INSTRUCTION MANUAL

PC201 Card and Software
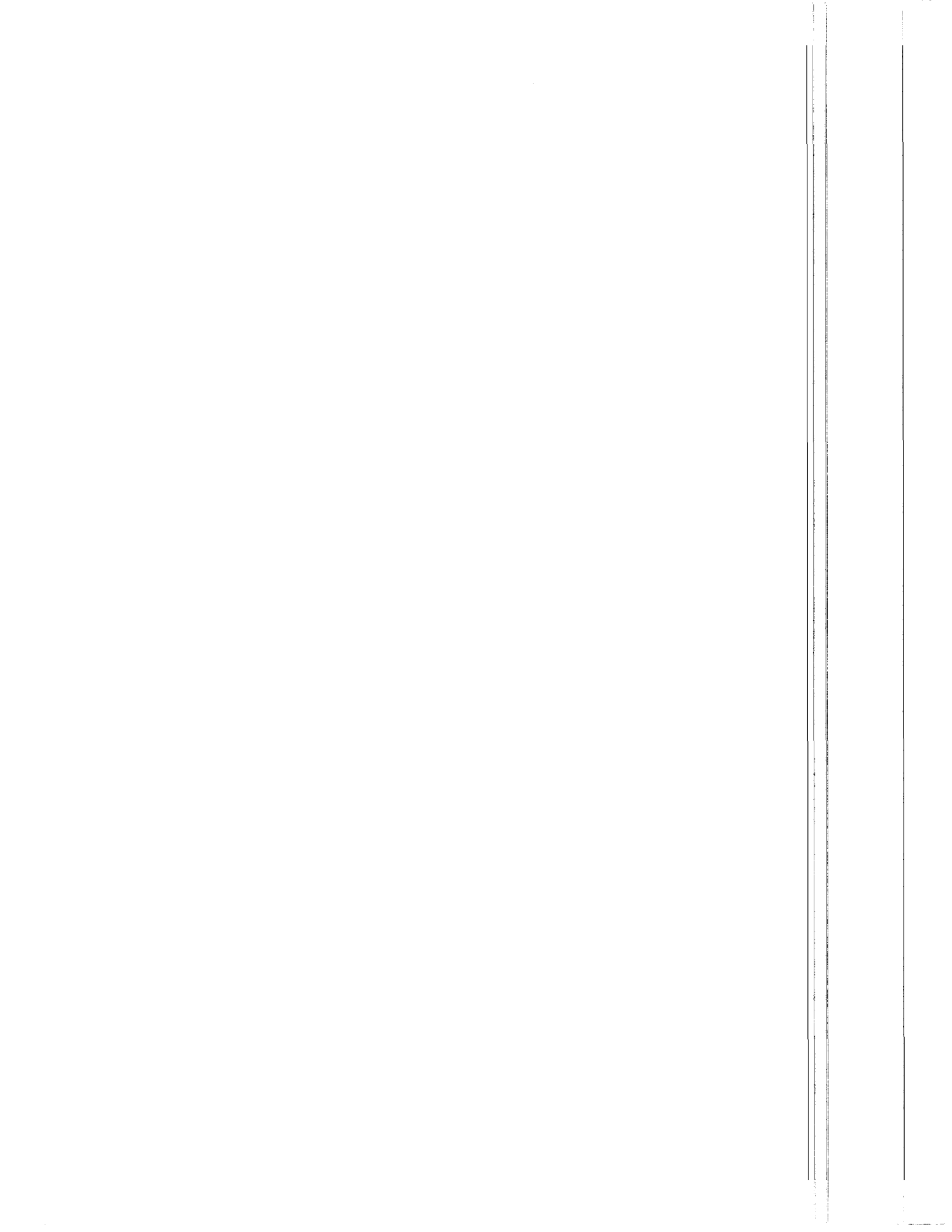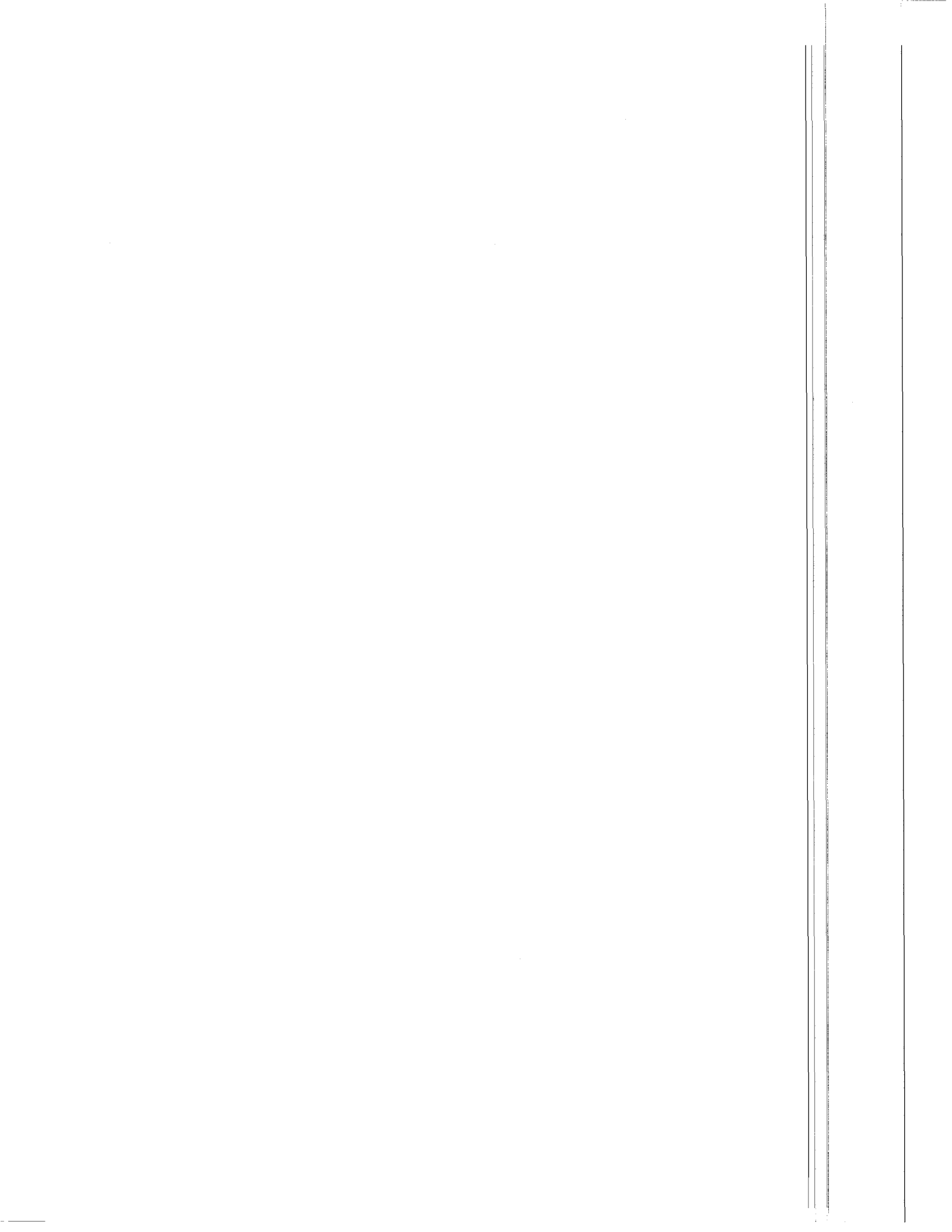
PC201 CARD & SOFTWARE
INSTRUCTION MANUAL

REVISION: 11/92

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PC201
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INTRODUCTION

Model PC201 Clock-SI0 Tape Read Card & Software for IBM-PC^R is designed to support data retrieval functions for Campbell Scientific's dataloggers. The following subsection contains a general overview of the PC201 Card and its software capabilities. Upon receipt of the PC201 package you should find:

- PC201 Clock-SI0 Tape Read Card

- Card Guide

- AAA Batteries (2)

- SC235P Cassette Patch Cord

- SC225 34 Rectangular Socket to 25 Pin "D" Cable

- 5-1/4" 360 Kb diskette containing software for tape read/write and clock functions. 3-1/2" 720Kb disk is available if requested at time of order.

- Operator's Manual

The following computer resources are necessary to retrieve data with the PC201:

- IBM PC/XT/AT or compatible

- PC-DOS or MS-DOS Ver.2.1 or greater

- Minimum 256K bytes of RAM

- Two floppy disk drives or one floppy and a hard disk

- 115 bytes disk space used when PC201 installed

- One full length slot for PC201 Card

A word about this manual. Reference to "PC201 programs" or "programs" will assume reference to "executable programs" (see next page) unless noted. We will use the standard notation for a carriage return when referring to the IBM "Enter" key e.g.**'CR'**. Whenever reference is made to command entries in this manual, we will display the entry as:

'COMMAND'

where the entry lies between the ' ' delimiters. The symbols,' ', are not entered as part of the command.

I.1 SYSTEM OVERVIEW

Software on the PC201 diskette reads or writes cassette tapes using Campbell Scientific's formats. The battery powered clock on the PC201 card can be used to set the standard IBM clock whenever the PC is reset or powered up. The serial I/O port provided on the PC201 card is compatible with the standard IBM Serial Asynchronous Communications Adapter. With the addition of the PC203 Power-up Control Box, PC208 TELCOM program and the Hayes Smartmodem, the PC can collect data automatically over switched phone networks. The telecommunication functions are compatible with Campbell Scientific's SRM-6A RAD Short Haul Modems for twisted pairs (up to 6.5 miles) and RF95 Modems for radio communication. If different communication devices are connected simultaneously at the calling end, a multiplexer is required to select the appropriate device. The PC201, PC203 and modem combination allows an incoming call to power up the PC and access information contained in the PC. A description of the telecommunications functions is contained in the PC208 Instruction Manual.

I.2 PC201 DISKETTE

Software on the PC201 diskette contains the following files:

TAPE.COM	IBMTOCLK.EXE
TAPEFMT1.COM	BATTERY.EXE
TAPEWR.COM	SIG.COM
CLKTOIBM.EXE	PC201.SIG

Use of these programs is described in Section 1. All the programs are executed by entering the program name on the IBM command line, then pressing **'CR'**. This action loads and executes the program. The program displays prompts, guiding the user.

The file PC201.SIG contains a signature for each of the PC201 software files. These signatures are unique to that file. If anything is changed then the signature will change. This is useful when you copy the file to another disk or to verify that the program hasn't been altered. The file SIG.COM generates the unique signature. To execute SIG.COM type **'SIG**

FILENAME' 'CR'. This will generate the signature for the file you specified. This signature can be compared to the signature found in PC201.SIG. To see the signatures in PC201.SIG the user can execute the DOS command TYPE to view the contents of the file.

We suggest creating a PC201 backup disk and copying the executable programs of interest onto a working disk by inserting the PC201 diskette in drive A, a formatted diskette in drive B and typing:

'COPY A:*.* B:'

After the copy has been completed put the PC201 diskette away for a permanent backup and label the new diskette as your working PC201 disk.

I.3 PC201 CARD INSTALLATION

Insert the two alkaline "AAA" batteries into the battery clip on the PC201 card. The "+" end of the batteries must be at the top of the card, indicated by the "+" signs etched into the printed circuit card (Figure I.1).

> BEFORE OPENING THE IBM PC SYSTEM UNIT BOX, UNPLUG THE AC POWER FROM THE PC.

Open the IBM PC system unit by removing five screws around the outside of the back of the system unit box, then slide the shell of the box off the front of the system unit. Install the card guide provided with the PC201 package in the desired location at the front of the system unit box. The PC201 card can be installed in any long slot in the IBM PC.

The PC-DOS Manual refers to RS232 serial ports as COM1, COM2, COM3, and COM4. The PC201 Card can be configured as either COM1, COM2, COM3, or COM4.

If your IBM already has an Asynchronous Communications Adapter, you must ensure that each card is addressed to a different COM port.

The PC201 I/O address is determined by the dip switch settings (Figure I) at location M36. The seven switches correspond to bits 3-9 of the I/O address. The card is shipped configured as COM1, with all switches down or closed (address 3F8H) and the interrupt selection jumper at location P43 connecting pins 3 and 4. This selects the IRQ4 interrupt line on the IBM bus. If the PC201 Card is used as COM2, COM3, or COM4 refer to Section 2.2 for addressing.

Once the card is installed, it can be tested by setting and reading the PC201 clock using the IBMTOCLK and CLKTOIBM programs described in Section 1.5. The SC225 ribbon cable provided connects to the back of the PC201 card. Note that the rectangular connector on the ribbon cable is keyed for proper insertion. The 25 pin D-type connector looks like Data Terminal Equipment (DTE) and can be used to connect to any RS232 Data Communications Equipment (DCE), e.g. a modem. Functionally, it is the same as the standard IBM Serial Asynchronous Communications Adapter.

I.4 A QUICK SET-UP PROCEDURE FOR READING TAPES

TURN ON YOUR TAPE RECORDER

Listen to your data with the volume control on mid-range. You should adjust the skew position of the head if the data sounds muffled. Improper head skew attenuates the high frequency response of the tape recorder. The adjustment screw is near the head assembly (Figure I.2) and can be adjusted back and forth until you hear the crispest sounding data which indicates maximum high frequency response.

CONNECT

Connect the two cables from the tape recorder MONITOR (labeled EAR on the Model RC35 (Realistic CTR-85)) and REM to the PC201 monitor and remote located on the back panel.

Interrupt Selection Jumper

(Location P43)

Dip Switches
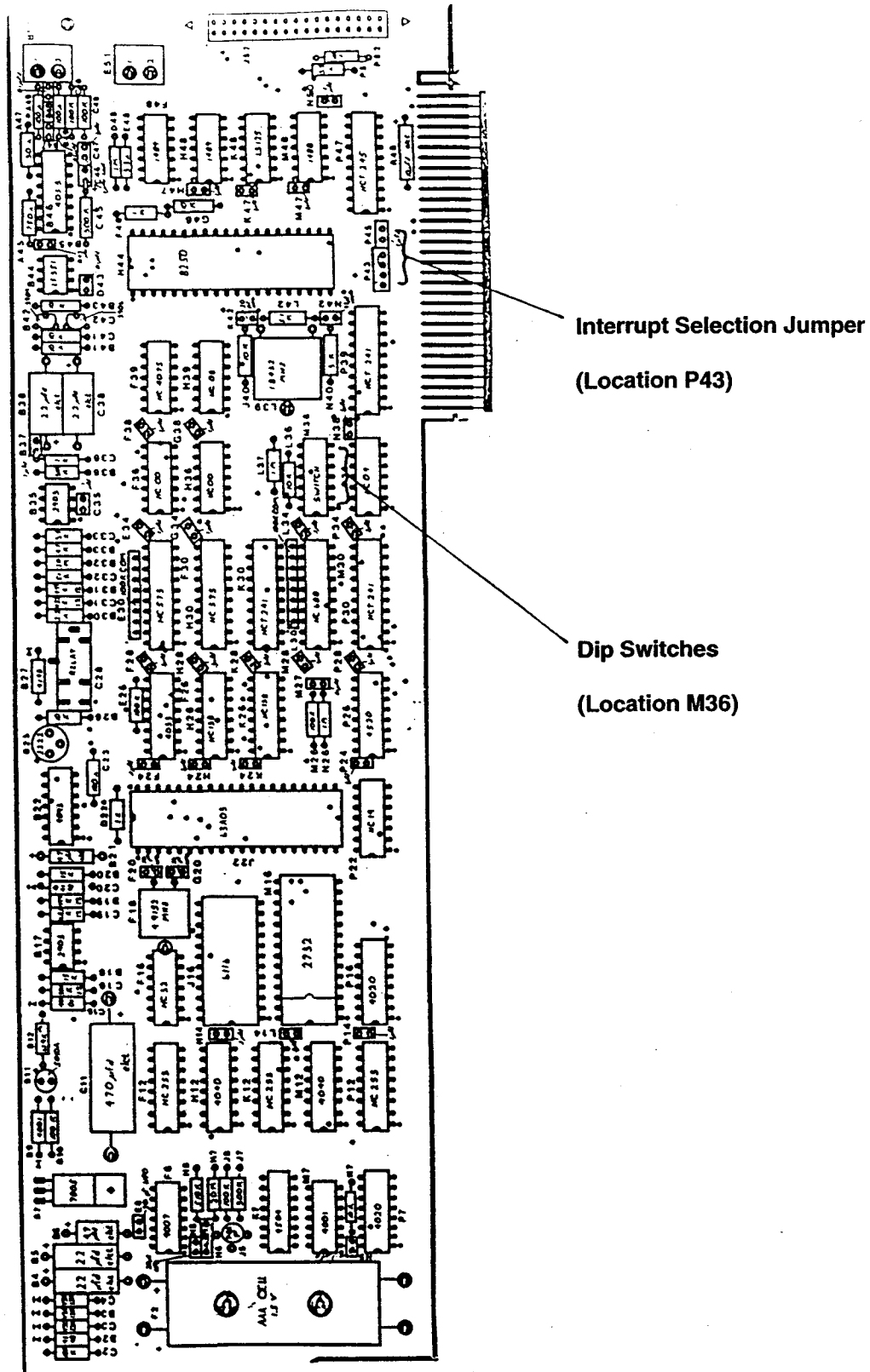
(Location M36)

FIGURE I.1 Location of PC201 Card Address Switch & Interrupt Jumper

INTRODUCTION

TAPE FORMAT

If the data on the cassette tape is written in Format II, then type **'TAPE' 'CR'**. If the data is written in Format I, then type **'TAPEFMT1' 'CR'**.

TURN TAPE RECORDER ON

Rewind and depress the PLAY button on the tape recorder.

FILE NAME

The program asks for a file name. Type in a file name **'FILENAME.EXTNAME'** followed by a **'CR'**.

SELECT OPTION

Enter **'S'** to turn the tape recorder on.

READING FORMAT II

A cursor at the top of the screen moves between 0-100 as the tape is read. The volume and head skew are optimized by adjusting so the cursor moves closer to 0.

READING FORMAT I

A cursor moves between "data", "error" and "gap" as the PC201 reads tape. Adjust the volume and head skew until the cursor moves between data and gap.

EXIT

Enter **'E'** and the program exits back to PC-DOS. You can now look at the data in the file you created.

FIGURE I.2 Head Alignment Adjustment Screw for the RC35 Recorder

SECTION 1. PC201 SOFTWARE FUNCTIONS

1.1 RECORDER SET-UP

HEAD ALIGNMENT

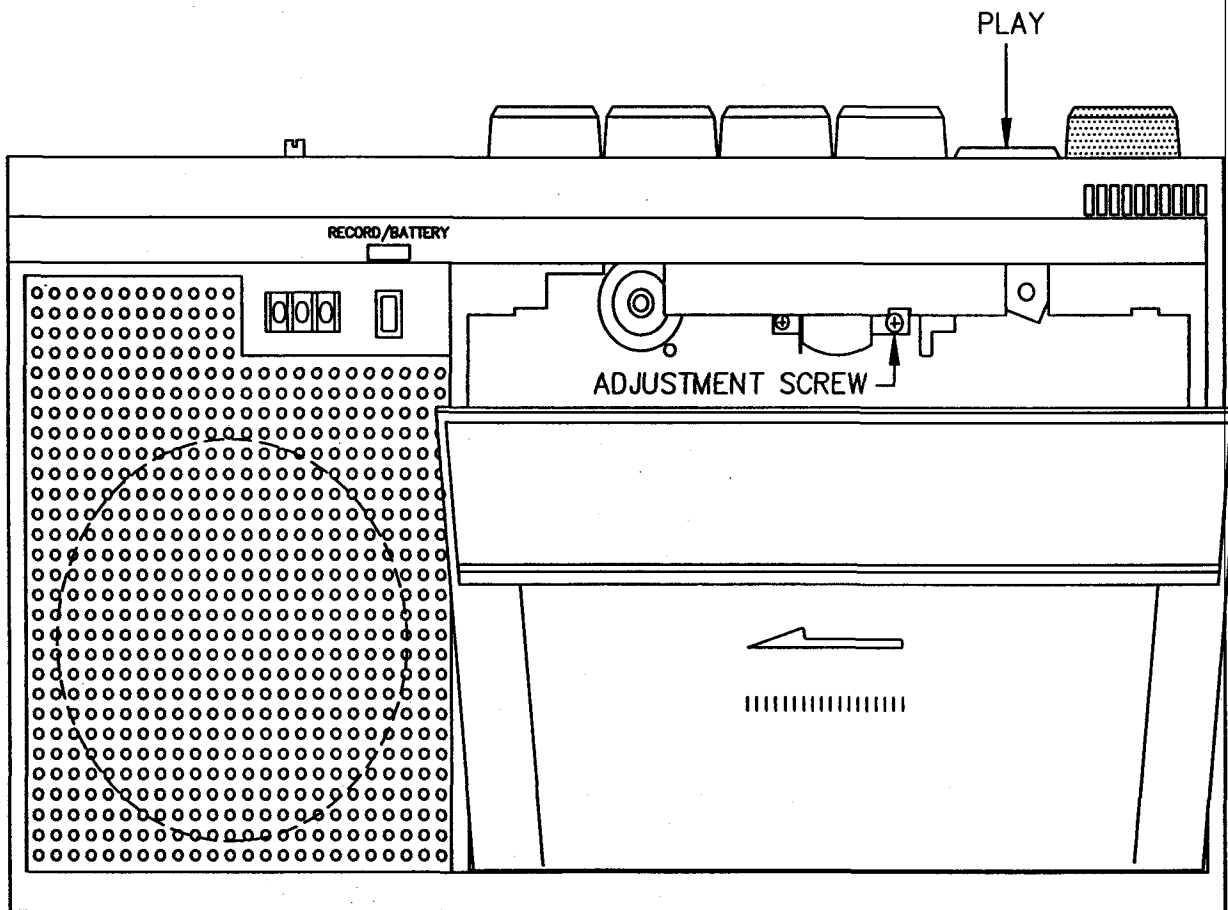The first adjustment to check if errors are encountered in playback is the recorder head alignment. Refer to Section I.4 for this procedure. Location of the adjustment screw is shown in Figure I.2. The playback quality indicator displayed by the tape read programs can also be used to optimize both alignment and volume. Once the head has been aligned correctly, move the volume control back to a mid-range setting.

TAPE RECORDER/PC201 CONNECTIONS

The PC201 card provides an interface between the cassette tape recorder and the PC. Next a user must connect the proper patch cords between the PC201 card and the tape recorder. There are two small connectors (REMOTE is 2.5 mm and MIC/MONITOR is 3.5 mm) located at the top of the PC201 card. When reading tape, the patch cord that connects to the top connector on the PC201 card should be connected to the jack labeled EAR on the tape recorder. The patch cord connected to the lower (smaller) jack of the PC201 card should connect to the tape recorder jack labeled REM. With both patch cords connected and the PLAY button on the recorder depressed, the PC201 card is able to control the recorder and read the data.

DISTINGUISHING FORMATS I AND II

Format I was used by the CR5 Datalogger and early CR21 Microloggers. Format II is the only format used by the 21X, CR7, and CR10 dataloggers. If the format is unknown, there are a few clues which help determine the format. Both formats are organized into blocks. The block length of Format II is always 5 seconds long and consistent in length. With Format I, the block lengths may vary. Format I data starts at the beginning of the block and goes to the end, but Format II has a short, regular beep preceding data and follows data with a lower frequency short beep. Format II data sounds like noise; whereas, Format 1 data has a regular beat. If all else fails first try the TAPE program and then the TAPEFMT1 program.

1.2 READING FORMAT II - TAPE PROGRAM

The TAPE program reads cassette tape generated using Campbell Scientific's Format II. A full C60 cassette stores 180,000 datapoints (360,000 bytes). When converted and stored on disk in either "Printable ASCII" or "Comma Delineated ASCII", a full tape generates either 1.8 Megabytes or 1.1 Megabytes, respectively. The TAPE program checks available disk space before reading a tape block and if another block of data cannot be written to disk, it displays a message indicating the disk is full and returns to the PC-DOS system. The TAPE program must be executed again using a new data storage disk to commence reading.

The user enters **'TAPE' 'CR'** on the command line to load and execute the TAPE program. The PC must be logged onto the disk and directory containing TAPE or the appropriate "path" must be specified per the PC-DOS Manual. The first action the TAPE program requests is the name of the destination file. File names are limited to the same rules that apply for PC-DOS file name structures. If the user wants the destination file to reside on a drive other than the currently logged drive, the file name must be prefixed with the drive letter and a colon, e.g. **'A:'**, **'B:'** or **'C:'**. The file name can be entered on the command line along with the program name. For example, **'TAPE NAME.DAT' 'CR'** executes the TAPE program and stores data in file "NAME.DAT". If a **'CR'** only is entered instead of a file name, the program aborts and returns to PC-DOS.

Once the destination file name is entered, options are displayed on the screen as shown in Figure 1.1.

**Maximum Timing Deviation
(% of timing margin)**

0 10 20 30 40 50 60 70 80 90 100

Bit Cell = μsec

Options	Current Values
F = Change File Name	NAME.DAT
D = Change File Data Format	C. D. ASCII
G = Change Allow. Gap Time	5 seconds
S = Start Reading	Not Reading
R = Restart Reading	
E = Exit	

Select option:

FIGURE 1.1 TAPE Program Screen Display

1.2.1 DESCRIPTION OF OPTIONS

The "Current Values" shown in Figure 1.1 are the default settings of each option listed on the left side of the screen. To change any of the default settings, enter the letter to the left of the equal sign i.e. 'F', 'D', 'G', etc. If an option is selected while the PC201 card is reading, the TAPE program may take up to five seconds to respond. A detailed description of each option is given below:

CHANGE FILE NAME

'F' option: any legal file name

This option clears existing date buffers, closes the current data file and opens the new file. A prompt asks for the new destination file. If only a 'CR' is entered, the program aborts and returns the user to the PC-DOS system. To start a new file, type **'NEWFILENAME' 'CR'** and the new file will appear as the "Current Values" parameter.

CHANGE FILE DATA FORMAT

'D' option: Comma Delineated ASCII
             Printable ASCII
             Same As On Tape

One of the three format options is selected by toggling the "D" key.

"Comma Delineated ASCII" strips all IDs, leading zeros, unnecessary decimal points, plus

signs, and spaces. Data points are separated by commas. Output arrays are separated by carriage return, line feed.3

1,234,1145,23.65,-12.26,625.9

1,234,1200,24.1,-10.98,650.3

"Comma Delineated ASCII" averages about 6 bytes per datapoint.

"Printable ASCII" is the standard datalogger ASCII output described in the datalogger manual. Each 10 character datapoint contains a 2 digit ID, polarity sign, decimal point and 2 spaces following the value. An example of "Printable ASCII" is shown below:

01+0001.	02+0234.	03+11145
04+23.65	05-12.26	06+625.9
01+0001.	02+0234.	04+1200.
04+24.10	05-10.98	06+650.3

The end of each Output Array or every eight datapoints (80 characters) is followed by a carriage return, line feed.

"Same as on Tape" stores data in the file exactly as it is received from the tape. Selecting this option when reading Format II datalogger tapes stores the data in CSI's binary Final Storage Format, described in the CR7X, 21X, or CR10 Operator's Manual. The "Same as on Tape" option should be selected when reading a tape generated with the TAPEWR program or CSI's C20 Cassette Interface.

CHANGE ALLOWABLE GAP TIME

'G' option: any integer from 0 (infinite gap) to 59 seconds

The gap time is the time between data blocks on tape, 1.5 seconds for data tapes from CSI's dataloggers. The default setting for the allowable gap time is 5 seconds. Whenever the TAPE program detects a gap which exceeds the allowable gap time, it stops reading and allows a file name change before reading the next group of data. To separate groups of data when logging, pull out the REM jack and record a longer than normal gap.

START READING

'S' option: none

Entering 'S' starts the recorder and initiates the reading and storing of data to the disk. The "option" description changes to "Stop Reading" and "Current Value" changes to "Reading" when 'S' is selected. The "Option" and "Current Value" displays change back again if 'S' is toggled or the gap time is exceeded.

RESTART READING

'R' option: none

At the beginning of a tape read operation, it is often necessary to make adjustments in a trial run. This option is used to reinitialize the file after adjustments have been made. A prompt appears that allows you to rewind the recorder, confirm the "Restart", and start over. Data previously written into the file is erased.

EXIT

'E' option: none

This option terminates the TAPE program execution. Data buffers are cleared and the destination file is closed before termination.

1.2.2 PLAYBACK QUALITY INDICATORS

Playback quality information is displayed on the screen as an aid in making recorder adjustments. The timing for each voltage transition detected by the PC201 card is compared with what it ideally should be. Every 16 words (32 bytes) the maximum timing deviation from the ideal is displayed on the screen. The displayed units are in the percentage of allowable timing margin. If the timing deviation reaches 100% then one or more of the last 16 words are in error. The 512 word tape block contains an elaborate parity array which allows correction of read errors up to a certain point. If uncorrectable errors are detected, the block number and the number of uncorrectable errors are displayed on the lower part of the screen.

The PC indicates the period of one bit cell at the start of a block of data in microseconds (μs). A bit cell is the tape space required to store one bit of information. This is useful only if your

tape recorder has speed adjustment capability. With Format II a bit cell should be 256 μs long. A value of 256, plus or minus 30%, should be readable. As the tape speed is increased, timing errors increase, causing data read errors.

1.3 READING FORMAT I - TAPEFMT1 PROGRAM

The TAPEFMT1 program is used to read CSI's Format I tapes. The prompts and options for TAPEFMT1 are about the same as those used in the TAPE program. Refer to Section 1.2 for information on how to use the options. Format I is recorded in ASCII so no conversion options are available.

No timing deviation is used with Format I but a "Read Status" is displayed in the upper right hand corner of the screen. As the PC201 reads the tape, a cursor moves from "Gap" to "Data" or from "Gap" to "Error". If the cursor moves to the "Error" condition, a read error has occurred. Read errors on Format I tapes occur for individual characters and are indicated by a "?" in the data file. A block number and the number of errors are displayed on the lower part of the screen.

1.4 WRITING TO TAPE - TAPEWR PROGRAM

The TAPEWR program is used to write a disk file to cassette tape using CSI's tape Format II. The TAPEWR program will not write to tape in Format I. This program is useful for transferring files between computers that both support Format II. Tapes written with this program can be read using the TAPE program, specifying the "Same as on Tape" option or the Model C20 Cassette Interface. Data is written in 512 word blocks (1024 bytes) with each byte maintaining all eight bits of the original information. If the disk file is not an even multiple of 1024 bytes, nulls are used to fill out the last block.

When writing to tape the patch cord connected to the top (larger) connector of the PC201 card must be connected to the MIC (or CMT IN) connector on the tape recorder. Push the RECORD and PLAY buttons with the REMOTE patch cord unplugged to advance past the leader at the start of the tape. Connect the REMOTE cord and type 'TAPEWR' 'CR'. Enter the name of the file to be written to tape. When the tape recorder is prepared enter 'CR'

to start writing. The tape is controlled by the PC201 until the source file is written to tape, at which time the program returns the user to the PC-DOS system.

The screen displays:

Campbell Scientific Tape Write - Version 3

Enter source file name: **'FILENAME' 'CR'**

1.5 USING THE PC201 CLOCK

1.5.1 CLKTOIBM

This program uses the battery powered clock on CSI's PC201 Card to set the IBM clock with the date and time. Generally this program is called from the AUTOEXEC.BAT file and executed at power up to set the PC clock. Thereafter, any time or date information needed by the operating system or programs running on the PC can be obtained from the standard PC clock. The CLKTOIBM program is a machine code program and can be executed by typing **'CLKTOIBM' 'CR'** on the PC-DOS command line. After execution the program returns to the PC-DOS system with a message that the clock has been set.

1.5.2 IBMTOCLK

This program reads the standard PC clock and sets the battery powered PC201 clock with the date and time. This program is used to set the proper time and date into the PC201 clock and should be needed infrequently. The procedure requires running the DATE and TIME programs supplied with PC-DOS to set the PC clock. Execute the IBMTOCLK program to set the clock on the PC201 card by typing **'IBMTOCLK' 'CR'** as a PC-DOS command. After execution the program returns to the PC-DOS system with a message that the clock has been set.

1.6 CHECKING BATTERY STATUS

This program checks the status of the batteries in the PC201 Card. The two "AAA" batteries will last approximately two years on a full charge. To execute the program, type **'BATTERY' 'CR'**. The program issues a message regarding the battery status, then returns to the PC-DOS system.

CAUTION: The battery check will be valid only if the batteries are installed. An open circuit will not return a proper battery status.

1.7 FILE SIGNATURE CHECK - SIG PROGRAM

This program will give the signature of a file. This signature will not change unless the file has been changed in some way. This is used to verify a proper copy has been made. To execute the program, type **'SIG FILENAME' 'CR'**. The program will give the file name followed by the file size (in bytes), creation date, time and the signature.

SECTION 2. PC201 TECHNICAL REFERENCE

The PC201 Clock, Tape & Serial I/O Card provides the hardware necessary to read or write Campbell Scientific cassette data tapes and aid in unattended operation of the IBM PC. The card contains a battery backed up real time clock and an asynchronous serial communications port which may be configured as COM1, COM2, COM3, or COM4. The PC201 is addressable to any I/O address in the PC I/O map, but supporting software must be changed if addresses other than COM1, COM2, COM3, or COM4 are used. The software clock is implemented with the 6303 processor. If the PC203 Power-up Control Box is connected to the PC201, the clock is synchronized to the 50 Hz or 60 Hz signal originating from the 115 VAC power line. When the AC signal is not available, the clock is maintained by a battery powered 16.384 kHz crystal oscillator on the PC201 card. The two alkaline "AAA" cell batteries should be replaced every two years. The clock can be set with IBMTOCLK and read with CLKTOIBM. The status of the battery can be checked by reading the status byte from the PC201 card. Clock accuracy without the PC203 is ±3 minutes per month. With the PC203, accuracy is equal to the accuracy of 60 Hz.

The asynchronous serial communications port is designed to be functionally equivalent to the IBM Asynchronous Communications Adapter with a couple of exceptions. The OUT1 modem control line from the 8250 UART on the standard IBM card is not used. The PC201 uses this output to interrupt the 6303 processor, causing it to abort a current command and insuring its attention prior to issuing the 6303 a command. Another difference is that the PC201 card does not provide a current loop option for serial communications. The PC201 card is equipped with a 34 pin rectangular connector designed to provide a standard RS232 port when proper cabling is used. Other conductors on the 34 pin connector are used in conjunction with either the PC203 Power-up Control Box or the Campbell Scientific 9 pin interface. The 9 pin interface may be used directly with Campbell Scientific's Model SM16/SM64 or SM192/SM716 Storage Modules.

Tape read/write circuitry provided on the PC201 card reads or writes to Campbell Scientific data cassette tapes. Specific commands are not provided in the 6303 ROM to accomplish tape read/write functions, but commands are provided to down load and execute 6303 code from the PC. This method allows flexibility for future variations in tape formats without requiring ROM alterations.

Information regarding unattended operation is contained in the PC208 Datalogger Support Software Manual; a brief summary of capabilities is included here. Software associated with these functions is contained on the PC208 diskette. In combination with the PC203 Power-up Control Box, the PC can be powered up at a predetermined time, execute a program, and power down without user assistance. A watch dog function is included which powers the system down, then up, if it is not progressing properly due to a momentary power failure or program error. Power-up software allows the PC to execute a given program at a given time with a watch dog to ensure the proper completion of that program.

Another function built into the PC201 card is the ability to use the PC to answer an incoming call. To accomplish this the PC201 card must be connected to the PC203 Power Controller box, which in turn is connected to a suitable modem such as the Hayes Smartmodem. The modem must be set to the answer mode with its power left on. An incoming call activates the modem Ring Indicator line which is sensed by the PC201 card. The PC201 card, in turn, powers up the PC through the PC203 and activates the Data Terminal Ready line to the modem. The modem answers the call when it senses the DTR line active and sets the Carrier Detect line after establishing the carrier signal. At the time the Ring Indicator is sensed, the PC201 card sets a timer to thirty seconds and powers the PC on. If the Carrier Detect is not sensed within this time, the PC is turned off. When the Carrier Detect is sensed by the PC201 card, the timer is inhibited from counting down. After the call is completed, the Carrier Detect goes in-active and the timer counts down. Power is turned off 15 or 20 seconds later when the timer reaches zero.

2.1 ELECTRICAL SPECIFICATIONS

The 12 VAC line from PC203 box must supply about 100 mA. Batteries must supply 13 to 17 μA when other 12 V supplies are not active.

2.2 I/O PORT ADDRESSING AND JUMPER SELECTION

The PC201 card can be configured at any address in the PC I/O address map. It is recommended that the I/O addressing be set up so that the PC201 card uses the address area and interrupt lines intended for the standard IBM Asynchronous Serial Communications Adapter (COM1, COM2, COM3, or COM4). The PC201 card is shipped configured as COM1. If an existing card is already configured as COM1, either the PC201 card or the existing card must be configured for another COM address.

The I/O addressing is accomplished with the seven switches (bits 3-9 of the address) located at M36 (Figure I.1). The interrupt selection jumper at location P43 must also be configured properly.

COM1 configuration (address 3F8H):
Close (on) all seven switches and install the connector between pins 3 & 4 (1 & 2 open) of the jumper located at P43.

COM2 configuration (address 2F8H):
Close (on) all the switches except switch number 6 which must be open (off). Connect pins 1 & 2 (3 & 4 open) of the jumper at location P43. Pins 1 & 2 are those closest to the battery end of the card.

COM3 (address 3E8H):
Close (on) all of the switches except switch number 2 which must be open (off). Install the connector between pins 3 and 4 (1 and 2 open) of the jumper located at P43. Pins 1 and 2 are those closest to the battery end of the card.

COM4 (address 2E8H):
Close (on) switches 1, 3, 4, 5, and 7. Open (off) switches 2, and 6. Install the connector between pins 1 and 2 (3 and 4 open) of the jumper located at P43. Pins 1 and 2 are those closest to the battery end of the card.

The UART functions which match the standard IBM serial communications card use eight address locations in the I/O address map, starting with the base address. Additional functions of the PC201 card use I/O map space normally used as an overlap area of the COM1 or COM2 card in the PC system. The I/O address space used for these additional functions is located at the base address of the PC201 card plus 400H. Configured as COM1, the additional functions are accessed through I/O address 7F8H and 7F9H; configured as COM2, these functions are addressed at 6F8H and 6F9H. The following describes the COM1 I/O addressing as the PC201 card is received from Campbell Scientific:

3F8 - 3FFH   8250 UART (OUT1 set then clear for 6303 non-maskable interrupt).

7F8   8 bit I/O port for communication between 6303 and IBM.

7F9   Bit DO, "from PC" status; bit D1, "to PC" status. DO is set when the PC writes to the 8 bit port and remains set until the 6303 reads the port. D1 is set when the 6303 writes to the 8 bit port and remains set until the PC reads the 8 bit port.

2.3 CONNECTOR PIN OUT

The PC201 card is equipped with one 34 pin rectangular connector. A small arrow or triangle molded into the plastic shell on the PC201 card marks pin 1. Pin 2 is opposite pin 1, and pin 3 is next to pin 1. Conductors on the connector can be grouped into three categories. Table 2.1 lists both the PC201 pins and the corresponding pin number at the end of the connecting cable. PC201 pins 1-20 are described in terms of the RS232 connections provided by the SC225 cable shipped with the PC201 Card. The port functions as RS232 Data Terminal Equipment (DTE). Pins 21 through 24 are used with the PC203 Power-up Control Box. Pins 25 through 34 contain some duplicate lines from the RS232 section and match the pinout of Campbell Scientific's Storage Modules. Campbell Scientific's SC209 cable allows direct connection between these pins and the Storage Modules.

The Model SC234 cable provided with the PC203 brings all 34 pins of the PC201 out to the PC203, which has a second port for connecting RS232 and Campbell Scientific 9 pin I/O devices.

TABLE 2.1 PC201 34 Pin Connector Description

PC201 Pin	Signal Source	PC201 Description	Connecting End
		---------- RS232 ----------	-------- RS232 --------
1		Ground	1
2	nc*		14
3	PC201	Txd - Transmitted data	2
4	nc		15
5	other	Rxd - Received data	3
6	nc		16
7	PC201	RTS - Request To Send	4
8	nc		17
9	other	CTS - Clear To Send	5
10	nc		18
11	other	DSR - Data Set Ready	6
12	nc		19
13		Ground	7
14	PC201	DTR - Data Terminal Ready	20
15	other	RLSD - Receive Line Signal Detect	8
16	nc		21
17	nc		9
18	other	RI - Ring Indicator	22
19	nc		10
20	nc		23
		------------ PC203 ------------	
21	PC203	Power Switch Status, +5 V if switch is on	
22	PC201	Power Control, +5 V turns on relay.	
23	PC203	13.5 VAC supply & time base for PC201 card.	
24		Ground.	
		------------ CSI 9 PIN I/O ------------	-------CSI 9 PIN I/O-------
25	PC201	+5 VDC from PC bus.	1
26	PC201	Printer Enable, same as RTS.	6
27		Ground.	2
28	PC201	Unload Enable, same as DTR.	7
29	other	Ring, same as RI.	3
30	PC201	+12 VDC from PC bus.	8
31	other	Rxd, same as Rxd.	4
32	PC201	Txd, same as Txd.	9
33	PC201	Modem Enable, controlled by 6303.	5
34	nc		

*nc - no connect to PC201 circuitry.

2.4 PC201 COMMAND SUMMARY

The additional functions provided by the PC201 card such as tape read/write and the battery backed up clock are accessible to the PC through a series of commands. These commands and subsequent parameters are passed between the PC and the 6303 using a one byte parallel port with two bits of a second port providing communication status information. Sending a byte to the other processor is coordinated by checking the appropriate status bit to see if last byte sent has been received. If so, the next byte is sent. This procedure is demonstrated in several programs provided with the PC201 diskette.

Each command sent to the PC201 should be preceded by a PC201 interrupt. The interrupt serves to prepare the PC201 for the incoming command. The command byte is then issued to the PC201 by writing to the 8 bit parallel port referenced in Section 2.2. If the command is one which requires additional parameters from the PC, the PC must wait for the 6303 to read each byte from the parallel port before sending the next byte. In all cases, if the PC waits more than 5 milliseconds for the 6303 to read a byte from the parallel port, a hardware problem exists in the PC201 card. Commands which invoke a response can be considered complete when the PC has received the last byte of the response. For commands which do not require a response, the 6303 sends a null, indicating completion of command execution.

PC201 INTERRUPT

This function has no command byte and is performed by first clearing, then setting the OUT1 line on the 8250 UART. This causes the 6303 to abort any command currently under execution and clean out any byte currently being received through the parallel port. The 6303 then places a status byte in the parallel port to the PC. After toggling the OUT1 line, the PC should wait for at least 100 microseconds before reading status from the parallel port. If the status is not there, a hardware problem exists. If the status is read, the 6303 is ready for the next command. The 8 bits of the status code are described below; the functions are asserted high (true):

D7 Pow Ok (6303 has adequate power for 50 ms of operation)
D6 Bat Ok (Battery voltage > 2.29 V)
D5 S5 Ok (system 5 V supply is ok)
D4 Unattended Active Flag (software flag)
D3 Answer Modem Active (incoming call)
D2 Carrier Detect from modem
D1 PC203 On/Off Switch is on
D0 RI (ring from modem)

01H SET CLOCK

The command byte is followed by eight bytes to set the PC201 clock. The new date and time are loaded into the clock registers as soon as the last byte is received by the 6303. A null is then sent to the PC, indicating completion of the command. Out of bound values are set in bounds before they are written to the clock. The 8 bytes following the command byte are as follows:

Byte 0 - 1/100 seconds (0-99)
Byte 1 - seconds (0-59)
Byte 2 - minutes (0-59)
Byte 3 - hours (0-23)
Byte 4 - day of month (1-31)
Byte 5 - month (1-12)
Byte 6 - least significant byte of year
Byte 7 - most significant byte of year

02H READ CLOCK

When the 6303 receives the command byte, it responds with eight bytes of clock information as described in the Set Clock command.

03H SET ALARM

This command is identical to the Set Clock command. When the clock value becomes greater than or equal to the alarm value, the IBM powers up. The alarm is used to initiate unattended tasks. The Unattended Active Flag is set at the time of power up, indicating an unattended task is active. The flag is cleared by the Unattended Done command. As long as there is no evidence of attended use while the flag is set, the PC watch dog is activated.

04H READ ALARM

Same as Read Clock command except that Alarm data is returned.

05H UNATTENDED DONE

If a power failure occurs during unattended operation, the Unattended Active Flag is checked when power returns to determine the previous state of the PC. Executing this command clears the flag, indicating to the 6303 that the unattended job is done and the power can be turned off if there is no evidence of attended use. Once the flag is cleared, the 6303 issues a null to the PC, indicating completion of the command. Altering the alarm does not alter this flag.

If the PC power is left on all the time, the task execution on the PC must check the alarm time, execute the task at the proper time, and maintain the watch dog. The Unattended Active Flag remains set and power on as long as the Unattended Done command is not executed. If a problem occurs, the watch dog powers the computer down, then up, if the Unattended Active Flag remains active.

06H SET WATCH DOG TIMER

This command sets the watch dog timer, allowing enough time to execute the next task during unattended operation. Three events cause the PC201 to power up the PC. Two of them, the switch on the Power-up Control Box and the Ring Indicator signal of an answer modem, are considered attended activities where the user can fix potential problems. When the alarm function powers up the PC it is considered unattended operation, requiring a watch dog to power down-power up reset the system in the event of failure. The watch dog is a timer which must be continuously reset during normal execution. When the PC powers up, the timer is automatically loaded with the same value as when last set.

The command byte is followed by a 2 byte integer, Least Significant Byte (LSB) first, which is the number of seconds before the computer is reset. After receiving the second byte, the 6303 responds with a null to indicate the command is complete. If the maximum count (FFFFH) is set into the timer, the computer never resets.

WARNING: 120 seconds may be inadequate for the PC to execute its power-up memory test and initialization phase, prohibiting setting the watch dog again. For this reason, never set the timer to less than 120 seconds.

07H READ ERROR LOG

System errors detected by the PC201 are recorded, along with the time of occurrence, in an error log. Only the most recent error code is kept along with the total number of errors that have occurred. The error log is obtained by using this command.

The returned bytes are as follows:

Byte 0 - Error Counter.
Byte 1 - Error Code of most recent error.
    00H - No errors have been logged.
    01H - System power did not come on when relay was activated.
    02H - PC watch dog did not get reset on time, or 6303 crashed.
    03H - AC power failure occurred while system was active.

--------------Time of Most Recent Error--------------

Byte 2 - 1/100 seconds (0-99)
Byte 3 - seconds (0-59)
Byte 4 - minutes (0-59)
Byte 5 - hours (0-23)
Byte 6 - Day of Month (1-31)
Byte 7 - Month (1-12)
Byte 8 - Least significant byte of Year
Byte 9 - Most significant byte of Year

08H CLEAR ERROR LOG

This command clears Error Counter and Error Log then sends a null.
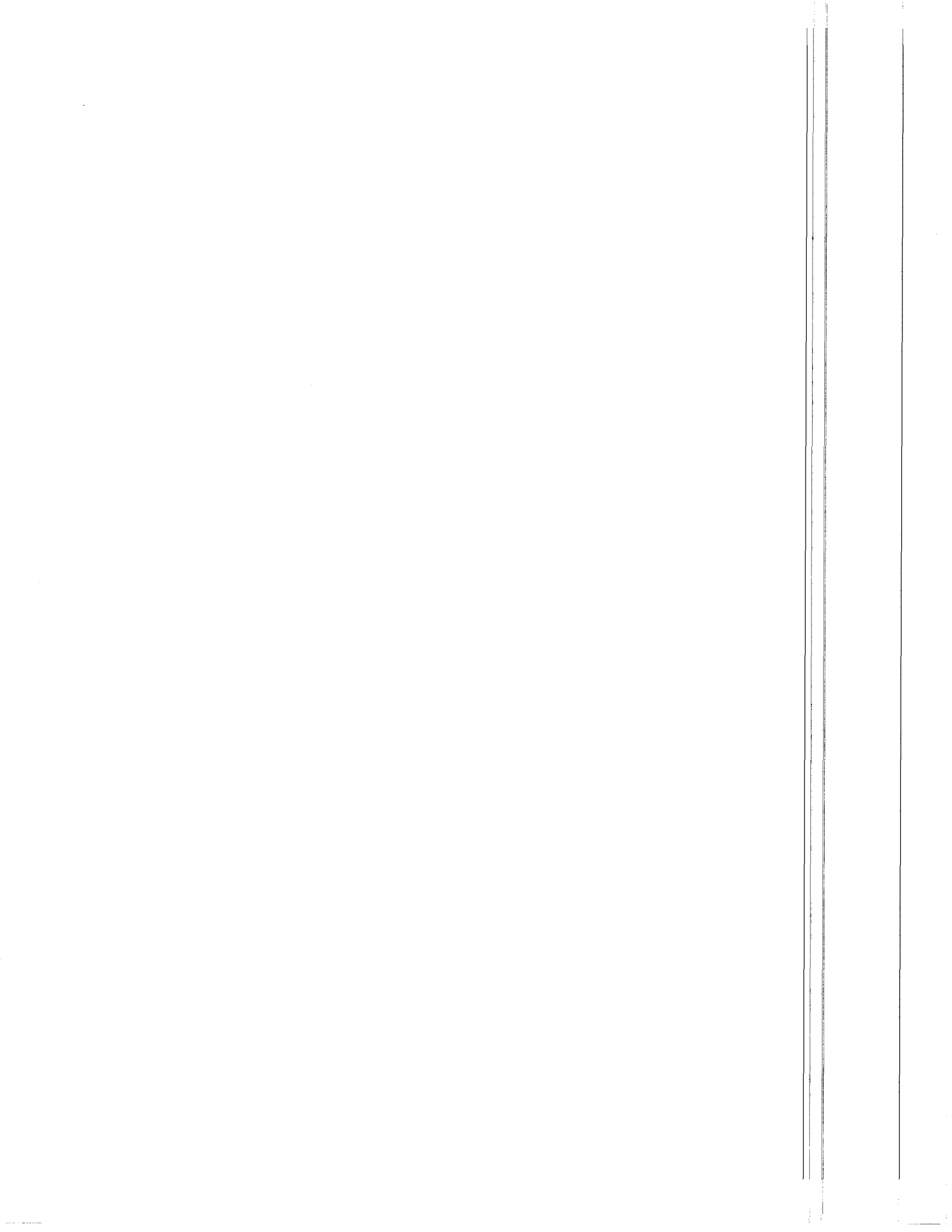
APPENDIX A. CAMPBELL SCIENTIFIC
FINAL STORAGE DATA FORMAT

The Campbell Scientific Final Storage Format is used primarily to compress datalogger data for storage on devices such as cassette tape and computer disk. The fundamental storage unit of this format is a two byte data word. The first byte of each two byte pair is used to designate the type and use of a word or subsequent words. Given bits ABCD EFGH where A is most significant bit of the first byte of a word, if bits D, E, and F are not all ones, then it is the first of a two byte data value. If D, E, and F are all ones, the data type and use of other bits are as follows:

ABCD	EFGH	Description
1 1 1 1	1 1 0 x	Start new array. Starting with H as the most significant bit, the rest of this word is used as an array ID number ranging from 0 through 511. This start of array byte also marks the end of either the ASCII or the 8 bit data modes.
1 1 1 1	1 1 1 0	Start new array and begin 8 bit data mode. The second byte of this word is the first of a string of 8 bit data values which range from 0 through 251. It will stay in the 8 bit data mode until either an end of byte mode byte is detected or until the start of a new array is detected.
0 1 1 1	1 1 1 0	Begin 8 bit data mode. The second byte of this word is the first of a string of 8 bit data values which range from 0 through 251.
0 1 1 1	1 1 0 1	Begin ASCII data mode. The second byte of this word is the first of a string of ASCII characters. It will stay in the ASCII data mode until either an end of byte mode byte is detected or until the start of a new array is detected.
1 1 1 1	1 1 1 1	End of byte mode character. This byte is used to mark the end of either 8 bit data or ASCII data. It is required only when the next byte in memory is either not the start of a new array or not on an even word boundary. If this byte is the first byte of a word, then the second byte of the word must be the same as the first and acts as a fill byte.
x x 0 1	1 1 x x	First byte of a 4 byte value.
0 0 1 1	1 1 x x	Third byte of a 4 byte value.
0 1 1 1	1 1 1 1	Fill word. The fill word is used to fill the end of a block when it is necessary to write an incomplete block of data to tape. While reading, data fill words should be ignored; they are not part of the data. In some cases it may be necessary to keep extra information for special programs which operate on data files. The second byte of the fill word can be any value and is a good place to keep extra information that is not part of the data but must be kept with the data for special programs.
0 1 1 1	1 1 0 0	Error word. Error words will occur in data which has been read from tape in which irrecoverable errors were detected. The second byte is always zero.

APPENDIX A. CAMPBELL SCIENTIFIC FINAL STORAGE DATA FORMAT

Two Byte Data 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 through H	Bits 12 through 8 resp. of binary mantissa.
2nd byte	Bits 7 through 0 of binary mantissa.

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

The decimal range of the mantissa is 0 to 6999.

Four Byte Data Format

1st byte	2nd byte	3rd byte	4th byte
AB01 11CD	xxxx xxxx	0011 11EF	xxxx xxxx

Bits or byte	Description
B	Polarity, 0 = "+", 1 = "-".
C, D, A	Decimal exponent.
E, F	Bits 17 and 16 resp. of binary mantissa.
2nd byte	Bits 15-8 of binary mantissa.
4th byte	Bits 7-0 of binary mantissa.

Interpretation of the decimal exponent is as follows:

Bits C D A	Decimal location
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

The exponent is actually a binary value indicating the negative decimal exponent.

APPENDIX B. CAMPBELL SCIENTIFIC
PRINTABLE ASCII DATA FORMAT

The printable ASCII data format is used when datalogger data needs to be displayed, printed, edited, or used by a program not capable of handling the Campbell Scientific Final Storage Format. Printable ASCII Data recorded by Campbell Scientific equipment should look like one of the following:

CR5 R235 data:

00+T01 01+T02 03+T03 04-000 05+A00
06+B00 07++00 08+-00 09+.00

10+T00 11 000

CR5 TC235A data:

00+1500 01+1500 02+1500 03-0000

CR21 data:

01+0000. 02 0000. 03 -000. 04+000.0 05-
00.00 06+0.000

CR7, CR10 or 21X data:

01+0000. 02+000.0 03-00.00 04+0.000 05-
00000. 06+0000.0

If printable ASCII format data is converted back to Final Storage Format, there are a few things that must be considered. For CR5 and TC235A data, if the number is µ1500, then 1500 should be subtracted. Over range characters (AB ±.T) must be converted to numbers. If the channel ID is 00, the data point is at the start of a line, the original data value is µ1500, and data is positive, then a start of array marker will be used. On CR21, CR10, CR7 or 21X data, if the channel ID is 01, the data is an integer, the data point is at the start of a line, the value is < 512, and the data is positive, then a start of array will be used.

There are also a few places where the conversion may not go as expected. If more than 200 values are recorded in a single array of data, it is possible that an extra Start New Array code will be used when it may not have really been a new array. What could have been stored as eight bit Data may end up as two byte data. In any case, when the conversion is made back to the Printable ASCII format, the resultant file will contain all of the original Information.

> **NOTE:** A disk file may or may not end with a carriage return line feed.
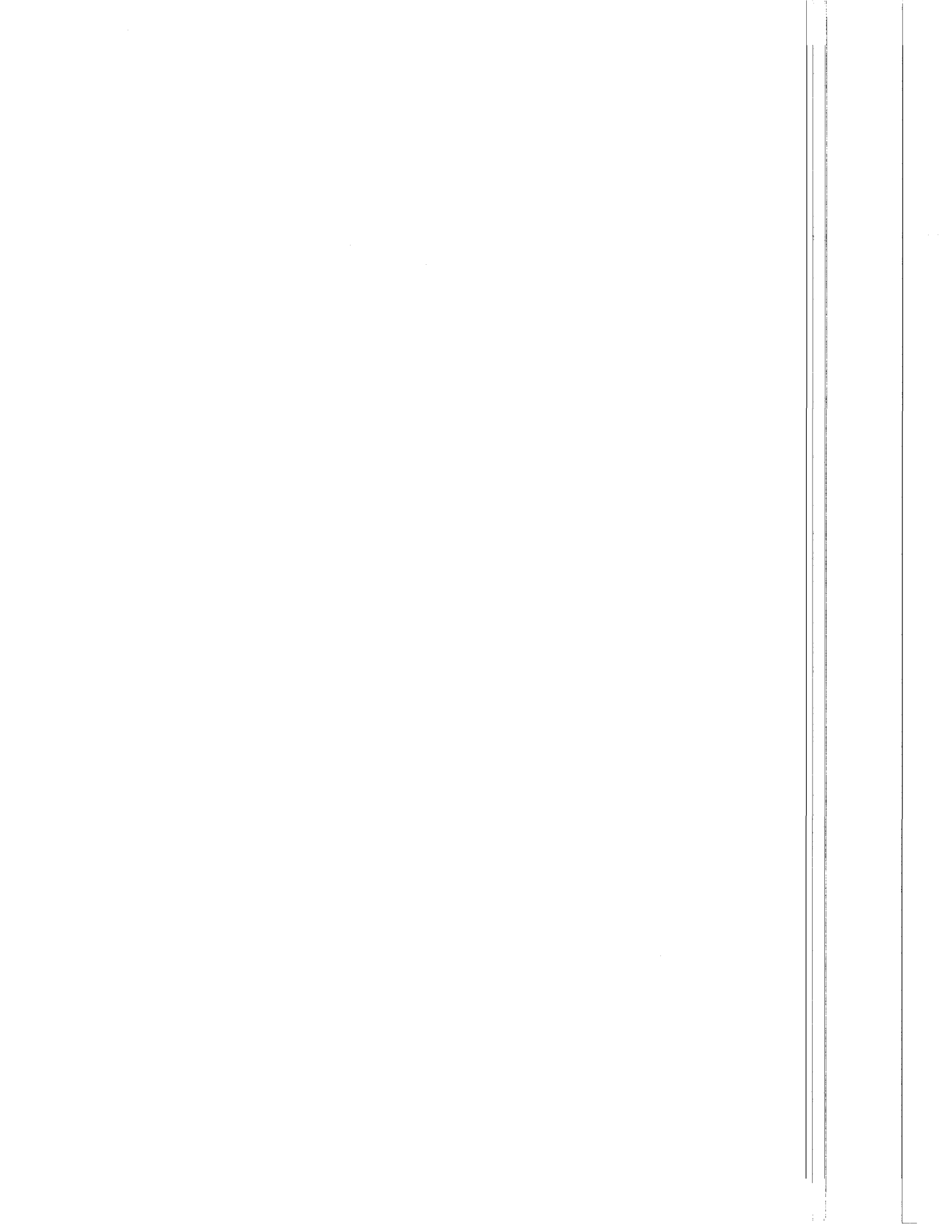
APPENDIX C. CAMPBELL SCIENTIFIC COMMA DELINEATED ASCII

Comma Delineated ASCII data separates data
values with commas and separates arrays by a
carriage return line feed. All unnecessary
leading and trailing zeros, decimal points, and
plus signs are removed as well as output IDs.

> **NOTE:** A disk file may or may not end with
> a carriage return line feed.
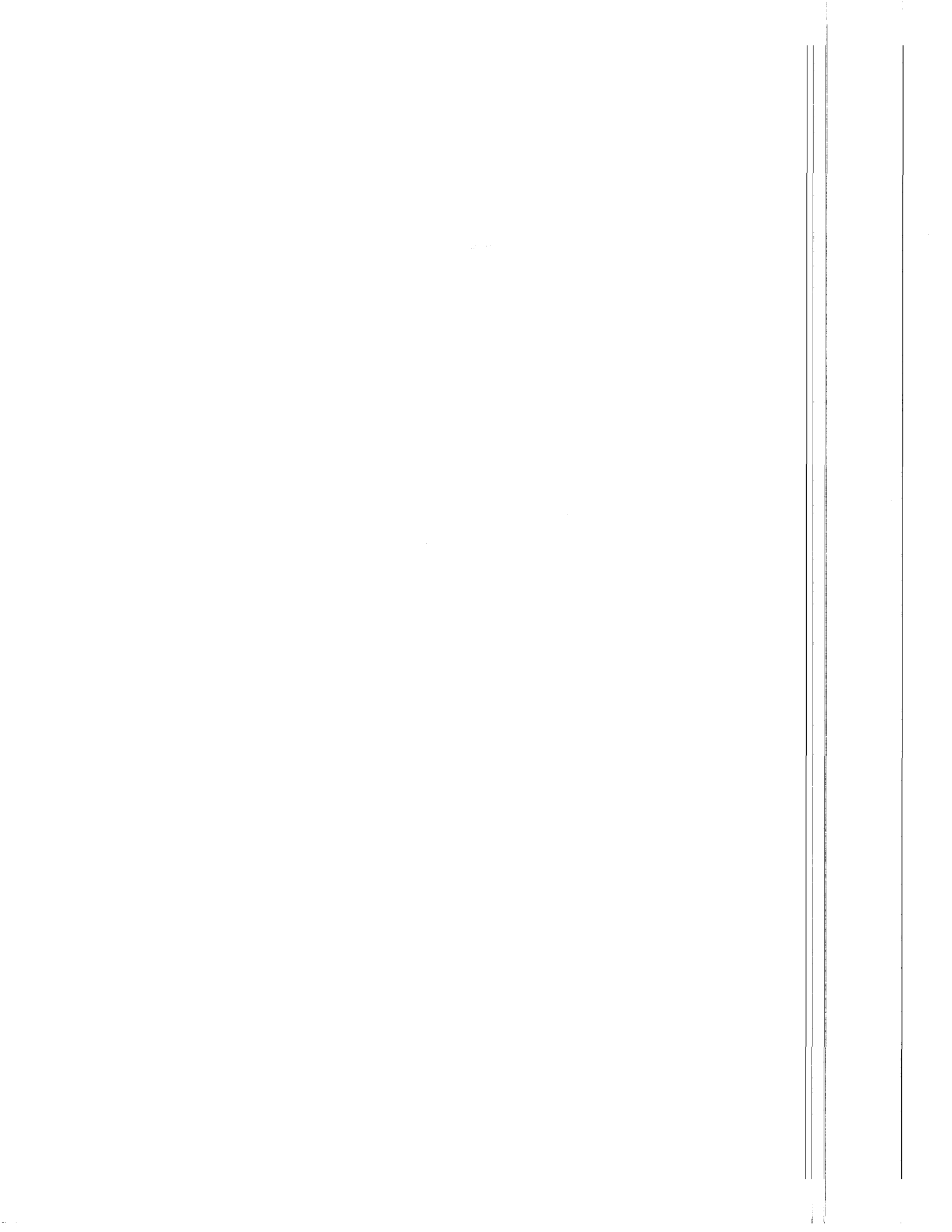
APPENDIX D. USE OF COM3 AND COM4

The addresses and interrupts used by the PC201 software are given in the following Table. Earlier versions of the PC201 software used different addresses and interrupts.

TABLE D-1. COM PORT Addresses and PC201 Card Settings.

Addresses and Interrupts (IRQ) Supported by PC201			PC201 CARD Settings	
Com Port	IRQ	Address	Switch	Jumper 1234567
COM1	4	03F8	1111111	3 & 4
COM2	3	02F8	1111101	1 & 2
COM3	4	03E8	1011111	3 & 4
COM4	3	02E8	1011101	1 & 2

1=CLOSED, 0=OPEN

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