit and it is cause for retry processing by the source LIM.

5. **CRC** — same as for header.

Figure 2 is a block diagram representation of data flow throughout the system.

Transmission

Any LIM can transmit a message at any time. There is no loop master or traffic director. Each LIM can transmit and receive messages simultaneously, even in a two PCU system. LIM startup/shutdown is localized requiring no interaction with other LIM's on the Loop. Each LIM receives all incoming messages and transmits a new stream of messages in a "store and forward" fashion to the next LIM. In so doing, the LIM introduces a time delay through each node and provides loop storage. If there are no messages to be transmitted, the LIM transmits flag characters (null packets) as the loop idle condition. When a message arrives and needs to be forwarded, the transmitter stops sending null packets and begins sending the message.

The LIM can also originate a message in its transmit buffer; however, messages usually come from the BIM. Once the transmit buffer is filled, its content is sent as soon as possible. If the transmitter buffer is not currently busy, the message goes out immediately; otherwise the message waits for the first flag character (null packet) and is then transmitted. When the transmit buffer sends a message it is marked "busy", until the message goes completely around the loop and is returned to the source PCU. If the message reached its destination successfully, the transmit buffer is freed up and can be used for the next message. A FIFO (first in, first out) queue with a depth of six messages is used to keep track of incoming messages. If a message is received during transmission of the LIM's own message, the incoming message is forwarded after its own message is completed.

Security

In the unlikely event of a message error, the BIM responds with message retries up to 127 times. If transmission is unsuccessful after 127 retries, the destination PCU is marked off-line. When the PCU is marked off-line, the LIM informs the BIM that further communications with that destination must be deferred until it responds normally. The LIM then interrogates the off-line node every 2 seconds, and when the node responds, it is once again marked on-line.

Watchdog timer — When the LIM transmits a message, it starts a watchdog timer covering the transmit buffer. Whenever the normal transmit buffer

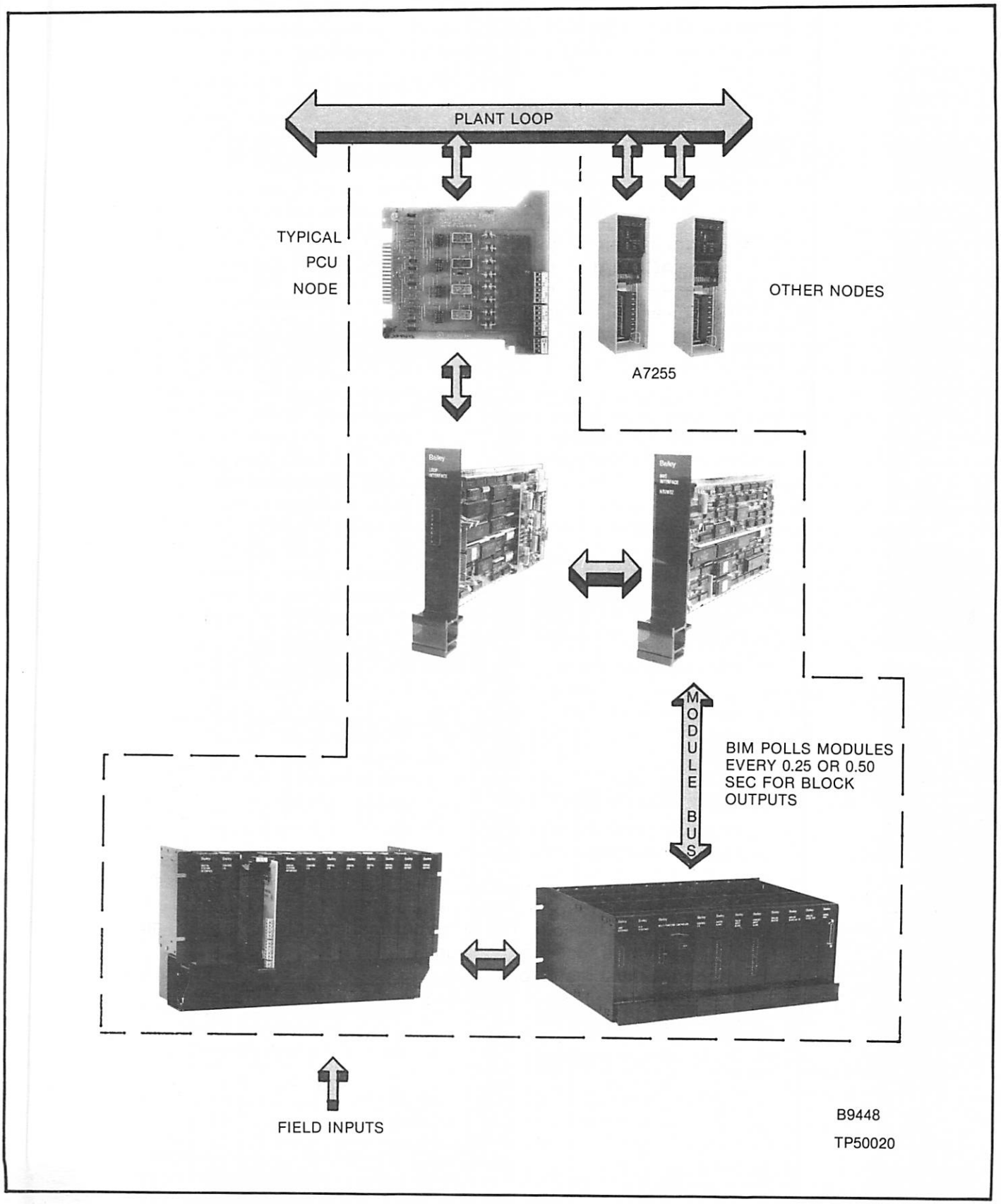

FIGURE 2 — Block Diagram of Data Flow

is busy, its watchdog is running. Under normal circumstances, the message will return before the watchdog expires and the LIM will disable the time. If the message is lost, the watchdog will expire and the message will be re-transmitted if there are retries left and if there are none, the PCU will be marked off-line.

Acknowledge/Non-Acknowledge check — This field is the last byte of the message data segment that assures full message receipt. When a message is returned, the sender examines the ACK/NAK field to determine what to do. If a message returns with an ACK, the transmission is successful and the transmit buffer is freed. If a message returns with a no-response NAK, retries are performed. If a message returns with a busy NAK, the sender has confirmation that the intended destination is active, but the message could not be received because the destination's buffer was full. The sending LIM responds with a modified retry count (up to 64 retries). If they all fail for the same reason, the destination is marked off-line. If a message returns with none of the three valid ACK/NAK codes, it indicates that an error occurred somewhere on the loop, and retries are used for recovery.

Circulation count check — All messages are transmitted with an initial circulation count of zero. Every LIM which forwards the message increments and tests the circulation count. If the count ever exceeds 127, the message is discarded.

Sequence of transmission check — The transmission protocol insures that messages are received in the same order that the BIM requests them. In addition, each LIM maintains a counter in its transmit buffer which is incremented every time a sourcing transmission occurs. When a message returns to its source LIM, the sequence count is compared to the sequence count in the transmit buffer and they must match or the message is discarded. This security feature serves to identify messages which may otherwise be identical in content, and can be viewed as a time-stamp.

Header data order check — Every LIM receives all incoming messages. It uses the frame-sync field to identify the frame as header or data. Whenever the order is wrong, a sequence error is detected. The frame is then discarded and the LIM recovers by always expecting the next frame to be a header.

Message Reception

Each LIM contains one dedicated transmit buffer, one relocatable receiver buffer and a circular loop buffer. All incoming messages are put into the loop buffer for processing. A LIM performs the Store/Forward function when its PCU number matches neither the destination nor source PCU fields in the message header and no errors occurred on receipt.

Redundant Module Pairs

Any PCU can be equipped with a redundant LIM/BIM module pair. When so equipped, one pair operates as a primary, the other as a secondary. The Primary/Secondary determination is initially made by the BIM at power-on time with each BIM racing to become primary and only one succeeding; thereafter, the primary LIM/BIM pair performs Plant Communication Loop interface functions while the secondary remains idle as a standby. In the event of a primary failure, the secondary takes over in approximately 5 seconds.

Off-Line Process Control Unit

A PCU is marked off-line and only if a message transmission failure occurs. The PCU is marked off-line by the LIM which attempted the transmission and it is off-line only to that LIM. When a LIM marks a PCU off-line, it sends a "NOL" (node-off-line) message to the BIM indicating that a transmission to the PCU failed. The BIM stops generating messages intended for the failed PCU. The LIM discards any BIM messages for a destination which is off-line and counts the total number discarded.

Each LIM maintains a record of the status of all possible destination PCUs. When the LIM locates an off-line PCU, it sends a "Hey" message to the PCU. If the destination responds to the Hey message with an ACK, the PCU is placed on-line and a "Node-on-Line" message is sent to the BIM, indicating that messages can again be sent to the PCU.

The LIM has the capability of doing report logic which scans the PCU status table looking for PCU's whose status change needs to be reported to the BIM. The report logic runs when the LIM is idle.

Module Intercommunication

The LIM interfaces with the BIM through BIM memory. A bi-directional interrupt line between the two processors is used for signaling a change in memory content. The LIM has a byte at a time access to BIM memory via a DMA (direct memory access) cable.

The LIM and the BIM exchange variable-length messages through buffers in the LIM. The BIM provides a 2K byte circular FIFO receive buffer and a 512 byte circular FIFO transmit buffer. When the BIM wants to transmit a message, it sends an interrupt request to the LIM. The message is moved to the LIM's transmit buffer when it is free. The LIM informs the BIM that the message was sent.

The LIM and BIM each maintain handshakes so that each can tell if the other is operational. There are timers associated with both modules that are set by one module and reset by the other. If the module responsible for reset finds the timer already reset, it is assumed that the other module failed.

The LIM's RAM maintains event and error counters which summarize LIM status at any point in time.

Interrupts

There are three levels of LIM interrupts: Non-Maskable Interrupt (NMI) - message routing and disposition, Interrupt Request (IRQ) - signalling purposes, and IDLE - no other active interrupts. Interrupts are generated in the BIM and by Loop events.

On power up or hardware reset, the LIM executes startup logic. The reset signal originates in the BIM, so that a LIM/BIM pair on a loop is independent of other LIM/BIM pairs, requiring no interaction. When a reset occurs, the LIM performs a software reset and executes a "wait command". This command halts the LIM processor until an interrupt arrives from the BIM. This interrupt is sent after the BIM initializes its memory.

The BIM channels Plant Loop information that is needed by local modules. It also gathers desired data from the Module Bus and transmits it to interested remote PCU's. The BIM also handles the PCU status signal. This signal monitors the power supply and cooling fans.

Module Bus checks — During sending function, checks are done for: maximum response time, number of retransmits for busy PCUs, and number of retransmits for detected errors. During receive function, checks for: recognizable messages and organizes replies to requests.

Exception reporting — Each point (process input) has a set of exception reporting parameters, e.g., high/low alarm limits, minimum/maximum report time intervals, percent of change in span, etc. When a point changes in excess of a given parameter, or an alarm occurs, an Exception Report (XR) is generated. The BIM polls modules for XRs destined for a given PCU. The BIM02 "packs" all XRs for a particular PCU into one message. For example, suppose there are 10 XRs going to PCU number 4. The BIM02 would pack these XRs into one message and transmit one time to PCU Number 4. The BIM01 does not have the packing function and would require 10 individual transmits.

The exception reporting technique eliminates irrelevant information from the Plant Loop, thereby greatly increasing data throughput. To ensure that relatively static data or rapidly changing data is reported, the parameters minimum/maximum report time are used. The Maximum report time parameter ensures that data items are reported even if they don't change. The minimum report time parameter is used to control the amount of XRs generated by a single rapidly changing point. **NOTE:** If a point goes into or out of alarm, the time parameters are ignored.

The BIM has no configuration or database prior to start up. At start up or reset, the BIM polls the module bus addresses (2-31) to find out which modules are present and what their input requirements are. When a module is acknowledged, a local module record is created in the BIM database and the XR process can begin.

Section III — Installation

Receiving and Handling

Upon receipt, examine the modules for possible damage as a result of transit. If damage is found or if there is any evidence of rough handling, file a damage claim with the responsible transportation company and notify the nearest Bailey Sales Office.

Retain the original packing material and container for storage purposes. If storing the modules, they should be stored in a protected environment that is free of extremes in temperature, moisture and air quality.

Set-Up

Prior to inserting the modules into the Module Mounting Unit (MMU), the following dipswitches on the LIM must be set: S1 - the Option Dipswitch and S2 - the Address Dipswitch. On the BIM, S1 - the Address/Option dipswitch must be set. Figures 3 and 4 show the location of these switches.

Option Dipswitch

Switch S1 on the LIM is used in event and error counters and testing purposes. This dipswitch can address up to 255 address locations in memory ranging from $00 to $FF. The switch is normally set to Hexadecimal 30. In this setting, the total messages transmitted is displayed on the front panel LEDs. Tables 6 and 7 in the **Troubleshooting** section provide other event counter and error counter addresses. Each counter is a cumulative byte-wide counter that increments as events or errors occur.

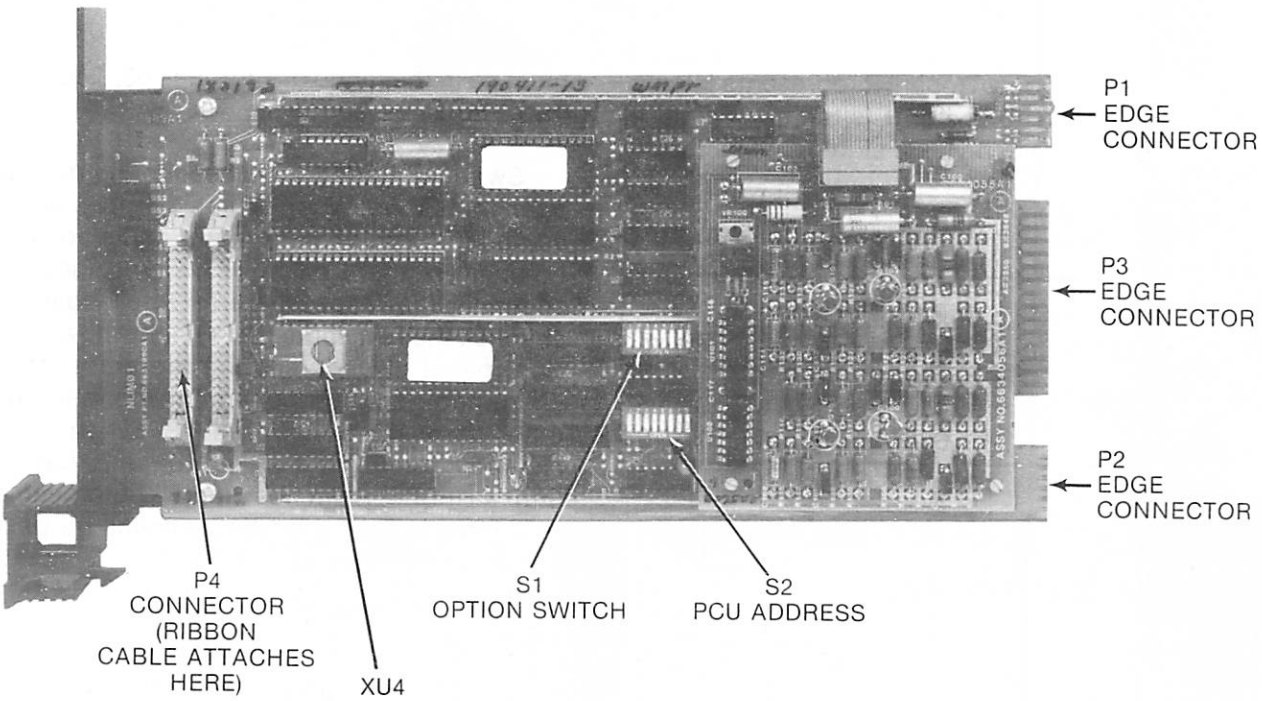

FIGURE 3 — Loop Interface Module Component Locations

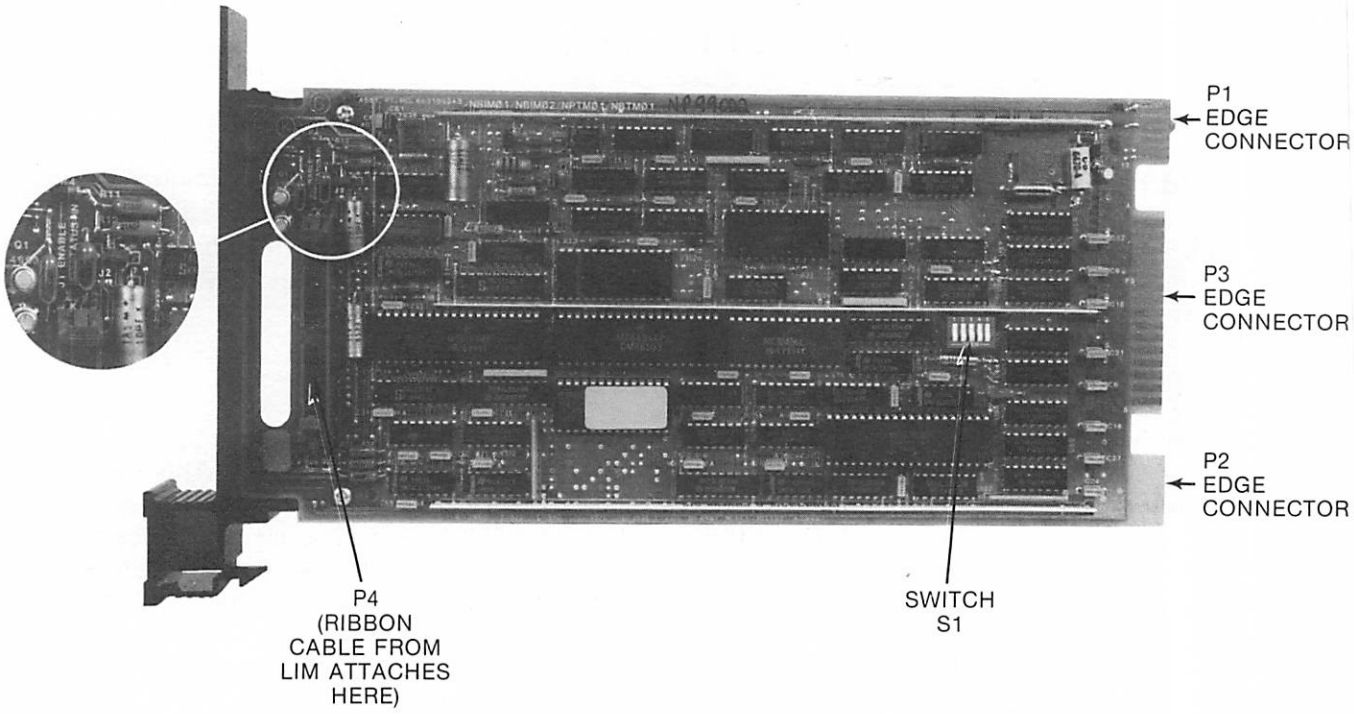

FIGURE 4 — Bus Interface Module Component Locations

When a switch is down (open) it represents a logic 1; up (closed), a logic 0. Switch 1 is the most significant bit (MSB); switch 8 the least significant bit (LSB).

Example:

Hexadecimal Address	Pole Positions 1	2	3	4	5	6	7	8
30	0	0	1	1	0	0	0	0
42	0	1	0	0	0	0	1	0

Address Dipswitch

The Address Dipswitch, S2, is used to set the PCU address in the system configuration. Each PCU must have a different address than the other. The address must be in the range of 1 through 63. Redundant LIMs have the same address.

Switches 1 and 2 are closed for normal operation; open for testing. When switch 1 is open and 2 is closed, the LIM operates normally, and also continuously monitors the error rates on both incoming Loop channels. If an excessive error rate is found on either channel, the LIM shuts that channel down, flashes its front panel LEDs indicating the presence of a problem, and continues operating normally using the other channel. The LIM will NEVER shut down both channels, however, it will continue to flash its LEDs until a RESET. Switches 1 and 2 both open are used for factory testing and field service purposes.

Switches 3 (Most Significant Bit with a binary weight of 32) through 8 (Least Significant Bit with a binary weight of 1) are used to set the PCU address. Table 1 provides the switch settings.

TABLE 1 — PCU Address (S2) Settings

PCU Address	Switch Number								PCU Address	Switch Number							
	1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8
1	0	0	0	0	0	0	0	1	33	0	0	1	0	0	0	0	1
2	0	0	0	0	0	0	1	0	34	0	0	1	0	0	0	1	0
3	0	0	0	0	0	0	1	1	35	0	0	1	0	0	0	1	1
4	0	0	0	0	0	1	0	0	36	0	0	1	0	0	1	0	0
5	0	0	0	0	0	1	0	1	37	0	0	1	0	0	1	0	1
6	0	0	0	0	0	1	1	0	38	0	0	1	0	0	1	1	0
7	0	0	0	0	0	1	1	1	39	0	0	1	0	0	1	1	1
8	0	0	0	0	1	0	0	0	40	0	0	1	0	1	0	0	0
9	0	0	0	0	1	0	0	1	41	0	0	1	0	1	0	0	1
10	0	0	0	0	1	0	1	0	42	0	0	1	0	1	0	1	0
11	0	0	0	0	1	0	1	1	43	0	0	1	0	1	0	1	1
12	0	0	0	0	1	1	0	0	44	0	0	1	0	1	1	0	0
13	0	0	0	0	1	1	0	1	45	0	0	1	0	1	1	0	1
14	0	0	0	0	1	1	1	0	46	0	0	1	0	1	1	1	0
15	0	0	0	0	1	1	1	1	47	0	0	1	0	1	1	1	1
16	0	0	0	1	0	0	0	0	48	0	0	1	1	0	0	0	0
17	0	0	0	1	0	0	0	1	49	0	0	1	1	0	0	0	1
18	0	0	0	1	0	0	1	0	50	0	0	1	1	0	0	1	0
19	0	0	0	1	0	0	1	1	51	0	0	1	1	0	0	1	1
20	0	0	0	1	0	1	0	0	52	0	0	1	1	0	1	0	0
21	0	0	0	1	0	1	0	1	53	0	0	1	1	0	1	0	1
22	0	0	0	1	0	1	1	0	54	0	0	1	1	0	1	1	0
23	0	0	0	1	0	1	1	1	55	0	0	1	1	0	1	1	1
24	0	0	0	1	1	0	0	0	56	0	0	1	1	1	0	0	0
25	0	0	0	1	1	0	0	1	57	0	0	1	1	1	0	0	1
26	0	0	0	1	1	0	1	0	58	0	0	1	1	1	0	1	0
27	0	0	0	1	1	0	1	1	59	0	0	1	1	1	0	1	1
28	0	0	0	1	1	1	0	0	60	0	0	1	1	1	1	0	0
29	0	0	0	1	1	1	0	1	61	0	0	1	1	1	1	0	1
30	0	0	0	1	1	1	1	0	62	0	0	1	1	1	1	1	0
31	0	0	0	1	1	1	1	1	63	0	0	1	1	1	1	1	1
32	0	0	1	0	0	0	0	0									

Jumpers J1-J2

There are two jumpers on the BIM. Jumper J1 is used to ENABLE or DISABLE the Status Message that is sent to an Operator Interface Unit. Jumper J2 is used to convert the BIM02 to a BIM01. Refer to Figure 4.

IMPORTANT NOTE: If your BIM02 is being used as a replacement for a BIM01, the following change MUST be made.

Jumper J2 - remove jumper from pins 2 and 3.
jumper pins 1 and 2 together.

If this change is not made, the BIM may not operate properly.

Address Dipswitch - BIM

The BIM Address Switch, S1, is a multi-purpose switch that defines redundant LIM/BIMs, software execution codes and module address. There are five switch positions. Table 2 defines the switch settings.

Module Installation

After setting the switches on both modules, connect the Bailey supplied ribbon cable from the P4 connector on the LIM to the P4 connector on the BIM (see Figure 3). You are now ready to install the modules. Insert the LIM/BIM into adjacent guide rails of the Module Mounting Unit (MMU). **NOTE:** The LIM and BIM can be inserted under power. There are no hazardous voltage levels present on the LIM. Push on the front panel of the modules until the latches "click." Make sure that the P3 card edge connector of the LIM engages the NKLM01 cable attached to the rear of the MMU. **NOTE:** Depending upon your system, you will have a NTPL01 Termination Unit and NKLM01 cable, or an NIPL01 Termination Module and NKTM01 cable. Refer to Product Instruction E93-911, Termination Unit Manual, for complete installation information.

TABLE 2 — BIM Address Dipswitch (S1) Settings

Switch Function	Switch/Function	Description
LIM/BIM Redundancy	1 0 1	 No redundant LIM/BIM pair Redundant LIM/BIM pair**
Software Execution Specification Codes	2 3 4 0 0 0 0 0 1 0 1 0 0 1 1 1 0 0 1 0 1 *1 1 0 1 1 1	 Execute Normal BIM system software Execute Normal BIM system software without termination due to catastrophic errors Execute BIM RAM test Execute BIM ROM test Execute LIM Interrupt Request (IRQ) test Not Used Execute BIM software at fast poll rate (.25 seconds) Execute BIM software at fast poll rate without termination due to catastrophic errors
Module Bus Address Switch	5 0	 Reserved modules addresses 0 and 1 for BIM**

***Selectable Poll Rates** — The "fast" poll rate option allows faster data throughput between the BIM and the Plant Loop. This poll rate cannot be used in all configurations and is governed by the following constraints:

1. Maximum of 8 modules
2. Maximum of 250 points
3. Maximum of 64 points changing every second

**When redundant LIM/BIM pairs are used, unique module bus addresses must be selected for each pair (S5).

Section IV — Operation

General

Once the modules are initialized and on-line, they perform their duties. The user need only be cognizant of the LIM's counter LEDs and the BIM's Status LED.

Event Counter

The LIM maintains counters to keep track of events such as total messages transmitted, messages taken from the BIM's transmit buffer, etc. Each counter has an address ranging from $(30)_{16}$ to $(3E)_{16}$. To view the contents of a counter, set switch S1 to the counter's address. The contents of the selected counter will appear on the front panel LEDs. Refer to the **Installation** section for the location of switch S1, and Table 6 in the **Troubleshooting** section for counter addresses and switch settings.

Error Counter

The LIM also maintains counters to keep track of errors such as unresolved interrupts, transmit failures, etc. Each counter has an address ranging from $(40)_{16}$ to $(51)_{16}$. To view the contents of a given counter, follow the procedure for viewing Event Counters in the preceding paragraph.

NOTE: Error messages are sent to any monitoring device on the Loop (e.g., Operator Interface Unit, Management Command System, Computer Interface Unit).

Module Status

The operating status of the module pair is determined by observing the Status LED of the BIM. If the LED is green, the modules are on-line and operating properly. If the LED is red, the modules have failed.

BIM Memory Utilization

The following procedures are designed to ensure that the user's PCU configuration does not overload the BIM's memory capacity. There are two methods to use. The first method is simple, fast and should be used initially. The second method is tedious; however, it is more exact. This method should be used if the first method indicates a potential problem.

Method Number 1 — Quick Evaluation

This method requires weighing the various items in the common database, multiplying the quantity of each item by its weight and summing the products. A result of less than one indicates that a particular configuration will "fit" into the allocated RAM. A result of greater than one implies a potential problem requiring further analysis. The weights in Table 3 are conservative and biased on the safe side of account for a minimum of record sharing. It is not uncommon for further analysis to reveal an excess of memory.

Method Number 2 — Detailed Evaluation

If Method Number 1 indicates a potential problem, this procedure should be done. This procedure requires detailed analysis of block types, source and destination distributions, and record sizes. The most difficult part is determining the amount of record sharing for a particular PCU configuration.

Table 4 lists the names and sizes of all records that can be allocated from free memory. Four rules govern this allcoation:

1. A Remote PCU Record must be assigned to each destination of all messages.

2. A Local Module Record must be assigned to each module answering on the Module Bus.

3. Record sharing is done wherever possible except on the Routing Record level (both receive data and transmit data).

Example:

A point received for two distinct local modules shares all records except the received Block Local Routing Record.

or

Two analog inputs from the same Analog Master Module (AMM) would share the same Local Module Record, but not the Local Block Record or the transmitted Block Remote Routing record.

4. If an OIU is on the Loop, it should be routed to the module status of each module on the Module Bus.

Sample Configuration Analysis

The following information is a sample configuration using both Receive and Transmit Data Structures.

The sample configuration has:

3 Controller Modules (COM)

— each COM provides a loop Exception Report for each OIU

— each COM inputs one digital and one analog, all unique for those modules

2 Logic Master Modules (LIM)

— each LMM has 128 inputs reported remotely
— each LMM needs 10 digital inputs from the same remote source; 5 of the 10 for each LMM are shared by all and 5 are unique

1 Multi-Function Controller (MFC)

— needs five analog inputs, only needed by it, from a remote source

2 separate Operator Interface Units (OIUs) requiring all status and block Exception Reports

The local PCU

— has 1 LIM/BIM pair (no redundancy)
— receives all inputs from the same remote PCU.

In the remote PCU

— all analog received data come from the same remote AMM and all digital received data come from the same remote LMM.

Based on the above information, Table 5 provides the guidelines for computing the total amount of memory used.

Column1 of the table is the record type, column 2 breaks down the record types by component, column 3 is the total of column 2, column 4 is the number of bytes each record type uses (from Table 4), and column 5 is the product of columns 3 and 4.

TABLE 3 — Memory Utilization Weight Table

Use of Memory	Weight
Each module addressable on the Module Bus (except CTM or SPM)	.003
Each transmitted loop (Station) exception report	.003
Each transmitted digital (Boolean) exception report	.002
Each transmitted analog (real) exception report	.002
Each transmitted remote switch (Plant Loop/OIU) exception report	.002
Each transmitted remote manual set constant (RMSC) exception report	.002
Each transmitted device driver exception report	.002
Each remote module that sends exception reports to PCU in question	.001
Each received exception report (analog or digital)	.002
Total miscellaneous overhead	.06

TABLE 4 — Data Structure Byte Usage

Name	Number of Bytes
Transmit Data Structures	
Local Module Record	18
Remote Module Status Route Record	3
Local Block Record:	
Digital	7
Device Driver	9
Plant Loop/OIU	9
Remote Manual Set Constant	10
Analog	10
Loop	20
Transmit Block Remote Routine Record	3
Receive Data Structures	
Remote PCU Record	9
Remote Module Record	5
Remote Block Record	
Digital	7
Analog	10
Received Block Local Routine Record	5
Total Free Memory Available	
BIM01	$9{,}728_{10}$
BIM02	$25{,}088_{10}$

TABLE 5 — Evaluation Method Number 2 — Configuration Analysis

(1) Record Type	(2) Composed of	(3) Total # of Records	(4) Bytes/ Records	(5) Total Bytes Used
RECEIVE DATA Remote PCU	2 OIU 1 Remote PCU	3	9	27
Remote Module	1 AMM 1 LMM	2	5	10
Remote Block	Digital 5 for all LMMs 5 for LMM 1 5 for LMM 2 1 for COM 1 1 for COM 2 1 for COM 3 Analog 5 for MFC 1 for COM 1 1 for COM 2 1 for COM 3	18 8	7 10	126 80
Local Routing	10 for LMM 1 10 for LMM 2 5 for MFC 1 2 for COM 1 2 for COM 2 2 for COM 3	31	5	155
TRANSMIT Local Module	3 COMs 2 LMMs 1 MFC	6	18	108
Remote Module Status Route	6 local modules x 2 OIUs	12	3	36
Local Block	Digital 128 for LMM 1 128 for LMM 2 Loop 1 for COM 1 1 for COM 2 1 for COM 3	256 3	7 20	1,792 60

TABLE 5 — Evaluation Method Number 2 — Configuration Analysis (continued)

(1) Record Type	(2) Composed of	(3) Total # of Records	(4) Bytes/ Records	(5) Total Bytes Used
Remote Route	128 for LMM 1 128 for LMM 2 1 for COM 1 1 for COM 2 1 for COM 3 x 2 OIU	518	3	1,554
			Total Bytes Used	3,948

Troubleshooting

General

The LIM provides Event and Error Counters to assist in diagnosing problems. The Option Switch S1 is used to set the address ($00 to $FF) to view events and errors. Table 6 lists the Event Counter addresses; Table 7 lists the Error Counter addresses. The Error Counter is similar to the Event Counter, except that it represents events caused by "hard" errors. For switch setting information, see the **Installation** section.

TABLE 6 — S1 - Event Counter Address

Counter Address	Hex Address	Switch Positions/ (Binary Address) 1234 5678	Description
48	30	0011 0000	Total messages transmitted, including forwarding.
49	31	0011 0001	Transmit retries.
50	32	0011 0010	Composite BIM Receive/Transmit, 4 bits each. Receive is viewed at the top LED.
51	33	0011 0011	Messages taken from the BIM transmit buffer.
52	34	0011 0100	Messages stored in BIM receive buffer.
53	35	0011 0101	Interrupt Requests (IRQs) sent by BIM.
54	36	0011 0110	High Priority (HP) messages transmitted.
55	37	0011 0111	High Priority messages received.
56	38	0011 1000	Commands issued by the BIM.
57	39	0011 1001	Missed BIM transmit requests.
58	3A	0011 1010	Spurious Non-Maskable Interrupts (NMI) caused by "address present."
59	3B	0011 1011	HEY (request for an interrupt; generated by BIM) message sent.
60	3C	0011 1100	Messages discarded when the destination is off-line.
61	3D	0011 1101	HEY time expirations.
62	3E	0011 1110	Passes through the IDLE level (2 bytes wide).

TABLE 7 — S1 - Error Count Addresses

Counter Address	Hex Address	Switch Postions/ (Binary Address) 1234 5678	Description
64	40	0100 0000	Composite error count developed every handshake period - the summation of all other error counters.
65	41	0100 0001	Unresolved NMI interrupts
66	42	0100 0010	Unresolved IRQ interrupts.
67	43	0100 0011	Unresolved timer interrupts.
68	44	0100 0100	Queue overflow message losses.
69	45	0100 0101	Checksum failures.
70	46	0100 0110	Unresolved BIM IRQs.
71	47	0100 0111	Sequence errors.
72	48	0100 1000	Header CRC/OVRN errors.
73	49	0100 1001	Data CRC/OVRN errors.
74	4A	0100 1010	Messages developing data CRC errors en route to destination.
75	4B	0100 1011	Transmission failures.
76	4C	0100 1100	Watchdog timer expirations.
77	4D	0100 1101	Data length errors.
78	4E	0100 1110	Loop - 1 Receive (RCV) failure
79	4F	0100 1111	Loop - 2 Receive failures
80	50	0101 0000	Loop - 1 Transmit (TX) failure
81	51	0101 0001	Loop - 2 Transmit failures

Maintenance/Service

There is no periodic maintenance required for the modules. Module replacement and company services are available for special maintenance requirements. Contact your nearest Bailey office for service.

Addendum

The purpose of this addendum is to highlight the functional differences between the two versions of the Bus Interface Module (BIM).

Because of functionality differences, BIM01s and BIM02s **CANNOT** exist on the same Plant Loop. The BIM01 transmits Exception Reports bound for the same destination PCU one message at a time. The BIM02 "packs" all Exception Reports bound for the same destination PCU and transmits them in one message.

Note that the BIM02 will communicate with either the LIM01 or the LIM02.

Set-Up

The earlier version of the BIM01 is no longer being manufactured. Currently only BIM02 modules are being manufactured and shipped. Jumper J2 determines if the module acts as an 01 or 02.

To convert the BIM02 into a BIM01:

Remove Jumper **J2** from pins 2 and 3.
Put Jumper **J2** on pins 1 and 2.

Refer to Figure 4 for jumper locations.

NOTICE

Data loss can result if:

You replace a BIM01 with a BIM02 without making the jumper change, and your OIU does not have the latest PIM software (the OIU would not be able to "unpack" the message).

Your configuration has redundant BIM02s and you replace with BIM01s. The 01 has less memory and less point capacity, and you could lose points configured beyond its memory capacity.

Jumper J1 is used to ENABLE or DISABLE the status signal monitored by the Power Entry Panel in a hardware cabinet. If the BIM is being used in a Mini-90 enclosure, the jumper should be set to the DISABLE postion; otherwise leave in the ENABLE position.

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