53A-426 QUAD ARINC-429 RECEIVER CARD

OPERATING MANUAL

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TRADEMARK NOTIFICATION

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OPERATING MANUAL

DESCRIPTION

The 53A-426 Quad ARINC-429 Receiver Card is a printed circuit board assembly for use in a 53/63 Series System. The card allows the user to test and analyze data received from the Mark 33 Digital Information Transfer System (DITS) found on many commercial aircraft. The 53A-426 Card has four independent receivers, each having an associated buffer memory for storing up to 32,000 ARINC-429 words (four bytes each) received on the DITS bus, for a total of 512,000 bytes of on-card memory.

The 53A-426 Card captures ARINC-429 data using one of the following four primary data-capture modes. Each channel is separately programmable.

- o Monitor Mode

  In Monitor Mode, the 53A-426 Card captures all ARINC-429 traffic received on the DITS bus and sequentially stores the captured data in the card's memory.

- o Select-labels Monitor Mode

  In Select-labels Monitor Mode, the 53A-426 Card stores data based on a user-defined list of up to six ARINC-429 labels for each of four channels. For each of the six user-defined labels, the Select-labels Monitor Mode also allows the data to be captured to be further restricted by defining the value of the source/destination-identifier (SDI) field and/or the sign/status-matrix (SSM) field. (A definition of the use of the SDI and SSM fields may be found in the ARINC-429 specification.)

- o Limit-check Mode

  In Limit-check Mode, the 53A-426 Card triggers capture of ARINC-429 data based on a limit condition for a single user-defined label, or single user-defined label and SDI and/or SSM field value. The data for the defined label is automatically checked against a user-defined limit. The 53A-426 captures a pre-determined number of bytes following the trigger, using the point where the limit condition was satisfied as a trigger condition. If interrupts are enabled, it generates an interrupt to the system controller when the limiting condition is met and the preset number of bytes to be captured are stored.

- o All-label Mode

  In All-label Mode, the 53A-426 Card captures and stores the latest data for all 256 ARINC-429 labels, or for all the labels and their SDI bits and/or their SSM bits. Each ARINC-429 label or labels and SDI and/or SSM bits has one specific location in memory.

In each of the primary data-capture modes, the 53A-426 Card allows data to be stored in one of the following three ways:

- o ARINC-429 data words only.
- o ARINC-429 data words plus time-stamp and error bytes.
- o Only those ARINC-429 data words (including time-stamp and error bytes) in which an error has occurred.

Data stored in memory can be read while the 53A-426 Card is receiving data with no loss of data. In Monitor and Select-label modes, the data is stored in a first-in-first-out (FIFO) structure. This means that reading data effectively frees up those storage locations for further data capture. In All-labels mode, memory is continuously updated to reflect the most current data. Older data is not retained by the Card. In Limit-check mode, the most current data received is available to the system controller until the trigger event occurs. At that point, the number of words previously specified by the user is stored and retained until the receiver is re-enabled, the mode for that channel is changed, or the data storage method is re-specified.

Extensive built in test equipment (BITE) is provided, including a self-test of the RAM memories and the front end processors. Status LEDs at the front edge of the card provide a visual indication of data reception and received-data errors on each channel.

The 53A-426 Card also provides an Error Return command which returns the error code for any errors encountered during self-test or programming.

CONTROLS AND INDICATORS

The following controls and indicators are provided to select and display the functions of the 53A-426 Card's operating environment.

Address-Select Switch

The 53A-426 Card has a miniature 10-position switch which selects the 53A-426 Card's address (0-9) in the 53/63 Series System. Open the switch's cover 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-426 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 with which the system controller is currently communicating. The Power LED being lit not only indicates that the 53A-426 Card is unaddressed, but that all required dc power (5 V dc, ±15 V 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

Status LEDs

Nine status LEDs are located near the front-edge connector, arranged in the order listed below.

LED	When lit, indicates:
REC1	Channel 1 has detected data transmission over the Mark 33 DITS bus.
ERR1	Channel 1 has detected an error in the received data.
REC2	Channel 2 has detected data transmission over the Mark 33 DITS bus.
ERR2	Channel 2 has detected an error in the received data.
REC3	Channel 3 has detected data transmission over the Mark 33 DITS bus.
ERR3	Channel 3 has detected an error in the received data.
REC4	Channel 4 has detected data transmission over the Mark 33 DITS bus.
ERR4	Channel 4 has detected an error in the received data.
ERR	During self test, the ERR LED blinks on and off. If an error is encountered during self test, the ERR LED stays on continuously. The ERR LED also comes on if an error is encountered during programming.

Halt Switch

This 1-position slide switch is near the card's backplane edge connector. It selects the state of the 53A-426 Card after an @XH (Halt) command or STOP command is received by the 53/63 System.

a. If the Halt Switch is in the ON position, then the 53A-426 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-426 Card becomes unaddressed, the Power LED is lit, and any programmed parameters of the card remain unchanged.

SPECIFICATIONS

Configuration:	Quad ARINC-429 Receiver.
Data Rate (ARINC-429):	High-speed (90 Kb/s to 110 Kb/s); Slow speed (12 KB/s to 14.5 Kb/s). Consult factory for other bit rates.
Processors:	1 - 80186 (PLCC). 1 - 87452 per channel.
Coupling:	Connects directly to Mark 33 DITS bus.
Storage Capacity/Channel	
Monitor Mode:	32,000 ARINC-429 words without time-stamp/error storage; 16,000 ARINC-429 words with time-stamp/error storage.
Select-labels Mode:	32,000 ARINC-429 words without time-stamp/error storage; 16,000 ARINC-429 words with time-stamp/error storage.
Limit-check Mode:	32,000 ARINC-429 words without time-stamp/error storage; 16,000 ARINC-429 words with time-stamp/error storage.
All-label Mode:	1 ARINC-429 word per label with or without time-stamp/error storage; or 1 ARINC-429 word per label and SDI and/or SSM bits with or without time-stamp/error storage.
Time-stamp Resolution (programmable):	10 µs to 0.65535 s in 10 µs steps. 100 µs to 6.5535 s in 100 µs steps. 1 ms to 65.535 s in 1 ms steps. 10 ms to 655.35 s in 10 ms steps. 100 ms to 6553.5 s in 100 ms steps.
Interword-gap Time:	High-speed (100-kb/s data rate): 35 µs, nominal. Slow-speed (12-kb/s to 14.5-kb/s data rate): 266 µs, nominal.
Data Transfer Rate (with 1 to 4 channels receiving data)	
53A-426 Card - 53A/63A System Backplane Transfer Rate:	650 kbytes/s for block transfers.
Effective Transfer Rate with 53A-171 Card:	250 kbytes/s for block transfers.

Power-up:

General:

The 53A-426 Card defaults to the following states on power-up:

- Interrupts disabled.
- Channel 1 selected.
- All channels in Monitor Mode.
- Data storage is time-stamp/ error storage for all channels.
- All receivers are disabled.
- Power LED is lit.
- ERR LED out if no errors are found during self-test.
- 1 ms time stamp resolution selected.
- <CR><LF> appended to the end of data transfers.
- Slow bit rate is selected for all channels (12-14.5 Kb/s).

Mode-Specific:

Select-labels Mode:

- Capture label is label 0.
- Capture on label only.

Limit-check Mode:

- Capture label is label 0.
- Capture on label only.
- Limit comparison is equal.
- Limit parameter = 0.
- Pre-trigger and post-trigger = 0.

All-label Mode:

- Data is collected for all labels and is returned for label 0.

Self-tests Performed: Memory, front end processors test.

Power Requirements: 5-volt and ±15-volt 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): 0.5 A, maximum quiescent.
0.6 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 Supply): 50 Ma, maximum quiescent.
60 mA, peak.

Current (-15-volt Supply): 40 mA, maximum quiescent.
50 mA, peak.

Cooling: Provided by the fan in the 53/63 Series Card Cage.

Temperature:	-10°C to +65°C, operating (assumes ambient temperature of 55° and airflow to assure less than 10°C temperature rise). -40°C to +85°C, storage.
Humidity:	Less than 95% R.H. non-condensing, -10°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 +55°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 Series Card Cage, the card is installed in a function-card slot. When ordered alone, the shipping dimensions are: 254 mm x 254 mm x 127 mm. (10 in x 10 in x 5 in).
Weight:	0.36 kg. (0.8 lb).
Weight, Shipping:	When ordered with a 53/63 Series Card Cage, the card is installed in a function-card slot. When ordered alone, the shipping weight is: 0.73 kg. (1.6 lb).
Mounting Position:	Any orientation.
Mounting Location:	Installs in any function-card slot of the 53/63 Series Card Cage.
I/O Connections:	A 48-pin hooded connector (53A-780) connects to all front-edge signals.
Required Equipment (not supplied):	53A-780 Hooded Connector or 53A-746 Data Cable.
Equipment Supplied:	1 - 53A-426 Quad ARINC-429 Receiver Card. 1 - Spare fuse (Part # 42202-52001). 1 - Operating manual (Part # 00000-14260). 1 - Service manual (Part # 00000-24260).
Software Version:	V1.4.

OPERATION

Overview

The 53A-426 Card receives data from the Mark 33 Digital Information Transfer System (DITS) found on commercial aircraft. The card has four primary modes used to capture ARINC-429 data:

- Monitor Mode
- Select-labels Monitor Mode
- Limit-check Mode
- All-label Mode

In each of the above modes, data storage may be restricted to errors only (only those cases when there is an error in the data word). With errors-only storage selected, time-stamp and error bytes are automatically appended to the data words. You can not de-select storage of time-stamp and error bytes.

Note that in this manual the terms "input" and "output" are always used in reference to the system controller. The term "output" means the data being sent FROM the system controller TO the 53A-426 Card; the term "input" means the data being sent FROM the card TO the system controller.

The Operation section contains the following subsections:

- Overview of each of the four Activity Modes.
- Description of the data format for capture labels and secondary capture definition (SSM, SDI), and the data format for returned ARINC-429 label/data information, error and time-stamp values. These formats are referred to in the detailed command descriptions.
- Description of methods of data capture for each Activity Mode. For example, single data word, blocked data formats for all words collected or for a specified number of data words are provided, depending on the Activity Mode. Interrupt handling is also described in this subsection.
- Descriptions of each of the card commands. An overview lists the global and single channel commands in alphabetical order. This is followed by a detailed description of each command, including examples and errors.

Activity Modes

Monitor Mode

In this mode, the 53A-426 Card captures all data traffic on the ARINC-429 bus and stores the data sequentially in the card's memory. In Monitor Mode, data storage is organized as a first-in/first-out (FIFO) memory.

If the FIFO memory becomes full, any new data to be stored will be lost and an error will be generated. To prevent this overflow condition from occurring, the 53A-426 Card can generate an interrupt to the system controller when the FIFO memory becomes 3/4 full. This gives time to read data from memory, thus making room for new data.

Select-labels Monitor Mode

In this mode, the 53A-426 Card captures data based on a user-defined list of up to six ARINC-429 labels for each of four channels (up to 24 different labels may be defined if all four channels are connected to the same bus), and stores the data sequentially in the card's memory. Labels are defined by outputting a list of labels and secondary-mode bytes to the 53A-426 Card. (See the LC and LL commands in the Card Commands subsection of this manual for details on how to load labels and secondary-mode bytes.) The proper formats for the label and secondary-mode bytes are shown in the Label Byte Format and Secondary Mode Byte Format subsections.

As in the Monitor Mode, data storage is organized as a FIFO memory with an error generated for memory overflow and a 3/4-full memory interrupt capability.

Limit-check Mode

In Limit-check Mode, the 53A-426 Card captures data for a single user-defined ARINC-429 label. The label is defined by outputting a label and secondary-mode byte to the card (see the SL command). The proper formats for the label and secondary-mode bytes are shown in the Label Byte Format and Secondary Mode Byte Format subsections.

In this mode, the 53A-426 Card checks the data for the defined label against a user-defined limit (see the LP command). A 'greater than', 'equal to', or 'less than' 23 bit binary comparison will be made between the user-defined limit and the received data. The trigger event is defined as the received data which meets the specified comparison.

In the Limit-check Mode, data is stored based upon the trigger event and a user-defined pre-trigger and post-trigger number of words.

Once the trigger event has occurred and the pre-set number of words after the trigger event have been received, the receiver will be disabled and the data block defined by the pre-trigger number of words will be available for readback. The size of the data block available for readback is equal to a) the total of the pre-trigger value, post-trigger value, and one word for the trigger event, or b) the number of words received, whichever is less.

The Limit-check Mode can also generate an interrupt upon completion of data storage.

All-label Mode

In this mode, the 53A-426 Card captures and stores all ARINC-429 data received. Each ARINC-429 label or the label and the SDI and/or the SSM fields has one specific RAM location

that is accessible by sending the label and secondary-mode bytes to the card (see the BT command). Only the latest data for each label or label/SDI/SSM combination is saved.

Formats

Loading Labels and Secondary Mode Bytes

Before received ARINC-429 data can be returned to the system controller, the labels whose data is to be returned must be specified. The following formats are used with the LC, LL, SL, and BT commands to inform the 53A-426 of which label data to return when the system controller next requests input from the 53/63 System. The label and secondary-mode bytes for the Select-labels Monitor Mode, Limit-check Mode, and the All-label Modes are loaded sequentially into the 53A-426 Card's memory as label/mode-byte pairs. The label/mode-byte pairs are output to the 53A-426 Card in the following sequence:

ARINC-429 label 1	Label address 1
Secondary-mode byte 1	
.	
.	
.	
ARINC-429 label n - 1	Label address n - 1
Secondary-mode byte n - 1	
ARINC-429 label n	Label address n
Secondary-mode byte n	

In the Select-labels Monitor Mode the variable "n" has a maximum value of 6, with each pair individually addressable (see the LC and LL commands in the Command section of this manual).

In the Limit-check Mode, only a single pair is loaded. (See the SL command in the Command section of this manual).

In the All-label Modes the variable "n" has a maximum value of 50. (See the BT command in the Command section of this manual).

Label Byte Format

The label field used in commands for the Select-labels Monitor Mode, Limit-check Mode, and the All-label Modes is an 8-bit byte in the following format:

Label byte:

Bit Position	7	6	5	4	3	2	1	0
ARINC-429 Bit Position	1	2	3	4	5	6	7	8

Secondary Mode Byte Format

The secondary-mode byte field used in the commands for the Select-labels Monitor Mode, Limit-check Mode, and the All-label Modes is an 8-bit byte in the following format:

Secondary mode byte:

Bit Position	7	6	5	4	3	2	1	0
ARINC-429 Bit Position					10	9	31	30
Data	SDI	SSM			SDI2	SDI1	SSM2	SSM1

SDI and SSM Bits

The SDI and SSM bits define the secondary capture modes used in Select-labels Monitor Mode and the Limit-check Mode. In the All-label Modes the SDI and SSM bits are ignored. Table 426-1 lists the values of the SDI and SSM bits which define the different secondary capture modes.

TABLE 426-1
Secondary Capture Modes

SDI	SSM	Mode
0	0	Capture data based on label only.
0	1	Capture data based on label and SSM.
1	0	Capture data based on label and SDI.
1	1	Capture data based on label, SDI, and SSM.

SSM1 and SSM2 Bits

The SSM1 and SSM2 bits (ARINC-429 bit positions 30 and 31 respectively) define the value of the SSM field for the label to be captured.

SDI1 and SDI2 Bits

The SDI1 and SDI2 bits (ARINC-429 bit positions 9 and 10 respectively) define the value of the SDI field for the label to be captured.

Limit Byte Format

The limit for the Limit-check Mode consists of three 8-bit bytes in the following format:

Limit bytes:

Bit Position	7	6	5	4	3	2	1	0
	ARINC-429 Bit Position							
Byte 1	16	15	14	13	12	11	10	9
Byte 2	24	23	22	21	20	19	18	17
Byte 3	N/U	31	30	29	28	27	26	25

Bit position 32 of the ARINC-429 word is not used for limit checking. If the SDI field is used for the label-selection process, ARINC-429 bits 9 and 10 are not used for limit checking. If the SSM field is used for the label-selection process, ARINC-429 bits 30 and 31 are not used for limit checking. The comparison assumes that both the limit value and the value to be compared are unsigned, positive magnitude integers.

Label/Data Read Format

ARINC-429 defines bit ordering differently for the label and the data. For the label, the first bit transmitted on the ARINC-429 bus is the most significant bit. For the data, the first data bit transmitted on the ARINC-429 bus is the least significant bit. If the label and data are both stored in transmitted order, the system controller would have to perform a bit reversal on the label. The 53A-426 reverses the label bit order in hardware, which allows the system controller to use the label and data bytes without having to reverse bit position on any byte.

In all four primary data-capture modes, data is read back from a channel of the 53A-426 Card using one of the following two formats based on the data storage mode selected.

- Four bytes are returned when only ARINC-429 data words are stored.

  4-byte format (ARINC-429 data only):

Bit Position	7	6	5	4	3	2	1	0
	ARINC-429 Bit Position							
Byte 1	1	2	3	4	5	6	7	8
Byte 2	16	15	14	13	12	11	10	9
Byte 3	24	23	22	21	20	19	18	17
Byte 4	32	31	30	29	28	27	26	25

- Eight bytes are returned when time-stamp and error bytes are stored along with the data.

  8-byte format (ARINC-429 data with time-stamp and error bytes):

Bit Position	7	6	5	4	3	2	1	0
	ARINC-429 Bit Position							
Byte 1	1	2	3	4	5	6	7	8
Byte 2	16	15	14	13	12	11	10	9
Byte 3	24	23	22	21	20	19	18	17
Byte 4	32	31	30	29	28	27	26	25
Byte 5	Error byte							
Byte 6	Reserved							
Byte 7	Time-stamp byte 2							
Byte 8	Time-stamp byte 1							

Error Byte

Data errors are returned in byte 5 of the 8-byte format whenever storage of data with time-stamp and error bytes is selected. The format of the error byte is as follows:

Bit Position	7	6	5	4	3	2	1	0
Byte 5	0	0	0	0	IWG	LSE	0	PE

The error bits have the following meanings when set high:

IWG - Interword-gap time < nominal (35 μs for 100-kb/s; 266 μs for 12 to 14.5 kb/s data rate).

LSE - Number of bits received for ARINC-429 word < 32 bits.

PE - Parity for received ARINC-429 word is not odd.

33 Bit Errors

33 bit words received at the slow bit rate will be indicated by the correct storage of the first 32 bits stored as one word, followed by a word with all bits set to zero and, if time stamp error bytes are stored, an IWG (InterWord Gap time) error and LSE (number of bits received) error indicated. 33 bit words received at the fast bit rate will be stored the same as at the slow bit rate, with the addition that if another word follows the first within the minimum IWG time, the following (second) word will be stored incorrectly.

Time-Stamp Bytes

Time-stamp bytes are the last two of eight bytes that appear when reading back data with time-stamp and error bytes. The time-stamp bytes reflect the current state of a 16-bit counter which is set to zero when the receivers are enabled or when the counter overflows. The format of these two bytes is as follows:

Time-stamp bytes:

Bit Position	7	6	5	4	3	2	1	0
Byte 7	T15	T14	T13	T12	T11	T10	T9	T8
Byte 8	T7	T6	T5	T4	T3	T2	T1	T0

Table 426-2 lists the decimal value associated with each bit in the two time-stamp bytes. If one or more bits are set high, the respective values are summed; the resultant is then multiplied by the time-stamp resolution (see TR Command) to produce the time-stamp value. In other words, the two time-stamp bytes simply contain a 16-bit binary number which is multiplied by the time-stamp resolution to produce the time-stamp value.

TABLE 426-2

Time-stamp Value (N x Time-stamp Resolution)

Bit	N
T0	1
T1	2
T2	4
T3	8
T4	16
T5	32
T6	64
T7	128
T8	256
T9	512
T10	1,024
T11	2,048
T12	4,096
T13	8,192
T14	16,384
T15	32,768

Example: Assume the time-stamp resolution is set to 1 ms. If byte 7 is equal to A7h (T15, T13, T10, T9, and T8 set high), and byte 8 is equal to 51h (T6, T4, and T10 set high), then the sum of all the high bits is 42,833. Multiplying this times the time-stamp resolution indicates 42.833 seconds since the receiver was enabled or since the counter last overflowed. [The decimal value 42,833 may also be determined by multiplying the decimal value of byte 7 (167) by 256 and adding the decimal value of byte 8 (81).]

NOTE: When time-stamp and error bytes are stored with ARINC-429 data words, the maximum number of ARINC-429 words stored for the Monitor Mode, Select Labels Monitor Mode, and Limit-check Mode of each channel is reduced by half. For example, the memory capacity in Monitor Mode, which normally is 32,000 words per channel, becomes 16,000 words per channel when time-stamp and error bytes are stored.

Data Access

Modes

In Monitor Mode and Select-labels Monitor Mode, ARINC-429 data words and time-stamp bytes can be accessed in three ways:

1. The next data word in the FIFO memory is returned in response to an input request. This is the default data-access method in effect at power-up, and upon completion of the other two data-access methods. If an input is requested and no new data is available, a pad word (all bits = 1) is returned.

2. A specified number of data words are returned in response to an input request. If the number of words specified exceeds the number of data words currently stored, then the

card will return to the first data-access method once the data words currently stored have been returned.

3. All data words stored in the FIFO memory are returned in response to an input request. In this data-access method, two bytes are prefixed to the returned data. These two bytes contain the binary value for the number of ARINC-429 words stored at the time of the input request. The first byte returned is the high-order byte; the second byte returned is the low-order byte. Following these two bytes, data is returned beginning with the first word stored in memory. After returning all data words stored in memory or if no words are stored, the 53A-426 Card returns to the first data-access method.

In Limit-check Mode, ARINC-429 data words and time-stamp bytes can be accessed in two ways:

1. While the channel is storing data, one data word is returned which is most current at the time the input request is received.

2. After the trigger event has occurred and the post-trigger number of words have been captured, then the three data access methods listed for the Monitor Mode can be used. All data reads for the Limit-check Mode are nondestructive reads. Once the last word stored has been read, data reads will start over with the first word stored in memory.

In All-Label Modes, the most current ARINC-429 data words and time-stamp bytes for the defined list of labels (see the BT command) are returned in response to an input request.

The data-access method can be changed before the previous method has been completed without causing any data to be lost. Also, other commands may be sent to the 53A-426 Card while it is accessing data with any of the described methods, without causing any data to be lost.

Data Termination

The data transfer termination characters and/or the no available data indication for the Monitor and Select-Labels Modes can be user-selected to be one of the following methods:

1. Data will be returned until all of the stored ARINC words have been read. If no data is available at any time, a pad word (all bits = 1) will be returned.

2. The Block Transfer Modes described above will be terminated with <CR><LF> characters. A single word transfer will be terminated with <CR><LF> characters if no more data is available. If no data is available after the <CR><LF> characters have been returned, a pad word will be returned, terminated by the <CR><LF> characters if no data is available.

3. This is the same as method 2 above except that the pad word is never returned. The <CR><LF> characters are always output when no data is available.

The data transfer termination characters for the Limit-Check Mode can be user-selected to be one of the following methods:

1. Pad words will be returned until the first word to be stored is received. After the first word is received, the most current word will be returned until collection is complete.

After data collection is complete, the data stored is treated as an unending circular buffer.

2. The Block Transfer Modes described above will be terminated with <CR><LF> characters. A single word transfer will never be terminated with <CR><LF> characters. If no data is available, a pad word will be returned.

The data transfer termination characters for the All-Labels Modes can be user-selected to be one of the following methods:

1. The block of data specified by the All-Label Mode label list will be returned with no termination characters.

2. The block of data specified by the All-Label Mode label list will be returned terminated with the <CR><LF> characters.

Interrupts

The 53A-426 Card's interrupt capability (see IN command), used to aid in data collection, varies depending on one of the following two conditions:

1. In Monitor Mode or Select-labels Monitor Mode, interrupts are generated when the memory becomes 3/4 full. This interrupt is provided so that the user can prevent new data from being lost when the memory becomes completely full.

2. In Limit-check Mode, interrupts are generated when the received data meets a limit condition (see the LP command) and the preset number of bytes have been stored (see the PT an PR commands).

The 53/63 Series Systems handle interrupts via the 53A-171 Control Card using the @XS system command (see the 53A-171 Operating Manual and Appendix A of this Manual for additional information).

The EX (Examine Status) command may be used to determine the cause of the interrupt.

Card Commands

Overview

The 53A-426 Card is programmed by ASCII characters issued from the system controller to the 53/63 System's communications card. The 53A-426 Card is interfaced to the communications card through the 53 Series or 63 Series Card Cage's backplane.

To address a function card for the first time, the @XY system command must be issued. X is the mainframe address (0-9) selected on the 53A-171 Control Card in the addressed mainframe; Y is the 53A-426 Card's address (0-9) within the addressed mainframe. The 53A-426 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-426 Card is addressed, the commands listed below may be issued until another function card is addressed.

An overview of the commands, listed alphabetically within each category, is given below, followed by an outline of the usual order of commands. A detailed explanation of each command follows, with examples of use and syntax.

Global Commands Summary

Global commands function independently of the currently selected channel.

Command	Summary
CD	Clear Data - Clears the message RAM for one channel or all channels.
CL	Clear Label - Clears the stored capture label(s) for the Select-labels Monitor or Limit-check Modes on one channel or all channels.
ER	Error Return - Sets the 53A-426 to return the error codes for all programming or hardware errors stored.
EX	Examine Status - Sets the 53A-426 to return the Card's status byte.
RD	Receiver Disable - Disables data reception for a single channel or for all four channels.
RE	Receiver Enable - Enables data reception for a single channel or for all four channels.
RS	Reset - Stops the receiver operation and returns the 53A-426 Card to its power-up state.
SC	Select Channel - Selects the channel to be active for subsequent channel commands.
ST	Self Test - Used to perform a complete self-test of the 53A-426 Card.
TR	Time-stamp Resolution - Sets the time-stamp resolution value for all four channels.

Channel Specific Commands Summary

Channel specific commands affect only the currently selected channel.

Command Summary

BR	Bit Rate - Selects a slow (12 to 14.5 Kb/s) or a fast (100 Kb/s) bit rate for the received data.
BT	Block Transfer - Defines the list of labels whose data will be returned for the All-label Modes.
DS	Data Storage - Sets the type of data words to be stored.
IN	Interrupt - Enables or disables interrupts.
LC	Label Change - Selectively changes one label in the list of capture labels for the Select-label Monitor Mode.
LL	Load Labels - Specifies a set of labels and secondary capture modes for the Select-labels Mode.
LP	Limit Parameters - Sets the value of the limit parameter and the type of comparison for the Limit-check Mode.
MM	Main Mode - Selects one of the four primary capture modes (Monitor, Select-labels, Limit-check, and All-labels), and selects one of four sub-modes in the All-labels mode.
PR	Pre-Trigger - Sets the number of words to store before the trigger event has occurred for the Limit-check Mode.
PT	Post Trigger - Sets the number of words to store after the trigger event has occurred for the Limit-check Mode.
SD	Select Data - Specifies the data word return format as a single word or as one of the two block transfer modes for Monitor and Select-labels modes.
SL	Set Label - Defines the capture label and secondary mode byte for the Limit-check mode.
TD	Terminate Data - Defines whether or not <CR><LF> is appended to the end of a data transfer.

Command Order

The order in which commands are given is significant, and depends on the mode being used. If required commands are not present, or are not in the correct sequence, errors may result. The usual order of commands is as follows:

RS (Reset) - When this command is issued, it resets the 53A-426 to its power-up state. All receivers are disabled, the RAMs are cleared, any data label lists are cleared, and default activity modes and time-stamp resolution are selected.

TR (Time-stamp Resolution) - This command may be issued first to set the time-stamp resolutions for all four channels. This command is not necessary if you do not require time-stamping of the data.

SC (Select channel) - The individual channels may now be selected, and the mode, capture label, bit rate, data capture and data readback, etc. specified for each channel.

The BR (Bit Rate), MM (Main Mode), and DS (Data Storage) commands select fast or slow bit rate, the activity mode, and whether error and time-stamp information are to be stored with the data. A TD (Terminate Data) command may be sent to specify termination of data transfers with a <CR><LF>. An IN (Interrupt) command may be sent to enable interrupts.

If the Monitor or Select-label Mode has been programmed, the SD (Select Data) command may be issued to define the data access mode to return a single word, a specified number of words, or all words.

If the Monitor Mode has been selected, the channel is now ready for operation and the receiver may be enabled with the RE (Receiver Enable) command for data collection.

If the Select-label Mode has been programmed, an LL (Load Labels) command may be issued to define up to six capture labels, optionally including SDI and SSM capture specifications. An LC (Label Change) or CL (Clear Labels) command may be used to selectively change one of the six capture labels, or to clear the capture label list for redefinition. The Select-label Monitor Mode is now ready for operation and the receiver may be enabled with the RE (Receiver Enable) command for data collection.

If the Limit-check Mode has been programmed, an SL (Set Label) command and an LP (Limit Parameters) command are sent to define the single capture label with optional SDI and SSM bit capture specification and the limit-check trigger word. A PR (Pre-trigger) and/or PT (Post-trigger) command may optionally be sent to specify the number of words collected prior to the limit-check trigger event and the number of words to be collected after the trigger event.

The Limit-check Mode is now ready for operation and the receiver may be enabled with the RE (Receiver Enable) command for data collection.

The All-label Mode has four sub-modes, previously defined by the MM (Main Mode) command. Depending on the sub-mode selected, either 256, 1024, or 4096 separate "mailboxes" are set up with the latest data for each label/SDI/SSM combination stored in each.

In the All-label Mode, a BT (Block Transfer) command is sent to define a list of labels (optionally including secondary mode SDI/SSM specifications) to be sent as a block of data. A CD (Clear Data) command is required to clear old data stored for all labels to ensure that only new data is present after the receiver is enabled.

The All-label Mode is now ready for operation and the receiver may be enabled with the RE (Receiver Enable) command for data collection.

The next channel may now be selected and programmed. All channels may be set up and the receiver enabled at the same time with the RE (Receiver Enable) command, if desired. The receiver may be disabled with the RD (Receiver Disable) command and data then collected in the format specified, or data may be read "on-the-fly" while the receivers are enabled.

The following summary outlines the commands typically sent for each of the four primary activity modes of the 53A-426:

For all modes:

RS (Reset)
TR (Time-stamp Resolution)
SC (Select Channel)
BR (Bit Rate)
MM (Main Mode)
DS (Data Storage)
TD (Terminate Data)
IN (Interrupt)

For Monitor Mode:

SD (Select DATA)
RE (Receiver Enable)

For Select-label Mode:

SD (Select DATA)
LL (Load Label)
RE (Receiver Enable)

For Limit-check Mode:

SL (Set Label)
LP (Limit Parameters)
PR (Pre-trigger)
PT (Post-trigger)
RE (Receiver Enable)

The following list shows which of the above commands are required, and which are optional.

	Required	Optional
Start-up:	RS	TR
Each channel:	SC BR MM DS	TD IN

Monitor or Select-label Mode: SD

Monitor Mode ready.

RE

Select-label Mode: LL
LC
CL

Select-label Mode ready.

RE

Limit-check Mode:

SL PR
LP PT

Limit-check Mode ready.

RE

All-label Mode: BT
CD

All-label Mode ready.

RE

Except for the BT, IN, SD, and TD commands, all channel specific commands must be sent while the receiver is disabled. Of the global commands, the TR and CL commands must also be sent while the receiver is disabled.

The command order listed above is provided as a guide for first-time programmers of the 53A-426. Command ordering may be changed as long as the following rules are observed:

1. Commands that are not global and apply only to a single channel should be sent following the Select Channel command.

2. Commands that are mode dependent should be sent only after the mode has been defined with the Main Mode command.

3. Commands that do not define the data access mode should only be sent while the receiver is disabled.

Command Descriptions
Detailed descriptions of the 53A-426 Card's commands, in alphabetical order, are as follows:

Command

Description

[f/s]BR

The BR (Bit Rate) command sets the bit rate for the selected channel's received data to either a slow bit rate (12 to 14.5 kb/s) or a fast bit rate (100 kb/s).

[f/s] is a 1-digit decimal integer that specifies the nominal bit rate as follows:

[f/s]	Bit Rate (kb/s)
0	12 - 14.5
1	100

Bit rates outside the 12 to 14.5 Kb/s for the slow rate and outside 90 to 108 Kb/s for the fast rate will result in receiver bit count errors or interword gap errors. If necessary, component modifications may be made to accommodate other bit rates. Please consult the factory for additional information.

On power-up or after an RS (Reset) command, the bit rate for all channels defaults to slow (12-14.5 Kb/s).

Examples:

1. 0BR selects a slow bit rate (12 kb/s to 14.5 kb/s) for the selected channel.

2. 1BR selects a fast bit rate (100 kb/s) for the selected channel.

Errors:

If the selected channel is currently receiving data, a command-receiving error will result.

Command	Description

BT

The BT (Block Transfer) command defines the list of labels in the All-labels mode for the selected channel. Data will be returned for those labels in response to subsequent input requests from the system controller.

Syntax: [num]BT[labi][mdi]

[num] is a 1- to 2-digit decimal integer from 1 to 50 that specifies the number of labels contained in the block transfer.

[labi] is the binary value of the ith label whose data is to be returned. The data will be returned in the same order in which labels were loaded for the BT command.

[mdi] is the 8-bit binary value that specifies the secondary capture mode and the SDI and SSM fields, if used. (See the Formats section of this manual for a description of the format for the [labi] label and [mdi] and secondary mode byte fields.)

CAUTION:

A [labi] byte and an [mdi] must be sent for the number of label/secondary mode parameters specified by [num]. If fewer bytes than required are sent, subsequent commands will be used as label/secondary mode parameters until the required number of bytes is received.

Example:

In the following example the selected channel is assumed to be in the All-label Mode, labels-only sub-mode without time-stamp/error storage.

Three labels are selected whose data are to be returned:

lab1 = 023 octal (ADF Frequency)
lab2 = 222 octal (VOR Omnibearing)
lab3 - 125 octal (Greenwich Mean Time)
md1 = 0h
md2 = 01h
md3 = 02h

The [md1] byte is not used, but must still be included in the command string.

3BT[lab1][md1][lab2][md2][lab3][md3]

sets the selected channel to return the current stored data for lab1, lab2, and lab3 as twelve sequential bytes upon an input request.

Data Return Sequence

Byte	Data
1	lab1 label
2-4	lab1 data bytes
5	lab2 label
6-8	lab2 data bytes
9	lab3 label
10-12	lab3 data bytes

A <CR><LF> will be returned following the twelve bytes if the TD command specifies termination characters.

Errors:

If the selected channel is not in the All-labels Mode, a command mode error will result.

Command	Description

CD

The CD (Clear Data) command clears all of the message RAM for the specified channel or all channels. In addition to clearing stored data for the specified channel(s), the CD command also clears the specified channel's interrupt bit in the byte returned in response to an EX (Examine Status) command.

Syntax: [chan]CD

[chan] is a 1-digit decimal integer that specifies the following:

[chan]	Channel(s) Cleared
no parameter	1-4
0	1-4
1	1
2	2
3	3
4	4

The RE (Receiver Enable) command clears message RAM in all modes except the All-label Modes. The CD command is therefore most useful in the All-label Mode to clear memory prior to enabling the receiver to guarantee that the data in memory is valid data. For the All-label Modes, all label locations will be cleared to all 1's except for label location FF which will be cleared to all 0's.

The CD command may be sent when the receiver is enabled, except in the Limit-check Mode (see Error note below).

Examples:

1. 0CD (or simply CD) clears all of the message RAM on the 73A-426 Module.

2. 1CD clears all of the message RAM for channel 1.

Errors:

A command receiving error will result if the specified channel is in the Limit-check mode and has not completed data reception.

Command	Description

CL

The CL (Clear Label) command clears from memory any previously defined labels (see the LC, LL and SL commands) for the Select-labels Monitor Mode and Limit-check Mode, for the specified channels. For this command to function properly, the specified channel(s) must be in the Select-labels Monitor Mode or Limit-check Mode with their receivers disabled.

Syntax: [chan]CL

[chan] is a 1-digit decimal integer that specifies the following:

[chan]	Channel(s) Cleared
no parameter	1-4
0	1-4
1	1
2	2
3	3
4	4

On power-up or following an RS (Reset) command, all labels are cleared.

Examples:

1. 0CL (or simply CL) clears the capture labels for all the channels.

2. 1CL clears the capture labels for channel 1.

Errors:

A command receiving error will result if a specified channel(s)'s receiver is enabled.

A command mode error will result if the specified channel(s) is not in Select-labels Monitor Mode or Limit-check Mode.

Command	Description

DS

The DS (Data Storage) command specifies the type of data words to be stored for the active channel. For this command to function properly, the active channel's receiver must be disabled.

Syntax: [type]DS

[type] is a 1-digit decimal integer that specifies the type of data words stored as follows:

[type]	Type of Data Words Stored
0	Labels and data only.
1	Labels and data, plus time-stamp and error bytes.
2	Only those data words in which errors are detected, plus time-stamp and error bytes for those words.

In addition to changing the data storage type, the DS command also clears the memory for all modes except the All-label modes, clears the error and interrupt bits in the status byte, and clears the pre-trigger and post-trigger values for the Limit-check Mode.

On power-up or following an RS (Reset) command, type 1 storage is enabled for all four channels.

Errors:

A command receiving error will result if the active channel(s)'s receiver is enabled.

Command	Description

ER

The ER (Error Return) command allows you to read back the codes of any errors encountered during the use of the 73A-426 Module. Each returned error code consists of two ASCII characters, followed by <CR><LF>.

Syntax: ER

After the ER command is issued, the 73A-426 Module will continue to return error codes until the error code 99 (no additional errors to report) is returned. Additional requests for input after error code 99 is returned will cause the 73A-426 Module to return data for the active channel in the currently selected data-return mode (see the SD command).

If an ER command is issued and no errors are found, only error code 99 is returned. Because the error buffer can store a maximum of 16 errors, only the first 16 errors are returned; any additional errors are lost. Errors are returned in reverse order (the last error encountered is returned first, and the first error encountered is returned last).

Each error code is returned as two ASCII characters followed by <CR><LF>.

NOTE: Issuing the CD, DS, MM, SC, or SD command before receiving error code 99 will cause the 73A-426 Module to cease returning error codes and return to the previously selected data return mode for the selected channel.

ERROR CODES

Fatal Errors:

Fatal errors cause the 53A-426 Card to disable the ARINC receiver inputs. The 53A-426 Card accepts commands from the system controller, but will not perform functions for any commands. Any input from the card will return only the error code for the fatal error:

Error Code		
Char 1	Char 2	Description
0	0	RAM failure
0	1	(Reserved)
0	2	Interrupt-controller failure
0	3	(Reserved)
0	4	General hardware failure

Nonfatal Errors:

Nonfatal errors do not cause the 53A-426 Card to totally suspend its operations. However, a hardware error (error code X3) within a channel disables data reception on that channel until the hardware error is cleared.

Error Code Char 1	Char 2	Description
X	0	Unrecognized command
X	1	Syntax error
X	2	(Reserved)
X	3	ARINC-receiver error (hardware)
X	4	Memory overflow
X	5	Command receiving error. Invalid command while channel is receiving data.
X	6	Command mode error. Invalid command for mode selected.
9	9	No additional errors to report.

X = Number of the channel in which the error occurred.

The ER command does not clear the channel ERR LEDs (see EX command). The main ERR LED, if set, will be cleared after error code 99 is returned.

Command	Description
EX	The EX (Examine Status) command allows you to read back the 53A-426 Card's status.

Syntax: EX

The status is read back as one byte in 8-bit binary format followed by <CR><LF>. The status byte has the following format:

Bit Position	7	6	5	4	3	2	1	0
	ERR4	INT4	ERR3	INT3	ERR2	INT2	ERR1	INT1

INT1, INT2, INT3, AND INT4 Bits

INT1 through INT4 indicate when an interrupt condition has been met for channel 1 through channel 4, respectively. Reading the status byte will only clear the interrupt bit in the status byte; it will not clear an active VXIbus interrupt.

ERR1, ERR2, ERR3, and ERR4 Bits

ERR1 through ERR4 indicate when a received data error has been detected for channel 1 through channel 4, respectively. Reading the status byte will cause the error LEDs to go out for each channel reporting an error.

Command	Description

IN

The IN (Interrupt) command enables or disables interrupts from the 53A-426 Card to the system controller for the active channel. After an interrupt occurs it is latched by the 53A-426 Card. The interrupt clears when the interrupt status of the 53/63 Series System is check with the @XS command (see Appendix A).

Syntax: [e/d]IN

[e/d] is a 1-digit decimal integer that specifies the following:

[e/d]	Action
0	Interrupts are disabled.
1	Interrupts are enabled.

If interrupts are enabled, interrupts are conditionally generated by the 53A-426 Card for each channel, depending on the selected mode:

1. In Monitor Mode or Select-labels Monitor Mode, interrupts are generated when the memory becomes 3/4 full. This interrupt is provided so that you can prevent new data from being lost when the memory becomes completely full.

2. In Limit-check Mode, interrupts are generated when the received data meets a limit condition (see the LP command) and the preset number of bytes have been stored (see the PT and PR commands).

Programming Caution:

When the application program enters its interrupt handler and executes the @XS command, the handler should readdress the card cage immediately after receiving a colon (:). The following BASIC program illustrates one way to do this for a card at address "11":

```
1000 REM  INTERRUPT HANDLER
1010 PRINT "@1s"
     (accesses the interrupt mode)
1020 INPUT A$
1030 IF A$ = "1" GOSUB 1100
1040 IF A$ <> ":" GOTO 1020
1050 PRINT "@1"
     (exits 53/63 system interrupt mode)
1100 REM  426 INTERRUPT HANDLER
1110 PRINT "@11"
     (access card at address "11")
     .
     .
1200 RETURN
```

If the 53/63 system card cage is not readdressed to end the @XS command, subsequent interrupts from the 53A-426 Card may be lost.

Command	Description

LC

The LC (Label Change) command selectively changes one label in the list of six capture labels in Select-labels Monitor Mode for the active channel. For this command to function properly, the active channel must be in the Select-labels Monitor Mode with its receiver disabled.

Syntax: [addr]LC[lb][md]

[addr] is a 1-digit decimal integer, from 1 to 6, that specifies which of the six labels to change in Select-labels Monitor Mode.

[lb] is a single character in 8-bit binary format which specifies the value for the new label.

[md] is a single character in 8-bit binary format which specifies the secondary capture mode for the new label. (See the Formats subsection of this manual for a description of the format for the [lb] label and [md] secondary mode bytes).

NOTE: In the following examples the [lb] and [md] parameters will be shown as hex characters. The examples should not be copied directly as shown as an ASCII string. The parameters are only representative of the required 8-bit byte.

Examples:

1. In this example, the selected channel is assumed to be in the Select-labels Monitor Mode, [lb] is assumed to be a byte equal to octal 023 (ADF Frequency), and [md] is a byte equal to decimal 0 (capture based on label only).

   2LC[13h][00h] sets the label at address 2 in the 6-label list to octal 023, and sets the secondary capture mode for Label 2 to capture data based on the label only.

2. In this example, the selected channel is assumed to be in the Select-labels Monitor Mode, [lb] is assumed to be a byte equal to octal 125 (Greenwich Mean Time), and [md] is a byte equal to decimal 136 (capture based on label with SDI field having a value of binary 10).

   4LC[55][88] sets the label at address 4 in the 6-label list to octal 125, and sets the secondary capture mode for Label 4 to capture data based on the label with the SDI field having a value of binary 10.

3. In this example, the selected channel is assumed to be in the Select-labels Monitor Mode, [lb] is assumed to be a byte equal to octal 222 (VOR Omnibearing) and [md] is a byte equal to decimal 66 (capture based on the label with the SSM field having a value of binary 10).

16LC[92][42] sets the label at address 6 in the 6-label list to octal 222, and sets the secondary capture mode for Label 6 to capture data based on the label with the SSM field having a value of binary 10.

Errors:

A syntax error will result if an out-of-range value is specified for [addr] or if the label address has not been previously loaded with the LL command.

A command mode error will result if the active channel is not in the Select-labels Monitor Mode.

A command receiving error will result if the active channel's receiver is enabled.

Command	Description

LL

The LL (Load Labels) command specifies a set of labels and secondary capture modes in Select-labels Monitor Mode for the active channel. For this command to function properly, the active channel must be in the Select-labels Mode with its receiver disabled.

Syntax: [num]LL[labi][mdi]

[num] is a 1- to 2-digit decimal integer from 1 to 6 that specifies the number of label/mode pairs to be stored. The label/mode pairs will be stored in memory in the same sequence in which they are sent, i.e., the first pair will be stored at label address 1, the second pair at label address 2, etc. The label address from 1 to 6 is used to selectively change a single label later with the LC (Label Change) command.

[labi] is the 8-bit binary value of the ith label to be captured.

[mdi] is the 8-bit binary value which specifies the secondary capture mode for the ith label and the SDI and SSM fields. (See the Formats subsection of this manual for a description of the format for the [labi] label and [mdi] secondary mode fields).

CAUTION:

A [labi] byte and an [mdi] must be sent for the number of label/secondary mode parameters specified by [num]. If fewer bytes than required are sent, subsequent command characters sent to this module or other modules will be misinterpreted as the completion of this command, resulting in incorrect operation of the 73A-426.

Examples:

1. In this example, [lab1] is assumed to be a byte equal to octal 100 (selected course) and [md1] is a byte equal to decimal 0 (capture based on label only).

   1LL[40h][00h] sets the first label in the 6-label list to octal 100, and sets the secondary capture mode for the first label to capture data based on the label only.

   In this example, the label value of 100 has an ASCII code equivalent to the "@" character, which is normally used by the 53/63 system to unaddress a function card. The 53/63 system has logic that allows a function card to disable this unaddress function temporarily. The 53A-426 uses the [num] argument to determine the number of bytes to perform the disable function. If the correct number of arguments are not supplied to the LL command, improper addressing of the 53/63 function cards may result.

2. In this example, [lab1] is assumed to be a byte equal to octal 125 (Greenwich Mean Time), [lab2] is assumed to be a byte equal to octal

023 (Selected Heading); [md1] is a byte equal to decimal 136 (capture based on label with SDI field having a value of binary 10); and [md2] is a byte equal to decimal 0 (capture based on label only).

2LL[55h][88h][13h][00h] sets the first label in the 6-label list to octal 100, and sets the secondary capture mode for the first label to capture data based on the label with the SDI field having a value of binary 10. It sets the second label in the 10-label list to octal 023; and sets the secondary capture mode for the second label to capture data based on the label only.

Errors:

A command mode error will result if the active channel is not in the Select-labels Monitor Mode.

A command receiving error will result if the active channel's receiver is enabled.

Command	Description
LP	The LP (Limit Parameters) command defines the value of the limit parameter and the type of comparison used for the trigger event in the Limit-check Mode for the active channel. For this command to function properly, the active channel must be in the Limit-check Mode with its receiver disabled.

Syntax: [comp]LP[lim]

[comp] is a 1-digit decimal integer that specifies the type of comparison used for the trigger event as follows:

[comp]	Trigger Event
1	Received data = [lim].
2	Received data < [lim] (binary comparison).
3	Received data > [lim] (binary comparison).

>= or <= functions may be performed by increasing or decreasing the limit value by 1.

[lim] is a 3-byte binary value which specifies the limit to be checked for. (See the Formats subsection of this manual for the format of the Limit Bytes, and handling of Bit 32 and the SDI and SSM bits). In addition to loading the limit parameter, the LP command also clears the memory and the error and interrupt bits in the status byte.

Errors:

A command mode error will result if the active channel is not in the Limit-check Mode.

A command receiving error will result if the active channel's receiver is enabled.

Command	Description

MM

The MM (Main Mode) command selects one of the four primary capture modes for the active channel.

Syntax: [mode]MM

The All-label Mode is programmed as one of four sub-modes to permit proper partitioning of memory for maximum data transfer rate performance. In addition to changing the main mode, the MM command also clears the memory for all modes except the All-label Modes.

[mode] is a 1-digit decimal integer that specifies the primary capture mode as follows:

[mode]	Primary Capture Mode
0	Monitor Mode
1	Select-labels Monitor Mode
2	Limit-check Mode
3	All-label Mode Labels Only
4	All-label Mode Labels and SDI
5	All-label Mode Labels and SSM
6	All-label Mode Labels, SDI, and SSM

NOTE: When executed, the MM command clears the memory for the Monitor Mode, Select-labels Monitor Mode, and the Limit-check Mode.

To clear memory for the All-label Mode the Clear Data (CD) command must be used.

On power-up or following an RS (Reset) command, all channels are placed in the Monitor Mode.

Errors:

A command receiving error will result if the active channel's receiver is enabled.

Command	Description
PR	The PR (Pre-Trigger) command sets the number of words to store before the trigger event has occurred in the Limit-check Mode for the active channel. For this command to function properly, the active channel must be in the Limit-check Mode with its receiver disabled. Syntax: [num]PR [num] is a 1- to 5-digit decimal integer specifying the number of words to capture before the trigger condition has been met. [num] has a value from 0 to 31,999 for data storage without time-stamp error bytes, and 0 to 15,999 for data storage with time-stamp error bytes. Example: 100PR sets the number of words to be stored before the trigger event has occurred to 100 words. Errors: A command receiving error will result if the active channel's receiver is enabled. A command mode error will result if the active channel is not in the Limit-check mode. The combined total of [num] for the PR command and the Post-Trigger (PT) command must not exceed 31,999 for data storage without time-stamp/error bytes, and 15,999 for data storage with time-stamp/error bytes. If these limits are exceeded, then a syntax error will result on the PR or PT command, whichever causes the limit to be exceeded.

Command	Description

PT

The PT (Post-Trigger) command sets the number of words to store after the trigger event has occurred for the Limit-check Mode for the active channel.

Syntax: [num]PT

[num] is a 1- to 5-digit decimal integer specifying the number of words to capture after the trigger event. [num] has a value from 0 to 31,999 for data storage without time-stamp/error bytes, and 0 to 15,999 for data storage with time-stamp/error bytes.

Examples:

1. This example assumes that the selected channel is in the Limit-check Mode and is not currently receiving data.

   100PT sets the number of words to be stored after the trigger event has occurred to 100 words.

2. 200PR2000PT sets the number os words to be stored prior to the trigger event to 200 words and following the event to 2000 words. After data collection is completed, these 2200 words plus the trigger word will be returned as a 2201 word circular buffer in response to repeated input requests.

Errors:

If the PT command is issued to a channel which is not in the Limit-check Mode, a command-mode error will result.

If the PT command is issued to a channel currently receiving data, a command-receiving error will result.

The combined total of [num] for the post-trigger command and the Pre-Trigger (PR) command must not exceed 31,999 for data storage without time-stamp/error bytes, and 15,999 for data storage with time-stamp/error bytes. If these limits are exceeded then a syntax error will result on the PR or PT command, whichever causes the limit to be exceeded.

Command	Description

RD

The RD (Receive Disable) command disables data reception for a single channel or for all four channels.

Syntax: [chan]RD

[chan] is a 1-digit decimal integer (or blank) that specifies the following:

[chan]	Channel(s) Disabled
blank	1-4
0	1-4
1	1
2	2
3	3
4	4

NOTE: The RD command does not destroy the data already stored in memory. The data stored in memory is still accessible by the system controller.

The receiver is automatically disabled after all post-trigger data is collected in the Limit-check Mode. An RE (Receiver Enable) command is required to reactivate the receiver in this mode for a new data collection.

On power-up or following an RS command, the receivers on all channels are disabled.

NOTE: If the RD command is issued to a channel in the Limit-check Mode before data collection is complete, in addition to disabling the receiver, an adjustment is made on the data available for read-back. The data adjustment is based on the pre-trigger value, the post-trigger value, the number of words received, and on whether the comparison limit has been met, as follows:

IF	WS > PTV + PRV + CP
THEN	NW = PTV + PRV + CP
ELSE	NW = WS

where:

WS = Number of words stored
PTV = Post-trigger value
PRV = Pre-trigger value
CP = 1 if the comparison limit has been met;
0 if the comparison limit has not been met
NW = Number of words available for read-back

Examples:

1. 0RD (or simply RD) disables data reception on all four channels.

2. 2RD disables data reception on channel 2.

Command	Description

RE

The RE (Receiver Enable) command enables data reception for a single channel or for all four channels. Any data transmission occurring on the ARINC-429 data bus will be collected once the receiver is enabled.

Syntax: [chan]RE

[chan] is a 1-digit decimal integer (or blank) that specifies the following:

[chan]	Channel(s) Enabled
blank	1-4
0	1-4
1	1
2	2
3	3
4	4

In addition to enabling the receiver, the RE command also clears the memory for all modes except the All-label modes, clears the error and interrupt bits in the status byte, and clears the channel Error LED.

Examples:

1. 4RE enables channel 4 to receive data.

2. 0RE (or simply RE) enables all four channels to receive data.

Command	Description
RS	The RS (Reset) command stops the receiver operation and returns the 53A-426 Card to its power-up state. See the Specifications section of the manual for a listing of the power-up status.

Command	Description
SC	The SC (Select Channel) command selects the channel to be active for subsequent commands.

Syntax: [chan]SC

[chan] is a 1-digit decimal integer that specifies the following:

[chan]	Channel Selected
1	1
2	2
3	3
4	4

On power-up or following an RS (Reset) command, channel 1 is selected.

Note that if this command is issued to change the selected channel prior to the completion of a multi-word transfer, an address counter for the Monitor Mode, Select-labels Monitor Mode, or Limit-check Mode will be saved, so that data access may be resumed from that point when the channel is re-selected.

Example:

3SC selects channel 3 to be the active channel for subsequent commands from the system controller.

Command	Description

SD

The SD (Select Data) command specifies the data input mode for return of data words to the system controller from the selected channel.

Syntax: [mode][num]SD

[mode] is a 1-digit decimal integer that specifies the data-return mode as follows:

[mode]	Quantity of Data Returned
0	Single word/Single block
1	Number of ARINC-429 data words specified by [num]
2	All available data

Upon completion of [mode] = 1 or 2, the selected channel reverts to [mode] = 0.

[num] is a 1- to 5-digit decimal integer (used in mode 1 only), from 1 to 32,000 (from 1 to 16,000 with time-stamp and error bytes stored), that specifies the number of data words to be returned. Returned data will start at the next word to be read from memory. If [num] is greater than the number of data words stored, then all of the currently stored data words will be returned. The data input mode will then return to mode 0.

NOTE: When [mode] = 0 or 2 the parameter [num] should not be sent.

See the Data Access subsection in the Operation section of this manual for more information on the operation of the three data access modes.

Examples:

1. This example assumes that the selected channel is in Select-labels Monitor Mode.

   0SD sets the selected channel on the 53A-426 Card to return the next stored word in response to an input request from the system controller. Every input request will return the next word stored in memory.

2. This example assumes that the selected channel is in Select-labels Monitor Mode. 122SD sets the selected channel on the 53A-426 Card to return the next 22 stored words for the selected label in response to an input request from the system controller.

3. This example assumes that the selected channel is in Select-labels Monitor Mode. 2SD sets the selected channel on the 53A-426 Card to return all stored data words in response to an input request from the system controller. The first two bytes (each byte is 8-bit binary) returned will contain the number of data words being returned. The first byte will be the MSB value and the second byte will be the LSB value.

Errors:

If the SD command is issued, for [mode] = 1 or 2, to a channel in the All-label mode, then a command-mode error will result.

If the SD command is issued, for [mode] = 1 or 2, to a channel in the Limit-check mode still storing data, then a command-receiving error will result.

Command	Description
SL	The SL (Set Label) command defines the capture label for the Limit-check Mode.

Syntax: SL[lb][md]

[lb] is the single byte binary value for the label.

[md] is the secondary capture mode for the label. See the Activity Modes subsection of this manual for a description of the format of the [lb] and [md] bytes.

If two bytes are not sent following the SL command, one for the label and one for the secondary capture mode, improper addressing and operation of the 53/63 system may result (see LL command for additional explanation). <CR><LF> characters may be sent following the two bytes.

Errors:

If the selected channel is not in Limit-check Mode, a command mode error will result.

If the selected channel's receiver is enabled when this command is sent, a command-receiving error will result.

Command	Description
ST	The ST (Self Test) command is used to perform a complete self-test of the 53A-426 Card. The error codes for any errors found can be read by using the ER command. When this self-test is complete, the 53A-426 will be returned to its power-up state. (See the Specifications section of the manual for a listing of the power-up status.)

Command	Description

TD

The TD (Terminate Data) command defines whether or not <CR><LF> is appended to the end of a data transfer for the selected channel.

Syntax: [crlf]TD

[crlf] is a 1-digit decimal integer that specifies the following:

[crlf]	Action
0	<CR><LF> is not appended to the end of either block or single-word data transfers. Pad words are returned if no new data is available.
1	<CR><LF> is appended to the end of block transfers. <CR><LF> is appended to the end of single-word transfers if no new data is available. Pad words are inserted after <CR><LF> if no new data is available.
2	<CR><LF> is appended to the end of block transfers. <CR><LF> is returned whenever no new data is available. Pad words are not returned. (Note: This mode only affects the Monitor and Select-Labels Modes; to the Limit-Check and All-Labels Modes, this mode is identical to Mode 1.)

See Appendix D for recommended usage of the <CR><LF> terminator.

On power-up or following an RS (Reset) command, the 53A-426 is programmed to append <CR><LF>s.

NOTE: In Limit-check Mode, <CR><LF> will not be appended to single word transfers. If selected, <CR><LF> will only be appended to block transfers.

Command	Description

TR

The TR (Time-stamp Resolution) command sets the time-stamp resolution for all four channels.

Syntax: [res]TR

[res] is a 1-digit decimal integer that specifies the time-stamp resolution as follows:

[res]	Time-stamp Resolution
0	10 µs
1	100 µs
2	1 ms
3	10 ms
4	100 ms

The time-stamp resolution is multiplied by the time-stamp value to determine the actual time values. (See the subsection on Time-stamp Bytes for additional details.)

On power-up or following an RS (Reset) command, the time-stamp resolution is set to 1 msec.

Examples:

1. 0TR sets all four channels to time-stamp in 10-us steps.

2. 3TR sets all four channels to time-stamp in 10-ms steps.

Errors:

If this command is issued while a channel is currently receiving and storing data with time-stamp, then a command receiving error will result.

INSTALLATION

The 53A-426 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-426" is at the top for a 53 Series Chassis and to the left for a 63 Series Chassis.

CAUTION:

The 53A-426 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.

GLOSSARY

DITS	Mark 33 Digital Information Transfer System
FIFO	first-in/first-out memory
input	The data being sent FROM the card TO the system controller (typically ARINC-429 data, time-stamp values, and status).
IWG	Inter-Word Gap time
LSE	less than standard number of bits received
output	The data being sent FROM the system controller TO the 53A-426 Card (typically commands and set-up parameters).
SDI	source/destination-identifier
SSM	sign/status-matrix

APPENDIX A

53/63 SERIES SYSTEM COMMANDS

Command	Description
@XY	The @XY (Address) command addresses a function card in the 53/63 System. @ is a delimiter used by the 53/63 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 System detects a new @ character.
@XS	The @XS (Status) command provides the interrupt status of all function cards within the card cage defined by X. The card cage backplane interrupt status of all function cards in the addressed card cage is latched into the 53A-171 Control Card when the @XS command is issued. The 53A-426 Card has interrupt capability that indicates errors, when buffers are 3/4 full, and Limit-check mode data collection completion for the four channels. All function cards in all card cages become unaddressed after the @XS command. The @XS command clears all interrupts stored on the 53A-426 Card. The 53A-171 Control Card Operating Manual describes the @XS command in detail.
@XH	The @XH (Halt) command halts all function cards within the card cage defined by X. The command does not affect function cards in other card cages. How a function card reacts to the @XH command depends on the card. In all cases, an addressed function card (Power LED out) becomes unaddressed (Power LED lit). On the 53A-426 Card, the position of the Halt switch determines the @XH command's effect: 1. If the Halt switch is in the ON position, the 53A-426 Card resets to its power-up state. 2. If the Halt switch is in the OFF position, the 53A-426 Card is simply unaddressed.
STOP	The STOP command is not a string of ASCII characters. The 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-426 Card, reacts as if it received the @XH command described above. How the system controller executes the STOP command depends on the communications card used. With the 53A-128 IEEE-488 Card, for example, a STOP command is executed when the system controller asserts the IEEE-488 bus line IFC (Interface Clear) true.

APPENDIX B

FRONT-EDGE-CONNECTOR PIN ASSIGNMENTS

Pin No.	Function
1	ARINC-429 CHANNEL 1 LINE A
2	ARINC-429 CHANNEL 1 LINE B
3	
4	
5	
6	
7	ARINC-429 CHANNEL 2 LINE A
8	ARINC-429 CHANNEL 2 LINE B
9	
10	
11	
12	
13	ARINC-429 CHANNEL 3 LINE A
14	ARINC-429 CHANNEL 3 LINE B
15	
16	
17	
18	
19	ARINC-429 CHANNEL 4 LINE A
20	ARINC-429 CHANNEL 4 LINE B
21	
22	
23	
24	GROUND
A-BB	GROUND

The front-edge-connector signals are specified as follows:

ARINC-429 CHANNEL n LINE A (pins 1, 7, 13, 19)
These are the analog input signals for direct connection to the ARINC-429 bus, line A.

ARINC-429 CHANNEL n LINE B (pins 2, 8, 14, 20)
These are the analog input signals for direct connection to the ARINC-429 bus, line B.

In the above signal names, "n" represents a channel number (1 through 4). The pins noted in parentheses following each signal name correspond to channels 1 through 4, respectively.

APPENDIX C

SAMPLE BASIC PROGRAM FOR THE 53A-426

The sample programs below are 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-426 Card has been set to address 1. The address of the 53/63 Card Cage containing the 53A-426 Card is address 1.

For this program, PCX 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 Returns a unit descriptor associated with the name of the device.

IBTMO Sets the device timeouts.

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.

Sample BASIC Programs

In this program listing, lines which are indented and not preceded by a line number are not part of the BASIC program. They are inserted here as comments to explain what the program is doing at each numbered line. Lines 1 through 50 are included in the program to initialize the 53A-903 IEEE-488 interface card in the PC.

```
1    CLEAR  ,60000!

2    IBINIT1 = 60000!

3    IBINIT2 = IBINIT1 + 3

4    IBLOAD "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   BDNAME$="PCX":CALL IBFIND (BDNAME$,PCX%)
     Find the IEEE-488 devices.

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

```
30   CALL IBSIC(GPIB0%):CALL IBCLR(PCX%)
```
Reset the IEEE-488 devices.

```
40   TIMEOUT%=0
```
Disable the IEEE-488 device timeouts.

```
50   CALL IBTMO(PCX%,TIMEOUT%):CALL IBTMO(GPIB0%,TIMEOUT%)
```

Sample Program #1

This sample program uses the Monitor mode without time-stamp/error storage to capture 10 words of data from the ARINC bus and display the data after 10 words have been captured.

```
80  DIM WRDBUFFER$(10):CLS
```
This command sequence sets channel 1 to Monitor mode without time-stamp/error storage, no <CR><LF> data termination, interrupts are disabled, and the fast bit rate.

```
90   WRT$ = "@111SC0MM0DS0TD0IN1BR":CALL IBWRT(PCX%,WRT$)
```
Enable the channel 1 receiver.

```
100  WRT$ = "1RE":CALL IBWRT(PCX%,WRT$)
```
Wait for 10 words to be stored.

```
110  RD$ = SPACE$(2)
```
Use the SD command to determine the number of words stored.

```
120  WRT$ = "2SD":CALL IBWRT(PCX%,WRT$):CALL IBRD(PCX%,RD$)

130  WRDSSTRD = ASC(MID$(RD$,1,1)) + (256 * ASC(MID$(RD$,2,1)))

140  IF WRDSSTRD < 10 THEN GOTO 120
```
Read 10 words of data.

```
150  RD$ = SPACE$(4)

160  FOR I = 0 TO 9

170  CALL IBRD(PCX%,RD$):WRDBUFFER$(I) = RD$

180  NEXT I
```
Display the received data.

```
190  FOR I = 0 TO 9

200  RECDTA$ = ""

210  FOR BYTCNT = 1 TO 4

220  BYT$ = HEX$(ASC(MID$(WRDBUFFER$(I),BYTCNT,1)))

230  IF LEN(BYT$) = 1 THEN BYT$ = "0" + BYT$
```

```
240 RECDTA$ = RECDTA$ + BYT$ + SPACE$(1)

250 NEXT BYTCNT

260 PRINT RECDTA$

270 NEXT I

280 END
```

Sample Program #2

This sample program uses the Limit-check Mode with time-stamp/error storage to capture 10 words before and after the trigger event has occurred from the ARINC bus and display the data.

```
80 DIM WRDBUFFER$(21):CLS
```
Set channel 1 to Limit-check mode with time-stamp/error storage, no <CR><LF> data termination, interrupts are enabled, and the fast bit rate.

```
90 WRT$ = "@112SC2MM1DS0TD1IN1BR":CALL IBWRT(PCX%,WRT$)
```
Capture 10 words before and after the trigger event.

```
100 WRT$ = "10PR10PT":CALL IBWRT(PCX%,WRT$)
```
Set the label to capture to octal 023 (ADF Frequency), capture on the label only.

```
110 WRT$ = "SL" + CHR$(19) + CHR$(0):CALL IBWRT(PCX%,WRT$)
```
Set the trigger event to occur when the second and third stored bytes are equal to zero and the third received byte is equal to decimal 126.

```
120 WRT$ = "1LP" + CHR$(0) + CHR$(0) + CHR$(126)

130 CALL IBWRT(PCX%,WRT$)
```
Enable the receiver.

```
140 WRT$ = "2RE":CALL IBWRT(PCX%,WRT$)
```
Wait for the data storage to complete.

```
150 RD$ = SPACE$(3)

160 WRT$ = "EX":CALL IBWRT(PCX%,WRT$)

170 CALL IBRD(PCX%,RD$)

180 IF ASC(MID$(RD$,1,1)) <> 4 THEN GOTO 160
```
Use the SD command to determine the number of words stored.

```
190 RD$ = SPACE$(2)

200 WRT$ = "2SD":CALL IBWRT(PCX%,WRT$):CALL IBRD(PCX%,RD$)
```

```
210 WRDSSTRD = ASC(MID$(RD$,1,1)) + (256 * ASC(MID$(RD$,2,1)))
    Read data.

220 RD$ = SPACE$(8)

230 FOR I = 0 TO (WRDSSTRD - 1)

240 CALL IBRD(PCX%,RD$):WRDBUFFER$(I) = RD$

250 NEXT I
    Display the received data.

260 FOR I = 0 TO (WRDSSTRD - 1)

270 RECDTA$ = ""

280 FOR BYTCNT = 1 TO 8

290 BYT$ = HEX$(ASC(MID$(WRDBUFFER$(I),BYTCNT,1)))

300 IF LEN(BYT$) = 1 THEN BYT$ = "0" + BYT$

310 RECDTA$ = RECDTA$ + BYT$ + SPACE$(1)

320 NEXT BYTCNT

330 PRINT RECDTA$

340 NEXT I

350 END
```

APPENDIX D

USE OF THE <CR><LF> TERMINATOR

With the TD command, the 53A-426 provides a programmable <CR><LF> terminator for its three data access modes. Use of the terminator is recommended for all communications interfaces except RS-232.

In IEEE-488 communications applications, a <CR><LF> terminator is recommended because it allows termination of system controller input on the occurrence of an IEEE-488 bus EOI (End Or Identify) signal for all three data access modes. Inputs should not be terminated on <LF> without an EOI because 8 bit data content may contain codes equivalent to the <LF> ASCII code and terminate the read prematurely.

CDS IEEE-488 interfaced systems (53/63 - IBX, PCX) automatically discriminate between a line feed occurring at the end of a data transfer and a line feed occurring in the middle of a data transfer. With the EOI Enable Switch set to the ON position on the 53A-128 IEEE-488 Communications Card, an EOI signal will be generated when a line feed occurring at the end of a data transfer is returned to the system controller.

NOTE: Not using the EOI terminator in IEEE-488 applications poses other risks. The IEEE-488 specification expects an addressed talker to untalk itself, as a CDS system does when the talker asserts the EOI line on the IEEE-488 bus, and does not prohibit a controller from setting the NRFD signal line to the Ready For Data state after a non-EOI terminated transfer is completed. If a controller sets NRFD to Ready for Data after transfer is complete (often true in DMA transfers), loss of the first data byte on the next input may occur. For this reason, it is not recommended that the 53A-426 be used in IEEE-488 applications without a line feed terminator.

All CDS-configured Instrument Systems, even those that are not IEEE-488 based, provide an EOI type capability (except for 53A/B-RSX RS-232 Instrument System). Typically this capability is facilitated by internal logic that differentiates between a real line feed terminator and data content that looks like a line feed. Use of this EOI capability, which requires the <CR><LF> terminator to be sent, is recommended in all applications.

In an RS-232 board system, where no EOI type line is available, input needs to be stopped based on data content or byte count. For each of the three data access modes (see SD command), a data content or byte count termination method is possible. In mode 0 (single word transfer) a pad byte is provided in the label byte location indicating no more data. Since label 255 (the pad byte value) is not normally used in ARINC-429 applications, the pad value may be used to stop signal input requests.

In mode 1 (specified number of words), the byte count is part of the command and may be used to count the number of bytes.

In mode 2 (all available data), a byte count is prepended to the data and may be used. In these cases, the <CR><LF> terminator may also be used.