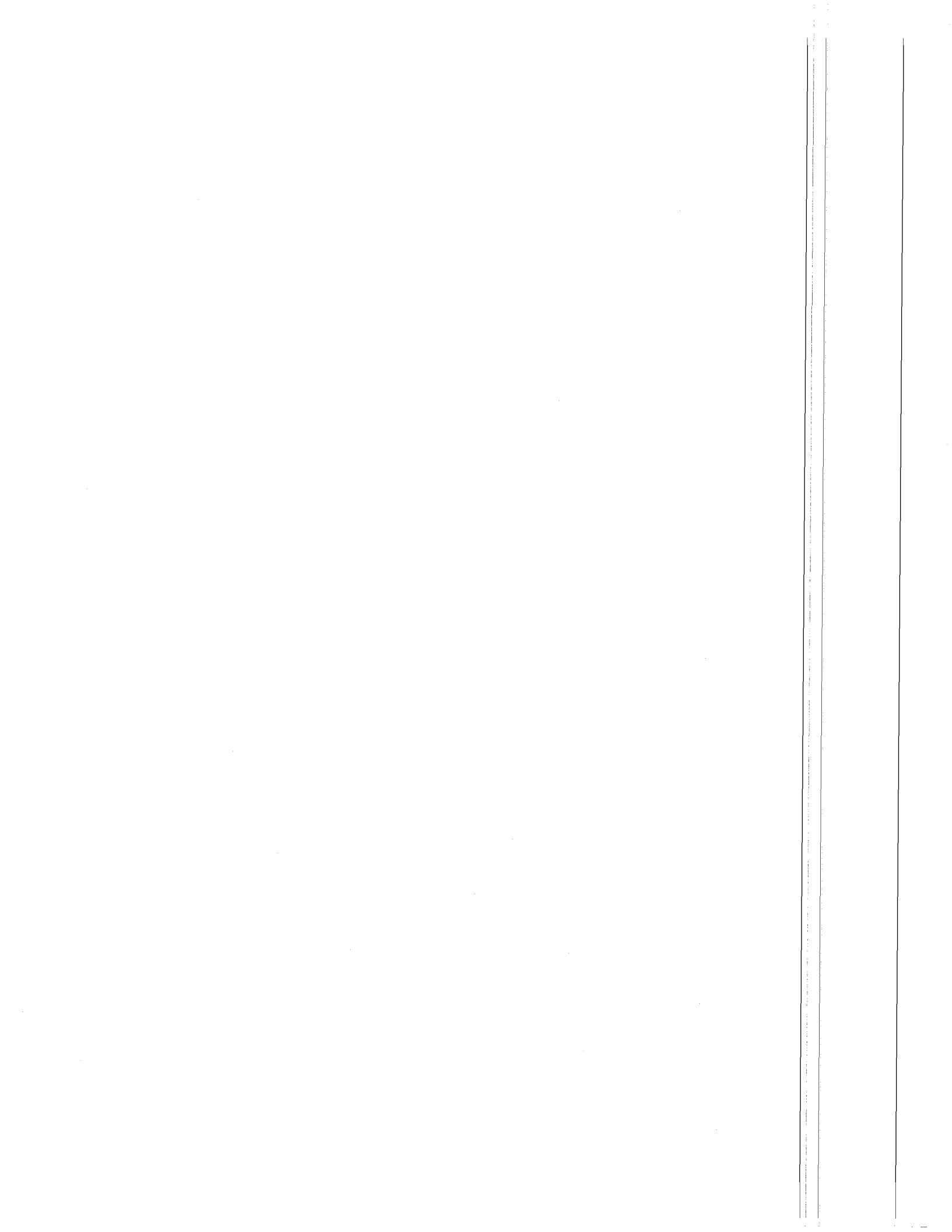


# INSTRUCTION MANUAL



## C20 Cassette Interface

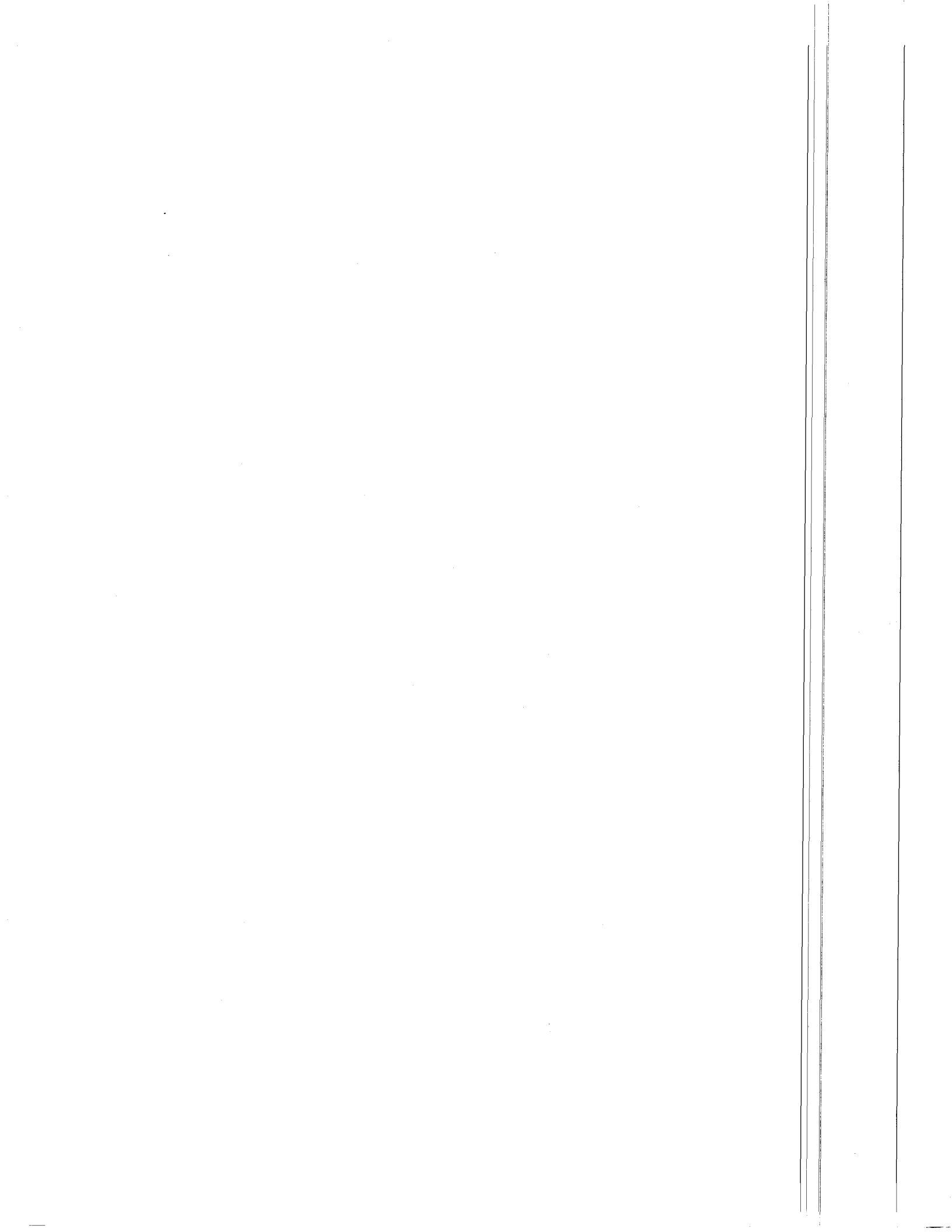
Campbell Scientific, Inc.



**C20 CASSETTE INTERFACE  
INSTRUCTION MANUAL**

**REVISION: 6/89**

**COPYRIGHT (c) 1983, 1989, CAMPBELL SCIENTIFIC, INC.**



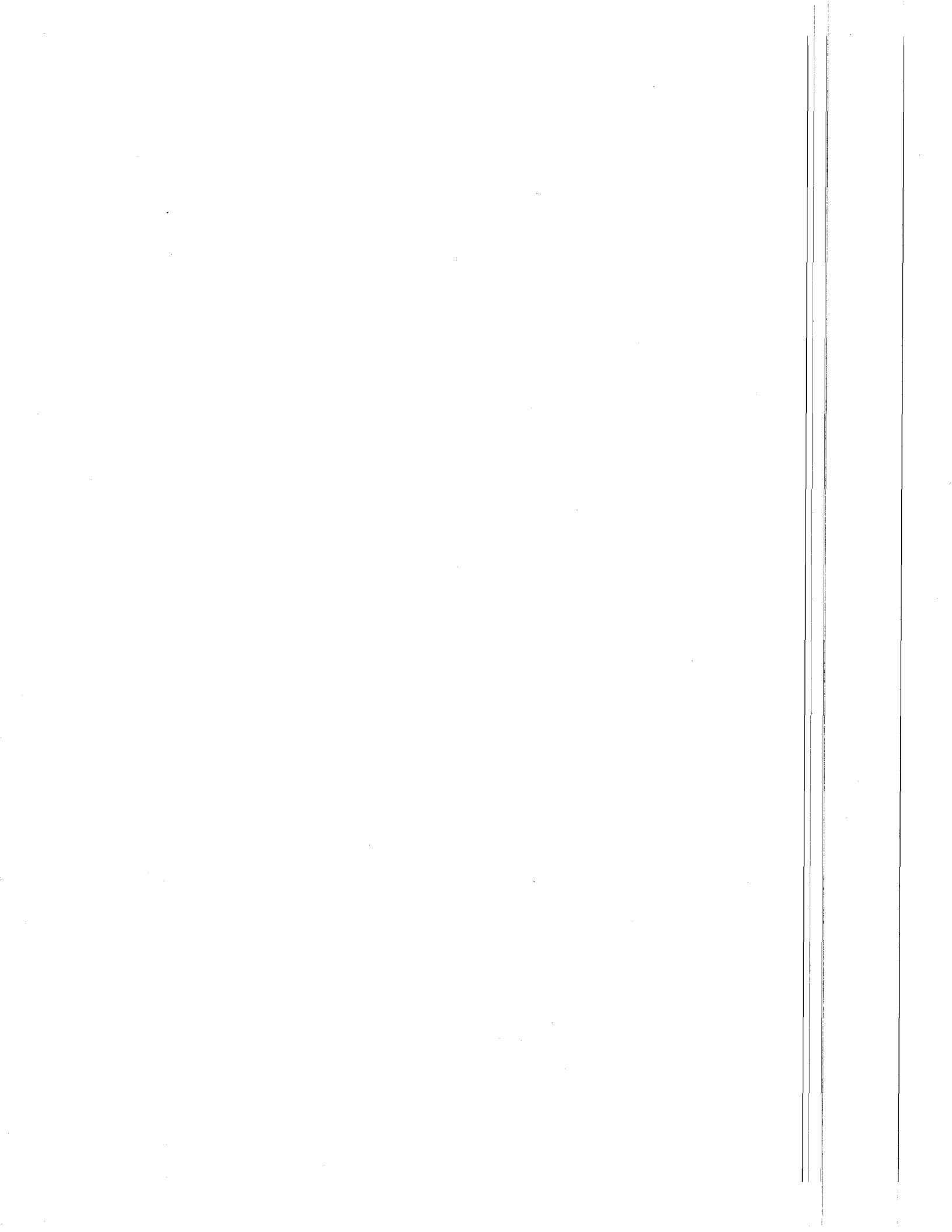
## WARRANTY AND ASSISTANCE

The C20 CASSETTE INTERFACE is warranted against defects in materials and workmanship. This warranty applies for twelve months from date of delivery. CSI will repair or replace products which prove to be defective during the warranty period provided they are returned prepaid to CAMPBELL SCIENTIFIC, INC. CAMPBELL SCIENTIFIC, INC. will return warranted equipment by surface carrier prepaid. No other warranty is expressed or implied. CAMPBELL SCIENTIFIC, INC. is not liable for consequential damages.

Products may not be returned without prior authorization. To obtain a Returned Materials Authorization (RMA), contact CAMPBELL SCIENTIFIC, INC., phone (801) 755-2342. An RMA number will be issued in order to facilitate Repair Personnel in identifying an instrument upon arrival. Please write this number clearly on the outside of the shipping container.

CAMPBELL SCIENTIFIC, INC. does not accept collect calls.

Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.



## PROLOGUE

### C20 POWER SUPPLY

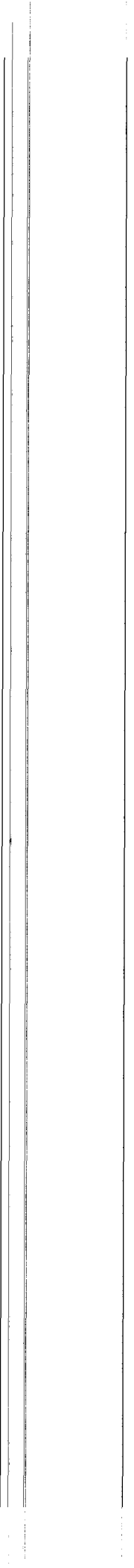
The C20 power supply can accommodate either a 120 VAC or 240 VAC input in a frequency range of 47-63 Hz. The voltage option is provided by the removable adaptor card accessed from the back panel of the C20. The card and the power fuse are located behind the clear plastic cover directly above the panel silk screen "47-63 Hz". When shipped from the factory, the power supply is configured for 120 VAC input. The 240 VAC input is obtained by repositioning the adaptor card. To remove the card, slide the clear plastic cover to the left and push the fuse cam arm to the extreme left so it clears the adaptor card. Carefully pull the card out with pliers or by hooking the exposed hole with a pointed object. Rotate the card 180° in the horizontal plane (i.e., maintain the original top and bottom) so the marked "240" can be read and reinsert.

The power supply sources 2 amps at 5 VDC and 400 mA at  $\pm 12$  VDC. It should not be used to power peripherals.

### EARLY CR21/CR5 DATATAPE COMPATIBILITY

#### Attention:

Users generating datatapes with either an R235 CR5/Cassette Interface or an SC235 CR21-Cassette Connector purchased prior to May 1982, should be aware of the information contained in Appendix D.

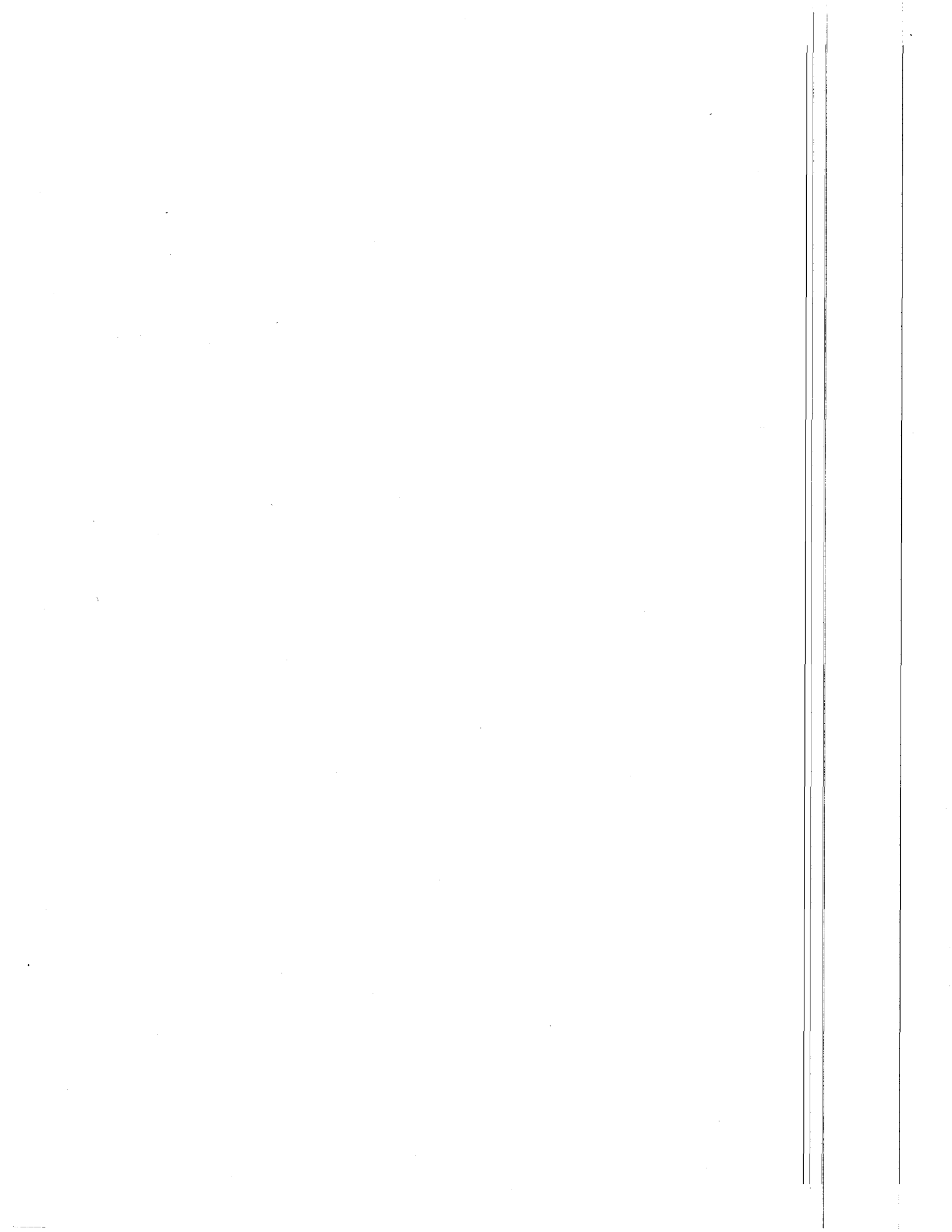


## TABLE OF CONTENTS

PROLOGUE		
	C20 Power Supply .....	1
	Early CR21/CR5 Datatape Compatibility .....	1
1.	INTRODUCTION	
1.1	General Description and Purpose .....	1-1
1.2	A Quick Set-Up Procedure for Reading Tapes ....	1-2
2.	FUNCTIONAL OPERATION - SWITCH SETTINGS	
2.1	General .....	2-1
2.2	Baud Rate, Parity and Stop Bits .....	2-2
2.3	Program Mode and Communications Protocol .....	2-2
2.4	Default Mode Protocol .....	2-3
2.5	User Programmable Mode Protocol .....	2-4
2.6	Port Selection, "Port A and B" or "Port B Only" .....	2-7
2.7	Format Selection .....	2-8
3.	WRITING TO TAPE	
3.1	General .....	3-1
3.2	Writing to Tape .....	3-1
3.3	Connections .....	3-1
3.4	Write Mode of Operation - Switch Settings .....	3-2
4.	A QUICK TROUBLE SHOOTING GUIDE .....	4-1

## APPENDICES

Appendix A.	Ports A and B Configuration .....	A-1
Appendix B.	Datalogger Format II	
B.1	General .....	B-1
B.2	Datalogger Final Memory Storage Format .....	B-1
B.3	C20 Decoded Representation of ASCII Datalogger Format .....	B-3



## TABLE OF CONTENTS

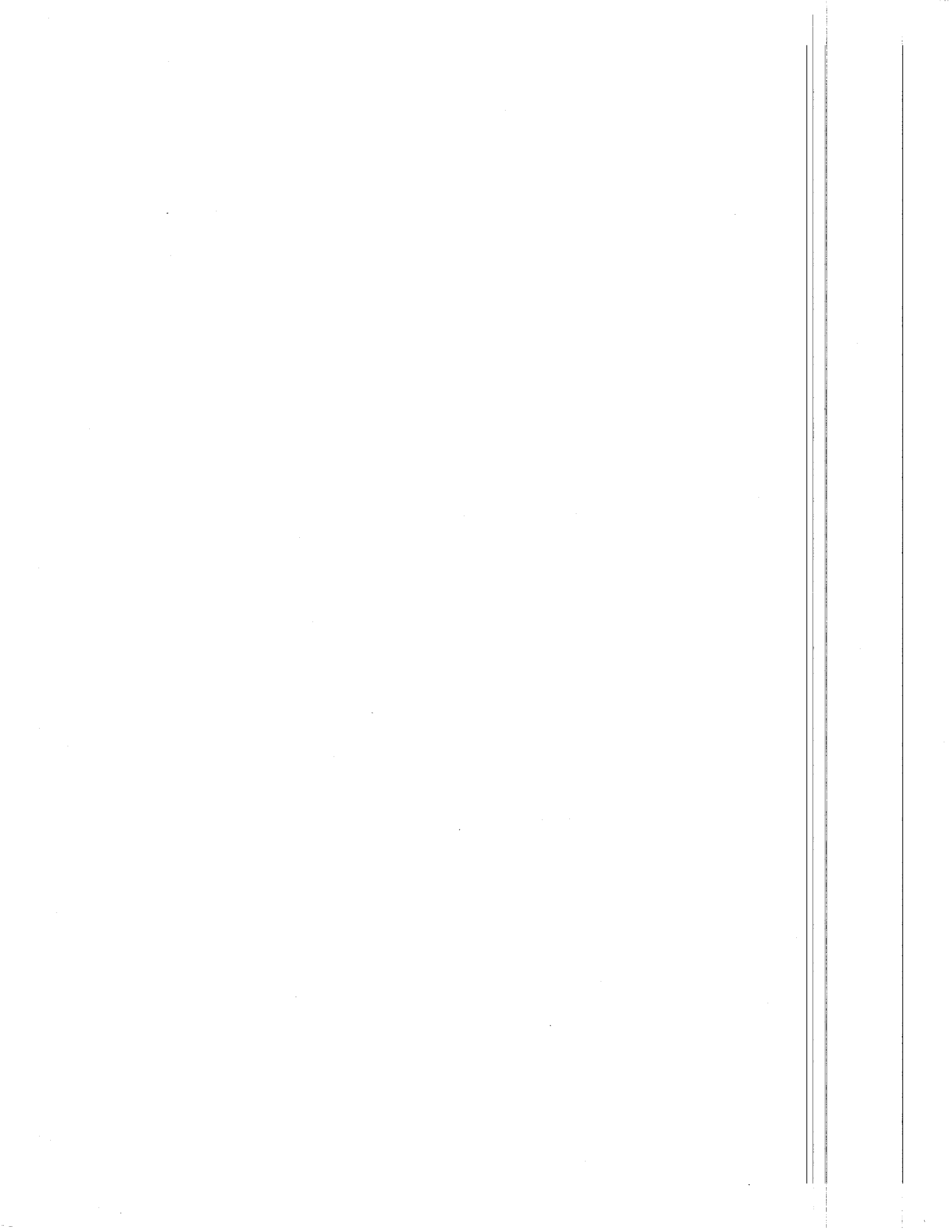
Appendix C.	Programming Examples	
C.1	BASIC Program .....	C-1
C.2	A Program that will read Data from the C20 onto Disk when the C20 is in the Default Mode .....	C-2
C.3	Basic Tape Read Program for the IBM-PC or XT Computer .....	C-2
C.4	A BASIC Program that writes an ASCII File to Tape .....	C-3
C.5	A Program written in Z80 Machine Language that writes 8k Bytes from the Computer Memory to Tape .....	C-3
Appendix D.	Early CR21/CR5 Datatape Compatibility	
D.1	General .....	D-1
D.2	Identifying and Modifying an "Unmodified" SC235 .....	D-2
D.3	Identifying and Modifying an "Unmodified" R235 .....	D-4
Appendix E.	Tape Recorder Head Alignment .....	E-1
Appendix F.	Terminology .....	F-1

### TABLES

2-1	Default Mode Protocol .....	2-3
2-2	Programmable Preamble Delay .....	2-5
2-3	Programmable Mode Port Options .....	2-5
2-4	Summary of C20 Format Switch Selections for Reading Tapes .....	2-10
A-1	C20 RS-232-C Pin Description .....	A-2,3

### FIGURES

1-1	Head Alignment Adjustment Screw of Tape Recorder ....	1-3
2-1	C20 Front Panel .....	2-1
A-1	C20 Port Pin Numbers .....	A-1
A-2	Block Diagram of RS-232-C Standard Pin Description ..	A-4
A-3	Model 2321 Z80 CPU Board showing PORT A and PORT B configuration jumpers .....	A-5
A-4	Factory Configuration of the Jumpers for Port A and Port B .....	A-6
D-1	Unmodified and Modified Backshell of SC235 .....	D-3
D-2	Unmodified R235 T135-2 Card .....	D-4



## SECTION 1. INTRODUCTION

### 1.1 GENERAL DESCRIPTION AND PURPOSE

Campbell Scientific's C20 CASSETTE INTERFACE allows the users of CSI's dataloggers to retrieve data stored on tape. It's main purpose is to read tapes generated by the CR5, CR21, or CR7 dataloggers, decode the format, and transmit the data in a usable form to your computer, modem, terminal, printer, or any other equipment that can communicate via the standard RS232 interface.

The C20 is designed for simple operation yet includes the flexibility to interface with most of the broad range of computers and communication equipment available today. Hardware "handshaking" (for example, using such lines as "clear to send" or "data terminal ready") through two independent RS232 ports allows the user to interface his tape recorder with either data communication type equipment (DCE) such as computers and modems or with data terminal type equipment (DTE) such as terminals or printers, or with both types of equipment simultaneously. Additionally, "software handshaking" such as single byte commands to "stop!", "send one line of data" or "send data continuously" makes communication straight forward. Such protocol is user programmable if the default protocol is incompatible with your particular equipment.

The C20 CASSETTE INTERFACE reads Campbell Scientific's new high density, high speed, high reliability tape format, Format II. For example, 180,000 low resolution data points as opposed to 8,000 can now be stored on a single side of a 60 minute cassette tape (30 minutes/side). At the 9600 bit per second (baud) rate the C20 reads, decodes and outputs the data at a rate of 100 datapoints per second (100 data points = 1000 ASCII characters = 10,000 bits). The C20 can also be switched to read tapes written in the original format, Format I.

The new format incorporates a unique error detection and correction process that greatly improves data integrity and minimizes the problems arising from damaged tapes. For example, a "burst error" that wipes out up to 16 adjacent datapoints on tape will be corrected by the C20 with no loss of data. The error correcting scheme is also optimized to correct randomly dispersed errors.

Data written to tape by CSI dataloggers using the new format can be read and output by the C20 in either of two different forms: (1) as ten-byte ASCII data values or (2) as two-byte or four-byte binary data values. Appendix B describes in detail the data

## SECTION 1. INTRODUCTION

format you can expect out of your C20 and the specific advantages of each representation.

The C20 also writes to tape using CSI's high speed, high density, error-correcting format. It can write (and read back) ASCII or any other file types received from either the computer port or the terminal port.

You should by now have a sense of the capability of your tape reader. It is more than "just a tape reader" yet principally, you DO want to "simply" read your tapes. The following "quick setup procedure" will show you how to do just that.

### 1.2 A QUICK SET-UP PROCEDURE FOR READING TAPES

#### TURN ON YOUR TAPE RECORDER

Listen to your data with the volume control on midrange. You should adjust the skew position of the head if the data sounds muffled. Improper head skew cuts down the high frequency response of the tape recorder. The adjustment screw is near the head assembly (Figure 1-1) and can be adjusted back and forth until you can hear the maximum high frequency response. Refer to Appendix E for more detailed information regarding head alignment procedure.

#### CONNECT

Connect the two cables from the tape recorder MONITOR and REMOTE to the C20 monitor (MON) and remote (REM) located on the back panel.

#### PROGRAM MODE

Move switch 5 on the C20's (Figure 2-1) front panel (PROGRAM MODE) to the DEFAULT position (closed).

#### TAPE FORMAT

Set switches 7 and 8 on the C20's front panel to match the tape format on the tape you wish to read. If the data on the cassette tape is written in Format II then the switches should be set to the II, DECODE position (open, closed). If the data is written in Format I then the switches should be set to the I, ASCII position (open, open). For further information see Section 2.7.

#### TURN TAPE RECORDER ON

Rewind and turn on the tape recorder. Make sure the tape recorder is running.

## PANEL LIGHTS

Watch the lights on the front panel. As soon as the tape recorder begins playing data, the green data light (LED) should light up. If it does not light up, or if the red error indicator light flashes, the C20 is not getting data or it is getting erroneous data.

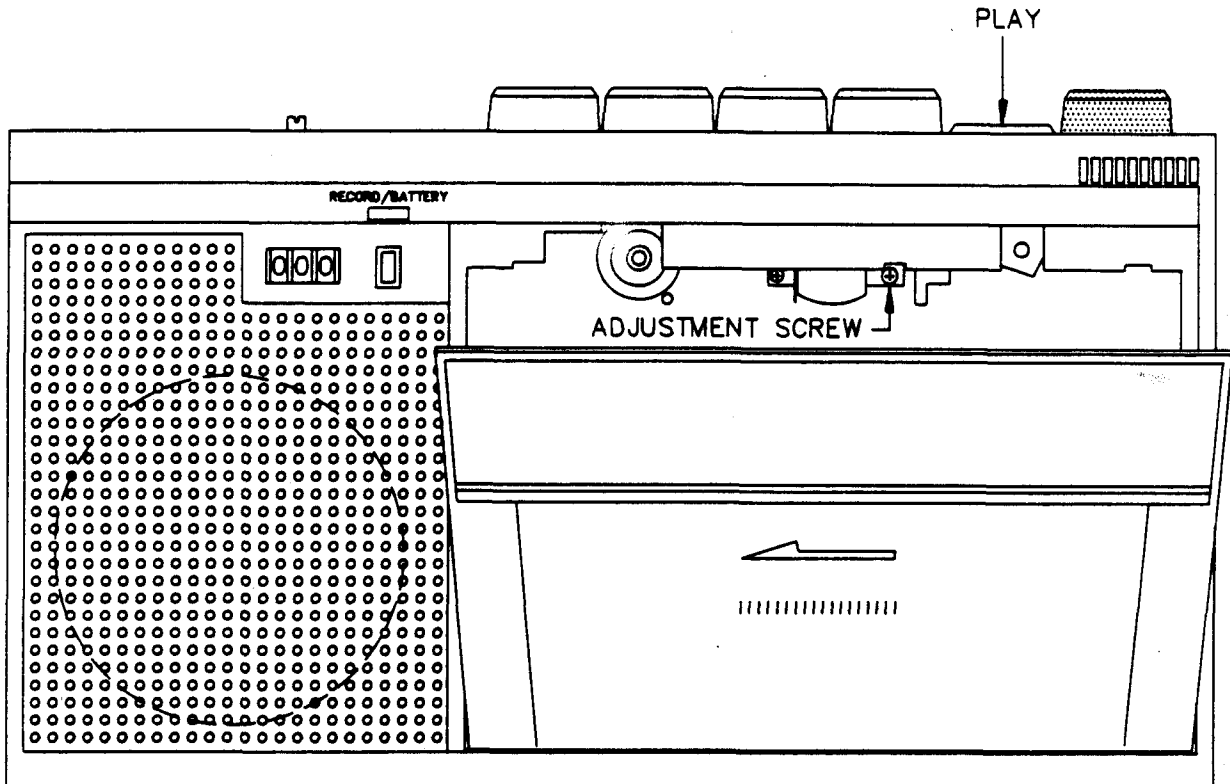


Figure 1-1. Head Alignment Adjustment Screw for Tape Recorder

## ADJUSTMENT

Adjust the volume control toward both extremes until the red light starts flashing, then set it half way in between these two extremes. Now, you should be reading good data, with the green light staying on for about 3.5 seconds (the length of time for one block of data) and off for 1.5 seconds (the "gap time" between blocks of data). If the red light continues to flash, check the skew adjustment, as described in the first step.

## SECTION 1. INTRODUCTION

### TRANSMIT LIGHTS

See if the transmit lights at PORT A and PORT B are working. If switch 6 is open (C20 TO PORTS A AND B) then both transmit lights should begin flashing once the first block of data has been read and processed by the C20. If switch 6 is closed, only PORT B should be flashing.

### CONNECTING C20 WITH VARIOUS TYPES OF EQUIPMENT

At this point you are assured that the C20 is reading tape and transmitting data out PORT B or out both ports. Using the ribbon cable supplied with your C20, connect your terminal (or any other equipment specified as "DTE") to PORT A. Connect your computer (or any other equipment specified as "DCE") to PORT B. Figure A-2 (Appendix A) illustrates in a general way the connection between the C20 and various types of equipment. Appendix A describes in detail the pin functions of each of the two serial ports (PORT A and PORT B).

If your computer and terminal are packaged as a single unit with only one RS232/C port configured as DCE, you must do one of the following: 1) connect to Port B and use the DEFAULT protocol only, or 2) connect to Port A after reconfiguring it as a DTE port (see Appendix A for details) and use either the DEFAULT or PROGRAMMABLE protocol.

### SETTING BAUD RATES AND PARITY SWITCHES

Set the baud rate and parity switches to match the requirements of your specific communication equipment. Section 2 provides a complete description of the function of each switch.

### PROTOCOL

Decide whether the default protocol will suffice or whether you should program the C20 with your own protocol. Your computer program can easily incorporate commands that program the C20 (see the BASIC program in Appendix C for example) or you can program it from your terminal. See Section 2 for descriptions of the PROGRAM switch.

### PROGRAMMING

Program your computer to accept the data coming from PORT B of the C20 (see Appendix C for some sample programs written in BASIC). If your computer program echoes (retransmits characters it receives), set switch 6 closed (C20 TO PORT B ONLY). Otherwise, leave switch 6 open and the C20 will transmit to the terminal or printer and the computer.

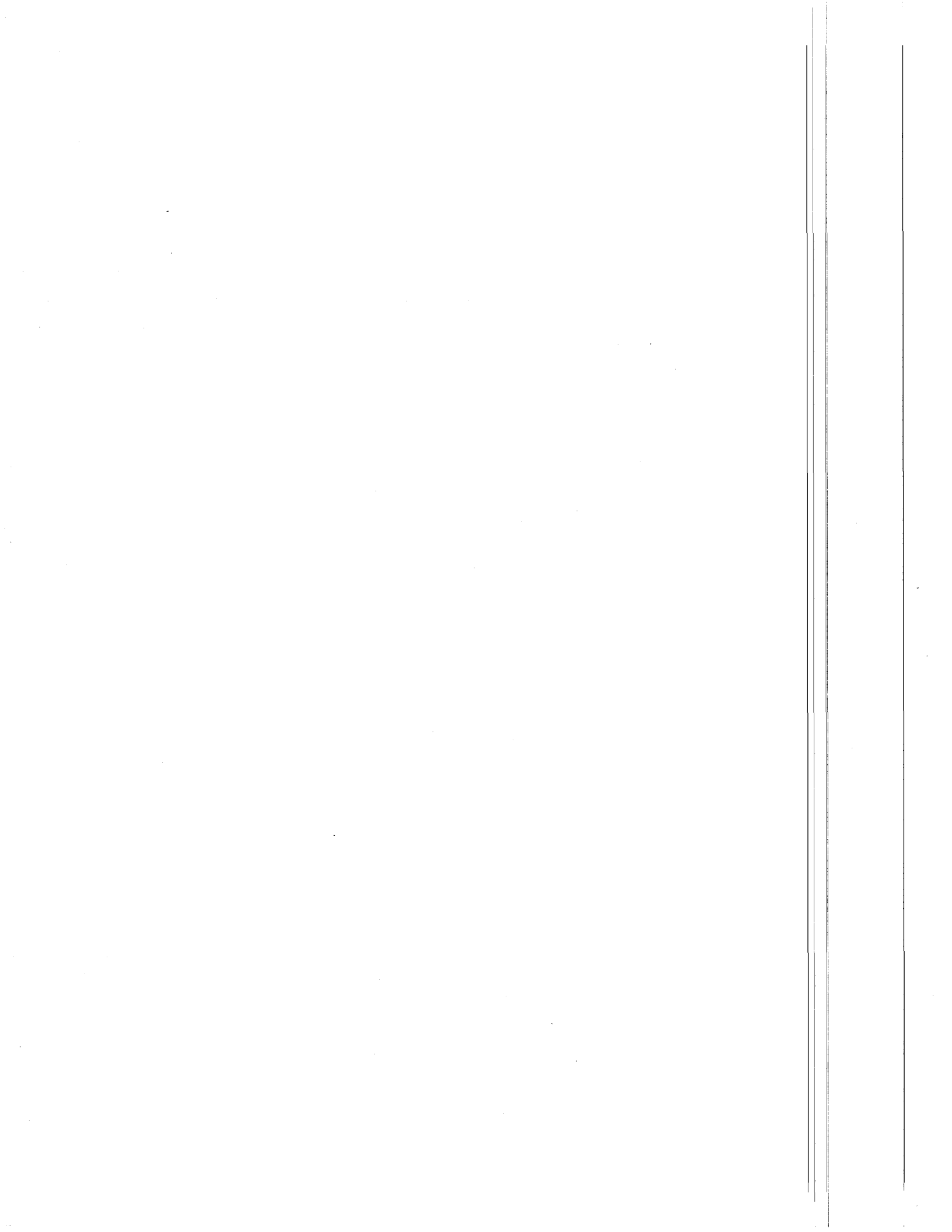
## SECTION 1. INTRODUCTION

### RUNNING PROGRAM

Once your C20 is set up, rewind your tape recorder, start up your program, turn on your tape recorder and watch your data come screaming out.

### EXIT COMMAND

When you are finished reading the tape, give the C20 the "exit" command (default "escape" character or user programmed). The C20 will turn off the tape recorder and enter its "transparent" mode, allowing you to carry on communication between the terminal and computer without interference from the C20.



## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

### 2.1 GENERAL

The various operating modes of the C20 Cassette Interface are determined by the switch settings and through communication commands at either of the two serial ports (PORT A and PORT B). A switch-by-switch description follows explaining the specifics of the various modes of operation and the necessary switch settings and commands for each mode. The front panel description is reproduced in Figure 2-1 for reference.

Note! Any change in switch positions will reset the C20 to start all over again under the control of the new switch settings.

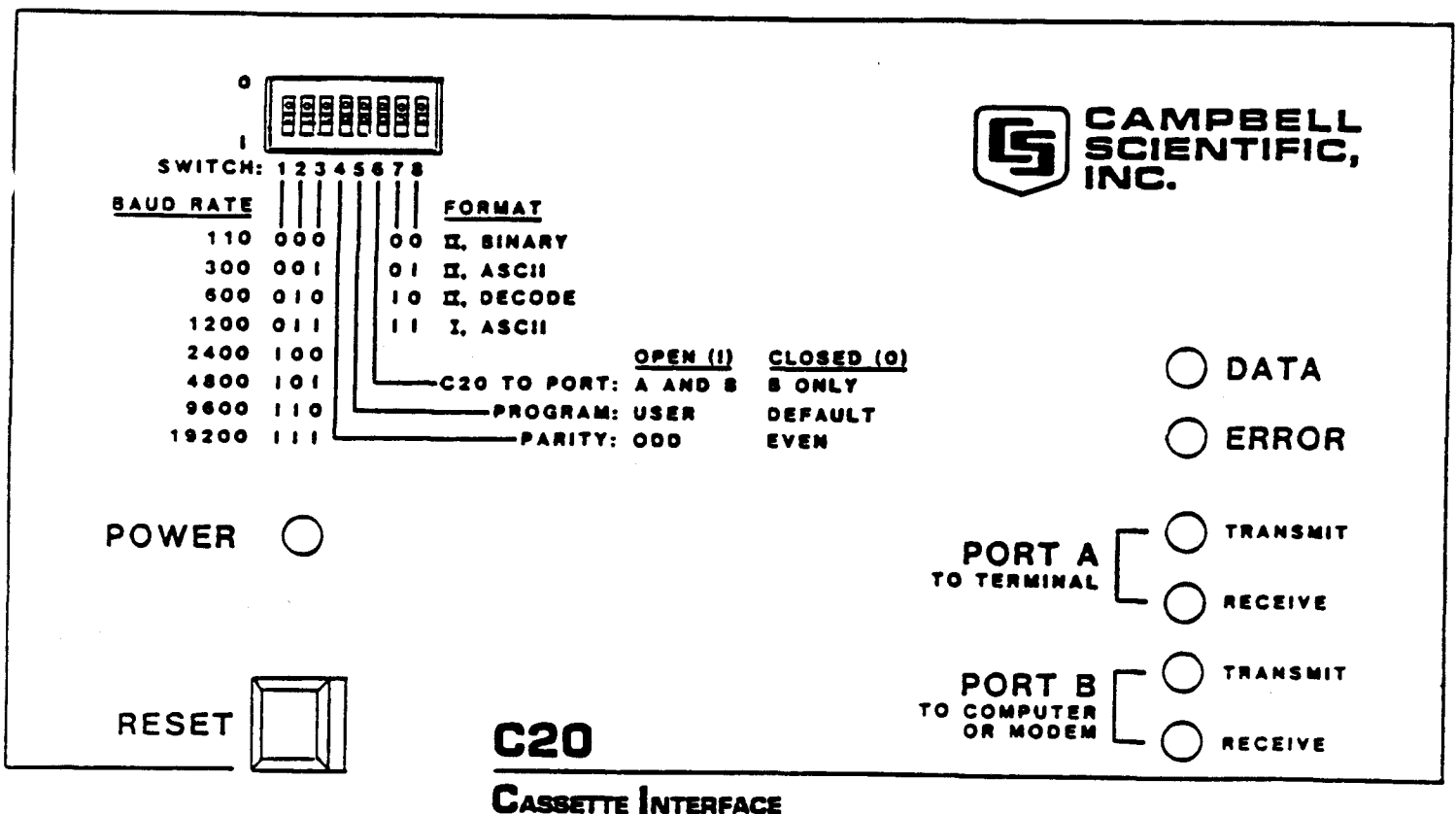


Figure 2-1. C20 Front Panel

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

### 2.2 BAUD RATE, PARITY AND STOP BITS

Switches 1, 2 and 3 set the communication baud rate at the two serial ports. Both ports transmit and receive at the same selected baud rate. The switch setting must match the baud rate setting on whatever equipment is connected to these ports.

Switch 4 sets the parity bit when ASCII characters are being transmitted. In these cases, 7 bits of data and the one parity bit are transmitted. Non-ASCII (BINARY) information is transmitted with 8 data bits and no parity. Section 2.7 describes the various format options.

The C20 transmits 2 stop bits after each byte to PORT B (to Computer) and only 1 stop bit after each byte to PORT A (to Terminal).

### 2.3 PROGRAM MODE AND COMMUNICATIONS PROTOCOL

Switch 5 determines whether the DEFAULT or USER PROGRAMMABLE communication protocol is employed. Before discussing the DEFAULT protocol and how to program your own protocol we should define the 3 features that comprise the C20 protocol.

1. Communication Commands - The C20 responds to four different communication commands. The command characters are fixed in the DEFAULT mode but the user can define the characters in the PROGRAMMABLE mode. The function of the commands are as follows.

STOP command - transmission of characters is stopped within 1 character of the present character being transmitted when this command is received.

SEND ONE LINE command - the C20 transmits data through the end of the postamble and then stops, awaiting another command. The end of the postamble defines the end of a line of data. The amount of data contained in one line is a function of the output format defined in Section 2.7.

SEND CONTINUOUSLY command - the C20 transmits data continuously until another command is received or the data tape ends.

EXIT command - terminates the C20's read program, stops the tape recorder and causes the C20 to enter the "transparent" mode where it passes any communication it receives between it's ports. Resetting the C20 or changing a switch position is the only way the tape read mode can be reentered.

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

2. Postamble - The postamble is one or more characters following a group of data and defines the end of a line of data. There are 2 fixed postambles in the DEFAULT mode depending on the position of switch 6 whereas the user may define up to a 16 ASCII character postamble in the PROGRAMMABLE mode.
3. Preamble Delay - This parameter is the time delay between the C20 receiving a transmission command and the transmission of the first character. The preamble delay in the DEFAULT mode is fixed at 1 msec but can be user specified in the PROGRAMMABLE mode.

### 2.4 DEFAULT MODE PROTOCOL

With switch 5 in the DEFAULT position (closed), the C20 is in the tape READ mode and will operate with the preprogrammed protocol shown in Table 2-1.

TABLE 2-1. DEFAULT MODE PROTOCOL

COMMUNICATION COMMANDS	ASCII CHARACTER
"STOP!"	12 hex (19 dec, ^S)
"SEND ONE LINE"	11 hex (17 dec, ^Q)
"SEND CONTINUOUS"	14 hex (20 dec, ^T)
"EXIT"	1B hex (27 dec, ESC)
POSTAMBLE	
Switch 6 set to B only	0D hex (13 dec, CR)
Switch 6 set to A and B	0D, 0A hex (13, 10 dec; CR, LF)
PREAMBLE DELAY	1 msec

Note that the DEFAULT postamble depends upon the setting of Switch 6. Many computers echo the characters (full duplex) they receive and generate line feeds (LF) after they receive a carriage return (CR). For these situations, Switch 6 should be set to "B port only" and the postamble is a CR. For situations where the data is going to a terminal only or where the computer does not echo and can tolerate a LF postamble, Switch 6 should be in the "A and B" port position.

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

If the C20 does not receive a command in the DEFAULT mode, it begins transmission as soon as it finds, reads and processes the first complete block of data on tape. Once found, a FORMAT II block of data takes 3.5 sec. to read. Thus, data can be read continuously into equipment that cannot issue a "start" command. CAUTION! If your computer is not ready for data, make sure the tape recorder is turned off until it is ready. The C20 still responds to any command you give it in this mode, e.g., STOP (^S), SEND ONE LINE (^Q), etc. Remember, if you change a switch or reset the C20, it forgets any previous commands and starts over from scratch. Therefore, do not start running your computer program and then reset the C20 and expect it to perform correctly.

In short, remember the following sequential procedure when operating in the DEFAULT mode: (1) make sure the C20 switch positions are all set correctly and that the C20 is operable (2) then call up your computer's tape read program (the C20 will not interfere with communication between terminal and computer except for the command characters) (3) finally, turn on the tape recorder.

### 2.5 USER PROGRAMMABLE MODE PROTOCOL

The USER PROGRAMMABLE mode is available for those cases when the default protocol is incompatible with your system. Even if you program the C20 with the default protocol you may find it easier to use the programmable mode. You will see why shortly.

First, what are the specifications of the programmed protocol?

1. Communications commands - any ASCII character can be used to designate the communication commands shown in Table 2-1. CAUTION! DO NOT use ASCII command characters that appear as part of data if your computer echoes back through the C20 to your terminal. This is discussed further in Section 2.6.
2. Postamble - the postamble can be a sequence of any ASCII characters up to 16 characters in length. The user must send a 1B hex ("ESCAPE") character to indicate the end of his postamble sequence.
3. Preamble Delay - the preamble delay parameter can be any delay between 1 msec and 900 msec in 100 msec increments. (see Table 2-2).

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

TABLE 2-2. PROGRAMMABLE PREAMBLE DELAY

DELAY	ASCII CHAR.
1 MSEC	0
100 MSEC	1
200 MSEC	2
300 MSEC	3
!	
!	
!	
900 MSEC	9

Answering any of the protocol questions other than the postamble with a carriage return inserts the default protocol.

### PROGRAMMING SEQUENCE

When Switch 5 is set to the USER PROGRAMMABLE mode, the C20 sends an option menu (Table 2-3) to PORT A only and waits for an appropriate OPTION COMMAND from PORT A only.

TABLE 2-3. PROGRAMMABLE MODE PORT OPTIONS

A = READ (A)  
B = READ (B)  
W = WRITE (A)  
V = WRITE (B)  
T = TRANSPARENT  
OPTION?

A means "I want to program from Port A (my terminal)".  
B means "I want to program from Port B (my computer)".  
W means "I want to write data to tape from Port A".  
V means "I want to write data to tape from Port B".  
T means "I want the C20 to be completely transparent".

### OPTION A

Choosing option "A" will cause the C20 to listen to PORT A for the read protocol sequence. Prompt messages to step you through the keyboard entries are sent to PORT A only with this option.

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

If your computer and terminal are packaged as a single unit with a single port configured as DCE (e.g. many HP's) you will need to reconfigure Port A as a DTE port (see Appendix A for details). Once this is done you can send the "A" option COMMAND and program the C20 manually from your terminal or with a computer routine. Once the C20 receives the "A" OPTION COMMAND, your program must wait until the PORT A prompt message is transmitted before sending the next protocol character. Regardless of how you program the C20 in situations where PORT A is reconfigured as DTE, you must first send it an "A" option command informing it you are going to program from PORT A. Single unit computers such as IBM-PC's have a single port configured as DTE and connect directly to PORT A without reconfiguration.

### OPTION B

Choosing option "B" will cause the C20 to listen to PORT B, your computer in most cases. No prompts whatsoever are sent with this option. Instead, the C20 waits for the "READY TO PROGRAM" signal, a 16 hex (^V), from the computer. Until this character is received at Port B, the C20 is transparent to communication between the terminal and the computer, allowing the user to initiate their tape read program without interference from the C20. The characters immediately following the "AV" at Port B are interpreted by the C20 as the programmable tape read protocol.

Whether programming from PORT A or from PORT B the string of parameters must include one character per communication command, 0 to 16 characters as a postamble delineated with an "ESC" at the end of the postamble string and one ASCII numeral to designate the preamble delay. If an illegal character is received the C20 will reset.

After all the protocol parameters are received by the C20 in the USER PROGRAMMABLE mode, the C20 then turns on the tape recorder and reads in a block of data. Unlike the DEFAULT mode, the C20 waits for an initial start command, either "TRANSMIT ONE LINE" or "TRANSMIT CONTINUOUSLY", before it begins transmission to either port.

The advantages of option B in the USER PROGRAMMABLE mode can now be discussed. The tape recorder can be left turned on but the C20 keeps it turned off until it receives the programmable protocol. In the DEFAULT mode, you must keep your recorder off until you initiate your computer program from the terminal because the C20 begins to read the tape immediately. In addition, your terminal and computer can communicate freely after selecting the B option with the exception of using the "READY" command "^V". In the DEFAULT mode, "^S", "^Q", "^T" and "ESC" are all interpreted by the C20 as communication commands.

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

Appendix C includes a simple BASIC program that programs the C20, asks for and receives one line of data, stores the data on disk, and exits the program upon command from the terminal while commanding the C20 to exit its "READ" mode and enter its "TRANSPARENT" mode.

### OPTION T

Choosing Option "T" puts the C20 in a "TRANSPARENT" mode where any characters received from Port A are transmitted to Port B and visa versa. This mode allows the user to keep the C20 connected between their terminal and computer when not using the cassette interface function of the C20. Sending the C20 a "T" after power-up or reset when in the USER PROGRAMMABLE mode (switch 5 open) hides the C20's presence. Note: The "TRANSPARENT" mode can always be entered when the C20 is in the middle of reading tapes by giving it the "EXIT" command.

A specific example using the "TRANSPARENT" mode is connecting the C20 between a terminal and a modem communicating with a remote computer. When you are ready to read tapes, DO NOT exit the TRANSPARENT mode via the RESET switch as momentary power down occurs, causing the modem to hang up. Instead, exit the TRANSPARENT mode by toggling one of the panel control switches. This action resets the C20 without power interruption.

### OPTIONS W AND V

Options "W" and "V" are discussed in Section 3.

### 2.6 PORT SELECTION, "PORT A AND B" OR "PORT B ONLY"

Switch 6 determines which port the C20 communicates through, the options being either through both ports or through Port B only. By "communicate", we mean (1) transmit data read from tape and (2) respond to commands received. In either switch position, any non-command character received at one port is transmitted out the other port.

What is the significance of this switch? It allows the C20 to operate between terminal and computer whether or not the computer echos back to the terminal. If your computer tape read program does not echo and you want data to go to both ports and commands to be read from either port, you should have switch 6 in the OPEN position, C20 TO PORT A AND B. If, on the other hand, your computer program echos, then you should have switch 6 in the CLOSED position, C20 TO PORT B ONLY. The C20 will then transmit data only to Port B while passing all echoed data received at Port B onto Port A. It will also listen only to commands from Port B while it passes anything it receives from Port A onto Port B and all non commands from Port B onto Port A. Note that if

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

your computer is echoing but you have switch 6 open, then Port A will see double characters. CAUTION! As noted above, DO NOT program your C20 with command characters that may also appear as part of your data since these characters will be interpreted as commands when echoed back by the computer.

As noted above, the position of switch 6 also determines the DEFAULT mode postamble. If B ONLY is selected, then only a CR is sent, otherwise, CR and LF are sent.

### 2.7 FORMAT SELECTION

The form of the data output by the C20 through PORTS A and B depends on the setting of switches 7 and 8. The four options are (1) 11, BINARY, (2) 11, ASCII, (3) 11, DECODE and (4) 1, ASCII. The front panel (Figure 2-1) shows the corresponding switch positions.

The proper setting of the FORMAT switches depends upon (1) the format of your data on tape, i.e., is the tape format CSI FORMAT I (original) or CSI FORMAT II (the new high density format) and (2) what representation you want your data transmitted in, ASCII or BINARY.

TAPE FORMAT I, ASCII - Refers to the original CSI tape format generated by all CR5 Digital Recorders and those CR21 Microloggers shipped prior to June 1982, and not updated. All tapes generated by such dataloggers must be read with the FORMAT switch position in the fourth position, 1, ASCII. The data on tape is formatted as ten character ASCII data values, including spaces.

TAPE FORMAT II - Is the standard format used in current CR21 Microloggers, 21X Microloggers, and CR7 Measurement and Control Systems. Any tapes generated by the C20 Cassette Interface also use this high density, error-correcting format. Two format switch options exist when reading FORMAT II tapes.

1. 11, DECODE output - In most cases the decoded ten character ASCII data values will be the most useful output representation of FORMAT II tapes. The values consist of a four or five digit number, decimal point, sign and data point identification. Appendix B specifies the details. Switching the C20 FORMAT switches to the 11, DECODE position causes the C20 to first decode the binary format generated by the datalogger into the ASCII representation before outputting. Seven ASCII data bits and the selected eighth parity bit are sent for each character. The user selected postamble is sent at the end of every 79th character or before the start of a new data array.

## SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

2. 11, BINARY output - Data stored on tape by a CR21, 21X or CR7 datalogger takes the form of the FINAL MEMORY STORAGE FORMAT in the datalogger. The data is represented as two byte binary encoded data values in the CR21 and as two byte or four byte binary encoded data values (depending upon desired resolution) in the CR7. Appendix B specifies the details of this FINAL MEMORY STORAGE FORMAT. If the C20 FORMAT switches are in the 11, BINARY position, then the C20 will output the direct representation of the data stored on tape without decoding to ASCII. Since the bytes output by the C20 are not ASCII characters, 8 bits without parity are transmitted. Further, the user selected postamble is sent at the end of every 1024 bytes.

The primary feature of leaving the data in the FINAL MEMORY STORAGE FORMAT is the compact mass storage on such devices as floppy discs. Instead of using 10 bytes to represent the data point in ASCII only 2 bytes are required. ASCII representation can be obtained directly by writing a conversion program or by generating a binary tape on the C20, then reading the tape into the computer using the 11, DECODE format selection.

The following two paragraphs deal with reading tapes written by the C20.

TAPE FORMAT 11, ASCII - ASCII files written to tape by the C20 with the FORMAT switches in the 11, ASCII position, should be read with the FORMAT switches in the 11, ASCII position. The C20 outputs the identical ASCII character stored on tape with the exception that all LF's on the source tape are stripped and the user selected postamble replaces any CR's. The eighth bit is the parity bit selected by the PARITY switch.

TAPE FORMAT 11, BINARY - BINARY files written to tape by the C20 with the FORMAT switches in the 11, BINARY position, should be read with the FORMAT switches in the 11, BINARY position. Eight data bits without parity are sent, and all bytes stored on tape are transmitted. The user selected postamble is transmitted at the end of every 1024 bytes.

Table 2-4 summarizes the proper FORMAT switch settings for the various tape sources. The only tape source which allows an option in the output format is CSI datalogger tapes written in FORMAT 11. These tapes can be read and output as binary or decoded to ASCII. The last column of Table 2-4 references the postamble associated with the various output formats. "User selectable" refers to the user selecting either the DEFAULT or USER PROGRAMMABLE postamble.

SECTION 2. FUNCTIONAL OPERATION - SWITCH SETTINGS

TABLE 2-4. SUMMARY OF C20 FORMAT SWITCH SELECTIONS FOR READING TAPES

TAPE SOURCE	TAPE FORMAT	C20 FORMAT SWITCH SELECTION	OUTPUT	POSTAMBLE
CSI dataloggers	CSI I	I, ASCII	ASCII	User selectable, after every 79th character or before the start of a new data output scan
CSI dataloggers	CSI II	II, DECODE	ASCII	User selectable, after every 79th character or before the start of a new data output scan
CSI dataloggers	CSI II	II, BINARY	binary no parity	user selectable, after every 1024 bytes
C20 II, ASCII format write selection	CSI II	II, ASCII	ASCII	Source tape LF's are stripped and the user selectable postamble (DEFAULT or USER PROGRAMMABLE mode) replaces any source tape CR's
C20 II, BINARY format write selection	CSI II	II, BINARY	binary no parity	user selectable, after every 1024 bytes

## SECTION 3. WRITING TO TAPE

### 3.1 GENERAL

The C20 Cassette Interface writes to tape using the high density, error correcting FORMAT II. It will write either ASCII or non ASCII files received from either serial port.

The C20 buffers up 1024 bytes of data then writes this block to tape while it buffers up the next block to be written to tape. If an ASCII file is being written, then a "residual dump command," (ESC, 1B hex) signals the end of the file. The rest of the block is filled with nulls (00 hex). There is no such command recognized when writing non ASCII files, so such files must be integral 1K byte blocks in length, i.e., a fraction of a 1K byte block of data will not be written to tape. Filler bytes can be used to fill any partial blocks.

### 3.2 WRITING TO TAPE

In order to put the C20 into the tape WRITE mode, Switch 5 must be in the "open" or USER PROGRAMMABLE mode. As discussed in Section 2.5 the C20 responds by listing five options (Table 2-3) on the terminal. Options "A", "B" and "T" have already been discussed in connection with the tape READ mode. Selection of either option "W" or "V" puts the C20 into the tape WRITE mode.

Option "W" means that all subsequent data received at either port is interpreted as data to be written to tape. Option "V" puts the C20 in a transparent mode similar to option "B" described above. In this case, the "READY" signal (^V, 16 hex) alerts the C20 that all subsequent characters received at either port will be interpreted as data to be written to tape. Option "V" allows the user to set up their computer from the terminal for executing their "tape write" program with no interference from the C20.

The green data light (LED) indicates that the C20 is writing to tape. Do not reset the C20 or turn off the tape recorder until the green LED goes off.

### 3.3 CONNECTIONS

Connections are made in an identical manner as when the C20 is reading tape, except that the MIC Jack of the cassette recorder is connected to the MIC Jack of the C20. CAUTION - make sure the tape recorder's RECORD button is activated.

## SECTION 3. WRITING TO TAPE

The hardware protocol in the serial communication via Ports A and B is described in Appendix A. It is noted in Table A-1 that the C20 relies on equipment recognizing the Data Terminal Ready line at PORT B and the Clear To Send line at PORT A as control lines for whether or not to send more data ("wait" lines). The C20 ports can communicate as fast as 19200 baud depending on the switch setting, but writing data to tape occurs at a slower rate. If the C20 receives data faster than 2400 baud the C20 pulls the "wait lines" low on its two ports until it has a chance to empty its buffer onto tape.

### 3.4 WRITE MODE OF OPERATION - SWITCH SETTINGS

#### BAUD RATE AND PARITY

Switches 1,2,3 and 4 have identical meaning as in the read mode. They must match the baud rate and parity of the equipment you connect to the two serial ports.

#### USER PROGRAMMABLE MODE

Switch 5 must be in the USER PROGRAMMABLE mode (open). This allows you to program the C20 to write (as opposed to read) by sending the C20 either a "W" or a "V" option from Port A upon reset or power-up.

#### PORT SELECTION

Switch 6, C20 TO PORT A and B or PORT B ONLY is used in a manner similar to the tape read program. In either switch position, the C20 transmits data received at one port out the other port. Switch 6 determines which port is receiving the data to be written to tape: either (1) PORT A AND B or (2) PORT B ONLY. If PORT A AND B is selected (switch open), then the C20 will write data received at either port to tape; if PORT B ONLY (closed) is selected, then the C20 will write to tape and listen for the "residual dump" command (ESC, 1B hex), from PORT B only. The PORT A AND B position is used if you are connected only to PORT A or if your computer does not echo. The PORT B ONLY position is used if your computer echoes back to the terminal or if the computer is used to transmit the file to be written.

#### FORMAT SELECTION

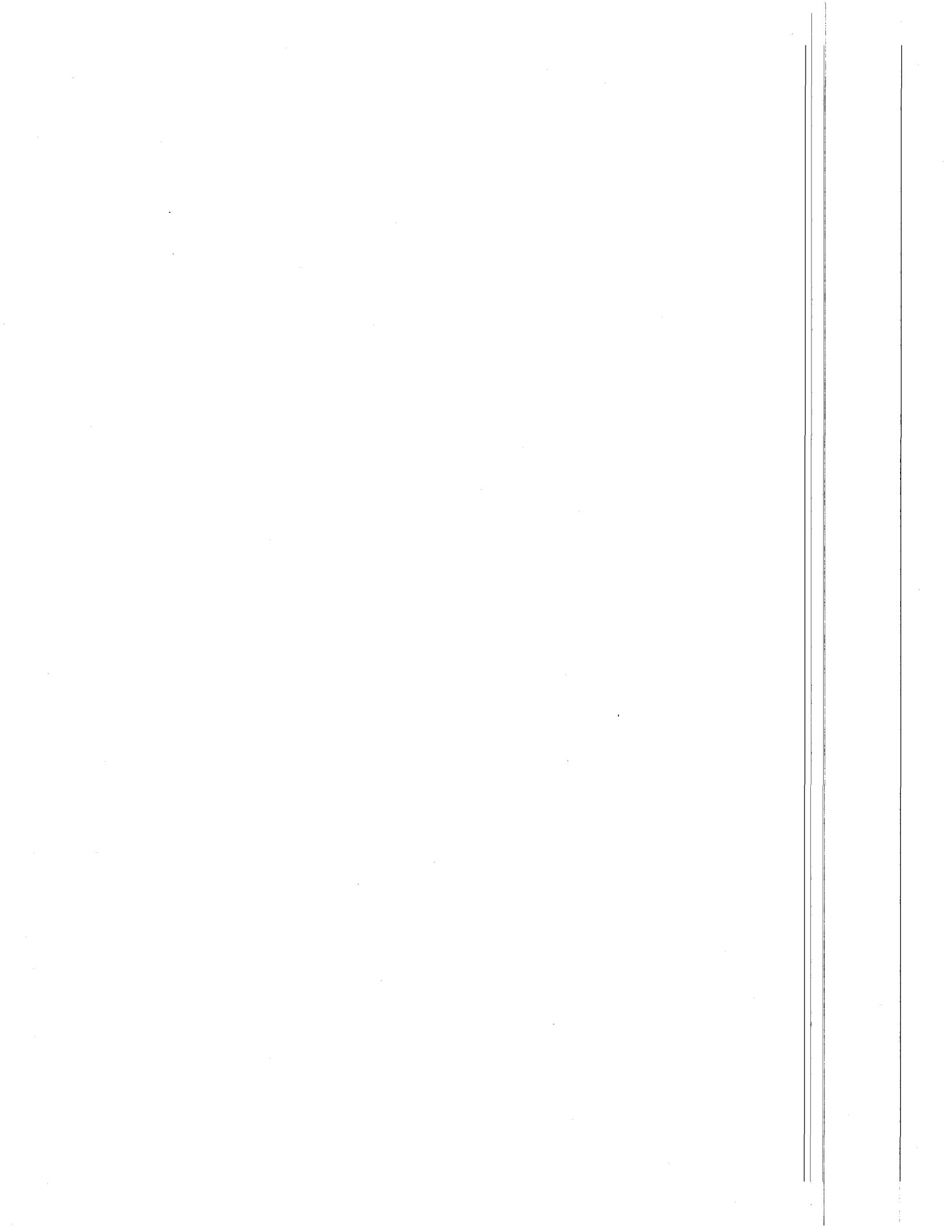
In the write mode, the format switches determine whether the file to be written to tape is non-ASCII or ASCII data.

11, BINARY - When non-ASCII files are to be written, the switches should be in the 11, BINARY position. In this position, all data received by the C20 are written to tape, i.e., no communication commands are recognized. Eight bit bytes without

### SECTION 3. WRITING TO TAPE

parity are sent to tape in 1K byte blocks. Fractions of blocks are not written so the user must complete any fractional blocks with filler data.

11, ASCII - ASCII files should be written to tape with the switches in any position other than 11, BINARY. With the ASCII format the C20 recognizes the "ESC" (1B hex) command as a "residual tape dump and exit" command. When this command is received the remaining 1K byte block is filled with "null" characters (hex 00) before writing to tape and the C20 enters the "transparent" mode (option T) allowing terminal/computer communication.



## SECTION 4. A QUICK TROUBLE SHOOTING GUIDE

For minor problems that arise in using your C20 Cassette Interface, the front panel indicator lights will prove an invaluable debugging source. Below is a brief trouble shooting guide that also serves to further acquaint you with the C20 functions.

SYMPTOM	POSSIBLE PROBLEM OR SOLUTION
The tape recorder is turned on but does not run.	Push the reset button and check the PROGRAM switch (5). In the DEFAULT position (closed), the tape recorder should start running and the C20 begin searching for the first block of data. In the USER PROGRAMMABLE position (open), the C20 waits to be programmed before it turns on the tape.
The tape recorder is turned on and running but neither the green data light nor the red error light are working.	Disconnect the cable into the monitor jack on the recorder and listen to make sure you have data on the tape. Make sure the volume is in midrange.
The red light flashes intermittently along with the green data light.	Adjust the volume control until only the green light flashes. If the red light continues to flash, check the head alignment on the cassette recorder (Figure 1-1).
The green light is flashing indicating data is being read but no data is entering the terminal.	Check your PORT A transmit light. If it is flashing then the C20 is transmitting. Check your connections. Check the baud rate and parity switches to insure the C20 matches your terminal. If PORT A is not flashing but PORT B is flashing, then check switch 6. It should be on PORT A AND B (open). Make sure the C20 is not waiting for a transmit command.

## SECTION 4. A QUICK TROUBLE SHOOTING GUIDE

SYMPTOM	POSSIBLE PROBLEM OR SOLUTION
The C20 keeps transmitting more than one line even though my computer program sent it a "SEND ONE LINE" command.	Did you reset your C20 after your computer sent the command? If so, the C20 ignores any previous commands. In the DEFAULT mode, the C20 will transmit continuously until told to do otherwise.
Your computer occasionally misses characters transmitted by the C20.	Is your computer fast enough to accomplish the given task and still pick up the next character? If your program is processing the character before storing it away, you should change your program so all the processing is done at the end of a line of data. At this point you have unlimited time because no more data will be sent until your program asks for it. Some situations may require lowering the baud rate at which data is transferred. If your C20 is connected between your computer and terminal and your computer echos received characters to the terminal (via the C20), make sure your computer transmits only one stop bit. This action increases the time your computer has to receive, store and transmit a character before receiving the next one.
The red light flashes once when the RESET button is pushed.	This condition is the result of the C20's built-in self test routine indicating the C20 has a bad PROM.
The red light flashes twice when the RESET button is pushed.	This condition is the result of the C20's built-in self test routine indicating the C20 has one or more bad RAM chips.

## APPENDIX A. PORTS A AND B CONFIGURATION

Ports A and B are RS-232-C compatible serial I/O ports. By "RS-232-C compatible", we mean that the electrical specifications on the pins comply with the EIA STANDARD RS-232-C INTERFACE and that the data and control function of the pins corresponds to the most common Interpretation of the EIA STANDARD RS-232-C INTERFACE. You should be aware that there is more than one Interpretation of the function of the various control lines on the RS-232 interface. Figure A-1 shows the pin numbers for both ports as viewed looking into the connectors at the back of the C20.

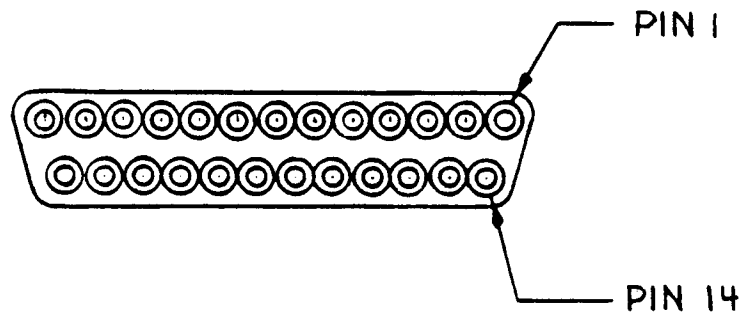


Figure A-1. C20 Port Pin Numbers

Table A-1 specifies the functional description of the pins on the C20 Cassette Interface. Column 1 list the active pins in the C20 ports. The EIA standard pin description is written with respect to Data Terminal Equipment (DTE) such as terminals, printers etc. When looking at Data Communication Equipment (DCE) such as modems and computers the description remains the same for the same pin number but the actual function on the DCE is not the same as on the DTE. To resolve this confusion the user is supposed to view the description of the DCE pin in terms of the function of the corresponding DTE pin on the other end. This is why the standard description of pin 3, for example, matches the function of Port B (column 4) but not Port A (column 3). Port B is a DTE port because the computer views it as a terminal but Port A is DCE port because the terminal views it as a computer.

APPENDIX A. PORTS A AND B CONFIGURATION

TABLE A-1. C20 RS-232-C PIN DESCRIPTION

PIN NO. 25 PIN D CONNECTOR	RS-232-C STANDARD INTERFACE DESCRIPTION	C20 PIN FUNCTIONAL DESCRIPTION	
		PORT A to Terminal (Configured as DCE)	PORT B to Computer (Configured as DTE)
1	Protective Ground	Protective Ground	Protective Ground
2	TDX-Transmitted Data (from DTE)	Received Data	Transmitted Data
3	RXD-Received Data (from DCE)	Transmitted Data	Received Data
4	RTS-Request to Send	An INPUT. Used to determine the state of Pin 4 at PORT B. Applicable in modem control. Also controls C20 reception: high or no connection allows, low blocks.	An OUTPUT. Determined by the state of Pin 4 at PORT A. Held high if no connection at PORT A.
5	CTS-Clear to Send	An OUTPUT. Determined by the state of Pin 5 at PORT B. Held high if no connection at PORT B.	An INPUT. Used to determine the state of Pin 5 at PORT A. Applicable in modem control. Also controls C20 transmission: high or no connection allows, low blocks.
7	Signal Ground	Signal Ground	Signal Ground

## APPENDIX A. PORTS A AND B CONFIGURATION

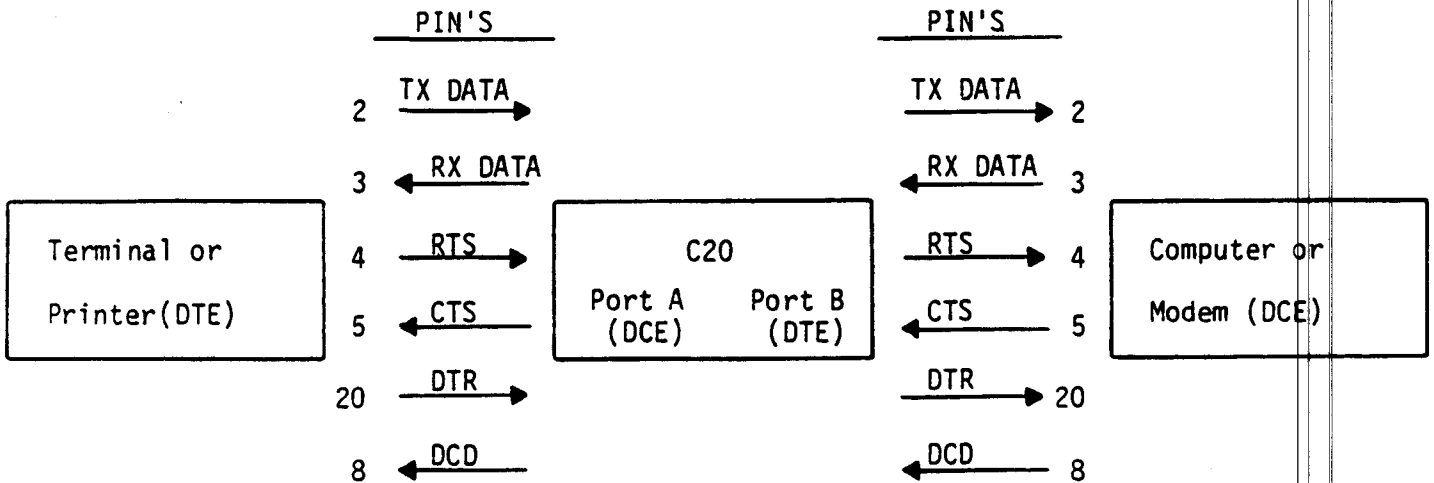
8	DCD-Signal Detector or Data carrier Detect	An OUTPUT. Determined by the state of Pin 8 at PORT B. Held high when no connection at PORT B. Appli- cable in modem control.	An INPUT. Determines the state of Pin 8 at PORT A. Also controls C20 reception: high or no connection allows, low blocks.
20	DTR-Data Terminal Ready	An INPUT. Used to deter- mine the state of Pin 20 at PORT B. Also controls C20 transmission: high or no connection allows, low blocks.	An OUTPUT. Determined by the state of Pin 20 at PORT A. Also, used by C20 in it's WRITE mode to signal when ready for more data.

In summary, the function of the pins at the C20's serial ports are determined by: (1) the function of the corresponding pins at the other port (the "transparent" function) and (2) by the specific needs of the C20 read and write functions. In general, the C20 outputs from one port what it sees as input at the other port, including data and control functions. This allows the C20 to look as transparent as possible to the normal communication of your equipment. At the same time it can transmit data read from tape out both ports (using Pin 3 at PORT A and Pin 2 at PORT B) and write to tape data received at both ports. It stops transmission of read data when the CTS line at Port B or the DTR line at Port A is pulled low. It stops reception of data when the DCD line at Port A is pulled low. It stops reception of data when the DCD line at Port B or the RTS line at Port A is pulled low. Finally, it relies on the DTR line to the computer to start and stop incoming data when writing to tape. Figure A-2 is a block diagram of DTE and DCE devices connected through the C20. The description and direction is in terms of the DTE device as per RS-232-C convention.

Both Port A and Port B can be reconfigured to communicate with the other type of equipment (Port A with DCE or Port B with DTE) by changing appropriate jumpers on the tape read board. Figure A-3 is a stuffing chart for the 2321-01 Z80 CPU board. The jumper sets for both PORT A and B are identified. The jumper

## APPENDIX A. PORTS A AND B CONFIGURATION

configuration shown in Figure A-3 is DCE for PORT A (8 pin pairs all jumpered parallel to the length of the board) and DTE for PORT B (8 pin pairs all jumpered perpendicular to the length of the board). To reconfigure PORT A as DTE jumper the PORT A pin set perpendicular to the length of the board (as shown for PORT B). Likewise PORT B can be reconfigured as DCE by jumpering the pin set parallel to the length of the board (as shown for PORT A).



**Figure A-2. Block diagram of RS-232-C Standard Pin Description used by the C20**

APPENDIX A. PORTS A AND B CONFIGURATION

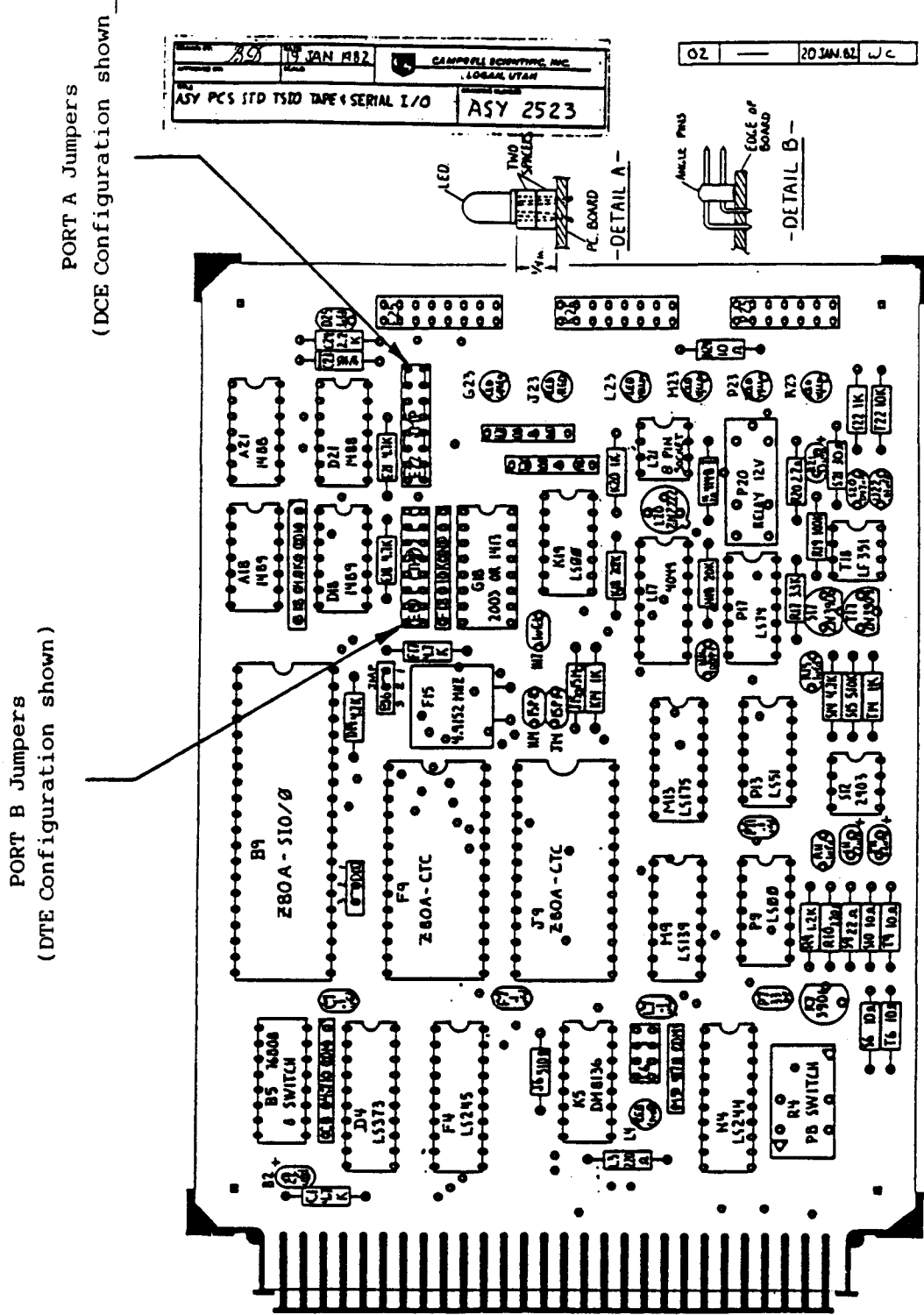


Figure A-3. Model 2321 Z80 CPU Board showing PORT A and PORT B configuration jumpers.

APPENDIX A. PORTS A AND B CONFIGURATION

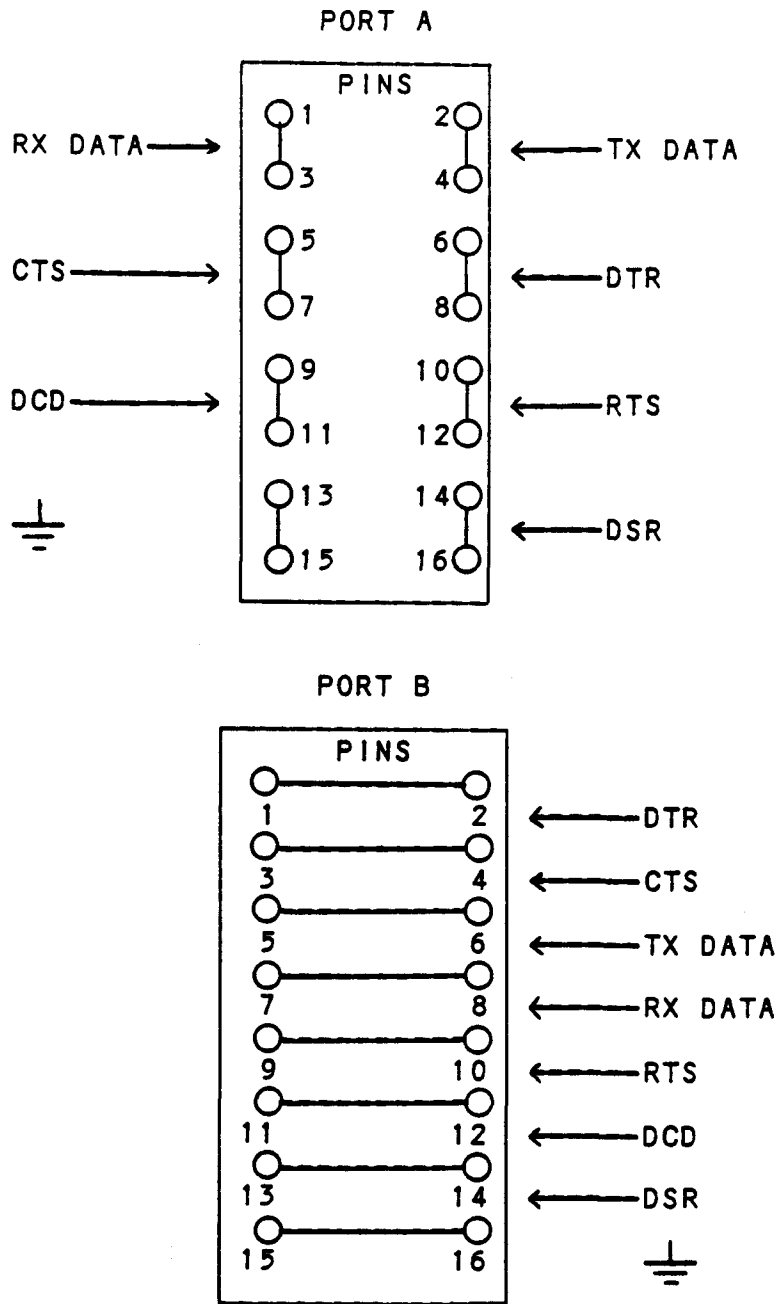


Figure A-4. Factory Configuration of the Jumpers for Port A and Port B. Removal of the Jumper for an Input Control Signal will cause the C20 to Assume the Signal is Active.

## APPENDIX B. DATALOGGER FORMAT II

### B.1 GENERAL

When reading tapes formatted in the high density, error-correcting FORMAT II, the C20 Cassette Interface will either decode CSI datalogger values into 10-character ASCII datapoints or it will transmit the binary words directly in their FINAL MEMORY STORAGE FORMAT form. This appendix describes the various data representations to help the user decide which form to select.

### B.2 DATALOGGER FINAL MEMORY STORAGE FORMAT

CR21 data stored in final memory and written to tape is formatted as two byte data values. CR7 data is formatted as either two byte data values identical to CR21 data or as four byte data values with higher resolution. Each two byte pair contains information that identifies it as a two byte data value, the first half of a four byte data value, or the second half of a four byte data value.

Representing the bits in the FIRST BYTE of each two byte pair as ABCD EFGH where A is the most significant bit, the byte pairs are described below.

#### TWO BYTE FORMAT

If bits D, E, and F are not all ones, then the value is a two byte number as follows:

BITS	DESCRIPTION
A	Polarity, 0 = +, 1 = -
B, C	Decimal locators
D-H plus second byte	13 bit binary mantissa (D=MSB). Largest possible number without D,E and F all 1 is 7167. CSI defines the largest allowable range as 6999.

## APPENDIX B. DATALOGGER FORMAT II

The decimal locators can be thought of as a negative base 10 exponent with decimal locations as follows:

B C	Decimal location
0 0	XXXX.
0 1	XXX.X
1 0	XX.XX
1 1	X.XXX

### DECODING BYTE PAIR WHEN D,E,F EQUAL 1

If D,E and F are all ones, the data type is determined by the other bits as shown below. X implies a "don't care" condition, i.e., the bit can be either 1 or 0 and is not used in the decode decision.

A B C D E F G H	DATA TYPE AND SECOND BYTE FORMAT
1 1 1 1 1 1 X X	A,B,C = 1 - Start of output scan array, G & H are the most significant bits of the output array ID number (bits not used in the CR21)
X X 0 1 1 1 X X	C = 0 - First byte of a 4 byte value
0 0 1 1 1 1 X X	A,B = 0; C = 1 - Third byte of a 4 byte value
0 1 1 1 1 1 1 1	A = 0; B,C = 1 - First byte of a 2 byte dummy or "fill" word

### FOUR BYTE DATA FORMAT

Continuing to use the A-H bit representation, the four byte number is shown below as two byte pairs.

AB0111GH      XXXXXXXX      001111GH      XXXXXXXX

BITS, 1ST BYTE PAIR	DESCRIPTION
CDEF = 0111	Code designating 1st byte pair of four byte number
B	Polarity, 0 = +, 1 = -
G,H,A	Decimal locator as defined below
2nd byte	16th - 9th bit (left to right) of 17 bit binary mantissa

## APPENDIX B. DATALOGGER FORMAT II

BITS, 2ND BYTE PAIR	DESCRIPTION
ABCDEF = 001111	Code designating 2nd byte pair of four byte number
G	Unused bit
H	17th and MSB of 17 bit binary value
2nd byte	8th - 1st bit (left to right) of 17 bit binary value

CSI defines the largest allowable range of the value to be 99999.

Interpretation of the decimal locator for a 4 byte data value is given below. The decimal equivalent of bits CDA is the negative exponent to the base 10.

BITS	DECIMAL FORMAT
G H A	5 digits
0 0 0	XXXXX.
0 0 1	XXXX.X
0 1 0	XXX.XX
0 1 1	XX.XXX
1 0 0	X.XXXX
1 0 1	.XXXXX

### DUMMY TWO-BYTE WORD

The "dummy word" is a non-data two-byte word that simply fills up a 1024 byte block after a residual data dump from the datalogger to tape. The error correction technique of the C20 requires a complete block of 1024 bytes. When read by the C20 with FORMAT switches at II, DECODE position, this dummy word is simply thrown away.

### B.3 C20 DECODED REPRESENTATION OF ASCII DATALOGGER FORMAT

#### TWO BYTE DATA VALUES

A two-byte word is decoded into a ten-character ASCII datapoint as follows:

Designate the ten ASCII characters as:

ABCDEFGHIJ

AB            A two digit identification number, range 01-99  
 C            Polarity, + or -  
 DEFGH       4 digits and a decimal (see decimal location  
                  above)  
 IJ           2 spaces separating data points

An example of two adjacent datapoints would be:

01+0001. 02-11.30

#### FOUR BYTE DATA VALUES

A four-byte CR7 word is decoded into a ten-character ASCII datapoint as follows:

Designate the ten ASCII characters as follows:

ABCDEFGHIJ

AB            A two digit identification number, range 01--99  
 C            Polarity, + or -  
 DEFGHI      5 digits and a decimal (see decimal location  
                  above)  
 J            1 space separating data points

An example of two adjacent datapoints would be:

03+493.22 04-.49577

#### ASCII POSTAMBLE

The postamble is sent by the C20 after 79 characters have been sent or before the start of an output scan array, whichever comes first.

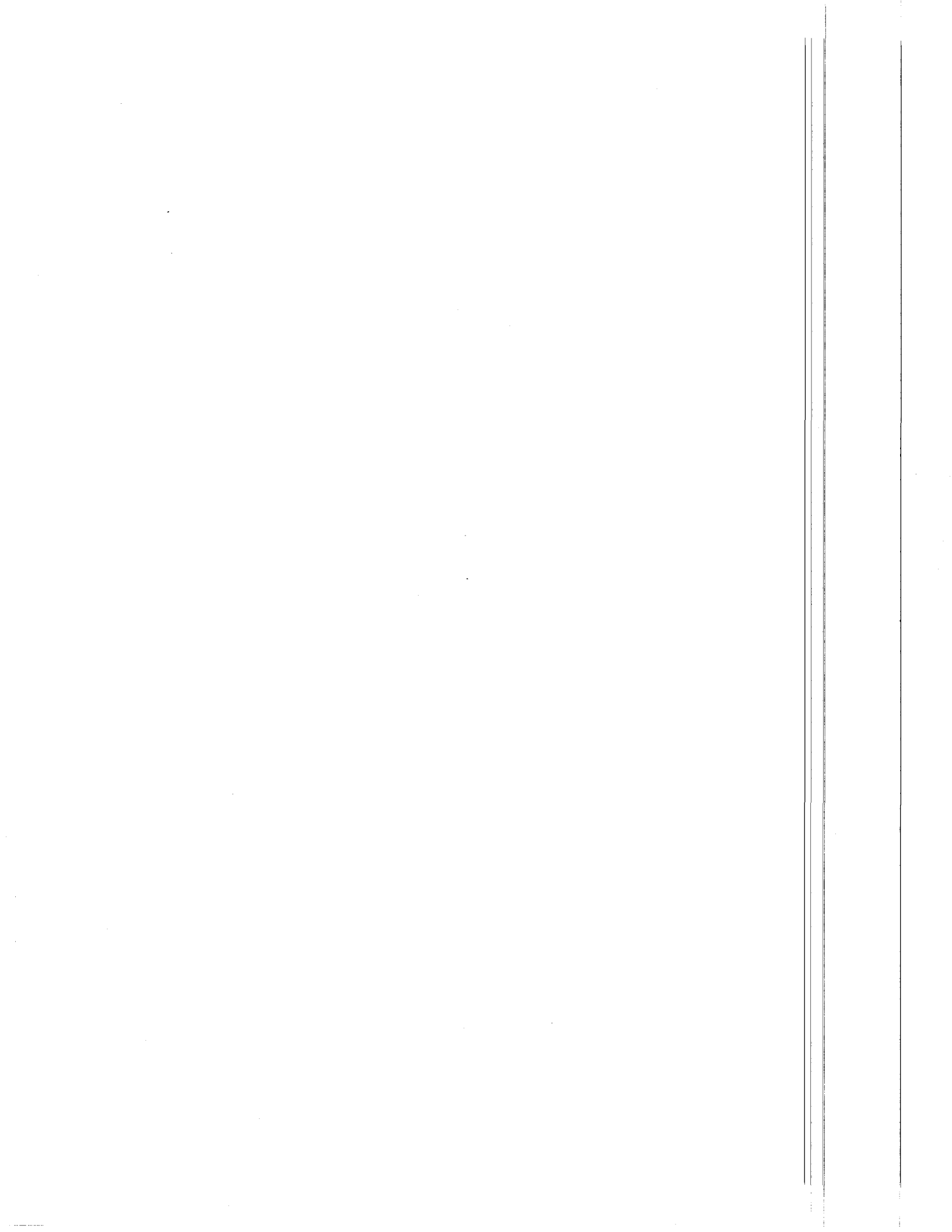
#### ERRORS

When the FORMAT switches are in the "FORMAT II, DECODE" position, a two byte value that cannot be corrected is decoded as xx??????. The xx indicates the uncertainty of the current ID of the data value. The xx will appear in place of an ID number until the next start of output scan array is read. If a two byte pair is

## APPENDIX B. DATALOGGER FORMAT II

decoded as the 2nd pair of a 4 byte value, but the immediately preceding two byte pair was uncorrectable, then xx?????? is again sent, since only half of a 4 byte data value is known.

When the C20 is reading tapes with the FORMAT switches in BINARY or ASCII, an uncorrectable error will result in ?? in place of two bytes of data. The C20 treats every two byte pair as one word, either as two good bytes or as two bytes that cannot be corrected.



## APPENDIX C. PROGRAMMING EXAMPLES

### C.1 BASIC PROGRAM

A program is shown below that programs the C20 protocol, requests a line at a time and transfers the data to disk.

Switch 6 is set to transmit to Port B only and the program echoes data back to the terminal. Switch 5 is set to the USER PROGRAM position. The user calls this program from the terminal after typing B to the C20. The tape recorder is turned on and ready to play back the tape.

Line 2 of the program first signals the C20 to exit its transparent mode and accept the subsequent characters as protocol parameters (^V, 16 hex, 22 decimal). It then sends the USER PROGRAMMED protocol: S for STOP, L for TRANSMIT ONE LINE OF DATA, T for TRANSMIT CONTINUOUSLY, E for EXIT, carriage return (13 decimal) for postamble delineated by "ESC" (27 dec.) and 0 for preamble delay (1 msec). Note only the SEND ONE LINE OF DATA command and EXIT command are actually used in this program.

The remainder of the program sends the C20 the "SEND ONE LINE" command (line 10), inputs the line terminated by the programmed postamble, stores the data on disk, and then asks for and gets another line, etc. Upon receiving an "EXIT" command from the terminal, the program will end and the C20 will get the echoed command from Port B, shut off the tape recorder and enter its transparent mode. The user can then communicate between the terminal and computer without interference from the C20.

This simple program relies on the E exit command being sent from the terminal when the tape is finished so the entire line is the one character E; otherwise it might appear in the middle of a line of data. A slight modification would allow you to stop your program and the C20 even if the "EXIT" command was sent in the middle of a line of data.

```
2 PRINT CHR$(22);"SLTE";CHR$(13);CHR$(27);"0"  
5 OPEN "0",1,"DATA.DAT"  
10 PRINT "L";  
20 LINE INPUT AS  
25 IF AS="E" THEN GOTO 60  
30 PRINT #1,AS  
50 GOTO 10  
60 END
```

## APPENDIX C. PROGRAMMING EXAMPLES

### C.2 A PROGRAM THAT WILL READ DATA FROM THE C20 ONTO DISK WHEN THE C20 IS IN THE DEFAULT MODE

Use the same program as in C.1 above, except delete line 2 (which programs the C20) and change lines 10 and 25 to the default commands. You need to know what your program does with control characters. Will it echo them? Remember, the C20 will listen for commands from Port B only when switch 6 is closed. Everything it receives from Port A is transmitted to Port B.

### C.3 BASIC TAPE READ PROGRAM FOR THE IBM-PC OR XT COMPUTER

Make the appropriate connections and set the switches as indicated. Get into BASIC and run the unload program given below. Enter the name of the file in which the data is to be stored, send a carriage return (CR) and press the playback button on the cassette recorder. This program takes advantage of the built in timer and will stop the program after 10 seconds of inactivity. If this delay is too short it can be lengthened by changing the value in line #90.

#### CONNECTIONS

- 1 C20 PORT A "TO TERMINAL" - Connected to IBM's Asynchronous Communications Adaptor.
- 2 C20 PORT B "TO MODEM" - Not connected.

<u>C20 SWITCH #</u>	<u>C20 SWITCH POSITION</u>	<u>FUNCTION</u>
1	1 OPEN	BAUD RATE
2	1 OPEN	EQUALS
3	0 CLOSED	9600 BAUD
4	0 CLOSED	EVEN PARITY
5	0 CLOSED	DEFAULT
6	1 OPEN	TO PORTS A & B
7		FORMAT
8		FORMAT

#### C20 UNLOAD PROGRAM (BASIC version 2.0 written by Microsoft)

```
10 REM SET IBM ASYNCHRONOUS COMMUNICATIONS ADAPTER TO 9600 BAUD
20 OPEN "COM1:9600" AS 1
30 INPUT "NAME OF FILE TO LOAD DATA INTO?"; FLE$
40 OPEN FLE$ FOR OUTPUT AS 2
50 REM REQUEST A LINE OF DATA
60 PRINT #1,CHR$(17);
70 TM=TIMER
```

```

80  T$=""
90  IF TIMER-TM > 10 THEN 140
100 IF NOT EOF(1) THEN T$=T$+INPUT$(LOC(1),#1) ELSE 90
110 PRINT T$;
120 PRINT #2,T$;
130 IF EOF(1) THEN 60 ELSE 80
140 PRINT CHR$(13);CHR$(10);CHR$(7)
150 PRINT "END OF DATA ON TAPE"
160 CLOSE(2)
170 END

```

#### C.4 A BASIC PROGRAM THAT WRITES AN ASCII FILE TO TAPE

The C20 FORMAT switch is in the ASCII position, switch 5 is in USER PROGRAMMABLE position, and the user selects "OPTION V" upon C20 reset.

Line 30 signals the C20 that the computer is ready to write to tape by sending a ^V (22 dec). All subsequent characters from the "PARITY.MAC" file will be written to tape. Switch 6 is in the C20 TO PORT A AND B position (open) so the C20 will send to the terminal everything received at Port B from the computer.

Line 90 sends the C20 the "end of message" signal, ESC (1B hex, 27 dec.), causing the C20 to fill the last 1K block of characters with nulls and enter the transparent mode. Therefore Line 100 is a message sent to the terminal but not written to tape.

```

10 PRINT "ENTER THE NAME OF THE FILE TO BE COPIED ONTO TAPE"
20 INPUT B$
30 PRINT CHR$(22)
40 OPEN "I",1,B$
50 LINE INPUT #1,A$
60 PRINT A$
70 IF NOT EOF (1) GOTO 50
80 CLOSE 1
90 PRINT CHR$(27)
100 PRINT "HIT RESET ON C20 WHEN DONE DUMPING TO TAPE"
110 END

```

#### C.5 A PROGRAM WRITTEN IN Z80 MACHINE LANGUAGE THAT WRITES 8K BYTES FROM THE COMPUTER MEMORY TO TAPE

The C20 FORMAT switch is in the BINARY position, switch 5 is in the USER PROGRAMMABLE position, and the user selects "OPTION V" upon C20 reset (i.e., write from Port B).

Switch 6 is in the B ONLY position because non-ASCII data scrambles most terminals. The C20 will not pass on to Port A what it receives at Port B but simply writes it to tape.

## APPENDIX C. PROGRAMMING EXAMPLES

The computer transmits to the C20 at 9600 baud until the C20 pulls the Data Terminal Ready line, at which time the incoming data is stopped until the C20 has room for more.

```

ENTRY MAIN
MAIN:  LD C,0C8H           ;out port of computer
       CALL CHK           ;transmit buffer empty and is C20 ready
                               ; (data terminal ready)?
       LD A,22            ;CONTROL V is sent, signaling next data
                               ;is to be written
       OUT (0C8H),A       ;send to C20

M1:    LD HL,2000H        ;memory address where data stored

M2:    CALL CHK
       OUTI               ;outputs data and increments pointer
                               ;2000 TO 4000H memory location
       BIT 6,H            ;ouputs 8K bytes in memory
       JR Z,M2           ;exits program
       JP 0

CHK:   IN A,(0C9H)        ;subroutine that checks trans. ready
       BIT 7,A           ;and checks data terminal ready line
       JR Z,CHK
       BIT 0,A
       JR Z,CHK
       RET

END

```

## APPENDIX C. PROGRAMMING EXAMPLES

### USE OF THE C20 AND AN IBM PC WITH "TERM" TO WRITE A FILE (DLD) TO TAPE

#### CONNECTIONS

PORT A ----- TO COM\_ PORT ON IBM PC  
PORT B ----- NOT CONNECTED

C20 mic and remote connected to mic and remote on cassette recorder. Press the "Play" and "Record" buttons simultaneously.

<u>SWITCH #</u>	<u>SWITCH</u>	<u>POSITIONS</u>	<u>DESCRIPTION</u>
1	0	Closed	Baud rate
2	1	Open	Baud rate 1200 Baud
3	1	Open	Baud rate
4	1	Open	Parity (neither is correct)
5	1	Open	User Programmable
6	1	Open	To Ports A and B
7	0	Closed	Format II, ASCII
8	1	Open	Format II, ASCII

#### INSTRUCTIONS

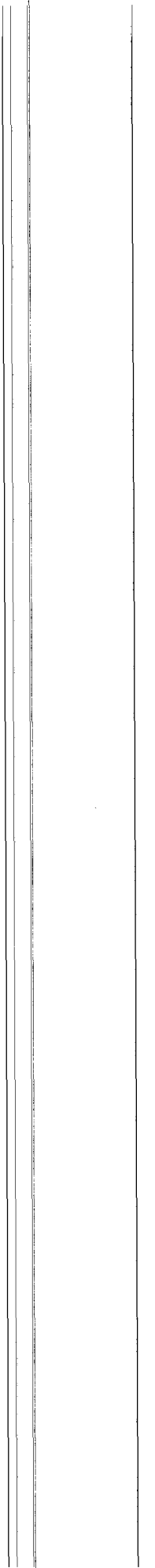
Make connections and set switches as shown above. Run CSI's "TERM" program. Create a station file similar to the example below:

```
Telecommunication Parameters For Station: C20
                                     Datalogger Type: None
Use Asynchronous Communications Adapter: COM2
                                     Communications Baud Rate: 1200
Interface Device:
#1: End
```

Save the station file and enter the "Terminal emulator" mode. Press the "RESET" button on the C20. The garbage on the screen is the same as:

```
A = READ (A)
B = READ (B)
W = WRITE (A)
V = WRITE (B)
T = TRANSPARENT
OPTION?
```

Enter "W" without a carriage return. Hit the ctrl. underline to obtain the "TERM" menu and select "X". Enter "N" when asked whether to wait for an echo and then enter the "filename.dld" and a carriage return. Port A and Port B transmit lights and the Port A receive light should turn on. The Data light and the tape recorder should turn on occasionally if the file is long enough. Once the transmission has stopped and the "TERM" menu has returned enter the "Terminal emulator" mode and hit the "Esc" key to cause the C20 to dump the partial or residual block of data to the tape.



## APPENDIX D. EARLY CR21/CR5 DATATAPE COMPATIBILITY

### D.1 GENERAL

This section contains information describing past versions of the SC235 CR21 - Cassette Connector (used in generating CR21 datatapes) and the R235 CR5/Cassette Interface module (used in generating CR5 datatapes) which perform tape signal conditioning that is not optimized to the C20 tape read circuitry.

In the following discussion, the terms "modified" SC235 or R235 refers to the current versions while "unmodified" refers to the versions used in the past. In addition, "FORMAT I" refers to CSI's original tape format used by the CR5 and CR21 dataloggers. "FORMAT II" refers to CSI's new high density, error correcting tape format generated by the CR7 or updated CR21 dataloggers.

Details are provided below but the situation can be summarized as follows:

1. Tapes generated in FORMAT II by a CR21 using an "unmodified" version SC235 cable CAN NOT BE READ by the C20. The data is lost forever!!!
2. Tapes generated in CSI's original FORMAT I by either a CR21 using an "unmodified" SC235 or a CR5 with an "unmodified" R235 can be read by the C20 but the playback recorder volume adjustment is very sensitive. Since tapes produced by these unmodified devices reduce the tolerance in the C20's tape read capability, it behooves the user to make the modifications described below if they plan on using the C20 to read their tapes.

For situations where users find it impossible to read tapes generated by unmodified SC235's or R235's, CSI has a TAPE READ ADAPTER that optimizes the tape recorder output to the C20 tape read circuitry. Consult the factory for details.

3. Tapes generated in FORMAT I by "modified" SC235's and R235's can still be read by CSI's previous tape reader, the A235 Cassette/Computer Interface. The A235 DOES NOT have the capability to read tapes generated in FORMAT II.

## APPENDIX D. EARLY CR21/CR5 DATATAPE COMPATIBILITY

4. Commencing in November 1981, CSI modified the SC235, optimizing it for the C20 tape read circuitry. Commencing in May 1982, the SC235 has a bronze anodized backshell to distinguish it from the earlier unmodified versions with chrome backshells. From November 1981 to May 1982, modified SC235's used the chrome backshells.
5. Commencing in May 1982, CSI modified the CR5/R235 beginning with Serial Number (SN) 1404. R235's with SN's smaller than 1265 write to tape with a wave form similar to the "modified" R235's. The C20 should maintain its full tolerance when reading tapes generated by these very early R235's.

Tapes generated by R235's with SN's between 1265 - 1404 are very sensitive to the volume adjustment on the playback recorder. The TAPE READ ADAPTOR may be required to playback these tapes. R235's in this SN range should be modified if the C20 is going to be used in playback.

### D.2 IDENTIFYING AND MODIFYING AN "UNMODIFIED" SC235.

CSI has produced three different SC235's since their inception. The first SC235's did not use a circuit card in the backshell. The components were soldered together and potted with RTV silicon adhesive. These early SC235's produce a wave form very similar to the "modified" version and the C20 should maintain its full tolerance when reading tapes generated through these cables.

In February 1980, circuit card T195 was added to the backshell and two (2) component changes were made, including the addition of a .001 ufd capacitor in the data signal line. In November 1981, the modified version became the standard SC235. The circuit card was modified and labeled as #1266-01. In the modified version, the component side is down when viewed after removing the backshell cover. Figure D-1 shows the unmodified and modified backshell. The T195 card can be modified by replacing the .001 ufd capacitor with a wire tie.

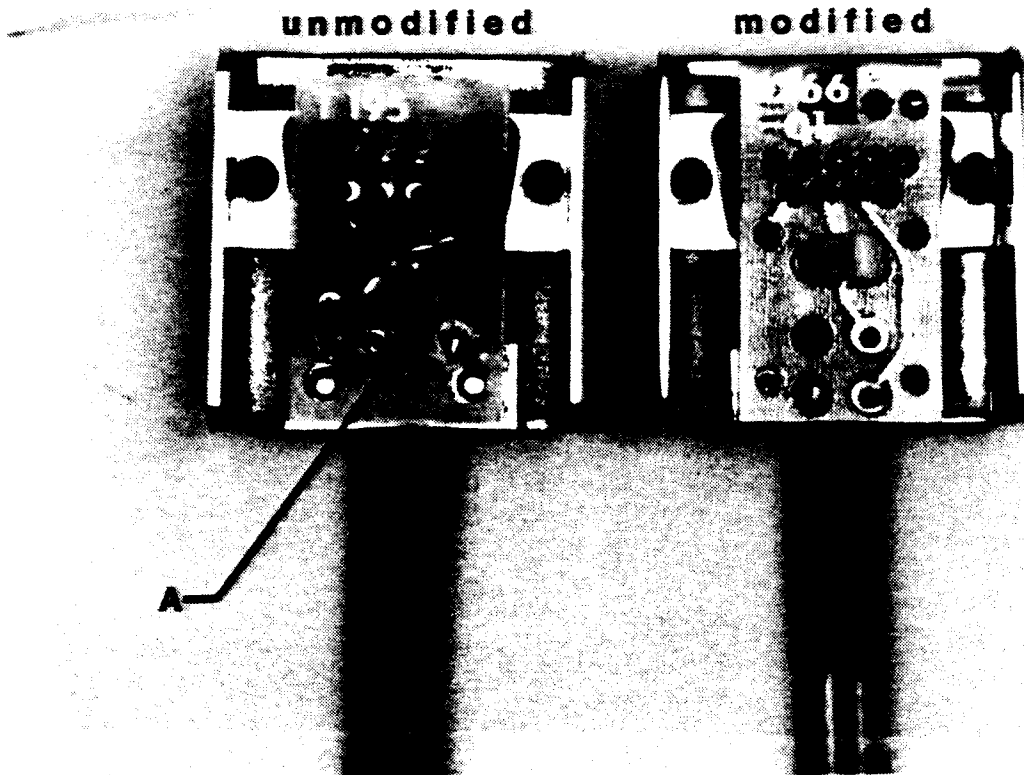


Figure D-1. Unmodified (left) and new modified (right) SC235. (A) - to modify remove the .001 ufd capacitor and replace with wire tie.

APPENDIX D. EARLY CR21/CR5 DATATAPE COMPATIBILITY

D.3 IDENTIFYING AND MODIFYING AN "UNMODIFIED" R235.

Figure D-2 is a location diagram for the R235 T135-2 card. The modification requires removing the .001 ufd capacitor (C6) and replacing it with a wire tie.

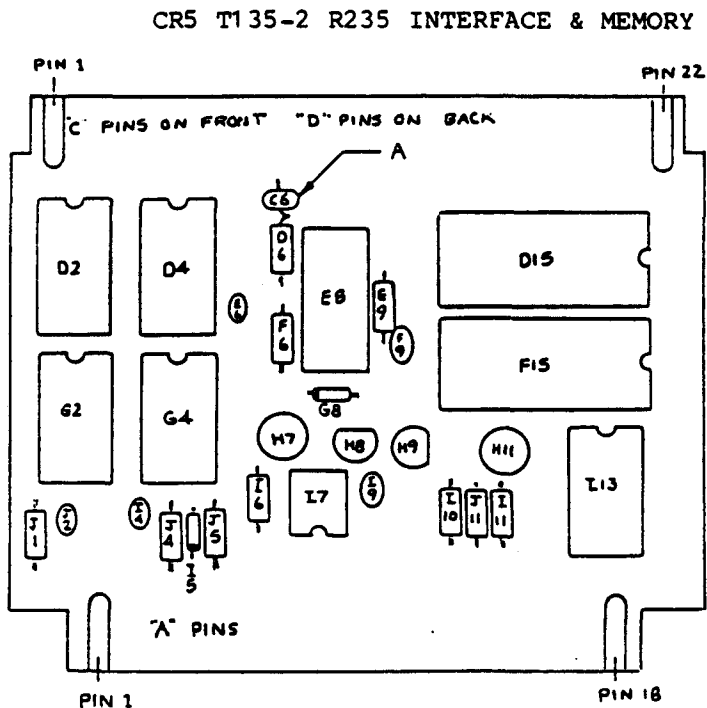


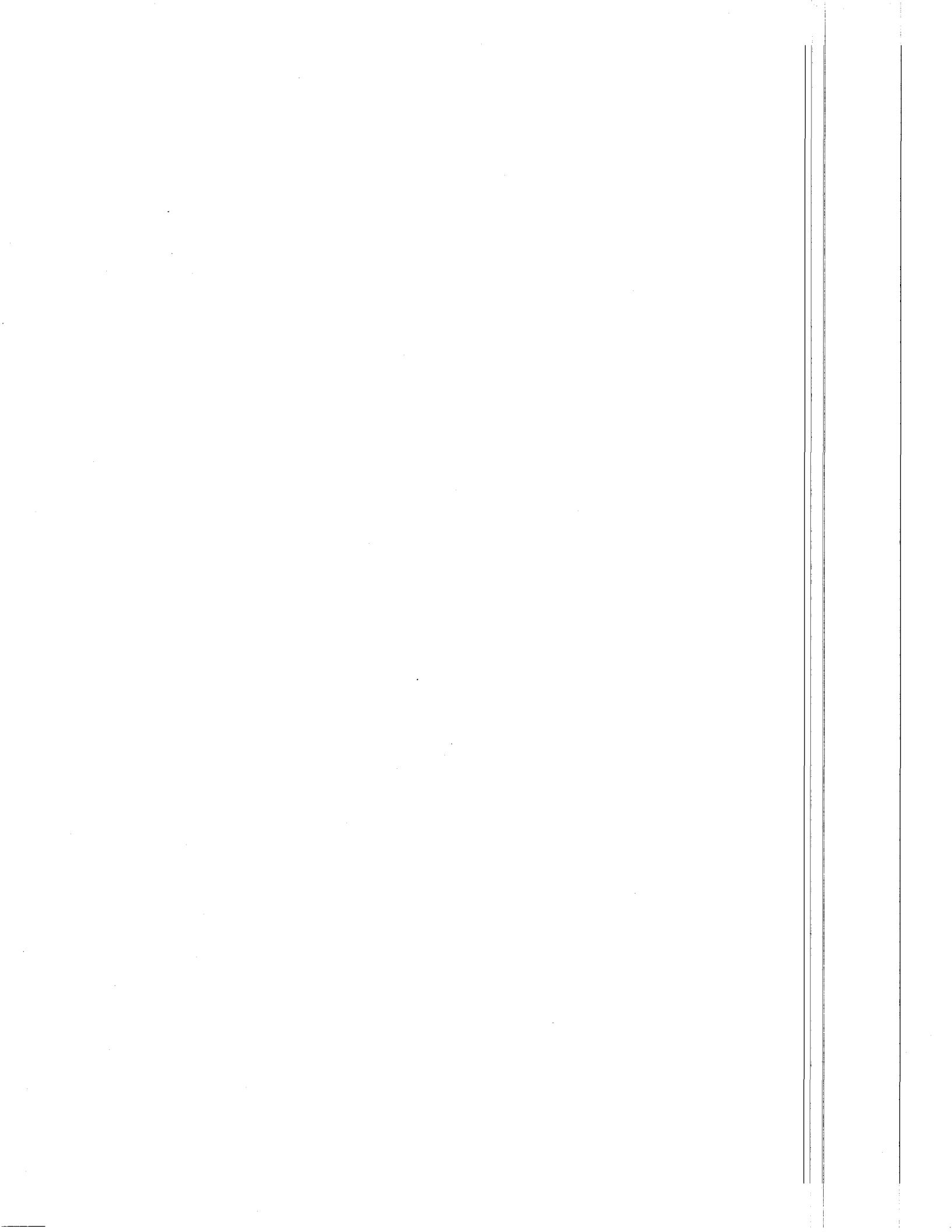
Figure D-2. Unmodified R235 T135-2 Card. (A) - To modify remove the .001 ufd capacitor (C6)

## APPENDIX E. TAPE RECORDER HEAD ALIGNMENT

In most datalogging situations, the "field" tape recorder remains at the site while a separate recorder is used with the C20 to playback all the field data tapes. When the recorders are received from CSI, the head alignment has been adjusted to a common standard but the alignment may shift after a period of use. Playback difficulties will occur if the playback recorder alignment is significantly different from the recorder alignment which generated the tape. This problem is easily overcome by adjusting the playback alignment to match the data tape.

In most cases the the correct head alignment can be obtained by listening to the tape and adjusting the head alignment screw (Figure 1-1) until the crispest sound is obtained. Improper head alignment limits the high frequency response and results in a muffled sound. By comparison, proper alignment results in a crisp, sharp sound. Adjusting the head alignment screw too far in either direction results in a muffled sound with the proper alignment lying in between the extremes. Note that this procedure only adjusts the playback alignment to read a particular data tape. If several recorders are adjusted to a common alignment, the procedure must be repeated using the same tape.

A more rigorous head alignment procedure involves the use of an AC volt meter. Select the 1V range and connect the volt meter to the Monitor output on the recorder. Make sure the volume control is at midrange (#5 on Panasonic Model RQ356) or slightly below and play a data tape. Adjust the head alignment to obtain the maximum voltage reading.



## APPENDIX F. TERMINOLOGY

This operator's manual uses terms that are common in the field of communication and electronics, some of which may not be familiar to the user of the C20 Cassette Interface. This appendix of special terminology may be helpful in such cases.

**ASCII** -- abbreviation for American Standard Code for Information Interchange (pronounced "askee"). A specific binary code of 128 characters represented by 7 bit binary numbers. The C20 makes certain assumptions about protocol (start/stop commands, end of line) when the FORMAT switch is in the ASCII position. It also knows that communication is in 7 bit characters, so it uses the eighth bit of a "byte" for parity.

**BAUD RATE** -- The speed of transmission of information across a serial interface, expressed in units of bits per second. For example, 9600 baud refers to bits being transmitted (or received) from one piece of equipment to another at a rate of 9600 bits per second. Thus, a 7 bit ASCII character plus parity plus 1 stop bit (total 9 bits) would be transmitted in  $9/9600 \text{ sec} = .94 \text{ msec}$ . or about 1000 characters/sec. When communicating via a serial interface, the baud rate settings of two pieces of equipment must match each other. The C20 communicates in such a manner via its two serial ports, labeled PORT A and PORT B.

**BINARY** -- A numbering system using the base 2. All data communication involving the C20 is in a binary form (on/off, high/low, one/zero). How the C20 interprets and outputs binary data read from tape, i.e., how binary data is decoded, depends upon the FORMAT switch.

**BIT** -- A binary digit. A one (1) or zero (0). The C20 communicates through its two ports and with tape via bit combinations and sequences that encode "data".

**BYTE** -- A combination of bits, usually 8 bits in length. For example, CSI DATALOGGER FINAL STORAGE is organized in two byte (16 bit) or four byte (32 bit) data values.

**CHARACTER** -- A combination of bits taken together to convey a specific meaning. In this manual, "character" refers exclusively to ASCII encoded 7 bit numbers.

## APPENDIX F. TERMINOLOGY

**DATA VALUE** -- A group of characters, bytes, or bits that are encoded with a specific meaning describing results of data collection. For example, a data value from CSI dataloggers contains such information as quantity, polarity, and sequence. The information contained in a data value can be represented in different forms (different codes); for example: CSI DATALOGGER FINAL MEMORY STORAGE (two byte or four byte representation) or ten character ASCII format.

**DATA COMMUNICATION EQUIPMENT (DCE)** -- A specific type of equipment used in data transmission and processing, commonly used in relation to communication interface specifications when defining the DIRECTION of the data and control signals. DCE transmits data to Data Terminal Equipment (DTE) over line 3 of an RS-232-C interface and receives data from DTE over line 2. Computers and modems are generally configured as DCE. PORT B of the C20 is configured at the factory to communicate with DCE, i.e., PORT B looks like DTE.

**DATA TERMINAL EQUIPMENT (DTE)** -- A specific type of equipment used in data transmission and processing, commonly used in relation to communication interface specifications when defining the DIRECTION of the data and control signals. DTE is used to describe equipment that transmits data to its counterpart, Data Communication Equipment (DCE), over line 2 of an RS-232-C interface, and receives data from DCE over line 3. Terminals and printers are generally configured as DTE. PORT A of the C20 is configured at the factory to communicate with DTE, i.e., PORT A looks like DCE.

**FORMAT** -- The form, representation or specific encoding of data or information. The C20 will read tape that is written in a specific format. It will output data in specified formats according to the switch setting.

**INTERFACE** -- A connection allowing two pieces of equipment to communicate with each other or carry on mutual operations. For example, the C20 is a Cassette INTERFACE in that it communicates information stored on tape to other equipment (terminals, computers, etc.) or communicates information stored in other equipment to a cassette recorder.

**OUTPUT SCAN ARRAY** -- A term used by CSI referring to the periodic storage of final processed data into the memory of the datalogger. The number and configuration of any output scan array depends upon the user programming.

## APPENDIX F. TERMINOLOGY

**PARITY** -- A bit or group of bits containing redundant information about data, used to detect or correct errors arising in the transmission process. The C20 transmits a parity bit over its two serial ports when ASCII data is sent. The C20 also reads (or writes) parity bits along with data on tape that are used in the error correcting code of CSI's new tape format.

**POSTAMBLE** -- A message signaling "end of line". Used by computers as part of the "software protocol" when communicating with the outside world, specifically used in conjunction with a "send one line of data" command. The computer knows when it receives the postamble that it has its one line and need not worry about any more until it sends a command for the next line.

**PREAMBLE** -- A message signaling "start of line". The C20 sends a preamble delay, meaning that it delays a specified amount of time after receiving a start command before it begins transmitting data.

**PROTOCOL** -- A set of control signals used to help two pieces of equipment communicate with each other, such as "I'm ready/not ready"; "Send me some data/Stop sending data"; "I'm done/ready to start". Such protocol can be "software", i.e., encoded messages sent back and forth as part of data information, or "hardware", i.e., signals on specified lines conveying certain commands. The C20 uses such protocol in communicating with other equipment via Ports A and B.

**RS-232-C INTERFACE** -- A standard interface between Data Terminal Equipment and Data Communication Equipment employing serial binary data interchange. The standard specifies electrical and functional characteristics of such an interface. The C20's serial ports (PORT A and PORT B) are designed to communicate over such an interface, both in terms of electrical characteristics and in terms of the relevant pins it needs to carry out its functions. (See Appendix A for details).

**SERIAL** -- Refers to data communicated one bit at a time over a single line in a sequential manner (as opposed to parallel all at once with each bit having its own line). PORTS A and B on the C20 are serial ports in that the data is communicated in a serial manner.

