53A-431 QUAD UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER CARD

OPERATING MANUAL

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Englewood, CO 80110
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Printed in U.S.A.

10/05/89 8607-03-A through 8810-03-E V2.8

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53A-431 QUAD UNIVERSAL ASYNCHRONOUS RECEIVER TRANSMITTER CARD

DESCRIPTION

The 53A-431 Quad Universal Asynchronous Receiver Transmitter (UART) Card is a printed circuit board assembly for use in a CDS 53/63 Series System. The 53A-431 Card can interface up to four data terminals or serial communications networks with the user's system controller (calculator or computer) using either EIA RS-422 or EIA RS-232C inputs and outputs. The choice of RS-422 or RS-232C is switch-selectable on a per-channel basis as are the wide variety of programmable speeds, format characteristics, and extensive interrupt capabilities. The card stores the programmable parameters in a non-volatile, battery-powered RAM. The card supports both the XON/XOFF protocol and the asynchronous protocol (data-terminal-ready [DTR]/clear-to-send [CTS] handshake).

CONTROLS AND INDICATORS

The following controls and indicators are provided to select and display the functions of the 53A-431 Card's operating environment.

Address-Select Switch

The 53A-431 Card has a miniature, 10-position switch labeled "ADDRESS" that selects the 53A-431 Card's address (0-9) in the 53/63 Series System. The switch's cover opens to allow the address to be re-selected. A screwdriver with a narrow, flat blade should be used to turn the cam-action wiper to the desired address position.

Power LED

The Power LED provides a valuable diagnostic tool by giving the system programmer a visual indication of what action the system is taking. Whenever the 53A-431 Card is addressed by the system controller, the LED will go out. The LED will remain out until another function card is addressed. Since only one function card can be addressed at a time, the LED indicates to the system programmer which function card the system controller is now communicating with. The Power LED being lit not only indicates that the 53A-431 Card is unaddressed, but that all required DC power (5V DC, +15V DC, and -15V DC) is being supplied.

Fuses

The 5V DC, +15V DC and -15V 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-431 Card to indicate the status of the card's operation:

Channel LEDs

There are four Channel LEDs (CH0-CH3); only one LED is lit at a time. The lit Channel LED corresponds to the last channel programmed; the lit Channel LED indicates the channel referred to when the following LEDs are lit.

TXD (Transmit Data) LED

This LED blinks off if data is being transmitted. It is normally on.

RXD (Receive Data) LED

This LED blinks off if data is being received. It is normally on.

CTS (Clear To Send) LED

This LED is lit if the "Clear To Send" (CTS) line is true. The 53A-431 Card receives the CTS signal from the device communicating with the card. It is normally on. The 53A-431 Card has a pull-up resistor to place this signal in an active state should the user not connect this signal.

DCD (Data Carrier Detect) LED

This LED is lit if the ""Data Carrier Detect" (DCD) line is true. The 53A-431 Card receives the DCD signal from the device communicating with the card. It is normally on. The 53A-431 Card has a pull-up resistor to place this signal in an active state should the user not connect this signal.

DTR (Data Terminal Ready) LED

This LED is lit if the "Data Terminal Ready" (DTR) line is true. The 53A-431 Card sends the DTR signal to the device communicating with the card. This LED will extinguish when the channels receive buffer is 2 bytes from overflowing. It is normally on.

RTS (Request To Send) LED

This LED is lit if the "Request To Send" (RTS) line is true. The 53A-431 Card sends the RTS signal to the device communicating with the card. This LED will only be on during transmission of data. It is normally off.

ERR (Error) LED

This LED is lit if an error (link error or programming error) is detected. If the E command is issued (see Operation section), the actual error is encoded and sent to the system controller, and the error LED goes out.

Switches

The following switches are provided to select the proper functions for the 53A-431 Card's operating environment:

Halt Switch

This two-position slide switch is located near the card's backplane edge connector. It selects the state of the 53A-431 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-431 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-431 Card becomes unaddressed, the Power LED is lit, and any programmed parameters of the card remain unchanged.

Data-Inverting Switches

Eight two-position slide switches allow all transmitted and received signals to be inverted or non-inverted depending on the switch position:

Switch	Channel	Signals	Switch On	Switch Off
S232	CH0	Transmitted	Non-inverting	Inverting
S222	CH0	Received	Non-inverting	Inverting
S42	CH1	Transmitted	Non-inverting	Inverting
S51	CH1	Received	Non-inverting	Inverting
S72	CH2	Transmitted	Non-inverting	Inverting
S81	CH2	Received	Non-inverting	Inverting
S1012	CH3	Transmitted	Non-inverting	Inverting
S1012 21	CH3	Received	Non-inverting	Inverting

NOTE: Use of the inverting switches will cause the Loopback command to fail and will prevent data transmission unless the user drives CTS to the proper state.

Echo Switches

Four two-position slide switches (one for each channel let you select whether or not a channel is to echo data back to the transmitting device. If a switch is on, all received data is echoed back; if the switch is off, the received data is not echoed back:

NOTE: With the echo function, the received data is echoed back through the transmitter-half of the same channel. This may cause a collision between data transmitted and data echoed back. The echo function should only be used if the channel is being operated half-duplex, that is, the channel is not transmitting and receiving data at the same time.

Switch	Channel
S122	CH0 OFF
S41	CH1 OFF
S71	CH2 OFF
S1011	CH3 OFF

RS-22C/RS-422 Switches

These 1- and 3-section rocker switches toggle the interface signal lines on the front-edge connector between the EIA RS-232C and the EIA RS-422 standards. Six switches for each channel must be moved to convert all the signals for that channel. The first five switches toggle the TXD, RTS/DTR, RXD, CTS, and DCD lines between RS-232C and RS-422 operation. The sixth switch changes how one of the front-edge connector pins for the channel is used: For RS-232C operation, the pin provides the RS-232C signal ground; for RS-422 operation, the pin provides the low side of the differential Data Carrier Detect (DCD-) input. Except for the combined RTS/DTR switch, it is possible to mix RS-232C signals and RS-422 signals on the same channel:

Switch	RS-232C/RS-422	Channel	Function
S031	C1/C2	CH0	TXD
S032	C1/C2	CH0	RTS/DTR
S02-1	Closed/Open	CH0	RXD
S02-2	Closed/Open	CH0	CTS
S02-3	Closed/Open	CH0	DCD
S121	C2/C1	CH0	Signal Gnd/DCD-
S321	C1/C2	CH1	TXD
S322	C1/C2	CH1	RTS/DTR
S311-1	Closed/Open	CH1	RXD
S311-2	Closed/Open	CH1	CTS
S311-3	Closed/Open	CH1	DCD
S312	C2/C1	CH1	Signal Gnd/DCD-
S52	C1/C2	CH2	TXD
S621	C1/C2	CH2	RTS/DTR
S611-1	Closed/Open	CH2	RXD
S611-2	Closed/Open	CH2	CTS
S611-3	Closed/Open	CH2	DCD
S612	C2/C1	CH2	Signal Gnd/DCD-
S82	C1/C2	CH3	TXD

Switch	RS-232C/RS-422	Channel	Function
S921	C1/C2	CH3	RTS/DTR
S911-1	Closed/Open	CH3	RXD
S911-2	Closed/Open	CH3	CTS
S911-3	Closed/Open	CH3	DCD
S912	C2/C1	CH3	Signal Gnd/DCD-

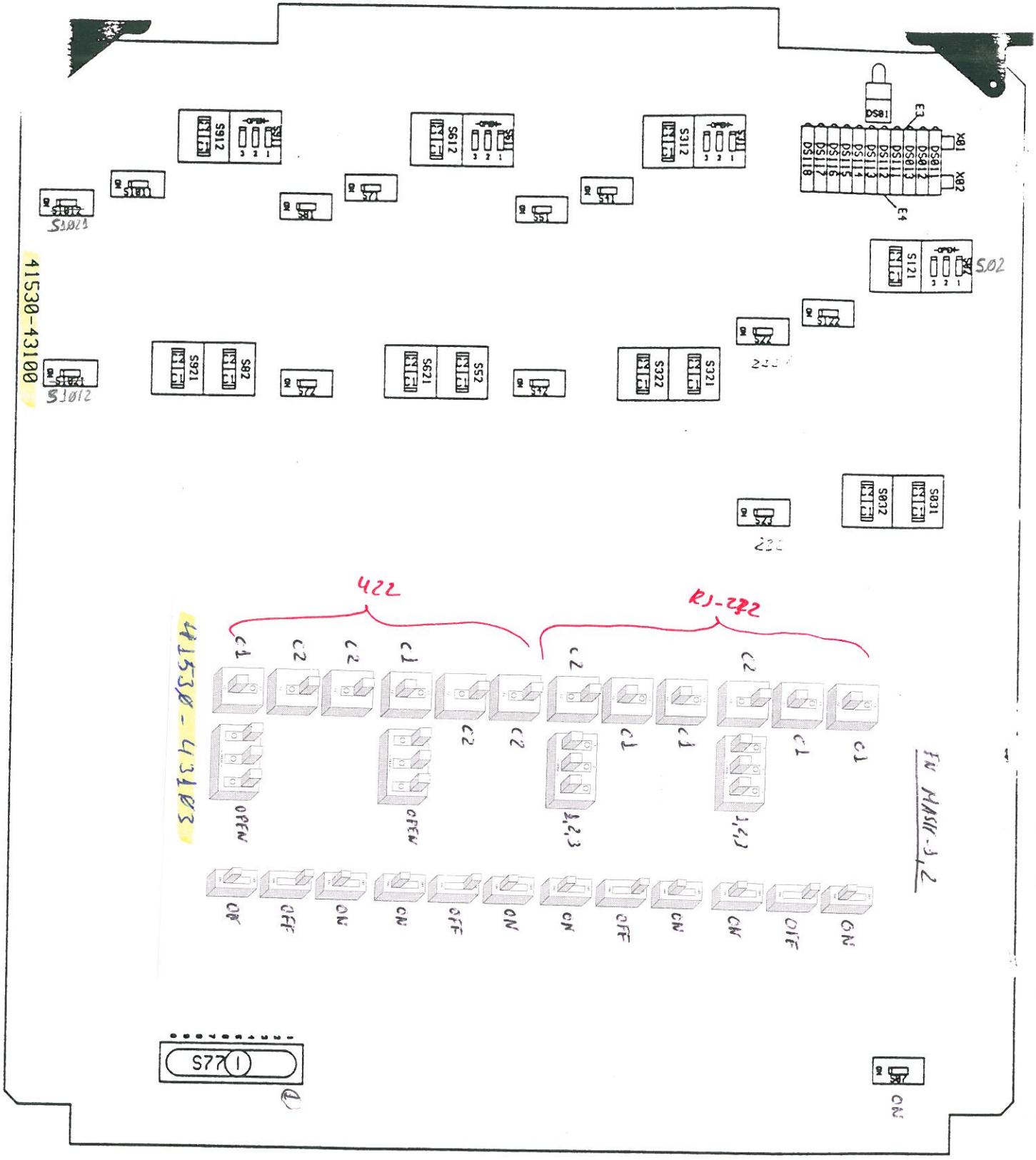


Figure 431-1: 53A-431 Controls and Indicators

Baud Rates (each channel):	Programmable: 110, 300, 600, 1200, 1800, 2400, 4800, 9600, and 19,200 baud.
Word Lengths (each channel):	Programmable: 5, 6, 7, or 8 bits with 1, 1.5, or 2 stop bits.
Parity Generation/Checking (each channel):	Programmable: odd, even, or none. Note: If there are less than 8 data bits the parity bit is returned to the controller as part of the data byte.
Error Detection (each channel):	Parity and receiver overflow errors are detected. DCD not present is also detected.
Data Bandwidths:	The 53A-431 Card can keep all four channels transmitting and receiving data continuously at 19,200 baud. Most system controllers cannot keep the channel buffers current at that rate; transmit buffers will empty, and receive buffers will overflow. To maintain 19,200 baud continuously, the system controller must be capable of 15,360 bytes of data I/O per second, plus command processing.
Interrupts:	Seven types, programmable.
Power-up:	On power-up, the 53A-431 Card is unaddressed (power LED lit), the device control output LEDs out, and CH0 LED is lit (CH0 status on the status LEDs). Interrupts are disabled.
Power Requirements:	+5V and ±15V DC power is provided by the 53A-060 power supply in the 53/63 Series Card Cage.
Voltage (5V Supply):	4.75V DC to 5.25V DC.
Current (5V Supply):	0.95 A max. quiescent. 1.80 A peak. (During Loopback).
Voltage (±15V Supplies):	+14.5V DC to +15.5V DC. -14.5V DC to -15.5V DC.
Current (±15V Supplies):	25 mA max. quiescent. 100 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 °C and airflow to assure less than 10 °C temperature rise). -40 °C to +85 °C, storage.

SPECIFICATIONS

Interface Specifications:	EIA RS-232C 1969 EIA RS-422A 1978
Number of Channels:	Four.
Modes of Operation:	1) Asynchronous, with data-terminal ready and clear-to-send handshake. 2) XON/XOFF Protocol.
Interchange Circuit:	From the EIA RS-232C standard, the 53A-431 Card provides the following: AB Signal Ground BA Transmitted Data BB Received Data CA Request To Send (RTS) CB Clear To Send (CTS) CC Data Set Ready CD Data Terminal Ready (DTR) CF Data Carrier Detect (DCD)
Interface Type:	From the EIA RS-232C standard, the 53A-431 Card provides interface types A, B, C, D, and E.
Signal Levels RS-422 Transmitted:	2.0V min. differential (100-ohm load). 5.0V max. differential (100-ohm load).
RS-232C Transmitted:	±9V min. (3-kilohm load). ±14V max. (3-kilohm load).
RS-422 Received:	200 mV min. differential. 30V max. differential.
RS-232C Received:	+3V to +30V positive. -30V to 0V negative.
Logic Levels:	All signals may be switched between inverted and non-inverted levels.
Data Buffers Transmitter:	0 kBytes - 8 kBytes in 1-kByte blocks.* (0 kBytes - 48 kBytes in 1-kByte blocks with Option 001).*
Receiver:	0 kBytes - 8 kBytes in 1-kBytes blocks.* (0 kBytes - 48 kBytes in 1-kByte blocks with Option 001).*

* The receive and transmit data buffer locations can be allocated between the four UART channels in 1-kBytes increments.

Humidity:	Less than 95% R.H., noncondensing.
Dimensions:	197mm high, 220mm deep, 13mm wide. (7.5" x 8.66" x 0.5").
Dimensions, Shipping:	When ordered with a 53/63 Series Card Cage, the card is installed in one of the card cage function card slots. When ordered alone, the shipping dimensions are: 254mm x 254mm x 127mm. (10" x 10" x 5").
Weight:	0.23 kg. (0.5 lbs).
Weight, Shipping:	When ordered with a 53/63 Series Card Cage, the card is installed in one of the card cage function card slots. When ordered alone, the shipping weight is: 0.64 kg. (1.4 lbs).
Mounting Position:	Any orientation.
Mounting Location:	Plugs into any function card slot of the 53/63 Series Card Cage.
Output Connection:	A 48-pin card-edge connector (53A-780) provides a connection for all UART signals.
Required Equipment (not supplied):	53A-780 Hooded Connector or the 53A-754 EIA Cable.
Equipment Supplied:	1 - 53A-431 Quad Universal Asynchronous Receiver Transmitter Card. 1 - Spare fuse (part# 42202-52001). 1 - Operating manual (part# 00000-14310). 1 - Service manual (part# 00000-24310).

OPERATION

Overview

The 53A-431 Card is programmed by ASCII characters issued from the system controller to the 53/63 System's communications card. The 53A-431 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 system command "@XY" must be issued. "X" is the mainframe address (0-9) selected on the 53A-171 Control Card in the addressed card cage. "Y" is the 53A-431 Card's address (0-9) within the addressed card cage. The 53A-431 Card 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 discusses the "@XY" command and the other 53A/63A System commands. After the 53A-431 Card is addressed, the following commands may be issued until another function card is addressed:

The syntax for the 53A-431 Card commands is as follows:

Alpha characters must be uppercase.

If the character is not enclosed, that character itself is sent, otherwise:

[] encloses the symbol for the actual argument to be sent. These argument symbols are defined under each command heading; in normal text, the argument symbols are enclosed in quotation marks.

<CR>indicates a carriage-return.

<LF> indicates a line-feed.

The S character sent at the end of each command may be optionally replaced by a <CR> or followed by a <CR>. A <LF> may optionally follow any <CR>.
The two exceptions to the above rule are the R and T commands; the S must always be used with these two commands and <CR><LF> may not be sent.

If the host computer requests input from the 53A-431 Card without first sending a command, then the card will return a <CR><LF>.

CAUTION:

Sending the B command destroys the data in all channel buffers. To prevent accidental data loss, this command should only be issued on power-up or after all channel buffers are knowingly cleared.

Summary

An overview of the commands, listed alphabetically, is as follows:

B (Buffer) command defines the amount of RAM to be allocated to the eight buffers.

C (Count) command queries the 53A-431 Card for the character count and line count of a specific channel's receive buffer.

E (Error) command queries the 53A-431 Card to determine what errors have occurred.

I (Interrupt enable) command enables 53/63 System interrupts for a given channel.

L (Loopback) command loops the transmitter of a channel back to the receiver of the same channel.

M (Interrupt Matrix) command sets the character and buffer parameters that generate a 53/63 System interrupt.

Q (Query) command queries the status of the internal interrupts.

R (Receive Data) command indicates that the system controller is ready to receive data from the 53A-431 Card.

T (Transmit data) command notifies the 53A-431 Card that the system controller is ready to transmit data.

V (Version) command reports the software version number on 2.7 or later software.

[x] retransmit the last loaded buffer

Z (Zero) command will reinitialize a channel's buffer pointers to a power-up condition.

Card Commands

Detailed descriptions of the 53A-431 Card's commands, in the same order as listed above, are as follows:

Command	Description
B	The B (Buffer) command defines the amount of RAM to be allocated to the eight buffers - one transmit buffer and one receive buffer for each of the four channels.

Syntax: B[x],[t],[r]<CR> or B[x],[t],[r]S

x = channel number (0-3).

t = transmit-buffer size - two digits, including a leading zero, that represent the number of 1K byte blocks to be allocated. "t" must range from 00 to 48.

r = receive-buffer size - two digits, including a leading zero, that represent the number of 1K byte blocks to be allocated. "r" must range from 00 to 48.

The standard 53A-431 Card comes with 8K byte of RAM; an option card (53A-431-001) can expand the total RAM to 48K byte. As delivered, the 53A-431 Card allocates the RAM evenly to all buffers; thus, a standard 53A-431 Card has eight 1K byte buffers, and an expanded card has eight 6K byte buffers. To re-allocate any or all of the RAM, the B command is used; the amount of RAM re-allocated cannot be greater than the total amount of RAM available. The buffers may be allocated only in 1K byte blocks.

The B command may be chained with other commands; the S must be sent between commands. Programming results remain valid during power-down periods.

Example:

B0,03,00<CR> or B0,03,00S

Sets the channel 0 transmit buffer to 3K byte, and the receive buffer to 0K byte. This command is invalid unless the option card is installed or a previous command de-allocated RAM from other buffers, that is:

B1,00,00<CR> or B1,00,00S
B0,03,00<CR> or B0,03,00S

CAUTION: Even though only one channel is specified, the B command destroys the data in all channel buffers. To prevent accidental data loss, this command should only be issued on power-up or after all channel buffers are knowingly cleared.

Command	Description
C	The C (Count) command queries the 53A-431 Card for the character count and line count of a specific channel's receive buffer.

Syntax: C[x]<CR> or C[x]S

[x] specifies the channel

The format of the response is [cc], [lc]<CR><LF>, where:

cc = character count.
lc = line count.

The character count is the present number of characters in the buffer. The line count is the total number of lines (as defined by the interrupt character in the last-issued M command) received since the last reset. Keeping track of the line count allows the applications program to be line-oriented. The line count is incremented to 65, 767 and then rolls over to 0.

After outputting the C command, the system controller must request the response (input request) before outputting another command. Otherwise, the response is cancelled.

Example:

C3<CR> or C3S - output sent.
104, 12<CR><LF> - response received.

Channel 3 has 104 characters in its receive buffer, and 12 lines have been received since the last reset. If the previous time channel 3 was queried the line count was 9, then the input from the receive buffer could be handled as follows:

```
PRINT "@01R2S";
INPUT A$, B$, C$
```

Command	Description
E	The E (Error) command queries the 53A-431 Card to determine what errors have occurred.

Syntax: E<CR> or ES

The card responds with a string of numbers representing the errors, in chronological order, that have occurred since the last E command. Issuing the E command resets the error LED and the error flags. The format for the response is "e1, e2, e3,...en<CR><LF>", where:

e1 = first error code
e2 = second error code
e3 = third error code
en = last error code

The error codes are as follows: (x = channel number)

x0 = Multiple Interrupts (interrupts not serviced)
x1 = Parity Error
x2 = Fails Loop Back Self-Test
x4 = DCD Not Present
x5 = Transmit Buffer Overrun
x6 = Receive Buffer Overrun
x7 = Receiver Overrun
40 = No Errors
41 = Buffer Allocation Error
43 = RAM Error [Power-Up Self-Test (PUST)]
45 = Battery RAM Error (PUST)
46 = Non-Existent Memory
47 = Battery Dead
48 = Illegal Syntax
49 = Illegal Syntax, Expected Number
50 = Illegal Syntax, Expected Comma
51 = Unrecognized Command
52 = Error Buffer Overflow

After outputting the E command, the system controller must request the response (input request) before outputting another command. Otherwise, the response is cancelled.

Example:

E<CR> or ES - command sent.
00, 31, 40<CR><LF> - response returned.

Channel 0 has multiple interrupts (interrupts have not been serviced), and channel 3 had a parity error. The 40 code is appended to show that all errors have been reported.

Programming Caution: If the data inverting function is used the channel will fail Loopback Self-Test (error x 2). Be sure to clear these errors at power up.

Command	Description

I

The I (Interrupt enable) command enables 53A/63A System interrupts for a given channel.

Syntax: I[x],[c],[tb],[rb],[tbo],[rbo],[le]<CR> or
I[x],[c],[tb],[rb],[tbo],[rbo],[le]S

x = channel number (0-3).

c = enable character interrupt - 0 or 1.
"0" disables and "1" enables. The character is selected by the M command.

tb = enable transmit buffer interrupt - 0 or 1.
"0" disables and "1" enables. This is the transmit buffer interrupt defined by the M command; the interrupt is not activated until the M command defines the "emptied to" buffer size.

rb = enable receive buffer interrupt - 0 or 1.
"0" disables and "1" enables. This is the interrupt defined by the M command; the interrupt is not activated until the M command defines the "filled to" buffer size.

tbo = transmit buffer overflow interrupt - 0 or 1.
"0" means no overflow and "1" means overflow. This interrupt is generated if the transmit buffer overflows.

rbo = receive buffer overflow interrupt - 0 or 1.
"0" means no overflow and "1" means overflow. This interrupt is generated if the receive buffer overflows.

le = link error interrupt - 0 or 1.
"0" means no link error and "1" means link error. This interrupt is generated when there is a received parity error, the DCD interface line goes inactive, or the receiver is overrun due to a full receive buffer.

All interrupts are disabled on power-up. The I command does not remain valid during power-down periods.

Example:

I0,0,1,1,,1,1<CR> or I0,0,1,1,,1,1S

This sets channel 0 to interrupt at the buffer sizes defined by the M command for the transmit buffer or the receive buffer or if the receive buffer overflows, or if there is a link error. No interrupts are generated for a defined interrupt character or for a transmit buffer overflow.

Programming Caution: When the applications program enters its interrupt handler and executes the "@XS" command, the handler should re-address the card cage immediately after receiving the colon (:). For example:

```
1000      REM INTERRUPT HANDLER
1010      PRINT "@1S"
1020      INPUT A$
1030      IF A $ = "1" THEN GOTO 1100
1040      IF A$ < > ":" GOTO 1020
1050      PRINT"@11"
1060      RETURN
1100      REM 431 INTERRUPT HANDLER
1110      PRINT "@11"
1120      .
     .
     .
```

If the CDS Card Cage is not re-addressed to end the "@XS" command, subsequent interrupts from the 53A-431 may be lost.

Command	Description
L	The L (Loopback) command loops the transmitter of a channel back to the receiver of the same channel.

Syntax: L[x]<CR> or L[x]S

x = channel number 0-3, or 4. "0-3" make the connection and "4" sets all channels.

The command works in a toggle mode. To reset a channel, re-issue the Loopback command.

The command is reset on power-down.

Example:

L4<CR> or L4S

This sets all channels to the loopback mode.

Programming Cautions:

Do not use this command if the data inverting feature of the card is used unless the user has the CTS signal driven active (but inverted).

This command loops back only the data signals. Since the handshake lines are not connected, the receive buffer may be overrun.

Relay contact bounce during both open and closure may cause the UARTs to detect data that is spurious. The Z command should be used to clear the buffers prior to any data being transmitted or received.

Command	Description
M	The M (interrupt Matrix) command sets the character and buffer parameters that generate a 53/63 System interrupt. Servicing 53/63 System interrupts is described in the 53A-171 Control Card Manual under the "@XS" command.

Syntax: M[x],[c],[tb],[rb]<CR> or M[[x],[c],[tb],[rb]S

x = channel number (0-3).

c = the interrupt character, specified as a 2-digit hexadecimal integer that represents the desired ASCII character; when the desired ASCII character is received, an interrupt is generated. The default interrupt character is 0D (<CR>), that is, "c" is specified as 0D, which represents <CR>. The interrupt character also generates the line count returned in response to the Q command.

tb = the transmit-buffer size that generates an interrupt. When the transmit buffer is emptied to "tb" characters, the interrupt is generated. The value is a 5-digit decimal integer.

rb = the receive-buffer size that generates an interrupt. When the receive buffer is filled to "rb" characters, the interrupt is generated. The value is a 5-digit decimal integer.

If the XON/XOFF protocol is enabled (see P command), the 53A-431 Card transmits an XOFF character when the receive buffer is filled to "rb" characters. When an R command is issued, and XON character is sent when the receive buffer is emptied below "rb" characters. (see R command). Leading zeroes are not necessary for the "tb" and "rb" arguments.

The M command does not enable, disable, or generate interrupts. The I command (see below) must be used to enable interrupts defined by the M command. The M command remains valid during power-down periods.

Example:

M0, 41, 695, 2<CR> or M0, 41, 695, 2S

This sets up channel 0 to generate interrupts when 1) an uppercase A is received, 2) the transmit buffer is emptied until it has 695 characters yet to transmit, and 3) the receive buffer is filled with 2 characters.

Command	Description

P

The P (Program channel) command programs the serial-link specifications.

Syntax: P[x],[b],[d],[s],[p],[z]<CR> or P[x],[b],[d],[s],[p],[z]S

x = channel number (0-3).

b = baud rate: Values supported are: 110, 300, 600, 1200, 2400, 4800, 9600, and 19200.

d = number of data bits: Values supported are 5, 6, 7, and 8.

s = number of stop bits: Values supported are 1, 1½, and 2 stop bits; the programming codes are 0, 1, and 2, respectively.

p = parity: 0 = none, 1 = even, 2 = odd.

z = XON/XOFF protocol: 0 = off, 1 = on.
The XON/OFF protocol is used by certain manufacturers in place of a request-to-send/clear-to-send handshake. If this protocol is enabled on the 53A-431 Card, the following occurs:

1) When transmitting data, the card holds off transmitting if it receives an XOFF character; the card resumes transmitting if it receives an XON character.

2) When receiving data, the card transmits an XOFF character if the receiver buffer is filled to "rb" characters; the card transmits an XON character if the receive buffer is emptied below "rb" characters ("rb" = the size of the receive-buffer interrupt; see M command).

Before enabling the XON/XOFF protocol, the M command should be used to specify "rb" (see M command). Also, the RTS handshake is not disabled. The P command specifications remain valid during power-down periods.

Example:
P0,19200,7,1,0,0<CR> or P0,19200,7,1,0,0S
This sets channel 0 to 19200 baud, 7 data bits, 1 stop bit, no parity, and no XON/XOFF protocol.

CAUTION: If the XON/XOFF protocol is enabled, these two characters (11h and 13h) will not appear in the receive buffers. Therefore, the data being received may not have these two characters.

Command	Description

Q

The Q (Query) command queries the status of the internal interrupts.

Syntax: Q[x]<CR> or Q[x]S

x = channel number (0-3). This field is optional; if it is omitted, the 53A-431 Card returns a short-form status as follows:

a = 0 or 1 for channel 0.
b = 0 or 1 for channel 1.
c = 0 or 1 for channel 2.
d = 0 or 1 for channel 3.

For the particular channel, "0" indicates no pending interrupts; "1" indicates pending interrupts.

If "x" is specified, the status of all the interrupts associated with that channel is returned as follows:

[c],[tb],[rb],[tbo],[rbo],[le],<CR><LF>

The six returned values make up the interrupt status for the six interrupt parameters specified in the I command arguments. The returned values for each parameter are 0 (interrupt has not occurred) or 1 (interrupt has occurred). Reading the interrupt status for a channel resets the interrupts for that channel.

After outputting the Q command, the system controller must request the response (input request) before outputting another command. Otherwise, the response is cancelled.

Example:

Q<CR> or QS - output sent.
0,0,0,1<CR><LF> - response returned.

This command sequence requests the short form status report. Channels 0-3 have no interrupts, and channel 3 has a pending interrupt.

Q3<CR> or Q3S - output sent
1,0,1,0,,0,0,<CR><LF> - response returned.

This command sequence requests the interrupt status of channel 3. The response indicates a character interrupt and a receive interrupt occurred.

53A-128 Improvements

Dear CDS Customer,

As part of its ongoing program of product improvements, CDS has added three new features to the 53A-128 Card (Revision 8903-04-A and higher). Two are performance enhancements that take advantage of the capabilities of modern instrument controllers, while the third brings the 53A-128 action in response to a serial poll in line with modern software usage.

1) An Interface Clear Switch has been added that allows you to inhibit a 53/63 System from completely resetting in response to an Interface Clear (IFC). When this switch is set ON, IFC will clear the IEEE-488 interface only and not the entire 53/63 System. A Selective Device Clear (SDC) will still reset the entire system regardless of where the switch is set. This feature allows for greater system level software flexibility and control.

   NOTE: Setting this switch to the OFF position will maintain compatibility with earlier CDS systems that use either a 53A-128 or 53A-127 card.

2) A Talk Transfer Rate Switch has also been added for those applications requiring higher performance. The IEEE-488 Standard requires Ready For Data to be true for up to 2 microseconds in order to allow the bus time to stabilize, and to help prevent problems with certain older system controllers that momentarily set RFD while in the process of determining that a data byte is the last byte to be sent. However, in most modern systems .5 microseconds is adequate for this function. The TAlk Transfer Rate Switch allows the delay time to be set to a value between .5 and 2 microseconds in .5 microsecond steps. This allows the user to optimize overhead for a particular system controller and thereby increase system throughput.

   NOTE: For compatibility with earlier CDS systems, the switch should be set for 2 microsecond operation (position 1 closed). No more than one of the four switch positions should be closed at any point in time in order to insure proper operation.

3) The last feature prevents a potential systems level problem involving automatic serial poll. Previously, the 53A-128 output a "hidden" null character to an addressed function card during a serial poll. In most systems, this is not a problem since a) most function cards simply throw away null characters, and b) most systems controllers, particular PC based controllers, only do serial polls on command. In addition, most applications do not require a serial poll either when cards are addressed or in the middle of a command. However, in order to make CDS systems compatible with all systems controllers and applications, the 53A-128 will no longer put out this "hidden" character.

   NOTE: If you have a system controller that does automatic serial polling in response to a Service Request and are experiencing intermittent operation with your systems, please contact the CDS applications department at 1-800-CDS-ATE1 (1-800-238-2831).

Thank You,

Carl Glasow
Chief Engineer

Command	Description
R	The R (Receive Data) command indicates that the system controller is ready to receive data from the "x" channel of the 53A-431 Card.

Syntax: R[x]S

x = channel number (0-3).

There is no transfer count. The 53A-431 Card continues to send data from that channel to the system controller until the system controller changes the direction of transfer. That is, the system controller stops the transfer by outputting to the card. If the channel runs out of data, an ASCII null (00) character is sent. If ASCII null (00) characters are expected in the data received, the user should check character or line count before issuing an R command and only read the amount of data in the buffer.

If desired, the user may input a full 8-bit binary value for each character. The 53A-431 Card can support full 8-bit transfers for 8-bit applications (parity checking and line-feed monitoring by the 53/63 System communications card or control card are disabled). In 7-bit applications, zero is returned as the most-significant bit.

Example:

R1S

This command sequence initiates a data-transfer cycle from channel 1 to the system controller. The cycle terminates when the system controller next outputs to the 53A-431 Card.

CAUTION: <CR>, <LF>, or space characters must not follow the R command. To accomplish this, the programmer may have to suppress the automatic generation of these characters by the system controller.

NOTE: If the XON/XOFF protocol is enabled, and the receive buffer is filled to "rb" characters causing the XOFF character to be transmitted (see M command), issuing the R command will trigger the transmitting of the XON character once the receive buffer is emptied below "rb" characters.

Programming Caution: See Appendix C.

Command	Description
T	The T (Transmit data) command notifies the 53A-431 Card that the system controller is ready to transmit data to channel "x".

Syntax: T[x]S

x = channel number (0-3).

There is no transfer count. The 53A-431 Card continues to accept data from the system controller for channel "x" until the system controller stops sending data to the card and instead requests input from the 53A-431 Card. The 53A-431 Card supports full 8-bit transfers (a "@" character embedded in the data will not unaddress the card).

Example:

T1S

This starts a data-transfer cycle for channel 1. The cycle is terminated when the system controller next inputs from the 53A-431 Card.

When the system controller request input to terminate the T command transmission, the 53A-431 Card returns the short-form status as if a Q<CR> or QS command had been issued. For example, the card may return the following, signifying that channels 0 and 3 have pending interrupts:

1,0,0,1<CR><LF>

CAUTION: <CR>,<LF>, or space characters must not follow the T command. To accomplish this, the programmer may have to suppress the automatic generation of these characters by the system controller.

Programming Caution: See Appendix C.

Command	Description
V	The V (Version) command queries the 53A-431 card to determine the software version number.

Syntax: V<CR> or VS

The card responds with 6 characters in a string.

The response syntax is as follows:

V<CR> or VS - command sent.
V2.8<CR><LF> - response returned.

NOTE: This command is only valid for software versions V2.7 or later.

Command	Description
[x]	The command to cause the 53A-431 Card to retransmit the last loaded buffer consists of only the channel number. It is recommended that this command be used carefully since it will disrupt communications taking place at the time it is invoked. Syntax: x<CR> or xS x = channel number (0-3). **CAUTION:** The retransmit command will interrupt the transmission of a block of data if it is issued while data is being transmitted. Individual byte transmission will not be disturbed. However, the next byte to be transmitted will be the first byte of the block as buffer pointers are reset.

Command	Description
Z	The Z (Zero) command will reinitialize a channel's buffer pointers to a power-up condition. This will reset all character counts to 0 if channel 4 is specified, transmit and receive buffers if all 4 channels are zeroed.

Syntax: Z[x],[p]<CR> or Z[x],[p]S

x = channel number (0-4)

p = T zero transmit buffer
R zero receive buffer
B zero both channel buffers

Example:

Z1, R<CR> or Z1, RS

Zeros channel 1's receive buffer.

INSTALLATION

The 53A-431 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-431" is at the top for a 53 Series Chassis and to the left for a 63 Series Chassis.

CAUTION:

The 53A-431 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 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.

@XS The "@XS" (Status) command provides the interrupt status of all function cards within the mainframe defined by "X". The 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. All function cards in all card cages become unaddressed after the @XS command is issued. The 53A-431 Card has interrupt capability. The @XS command allows the interrupt status of the 53A-431 Card to be read as programmed by the I (Interrupt) command (see the Card Commands subsection in the OPERATION section of this manual for details of the I command). The 53A-171 Control Card Operating Manual describes the @XS command in detail.

@XH The "@XH" (Halt) command halts all function cards within the mainframe defined by "X". The command does not affect function cards in other mainframes. 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-431 Card, the position of the Halt Switch causes the "@XH" command to have the following effect: If the Halt Switch is on, the 53A-431 Card resets to it power-up state; if the Halt Switch is off, the 53A-431 Card is simply unaddressed.

Note: Parameters specified by the 53A-431 Card B (Buffer), M (Matrix interrupt), and P (Program channel) commands are not affected when power is removed from the 53A/63A System, or by the "@XH" command.

STOP The STOP command is not a string of ASCII characters. The command is hard-wired from the system controller (calculator or computer) to the 53A/63A System communications card in each mainframe. When the system controller issues a STOP command, each function card, including the 53A-431 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

INPUT/OUTPUT CONNECTIONS

All CTS and DCD signals are pulled to an active state. Therefore, it is unnecessary for the user to connect these signal lines if they are not to be used.

If the data inverting switches are in the inverting position, the handshake lines must be hooked up.

Pinouts

Pin No.	Channel No.	Signal Name	Function
1	0	TXD-	Transmit Data
2	0	RTS-	Request To Send
3	0	DTR-	Data Terminal Ready
4	0	RXD-	Receive Data
5	0	CTS-	Clear To Send
6	0	DCD-	Data Carrier Detect
7	1	TXD-	Transmit Data
8	1	RTS-	Request To Send
9	1	DTR-	Data Terminal Ready
10	1	RXD-	Receive Data
11	1	CTS-	Clear To Send
12	1	DCD-	Data Carrier Detect
13	2	TXD-	Transmit Data
14	2	RTS-	Request To Send
15	2	DTR-	Data Terminal Ready
16	2	RXD-	Receive Data
17	2	CTS-	Clear To Send
18	2	DCD-	Data Carrier Detect
19	3	TXD-	Transmit Data
20	3	RTS-	Request To Send
21	3	DTR-	Data Terminal Ready
22	3	RXD-	Receive Data
23	3	CTS-	Clear To Send
24	3	DCD-	Data Carrier Detect
A	0	* TXD+	Transmit Data
B	0	* RTS+	Request To Send
C	0	* DTR+	Data Terminal Ready
D	0	* RXD+	Receive Data
E	0	* CTS+	Clear To Send
F	0	* DCD+/GND	Clear To Send

Pin No.	Channel No.	Signal Name	Function
H	1	* TXD+	Transmit Data
J	1	* RTS+	Request To Send
K	1	* DTR+	Data Terminal Ready
L	1	* RXD+	Receive Data
M	1	* CTS+	Clear To Send
N	1	* DCD+/GND	Data Carrier Detect
P	2	* TXD+	Transmit Data
R	2	* RTS+	Request To Send
S	2	* DTR+	Data Terminal Ready
T	2	* RXD+	Receive Data
U	2	* CTS+	Clear To Send
V	2	* DCD+/GND	Data Carrier Detect
W	0	* TXD+	Transmit Data
X	0	* RTS+	Request To Send
Y	0	* DTR+	Data Terminal Ready
Z	0	* RXD+	Receive Data
AA	0	* CTS+	Clear To Send
BB	0	* DCD+/GND	Data Carrier Detect

* These signals are used in the RS-422 mode only. For the RS-232C mode, the DCD- signal can be switched to GND.

53A-431 Hookup Application Note

The 53A-431 provides several handshake signals to prevent data loss. The signals are defined as follows:

Signal	Effect
RTS	Active from 2 bit times prior to 53A-431 data transmission to 2 bit times after last byte transmitted.
CTS	Turns off 53A-431 transmitter if inactive.
DTR	Goes inactive when 53A-431 receive buffer within 2 bytes of its end. Will remain inactive until "R" command empties some data from buffer.
DCD	Will interrupt 53A-431 if inactive, 53A-431 will then interrupt controller if so programmed.

The simplest handshake hookup would be to hook the 53A-431 DTR to the user's CTS and the user's DTR or RTS to the 53A-431's CTS.

RTS will not go inactive when CTS goes inactive. Data transmission will stop until CTS returns to its active level.

APPENDIX C

PROGRAMMING APPLICATION NOTE

The 53A-431 Quad UART Card has a very fast 53/63 backplane interface. The card achieves this speed by having four interrupts generated by the backplane interface hardware to the Z80. These interrupts are: 1) command in, 2) command response, 3) data in, and 4) data out.

The "command in" interrupt is generated when a byte is sent to the 53A-431 from the system controller and the 53A-431 has not previously been set to a data transfer mode by the "R" or "T" commands. The "command response" interrupt is generated when the system controller requests input from the 53A-431 and the 53A-431 is not in the data transfer mode.

The "data in" interrupt occurs when data is sent from the system controller to the 53A-431 after the card received a "T" command and pulled the binary line on the 53/63 backplane. The "data out" interrupt occurs in response to a request for data after an "R" command.

Once the 53A-431 is placed in the data transfer mode, the only way to exit the mode is to reverse the flow of data on the backplane. For example:

```
10 PRINT @BPI, '@00T0S';
20 PRINT @BPI, 'DATA,DATA,DATA,ETC.';
30 INPUT @BPI,NULL$
.
.
.
```

In this example, the 53A-431's address is 00, channel 0 was sent data to transmit and <CR/LF> were suppressed as required. The transmitted data that was being loaded was halted by input from the 53A-431 Card. Note that if a string containing a CDS address sequence is sent to the CDS Card Cage prior to inputting from the 53A-431, that string will be transmitted out of the 53A-431 port. The purpose of the data transfer mode is to permit the transmission of an "@" out of the 53A-431. In the following example, the card is still addressed and the string is transmitted.

```
10 PRINT @BPI,'@00T0S';
20 PRINT @BPI,'DATA,DATA,DATA,ETC.';
30 PRINT @BPI,'@09F1'
40 INPUT @BPI,NULL$
.
.
```

The 53A-431 is removed from the data transfer mode for received data in the same manner:

```
10 PRINT @BPI,'@00R0S';
20 INPUT @BPI,DATA$
30 INPUT @BPI,MORE$
40 PRINT @BPI,'@09F1'
.
.
.
```

Note that in this case the change of direction of data permitted the 53A-431 to be unaddressed and another card to be commanded. The <CR><LF> at the end of the "R" command is again suppressed.

ACX Programming

When programming the 53A-431 Card with a CDS 53A-130 ACX, a special precaution must be taken. The ACX looks for a <LF> terminator at the end of input received from any card. However, the 53A-431 Card disables this circuitry. Therefore, the ACX must use the LINPUT command with SIZE to terminate input from the 53A-431 Card. For example:

```
10 PRINT @BPI,'@00R0S';
20 LINPUT @BPI,SIZE 10,DATA$
.
.
.
```

If the XYBASIC program used does not specify SIZE, then the system will hang.