53A-457 INTELLIGENT MONITOR CARD

OPERATING MANUAL

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TRADEMARK NOTIFICATION

53A-457 INTELLIGENT MONITOR CARD

OPERATING MANUAL

53A-457 MIL-STD-1553A/B INTELLIGENT MONITOR CARD

DESCRIPTION

Introduction

The complete implementation of many MIL-STD-1553 testing applications requires monitoring and analyzing both 1553 data bus traffic flow and data content. The 53A-457 MIL-STD-1553A/B Intelligent Monitor Card captures serial bus data as discrete "information transfers" according to a specification defined by the user through the system controller. The 53A-457 Intelligent Monitor, a printed circuit board assembly for use in a CDS 53/63 Series System, is a sophisticated tool that fulfills MIL-STD-1553 requirements.

The 1553 bus is used on military aircraft of all services, and on many commercial aircraft. MIL-STD-1553 provides for time division multiplexed communication by up to 31 Remote Terminal avionics units (RTs) through a high-speed, 2-wire, command/data bus. According to the defined protocol, a single bus controller at any time controls the flow of information among the RTs. The 53A-457 Intelligent Monitor uses a hierarchical algorithm based on message content, intermessage gaps, and mode code protocols to determine the beginning and ending of each information transfer. The card allows real-time input of MIL-STD-1553A or MIL-STD-1553B (called "1553" hereafter) bus data through a system controller.

The 53A-457 allows you to

- define captures based on word matches,
- define captures based on message sequences, and
- input the captured information in 'real time'.

The captured data can be input by the system controller as 32-bit data (four bytes) which identifies the word type, indicates errors, and contains the 16-bit 1553 data. Data is captured as whole messages, starting with the Bus Controller Command word and ending with the last word transmitted by the last Remote Terminal, or with the Bus Controller command word only for a Broadcast transmission.

Buffer storage of 65,000 words in FIFO (First In - First Out) arrangement provides sufficient depth for capturing large data streams. The buffer contents can be input by the system controller independent of ongoing storage.

In addition to the 53/63 system access (which includes local processor, IEEE-488, parallel or RS-232 capability), an additional 8-bit port (RS-422) is provided on the front card edge for very high speed input. The high-speed port is directly connected to the buffer and will provide inputs at speeds up to the free-running rate (bursts of data at 1 megabyte per second). In the free-running mode, data is output at the end of each information transfer designated for storage.

The 53A-457 Card may be programmed to interrupt the system controller on any state transition (word match), receiver error (error match), when the buffer begins filling, or when

it becomes full. Separate enabling is provided for each interrupt. The status of each interrupt can be determined so that when more than one interrupt is enabled, the correct software will be used.

The 53A-457 receiver can be programmed for low-noise data capture with input levels as low as 220 mV peak-to-peak or as high as 10V, on the transformer-coupled or direct-coupled inputs.

Defining Word Matches

If specific transfers are to be input, a 1553 word can be defined by the system controller which will limit storage to information transfers containing that word.

The word definition can be high-level:

- a list of invalid RT commands OR'd together so that all illegal information transfers can be captured,
- a list of RTs in a particular group OR'd together so that certain control scenarios may be captured, or
- a particular word or message error to detect a malfunction.

Words can be defined in terms of any or all of the bits of the 1553 word, the type of word, or the error content. The system controller can define up to six independent Command, Status, or Data words, as many combinations as are necessary may be OR'd together to define each of the arbitrarily defined words. Predefined words (any word, any command, any Status word, or any Data word) may also be used in determining a word match.

Defining Message Sequences

If the specific transfer can only be identified by a sequence of 1553 words or by a sequence of information transfers (or any combination), the system controller can output a state machine specification to define the capture. In the state machine mode, any of the arbitrarily defined or predefined words may be used for comparison to determine storage, interrupt, or transition outcomes in any of the ten possible states of the state machine (called "states" hereafter). State machine operation includes 5-bit counters to be employed at any step as word-match counters so that words embedded within a message may be compared to determine if storage is required.

Information Transfer Input

System controller input can continue at its maximum rate, and can input all 1553 words occurring on the bus. The Intelligent Monitor is automatically synchronized with bus activity and, if desired, can include word count and message format errors along with all bit and word type errors. All Broadcast commands, Superseding commands, and RT-to-RT transfers are identified and are stored intact.

Stored Information Format

All information is stored in complete messages. Words are stored in 32-bit format for each 1553 word and for each time tag. When input by the System Controller or from the front card edge, the words are read as four consecutive bytes. Transmitted 1553 words contain a word type identification byte, an error byte, the most significant byte of the 1553 word, and the least significant byte of the 1553 word. Time tag words are four bytes, starting with the most significant byte and progressing in descending significance to the least significant byte. The first word of each message is identified as such, and is the Bus Controller command word. All Bus Controller Command words, Remote Terminal Status words, and 1553 Data words are identified as such. When time tags are used they follow the first Bus Controller command word and each Remote Terminal Status word.

A 32-bit time tag is optional following the first word of each transmission (command or status word). Time tags following Command or Status words will be stored unless a system controller command is issued to disable that function.

The time base of the 32-bit time tags will have a selectable sampling rate to emphasize the storage duration of a full buffer, the resolution of a message's time of arrival, or a combination of both factors.

Sampling Rate	1553 Unit	Maximum Duration
½ µs	½ bit	35.79 minutes
1 µs	1 bit	71.58 minutes
10 µs	decimal time	11.93 hours
20 µs	word duration	23.86 hours

An external clock input may be selected as a time base instead of the on-board selections listed. The 32-bit timer can be reset with a user command or, synchronous with other boards, by an external TTL reset input. The use of an external clock and a clock reset permits redundant 1553 buses to be monitored with correlated timing.

NOTE: In this manual the terms "input" and "output", except when referring to front card edge signals, are used in reference to the system controller. The term "output" means the data being sent FROM the system controller TO the 53A-457 Card; the term "input" means the data being sent FROM the card TO the system controller. Front card edge signals are "output" to the attached device, and "input" from the attached device.

Front Card Edge Signals

In addition to the high-speed 8-bit data port, front card edge signals include the following:

- TTL inputs and outputs which control and define Intelligent Monitor activity.
- The on-board time tag clock is also output so that several boards may share a common clock through the use of their External Clock input. These inputs may be connected to other external circuitry as desired.
- Each of States 0 through 5 will also cause a signal on the corresponding TTL (open collector) output. This enables 1553 bus words to trigger other external circuitry as necessary. These outputs may be combined into wired-OR terms as needed.
- The derived 2MHz data clock and serial input data are output as TTL signals.
- Received data and a byte-available (Data) Strobe are output as differential (RS422 standard-TTL level) signals. A Data Acknowledge signal is input as a differential (RS422 standard-TTL level) signal.
- Message errors and word errors are each indicated by TTL output strobes.
- A TTL External Trigger is input so that data capture can be started by an external hardware signal, and a TTL Halt is input which can be used to stop data capture.

A TTL output indicates that the buffer is empty, and a separate output indicates that the buffer is full.

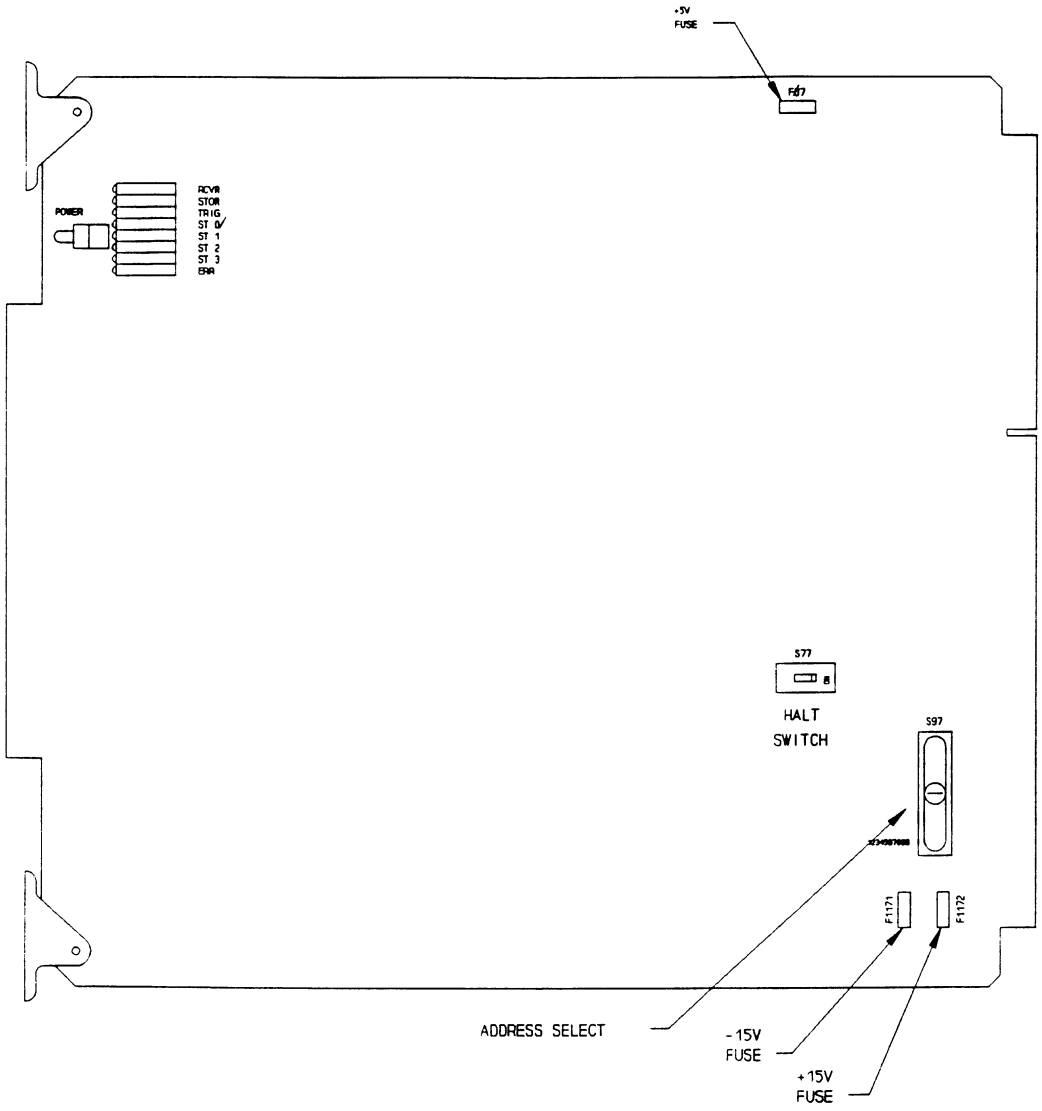

Figure 457-1: 53A-457 Controls and Indicators

CONTROLS AND INDICATORS

The following controls and indicators are provided to select and display the functions of the 53A-457 Card's operating environment. See Figure 457-1 for their physical locations.

Address Select Switch

The 53A-457 Card has a miniature 10-position switch that selects the card's address (0-9) in the 53/63 Series System. Open the switch's cover opens and use a screwdriver with a narrow, flat blade to turn the cam-action wiper to the desired position.

Power LED

The Power LED provides a valuable diagnostic tool by giving the system programmer a visual indication of the action which the system is currently taking. Whenever the 53A-457 Card is addressed by the system controller, the Power LED goes out. The LED remains out until another function card is addressed. Since only one function card can be addressed at a time, an unlit Power LED indicates the function card which is currently communicating with the system controller. The Power LED being lit not only indicates that the 53A-457 Card is unaddressed, but that all required dc power (5V dc, ±15V dc) is being supplied.

Fuses

The 5 volt dc and ±15 volt dc power buses each have a fuse that protects the system from overloads. If any fuse has blown, the Power LED will not light.

Function LEDS and Switches

LEDs

The following LEDs are provided at the top front edge of the 53A-457 Card to indicate the status of the card's operation:

RCV LED

This LED is lit when the 53A-457 Card is receiving data on the MIL-STD-1553 bus.

STOR LED

This LED is lit when the 53A-457 Card has stored data available for the system controller. It is cleared when all stored data has been input by the system controller, or the capture is re-started.

TRIG LED

This LED is lit when a 53A-457 Card programmed interrupt condition has occurred. It is cleared when an F command is issued and the board status is input.

ST0, ST1, ST2, ST3 LEDS

Four LEDs are lit to indicate which state the acquisition state machine is in. If all of the four LEDS are lit, the 53A-457 is not in the acquisition mode. When the state machine advances to State-1 (for example) the ST0 LED only will light. The ST0, ST1, and ST2

LEDs will light in a binary code to indicate which of states 0 through 9 is currently active.

ERR LED

This LED is lit whenever the capture specification is met and received data containing errors is stored in the FIFO buffer (or just "buffer"). It is cleared by issuing an "F" command and reading the board's status, or by resetting the card to its power-up condition.

Switches

Halt Switch

This slide switch is located near the card's backplane edge connector. It selects the state of the 53A-457 Card after an @XH (Halt) or STOP command is received by the 53/63 Series System.

a. If the Halt switch is in the ON position, then the 53A-457 Card is reset to its power-up state, all parameters are reset to their default values, and the Power LED is lit.

b. If the Halt switch is in the OFF position, then the 53A-457 Card becomes unaddressed, the Power LED is lit, and any programmed parameters of the card remain unchanged.

SPECIFICATIONS

Configuration:	MIL-STD-1553A/B Intelligent Bus Monitor.
Storage Capability:	Approximately 65,000 32-bit words - one word stored for each 1553 word plus one additional time tag word for each command or status word.
Message Rate:	Maximum data transfer rate of the 1553 bus is 34 words (Command word, Status word, and 32 Data words) in 684 microseconds. With time tags enabled, the board will output 144 data bytes (four bytes per 1553 word plus two 4-byte time tags) in 144 microseconds if the System Controller or recording device is capable of inputting at that rate. (See Operation section.)
Time Base:	16 Mhz crystal oscillator. Selectable time base for 32-bit time tags: external clock, ½, 1, 10, or 20 microsecond resolution. Time tags are reset to zero with front card edge input or with a software command.
Word Format:	Manchester bi-phase, self-clocking, 1 MHz, 20-bit-time word with command/data sync, data, and parity bits.
1553A/B:	All 1553B protocols are monitored and identified. The comparable set of 1553A protocols may be monitored by defining appropriate Word Matches (Word command) and State Machine definitions (State command). Format, Word Count, and Mode Code errors will occur whenever Bus Controller Mode Codes differ from 1553B Mode Codes. The 1553B Status Word reserved bit detection may be suppressed by the appropriate Define command. Complete 1553A monitoring may be obtained as a Define command operation with a Factory Option.
Default Status:	All LEDs - Off. External outputs - Not true (TTL high). External halt and trigger inputs - Disarmed. Data Capture - Stopped. Receive threshold - ±500 mV. Capture Specification - Any Word. Buffer Full Interrupt - Disabled. Buffer Not Empty Interrupt - Disabled. Receiver Error Interrupt - Disabled. Trigger Interrupt - Enabled. RT response error - 12 µs. RT response timeout - 14 µs. Time tag - 0 count (35.8 minute cycle). Time tags - Enabled. Time tag clock - 0.5 µs.
Programmed By:	One ASCII character or an ASCII character followed by binary data bytes.

TTL Inputs:	Input voltage may vary between +7V and -0.5V (any time). Input current is 200 µA maximum.
Signal Names:	External Receiver Active External Trigger External Halt Time tag Clock Time tag Reset
TTL Outputs:	48 mA maximum sink current, 15 mA maximum source current.
Signal Names:	Time tag Clock Time tag Reset On-board Receiver Active Bus Controller Transmission State Active (0 through 5) Buffer Full Buffer Empty Status Word Message Error Received Message Error
Differential Inputs (RS422):	Input voltage may vary between ±25V (any time). Input impedance is 12 kΩ minimum, sensitivity is ±200 mV, and hysteresis is 50 mV. May also be used as a TTL input with a 2V (±50 mV) threshold and 200 Ω input impedance or input conditions configured by the customer.
Signal Names:	Data Acknowledge.
Differential Outputs (RS422):	60 mA maximum sink current, 60 mA maximum source current. May also be used as TTL positive or negative logic inputs.
Signal Names:	Data Strobe. Data Bits (0 through 7).
1553 Bus Coupling:	Direct coupling - 1:1 turns ratio, 55Ω isolation resistor on each leg. Transformer stub coupling - 1.4:1 turns ratio.
1553 Analog Input Maximum Input:	40V PTP differential, direct-coupled. 27V PTP differential, transformer-coupled.
Threshold:	Programmable from ±20 mV to ±500 mV threshold relative to zero in ±20 mV increments, direct-coupled (±14 mV to ±353 mV, transformer-coupled).

Power Requirements:	+5 V and ±15 V dc power is provided by the internal Power Supply in the 53/63 Series Card Cage.
Voltage (5-volt Supply):	4.75 V dc to 5.25 V dc.
Current (5-volt Supply):	1.7 A, maximum quiescent. 1.7 A, peak.
Voltage (±15-volt Supplies):	+14.5 V dc to +15.5 V dc. -14.5 V dc to -15.5 V dc.
Current (±15-volt Supplies):	100 mA, maximum quiescent. 100 mA, peak.
Cooling:	Provided by the fan in the 53/63 Card Cage.
Temperature:	0°C to +50°C, operating. -40°C to +85°C, storage.
Humidity:	Less than 95% R.H. non-condensing, 0°C to +30°C. Less than 75% R.H. non-condensing, +31°C to +40°C. Less than 45% R.H. non-condensing, +41°C to +50°C.
Dimensions:	197 mm high, 221 mm deep, 13 mm wide. (7.75 in x 8.69 in x 0.5 in).
Dimensions, Shipping:	When ordered with a 53/63 Card Cage, the card is installed in one of the card cage's function-card slots. When ordered alone, the card's shipping dimensions are: 254 mm x 254 mm x 127 mm. (10 in x 10 in x 5 in).
Weight:	0.37 kg. (1.2 lb).
Weight, Shipping:	When ordered with a 53/63 Card Cage, the card is installed in one of the card cage's function-card slots. When ordered alone, the card's shipping weight is: 1.18 kg. (3.0 lbs).
Mounting Position:	Any orientation.
Mounting Location:	Installs in any function-card slot of the 53/63 Series Card Cage.
Equipment Supplied:	1 - 53A-457 Intelligent Monitor Card. 1 - Spare fuse (Part # 42202-52003). 1 - Operating Manual (Part # 00000-14570). 1 - Service Manual (Part # 00000-24570).
Software Revision:	V1.8

Factory Options: The 53A-457 Card uses field-programmable Logic Cell Arrays to implement the monitor logic. Users requiring customized capabilities should consult the factory to obtain an Intelligent Monitor which meets their requirements.

OPERATION

Overview

The 53A-457 Card is programmed by ASCII characters issued from the system controller to the 53/63 System's communications card. The 53A-457 Card is interfaced to the communications card through the 53 Series or 63 Series Card Cage's backplane.

Each command is a single letter (usually the first letter of the name of the command). Some commands have required or optional parameters. Detailed descriptions of each command are given at the end of this section.

Commands are issued by the system controller at three stages of the data capture process: to set initial capture definitions, to input comparison data, and to input captured information transfers.

Command Functions

Initial capture definition by the system controller may include modifying the default parameters (Receiver input threshold, Time tag resolution, error deletions, intermessage gap error timing, etc.) or the definitions of words and states for state machine operation. These definition commands are followed by the command to begin capture. The command to begin capture can result from a Go command, or it can result as an implicit function of the eXternal Trigger or High-speed port command.

Comparison data may be input before capture using the Flag command. This data is used as a reference to determine whether a specified information transfer has been captured, or to provide status signals indicating progress in obtaining the specified transfer. The Intelligent Monitor will compare all received 1553 data to the capture specification to determine if data is to be stored. Capture may occur almost immediately or it may require an extended period, depending upon the rate of occurrence of the information transfer specified.

Up to six word qualifiers may be defined by a summation of OR terms, each term consisting of the 16-bit word content and the type of 1553 word (command, status, or data). Error content may be specified for each word qualifier. Broadcast, RT-to-RT transfers or other special transfers may be specifically defined for capture. All transfers will be captured complete, beginning with the first Bus Controller command and ending with the last RT (or Bus Controller) word of the transfer.

Seven additional predefined word qualifiers may also be used to define captures: ANY WORD, ANY COMMAND WORD, ANY STATUS WORD, ANY DATA WORD, ANY COMMAND OR STATUS WORD, NO RESPONSE, or the END OF MESSAGE word. The predefined words may be employed to simplify board programming or to increase the specificity of a defined capture.

Capture can also be specified by sequence matching. Up to ten IF-THEN-ELSEIF states may be employed in a state machine which stores and makes transitions based upon a series of word-matches. A 5-bit count can be used in each state to count the occurrence of word-matches before storage and/or the next state transition.

The system controller will input the captured information transfer after capture criteria are met. Capture will continue while the system controller is inputting previously captured data. The first byte of each captured information transfer input will indicate a 1553 command word instead of the "no data" indication. A 64K word buffer (256K bytes) will buffer captured data awaiting input by the system controller. Data input will continue to indicate captured data until the buffer is emptied. When all captured data has been input, the data output will revert to the "no data" indication.

Whenever a 1553 information transfer occurs which meets the capture specification, that information will be stored unless a Kill command is issued ending capture, or a Word or State command is issued redefining the capture specification. Capture will end when a new capture definition is specified or a command to stop is issued by the system controller.

Message input by the system controller is independent of the storage process. In addition to the 53/63 8-bit data ports, a second data port is available on the front card-edge for direct high-speed input. The front card-edge port can output data at one megabyte per second. The maximum data transfer rate of the 1553 bus is 34 words (Command, Status, and 32 Data words) in 684 microseconds. With time tags enabled, the board will output 144 data bytes (four bytes per 1553 word plus two 4-byte time tags) in 144 microseconds, if the System Controller or recording device is capable of inputting at that rate. Therefore, data occurring at the maximum rate in any given period can be input by the System Controller in less than 25% of that period if the 53/63 system can maintain that input rate or the front card-edge input is used.

A free-running mode may be programmed by the system controller allowing data to be output at the end of each designated information transfer.

The message output is in 32-bit words (4 bytes) for each 1553 word, with each word containing 16-bit data, an 8-bit error descriptor, and eight bits of control codes. Four-byte time tags representing the time of arrival follow each command or status word. The first byte output contains the most significant 8 bits, and each byte subsequently output will contain 8 bits of lesser significance. The control code will indicate "end of data" when the system controller has input all stored data. If the system controller continues inputting, additional information transfers will be indicated as soon as each transfer designated for storage has completed.

Data Capture

Buffer data input by the system controller will be captured as complete messages (information transfers) meeting the specification as defined by the system controller. At power-up and after a Kill command or system reset (called "board reset" hereafter), the specification will be:

IF ANY WORD occurs THEN STORE information transfer.

By using the Word command, up to six arbitrary words can be defined. Definition of a word with the Word command changes the specification for capture. If the board reset specification was active before the word was defined, the changed specification becomes

IF WORD-N occurs THEN STORE information transfer.

WORD-N is always the last word defined until the State command is used. Use of the State command ends automatic replacement of the word number in the capture specification and the specification returns to using the word numbers, as output by the system controller.

Time tags following command and status words may be suppressed with a system controller Time tag command. When time tags are included, the minimum resolution step may be selected (with the Time tag command) to enable longer overall counting cycles.

By using the State command, up to ten sequential states may be programmed to identify information transfers for capture. The states are numbered 0 through 9 and may be programmed with either a single State command or a series of State commands. After the State command, when the Go command is issued, the capture specification will begin with the State-0 instruction. The specification will then progress towards capture according to the State-0 instruction and subsequent state instructions.

Each state is programmed with an IF or an IF-THEN-ELSEIF instruction. The basic instruction is:

IF Word-N occurs Count times THEN go to State-X
ELSEIF Word-M occurs THEN go to State-Y

Each of the instructions may have further variations. The variations include commands to store in the buffer, interrupt the System Controller, and/or trigger at the front card edge, whenever the IF or ELSEIF condition is satisfied.

If storage is to be controlled by external TTL signals, the eXternal command enables the External Trigger (to initiate the storage operation) and the External Halt (to halt storage).

Errors

Intelligent Monitor receiver circuitry is designed to accept and store data that contains word and protocol errors, which are noted within the stored data when such storage is programmed. Word count errors will be a function of the number of sync signals counted during a transmission or the number of 20μs word intervals (with bus voltage present) or a combination of the two measurements.

In redundant bus systems, there is a system requirement that only one bus is active at a time. The 53A-457 has a front card-edge input signal indicating when a parallel bus system (another 53A-457, for example) is active. An active (low) input on this signal will cause a "Bus Overlap Error" in the command word storage (see the Error command description) if the 53A-457 receiver is also active.

Interrupts may be generated on state transitions, receiver errors, or on a buffer-not-empty or buffer-full condition. State transition interrupts are enabled by using the State command. The receiver error interrupt, and buffer interrupts may be enabled using the Define command.

1553 Bus Operation

The 1553 bus is used on new military aircraft of all services, and on many commercial aircraft. MIL-STD-1553 provides for time division multiplexed communication by up to 31 Remote Terminal avionics units (RTs) through a high-speed, 2-wire, command/data bus. According to the defined protocol, a single bus controller at any time controls the flow of information among the RTs. The 53A-457 Intelligent Monitor uses a hierarchical algorithm based on message content, intermessage gaps, and mode code protocols to determine the beginning and ending of each information transfer. See Appendix D for a description of 1553 Bus errors.

The 1553 receiver circuitry will respond to bus signals if the voltage is greater than 500 mV (or the programmed threshold). This voltage is selected to reject small values of ground noise while receiving transmissions from typical RT units under the worst bus loading conditions. The 500 mV threshold can be adjusted with a Y-value command.

After each 1553 command word, an RT must respond within a defined interval if the command word was transmitted without errors and if it was not a "broadcast" word. The 1553 bus controller will re-transmit after the RT response or, if the RT did not respond, after a defined interval to verify the non-response. After board reset, a captured status word will generate a "late response" error if the time from command word mid-parity-bit until status word mid-sync exceeds 12 microseconds. Bus controllers may start a new command word 2 microseconds after the 12 microsecond response timeout. A 1553 word occurring 14 microseconds after a 1553 command word will be identified as a new command word by the Intelligent Monitor. The "Z" command may be issued by the system controller with an value between 4.5 and 13.5 microseconds to replace the 12 microsecond late response value.

Each word (Command, Status, or Data) is a 16-bit word encoded in a Manchester bi-phase format that eliminates the need for separate clock lines and rejects any DC voltage component on the common bus. The 16-bit word is preceded by a sync signal of 3-bit times and followed by an odd-parity bit to form the 20-bit-time 1553 word. The sync signal for a Command or Status word is defined as being high for 1½ bit times, then low for 1½ bit times. This signal is inverted (low, then high) for a Data word.

For bus controller to RT transfers, a 16-bit Command word is sent which specifies the RT that is to receive data, and how many Data words (up to 32) are to be received. The RT processes the command information and data, then returns a 16-bit Status word to the bus controller containing its own address and status information.

For RT to controller transfers, the bus controller sends a 16-bit Command word specifying the RT that is to transmit, and how many words (up to 32) are to be transmitted. The RT then returns a Status word with its address and status followed by the required data transmission.

For RT-to-RT transfers, the bus controller sends a 16-bit Command word specifying the RT that is to receive and how many words (up to 32) are to be received, followed by a 16-bit Command word specifying the RT that is to transmit and how many words (up to 32) are to be transmitted. The transmit RT then returns a Status word with its address and status followed by the required data transmission. The receive RT completes the transfer with a Status word.

In the broadcast RT-to-RT transfer, the bus controller sends a 16-bit Command word specifying RT address 31. This is followed by a no-response interval. The bus controller then sends a second 16-bit Command word specifying the RT which is to broadcast. This is followed by the Status word and data of the broadcasting RT. All broadcast mode RTs will receive the data

of the broadcasting RT. The bus analyzer will store both types of RT-to-RT transfer as a single transfer when storage is specified.

Default Status

On power-up, after a Kill command or after a board reset, the 53A-457 Card will have the following default status:

RCVR, STOR, TRIG, ERR LEDs - Off.
ST0, ST1, ST2, ST3 LEDs - On.
External outputs - Not true (TTL high).
External halt and trigger inputs - disarmed
Data Capture - Stopped
Receive threshold - 1.33V PTP
Capture Specification - Any Word
Buffer Full Interrupt - Disabled
Buffer Not Empty Interrupt - Disabled
Receiver Error Interrupt - Disabled
Trigger Interrupt - Enabled
RT response error - 12 μs
RT response timeout - 14 μs
Time tag - 0 count (35.8 minute cycle)
Time tags - Enabled
Time tag clock - 0.5 μs

Command Syntax

To address a function card for the first time, the system command @XY must be issued. X is the card cage address (0-9) selected on the 53A-171 Control Card in the addressed card cage. Y is the 53A-457 Card's address (0-9) within the addressed card cage. The 53A-457 Card's address is selected using the card's Address Select switch. Once a function card is addressed, it remains addressed until the system receives another @ character. Appendix A fully discusses the @XY command and the other 53/63 Series System commands. After the 53A-457 Card is addressed, commands may be issued until another function card is addressed. Each command is a single letter (usually the first letter of the name of the command). Some commands have required or optional parameters.

All legal commands have defined lengths that must be maintained. Using binary data can cause the system to hang up if the protocols for these lengths are not maintained. Characters such as spaces, nulls, commas, carriage returns <CR>, and line feeds <LF> do not affect card operation if they occur only between, and not in the middle of, legitimate command sequences.

The system controller may optionally be programmed to append a <CR><LF> at the end of a command to the 53A-457 Card without affecting how the card operates. The card appends a <LF> to the end of data character input by the system controller.

Summary

An alphabetical listing of the commands is shown below. Detailed descriptions of each command are in alphabetical order on the following pages.

D — The Define command outputs a binary character defining the data content of system controller input.

E — The Error command outputs a binary character defining user programming errors for the state machine definition.

F — The Flag command requests status from the 53A-457 Card.

G — The Go command starts data capture according to the current capture specification.

H — The High-speed Port command starts data capture and enables the front card edge high-speed data port for data input.

K — The Kill command resets the 53A-457 Card.

M — The Mask command is used to define up to two Capture Masks to define data capture.

S — The State command outputs state machine instructions to define a sequence of words which must occur in order for data capture to occur.

T — The Time tag command specifies whether time tags are to be eliminated from the captured data or, if used, which time base should be selected.

W — The Word command outputs word definitions leading to data storage, a system interrupt, or a state transition when a word match occurs.

X — The eXternal command arms the External Trigger and External Halt input signals on the front edge connector of the 53A-457 Card.

Y — The Y-value command programs the receiver voltage threshold.

Z — The Z-value command programs the maximum measured response time allowed for an RT response.

Command	Description

D

The Define command outputs a binary character defining the data content of system controller input. The 32-bit time tag following each Command, Status, or no-response word may be suppressed to minimize data input. The word counting operation may be programmed to ignore all received data words containing an error.

Syntax: Dn

n is one byte with bit definition as follows:

Bit 7 - Disable Status reserved bit detection (for 1553A operation) = 1
Bit 6 - Enable Receiver Error Interrupt
Bit 5 - Enable Buffer Full Interrupt
Bit 4 - Enable Buffer Not Empty Interrupt

The Intelligent Monitor defaults to 1553B operation (0). Each interrupt or error function is initialized (default) with a value of 0 (disabled). A function is enabled by programming a value of 1 and disabled by programming a 0. If a function is changed with a Define command, it can be changed again by issuing a subsequent Define command or by issuing a Kill command to re-initialize all the values.

NOTE: When more than one interrupt condition has been enabled, it may be desirable to determine which interrupt condition(s) caused the interrupt. To avoid missed interrupts, the system status should first be determined (see @XS command in Appendix A). This will establish that the 53A-457 Card is the interrupting device and clear the interrupt condition from the 53A System. The particular interrupt conditions may then be determined by examining the Intelligent Monitor's status (see Flag command).

Example:
An interrupt is required when the 64K buffer is full or if a receiver error occurs.

The value 24 is arrived at by the following two steps:

a. Bit 6 - Enable Receiver Error Interrupt = 1
   Bit 5 - Enable Buffer Full Interrupt = 1

b. $(2^6) + (2^5)$ = 0110 0000 (binary) = 96

Send the ASCII character "D", followed by one byte with the value 96. Most computers allow you to build bytes in a string with the expression

```
Wrt$ = "D" + CHR$(96).
Call IBWRT (PCX%,Wrt$)
```

Command	Description

E

The Error command requests user programming evaluation from the 53A-457 Card.

Syntax: E

An 8-bit (1-byte) value is returned by the 53A-457 Card in response to a system controller input following the Error command. The value will be a binary character containing two binary nibbles. The value in the upper nibble indicates the nature of the error. The value in the lower nibble indicates the word or state which contains the error.

Upper Nibble	Error Type
0000	No Error.
0001	Word specified in lower nibble has been referred to but is not defined.
0010	State specified in lower nibble has been defined improperly.
0011	State specified in lower nibble has been referred to but is not defined.
0100	State specified in lower nibble has been defined but is not referred to.
0101	The mask used for the IF transition in the state specified is not defined.
0110	The mask used for the ELSE transition in the state specified is not defined.

NOTE: If a programming error has been made in defining data capture, capture will not be initiated when the G (Go) command is given. To insure performance, the E command should be issued and the error value of 0000 should be verified before issuing the G command.

Example:
This example outputs the E command, inputs the error value, and sets the variable Error% equal to the error value.

```
Wrt$ = "E"
Call IBWRT (PCX%,Wrt$) : Call IBRD (PCX%,Rd$)
Error% = VAL(Rd$)
```

Command	Description

F

The Flag command requests status from the 53A-457 Card.

Syntax: F

An 8-bit (1-byte) value is returned by the 53A-457 Card in response to a system controller input following the Flag command. Bit definition of the returned value is as follows:

Bit 7 - Interrupt pending = 1
Bit 6 - Receiver error = 1 (cleared by F command)
Bit 5 - buffer empty = 1
Bit 4 - buffer full = 1
Bits 3 through 0 - Current state in capture sequence

The Buffer Empty bit (5) will be a 1 when the 53A-457 begins acquisition. It will change to 0 when the first message specified for capture is stored, and it will revert to 0 each time the FIFO is emptied by System Controller inputs of the captured data.

The Buffer Full bit (4) will be a 0 when the 53A-457 begins acquisition. It will change to 1 when the FIFO is full (approximately 65,300 32-bit words stored), and it will revert to 0 only if the 53A-457 stops the current acquisition (K command) and begins a new acquisition.

The Current State bits (0, 1, 2 and 3) will all be a 1 when the board is not in the acquisition mode. Acquisition states 0 through 9 will be indicated with a hexadecimal code.

NOTE: After the F command, or when reading 53A-457 status during the High-Speed mode, the status byte and the line feed character must be read back. If a single byte is read back the card will remain in the binary output state and subsequent readbacks or commands may work improperly.

Assume, for example, that the 8-bit value returned is 200. The binary equivalent of 192 is 11001000. Bits 7, 6 and 3 are set, indicating that the 53A-457 Card is in the Acquisition mode, has captured an information transfer containing an error, and a system interrupt is pending (an interrupt may be generated by a receiver error). Bit 6 will be cleared after this input and will remain cleared (0) until another transfer is stored containing an error. Bit 4 is clear, indicating that the buffer has stored data. Bits 2 through 0 contain the value 0, indicating that the default state is in effect.

A second input request returns captured data if a Go command has been issued, and a line feed character if acquisition has not begun. A Flag command must be issued before each status request to get a valid response.

NOTE: When the captured data is being read out via the High-speed port command, all 53/63 System Controller inputs will contain 53A-457 status. Therefore the Flag command System Controller output would be redundant. After a High-speed port command has been issued, any system input will read back board status, and any system output will stop data acquisition.

Example:
This example outputs the F command, inputs the status value, and sets variables according to the status.

```
Wrt$ = "F"
Call IBWRT (PCX%,Wrt$) : Call IBRD (PCX%,Rd$)
State% = (ASC(Rd$) AND &H0F)
BufferFull% = ((ASC(Rd$) AND &H10) = &H10)
BufferEmpty% = ((ASC(Rd$) AND &H20) = &H20)
ReceiveErr% = ((ASC(Rd$) AND &H40) = &H40)
Interrupt% = ((ASC(Rd$) AND &H80) = &H80)
```

Command	Description

G

The Go command starts data capture if the user has not made an error in programming the state machine. If the state machine is programmed properly or if the default state machine is still in effect, data will be output according to the current capture specification.

Data is output as 4-byte (32-bit) or 2-byte (two ASCII characters) words. There are 6 types of output words:

Cmd1: The first command Word of the Bus Controller is the first word of each message.

Cmd2: The second Command Word of a Bus Controller is used only when initiating an RT-to-RT transfer.

Stat: The Status word is the first word of an RT response.

Data: Data words transmitted by the Bus Controller or the RT will follow the **Cmd1** or **Stat** word.

Time: When not disabled, a 32-bit Time tag will follow each **Cmd1** or **Stat** word.

End: A 2-character word will indicate the end of the stored data.

The sequence of words read back will be in the order of the message as it was captured, **Time** words will be inserted during the capture to provide real-time references. Some examples of messages read back are:

Bus Controller sending four data words
Cmd1 Time Data Data Data Data Stat Time

RT-to-RT 2-word transfer
Cmd1 Time Cmd2 Stat Time Data Data Stat Time

Remote Terminal (RT) sending four data words
Cmd1 Time Stat Time Data Data Data Data

Bus Controller sending six data words without Time tags
Cmd1 Data Data Data Data Data Data Stat

The **End** word will be output when there is no captured message to output, it can occur after all the words have been read back, or before, if a message has not been captured.

Cmd1, Cmd2, Stat and Data word Description

The message output for these words contain 1553 bus words as received by the 53A-457 Monitor. Each word is composed of 32-bits (4 bytes), and contains, respectively: an 8-bit control code, an 8-bit error descriptor, and 16-bit (2-

byte) transmitted data. The most significant 3-bits of the control code (first byte) in each word indicates the type of word.

The formats for the second, third and fourth bytes of **Cmd1**, **Cmd2**, **Stat** and **Data** words are the same. The control byte (first byte) formats are:

Cmd1 Control byte (first byte of message)
- Bits 7, 6, 5 - Command word code = 1,1,1
- Bit 4 - Command format error = 1
- Bit 3 - Word count error = 1
- Bit 2 - Bus Overlap error = 1
- Bit 1 - Mode, RT-RT, or Broadcast Command = 1
- Bit 0 - Response error = 1

Cmd2 Control byte (first byte of word)
- Bits 7, 6, 5 - Command word code = 1,1,0

Stat Control byte (first byte of word)
- Bits 7, 6, 5 - Command word code = 1,0,0
- Bit 4 - Early response error = 1
- Bit 3 - Late response error = 1
- Bit 1 - Mode response = 1
- Bit 0 - Invalid response error = 1

Data Control byte (first byte of word)
- Bits 7, 6, 5 - Command word code = 0,1,0

The Error byte is described in more detail in Appendix D. The contents are:

Cmd1, **Cmd2**, **Stat** and **Data** Error byte (second byte)
- Bit 7 - Sync error
- Bit 6 - Too many bits
- Bit 5 - Too few bits
- Bit 4 - Parity error
- Bit 3 - Incorrect transition time (jitter)
- Bit 2 - Manchester error
- Bit 1 - Dropped bit
- Bit 0 - No Command Word Error= 1

The Data bytes are described in more detail in MIL-STD-1553.

Cmd1, **Cmd2**, **Stat** and **Data** Data bytes (third and fourth bytes)
- Bit 7, third byte - Data bit 2^{15} (most significant)
- Bit 6, third byte - Data bit 2^{14}
- Bit 5, third byte - Data bit 2^{13}
- Bit 4, third byte - Data bit 2^{12}
- Bit 3, third byte - Data bit 2^{11}
- Bit 2, third byte - Data bit 2^{10}
- Bit 1, third byte - Data bit 2^{9}
- Bit 0, third byte - Data bit 2^{8}

- Bit 7, fourth byte - Data bit 2^{7}

Bit 6, fourth byte - Data bit 2^6
Bit 5, fourth byte - Data bit 2^5
Bit 4, fourth byte - Data bit 2^4
Bit 3, fourth byte - Data bit 2^3
Bit 2, fourth byte - Data bit 2^2
Bit 1, fourth byte - Data bit 2^1
Bit 0, fourth byte - Data bit 2^0 (Least significant)

Time Word Description

Time tags follow each command or status word to indicate the time transmission began. The four time tag bytes are output in the order of decreasing significance. The Time word can be located in the sequence by determining the **Cmd1** or **Stat** control code of the preceding word.

First byte	- Bits 2^{31} through 2^{24}
Second byte	- Bits 2^{23} through 2^{16}
Third byte	- Bits 2^{15} through 2^8
Fourth byte	- Bits 2^7 through 2^0

End Word Description

The End word is a two byte word consisting of two ASCII characters, an asterisk ["*", 2A(hex)] and a line feed [0A(hex)] character. If the IEEE-488 EOI capability is enabled and uses a line feed to recognize the end of the string, an easy determination can be made that the 53A-457 FIFO has been emptied: the total data bytes input by the System Controller will be evenly divisible by four (4) until the End word is read back, at which time there will be a 2-byte remainder.

Example:
This example reads the captured data. Time tags have not been disabled and the capture specification was defined so that data will be error-free. (A mode command with bus controller data word is illustrated followed by the end-of-data (n_0) word in order to limit the size of the input data to be discussed.)

Send the 1-byte command "G".

Read back data from the card until the input string is full or until the EOI signal (IEEE-488) ends input. Each string input should be examined on a data group by data group basis to determine the nature of the data which follows. When the upper three bits of the first byte of data from a new information transfer are all zero, the end of data has been reached.

Byte 1 - binary data 11100000, indicates a command word, the first word of the information transfer and that the message contains no errors.

Byte 2 - No word errors = 00000001

Bytes 3,4 - Binary data 00110 1 11111 10000, hexadecimal 37F0: the upper 5 bits indicate a command to RT 6, the next bit (T/R) indicates the bus controller is sending data, followed by a 5-bit all 1's code to indicate a mode code instead of a sub-RT address, followed by the 5-bit code (10000) indicating the bus controller is sending a Transmit Vector Word (see MIL-STD-1553).

Bytes 5 to 8 - Hexadecimal 01234567: a 32-bit time tag indicating the current value of a free running timer.

Byte 9 - Binary data 01000000, indicates a data word, without errors.

Byte 10 - No word errors = 00000001

Bytes 11,12 - Hexadecimal 2345, the Transmit Vector Word (MIL-STD-1553).

Byte 13 - Binary data 10000000, indicates a status word, without errors.

Byte 14 - No word errors = 00000001

Bytes 15,16 - Binary data 00110 0 0 0 000 00000, hexadecimal 3000: the upper five bits indicate a Status word from RT 6, the next six bits are 0's in a Status word, and the lower five bits indicate RT status conditions and are all 0's in this example (see MIL-STD-1553).

Bytes 17 to 20 - Hexadecimal 012345BB, the 32-bit time tag of the status word. Note that the difference between the two values is hexadecimal 54 (decimal 84), with the default time tag resolution of 0.5 μs, this indicates that the Status word arrived 42 microseconds after the Command word (optimum response).

Byte 21 - ASCII "*" indicates the end of data has been reached.

Byte 22 - ASCII <LF> generates an EOI signal when an IEEE-488 interface is used.

NOTE: After a Go command has been issued, any system input which is not preceded by an Flag command will read back data from the card.

If a Kill command is sent to a 53A-457 Card which is actively comparing the current received data to the capture specification, and storing data accordingly. The card terminates comparison and storage awaiting another capture command or capture specification redefinition.

If a Go command is then sent to the card, the card will compare the received information transfers to the capture specification and store data again when a match occurs.

The Go, High-speed port, or Error commands are output by the system controller to indicate that captured data is to be input. Captured data, including errors and time tags, can be input while additional data is being received on the 1553 bus and stored. After each word is input by the system controller another word becomes available for buffer input. Since data input by the system controller indicates the end of 1553 data, the system controller may input indefinitely following these commands. (If the High-speed port command starts data capture, data can not be input by the System Controller, but will instead be output at the High-Speed port.

Command	Description

H

The High-speed port command starts data capture and enables the front card edge high-speed data port for data input. After the command, the high-speed port will remain active until a System Controller output or a board reset occurs.

Syntax: Hn

n specifies one of six values:

0 - High-speed data-acknowledge pulse.
1 - High-speed free-running.
2 - External trigger, High-speed data-acknowledge pulse.
3 - External trigger, High-speed free-running.
4 - High-speed data-acknowledge level.
5 - External trigger, High-speed data-acknowledge level.

NOTE: Since the Intelligent Monitor only examines the lower 2 bits of n, an ASCII character 0 through 5 may also be used,

There are three data transfer modes:

When the data-acknowledge pulse mode is enabled, each Data Strobe signal pulse out requires a Data Acknowledge signal in.

When the data-acknowledge level mode is enabled, the Data Strobe signal out remains low until a Data Acknowledge signal in is detected.

In both data-acknowledge modes, a new Data Strobe will not be issued until a Data Acknowledge signal (low/active) is received and completes (returns high/inactive).

When the free-running mode is enabled, captured data along with a Data Strobe will be output from the buffer as soon as it becomes available.

Data output through the high-speed port will have the same content as described for the Go command, except that an End of Data byte will not be issued when the buffer becomes empty or while it remains empty. If the state machine has been programmed incorrectly, the 53A-457 will not capture any data. An Error command may be issued to determine the nature of the programming error.

Example:
This example outputs the H command with a parameter of 4. The 53A-457 will begin capturing data and will output the data captured at the High Speed front card edge port. Each byte of data output will cause a data strobe to become active (low). It will remain active until a Data Acknowledge pulse (low) is returned. A subsequent byte of data will not be output until the Data Acknowledge signal goes low and returns to its inactive (high) state.

```
Wrt$ = "H4"
Call IBWRT (PCX%,Wrt$)
```

Command	Description
K	The Kill command resets the 53A-457 Card. Data capture ceases immediately, and all card parameters are restored to their power-up state. See the Default Status subsection above for a listing of the 53A-457 Card's state on power-up.

Example:
This example ends 53A-457 data capture and returns all programmable values to the default state. Data capture will again be defined as:

IF ANY WORD occurs THEN STORE information transfer.

```
Wrt$ = "K"
Call IBWRT (PCX%,Wrt$)
```

Command	Description

M

The Mask command is used to define up to two Capture Masks to define data capture. When errors are specified as part of a word definition (Word command), the specific errors of interest are specified by selecting one of the two capture masks as part of the word definition.

Syntax: $Mn_1n_2n_3$

n_1 is a single ASCII character (0 or 1) specifying which capture mask is being defined.

n_2 is a 1-byte binary value indicating one or more types of errors:

Bit 7 - mask used for RT-to-RT (n_3 follows).
Bit 6 - Format error.
Bit 5 - Addressing error.
Bit 4 - Transmission error.
Bit 3 - Mode Code error.
Bit 2 - Missing Response error.
Bit 1 - Invalid Response error.
Bit 0 - Word count error.

Bits 0 through 6 define capture conditions which are OR'd together when more than one is enabled (1). For example, if bits 0 and 3 only are enabled, data will be captured only if it contains a Word Count Error OR a Mode Code Error.

If Bit 7 is enabled (1):
bits 6, 5, and 4 are ignored,
an additional byte (n_3) is appended describing the RT-to-RT capture conditions, and
bits 3, 2, 1, and 0 may be programmed independently to specify capture conditions to be OR'd with the RT-to-RT conditions.

n_3 is an optional 1-byte binary value indicating one or more types of errors:

Bit 7 - RT-to-RT AND function.
Bit 6 - RT-to-RT OR Format error.
Bit 5 - RT-to-RT OR Addressing error.
Bit 4 - RT-to-RT OR Transmission error.
Bit 3 - RT-to-RT AND No (Format) error.
Bit 2 - RT-to-RT AND Any (Format) error.
Bit 1 - RT-to-RT AND Addressing error.
Bit 0 - RT-to-RT AND Transmission error.

If Bit 7 is enabled (1):
bits 6, 5, and 4 are ignored,
bits 3, 2, 1, and 0 disabled (0) defines a capture of ANY RT-to-RT message,

bit 3 enabled (1) defines a capture restricted to RT-to-RT messages with no errors,
bit 2 enabled (1) defines a capture restricted to RT-to-RT messages with errors, and
bits 1 and 0 may be programmed independently to specify RT-to-RT error capture conditions.

Example:
This example sets Mask-0 to trap missing or invalid response errors, and Mask-1 to trap any RT-to-RT error.

```
Wrt$ = "M0" + chr$(&h06) + "M1" + chr$(&h80) + chr$(&h08)
Call IBWRT (PCX%,Wrt$)
```

Command	Description

S

The State command outputs state machine instructions to define a sequence of words which must occur in order for data capture to occur.

Syntax: Sn

Up to ten sequential states may be programmed to identify information transfers for capture. The states are numbered 0 through 9 and may be programmed with a single State command or a series of State commands.

As many states as are needed may be programmed with a single State command. After the 3 or 4 byte string of the first state specified, additional 3 or 4 byte strings may be appended for the other states. The State command is completed by a new command or by an optional carriage return and line feed termination.

After the State command, when the Go command is issued, the capture specification will begin with the State-0 instruction. The specification will then progress towards capture according to the State-0 instruction and subsequent state instructions. The choice of state numbers used for programming is arbitrary with these exceptions:

- The state machine always begins with State-0.
- State-0 through State-5 are indicated, when active, by front card edge outputs.

Each state is programmed with an IF instruction and an optional ELSEIF instruction. Although each arbitrary word (see Word command) used in the instruction must be defined before acquisition begins, and each ELSEIF instruction requires a corresponding IF instruction, the order of programming for IF, ELSEIF and word definitions is not important.

The basic structure of a complete State Machine instruction is:

IF	Word-N occurs Count times
THEN	Interrupt, Store, and/or go to State-X
ELSEIF	Word-M occurs
THEN	Interrupt, Store, and/or go to State-Y

IF and ELSEIF instructions comprise a single Intelligent Monitor state. Comparisons for both words (Word-N and Word-M) are made at the same time. If the IF and ELSEIF comparison words are not mutually exclusive and are simultaneously matched, the IF-THEN transition will occur.

The word number used for comparison is selected from any of the words defined with the Word command (0 through 5), or from the predefined words ANY WORD (8), ANY COMMAND WORD (9), ANY STATUS WORD (A), ANY DATA WORD (B), ANY COMMAND OR STATUS WORD (C), END OF MESSAGE (E), or NO WORD (F).

If the count value is not greater than 1 for the IF instruction, the counter may be used for the ELSEIF instruction.

n is a 3- or 4-byte value defining parameters for one of the nine possible states. A separate n value is output for the IF and ELSEIF portions of an instruction. When the counter is used, n will have a length of 4 bytes, otherwise a count value of one will be assumed and n will have a length of three bytes. Several n values may be output in a single State command. Each n value is composed of:

First Byte - A single ASCII character (0 through 9) indicating the state to be programmed.

Second Byte - A binary value establishing parameters to be used in determining the transition and action to be taken when a transition occurs.

Bit 7: = 1
Bits 6,5,4: 3-bit error definition code (see M command)
X1XXXXXX Don't Care about Errors
X011XXXX Capture Mask-1 used
X010XXXX Capture Mask-0 used
X001XXXX Any error allowed
X000XXXX No errors allowed
Bit 3: Counter used = 1
Bit 2: Interrupt on transition = 1
Bit 1: Store capture on transition = 1
Bit 0: ELSEIF = 1, IF = 0

Third Byte - A binary character containing two binary nibbles. The value in the lower nibble is the next state after the IF-THEN transition. The value in the upper nibble is the WORD (Word command) to be matched for that transition.

Fourth Byte (optional) - A binary counter value is output which may vary between 1 and 31.

Example 1:
The testing problem requires that all 1553 information transfers be stored after the aircraft reaches a distance of 43.257 kilometers from the touchdown end of the runway prior to landing. The distance measurement will be sent from RT-4, subaddress 7, as the fifth and sixth words in the RT response. (Errors will be ignored.)

The given distance of +43 kilometers, since 0.000015258 is the value of the least significant bit, is represented by a 32-bit value of 002B 425D (or less). The fifth word of the RT response is the most significant distance word with the value of its least significant bit equal to 1-kilometer. Word 1 will be defined to match this word for values of 002B (43 kilometers) or less.

The following definitions are made using the Word command:

Word 0 - Command word requesting data from RT-4, subaddress 7.

Word 1 - First distance word from RT-4, subaddress 7. The word is a combination of OR terms including all distance readings equal to or less than the desired 002B minimum value.

The state machine will use five states with the following algorithms:

State	Algorithm Description
0	IF Word-0 occurs THEN GOTO State-1.
1	IF ANY DATA WORD occurs 4 times THEN GOTO State-2. ELSEIF END OF MESSAGE occurs THEN GOTO State-0.
2	IF Word-1 occurs THEN GOTO State-6. ELSEIF ANY WORD occurs THEN GOTO STATE-0.
6	IF END OF MESSAGE occurs THEN INTERRUPT AND STORE, GOTO State-7.
7	IF END OF MESSAGE occurs THEN STORE, GOTO State-7.

In this example, when the correct RT-data is requested (Word-0), four 1553 words are counted before checking the distance word to be compared. If the distance is equal to or less than the minimum established, the sequence will progress to State-6, otherwise the sequence will return to State-0. After the minimum distance has been reached, all subsequent information transfers are stored (State-7).

The coding for this capture specification is as follows:

n_1 value State-0 -
First Byte = 0
Second Byte = binary 11000000
Third Byte = hexadecimal 02

n_1 value State-1 -
First Byte = 1
Second Byte = binary 11001000 (IF)
Third Byte = hexadecimal B2
Fourth Byte = hexadecimal 04

n_1 value State-1 -
First Byte = 1
Second Byte = binary 11000001 (ELSEIF)
Third Byte = hexadecimal E0

n_1 value State-2 -

First Byte = 2
Second Byte = binary 11000000 (IF)
Third Byte = hexadecimal 16

n_1 value State-2 -
First Byte = 2
Second Byte = binary 11000001 (ELSEIF)
Third Byte = hexadecimal 80

n_1 value State-6 -
First Byte = 6
Second Byte = binary 11000110
Third Byte = hexadecimal E7

n_1 value State-7 -
First Byte = 7
Second Byte = binary 11000010
Third Byte = hexadecimal E7

Example 2:
Values specified as n are output immediately following the header word, without any carriage return, line feed, or other extraneous characters in between. Send the following characters:

```
Wrt$ = "S"
            + "0" + CHR$(&hC0) + CHR$(&h02)
            + "1" + CHR$(&hC8) + CHR$(&hB2) + CHR$(4)
            + "1" + CHR$(&hC1) + CHR$(&hE0)
            + "2" + CHR$(&hC0) + CHR$(&h16)
            + "2" + CHR$(&hC1) + CHR$(&h80)
            + "6" + CHR$(&hC6) + CHR$(&hE7)
            + "7" + CHR$(&hC2) + CHR$(&hE7)
Call IBWRT (PCX%,Wrt$)
```

This example has output values for each state in sequential order, primarily for readability. The ordering of character groups for each state may be arbitrary, since the state machine will always begin the capture operation with State-0, which must be an IF statement. Word comparisons in ELSEIF statements will be made concurrently with the word comparison in the next lower-numbered state. If both words match for the same information transfer, the transition of the IF statement will occur.

A carriage return or line feed may be appended to the 17-byte State command string shown. Or delimiters may be omitted and a new command may be appended.

Command	Description

T

The Time tag command specifies whether time tags are to be eliminated from the captured data, and if used, which time base should be selected. After power-up or reset, time tags are automatically inserted and the word counting operation counts each received word based on sync signals and 20μs intervals.

Syntax: Tn

n is a single hexadecimal coded value as follows:

8	Time tags disabled.
4	Time tag clock is 20μs.
3	Time tag clock is 10μs.
2	Time tag clock is 1μs.
1	Time tag clock is ½-μs.
0	External Time tag clock.

The 32-bit (4 byte) time tags will be stored following each Status Word and each Command Word beginning the message (not including the second Command Word of an RT-to-RT command). The four bytes will be output with the most significant byte first, with each byte following having a less significant group of 8-bits.

NOTE: Since the Intelligent Monitor only examines the lower 4 bits of n, an ASCII character with the same value as those shown may also be used,

Example:
This example sets the time tag clock to a 20μs rate.

```
Wrt$ = "T4"
Call IBWRT (PCX%,Wrt$)
```

Command	Description
W	The Word command outputs word definitions leading to data storage, a system interrupt, or a state transition when a word match occurs.

Syntax: Wn_1n_2

Definition of a word changes the specification for capture. Once a word is defined, it cannot be redefined without a board reset or Kill command. If the board reset specification was active before the word was defined the changed state machine specification becomes:

IF WORD-N occurs THEN store information transfer.

WORD-N is always the last word defined until the State command is used. Use of the State command ends automatic replacement of the word number in the capture specification and the specification remains fixed with the word numbers, as output by the system controller.

NOTE: Errors associated with capture definition or with word definition should be specified as part of the Mask or State command when using the defined word.

n_1 is a 1-byte value defining one of the six arbitrary words. Each n_1 value is composed of a single ASCII character (0 through 5) indicating the word to be programmed.

n_2 is a 5-byte value defining one of the OR terms for the selected arbitrary word. Each n_2 value is composed of:

First Byte - A single ASCII character, either (A, B, or C) indicating the type of 1553 word.

- A - Command word
- B - Status word
- C - Data word

Bytes 2 and 3 - A 16-bit Don't Care mask indicating which bits will be used with the values given in Bytes 4 and 5 (0), and which bits may have either a 0 or 1 (1).

Bytes 4 and 5 - The 16-bit data value to be compared with the 1553 word.

As many OR terms may be summed as are necessary. A carriage return or line feed may be appended to the Word command. Or delimiters may be omitted and another word definition or a new command can be appended.

Multiple word definitions may be combined for any arbitrary word definition if the definitions are mutually exclusive. A list of valid or invalid RT addresses may be OR'd together, a series of numerical or don't care values can define a numerical range, or a specific COMMAND WORD may be OR'd with a specific STATUS WORD since their order of occurrence is known.

In addition to the six arbitrarily defined words (Words 0 through 5), seven predefined words may be used in defining a capture. These words are:

Word-8 ANY WORD
Word-9 ANY COMMAND WORD
Word-A ANY STATUS WORD
Word-B ANY DATA WORD
Word-C ANY COMMAND OR STATUS WORD
Word-D NO RESPONSE
Word-E END OF MESSAGE WORD
Word-F NO WORD (inactive ELSE condition)

Example 1:
In the testing problem used as an example for the State command, two words were shown defined. This example illustrates how those definitions are made using the Word command:

Word 0 - Command word requesting data from RT-4, subaddress 7.

Byte 1 - 0 identifies word number
Byte 2 - A indicates a command word.
Bytes 3,4 - Hexadecimal 0000 indicates that a match should be made only with the 16-bit word in bytes 4 and 5.
Bytes 5,6 - Binary 00100 0 00111 01000 indicates that RT-4, subaddress 7 messages (containing 8 words) meet the match conditions when data is transmitted to the bus controller.

Word 1 - First distance word from RT-4, subaddress 7. Distance is +43 kilometers (002B hex) or less.

Byte 1 - 1 identifies word number
Byte 2 - C indicates a data word.
Bytes 3,4 - Hexadecimal 0003 indicates a comparison should be made with the most significant 14-bits of bytes 5 and 6 and with any value for the least significant 2-bits.
Bytes 5,6 - Hexadecimal 0028 (through 002B).

Byte 7 - C indicates a data word.
Bytes 8,9 - Hexadecimal 0007 indicates a comparison should be made with the most significant 13-bits of bytes 10 and 11 and with any value for the least significant 3-bits.
Bytes 10,11 - Hexadecimal 0020 (through 0027).

Byte 12 - C indicates a data word.
Bytes 13,14 - Hexadecimal 001F indicates a comparison should be made with the most significant 11-bits of bytes 15 and 16 and with any value for the least significant 5-bits.
Bytes 15,16 - Hexadecimal 0000 (through 001F).

n_2 values are output immediately following the n_1 word, without any carriage return, line feed, or other extraneous characters in between.

For this example, send the following characters:

```
Wrt$ =      "W"
          +    "0"
               +    "A"   + CHR$(&h00) + CHR$(&h00)
                          + CHR$(&h20) + CHR$(&hE8)
          +    "1"
               +    "C"   + CHR$(&h00) + CHR$(&h03)
                          + CHR$(&h00) + CHR$(&h28)
               +    "C"   + CHR$(&h00) + CHR$(&h07)
                          + CHR$(&h00) + CHR$(&h20)
               +    "C"   + CHR$(&h00) + CHR$(&h1F)
                          + CHR$(&h00) + CHR$(&h00)
Call IBWRT (PCX%,Wrt$)
```

A carriage return or line feed may be appended to the Word command. Or delimiters may be omitted and a new command can be appended.

Command	Description

X

The eXternal command arms the External Trigger and External Halt input signals on the front edge connector of the 53A-457 Card. These signals control the starting and stopping of data capture operation.

NOTE: The eXternal command is used to initiate data capture for readback by the system controller, and is equivalent to the Go command with external signal controls added. If the High-speed port command is used, the External Trigger and Halt signals will be armed by a parameter of the High-speed port command.

If the state machine has been programmed incorrectly, the 53A-457 will not capture any data. An Error command may be issued to determine the nature of the programming error.

After the X command has been issued, the 53A-457 will require a minimum of 500 milliseconds to prepare for data capture. The first External Trigger should not be issued before the delay period has elapsed. If it is sent too soon, the External Trigger pulse may be missed. A continuous active (low) signal on the External Trigger will cause capture to begin as soon as the 53A-457 is ready to begin capture.

The front card edge output signals, such as the outputs for states 0 to 5, may be connected to the External Trigger and Halt signals directly or via external logic. For example, when several 53A-457 Cards are used to create concatenated buffer storage, the first card can be triggered by its own State-0 output and halted by its own Buffer Full Output. Additional cards can be triggered by the previous card's Buffer Full output and halted by their own Buffer Full output. The first card can use an internal clock for the time tag. Additional cards can use the first card's time tag clock output as an External Time tag Clock input.

This command remains in effect unless canceled by a Kill command or by a reset.

Example:

This example puts the 53A-457 into the data capture mode. Capture will begin each time an External Trigger is received, and will stop each time an external halt is received.

```
Wrt$ = "X"
Call IBWRT (PCX%,Wrt$)
```

Command	Description
Y	The Y-value command programs the receiver voltage threshold. The peak-to-peak must be reliably exceeded by the input voltage to be detected as data.

Syntax: Yn

n specifies the 8-bit (1-byte) receive threshold amplitude. The maximum Y-value of 255 corresponds to a maximum receive threshold of ±5.00V threshold relative to zero, therefore 255 steps with ±20 mV resolution for each step are provided.

A reliable receiver voltage should exceed any bus bias voltage or ground bounce (to assure proper receiver turnoff), and be less than overshoot and ringing voltages (to avoid multiple transition detection) on the signal. Ideally, the threshold could be set between 40% and 70% of the transmitted signals, but this is not always achievable, given the fact that there are usually several different transmitters (Controllers and RTs) on the bus. A reset (default) initial value of 500 mV threshold relative to zero is assumed. This value will provide proper receiver detection in almost all cases. If excessive ground bounce must be avoided and transmit levels are sufficiently high to provide an adequate noise margin, or if very low transmission levels must be detected, the receiver threshold may be adjusted upwards or downwards as required.

Example:
The data protocols are being evaluated for a transmitter with a very strong signal and excessive bus bias. The signal has a 8V PTP variation and a 70% threshold setting is desired. Program the receive threshold for ±2.8V relative to zero.

For a receive threshold equal to 70% of an 8V PTP:

$$n = \frac{70\% * 8V}{10V} (255) = 142.8$$

Send the following characters to the card to program a receive threshold of ±2.8V.

```
Wrt$ = "Y" + chr$(143)
Call IBWRT (PCX%,Wrt$)
```

Command	Description
Z	The Z-value command programs the time allowed for an RT response without a late response error. Response time is defined as the time between the last mid-parity-bit transition of each bus controller transmission and the mid-sync transition of the RT response. MIL-STD-1553 specifies this interval as 4μs through 12 μs, inclusive. If the measured interval exceeds the value set, a response-time error is indicated for the first word of the RT response. The value is set at 12μs at power-up.

Syntax: Zn

n specifies the 8-bit (1-byte) interval output that defines the interval in 0.5μs increments. Values from 4μs (hexadecimal 08) to 13.5μs (hexadecimal 1B) may be programmed.

Example:
A 4μs margin for error is required for RT units in a certain system. To detect RTs without the operational margin, it is desired to program the maximum response time as 8μs on the 53A-457 Card.

The value is specified in 0.5μs increments.

$$n = \frac{8.0}{0.5} = 16.0$$

Send the following characters to the 53A-457 Card to program the card to generate a response-time error when the RT response time exceeds 8.0 μs.

```
Wrt$ = "Z" + chr$(16)
Call IBWRT (PCX%,Wrt$)
```

INSTALLATION

The 53A-457 Card is a function card; therefore, it may be plugged into any blue card slot. Setting the Address Select switch defines the card's programming address. To avoid confusion, it is recommended that the slot number and the programming address be the same.

CAUTION:

To avoid plugging the card in backwards, observe the following:

a. Match the keyed slot on the card to the key in the backplane connector. The component side should be to the right for a 53 Series Chassis and to the top for a 63 Series Chassis.

b. There are two ejectors on the card. Make sure the ejector marked 53A-457 is at the top for a 53 Series Chassis and to the left for a 63 Series Chassis.

CAUTION:

The 53A-457 Card is a piece of electronic equipment and therefore has some susceptibility to electrostatic damage (ESD). ESD precautions must be taken whenever the module is handled.

APPENDIX A

53/63 SERIES SYSTEM COMMANDS

Command	Description
@XY	The @XY (Address) command addresses a function card in the 53/63 Series System. @ is a delimiter used by the 53/63 Series System. X is a card cage address (0-9) defined by the Address Select switch on the 53A-171 Control Card in the addressed card cage. Y is a function-card address (0-9) defined by the Address Select switch on the function card. Once a card cage/function-card combination is addressed, it remains addressed until the 53/63 Series System detects a new @ character.
@XH	The @XH (Halt) command halts all function cards within the card cage defined by X. This command does not affect function cards in other card cages. How a function card reacts to the @XH command depends on the particular card. On the 53A-457 Card the position of the Halt switch causes the @XH command to have the following effects: If the Halt switch is on, the 53A-457 Card will cease acquisition and revert to the default values for all words, states and programmed parameters; if the Halt switch is off, the 53A-457 Card will discontinue the current programming string and prepare for the next character to be transmitted. In all cases, an addressed function card (Power LED out) becomes unaddressed (Power LED lit). *NOTE*: When reading back data from a 53A/63A system with this configuration: more than one 53A/63A card cage with 53A-123 Chaining Cards linking the cages, a 53A-130 ACX, 53A-152 ATX or A 53A-153 ATZ in the first cage as the Communications card, and a 53A-457 card in a cage remote from the 53A-130 card, **System commands** should be sent as detailed in Appendix F.
STOP	The STOP command is not a string of ASCII characters. This command is hard-wired from the system controller to the 53/63 System's communications card in each card cage. When the system controller issues a STOP command, each function card (including the 53A-457 Card) reacts as if it had received the @XH command described above. How the system controller executes a STOP command depends on the communications card used. For example, when using the 53A-128 IEEE-488 Communications Card, a STOP command is executed whenever the system controller asserts the IEEE-488 bus line IFC (Interface Clear) true.

APPENDIX B

INPUT/OUTPUT CONNECTIONS

PIN ASSIGNMENTS

Wiring Side		Component Side	
Function	Pin	Pin	Function
Direct-coupled Output Low	2	1	Direct-coupled Output High
Common Mode Voltage Input	4	3	Common Mode Voltage Input
Transformer-coupled Output Low	6	5	Transformer-coupled Output High
	8	7	
	10	9	
	12	11	
	14	13	
	16	15	
Digital Ground	18	17	Digital Ground
External Trigger Input	20	19	External Halt Input
Time tag Clock Input	22	21	Time tag Reset Input
	24	23	Receiver Active Input
	26	25	
Data Strobe Output (-)	28	27	Data Strobe Output (+)
Buffer Empty Output	30	29	Buffer Full Output
Data Bit-0 Output (-)	32	31	Data Bit-0 Output (+)
Data Bit-1 Output (-)	34	33	Data Bit-1 Output (+)
Data Bit-2 Output (-)	36	35	Data Bit-2 Output (+)
Data Bit-3 Output (-)	38	37	Data Bit-3 Output (+)
Data Bit-4 Output (-)	40	39	Data Bit-4 Output (+)
Data Bit-5 Output (-)	42	41	Data Bit-5 Output (+)
Data Bit-6 Output (-)	44	43	Data Bit-6 Output (+)
Data Bit-7 Output (-)	46	45	Data Bit-7 Output (+)
Data Acknowledge Input (-)	48	47	Data Acknowledge Input (+)
	50	49	
	52	51	
	54	53	
State-1 Active Output	56	55	State-0 Active Output
State-3 Active Output	58	57	State-2 Active Output
State-5 Active Output	60	59	State-4 Active Output
Receiver Active Output	62	61	Capture Active Output
	64	63	
Status Word Error Output	66	65	Receiver Error Output
Received Clock Output	68	67	Received Data Output
Bus Controller Xmsn Output	70	69	Received Sync Polarity Output
Time tag Clock Output	72	71	Time tag Reset Output
	74	73	
Digital Ground	76	75	Digital Ground

NOTE: Pins 27, 28, and 31 through 48 use RS-422 differential signals. A discussion of how to connect these signals is included in Appendix C.

PIN DESCRIPTIONS

1553 Bus Signals (Transformer-coupled: pins 5, 6; Direct-coupled: pins 1, 2)
Transformer-coupled and direct-coupled 1553 data bus signals are available at the front-edge connector of the 53A-457 Card.

Common Mode Voltage Input (pin 3, 4)
A common-mode voltage can be injected onto the 1553 data bus through the Common Mode Voltage Input when the 53A-457 Card is direct-coupled to the data bus.

Reconstructed Received Data/Clock Output (pins 67, 68)
Manchester-encoded TTL data received by the 53A-457 Card from the 1553 data bus is available at pin 9 as NRZ serial data. A reconstructed TTL clock is provided at pin 10 that transitions high when the data on pin 9 is stable. The clock transitions 16 times for each 1553 word for each data bit.

Receive Sync Polarity Output (pin 69)
This output indicates command, status, or data sync polarity for the current 1553 received word. The output at pin AA is stable for all 16 transitions of the received clock on pin 20. The sync outputs are high for a data sync and low for a command or status sync.

Receiver Active Output (pin 62)
This open-collector output indicates that data is being received from the 1553 bus being monitored. This signal can be used as an input to another board's Receiver Active Input (pin 15) to determine if there is a proper interval between transmissions on redundant buses. The output goes to active-low when the receive cycle begins, and remains active until the no-voltage (gap) condition occurs following the parity bit of the last word of the transmission.

Receiver Active Input (pin 23)
This input indicates that data is being received by a bus monitor connected to a redundant 1553 bus. This signal can be used to determine if there is a Bus Overlap error due to a premature transmission on a redundant bus.

Status Word Error Output (pin 66)
The Message Error Output line pulses low each time an RT status word is received with bit 6 (Message Error) set.

Receiver Error (pin 65)
If a received word is specified for capture and contains an error, a receiver error condition is latched. The error condition is cleared when the bus controller examines the error condition (Flag command) or when capture is restarted.

Bus Controller Transmission Output (pin 70)
This signal will go active low for 0.5 μs each time a 1553 command word is received.

Time tag Reset Input (pin 21)
When 1553 bus data is being stored in more than one system, the time tags associated with the stored data can be synchronized with this signal. When this signal goes active low, the time tag value will be reset to 00000000. It will remain at that value until this input is restored to its inactive high state.

Time tag Reset Output (pin 71)
When a T or K command is issued, the on-board time tag value will be reset to 00000000 at the same time that a 2μs active high pulse is output on this front card-edge pin. When 1553 bus data is being stored in more than one system, the time tags associated with the stored data on other 53A-457 Cards can be synchronized with this signal by connecting it to the Time tag Reset Input (pin 21) of the other boards.

Time tag Clock Input (pin 22)
The external Time tag Clock Input allows multiple boards which are collecting 1553 data on redundant buses to have synchronized time tag values. If this input is used, the Time tag Reset input (pin 21) should also be connected to the Reset output of the board outputting the Time Tag Clock (pin 72). The external Time tag reset and clock inputs are activated with the Time tag command.

Time tag Clock Output (pin 72)
The buffered Time tag clock is output so that it may be input at another 53A-457 Card's time tag Clock Input (pin 22) so that both (or several) boards will use the same time base.

Acquisition Off Output (pin 61)
This open-collector output goes low to indicate that the 53A-457 Intelligent Monitor card is not in the data acquisition mode.

Buffer Full Output (pin 29)
When the 65,300 word buffer has been filled by captured data, this output will go low and remain low until the acquisition is stopped and subsequently restarted.

Buffer Empty Output (pin 30)
When no captured data is stored in the buffer, this output will remain active low. As soon as data has been stored, the output will go to an inactive high state and will remain in that state until the buffer has been emptied by system inputs.

External Halt Input (pin 19)
The External Halt Input can be used to externally terminate 1553 data capture. When the External Halt Input is cycled low, the 53A-454 Card completes the information transfer in progress on the 1553 bus, and then returns control of the 53A-457 Card to the External Trigger Input (pin L). An External Trigger Input continues the data capture program at the next information transfer.

External Trigger Input (pin 20)
The External Trigger Input is armed by a system controller eXternal command, and initiates data capture when the signal is cycled low. Within 1μs after receiving the External Trigger Input signal, the 53A-457 Card begins comparisons according to the capture specification.

State-Machine Outputs 0 through 5 (pins 55 through 60)
Six open-collector outputs indicate the current state of the Intelligent Monitor state-machine. The outputs can be connected together in a wired-or configuration to indicate that the state-machine is in any one of the connected states.

NOTE: Front card edge Data and the Data Strobe and Data Acknowledge handshake lines all use differential (RS-422) signals. The handshake lines are active high on the positive (+) signal of the differential pair and opposite in polarity on the negative (-) signal. The Data has positive logic on the positive signal and negative logic on the negative signal. These signals can also be used as single-ended TTL signals as explained in Appendix C below.

Data Acknowledge Input (pins 47, 48)
When the front card-edge, high-speed data port is used with the data acknowledge mode, this signal is used for each data byte output by the 53A-457. In this mode, the Data Acknowledge must go active for at least 125 ns and must then become inactive before another Data Strobe (pins 27, 28) will be sent for the next data byte.

Data Strobe Output (pins 27, 28)
This signal indicates valid data at the front card-edge high-speed data port. The signal will go active after data has been valid for at least 135 ns, and remains active for a total pulse width of 187.5 ns. Data will remain valid until at least 50 ns after the Data Acknowledge signal becomes active and returns to its inactive state.

Data Bits 0 through 7 (pins 31 through 46)
Data captured in the buffer is sent through this high-speed 8-bit data port to a system input.

APPENDIX C

CONNECTING THE HIGH-SPEED DATA PORT

The high-speed data port consists of three sets of signals: a differential (RS-422) pair for the DATA ACKNOWLEDGE (DACK) input, a differential pair for the DATA STROBE (DSTB) output, and one differential pair for each of the eight DATA outputs (D0 through D7).

If the free-running mode is programmed, the DACK input is not used. For handshake modes, a programmable jumper block (PJ62) is provided for the DACK input. PJ62 is located in the second row of parts, inboard from the front card edge, in the middle of the row. Four diagrams are shown below explaining PJ62 program options:

Figure 457-2 53A-457 Card wiring.

Figure 457-3 Programming block connections provided by the factory for RS-422 operation.

Figure 457-4 Header block (customer provided) connections for a TTL active-high DSTB input.

Figure 457-5 Header block (customer provided) connections for a TTL active-low DSTB input.

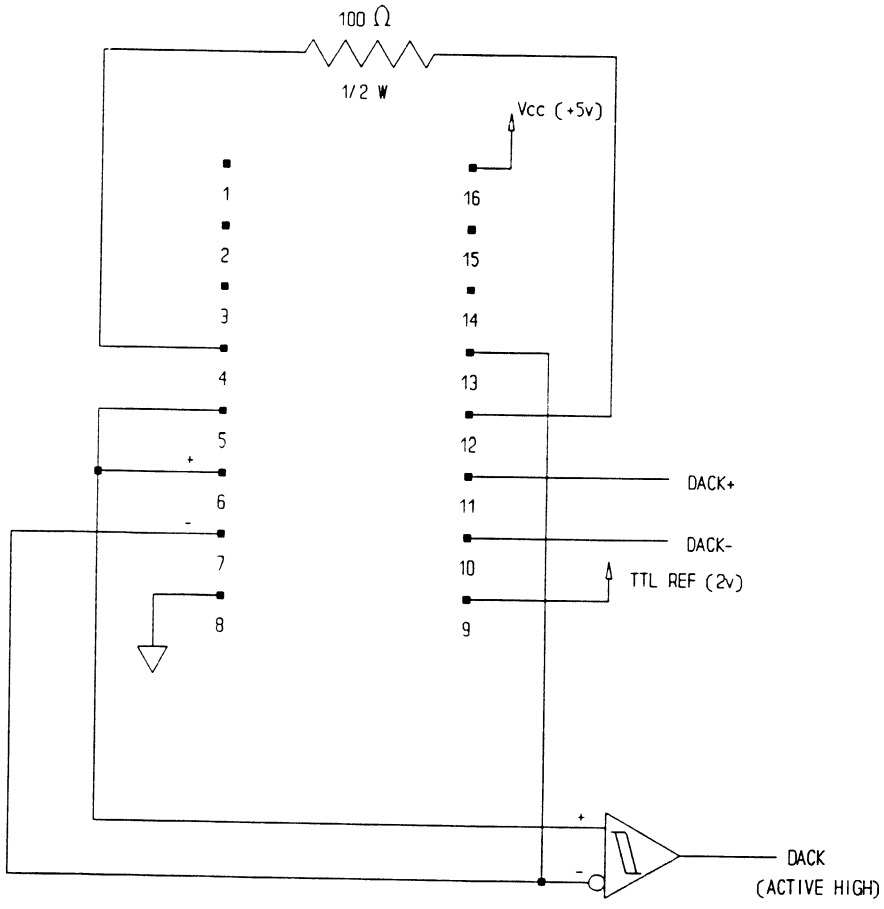

Figure 457-2: 53A-457 Card Wiring

Differential (RS-422) Operation

Shielded, twisted-pair wires should be connected between the 53A-457 input and outputs and the output and inputs of the connecting circuit. For cable lengths up to 15 feet, no additional termination circuitry is required. For cable lengths between 15 feet and 25 feet, 100 Ohm terminating loads should be added across the DSTB and DATA pairs at the receiver (connecting circuit) end of the cable. (A 100 Ohm termination is provided for the 53A-457 DACK receiver, see PJ62 diagram 457-2.) For cable lengths exceeding 25 feet, terminating circuits may be required at both ends of the cable. Consult an RS-422 application manual, such as the Texas Instruments Interface Circuits Data Book, for diagrams, charts, and tables specifying these interfaces.

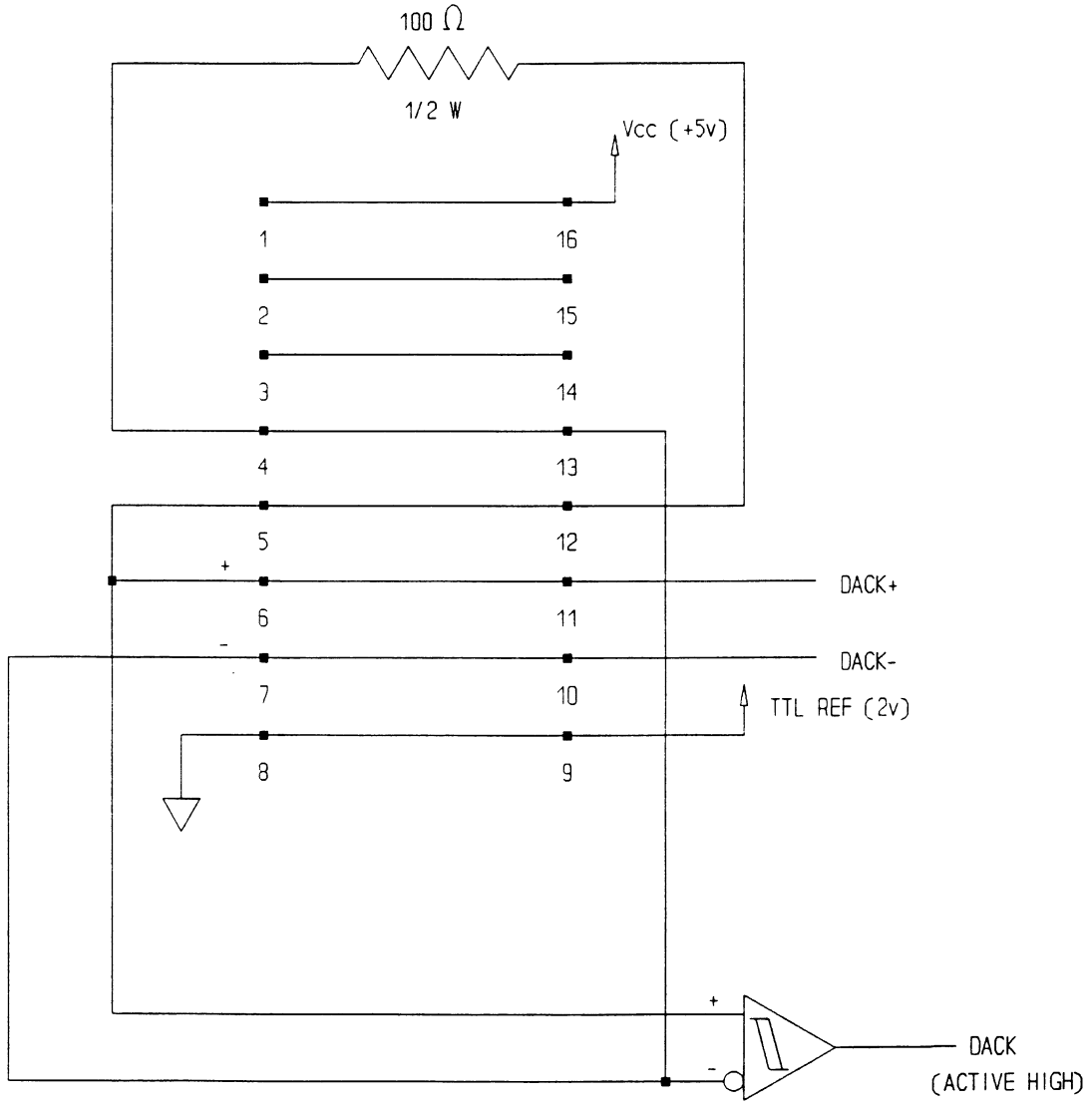

Figure 457-3: RS-422 Input (Factory Setting)

TTL (Single-Ended) Operation

TTL operation may be used if cable lengths are short and the cable and its connections are constructed carefully. Shielded, twisted-pair wires should be connected between the 53A-457 input and outputs and the output and inputs of the connecting circuit.

Pull-up resistors should be provided at the receivers provided by the customer. A 220 Ohm value is recommended for these resistors which also act as line terminations. The inactive wire of each twisted pair should be connected to ground at the receiver end.

A high-current driver should be used for the DACK signal (if used). A 74AS240 or 74AS244 bus driver circuit is recommended for the DACK transmitter. Any TTL input circuit (including the 74AS24X) may be used for the receivers. 74HC24X receivers provide high noise immunity because of their mid-point voltage thresholds. The 74LS24X receivers provide high noise immunity because of their input hysteresis.

For handshake operation using TTL signals, a wired header block should be inserted in place of the PJ62 jumper block for the DACK input. Figures 457-4 and 457-5 indicate the wiring required for active-high and active-low DACK signals. If a 74AS24X driver is used, the additional 100 Ohm resistor is not required. To modify the 2-Volt threshold reference provided, use a resistor between pins 8 and 9 of the header block to lower the threshold and a resistor wired between pins 16 and 9 to raise the threshold.

For Figures 457-4 and 457-5, there is a 100 ohm resistor between 1 and 16 for the 74LS 24X driver.

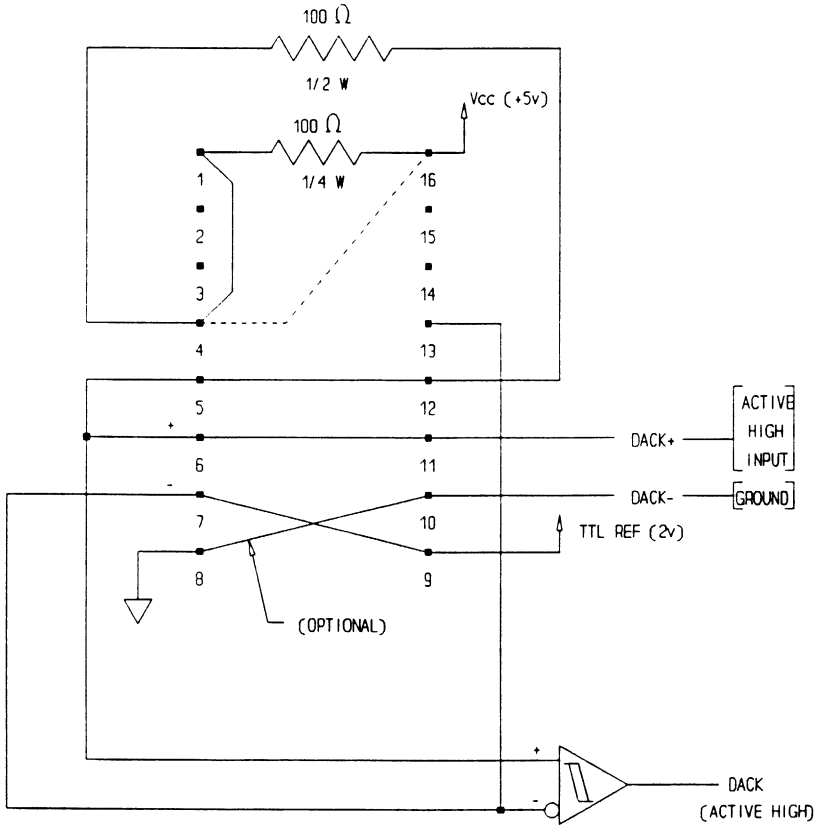

Figure 457-4: TTL Input, Active High Configuration

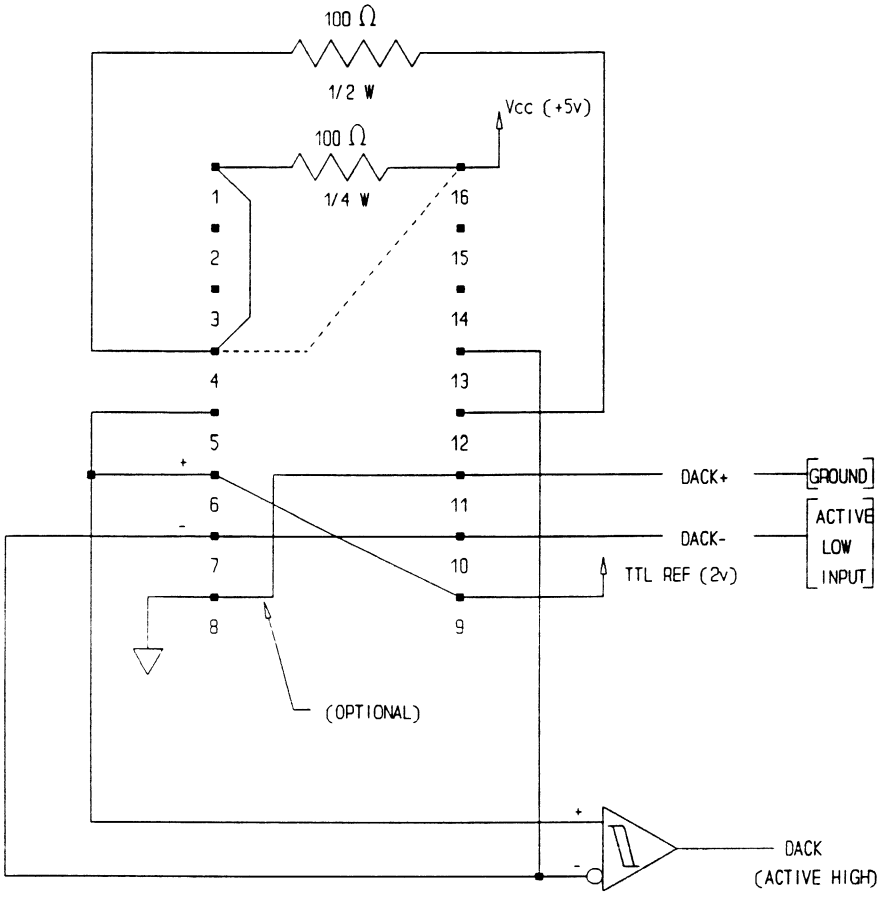

Figure 457-5: TTL Input, Active Low Configuration

APPENDIX D

1553 BUS ERRORS

Protocol and Transmission errors are included with the received word data values when captured data is read back (see Go command in Card Commands). The error indications and cause are:

MESSAGE HEADER (First Command Word, First Byte)
- Bit 4 - Format Error
- Bit 3 - Word Count Error
- Bit 2 - Bus Overlap Error
- Bit 0 - Response Error (summary)

MESSAGE HEADER (Intermediate Command Word, First Byte)
- Bit 0 - Response Error (missing)

RESPONSE HEADER (Status Word, First Byte)
- Bit 3 - Late Response Error
- Bit 2 - Early Response Error
- Bit 0 - Response Error (invalid)

TRANSMISSION ERRORS (Second Byte of each word)
- Bit 7 - Sync error
- Bit 6 - Too many bits
- Bit 5 - Too few bits
- Bit 4 - Parity error
- Bit 3 - Incorrect transition (jitter)
- Bit 2 - Manchester error
- Bit 1 - Dropped bit
- Bit 0 - NO TRANSMISSION ERROR IN WORD

Certain errors will be used by the 53A-457 to correct the Bus Controller/RT tracking algorithm.

Any time the next transmission occurs more than 14μs after the previous transmission, it will be assumed to be from the Bus Controller.

Any Command or Status Word with an RT address of 31 (11111) will be assumed to be a Broadcast Command Word.

Anytime a data value of 1 occurs during bit-times 10, 12, 13 or 14 of a Status Word and there is no Parity error, it will be assumed that the word is actually a Command Word.

PROTOCOL ERRORS

Format Error

Any error which occurs during the message will cause a Format Error. The Format Error thus serves as the sum of all the detected errors. In addition to errors specifically identified, protocol errors will also generate a Format Error and can be found by an examination of the processed data.

Illegal Mode Code - If a mode code is used which has not been defined in the 1553 standard, a Format Error will occur. The defined Mode Codes are:

CODE	T/R	DATA	BROADCAST ALLOWED
00000	1	NO	NO
00001	1	NO	YES
00010	1	NO	NO
00011	1	NO	YES
00100	1	NO	YES
00101	1	NO	YES
00110	1	NO	YES
00111	1	NO	YES
01000	1	NO	YES
10000	1	YES	NO
10001	0	YES	YES
10010	1	YES	NO
10011	1	YES	NO
10100	0	YES	YES
10101	0	YES	YES

T/R bit error: The data value occurring during bit-time 9 of the Command Word indicates the data source for data which may follow. If T/R = 0, the appropriate number of data words should follow the Command Word. Mode commands require the T/R bit as shown above. In an RT-to-RT transfer, the first Command Word must have T/R = 0, the second Command Word must have T/R = 1. If these rules are violated a Format Error will occur.

Wrong Address: If the RT address does not agree with the Bus Controller address transmitted, or the two RT addresses are the same in an RT-to-RT command, or the RT addresses do not appear in the right order for an RT-to-RT transfer, a Format Error will occur.

Response Error

A typical message cycle consists of a Bus Controller transmission and a Remote Terminal response. The RT must respond within 12μs. If that does not occur, the Bus Controller will re-transmit 14μs after the end of its last transmission. The RT need not respond if the Bus Controller command is invalid. An invalid command will occur if the Bus Controller transmitted the wrong number of words, an improper Mode Code, or if the command was invalid according to any of the test criteria the RT is programmed to apply.

The 53A-457 Intelligent Monitor Card begins a new message whenever a normal Bus Controller query/Remote Monitor response cycle completes. If the RT doesn't respond (and it is not a Broadcast command), the stored message will continue until a normal query/response cycle does complete. The Intelligent Monitor Card detects and indicates two kinds of response error, and indicates a summary of these errors in the first byte of the message:

Missing Response - If an RT response is required and does not occur within 12μs, a Response Error will be indicated in the first byte of the Command Word following the missing response.

Invalid Response -If an RT response occurs when it shouldn't, a Response Error will be indicated in the first byte of the Status Word.

A Response Error will not be indicated if the RT does not respond following a Mode Code or Word Count error. It should also be understood that an RT's failure to respond may be proper (e.g., if the RT detected a transmission error or an invalid sub-address), nevertheless a Response Error will be indicated for those cases.

Early Response Error
If the Status Word arrives less than 4μs after the Command Word, an early response will be indicated. The 4μs value can not be modified.

Late Response Error
If the Status Word arrives more than 12μs (default) after the Command Word, but less than 14μs, a late response will be indicated. The 12μs value can be modified with the Z command.

NOTE: **Response time is measured from the mid-bit transition of the Parity bit to the mid-sync transition of the next transmission. There must be a minimum of one bit-time of no-voltage (1μs gap) during this time.**

Word Count Error
If too many or too few data words occur, a Word Count Error will be indicated. The 53A-457 Intelligent Monitor will extract the necessary word count from the last five bits of the command word, or by implication from the Mode Code used in a Mode command. The number of Data Words transmitted must agree with the necessary word count. In an RT-to-RT message, the word count specified in the first Command Word must be the same as the Word count specified in the second Command Word. If the Busy Bit is set in the Status Word of an RT requested to send data, no Word Count error will be indicated if there are no subsequent Data Words.

Bus Overlap Error
This error will be indicated if a Receiver Active input is received at the wrong time on the front card edge, and this error has been enabled with the Define command.

TRANSMISSION ERRORS

Sync error
If an invalid sync signal is detected 20 bit-times after the previous sync signal, this error is stored with the data following the spurious sync signal.

Too many bits
If a second valid sync signal is not detected within 17 intermediate data bit-times, this error is stored for the unterminated word.

Too few bits
If a second valid sync signal is detected within 17 intermediate data bit-times, this error is stored for the shortened word.

Parity error
If the parity bit of the received word does not create an odd sum when added to the other 16 bits of the word, a parity error is stored.

Incorrect transition (jitter)
If a bit transition occurs more than 150 ns before or after the ideal transition time, a clock-recovery error is shown to indicate suspicious data.

Manchester error
If the data during the second half of each bit in the word is not opposite in polarity to the first half of the bit, a Manchester error is stored.

Dropped bit
If the 1553 bus voltage does not exceed the receiver threshold voltage (see Y-value command), data is not collected unless the no-data condition is limited to one bit-time. A dropped-bit error is stored in memory.

APPENDIX E

SAMPLE BASIC PROGRAM FOR THE 53A-457

The sample program below is written in Advanced BASIC (BASICA) for an IBM PC. The PC is connected to the CDS 53/63 Series Card Cage using a 53A-903 Card installed in the PC. The 53A-903 I/O Card provides an IEEE-488 interface between the PC and the CDS Card Cage. The 53A-457 Card has been set to address 9. The address of the 53/63 Card Cage containing the 53A-457 Card is address 1.

For this program, CDS is a variable containing the IEEE-488 address of the CDS 53/63 Series Card Cage and GPIB0 is a variable containing the IEEE-488 address of the 53A-903 I/O card. The 53A-903 commands used in this program are:

IBFIND, IBINIT1, IBINIT2, IBLOAD
: These commands load and initialize the software drivers for the 53A-903 card in the PC. The drivers are loaded from the software disk supplied with the 53A-903.

IBSIC : Resets the IEEE-488 interface, setting the interface IFC line true for 100 microseconds.

IBTMO : Defines the PC timeout for I/O operations to the 53A-903.

IBWRT : Writes the contents of a string variable to the 53/63 Series Card Cage.

IBRD : Reads data bytes from the 53/63 Series Card Cage and stores them in string variables. Note that the variable must first be filled with space characters equal to the maximum number of data bytes to be read.

In the programming examples shown, lines are skipped for clarity, the actual program cannot have any empty lines. Some lines are wrapped around so they can be seen on the printed page, BASICA allows line as long as 254 characters, but does not allow commands to continue onto the next line.

Sample BASIC Program For Initializing The IEEE-488 Interface

```
1   CLEAR ,60000!:'   BASIC declarations.

2   IBINIT1 = 60000!

3   IBINIT2 = IBINIT1 + 3

4   BLOAD "BIB.M",IBINIT1:KEY OFF

5   CALL IBINIT1(IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,
    IBBNA,IBONL,IBRSC,IBSRE,IBRSV,IBPAD,IBSAD,IBIST,IBDMA,
    IBEOS,IBTMO,IBEOT,IBRDF,IBWRTF)
```

```
6       CALL    IBINIT2(IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,
        IBCMDA,IBRD,IBRDA,IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBRDI,IBWRTI,
        IBRDIA,IBWRTIA,IBSTA%,IBERR%,IBCNT%)

10      ' Find the program locations for the IEEE-488 devices.

20      BDNAME$="CDS":CALL IBFIND (BDNAME$,CDS%)

30      BDNAME$="GPIB0":CALL IBFIND(BDNAME$,GPIB0%)

40      ' Reset the IEEE-488 devices.

50      CALL IBSIC(GPIB0%)

60      ' Disable the PC timeout function for I/O operations.

70      TIMEOUT%=0

80      CALL IBTMO(CDS%,TIMEOUT%):CALL IBTMO(GPIB0%,TIMEOUT%)
```

Sample Sub-Routines For Defining 53A-457 Read and Write Data

```
100     ' Define Card-Cage addressing functions

110     Cage$ = "@1"

120     Init$ = Cage$ + "S": Halt$ = Cage$ + "H"

130     A457$ = Cage$ + "1":  ' 53A-457 address

140     Delay = 2 : gosub 400

160     CR$ = chr$(&h0D) : LF$ = chr$(&h0A) : CRLF$ = CR$ + LF$

199     GOTO 1000

200     ' Sub-routine to determine the type of word.

210     IF (WrdType = 1) or (WrdType = 4) then Type$ = "Time" : WrdType = 2 : goto 299
        else Type$ = "End " : WrdType = 6

220     WordType = (ASC(Rd$) AND &HE0)

230     IF (WordType = &HE0) THEN Type$ = "Cmd1" : WrdType = 1 : GOTO 299

240     IF (WordType = &HC0) THEN Type$ = "Cmd2" : WrdType = 3 : GOTO 299

250     IF (WordType = &H80) THEN Type$ = "Stat" : WrdType = 4 : GOTO 299

260     IF (WordType = &H40) THEN Type$ = "Data" : WrdType = 5 : GOTO 299

299     RETURN
```

```
300     '     Sub-routine to convert Hex Character into binary characters
310     Bit0 = ASC("0") + ((ASC(Char$) and &h01)/&h01)
311     Bit1 = ASC("0") + ((ASC(Char$) and &h02)/&h02)
312     Bit2 = ASC("0") + ((ASC(Char$) and &h04)/&h04)
313     Bit3 = ASC("0") + ((ASC(Char$) and &h08)/&h08)
314     Bit4 = ASC("0") + ((ASC(Char$) and &h10)/&h10)
315     Bit5 = ASC("0") + ((ASC(Char$) and &h20)/&h20)
316     Bit6 = ASC("0") + ((ASC(Char$) and &h40)/&h40)
317     Bit7 = ASC("0") + ((ASC(Char$) and &h80)/&h80)
320     Char$ = chr$(Bit7) + chr$(Bit6) + chr$(Bit5) + chr$(Bit4) + chr$(Bit3) + chr$(Bit2)
        + chr$(Bit1) + chr$(Bit0)
330     RETURN
400     ' Sub-routine for a fixed delay
410     StarTime = TIMER : WHILE (TIMER - StarTime) < Delay : WEND
420     RETURN
500     ' Print TYPE, fetch binary data, and print error display
510     Locate XLoc,YLoc,0          : print Type$;
520     WordLoc = WordLoc + 1
530     if ((WrdType% = 2) or (WrdType% = 6)) then goto 620
540     Char$ = mid$(Rd$,1,1) : gosub 300 : Byte3$ = Char$
550     Char$ = mid$(Rd$,2,1) : gosub 300 : Byte2$ = Char$
560     Char$ = mid$(Rd$,3,1) : gosub 300 : Byte1$ = Char$
570     Char$ = mid$(Rd$,4,1) : gosub 300 : Byte0$ = Char$
580     Errur$ = mid$(Byte3$,4,5) : if Errur$ = "00000"   then goto 600
590     Locate XLoc,YLoc + 27,0 : Print Errur$;
600     Errur$ = mid$(Byte2$,1,7) : if Errur$ = "0000000" then goto 620
610     Locate XLoc,YLoc + 32,0 : Print Errur$;
```

```
620         Return
```

Sample BASIC Program For Displaying 53A-457 Captured Data

```
1000 Rd$ = Space$(4) : Wrt$ = A457$ + "G"

1010 CALL ibwrt(CDS%, Wrt$)

1020 Delay = 2 : gosub 400

1100 WordLoc = 0 : FirstWord = -1 : DataWord = 1

1110 CLS : Locate 1,1,0

1120 Print "Word #  HI-Data   LO-Data     ERRORS     Word #  HI-Data   LO-Data
     ERRORS"

1130 Locate 2,1,0

1140 Print "---------- ---------- ---------- ---------- ---------- ----------
     ----------"

1150 CALL IBRD(CDS%, Rd$) : ' Fetch next word

1160 gosub 200 : ' define word type

1170 XLoc = int(WordLoc/2) + 3 : YLoc = 1 + ((WordLoc mod 2) * 40)

1180 on WrdType% goto 2100,2200,2300,2400,2500,2600

1190 Locate 23,1,0 : INPUT "Press RETURN for next message", Char$

1200 Locate 3,1,0 : For ScrnLine = 3 to 23 : Print Space$(79); : next ScrnLine

1210 if (WrdType% = 0) then goto 1160 else goto 1150

2100 ' Print output for Cmd1 word

2120 if not FirstWord then WrdType% = 0 : WordLoc = 0: FirstWord = -1 : DataWord = 1 : goto
     1190

2130 gosub 500 : FirstWord = 0

2140 Char$ = mid$(Byte1$,1,5) + " " + mid$(Byte1$,6,1) +  " " + mid$(Byte1$,7,2) +
     mid$(Byte0$,1,3) + " " + mid$(Byte0$,4,5)

2150 Locate XLoc,YLoc + 7,0 : Print Char$;

2160 goto 1150

2200 ' Print output for Time word
```

```
2210 gosub 500

2220 Byte3$ = hex$(ASC(mid$(Rd$,1,1))) : if (len(Byte3$) = 1) then Byte3$ = "0" + Byte3$

2230 Byte2$ = hex$(ASC(mid$(Rd$,2,1))) : if (len(Byte2$) = 1) then Byte2$ = "0" + Byte2$

2240 Byte1$ = hex$(ASC(mid$(Rd$,3,1))) : if (len(Byte1$) = 1) then Byte1$ = "0" + Byte1$

2250 Byte0$ = hex$(ASC(mid$(Rd$,4,1))) : if (len(Byte0$) = 1) then Byte0$ = "0" + Byte0$

2260 Char$ = Byte3$ + Byte2$ + Byte1$ + Byte0$

2270 Locate XLoc,YLoc + 13,0 : Print Char$;

2280 goto 1150

2300 ' Print output for Cmd2 word

2310 gosub 500

2320 Char$ = mid$(Byte1$,1,5) + " " + mid$(Byte1$,6,1) +  " " + mid$(Byte1$,7,2) +
     mid$(Byte0$,1,3) + " " + mid$(Byte0$,4,5)

2330 Locate XLoc,YLoc +  7,0 : Print Char$;

2340 goto 1150

2400 ' Print output for Stat word

2410 gosub 500

2420 Char$ = mid$(Byte1$,1,5) + " " + mid$(Byte1$,6,3) +  " " + mid$(Byte0$,1,3) + " " +
     mid$(Byte0$,4,5)

2430 Locate XLoc,YLoc +  7,0 : Print Char$;

2440 goto 1150

2500 ' Print output for Data word

2510 gosub 500

2520 Char$ = mid$(Byte1$,1,4) + " " + mid$(Byte1$,5,4) +  " " + mid$(Byte0$,1,4) + " " +
     mid$(Byte0$,5,4)

2530 Locate XLoc,YLoc +  7,0 : Print Char$;

2540 Locate XLoc,YLoc +  4,0 : Print hex$(DataWord); : DataWord = DataWord + 1

2550 goto 1150

2600 ' Print output for End  word
```

```
2610 gosub 500

2620 WordLoc = 0            : FirstWord = -1 : DataWord = 1

2630 goto 1190
```

An example of returned data is shown below.

```
Word #  HI-Data   LO-Data     ERRORS    Word #  HI-Data   LO-Data     ERRORS

Cmd1   10010 0 10100 00101 10010        Time        00712256
Cmd2   00101 1 01001 10100              Stat   00101 000 000 00000
Time        007122AC                    Data1  0011 0001 0000 0001
Data2  0011 0010 0010 0011      0000100 Data3  0011 0011 0100 0101
Data4  0011 0101 0110 0111      0001001 Data5  0011 0101 1000 1001
Data6  0011 0110 1010 1011              Data7  0011 0111 1100 1101      0000100
Data8  0011 1000 1110 1111      0000010 Data9  0011 1001 0000 0001
DataA  0011 1010 0010 0011              DataB  0011 1011 0100 0101
DataC  0011 1100 0110 0111              DataD  0011 1101 1000 1001
DataE  0011 1110 1010 1011              DataF  0011 1111 1100 1101
Data10 0100 0000 1110 1111              Data11 0100 0001 0000 0001
Data12 0100 0010 0010 0011              Data13 0100 0011 0100 0101
Data14 0100 0100 0110 0111              Stat   01010 000 000 00000
Time        007125F9


Press RETURN for next message
```

APPENDIX F

USING THE 53A-457 IN A CHAINED CARD CAGE

After the 53A-457 has begun inputting 1553 words, the System Controller can input this information indefinitely. Since this information is binary, not ASCII, the 53A system uses the 457 Card's Binary output signal to identify this type of data. This avoids detecting System Commands (identified by a 40-hex, "@" ASCII byte), End-of-String commands (identified by a 0A-hex, or line feeds ASCII byte), which are not implied by the binary data.

The Binary output signal will avoid system ambiguities in almost all system configurations and the System Controller will be able to input binary data without problems as long as the programming procedures and system interfaces are used as outlined in this manual. There is only one system configuration which requires special programming procedures.

When reading back data from a 53A/63A system with: more than one 53A/63A Card Cage with 53A-123 Chaining Cards linking the cages, a 53A-130 ACX, 53A-152 ATX or a 53A-153 ATZ in the first cage as the Communications card, and a 53A-457 Card in a cage remote from the 53A-130 Card, **System commands** should be sent as follows.

53A Input - If a System command (e.g., "@01") is to be sent after reading binary data, an additional character should be sent preceding the "@" to insure that character's recognition. Any character other than an **F**, **Q**, or **K** may be sent (e.g., ";@01").

High-Speed Input - When the High-speed mode has been enabled for the 53A-457 card (H command), any character output to the 53A-457 Card will terminate data acquisition. By first inputting until a line feed End-of-String (EOI) is input, the binary-coded flag status (F command) and the ASCII coded line feed character will be input and the binary signal will be left in an inactive state. A System command (e.g., "@01") can then be output which will be recognized.