MOORE®

APPLICATION ENGINEERING RELEASE

AD320-10
Issue 5
February 1997

MODEL 320
LOCAL INSTRUMENT LINK
INDEPENDENT COMPUTER INTERFACE
USER'S MANUAL

MOORE PRODUCTS CO., Spring House, Pa. 19477

TABLE OF CONTENTS

1.0 INTRODUCTION

The MYCRO Local Instrument Link Independent Computer Interface (LIL ICI), Model 320, provides the user with a means of connecting a general purpose computer to a Local Instrument Link in the MYCRO Distributed System. The ICI was designed to simplify the task of interfacing from both a hardware and software stand-point, while also maintaining a high degree of flexibility. The ICI is based on the RS-232C serial data communication standard and can be connected to various data devices, such as modems. The ICI is also optionally configurable for a RS-422 asynchronous version. The command structure and data characters used provide a simple and straight-forward means to access the data of the MYCRO System. The send data commands allow for additional data transmission security to assure proper data changes. For ICI user computer communications, the ICI transmits only as a response to a command generated by the user's computer.

This manual describes Model 320 versions BBA and BCA. The major differences between the versions are the following:

A. BCA adds three new commands.

B. BCA redefines the response status word by moving one bit definition and adding a few new definitions.

C. BCA copies the response status word into the global database differently.

D. BCA adds a communication watchdog timer specifically for the Local Channel Send and Parameter Data Send commands and redefines the global database channels associated with the watchdog timer values.

1.1 DEFINITIONS

The following terms used throughout the remaining sections have the following meanings:

LIL — The MYCRO Local Instrument Link which provides a means of communication between stations connected to the LIL.

ICI — The Model 320 LIL Independent Computer Interface which consists of the Local Instrument Link Computer assembly and the interface assembly and operates as a station on the MYCRO Local Instrument Link.

LES — The Model 321 LIL Expansion Satellite which provides a means of communications between elements on the Hi-Level Link and stations on the Local Instrument Link and/or expands the LIL from 32 stations to 64 stations maximum.

PSC — The Model 324 Programmable Sequence Controller which primarily performs discrete logic and sequencing functions with batch sequencing langauge capabilities.

SLDC — The Model 352 Single-Loop Digital Controller which primarily performs regulating control functions.

LSC — The Model 382 Logic and Sequence Controller which primarily performs discrete logic and sequencing functions.

MDS — The Model 383 Multi-Point Display Station which provides local indication and alarming along with digital communication capabilities.

Link Interface Board — A circuit board assembly of the ICI which communicates with other devices of the LIL system (SLDC's, PSC's, etc.) over the Local Instrument Link.

Serial Port Board — A circuit board assembly of the ICI which communicates with the user's computer over the RS-232C link.

MPU Base Board — A circuit board assembly of the ICI which contains the microprocessor and associated components.

Station — Any stand-alone hardware element that resides on a Local Instrument Link, such as a Single-Loop Digital Controller, Programmable Sequence Controller, ICI, Local Expansion Satellite, etc.

Channel — An addressable data element in a station connected to the LIL. Each LIL station may generate up to 256 channels.

Parameter —One of up to 256 data addresses associated with each channel that can be addressed by other LIL stations. The first parameter of each existing channel is updated periodically to the LIL in the global database.

Command — The transmission generated by the user's computer and sent to the ICI for the purpose of requesting or sending data.

Response — The returned data from the interface to the user's computer.

Computer — The user's general purpose computer which is connected to the ICI.

1.2 REFERENCE DOCUMENTATION

It is assumed that the user is familiar with the computer and has access to adequate documentation that describes both its software and serial interface card characteristics.

The user must also be familiar with each station type connected to the LIL. Each station type has user's manuals, installation manuals, and link communications manuals associated with it.

1.3 SYSTEM BLOCK DIAGRAM DESCRIPTION

A block diagram of a typical installation is shown in Figure 6-1. Sections A and B of the ICI operate asynchronously and perform specific tasks.

Section A is the LIL computer, acting as a station with an address on the Local Instrument Link and performs the following tasks:

1. Fulfill all the communication responsibilities of a station for the LIL.
2. Receive data from the LIL and store this data in the shared memory. This data includes the LIL global database and commands from other stations.
3. Transmit requests generated by Section B to elements on the LIL.

Section B is the interface to the user's computer and performs the following tasks:

1. Interpret commands from the user's computer and generate the appropriate response to the computer.
2. Access the shared memory for data values at the request of the independent computer (request type commands).
3. Generate commands to Section A for transmission on the LIL at the request of the independent computer (send type commands or request type commands that require a link access).

2.0 ICI INSTALLATION AND CONFIGURATION

Installation of the ICI consists of connecting power, the Local Instrument Link and the user's computer to the ICI. Configuration of the ICI consists of setting switches and jumpers within the ICI and sending commands from the user's application program to the ICI.

2.1 PHYSICAL CONNECTIONS TO THE ICI

Figure 6-2 shows the rear termination strips of the ICI. The strips have the following connections:

Strip A - AC power
Strip B - Local Instrument Link
Strip C - User computer RS-232C
Strip D - User computer RS-422

The choice of RS-232C or RS-422 is made by a jumper selection on the ICI serial port board. The RS-232C data set or data terminal pinout is determined by a separate accessory board containing the appropriate DB25 connectors which mounts on strip C. See Section 2.3.

2.2 ICI LINK ADDRESS SELECTION

The address of the ICI on the Local Instrument Link is determined by switch settings of DIP switches SW1 and SW2 on the serial port board (see Figure 6-3). The switches have the following values when in the OFF position:

Switch	Value
SW2-2	32
SW2-1	16
SW1-8	8
SW1-4	4
SW1-2	2
SW1-1	1

The address of the ICI is determined by adding one (1) to the sum of the switches in the OFF position. For example, if SW1-8 and SW1-1 are OFF, the address is:

8 + 1 + 1 = 10

2.3 COMPUTER PORT CONFIGURATION

2.3.1 RS-232C/RS-422 SELECTION

The selection of either RS-232C or RS-422 is determined by the jumper positions of W5 and W6 on the serial port board (Figures 6-3 and 6-4) as follows:

W5 & W6 Position	Selection
pin 1 to 2	RS-422
pin 2 to 3	RS-232C

When RS-422 is selected, the computer is connected to the ICI using terminal strip D. When RS-232C is selected, the computer is connected to the ICI using terminal strip C.

2.3.2 DATA SET/DATA TERMINAL SELECTION

When using RS-232C, two possible pinouts are possible as determined by the connector used on the optional cable adapter board which mounts on terminal strip C. Figure 6-5 shows the wiring of the board and the pinouts for the ICI to appear as a data set (or data communication equipment) (DS or DCE) using the DB25 female connector and the pinouts for the ICI to appear as a data terminal (or data terminal equipment) (DT or DTE) using the DB25 male connector.

The desired RS-232C signal from the computer which is to drive the ICI CTS input line is jumper selectable by W1 when using the data set connector and by W2 when using the data terminal connector. The jumper may be removed completely to always enable the signal, if desired.

2.3.3 BAUD RATE SELECTION

The baud rate of the computer port is determined by the jumper position of W7 on the serial port board (Figures 6-3 and 6-4). The following baud rates are available:

W7 Position	Baud Rate
pin 1 to 14	38400
pin 2 to 13	19200
pin 3 to 12	9600
pin 4 to 11	4800
pin 5 to 10	2400
pin 6 to 9	1200
pin 7 to 8	300

2.3.4 DATA FORMAT SELECTION

The data format of the computer port is determined by SW2-4 and SW2-8 on the serial port board (Figure 6-3) as follows:

SW2-8	SW2-4	Start Bits	Data Bits	Parity	Stop Bits
ON	ON	1	7	even	1
ON	OFF	1	7	odd	1
OFF	ON	1	8	none	1
OFF	OFF	1	8	odd	1

Note that binary transmission method requires a data format that uses 8 data bits. ASCII transmission method may use any of the data formats. See Section 3.2; Transmission Method Selection.

2.4 MODEM OPERATION

The computer may be connected to the ICI using modems if desired. The ICI provides common modem communication speeds. When used in a dial-up application, the modem at the ICI should generally be a manually configurable auto-answer type. The modem at the computer can either be manual or auto-dial and configurable either manually or through commands issued from the computer. The use of auto-dial and auto-answer modems does not require telephones to be at either site. However, with the telephones, voice as well as data communications can be handled, although not simultaneously.

Short-haul modems can be used to locate a personal computer at a distance of up to 10 miles from the Model 320 using dedicated wiring. Request AD320-30 for more information on ICI/Short-haul modem applications.

2.5 SECURITY OPERATION

The ICI with an auto-answer modem can present security problems in certain applications. In this case, an external device can be installed between the ICI and the modem. These devices provide capabilities such as password protection and automatic call-back to prevent unauthorized access.

The ICI itself provides a means to prevent send commands from being processed as an additional means of security. This protection is applied to various commands as described in Section 3.4.

2.6 DIAGNOSTIC PORT

A diagnostic port is provided through J4 on the serial port board (Figure 6-3). This port is used by a monitor program in the ICI firmware. This port is primarily for maintenance purposes, as it allows memory to be read from (and be written to) to diagnose problems that may occur. The baud rate for this port is determined by the jumper position of W8 and provides the following baud rates:

W8 Position	Baud Rate
pin 1 to 8	19200
pin 2 to 7	9600
pin 3 to 6	1200
pin 4 to 5	300

This port is hardwired as a data set.

2.7 AUXILIARY COMPUTER PORT CONNECTOR

The ICI allows for the computer to be connected to J3 of the serial port board instead of the rear termination strip. The use of this connector is not the primary method for connecting the computer, but is mainly for front access when troubleshooting. Note that there may NOT be connections to both the rear termination strip and J3 simultaneously. This connector is hardwired to a data set configuration when a ribbon connector to DB25 connector converter cable is used.

3.0 COMMUNICATION PROGRAMMING CONSIDERATIONS

In addition to the physical data communication configuration selections described above, the ICI provides specific enabling and disabling of communication formats and command dependent response elements.

3.1 GENERAL COMMAND/RESPONSE MESSAGE FORMATS

When the computer is ready to send a command to the ICI, the computer issues a sync byte to the ICI that signals the ICI that a command is following. The data of the sync byte is dependent upon the transmission method selected. The command issued by the computer has the following general format:

A. Command message word count - number of words to be transferred excluding the error checkword.

B. Command word - the first word of the command. The upper byte contains the command number while the lower byte contains data that is command dependent.

C. Additional command and/or data words - these words are command dependent.

D. Checkword - the error checkword calculated by summing all words from the command message word count up to, but not including, the checkword ignoring any final carry. The use of the checkword is dependent upon the transmission method selected.

When the computer is ready for the ICI to transmit the response, the computer issues a sync byte to the ICI that signals the ICI to return the response. The data of this sync byte is also dependent upon the transmission method selected.

The response issued by the ICI has the following general format:

A. Response message word count - the number of words to be transferred excluding the error checkword.

B. Response status word - a word sent back in every response containing any error indications and general status information. The response status word is detailed in Appendix C.

C. Data words - the data requested by the command, if any.

D. Checkword - the error checkword calculated by summing all the words from the response message word count up to, but not including, the checkword ignoring any final carry. The use of the checkword is dependent upon the transmission method selected.

3.2 TRANSMISSION METHOD SELECTION

Switch 5 on the MPU board (Figure 6-6) selects whether binary or ASCII representation of the data is the transmission method for the commands and responses. The selection of the transmission method determines the following items:

A. The representation used for the data transmitted.

B. The command and response sync byte data values.

C. Whether or not the error checkword is used.

D. Whether or not a carriage return/line feed message termination sequence is used.

The switch positions are defined as follows:

SW5 Position	Transmission Method
ON	Binary
OFF	ASCII

3.2.1 BINARY TRANSMISSION METHOD

When binary is selected as the transmission method, the characteristics are as follows:

A. The data transmitted is the binary representation of each byte of the commands and responses in high-order byte to low-order byte sequence.

B. The sync bytes are the following values (in hex):

Command - 55
Response - AA

C. The error checkword is used.

D. The carriage return/line feed sequence is not used. Therefore, the transmissions are word count controlled. Depending upon your computer, this may be a byte count at the I/O driver level.

For example, the following command would have the data transmitted appear as follows:

Command Words	Binary Data Transmitted (Hex)
CMWC = 0002	CMD SYNC BYTE = 55
CMD = 0100	CMWC = 00
CHW = 0102	02
	CMD = 01
	00
	CHW = 01
	02
	RESP SYNC BYTE = AA

3.2.2 ASCII TRANSMISSION METHOD

When ASCII is selected as the transmission method, the characteristics are as follows:

A. The data transmitted is the ASCII representation of each of the hexadecimal digits of the commands and responses in high-order digit to low-order digit sequence.

B. The sync bytes are the following values (in hex notation):

Command - 03 (control-C)
Response - 12 (control-R)

C. The error checkword is not used. It is recommended that a data format using parity checking be selected when the ASCII transmission method is chosen.

D. A carriage return/line feed sequence is used as a message terminator.

For example, if the following command is sent to the ICI, the data transmitted would appear as follows:

Command Words	ASCII Data Transmitted (Hex)
CMWC = 0002	CMD SYNC BYTE = 03
CMD = 0100	CMWC = 30
CHW = NOT USED	30
	30
	32
	CMD = 30
	31
	30
	30
	CR = 0D
	LF = 0A
	RESP SYNC BYTE = 12

3.3 RESPONSE MESSAGE FORMAT

3.3.1 LINK ACKNOWLEDGE DELAY SELECTION

When the ICI has to communicate over the Local Instrument Link to send or receive data, the response message to the computer may be either immediately returned or delayed until the destination station acknowledges the command or returns the data. Switch 4 on the MPU board (Figure 6-6) selects the desired method of operation as follows:

SW4 Position	Link Acknowledge Delay
ON	Disabled
OFF	Enabled

For send commands, the action of each method is the following:

A. Disabled - the response is issued immediately to the computer whether or not the command is received by the destination station.

B. Enabled - the response is delayed until the destination station acknowledges receiving the command. This method is desirable as a data change integrity check.

For request commands that require a link access, the action of each method is the following:

A. Disabled - the response is issued immediately to the computer with the "DATA NOT READY" bit (bit 4) of the response status word set. A second request is then required to obtain the data. If the data is still unavailable, the response again returns "DATA NOT READY". This may be repeated until the data is returned, an error indication is returned, or the application program determines it has tried long enough.

B. Enabled - the response is delayed until the requested data is returned by the station. This method is desirable as it reduces the amount of computer processing required to obtain link data.

3.3.2 NULL-FILLED DATA SELECTION

The response message format for request commands when either an error response must be returned OR when the link acknowledge delay is DISABLED and the "DATA NOT READY" bit set may be one of the following:

A. The response message word count, the response status word, and (if in binary) the checkword.

B. The response message word count, the response status word, the appropriate number of data words containing null data, and (if in binary) the checkword.

Switch 3 on the MPU board (Figure 6-6) selects the null-filling option as follows:

SW3 Position	Null-Filled Data
ON	Disabled
OFF	Enabled

If the communication is operating under a word count controlled I/O driver (generally binary) and when the amount of response data must be known, the null data should be ENABLED. This way, the I/O driver always receives the proper amount of data to satisfy the word count. The only exception to this is when a transmission error occurs and the ICI cannot process the command properly. In this case, two words will be returned, the response message word count and the response status word.

If operating under a carriage return/line feed controlled I/O driver (generally ASCII) or when the driver uses the actual response message word count received, either method may be selected, but DISABLED will operate slightly faster since the null data is not being returned.

In any case, the response message word count actually returned will always be appropriate.

3.4 SEND COMMAND SECURITY

The ICI provides the capability to control the processing of commands related to sending data. The protection is selected to allow levels of security of the commands involved. Switches 1 and 2 on the MPU board (Figure 6-6) select the desired security level as follows:

SW1 Position	SW2 Position	Security Level	
ON	ON	None	Increasing Protection
ON	OFF	Record	
OFF	ON	Parameter	
OFF	OFF	Local	

Each increase in level provides the protection of the lower level as follows:

NONE — This selection allows all commands to be used.

RECORD — This level of security does not allow any record information (generally configuration) to be sent from the computer.

PARAMETER — This level of security does not allow any parameter data (such as setpoint changes or mode changes) to be sent from the computer. This level includes the record level.

LOCAL — This level of security does not allow the computer to contribute any computer generated data to the LIL database (the ICI contributes six (6) channels of status information, by default) or set the local channel amount. This level includes both the record and parameter levels making the ICI a read-only device.

An "INVALID REQUEST" error response is returned if the security is violated.

3.5 WATCHDOG TIMERS

The ICI contains various watchdog timers that are used to prevent the ICI from halting due to errors. These watchdog timers include the following:

A. Hardware - this watchdog timer prevents the ICI from halting completely. The timer value is approximately 2 seconds.

B. Communication (between characters) - this watchdog timer prevents the ICI from halting due to interrupted transmission during the command or response. The timer value is approximately 5 seconds.

C. Communication (between messages) - this watchdog timer is used to monitor the communication between the computer and the ICI. The communication watchdog timer flag is available to other stations on the LIL. The timer value defaults to 64 seconds and may be changed or disabled by the user.

D. Local Instrument Link - this watchdog timer prevents the ICI from halting due to link communication errors or requests not responded to. The timer value is approximately 4 seconds.

3.6 POWER-UP MESSAGE

If the ICI is operating in the ASCII transmission method, a message of the form "ICI 320 10-10-86 BCA" is sent to the computer when the ICI is powered-up or reset. This message is useful when the ICI is connected to a terminal as it signals that the ICI is ready to receive commands. This message is the only unsolicited information ever sent to the computer.

3.7 PROGRAM INITIALIZATION OF THE ICI

There are a number of commands provided that allow the application program to determine the status of the ICI and set certain parameters within the ICI. These commands are:

A. Perform Diagnostics
B. ICI Status
C. Set ICI Local Channel Amount
D. Set Communication Watchdog Timer

These commands are described in greater detail in Section 4.

4.0 COMMAND AND RESPONSE DESCRIPTIONS

The following sections describe each of the commands and their associated responses.

The response messages are shown assuming a normal response to the command. The response message word count is shown as an expression for those commands that may have variable length responses.

A dollar sign ($) is used in this document to designate that the value is a hexadecimal representation of the number.

4.1 CMD 1 — PERFORM DIAGNOSTICS

This command instructs the ICI to perform its internal diagnostic routines. The diagnostic routines test the following:

1. Error conditions detected by the Local Instrument Link Computer.
2. Interface local memory.
3. Interface dual-port (shared) memory.
4. Update rate of the Local Instrument Link.

The form of this command is:

CMWC = 0002
CMD = 0100
CHW (determined by computer)

The form of the response is:

RMWC = 0002
RSW = XXXX
CHW (determined by ICI)

4.2 CMD 2 — ICI STATUS

This command requests the current status of the ICI. The response consists of the response status word and a general status word. This command must be issued if the response status word error indicates a "class 0" error and should be issued if a timeout is detected at the computer. The general status word is defined in Appendix E.

The form of this command is:

CMWC = 0002
CMD = 0200
CHW ned by computer)

The form of the response is:

RMWC = 0003
RSW = XXXX
DATA = XXXX
CHW (determined by ICI)

Example: A possible response to this command might be:

RMWC = $0003
RSW = $00C3
DATA = $0C8F
CHW = $0D55

indicating that:

Transmission Method	= Binary
Null-Filled Data	= Enabled
Link Acknowledge Delay	= Enabled
Send Command Security	= None
Data Format	= 8 data bits, no parity
Station Address	= 16

4.3 CMD 3 — SET ICI LOCAL CHANNEL AMOUNT

This command sets the number of channels the ICI will contribute to the LIL database. The data value may range from $0006 (6 channels) through $0100 (256 channels). The first six channels are used by the ICI for status information. The value that is sent is copied into the first of these channels, the station data size. The remaining channels may be used to place data into the LIL database by the computer by issuing the "CMD 8 — LOCAL CHANNEL DATA SEND" command.

To initialize the data in the channels prior to allocating them for the LIL database, the "CMD 8 — LOCAL CHANNEL DATA SEND" command should be used before this command is issued. Otherwise, whatever data previously in the channels will appear in the LIL database when allocated. If the channel amount specified is less than 6 or greater than 256 channels, six (6) channels will be assigned and an "INVALID REQUEST" error code will be returned.

The form of the command is:

CMWC = 0003
CMD = 0300
DATA = XXXX
CHW (determined by computer)

The form of the response is:

RMWC = 0002
RSW = XXXX
CHW (determined by ICI)

Example: If the user requires three values to be updated to the LIL from the ICI, the number of channels would be the sum of the status channels, $0006 (6) and the desired number of values, $0003 (3). Therefore, DATA = $0009 and the command would be:

CMWC = $0003
CMD = $0300
DATA = $0009
CHW = $030C

4.4 CMD 4 — SET COMMUNICATION WATCHDOG TIMER

This command sets the amount of time (with 0.5 second resolution) the ICI will wait between transmissions with the computer before setting a watchdog timer flag to indicate that communications have ceased. The data value may range from $0000 (no timeout) to $FFFF (9 hours, 6 minutes, 7.5 seconds). The default value is $0080 (64 seconds). The watchdog timer flag shall be set to $0080 or "0" (zero) upon timeout and set to $0F80 or "1" (one) if armed.

In the BBA version, the communication watchdog timer monitors all commands. The watchdog timer flag is updated into channel five (5) of the ICI's global database and the current watchdog timer value is updated into channel six (6) of the ICI's global database.

If a watchdog timer value is specified, any command used will rearm the watchdog timer. If a timeout occurs, the ICI will perform a power-up reset (which includes the Local Instrument Link).

If no timer value is specified (disabled), the flag is set to $0F80.

In the BCA version, two (2) communication watchdog timers are maintained. Watchdog timer #1 monitors all commands while watchdog timer #2 monitors only the "CMD 8 — LOCAL CHANNEL DATA SEND" and "CMD 9 — PARAMETER DATA SEND" commands. Watchdog timer #1 flag is updated into channel five (5) of the ICI's global database and bit 6 of the response status word while watchdog timer #2 flag is updated into channel six (6) of the ICI's global database. The watchdog timer value is common to both timers and is not updated into the global database.

If a watchdog timer value is specified, any command used will rearm watchdog timer #1 while only the "CMD 8 — LOCAL CHANNEL DATA SEND" and "CMD 9 — PARAMETER DATA SEND" and "CMD 12 — RESPONSE TO RECEIVED RANDOM PARAMETER DATA REQUEST" commands will rearm watchdog timer #2. If a timeout occurs for either timer, the ICI does NOT perform a power-up reset, but the user-defined local channel data will be set to a value of $0000.

If no timer value is specified (disabled), watchdog timer #1 flag is set to $0F80 and watchdog timer #2 flag is set to $0080.

The form of the command is:

CMWC = 0003
CMD = 0400
DATA = XXXX
CHW (determined by computer)

The form of the response is:

RMWC = 0002
RSW = XXXX
CHW (determined by ICI)

Example: To set a 10 second watchdog timer, the command issued would be:

CMWC = $0003
CMD = $0400
DATA = $0014 ('Twenty' 0.5 second intervals)
CHW = $0417

4.5 CMD 5 — SEQUENTIAL CHANNEL DATA REQUEST

This command requests data starting at the specified channel for the desired number of channels (256 maximum) from a particular station in the LIL global database.

For each channel requested, a flag will be set or reset to indicate whether the channel is invalid or valid, respectively. A channel is invalid if the station is offline or the channel is not configured in the LIL global database for the station.

If the station is offline, the "STATION NOT IN GLOBAL DATABASE" error code will be returned and the flags set for each channel. If the station is online and the channels requested begin after or exceed the number of channels allocated for the station, the flags will be set for the invalid channels.

One flag word will be added to the response for each 16 channels (or part of 16 channels) requested. The flag for the first channel requested is in bit 15 (most significant bit) of the first flag word with each additional channel flag in the next lower bit and on to the next flag word until all channels have been flagged. For 256 channels requested, this adds an additional 16 words maximum.

The "data" for an invalid channel is zero ($0000) and the flag bit is set to a one (1). If there is any other error the ICI will respond with the appropriate error code set in the response status word and the data and flag words (up to the number requested) set to null data if the null-filling is enabled.

The form of the command is:

CMWC = 0003
CMD = 05NN
ADDR = SSCC
CHW (determined by computer)

The form of the response is:

RMWC = (NN+1)+(INT(NN/16)+1)+2
RSW = XXXX
DATA(1) = XXXX
.
.
.
DATA(NN+1) = XXXX
FLAG(1) = XXXX
.
.
.
FLAG(INT(NN/16)+1) = XXXX
CHW (determined by ICI)

Example: The values from the first loop of a SLDC, addressed as station 23 (SS = $16), are required at the user's computer. Loop 1 of any SLDC is updated into four consecutive channels (NN = $03) starting at channel 6 (CC = $05) (channel 6 - process value, channel 7 - setpoint, channel 8 - valve, and channel 9 -status).

The command would be:

CMWC = $0003
CMD = $0503
ADDR = $1605
CHW = $1B0B

A possible response might be:

RMWC = $0007
RSW = $00C3
DATA(1) = $0418
DATA(2) = $0430
DATA(3) = $0836
DATA(4) = $0011
FLAG(1) = $0000
CHW = $1159

which, converting the data values to percent of scale and decoding the controller status, indicates that:

PROCESS VALUE = 23.95%
SETPOINT = 24.58%
VALVE = 51.4%
CONTROLLER STATUS = CONSOLE AUTOMATIC

4.6 CMD 6 — RANDOM CHANNEL DATA REQUEST

This command requests data randomly for up to 256 channels from the LIL database held in the ICI.

For each channel requested, a flag will be set or reset to indicate whether the channel is invalid or valid, respectively. A channel is invalid if the station is offline or the channel is not configured in the LIL global database for the station.

One flag word will be added to the response for each 16 channels (or part of 16 channels) requested. The flag for the first channel requested is in bit 15 (most significant bit) of the first flag word with each additional channel flag in the next lower bit and on to the next flag word until all channels have been flagged. For 256 channels requested, this adds an additional 16 words maximum.

The "data" for an invalid channel is zero ($0000) and the flag bit is set to a one (1). If there is any other error, the ICI will respond with the appropriate error code set in the response status word and the data and flag words (up to the number requested) set to null data if the null-filling is enabled.

The form of this command is:

CMWC = (NN+1)+2
CMD = 06NN
ADDR(1) = SSCC

.
.
.

ADDR(NN+1) = SSCC
CHW (determined by computer)

The form of the response is:

```
RMWC                  = (NN+1)+(INT(NN/16)+1)+2
RSW                   = XXXX
DATA(1)               = XXXX
 .
 .
 .
DATA(NN+1)            = XXXX
FLAG(1)               = XXXX
 .
 .
 .
FLAG(INT(NN/16)+1)    = XXXX
CHW                     (determined by ICI)
```

Example: A subroutine in the user's computer checks the types of stations on the LIL. Station type for any LIL station is updated into channel 2 (CC = $01) of that station's contribution to the LIL database. There can be up to 64 stations, addresses 1 to 64 (SS = $00 to $3F). The number of channels requested is 64 (NN = $3F). The command would be:

```
CMWC     = $0042
CMD      = $063F
ADDR(1)  = $0001
ADDR(2)  = $0101
 .
 .
 .
ADDR(63) = $3E01
ADDR(64) = $3F01
CHW      = $E6C1
```

A possible response might be:

```
RMWC     = $0046
RSW      = $00C3
DATA(1)  = $0001
DATA(2)  = $0001
DATA(3)  = $0005
DATA(4)  = $0000
 .
 .
 .
DATA(64) = $0000
FLAG(1)  = $1FFF
FLAG(2)  = $FFFF
FLAG(3)  = $FFFF
FLAG(4)  = $FFFF
CHW      = $210C
```

indicating that there are SLDC's at station addresses 1 and 2 and an ICI at station address 3.

4.7 CMD 7 — RANDOM PARAMETER DATA REQUEST

This command requests parameter data randomly for any station on any LIL. Up to 5 parameters (updating or non-updating) may be requested from one station.

Since this command requires a link transmission to obtain the data, the ICI will respond immediately with the "DATA NOT READY" bit of the response status word set if the link acknowledge delay is disabled and the data words (up to the number requested) set to null data if the null-filling is enabled.

The form of this command is:

CMWC = N+4
CMD = 0700
ADDR = LLHH
SSN1
ADDR(1) = CCPP

.
.
.

ADDR(N) = CCPP
CHW (determined by computer)

The form of the response is:

RMWC = N+2
RSW = XXXX
DATA(1) = XXXX

.
.
.

DATA(N) = XXXX
CHW (determined by ICI)

Example: Non-updating tuning parameter values from the first loop of a SLDC, addressed as station 27 (SS = $1A), are required at the user's computer. Four tuning values (N = $04) are required:

proportional gain - channel 6 (CC = $05), parameter 2 (PP = $01)
integral time - channel 6 (CC = $05), parameter 3 (PP = $02)
derivative time - channel 6 (CC = $05), parameter 4 (PP = $03)
derivative gain - channel 6 (CC = $05), parameter 5 (PP = $04)

The SLDC resides on this ICI's Local Instrument Link, therefore LL = $00 and HH = $00. The command would be:

CMWC = $0008
CMD = $0700
ADDR = $0000
$1A41
ADDR(1) = $0501
ADDR(2) = $0502
ADDR(3) = $0503
ADDR(4) = $0504
CHW = $3553

A possible response might be:

RMWC = $0006
RSW = $00C3
DATA(1) = $17CE
DATA(2) = $2085
DATA(3) = $2080
DATA(4) = $2468
CHW = $7E04

which, when converted to the appropriate tuning ranges specified by the data, indicates that:

PROPORTIONAL GAIN = -0.50
INTEGRAL TIME = 0.05 minutes/repeat
DERIVATIVE TIME = 0.00 (no derivative action)
DERIVATIVE GAIN = 10.00 (even though no derivative action)

4.8 CMD 8 — LOCAL CHANNEL DATA SEND

This command updates the locally generated portion of the LIL database starting at the channel specified. Up to 250 channels of user-defined data, plus in the BCA version, the upper byte of some of the first six status channels, may be updated as allocated by the "CMD 3 — SET ICI LOCAL CHANNEL AMOUNT" command.

A value sent to a particular channel is then updated to the LIL every one-half second.

This command should be used to initialize data values prior to issuing the "CMD 3 — SET ICI LOCAL CHANNEL AMOUNT" command.

Data may be sent by this command to the channels as follows (channels 1-6: BCA only):

Channel
1 - No change allowed
2 - Upper byte only
3 - Upper byte only
3 - Upper byte only
4 - Upper byte only
5 - No change allowed
6 - No change allowed
7 -
. } Any data
. }
256 -

The form of this command is:

CMWC = (NN+1)+3
CMD = 08NN
ADDR = 00CC
DATA(1) = XXXX

DATA(NN+1) = XXXX
CHW (determined by computer)

The form of the response is:

RMWC = 0002
RSW = XXXX
CHW (determined by ICI)

Example: The user's computer repeatedly performs two complex calculations based on various values. The results of these calculations are to be updated in two channels (NN = $01) starting at channel 7 (CC = $06) in the ICI's portion of the LIL database. The user's computer must place the calculation results into the command as DATA(1) and DATA(2). If the calculation results were DATA(1) = $0800 and DATA(2) = $F800, the command would be:

CMWC = $0005
CMD = $0801
ADDR = $0006
DATA(1) = $0800
DATA(2) = $F800
CHW = $080C

4.9 CMD 9 — PARAMETER DATA SEND

This command sends parameter data to any station on any LIL. Only one (1) destination may be specified. The data may be a maximum of 10 words (NN = 0 to 9) in size, allowing multiple byte data (alphabetic or numeric) to be sent using one command.

This command contains a data type/command type byte (designated as DC) which describes the data being sent. See Appendix F for a description of the data type/command type byte.

The response will be delayed if the link acknowledge delay is enabled.

The form of this command is:

```
CMWC        = (NN+1)+5
CMD         = 09NN
ADDR        = LLHH
              SSDC
              CCPP
DATA(1)     = XXXX
.
.
.
DATA(NN+1) = XXXX
CHW           (determined by computer)
```

The form of the response is:

```
RMWC   = 0002
RSW    = XXXX
CHW      (determined by ICI)
```

Example 1: As an expansion on the example in Section 4.7, the user desires to set the proportional gain to +10.0 (translated to hex as $2864 (see SLDC Link Communication Manual, Section 2.1.1.3)). The data type of the value sent is a 12 BIT INTEGER PLUS RANGE BITS, ABSOLUTE (D = $A). The command type used is a PARAMETER SEND FROM A CONSOLE SOURCE (C = $5). The SLDC must be in the 'C' mode. The command would be as follows:

```
CMWC    = $0006
CMD     = $0900
ADDR    = $0000
ADDR    = $1AA5
ADDR    = $0501
DATA(1) = $2864
CHW     = $5110
```

Example 2: The user in example 1 wants to change the valve signal of loop 1 (channel 8 (CC = $07), parameter 1 (PP = $00)) up 10% from the present value (as opposed to an absolute change) using the data type 16-BIT INTEGER, RELATIVE (D = $2). Data in a relative parameter change is in a two's complement format with "up" changes scaled from 0% ($0000) to 50% ($07FF) and "down" changes scaled from -50% ($0800) to -0.03% ($0FFF). A 10% up change is scaled as $0199 (DATA). The command would be as follows:

```
CMWC    = $0006
CMD     = $0900
ADDR    = $0000
ADDR    = $1A25
ADDR    = $0700
DATA(1) = $0199
CHW     = $2BC4
```

Example 3: The user desired in SLDC station 21 (SS = $14) to change loop 1's status from Auto Internal to Manual External. This involves resetting to zero bit "0" (Auto/Manual) in the loop status word (channel 9 (CC = $08), parameter 1 (PP = $00)) and setting to one bit "3" (Internal/External) in the same status word.

Two commands are needed to accomplish this task. The first command's data value defines the mask for the bits that are to be reset to zero (MULTI-DISCRETE MASK OFF (D = $4), DATA = $0001) and the second command's data value defines the mask for those bits that are to be set to one (MULTI-DISCRETE MASK ON (D = $3), DATA = $0008). The two commands would be as follows:

1) CMWC = $0006
   CMD = $0900
   ADDR = $0000
   ADDR = $1445
   ADDR = $0800
   DATA(1) = $0001 (= 0000 0000 0000 0001)
   CHW = $254C

2) CMWC = $0006
   CMD = $0900
   ADDR = $0000
   ADDR = $1435
   ADDR = $0800
   DATA(1) = $0008 (= 0000 0000 0000 1000)
   CHW = $2540

4.10 CMD 10 — RECORD REQUEST

This command requests the data of a specified record of either the ICI or a LIL station. A record consists of 256 bytes of data. However, the record byte count (BBBB) may be in the range of 2-512 bytes. This allows reading a part of a record (using a non-zero offset count (OO)) or reading up to two (2) full records per request.

This command is also used to read an unsolicited record sent to this ICI (the "UNSOLICITED RECORD AVAILABLE" bit (bit 2) of the response status word set). See example 2 for the addressing information required to accomplish this. The information returned contains the source address, the record number, the offset count, the record byte count, the record data checksum, and the record send command checksum.

When an unsolicited record is received, the application program should request the record from the ICI's record buffer, which returns all the required information about the record, perform any desired error checking on the record, and send an acknowledgement to the source station using a "CMD 9 — PARAMETER DATA SEND" command as described in Appendix G.

The record data checksum is the byte-by-byte addition of the record data into a word, ignoring any final carry. The record send command checksum is the byte-by-byte addition from the source link number (LL (SRC)) to the low byte of CCCC into a byte, ignoring any final carry.

If this command requires a link transmission to obtain the data, the ICI will respond immediately with the "DATA NOT READY" bit of the response status word set if the link acknowledge delay is disabled and the data words (up to the number requested) set to null data if the null-filling is enabled.

The form of this command is:

CMWC = 0006
CMD = 0A00
ADDR = LLHH
  SSRR (high byte of RRRR)
  RROO (low byte of RRRR)
RBC = BBBB
CHW (determined by computer)

The form of the response is:

```
RMWC    = (BBBB/2)+10
RSW     = XXXX
SRC     = xxLL
          HHSS
DEST    = LLHH
          SSxx
REC     = RRRR
          OOBB (high byte of BBBB)
          BBCC (low byte of BBBB, high byte of CCCC)
          CCxx (low byte of CCCC, record send command checksum)
DATA(1) = XXXX

DATA(BBBB/2) = XXXX
CHW          (determined by ICI)
```

Example 1: The configuration identification of a SLDC consists of 12 bytes in record $000A at offset $72. To obtain this information from station 1 (SS = $00) on this LIL, the command would be as follows:

```
CMWC    = $0006
CMD     = $0A00
ADDR    = $0000
          $0000
          $0A72
RBC     = $000C
CHW     = $1484
```

A possible response might be:

```
RMWC    = $0010
RSW     = $00C3
SRC     = $F000
          $0000
DEST    = $0000
          $0F00
REC     = $000A
          $7200
          $0C01
          $67FF
DATA(1) = $4643 ⟶ FC
DATA(2) = $4F2D ⟶ O-
DATA(3) = $3131 ⟶ 11
DATA(4) = $0000
DATA(5) = $0000
DATA(6) = $0000
CHW     = $AC7E
```

Example 2: To obtain the data of an unsolicited record, the "CMD 10 — RECORD REQUEST" command must be issued to the location of the record buffer in the ICI. This is defined as record $0014, offset $00. Since at this time it is not known how much data was sent, the byte count of the request should be $0200 (512 bytes, the total buffer). Assuming this ICI is station 16 (SS = $0F), the command would be:

```
CMWC    = $0006
CMD     = $0A00
ADDR    = $0000
          $0F00
          $1400
RBC     = $0200
CHW     = $2F06
```

The first 11 words of a possible response might be:

```
RMWC      = $010A
RSW       = $00C3
SRC       = $F000
            $001F
DEST      = $0000
          = $0F00
REC       = $0008
            $0001
            $0016
            $4C99
DATA(1)   = $0026
```

indicating that the record source is station 32 (SS (SRC) = $1F), the record is $0008, offset $00, the record byte count is actually $0100 (256 bytes), the record data checksum is $164C, the record send command checksum is $99, and the first word of data is $0026. In this case, the second 256 bytes of the record buffer contain unknown (and therefore, invalid) data.

4.11 CMD 11 — RECORD SEND

This command sends data to a specific record of a LIL station.

The record data checksum must be calculated and sent along with the data. The record data checksum is the byte-by-byte addition of the record data into a word, ignoring any final carry.

The response will be delayed if the link acknowledge delay is enabled.

The station receiving the record will acknowledge back to this station using a "CMD 9 — PARAMETER DATA SEND COMMAND" which sets the "INPUT BUFFERS NOT EMPTY" bit (bit 3) of the response status word, which may be decoded after issuing any command. The acknowledgement is then read using a "CMD 15 — READ LIL COMMAND INPUT BUFFER" command. See Appendix G for details on the record send acknowledge.

The form of this command is:

```
CMWC          = (BBBB/2)+7
CMD           = 0B00
ADDR          = LLHH
                SSRR (high byte of RRRR)
                RROO (low byte of RRRR)
RBC           = BBBB
RDC           = CCCC
DATA(1)       = XXXX

DATA(BBB/2) = XXXX
CHW           (determined by computer)
```

The form of the response is:

```
RMWC    = 0002
RSW     = XXXX
CHW       (determined by ICI)
```

Example: To send the first record of a SLDC configuration (record $0008, offset $00) to station 1 (SS = $00), the first eight words of the command would be as follows:

```
CMWC      = $0087
CMD       = $0B00
ADDR      = $0000
            $0000
            $0800
RBC       = $0100
RDC       = $16EB
DATA(1)   = $0122
  .
  .
  .
DATA(128) = XXXX
```

4.12 CMD 12 — RESPONSE TO RECEIVED RANDOM PARAMETER DATA REQUEST

This command is used to send data to a station which has issued a "CMD 7 — RANDOM PARAMETER DATA REQUEST" command to this ICI.

This command should be issued if the "INPUT BUFFERS NOT EMPTY" bit (bit 3) of the response status word was set and the decoding of the response to a "CMD 15 — READ LIL COMMAND INPUT BUFFER" command indicates a command type of CMD 7 — RANDOM PARAMETER DATA REQUEST (C = $1).

The address information of the requesting station and the effective addresses of the data requested (the channels and parameters) are also contained in the response to the "CMD 15 — READ LIL COMMAND INPUT BUFFER" command. The application program of the receiving ICI maps the channels and parameters requested to specific pieces of data as defined in the application program.

The response to the requesting station consists of echoing the channel and parameter addresses and appending the appropriate data values.

The response to the computer will be delayed if the link acknowledge delay is enabled.

The form of this command is:

```
CMWC      = N*2+4
CMD       = 0C00
ADDR      = LLHH
            SSN1
DATA(1)   = CCPP
  .
  .
  .
DATA(N)   = CCPP
DATA(N+1) = XXXX
  .
  .
  .
DATA(N+N) = XXXX
CHW         (determined by computer)
```

The form of the response is:

```
RMWC  = 0002
RSW   = XXXX
CHW     (determined by ICI)
```

Example: Suppose an application program has defined a certain limit value to be contained at channel 6 (CC = $05), parameter 2 (PP = $01). After issuing a "CMD 15 — READ LIL COMMAND INPUT BUFFER" command because the "INPUT BUFFERS NOT EMPTY" bit of the response status word was set, the application program determined that station 32 (SS (SRC) = $1F) on this LIL issued a "CMD 7 — RANDOM PARAMETER DATA REQUEST" command for this limit value since D = $1, C = $1, and DATA(1) = $0501. Therefore, D is equal to the number of parameters requested (N), and if the limit value = $3A85, the command issued to return the data to the requesting station would be:

```
CMWC    = $0006
CMD     = $0C00
ADDR    = $0000
          $1F11
DATA(1) = $0501
DATA(2) = $3A85
CHW     = $5E9D
```

4.13 CMD 14 — READ RECORD REQUEST BUFFER - BCA

This command requests the contents of the record request buffer residing in the ICI. This buffer contains the information of "CMD 10 — RECORD REQUEST" commands issued by other stations on the LIL to this ICI.

This command should be issued if the "RECORD REQUEST BUFFER NOT EMPTY" bit (bit 5) of the response status word is set. If this command is issued when the buffer is empty, the "DATA NOT AVAILABLE" error code and the apprpriate amount of null data will be returned if the null-filling is enabled.

The data is returned to the requesting station using the "CMD 11 — RECORD SEND" command. The actual data returned is up to the user application program.

The form of this command is:

```
CMWC    = 0002
CMD     = 0E00
CHW     = (determined by computer)
```

The form of the response is:

```
RMWC    = 0009
RSW     = XXXX
SRC     = xxLL
          HHSS
DEST    = LLHH
          SSxx
REC     = RRRR
        = OOBB (high byte of BBBB)
          BBxx (low byte of BBBB)
CHW     = (determined by ICI)
```

Example: Suppose we define the first 10 bytes of record $0000 to contain a program name. This "RECORD" is actually a data variable in the application program. If we are station 16 (SS (DEST) = $0F) and station 32 (SS (SRC) = $1F) issues a "CMD 10 — RECORD REQUEST" command for this information, the response that would be returned when we read the record request buffer might be:

```
RMWC    = $0009
RSW     = $00C3
SRC     = $8E00
          $001F
DEST    = $0000
          $0F00
REC     = $0000
          $0000
          $0A00
CHW     = $A7EB
```

4.14 CMD 15 — READ LIL COMMAND INPUT BUFFER

This command requests the contents of one of the eight LIL command input buffers residing in the ICI. These buffers contain the information of "CMD 9 — PARAMETER DATA SEND", "CMD 7 — RANDOM PARAMETER DATA REQUEST", or "CMD 23 — MULTI-BYTE PARAMETER DATA REQUEST" commands issued by other stations on the LIL to this ICI.

This command should be issued if the "INPUT BUFFERS NOT EMPTY" bit (bit 3) of the response status word is set. Should there be more than one buffer not empty the "INPUT BUFFERS NOT EMPTY" bit shall remain set. If this command is issued when no buffers are full, the "DATA NOT AVAILABLE" error code and the appropriate amount of null data will be returned if the null-filling is enabled.

The actions taken by the receiving application program are up to the user. All information after the data type/command type byte (DC) are user-defined. However, to maintain compatibility with other stations on the LIL, address information should remain as defined. The channel and parameter information could be used to map into an application database or specify certain commands be issued.

If the command type code indicates that a "CMD 7 — RANDOM PARAMETER DATA REQUEST" command was issued (C = $1), the requested data is returned using the "CMD 12 — RESPONSE TO RECEIVED PARAMETER DATA REQUEST" command.

If the command type code indicates that a "CMD 23 — MULTI-BYTE PARAMETER DATA REQUEST" command was issued (C = $2), the requested data is returned using the "CMD 28 — RESPONSE TO RECEIVED MULTI-BYTE PARAMETER DATA REQUEST" command.

The form of this command is:

```
CMWC    = 0002
CMD     = 0F00
CHW       (determined by computer)
```

The form of the response is:

```
RMWC    = 0012
RSW     = XXXX
SRC     = xxLL
          HHSS
DEST    = LLHH
          SSDC
DATA(1) = XXXX
  .
  .
  .
DATA(12) = XXXX
CHW        (determined by ICI)
```

Example: Suppose we wish to allow another station to specify the communication watchdog timer value that we should set. The application program recognizes a "16-BIT INTEGER, ABSOLUTE; PARAMETER SEND FROM ANY SOURCE" (DC = $17) command directed to channel 6 (CC = $05), parameter 1 (PP = $00) with an appropriate data value as the command to set the watchdog timer. If we are station 16 (SS (DEST) = $0F) and station 32 (SS (SRC) = $1F) issues the "CMD 9 — PARAMETER DATA SEND" command, the response that would be returned when we read the LIL command input buffer might be:

```
RMWC    = $0012
RSW     = $00C3
SRC     = $0D00
          $001F
DEST    = $0000
          $0F17
DATA(1) = $0500
DATA(2) = $001E
DATA(3) = $6800
DATA(4) = $0000
  .
  .
  .
DATA(12) = $0000
CHW      = $8A29
```

The value in DATA(1) contains the channel and parameter information. The value in DATA(2) would then become the data value we would use in the "CMD 4 — SET COMMUNICATION WATCHDOG TIMER" command, in this example representing 15 seconds (30 0.5 second intervals). The upper byte of DATA(3) ($68) is the link command checksum which was appended by the source ICI.

4.15 CMD 23 — MULTI-BYTE PARAMETER DATA REQUEST - BCA

This command requests parameter data that is made up of multiple bytes, for example, 32-bit data. Only one parameter per station may be requested, but the amount of data may range from 1-10 words.

Since the command requires a link transmission to obtain the data, the ICI will respond immediately with the "DATA NOT READY" bit of the response status word set if the link acknowledge dealy is disabled and the data words (up to the number requested) set to null data if the null-filling is enabled.

The form of this command is:

CMWC = 0005
CMD = 1700
ADDR = LLHH
SSN2
CCPP
CHW = (determined by computer)

The form of the response is:

RMWC = N+2
RSW = XXXX
DATA(1) = XXXX

.
.
.

DATA(N) = XXXX
CHW (determined by ICI)

Example: To obtain a 32-bit (N = $2) timer value from a PSC addressed as station 11 (SS = $0A) contained in channel 15 (CC = $0E), parameter 2 (PP = $01), the command would be:

CMWC = $0005
CMD = $1700
ADDR = $0000
$0A22
$0E01
CHW = $2F28

A possible response might be:

RMWC = $0004
RSW = $00C3
DATA(1) = $005A
DATA(2) = $3278
CHW = $3399

indicating a timer value of 59111.60 minutes by expanding DATA(1) and DATA(2).

4.16 CMD 28 — RESPONSE TO RECEIVED MULTI-BYTE PARAMETER DATA REQUEST - BCA

This command is used to send data to a station which has issued a "MULTI-BYTE PARAMETER DATA REQUEST" command to this ICI.

This command should be issued if the "INPUT BUFFERS NOT EMPTY" bit (bit 3) of the response status word was set and the decoding of the response to a "READ LIL COMMAND INPUT BUFFER" command indicates a command type of CMD 23 — MULTI-BYTE PARAMETER DATA REQUEST (C = $2).

The address information of the requesting station and the effective address of the data requested (the channel and parameter) are also contained in the response to the "CMD 15 — READ LIL COMMAND INPUT BUFFER" command. The application program of the receiving ICI maps the channel and parameter requested to a specific piece of data as defined in the application program.

The response to the requesting station consists of echoing the channel and parameter address and appending the appropriate number of data words.

The response to the computer will be delayed if the link acknowledge delay is enabled.

The form of this command is:

```
CMWC      = N+5
CMD       = 1C00
ADDR      = LLHH
            SSN2
DATA(1)   = CCPP
DATA(2)   = XXXX
.
.
.
DATA(N+1) = XXXX
            CHW (determined by computer)
```

The form of the response is:

```
RMWC  = 0002
RSW   = XXXX
CHW     (determined by ICI)
```

Example: An application program has defined a 32-bit counter to be contained at channel 10 (CC = $09), paramter 5 (PP = $04). After issuing a "CMD 15 — READ LIL COMMAND INPUT BUFFER" command because the "INPUT BUFFERS NOT EMPTY" bit of the response status word was set, the application program determined that station 32 (SS(SRC) = $1F) on this LIL issued a "CMD 23 — MULTI-BYTE PARAMETER DATA REQUEST" command for the counter value since D = $2, C = $2, and DATA(1) = $0904. Therefore, D is equal to the number of words requested (N), and if the counter value = $000173E5, the command issued to return the data to the requesting station would be:

```
CMWC    = $0007
CMD     = $1C00
ADDR    = $0000
          $1F22
DATA(1) = $0904
DATA(2) = $0001
DATA(3) = $73E5
CHW     = $9C2F
```

5.0 APPENDICES

5.1 APPENDIX A - COMMAND SUMMARY TABLE

The commands of the ICI are the following:

COMMAND	DESCRIPTION
1	PERFORM DIAGNOSTICS
2	ICI STATUS
3	SET ICI LOCAL CHANNEL AMOUNT
4	SET COMMUNICATION WATCHDOG TIMER
5	SEQUENTIAL CHANNEL DATA REQUEST
6	RANDOM CHANNEL DATA REQUEST
7	RANDOM PARAMETER DATA REQUEST
8	LOCAL CHANNEL DATA SEND
9	PARAMETER DATA SEND
A	RECORD REQUEST
B	RECORD SEND
C	RESPONSE TO RECEIVED RANDOM PARAMETER DATA REQUEST
D	NOT USED (RESERVED)
E	READ RECORD REQUEST BUFFER - BCA
F	READ LIL COMMAND INPUT BUFFER
10	NOT USED (RESERVED)
11	
12	
13	
14	
15	
16	
17	MULTI-BYTE PARAMETER DATA REQUEST - BCA
18	NOT USED (RESERVED)
19	
1A	
1B	
1C	RESPONSE TO RECEIVED MULTI—BYTE PARAMETER DATA REQUEST - BCA
1D	NOT USED (RESERVED)
1E	
1F	

5.2 APPENDIX B - ABBREVIATIONS USED

The following is a list of abbreviations used in the descriptions of the commands and responses:

ABBREVIATION	DESCRIPTION	DATA VALUES	MEANING
ADDR	COMMAND ADDRESS INFORMATION		
BBBB	RECORD BYTE COUNT	0000-FFFE	0-65534
CC	CHANNEL NUMBER	00-FF	1-256
CCCC	RECORD DATA CHECKSUM	0000-FFFF	0-65535
CHW	ERROR CHECKWORD	0000-FFFF	0-65535
CMD	COMMAND WORD	01xx-FFxx	(1-255)xx
CMWC	COMMAND MESSAGE WORD COUNT	0002-FFFF	2-65535
DC	DATA TYPE/COMMAND TYPE	0-F*	0-15*
DEST	DESTINATION ADDRESS INFORMATION		
HH	HI-LEVEL LINK ADDRESS	00-1F	0-31
KK	RECORD SEND ACKNOWLEDGE ERROR CODE	00-FF	0-255
LL	LINK NUMBER	00-04	0-4
N	NUMBER OF ITEMS (PARAMETERS)	0-F	0-15
NN	NUMBER OF ITEMS (MISC)	00-FF	1-256
OO	OFFSET COUNT	00-FF	0-255
PP	PARAMETER NUMBER	00-FF	1-256
RBC	RECORD BYTE COUNT (BBBB)	0000-FFFE	0-65534
RDC	RECORD DATA CHECKSUM (CCCC)	0000-FFFF	0-65535
RMWC	RESPONSE MESSAGE WORD COUNT	0002-FFFF	2-65535
RRRR	RECORD NUMBER	0000-FFFF	0-65535
RSW	RESPONSE STATUS WORD	0000-FFFF	0-65535
SRC	SOURCE ADDRESS INFORMATION		
SS	LIL STATION ADDRESS	00-3F	1-65
xx	IRRELEVANT DATA		
XX	DATA VALUE (8-BIT)	00-FF	**
XXXX	DATA VALUE (16-BIT)	0000-FFFF	**
XXXXXXXX	DATA VALUE (32-BIT)	00000000-FFFFFFFF	**

* Each nibble

** The data values in the table commonly appear in the following formats:

A. 8-bit integer data.
B. 16-bit integer data representing analog values, single discrete values, or multi-discrete values.
C. 32-bit integer data representing analog values and multi-discrete values.
D. 32-bit floating point (using IEEE format) representing analog values.

5.3 APPENDIX C1 - RESPONSE STATUS WORD - BBA

The second word returned in the response is the response status word. This word contains error and status information about the current command and conditions within the ICI. The bits of the response status word are defined as follows:

BIT	DESCRIPTION
15	ERROR OR FAILURE
14	LIL DATABASE UPDATING
13	ERROR CLASS
12	ERROR CLASS
11	ERROR CLASS
10	ERROR CODE
9	ERROR CODE
8	ERROR CODE
7	NOT USED
6	NOT USED
5	NOT USED
4	DATA NOT READY
3	INPUT BUFFERS NOT EMPTY
2	UNSOLICITED RECORD AVAILABLE
1	GLOBAL INPUTS CONFIGURED
0	LIL INTERFACE ONLINE

Bit 15 - ERROR OR FAILURE - This bit is set to indicate that an error or failure has occurred. The error is defined by bits 13-8 and described in Appendix D.

Bit 14 - LIL DATABASE UPDATING - This bit is set to indicate that the LIL database is being periodically updated.

Bits 13-8 - ERROR CLASS and ERROR CODE - Described in Appendix D.

Bits 7-5 - NOT USED

Bit 4 - DATA NOT READY - This bit is set to indicate that data has been requested from a station, but the data has not been received yet. This bit should be tested to determine if the command has to be reissued to get the data.

Bit 3 - INPUT BUFFERS NOT EMPTY - If another station on the link sends a command to the ICI, it is placed in an empty input buffer and this bit is set. The "READ LIL COMMAND INPUT BUFFER" command is used to obtain the contents of the buffer. If more than one buffer is not empty, the bit remains set and subsequent read commands must be issued.

Bit 2 - UNSOLICITED RECORD AVAILABLE - This bit is set when another station sends record data that was not requested. The computer must issue a "RECORD REQUEST" command to the ICI itself to obtain the data.

Bit 1 - GLOBAL INPUTS CONFIGURED - This bit is set to indicate that the channels specified by the ICI to be updated into the LIL database have been configured into LIL database. It may take a few seconds for this bit to reflect this when the computer sets the local channel amount.

Bit 0 - LIL INTERFACE ONLINE - This bit is set to indicate that the Local Instrument Link is present.

The response status word is copied into the third channel of the ICI global database. The response status word error bits (bit 15 and bits 13-8) are copied into the lower byte of the fourth channel of the ICI global database. See Appendix J1 and Appendix K.

5.4 APPENDIX C2 - RESPONSE STATUS WORD - BCA

The second word returned in the response is the response status word. This word contains error and status information about the current command and conditions within the ICI. The bits of the response status word are defined as follows:

BIT	DESCRIPTION
15	ERROR OR FAILURE
14	NOT USED
13, 12, 11	ERROR CLASS
10, 9, 8	ERROR CODE
7	LIL DATABASE UPDATING
6	COMMUNICATION WATCHDOG TIMER FLAG
5	RECORD REQUEST BUFFER NOT EMPTY
4	DATA NOT READY
3	INPUT BUFFERS NOT EMPTY
2	UNSOLICITED RECORD AVAILABLE
1	GLOBAL INPUTS CONFIGURED
0	LIL INTERFACE ONLINE

Bit 15 - ERROR OR FAILURE - This bit is set to indicate that an error or failure has occurred. The error is defined by bits 13-8 and described in Appendix D.

Bit 14 - NOT USED

Bits 13-8 - ERROR CLASS and ERROR CODE - Described in Appendix D.

Bit 7 - LIL DATABASE UPDATING - This bit is set to indicate that the LIL database is being periodically updated.

Bit 6 - COMMUNICATION WATCHDOG TIMER FLAG - This bit is a copy of the communication watchdog timer flag channel. The bit is reset when a timeout occurs and set when no timeout is specified or the timer is armed.

Bit 5 - RECORD REQUEST BUFFER NOT EMPTY - This bit is set if another station issues a "RECORD REQUEST" command to this station. The "READ RECORD REQUEST BUFFER" command is used to obtain the contents of the buffer.

Bit 4 - DATA NOT READY - This bit is set to indicate that data has been requested from a station, but the data has not been received yet. This bit should be tested to determine if the command has to be reissued to get the data.

Bit 3 - INPUT BUFFERS NOT EMPTY - If another station on the link sends a command to the ICI, it is placed in an empty input buffer and this bit is set. The "READ LIL COMMAND INPUT BUFFER" command is used to obtain the contents of the buffer. If more than one buffer is not empty, the bit remains set and subsequent read commands must be issued.

Bit 2 - UNSOLICITED RECORD AVAILABLE - This bit is set when another station sends record data that was not requested. The computer must issue a "RECORD REQUEST" command to the ICI itself to obtain the data.

Bit 1 - GLOBAL INPUTS CONFIGURED - This bit is set to indicate that the channels specified by the ICI to be updated into the LIL database have been configured into LIL database. It may take a few seconds for this bit to reflect this when the computer sets the local channel amount.

Bit 0 - LIL INTERFACE ONLINE - This bit is set to indicate that the Local Instrument Link is present.

The lower byte of the response status word is copied into the lower byte of the third channel of the ICI global database. The upper byte of the response status word is copied into the lower byte of the fourth channel of the ICI global database. See Appendix J2 and Appendix K.

5.5 APPENDIX D - RESPONSE STATUS WORD ERROR CODES

The following table describes the error codes returned when bit 15 is set and ignoring bit 14 in BBA version.

ERROR CLASS	ERROR CODE	ERROR NUMBER (HEX)	DESCRIPTION
0			ICI Transmission Errors
	0	80	Timeout Between Characters
	1	81	Invalid Data or Bad Character
	2	82	Invalid Command
	3	83	Invalid Request
	4	84	Word Count Error
	5	85	Checksum Error
	6	86	Message Overflow
	7	87	Parity or Framing Error
1			Local Instrument Link Interface Errors
	0	88	Transfer Prevents Command Execution
	1	89	Station Not In Global Database
	2	8A	Data Not Available
	3	8B	Local Link Buffers Full
	4	8C	Global Database Not Ready
	5	8D	Link Command Timeout
	6	8E	Not Used
	7	8F	Not Used
2			Local Instrument Link Hardware Failures
	0	90	Link Not Present
	1	91	On-Board Dual-Port RAM
	2	92	Local RAM
	3	93	ROM Check
	4	94	Link Physical Interface Failure
	5	95	Not Used
	6	96	Not Used
	7	97	Off-Board Dual-Port RAM
3			ICI Hardware Failures
	0	98	Not Used
	1	99	ICI Buffer RAM
	2	9A	Local RAM
	3	9B	ROM Check
	4	9C	Piggyback Board
	5	9D	Receive Timeout
	6	9E	Transmit Timeout
	7	9F	Not Used
4			Link Command Errors
	0	A0	Not Used
	1	A1	Transmission Problem, Cmd Not Rec'd
	2	A2	Dest Buffers Full, Cmd Not Rec'd
	3	A3	Dest Station Offline, Cmd Not Sent
	4	A4	Gateway Offline, Cmd Not Sent
	5	A5	Link Cmd Checksum Error, Cmd Not Sent
	6	A6	Not Used
	7	A7	Not Used

5.6 APPENDIX E - ICI STATUS WORD

The general ICI status word is as follows:

BIT	DESCRIPTION
15	NOT USED
14	NOT USED
13	NOT USED
12	TRANSMISSION METHOD
11	NULL-FILLED DATA
10	LINK ACKNOWLEDGE DELAY
9	SEND COMMAND SECURITY (H)
8	SEND COMMAND SECURITY (L)
7	DATA FORMAT SWITCH SETTINGS
6	DATA FORMAT SWITCH SETTINGS
5	STATION ADDRESS SWITCH SETTINGS
4	STATION ADDRESS SWITCH SETTINGS
3	STATION ADDRESS SWITCH SETTINGS
2	STATION ADDRESS SWITCH SETTINGS
1	STATION ADDRESS SWITCH SETTINGS
0	STATION ADDRESS SWITCH SETTINGS

Note that the descriptions of bits 8-12 do not necessarily correspond to the order of the switches on the MPU board.

The bit values are defined as follows:

BIT 12	TRANSMISSION METHOD
0	BINARY
1	ASCII

BIT 11	NULL-FILLED DATA
0	DISABLED
1	ENABLED

BIT 10	LINK ACKNOWLEDGE DELAY
0	DISABLED
1	ENABLED

BIT 9	BIT 8	SEND COMMAND SECURITY
0	0	NONE
0	1	RECORD
1	0	PARAMETER
1	1	LOCAL

BIT 7	BIT 6	DATA FORMAT
0	0	1 START, 7 DATA, EVEN PARITY, 1 STOP
0	1	1 START, 7 DATA, ODD PARITY, 1 STOP
1	0	1 START, 8 DATA, NO PARITY, 1 STOP
1	1	1 START, 8 DATA, ODD PARITY, 1 STOP

Station address switch settings:

BIT	VALUE IF BIT = 1
5	32
4	16
3	8
2	4
1	2
0	1

Note: To obtain actual station address - add 1 to the value represented by the station address switch bits that are set to 1.

5.7 APPENDIX F - DATA TYPE/COMMAND TYPE CODES

The data type nibble (D) is defined as follows:

"D"	DATA TYPES	NUMBER OF DATA WORDS
0	RECORD SEND ACKNOWLEDGE (WITH C = 7)	3-4
1	16-BIT INTEGER, ABSOLUTE	1
2	16-BIT INTEGER, RELATIVE	1
3	16-BIT MULTI-DISCRETE MASK ON	1
4	16-BIT MULTI-DISCRETE MASK OFF	1
5		
6	32-BIT FLOATING POINT, ABSOLUTE	2
7	32-BIT FLOATING POINT, RELATIVE	2
8	MULTI-BYTE DATA (MESSAGES)	1-10
9	32-BIT INTEGER, ABSOLUTE	2
A	12-BIT INTEGER PLUS RANGE BITS, ABSOLUTE	1
B		
C		
D	NOT APPLICABLE	
E		
F		

The command type nibble (C) is defined as follows:

"C"	COMMAND TYPES
0	NOT APPLICABLE
1	RANDOM PARAMETER DATA REQUEST (D = NUMBER OF PARAMETERS)
2	MULTI-BYTE PARAMETER DATA REQUEST (D = NUMBER OF WORDS)
3	NOT APPLICABLE
4	PARAMETER SEND FROM A LOCAL SOURCE
5	PARAMETER SEND FROM A CONSOLE SOURCE
6	PARAMETER SEND FROM A COMPUTER SOURCE
7	PARAMETER SEND FROM ANY SOURCE
8	COMMAND IS HLL FORMAT
9	
A	
B	
C	NOT APPLICABLE
D	
E	
F	

The data type and command type codes are returned by the "READ LIL COMMAND INPUT BUFFER" command or set for the "PARAMETER DATA SEND" command.

See Appendix G for details on the record send acknowledge.

The "RANDOM PARAMETER DATA REQUEST" and "MULTI-BYTE PARAMETER DATA REQUEST" command type codes should never be issued using the "PARAMETER DATA SEND" command. The "RANDOM PARAMETER DATA REQUEST" and "MULTI-BYTE PARAMETER DATA REQUEST" commands are used for this purpose. The "RESPONSE TO RECEIVED RANDOM PARAMETER DATA REQUEST" and the "RESPONSE TO RECEIVED MULTI-BYTE PARAMETER DATA REQUEST" commands are used to send the data to the requesting station.

The command type codes dealing with the source of "PARAMETER DATA SEND" commands are used by the receiving station to determine if action should be taken with the data. When issuing a "PARAMETER DATA SEND" command, the application program sets the appropriate command type code. Since any of the possible sources may be issued, some rules-of-thumb that may be used are:

A. Application programs should never issue commands as a "LOCAL" source.

B. Application programs that are operator oriented should issue commands as a "CONSOLE" source.

C. Application programs that are calculation oriented should issue commands as a "COMPUTER" source.

D. Certain "PARAMETER DATA SEND" commands must be issued as an "ANY" source. Consult the link communication manual of the station in question to determine whether the command will be accepted from any source or whether "ANY" source must be explicity sent.

5.8 APPENDIX G - RECORD SEND ACKNOWLEDGE

A record send acknowledge is issued by a station in response to an unsolicited record being sent to it. A record send acknowledge is indicated by a data type/command type of $07.

A record sent acknowledge sent by another station is read by issuing a "READ LIL COMMAND INPUT BUFFER" command. A record send acknowledge is sent to another station by issuing a "PARAMETER DATA SEND" command.

When a record send ackowledge is being read, the response returned from the "READ LIL COMMAND INPUT BUFFER" command has the following form:

RMWC	= 0012	
RSW	= XXXX	
SRC	= xxLL	
	HHSS	
DEST	= LLHH	
	SS07	(DC = $07)
DATA(1)	= 05KK	(KK = ERROR CODE)
DATA(2)	= RRRR	
DATA(3)	= OOBB	(high byte of BBBB)
DATA(4)	= BBxx	(low byte of BBBB)
DATA(5)	= xxxx	
.		
.		
.		
DATA(12)	= xxxx	
CHW	(determined by ICI)	

When a record send acknowledge is being issued using the "PARAMETER DATA SEND" command, the command sent has the following form:

CMWC	= 0008	
CMD	= 0902	
ADDR	= LLHH	
	SS07	(DC = $07)
	05KK	(KK = ERROR CODE)
DATA(1)	= RRRR	
DATA(2)	= OOBB	(high byte of BBBB)
DATA(3)	= BB00	(low byte of BBBB)
CHW	(determined by computer)	

The error code (KK) is defined as follows:

KK	DESCRIPTION
00	NO ERROR
01	STATION NOT IN PROPER MODE TO ACCEPT RECORD
02	SOURCE OF STATION CONTROLLING DOWNLOAD DOES NOT MATCH RECORD SEND COMMAND
03	CHECKSUM ERROR ON RECORD SEND COMMAND
04	CHECKSUM ERROR ON RECORD DATA
05	INVALID RECORD NUMBER
06	INVALID OFFSET COUNT
07	INVALID NUMBER OF BYTES
08	RECORD RECEIVED IS OUT OF SEQUENCE
09	INVALID RECORD BUFFER FULL FLAG

5.9 APPENDIX H - SYSTEM ARCHITECTURE DESCRIPTION

The addressing scheme for devices on the Local Instrument Link allows for a hierarchical system architecture.

The following address parameters define the hierarchy:

A. Link Number - This address parameter refers to an address on a plant-wide communication link of a gateway between the plant-wide link and the Hi-Level Link.

B. Hi-Level Link Address - This address parameter refers to the address on the MYCRO Hi-Level Link of the gateway between the Hi-Level Link and the Local Instrument Link.

C. Station Address - This address parameter refers to a particular station connected to the Local Instrument Link.

D. Channel Number - This address parameter refers to a subset of related data within the station. Each station may have up to 256 channels and each channel may have up to 256 parameters.

E. Parameter Number - This address parameter refers to a particular piece of data in a channel. This data may be automatically updated onto the Local Instrument Link as global data (parameter 1) or be non-updating data (parameters 2-256).

A non-zero Hi-Level Link address or link number is used by the gateways to move up to the next level in the hierarchy.

A zero for an address of the next higher level means that the desired station address or Hi-Level Link address is on the current level.

5.10 APPENDIX I - LIL ICI DATABASE STRUCTURE

Each station on the LIL contributes up to 256 channels to the LIL database. Each channel has 256 parameters associated with it. Parameter 1 of each configured channel is updated periodically (every 1/2 second) to the link.

Each station, regardless of type, updates at least the first four (4) channels to reflect status information. The ICI uses the first six (6) channels as follows:

Channel 1 - Station Data Size: An analog value with a range of $0006-$0100 (6-256 channels)

Channel 2 - Station Type Word: An analog value equal to $0005

Channel 3 - Station Status Word:

BBA - Contains the current response status word. See Appendix C1 for a description of the response status word.

BCA - Contains the lower byte of the current response status word. See Appendix C2 for a description of the response status word. The upper byte of this channel contains certain bits that are defined for all stations on the LIL. The application may choose to set these bits as appropriate.

See Appendix J1 or Appendix J2 for a description of this channel as seen from the LIL.

Channel 4 - Station Error Code: Contains the current response status word error bits shifted into the lower byte of this channel. See Appendix D for a description of the error codes.

BCA - The upper byte of this channel may be used by the application to indicate "APPLICATION PROGRAM" errors.

See Appendix K for a description of this channel as seen from the LIL.

Channel 5 - Contains communication watchdog timer #1 flag which will be one of the following values:

$0080 - Timeout occurred
$0F80 - No timer value specified or timer armed

Channel 6 - BBA - Contains the current value of the communication watchdog timer and will be in the range of $0000-$FFFF.

BCA - Contains communication watchdog timer #2 flag which will be one of the following values:

$0080 - No timer value specified or timeout occurred
$0F80 - Timer armed

5.11 APPENDIX J1 - LIL ICI STATION STATUS WORD (CHANNEL 3) - BBA

The LIL ICI station status word as seen from the LIL is as follows:

BIT	DESCRIPTION
15	ERROR OR FAILURE
14	LIL DATABASE UPDATING
13, 12, 11	ERROR CLASS
10, 9, 8	ERROR CODE
7, 6, 5	NOT USED
4	DATA NOT READY
3	INPUT BUFFERS NOT EMPTY
2	UNSOLICITED RECORD AVAILABLE
1	GLOBAL INPUTS CONFIGURED
0	LIL INTERFACE ONLINE

5.12 APPENDIX J2 - LIL ICI STATION STATUS WORD (CHANNEL 3) - BCA

The LIL ICI station status word as seen from the LIL is as follows:

BIT	DESCRIPTION
15	USER DEFINED
14	STATION (OR APPLICATION) ERROR
13	CONFIGURATION (OR APPLICATION) CHANGE #3
12	CONFIGURATION (OR APPLICATION) CHANGE #2
11	CONFIGURATION (OR APPLICATION) CHANGE #1
10, 9, 8	USER DEFINED
7	LIL DATABASE UPDATING
6	COMMUNICATION WATCHDOG TIMER FLAG
5	RECORD REQUEST BUFFER NOT EMPTY
4	DATA NOT READY
3	INPUT BUFFERS NOT EMPTY
2	UNSOLICITED RECORD AVAILABLE
1	GLOBAL INPUTS CONFIGURED
0	LIL INTERFACE ONLINE

Note that the STATION ERROR and CONFIGURATION CHANGE bits are defined for system-wide use. These bits may be used to indicate application program conditions to other stations on the link.

5.10.2 FIGURE I2 - LIL ICI DATABASE STRUCTURE - BCA

LINK CHANNEL	PARAMETER NO. 1	PARAMETER NO. 2	PARAMETER NO. 3	...	PARAMETER NO. 256
1	STATION DATA SIZE ($0006-$0100)	USER DEFINED		...	USER DEFINED
2	STATION TYPE ($0005)				
3	STATION STATUS WORD				
4	STATION ERROR CODE				
5	WATCHDOG TIMER #1 FLAG				
6	WATCHDOG TIMER #2 FLAG				
7	USER DEFINED				
. . .					
256	USER DEFINED	USER DEFINED		...	USER DEFINED

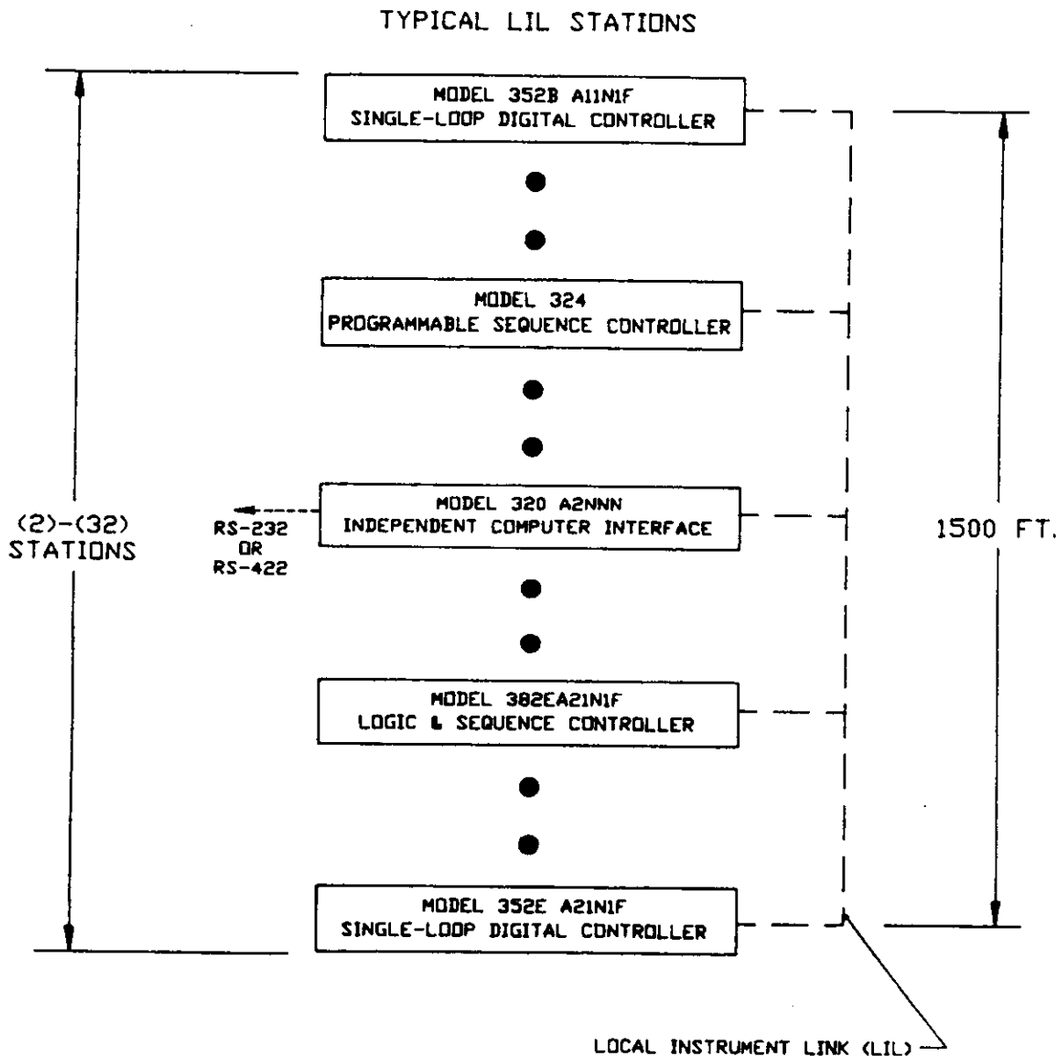

FIGURE 6-7

AS-1842-1
Local Instrument Link
Minimum System

5.13 APPENDIX K - LIL ICI STATION ERROR WORD (CHANNEL 4)

The LIL ICI station error word as seen from the LIL is as follows:

BIT	DESCRIPTION
15	
14	
13	
12	USER DEFINED - BCA
11	
10	
9	
8	
7	ERROR OR FAILURE
6	NOT USED
5	
4	ERROR CLASS
3	
2	
1	ERROR CODE
0	

Note that with BCA, the upper byte may be used to indicate application program errors when the STATION (OR APPLICATION) ERROR bit of Channel 3 is set.

5.14 APPENDIX L - DEFAULT SWITCH SETTINGS

	DEFAULT VALUE	SWITCH/ JUMPER	SETTING
SERIAL PORT BOARD			
Data Format	8 data bits	SW2-8	OFF
	NO parity	SW2-4	ON
Link Address	1	SW2-2	ON
		SW2-1	ON
		SW1-8	ON
		SW1-4	ON
		SW1-2	ON
		SW1-1	ON
Port Configuration	RS-232C	W5	2-3
		W6	2-3
Computer Port Baud Rate	9600	W7	3-12
Diagnostic Port Baud Rate	9600	W8	2-7
MPU BASEBOARD			
Transmission Method	Binary	SW5	ON
Link Acknowledge Delay	Enabled	SW4	OFF
Null-filled Data	Enabled	SW3	OFF
Send Command Security	None	SW2	ON
		SW1	ON
CABLE ADAPTER BOARD			
DS CTS Line Select	DTR	W1	4
DS CTS Line Select	DSR	W2	4

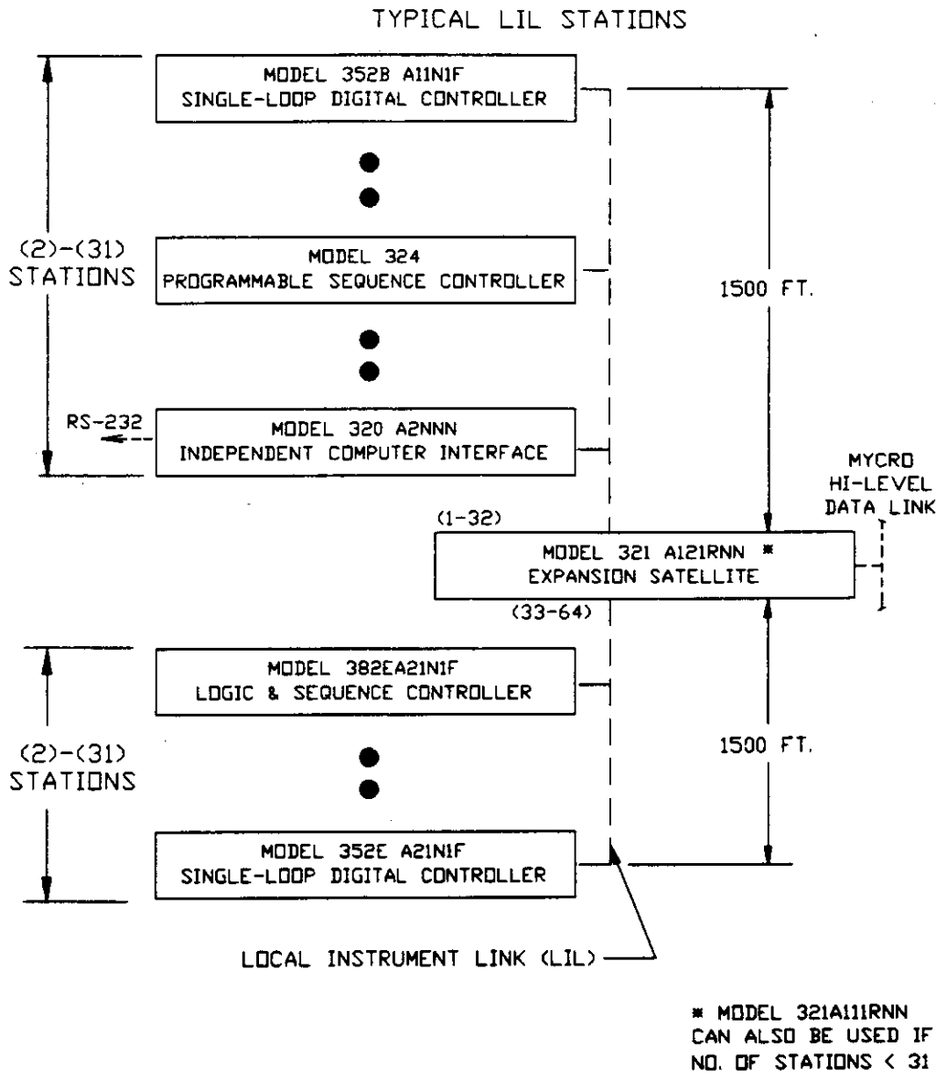

FIGURE 6-9

AS-1842-3
Local Instrument Link
Hi-Level Link Tie-In

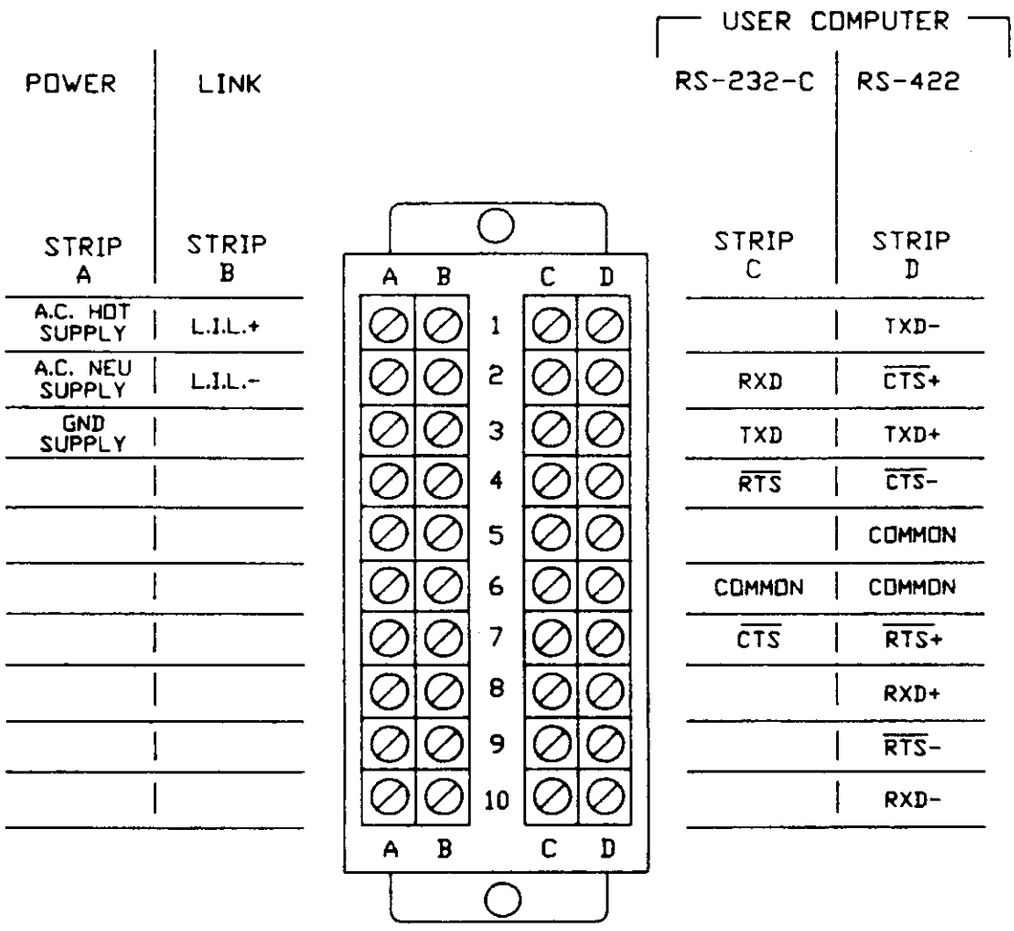

FIGURE 6-2

AS-2032-2
Rear Termination Strips Of ICI

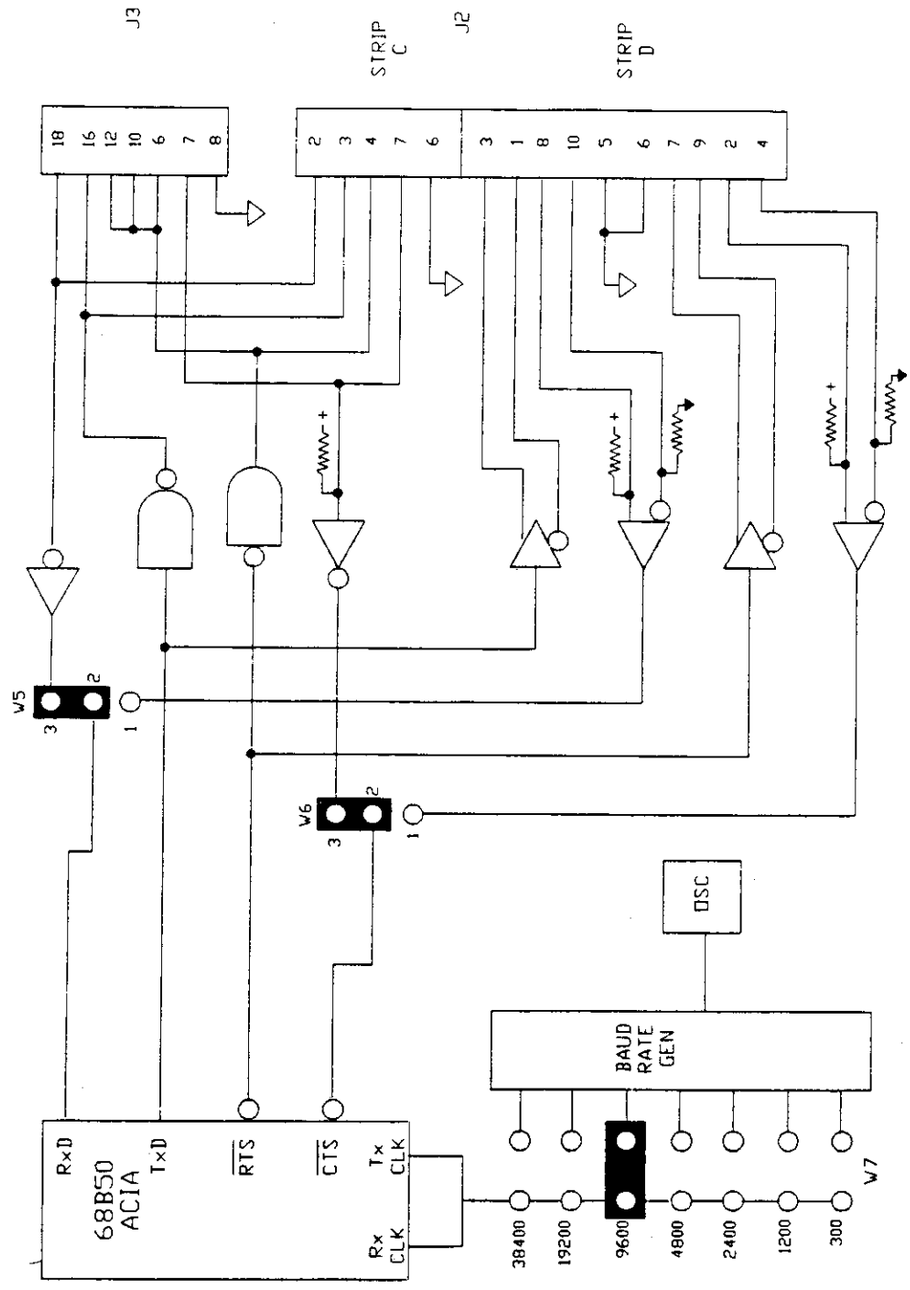

FIGURE 6-4
AS-2032-4
RS-232C/RS-422 Drivers And Receivers

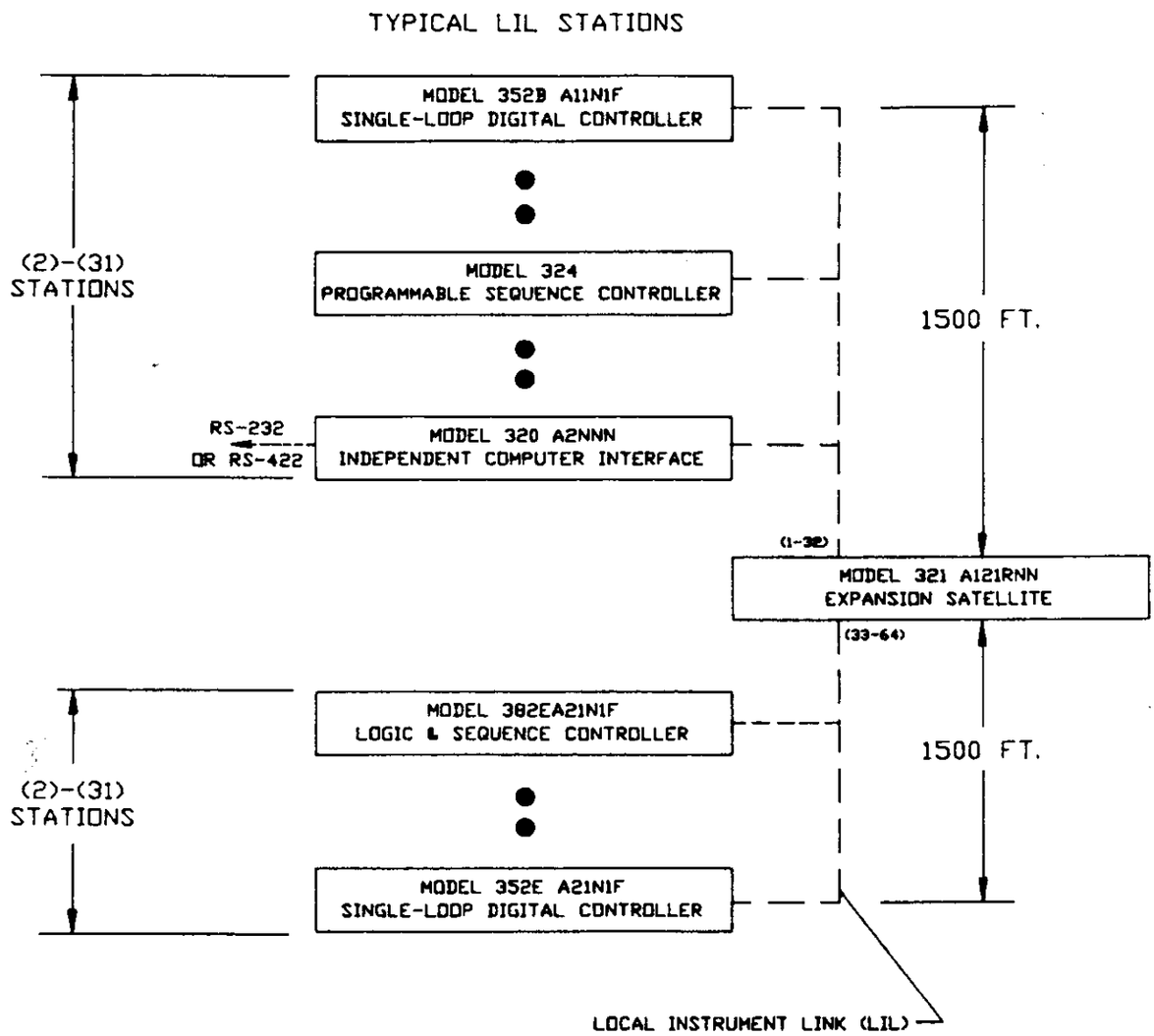

FIGURE 6-8

AS-1842-2
Local Instrument Link
Expanded System

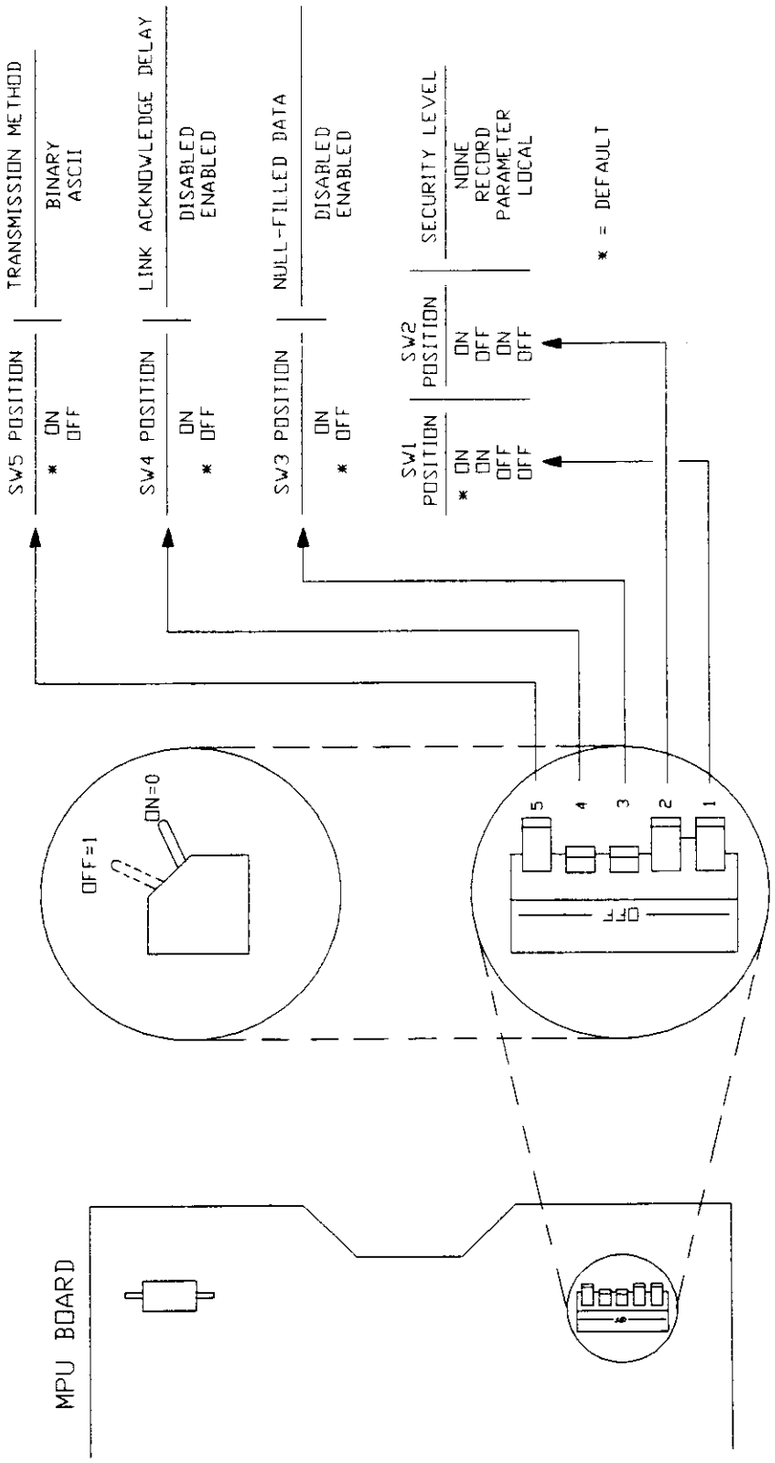

FIGURE 6-6
AS-2032-6
MPU Board DIP Switch