SMARTCHART™

MODEL 8100 RECORDER

INSTRUCTION MANUAL

MANUAL NO. 990621

REV F

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CONTENTS

CHAPTER 1
INTRODUCTION

GENERAL DESCRIPTION

The SMART CHART, Model 8100 Paperless Recorder performs much more than any standard strip chart recorder. The SMART CHART is a multiple input process monitor, data logger and strip chart recorder all in one instrument. The following is a list of the functions and features of the 8100 recorder:

Paperless Recording

The SMART CHART requires no paper, pens, or motor. It is completely solid state, and there are no moving parts. The SMART CHART uses the latest technology in microprocessor design to convert input signals to a digital format and displays them as a bar or line graph verses time on a 100 x 64 dot matrix, supertwist LCD.

Multiple inputs

The SMART CHART can record up to eight input channels simultaneously, while providing complete electrical isolation.

Accepts a variety of different inputs

The SMART CHART accepts a variety of standard inputs such as 4/20 mA, 0/1 VDC, 0/10 VDC, Millivolt, Thermocouple, RTD, strain gauge and frequency. Many other types of inputs such as pH, AC Voltage, AC Current and Pressure, can be provided as options.

Internal linearization of TC's and RTD's

The SMART CHART linearizes all types of thermocouple and RTD curves. It can also linearize any other special curve upon request.

Four digit presentation of input data

The SMART CHART displays input data as a four digit number in any type of engineering units with the decimal point automatically set.

64K bytes of RAM per input channel

Data memory for each channel (Static RAM) is 64K bytes (32640 data points). A total of 512 K bytes of RAM is provided for eight inputs.

Complete configuration via the function keypad

You can set the following parameters in the configuration mode using the front keypad. Refer to Chapter 2 for details.

Time & Date	Number of inputs	Low & high alarm points	Calibration
Recording interval	6 character ID code	Input type	Display range
Recording method	Totalization	Input range	Engineering unit

A multiple channel memory card

The SMART CHART uses a portable memory device called the memory card. This card can store up to eight channels of input data. The data files on the card may be reviewed on the recorder screen or down loaded to an IBM PC (or compatibles) for further analysis or hard copy print out, using DEVAR's DATAREADER software. Refer to the Chapter 5 for details. The card is battery powered and reusable. It will retain memory for up to 5 years depending on the memory size. The battery may be replaced without loss of memory provided the card is plugged into and powered by the SMART CHART or the CARDREADER unit. The SMART CHART provides a low battery indication, if the inserted card has a low battery or no battery at all. Refer to "Memory Card" in Chapter 3 for details.

Computer interface (RS232 communication port)

The SMART CHART provides an RS232 serial port, which can be connected directly to a PC. Data may then be read from any of the channels of the recorder into the PC. Refer to "RS232 Communications" in Chapter 3 for details.

Totalization

The SMART CHART can provide totalization for any of the input channels, displaying the totalized value as an 8-digit number. There is an option (activated by a DIP switch) which enables the user to reset the total value from the keypad. Refer to "Configuration Screen" in Chapter 2 for details.

Battery backup for memories and recorder

The SMART CHART backs up all the static RAM's and the real time clock using a 3.5V lithium battery. It will maintain the time, date, recorded data and configuration information when the power is off. In addition, there are two sealed rechargeable batteries which maintain recorder operation in case of AC power failure. This also makes the SMART CHART a perfect portable instrument, allowing the user to monitor and record vital data in areas where there is no AC power.

Front panel alarm indication

There are high and low alarm LED indicators for each input channel. When an alarm condition occurs, the corresponding channel LED turns on and a high or low alarm status is indicated. Relay contacts may also be provided for each input channel as an option.

Front panel low battery indications

There are LED low battery indicators for the main batteries, the RAM battery, and the memory card battery. If the RAM or the memory card batteries are low, they have to be replaced. If the main batteries are low, they need to be recharged. The main batteries may be recharged by plugging the recorder into an AC power outlet. The power switch does not have to be turned ON for recharging. The SMART CHART also provides LED indication when reading or storing data on a memory card. When reading the card, the LED turns on, and when storing data on the card, the LED flashes.

20 VDC transmitter power supply

The SMART CHART provides a 20 VDC @160 mA supply to power external transmitters.

Portable, panel and rack mount housing

The SMART CHART comes standard with a carrying handle (portable) or with optional mounting brackets for panel mounting. It may also be provided on a 19 inch plate for rack mounting.

THE KEYPAD

There is a 3 across by 4 down keypad on the front panel, allowing the operator to configure the SMART CHART recorder, record and analyze data. The following is a description of all the function keys:

MENU
EXIT

The 'MENU' function allows the user to use the pull down menu (if available).
The 'EXIT' function allows the user to exit from one page of configuration to the next. This function is only active in the configuration mode.

2^{ND} PLOT
SET

The '2nd PLOT' function selects the second channel to be displayed on the screen when the recorder is in dual mode. The second channel is displayed on the lower half of the screen (See SNGL/DUAL function key).
The 'SET' function sets a parameter during configuration. This function is only active in the configuration mode.

SAVE CARD
NEXT

The 'SAVE CARD' function saves recorded data from an input channel to the memory card. Using the 'SET' function key, specify where, on the card, data is to be saved. This is designed to prevent any unintentional storage or loss of any previously stored data.
The 'NEXT' function allows the user to move from one entry to the next during configuration. This function is available in configuration mode.

SINGLE
DUAL

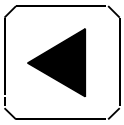
This key allows the user to view one channel, SINGLE mode(SNGL), or two channels, DUAL mode, on the screen. If the recorder is configured for only one channel, this key is inactive.

MAIN PLOT

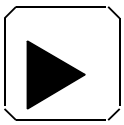
This key selects the input channel to be displayed on the screen. If the recorder is in DUAL Mode, the selected channel is displayed on the top half of the screen. In addition, when the recorder is reading a memory card, this key selects the data file to be displayed on the screen.

BAR
LINE

This key switches the displays between BAR graph and LINE graph format. When pressed the ID code for the channel being viewed will momentarily appear. When an input channel is being totalized, this key causes the totalized value to be displayed.



This key scrolls forward (toward present) through data, one data point at a time.

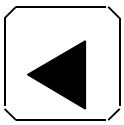


(Page) This key pages backward (into the past) through data, 80 data points at a time.

This key scrolls backward (into the past) through data, one data point at a time.

REAL TIME

This key switches between displaying previously recorded data to displaying real time data. It also switches between displaying a data file stored on a memory card to displaying an input channel on the screen. When an input channel is being totalized, this key causes the totalized value to disappear from the screen.

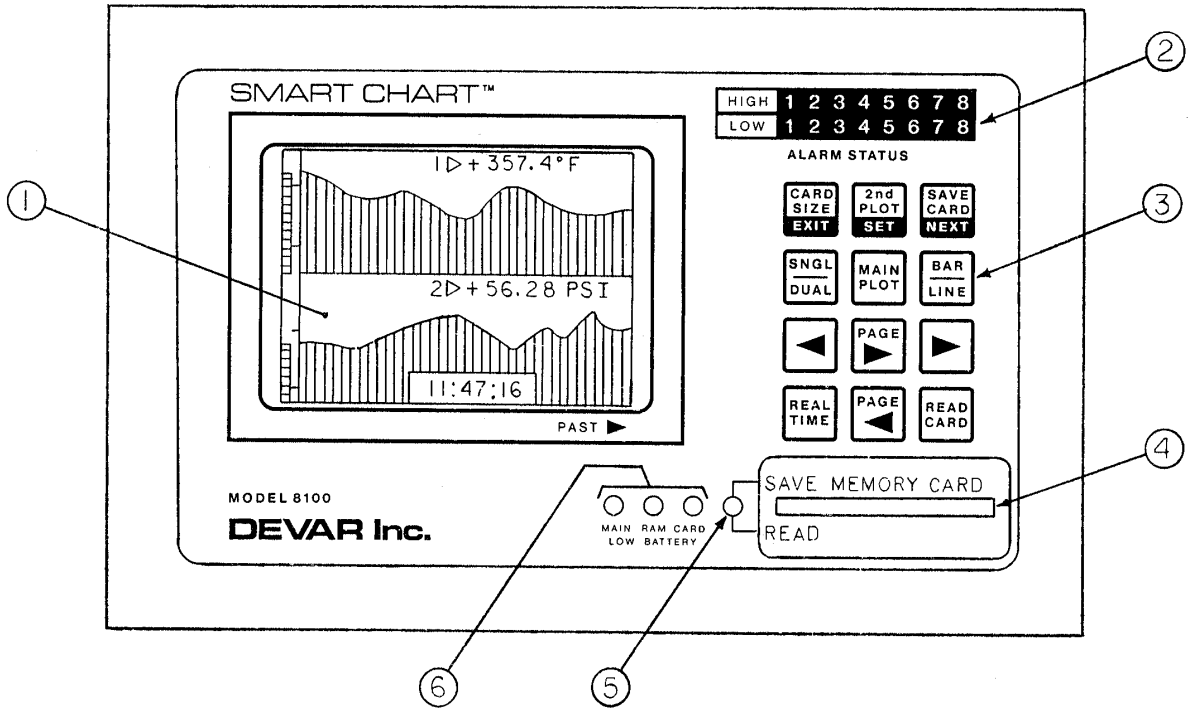


(Page) This key pages forward (toward present) through data 80 data points at a time.

READ CARD

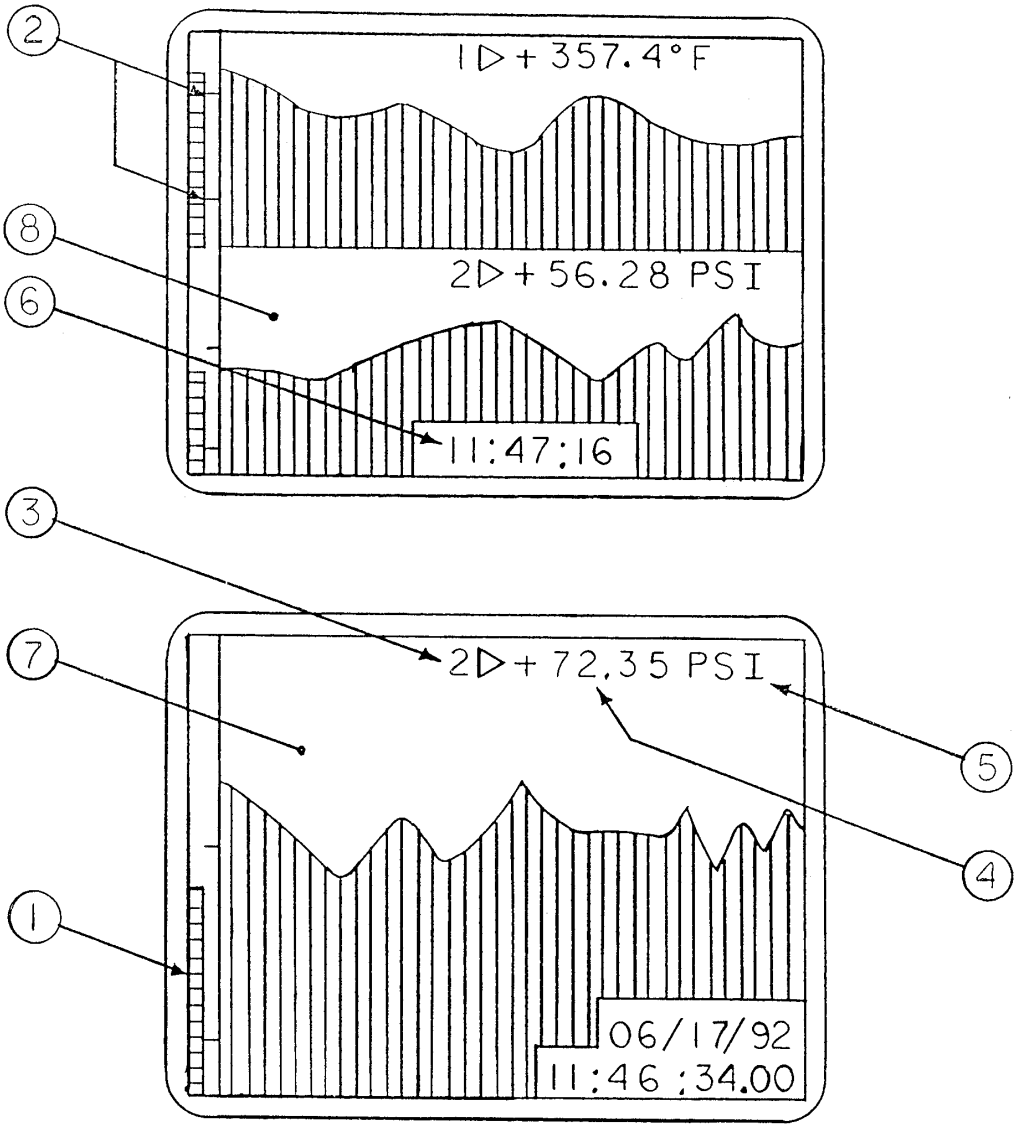
This key switches from displaying an input channel to displaying a data file from the memory card. While displaying a data file from the card, the recorder continues to record.

Note that all four scrolling keys are active whether the recorder is displaying past data from an input channel or from the memory card.



1 - 100 x 64 dot matrix graphic LCD
2 - Alarm status indications
3 - 3 x 4 function keypad
4 - Memory card slot
5 - Read / Save LED indication for the memory card
6 - Low battery indications

FIG 1.1 - DESCRIPTION OF THE FRONT PANEL



1 - Instantaneous bar graph representing input in real time
2 - There are two alarm points per input channel
3 - Input channel number (1 through 8)
4 - Amplitude of an input channel in four digit format
5 - Engineering unit of an input display
6 - Real time in Hour: Minute: Second
7 - Single screen, displaying past data
8 - Dual screen, in real time

FIG 1.2 - DESCRIPTION OF A SINGLE & DUAL LCD SCREEN

SPECIFICATIONS

GENERAL

System accuracy	0.1 % of span
Resolution	12 bits
Sampling rate	8 samples a second
Operating temperature	0º to 50ºC
Storage temperature	-20º to +70ºC
Thermal Zero Shift Millivolt Thermocouple	 Negligible 1ºC for every 23ºC ambient temperature change
Thermal Span Shift	Negligible
RFI resistance	Rated class 3C, 0.25 % of span per SAMA PMC 33.1-1978 (40 V/m field strength, 450 MHz)
3 dB Frequency	1 Hz
Response Time	250 msec
General Dimension	9.8"L x 6.3"H x 12.5"D
Housing	Steel, textured enamel finish (portable/panel mount)
Panel Cutout	6.06" x 9.56" (154 mm x 243 mm)
Power Requirements	115/220 VAC, 50/60 Hz 7.5 VA, Two Channel 14.5 VA, Eight Channel
Power Supply (output)	24 VDC at 160 mA
Computer Interface	RS232 serial port
Weight	13 lbs

DISPLAY

Type of Display	Supertwist dot matrix LCD (100 x 64 pixels)
Display Area	3.5 x 2.25 inches
Vertical Resolution	64 pixels (1.56 % of span)
Horizontal Resolution	One pixel per recording interval

INPUT

Number of inputs	2, 4, 6 or 8
Input Isolation	500 V rms.
Standard Inputs	
mV/TC input card	mV, Thermocouple, Voltage, mA (5 ohms load)
RTD input card	RTD (Single & Dual), Strain gauge, Potentiometer, 4 / 20 mA
Special Order	
pH input card	pH or ORP
Frequency input card	Frequency and Switch contact
AC input card	AC Voltage or Current input

Note: See specific sections for detailed specifications on input cards.

MEMORY

RAM	32640 data points per channel for Average, Peak and Valley recording modes. 10880 (32640/3) data points per channel for combined recording mode.
Recording Time	(Recording interval) X (Number of data points) = elapsed time (1 sec) X (32640 points) = 9 hours (1 min) X (32640 points) = 22.6 days (15 min) X (32640 points) = 340 days (1 hour) X (32640 points) = 3.7 years
Memory Card	128 Kbytes, 256 Kbytes and 512 Kbytes

CONFIGURATION

Keypad	3 x 4 tactile membrane switch
User Password	4 digit (factory set, activated via DIP switch)
Date	Month/Day/Year
Time (Military)	Hour:Minute:Second
Recording interval	Minute:Second:1/100 th of a second 0.25 sec (minimum) to 1 hour (maximum)
Recording method	Average, Peak, Valley, or Combined (Average, Peak & Valley)
Number of inputs	2 through 8
ID code	6 character's, alphanumeric
Input type	Thermocouple (J, K, E, T, R, S, C), mV/V, mA/A, RTD(Platinum, Nickel), pH, Frequency
Calibration	Apply and sample min. & max. input signals
Display range	4 digit (- 9999 to + 9999)
Engineering Unit	3 character max. (GPM, BTU, ... etc.)
Alarms	One high and one low per channel. Can be set to trip anywhere across the span
Deadband	3 % of span
Totalization Input rate Low input cutoff Scale (1 count equals..)	Available via keypad selection Units per Sec/Min/Hour/Day 0 to 10 %, adjustable 1,10,100,1000,0.1,0.01,0.001 Units

BATTERY

STATIC RAM Battery	AA size Lithium, 3.5 VDC / 1.8 AHr
Expected Life	3 years, 2 channel 2.5 years, 4 channel 2.1 years, 6 channel 1.8 years, 8 channel
MAIN Battery	Rechargable sealed lead acid, 12VDC / 4.0 AHr
Expected Life (not utilizing integral loop supply)	8 hours for 8 channel 15 hours for 2 channels
MEMORY CARD Battery	type CR2325 or BR2325 Lithium, 3.5 VDC / 165 mAH
Expected Life	5 years (128 Kbytes card, 2 channel) 4 years (256 Kbytes card, 4 channel) 3 years (512 Kbytes card, 8 channel)

OPTIONS

- E71	220 VAC power
- E30	SPDT, 3A relay alarm contacts
- 14I	AC current input
- 14E	AC voltage input
- 16	Frequency input
- 18	Pneumatic input
- 65	pH/Oxidation reduction potential input
- P	Panel Mount
- R	19 " rack mount adapter

ACCESSORIES

- CR232	Memory card reader and software
- MC128	128 Kbytes memory card (2 channel)
- MC256	256 Kbytes memory card (4 channel)
- MC512	512 Kbytes memory card (8 channel)
-MD301	AC Current Probe (500 A AC = 500 mV DC)
-MD510	AC Current Probe (1000 A AC = 1 V DC)
515324-01	Thermocouple/mV/mA Input Card
515324-02	RTD/mA Input Card
515519-01	Frequency Input Card
-HCS	Hard Carrying Case
-SCS	Soft Carrying Case

CHAPTER 2
GETTING STARTED

HARDWARE CONFIGURATION

To calibrate the hardware, the user needs to access the input cards. *Turn the power off, and remove the four screws at the corners of the back plate.* All the circuitry including the input cards can now be slid out. Note that turning off the power switch does not disconnect AC voltage to the power supply circuitry. The input card for each channel should be calibrated for the type and range of input. If an input card is calibrated for a particular range, the card can be used for smaller ranges without re-calibration. For example, if an input card is calibrated for 0/600ºF type 'J' TC, the card can be used for 0/400 or 100/500º F without re-calibration. Note that using the card for smaller ranges reduces the available resolution. Refer to Chapter 4 for details on input card calibration.

SOFTWARE CONFIGURATION

When the recorder is turned on, the main menu will come up on the screen. At this point, you may select configuration, recording, or RS232 communication. There is a security code option that can be activated via DIP switch SW1 on the digital board, see Fig. 7.4 for location of SW1. When this option is activated, the operator can go into configuration only if the right security code has been entered, otherwise entrance is denied and the main menu reappears. Refer to Fig 2.1, Functional Flow Chart, for a logical overview of the software. The various screens as they appear in configuration are described below.

MAIN MENU

> TO CONFIGURE
- PRESS NEXT KEY
> TO RECORD
- PRESS EXIT KEY
> RS232 COMM
- PRESS SET KEY

Press the **NEXT** key if the SMART CHART has to be configured or if the configuration has to be changed. Press the **EXIT** key to bypass configuration and go directly to recording data. Press the **SET** key if data from the SMART CHART has to be read into the computer.

CONFIGURATION MENU

* CONFIG MENU *
DATE > 08/15/92
TIME > 11:24:53
SMP TIME > 00:01.50
REC MTD > AVG
INPUTS > 2

The information on this screen applies to all input channels. Set the time, date, recording interval (SMP TIME), recording method (REC MTD), and number of inputs (INPUTS). Please note the format of SMP TIME is `*minutes:seconds.hundreths of a sec*`. Use the NEXT key to move to the next parameter and the SET key to change the flashing parameter. Proceed to the next screen by pressing the EXIT key.

CONFIGURATION SCREEN 1

* INPUT # 01 *
ID > PROC-1
TYPE > MA-A /**
MIN > + 0004
MAX > +0020
* CALIB *
APPLY MIN INPUT
APPLY MAX INPUT

Every input has at least 2 configuration screens. This is the first screen for input #1. This screen is used to set the ID code(6 digit alphanumeric), input type and input range (MAX, MIN). Calibrate the SMART CHART for the input as follows. When APPLY MIN INPUT is flashing, set the input source or simulator to the bottom of the range, and **press the SET key**. The SMART CHART registers this value as the bottom of the range. Press the NEXT key so that APPLY MAX INPUT is now flashing. Set the input source to the top of the range, and **press the SET key**. The SMART CHART registers this value as the top of the range. Press the EXIT key to proceed to the next screen.

CONFIGURATION SCREEN 2

* DISPLY RNG *
MIN > +0000
MAX > +0250
ENG UNIT > GPH
LO ALM > +0060
HI ALM > +0200
TOTALIZ > YES

The second screen is used to set the display range, engineering unit(ENG UNIT), and the alarm points for the channel. The display range is the range of numbers to be displayed on the screen. Note that the display range may or may not be the same as the input range. For this example, the input range is 4 / 20 mA, and the display range is 0 / 250 GPH. The alarm points are set based on the display range. For this example, the alarm points are set at 60 and 200 GPH. This input is being totalized. Press the EXIT key to proceed to the next screen.

CONFIGURATION SCREEN 3

* TOTALIZE MENU *
RATE > UNITS/HOUR
LO CUTOFF > 04 %
1 CT > 1 UNITS

The third screen appears only when the totalization option has been selected. This screen is used to set the input rate. This is specified as Units/Sec, Units/Min, Units/Hour, or Units/Day. In the previous example the display range is set to gallons per hour (GPH), therefore the RATE selection has to be Units/Hour. Set the low cutoff point anywhere from 0 to 10%. This specifies the input level below which there is no totalizing. Set the scale for the totalized counts. For example, 1 count (1 CT) could be equal to 1, 10, 100, 1000 units or 1 count could be equal to 0.1, 0.01, or 0.001 units. In this example 1 count equals 1 gallon. Refer to "Totalization" section in Chapter 3 for more information..

Note: If the totalize option is not selected the above screen does not appear. CONFIGURATION SCREEN1 and SCREEN2 will appear for every input. Therefore, if there are 2 inputs these screens will appear twice. Once for channel # 1 and once for channel # 2. At this point a new screen may appear, if the unit can be configured for extended memory. Refer to "Extended Memory" in Chapter 3 for more information.

DO YOU WISH TO
CLEAR PREVIOUS
DATA ? NO

After all the configuration screens, there is an option to either continue recording from where it was left off or to clear all the memory and start recording data from the beginning. Use the SET key to select the option. Press the EXIT key to begin recording.

PASSWORD OPTION

There is password option that can be activated via DIP switch SW1 on the digital board. When this option is set, the operator can configure the unit only if the correct password is entered. If the wrong password is entered the program returns to the main menu and access to the configuration menu is denied. To enter the password, use the SET key to set a digit and the NEXT key to move to the next digit. When all four digits are selected, press the EXIT key. If the correct password was entered the configuration menu appears, if not the main menu reappears. Refer to the following table for the dip switch assignment.

DIP Switch SW1 Position 1	ON	OFF
PASSWORD OPTION	ENABLED	DISABLED

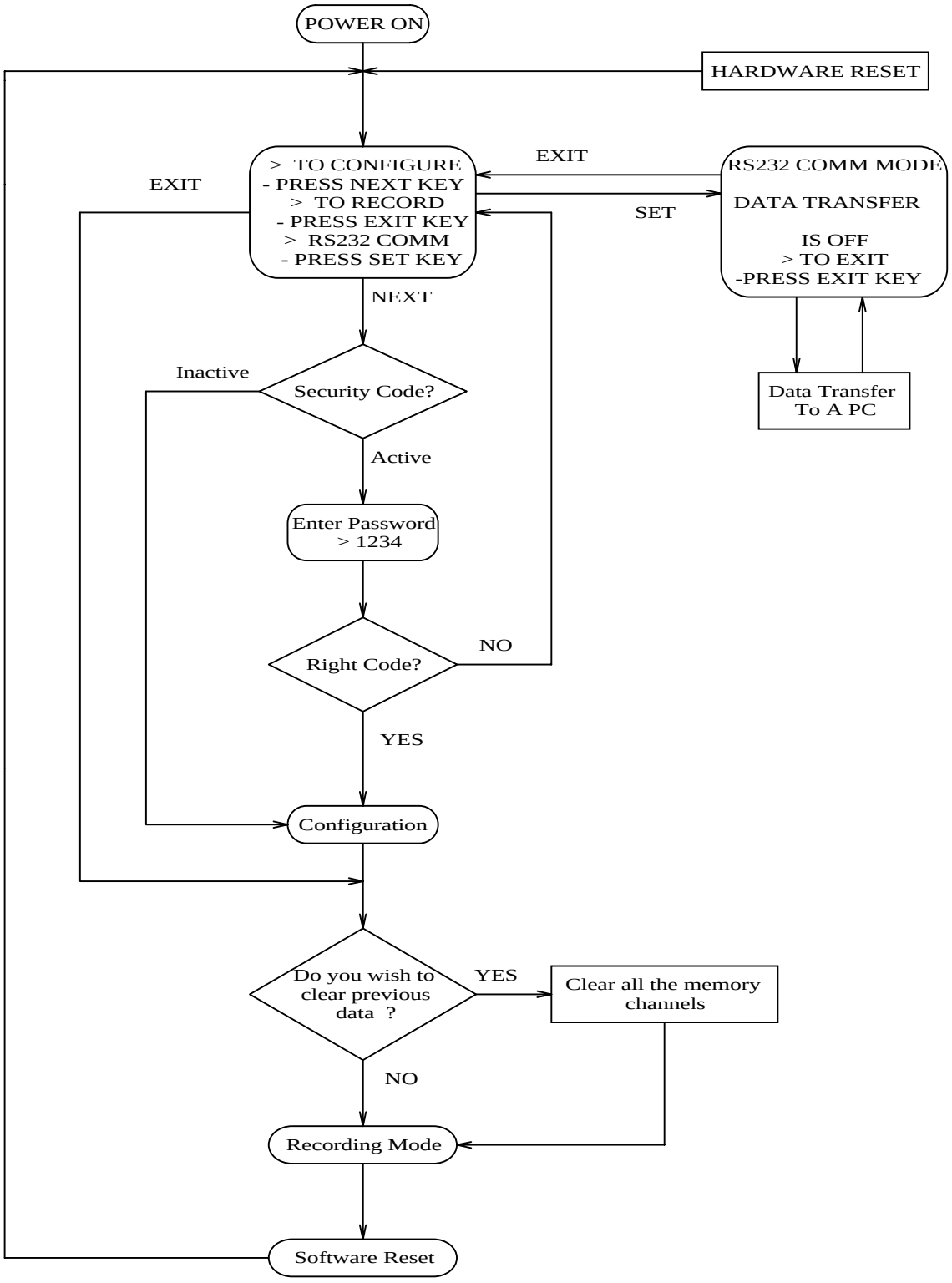


Fig.2.1 Functional Flow Chart

CHAPTER 3
RECORDING

DISPLAY FORMAT

Input channels may be displayed one at a time by pressing the MAIN PLOT key. Data may be presented as either a line or a bar graph. Press the BAR/LINE key to change the display from a line graph to a bar graph or vice versa. Every time this key is pressed the channel's ID code appears momentarily. Use the arrow keys to scroll through data. In order to return the display to real time, press the REAL TIME key. Note that scrolling through past data does not affect recording. The SMART CHART continues recording data while data is being viewed. When more than one channel is being recorded the user may view either a single channel or dual channels on the display by pressing the SNGL/DUAL key. When two channels are being displayed the main channel is displayed at the top of the screen. This channel can be changed by pressing the MAIN PLOT key. The display on the bottom of the screen can be changed by pressing the 2nd PLOT key. By using these two keys any two channels may be viewed simultaneously on the screen.

MEMORY CARD

Data from any input channel can be saved on a memory card. Using the MAIN PLOT key, display the channel to be saved on the SMART CHART. Insert the memory card into the slot and press the SAVE CARD key once. A prompt appears on the screen, e.g. "*STORE > A : OVEN-1 ?*". Storing data on the memory card has been deliberately broken into two steps to ensure that previously stored data on the memory card is not accidentally erased.

The first step, pressing SAVE CARD, produces the above prompt, indicating where (on the card) data is about to be stored. The second step, pressing the STORE CARD key again stores the data. Where the data is about to be stored is indicated by the letter "A" in the above prompt. Alphabets A through H correspond to channel positions 1 through 8 on the card. In the above example, the prompt indicates that data from the SMART CHART is about to be stored in the 1'st, or the "A" position on the card. If for any reason this is undesirable, the user can change the destination by pressing the SET key and the prompt changes from "A" to "B". Depending on the memory card size the selection range is A-H, corresponding to position 1-8 on the card. The user may abort this process, after step 1, by pressing the REAL TIME key at this point.

In the previous example, the tag "OVEN-1" indicates that in position "A" of the memory card data with ID code 'OVEN-1' has already been stored. Hence, by storing data in this position the user is overwriting 'OVEN-1' data. If this is of no consequence press the STORE key again and data will be transferred from the SMART CHART to the card. While data is being transferred, the store LED will be flashing. However, if there had been no data stored in that card position the prompt "STORE > A :------" would have appeared.

In order to read and display a data file from our memory card press the READ CARD key. Different data files from channels A through H of the card are selected by pressing the MAIN PLOT key. Pressing the REAL TIME key will return the recorder to displaying the input channels on the screen.

Memory cards come in different sizes. They are either 1 Channel card (64 K) or 2 Channel card (128 K) or 4 Channel card (256 K) or 8 Channel card (512 K).

SOFTWARE RESET

In addition to resetting the recorder from the momentary switch in the back (Hardware Reset), the user may reset the recorder from the front keypad (Software Reset) by pressing the REAL TIME, BAR/LINE and SET keys in succession. Start by pressing the REAL TIME key and then press the BAR/LINE key while still holding on to the previous key and then press the SET key while still holding on to the previous two keys. This will interrupt recording and take the SMART CHART back to the main menu.

TOTALIZATION

DIP SW1 POS. 4	RESET
ON	ENABLED
OFF	DISABLED

An input channel may be setup (in configuration) to totalize the input. The totalized value is displayed as an 8 digit number. Totalization does not interrupt the other functions available in recording. In order to display the totalized value ,press the BAR /LINE key. Pressing the REAL TIME key will make the totalized value disappear from the screen. There is an option of resetting the totalized value from the keypad. In order to reset, press and hold the BAR /LINE key for at least 5 seconds. This option is enabled via DIP switch SW1 on the digital board. If the recorder is reset (Hardware or Software Reset) and all previous data is cleared, the totalized value will also be reset. If the previous data is not cleared, the totalized value will remain intact and totalizing may be continued from here. Refer to "CONFIGURATION SCREEN 3" in Chapter 2 for more information.

RS232 COMMUNICATION

DIP SW1 POS. 2	Baud
ON	4800
OFF	9600

The SMART CHART may be connected directly to an IBM PC or compatible and recorded data may be down loaded for display, further analysis, or a print out. Data is read from the SMART CHART in a batch mode. This means the recorder has to be interrupted from whatever it is doing before data can be read. Reset the recorder if it is in the recording mode and return to the main menu. Once in the main menu press the SET key to go to the RS232 communications mode. Make sure the RS232 cable is connected to the correct serial port. Run the DATAREADER program on the computer and select the READ DATA option. Refer to Chapter 5 DATAREADER for details on how to work the program. The SMART CHART is factory set to communicate at 9600 bits per second, however the baud rate can be changed to 4800 bps. Refer to the above table and Fig. 7.4 for the location of SW1. In order to read data, the settings on the SMART CHART and the DATAREADER program have to be same. Refer to the section "Baud Rate/Serial Port" in Chapter 5 for more information

EXTENDED MEMORY

An 8 Channel SMART CHART can be used in the extended memory mode when configured for 1, 2 or 4 input channels. This feature allows the user to tradeoff input channels for more memory. Thus, an 8 Channel unit may be used as an 8 Channel unit with 64 K bytes of data memory per channel or as :

a) a 4 Channel unit with twice (128 K bytes) the data memory per channel or

b) a 2 Channel unit with four times (256 K bytes) the data memory per channel or

c) a 1 Channel unit with eight times (512 K bytes) the data memory per channel.

The memory capacity is further enhanced (doubled) by having a 8 Channel memory card inserted into the SMART CHART at all times. Once all the internal memory (512 K bytes) is filled, the SMART CHART will automatically download the data on to the 8 Channel memory card. This frees up the 512 K bytes of memory in the unit for storing more data. Retrieve the memory card from the SMART CHART and substitute another 8 Channel card in its place.

Configuration

DO YOU WISH TO USE EXTENDED MEMORY ? NO

This screen appears at the end of the configuration screens. Using the SET key select a YES option to configure the unit for extended memory. Press EXIT to proceed to the next screen.

* REMEMBER * INSERT A 512 K MEMORY CARD FOR AUTODOWNLOAD OF DATA TO CARD TO CONTINUE >> PRESS EXIT

If there is no memory card in the SMART CHART or if the card is not an 8 Channel card, then this message appears on the screen. Press the EXIT key to continue with configuration. The next screen prompt is "Do you wish to clear previous data? ". Select the appropriate option to go into the recording mode.

Extended memory for each channel is achieved by utilizing the memory of other channels. Consider an 8 channel SMART CHART configured for 2 inputs, "Oven1" and "Oven2" in the extended memory mode, see Fig. 3.1. The first time the memory of Channel 1 and Channel 2 is filled with data, it is copied into Channel 7 and Channel 8. The SMART CHART continues recording new data on Channel 1 and Channel 2. The second time the memory of Channel 1 and Channel 2 is filled with data, it is copied into Channel 5 and Channel 6. The third time the memory of Channel 1 and Channel 2 is filled with data, it is copied into Channel 3 and Channel 4. The SMART CHART has now stored data in Channels 3 through 8 and continues to record new data on Channels 1 and 2. When the memory of Channels 1 and 2 has been filled for the fourth time all 8 Channels will be downloaded on to a memory card. If the memory card is not installed the SMART CHART copies the new data from Channels 1 and 2 into Channels 7 and 8 overwriting the old data in those channels.

A one input SMART CHART extends memory 8 times, storing data in Channels 8 through 1. A two input SMART CHART extends memory 4 times, storing data in Channels 7, 5, 3 and 1. and in Channels 8, 6, 4 and 2. A four input SMART CHART extends memory 2 times storing data in Channels 8 & 4, 7 & 3, 6 & 2 and 5 & 1. Each of these memory extensions can be doubled by the use of a memory card.

SCREEN PROMPTS

Please note that all the previous discussion on memory roll over is entirely transparent to the user. The only indication on the SMART CHART is a momentary prompt, "SAVING DATA INTO NEXT CHAN", which appears on the screen when the roll over is taking place. Also, if the SMART CHART is ready to download data into a card and there is no card, the SMART CHART comes up with a prompt " INSERT 8 CHAN MEMORY CARD". This message disappears if the correct size card is inserted. However, if a wrong size card is inserted a prompt "WRONG SIZE CARD" appears. When the SMART CHART is actually downloading data to the card a prompt " PLEASE WAIT SAVING DATA INTO CARD" appears. The above prompts may be ignored if the use of a memory card is not being used for the purpose of extending memory.

READING DATA INTO THE PC

The DATAREADER program knows when a SMART CHART has saved data in Extended memory mode. In the above example (2 input configuration, Fig. 3.1) only 2 inputs were being recorded. When the DATAREADER program is asked to read Channel 1, the program realizes that data in Channels 3,5 and 7 also pertains to Input # 1. Therefore, this read operation will read in all 4 data files. If the user specifies a file name, for example TSTFIL, the program appends '_1', '_2', '_3' and '_4' to the selected file name. A look at the directory listing will reveal:

	Corresponding Data From Channel
TSTFIL_1.CRD	Channel 1
TSTFIL_2.CRD	Channel 3
TSTFIL_3.CRD	Channel 5
TSTFIL_4 CRD	Channel 7

Reading data directly from a SMART CHART is similar to reading data from a memory card. The most recent data or new data is in Channel 1 and the past or oldest data is in Channel 7. Refer to Chapter 5 for more details on how to read data.

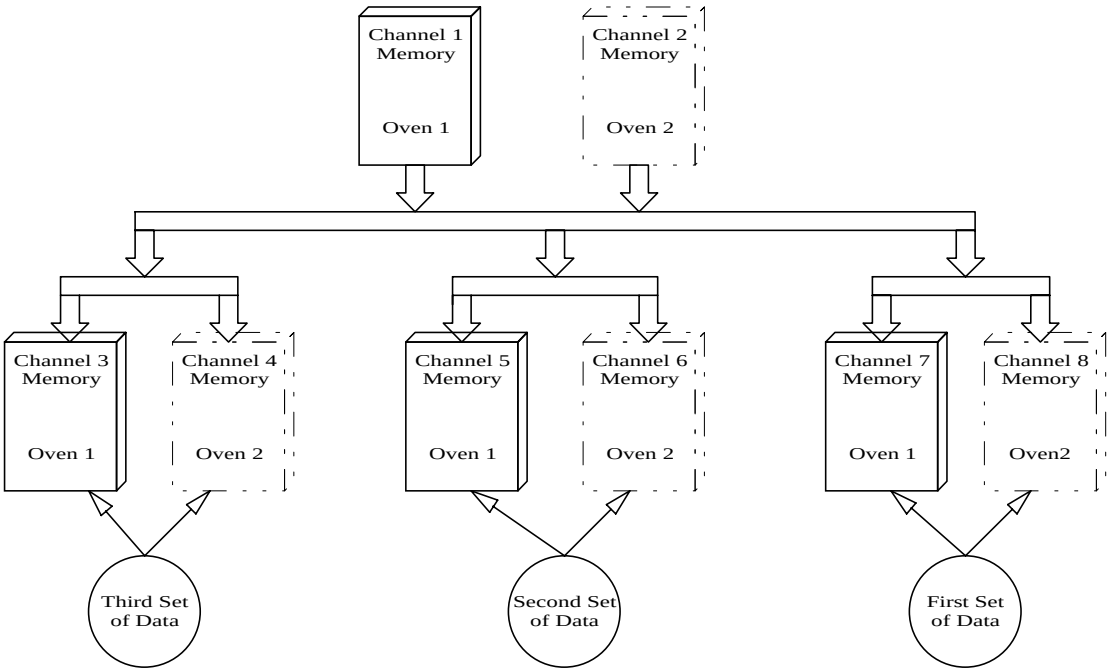


Fig. 3.1 - Two Input SMART CHART In Extended Memory Mode

CHAPTER 4
CALIBRATION PROCEDURE

Thermocouple, mV, mA Input Card

This input card can accommodate all types of thermocouples, millivolts, voltages, and currents. In order to calibrate the card for the desired type and range, DIP switches S1, S2 and S3 must be set. Table 4.1 summarizes different input selections :

INPUT SPAN	SELECTION
2 to 126 mV	See table 4.3, row 1 for span switch settings. See table 4.2 for offset calibration.
126 to 2500 mV	See 4.3, row 2 for span switch settings. See table 4.2 for offset switch settings.
Greater than 2.5 V	See table 4.5 for voltage to millivolt divider. See table 4.3 for span switch setting. See table 4.2 for offset switch setting.
2.5 to 9.9 V	See table 4.3, row 3 . **Note**: For this input range a voltage divider is not required when operating as a unity gain amplifier.
2.5 to 150 mA	Set switch S1 position 8 to "ON". See table 4.3 for span switch calibration. See table 4.2 for offset switch calibration. **Note**: millivolts = milliamps x 5 ohms
Thermocouple	See table 4.3 for span switch settings. See table 4.2 for offset switch settings. Consult a thermocouple table for millivolt output from thermocouple.

Table 4.1 - Input Range Selection Table

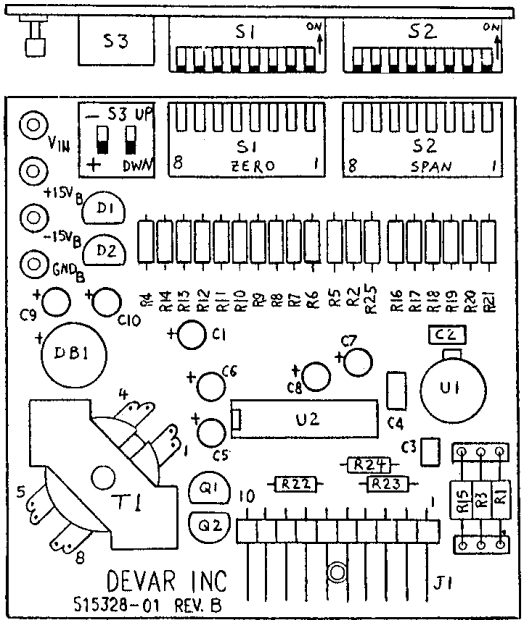


FIG 4.1 - Thermocouple, mV, mA INPUT CARD ASSEMBLY

DIP SWITCH S1: INPUT OFFSET								
POS 1	POS 2	POS 3	POS 4	POS 5	POS 6	POS 7	POS 8	
OFF adds zero, ON changes offset by:							mA Input (5ohm shunt)	All Other Inputs
0.5 mV	1 mV	2 mV	4 mV	8 mV	16 mV	32 mV		

Table 4.2 - Offset Range Switch Selection

DIP SWITCH S2: INPUT SPAN							
POS 1	POS 2	POS 3	POS 4	POS 5	POS 6	POS 7	POS 8
OFF adds zero, ON increases span by:							
2 mV	4 mV	8 mV	16 mV	32 mV	64 mV	ON	OFF
40 mV	80 mV	160 mV	320 mV	640 mV	1280 mV		ON
2.5 TO 9.9 VOLTS						OFF (GAIN=1)	DON'T CARE

Table 4.3 - Span Range Selection

DIP SWITCH S3			
POS 1: OFFSET SELECTION		**POS 2: UP/DWN SCALE**	
Depress Top	Depress Bottom	Depress Top	Depress Bottom
Negative	Positive	Up Scale	Down Scale

Table 4.4 - Offset Polarity and Up/Down Scale On Input Break Selection

NOTES:

1. Span is defined as the bottom of the input range subtracted from the top of the input range.

2. Millivolt spans and offsets selected using S1 and S2 are additive.

3. Always round span settings to a larger value. e.g. round a 7 mV span to 8 mV rather than 6.

4. Round positive offsets down and negative offsets up.

HIGH LEVEL INPUT

The input card can accommodate high level input signals (> 10 VDC) by adding voltage divider resistors to the card. Once the input voltage is divided down to a millivolt range, the proper switch positions can be selected from tables 4.2, 4.3 and 4.4. See Fig. 4.1.

INPUT SPAN	RATIO	R1	R3
2.4/10 VDC	1/100	100 K ohms(514490-1003)	1 K ohms (223737-21)
10/100 VDC	1/1000	100 K ohms (514491-1003)	100 ohms (223737-41)

Table 4.5 - Voltage Divider Resistor Selection

Thermocouple Inputs

Calibrating the input card for thermocouple is exactly the same as calibrating the input card for millivolts, except that the temperature range needs to be first converted to millivolts. To do this, find the millivolt output of the thermocouple in a thermocouple table. Record the millivolts output of the thermocouple

at the top and bottom of the temperature range and also the millivolt output of the thermocouple at the ambient (the ambient reading need only be approximate). Subtract the ambient millivolts from the top and bottom of the range. The resulting millivolt values will be used to calibrate the input card (see example in the following section).

The following two examples describe how to set switches S1 ,S2 ,S3 :

Example 1 - Input range = -5 to +15 mV

* Set switch S1 for 5 mV offset.
* Set switch S2 for 20 mV span (+15 - (-5)).
* Set switch S3 for negative offset.

Example 2 - Input range = +300 to +600ºF, type 'J' TC

From the thermocouple table, this range equals +7.947 mV to +17.186 mV (Ref. 0ºC). We need to compensate for ambient temperature. If the ambient temperature is 75ºF, corresponding to +1.220mV (from the table) then the compensated input range is 15.966 mV (17.186 - 1.220) and 6.727 mV (7.447 - 1.220).

* Set switch S1 for a 6 mV offset.
* Set switch S2 for a 10 mV span (15.966 - 6.727 = 9.239 round up to 10 mV).
* Set switch S3 for positive offset.

The following table shows the switch settings for three different inputs. Note that '1' is ON, and '0' is OFF.

INPUT	S3	DIP Switch. S1								DIP Switch. S2							
		8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
-5/15mV	- offset	0	0	0	0	1	0	1	0	0	1	1	1	0	1	0	1
4/20mA	+ offset	1	0	1	0	0	1	0	0	0	1	0	1	0	0	1	1
300 - 600ºF J-TC	+ offset	0	0	0	0	1	1	0	0	0	1	1	1	1	0	1	0
0 - 200ºF J-TC	- offset	0	0	0	0	0	1	0	1	0	1	1	1	1	1	0	0
0 - 200ºF T-TC	- offset	0	0	0	0	0	1	0	0	0	1	1	1	1	1	0	0
0 - 500ºF J-TC	- offset	0	0	0	0	0	1	0	1	0	1	1	1	0	1	1	1
0 -750ºF J-TC	- offset	0	0	0	0	0	1	0	1	0	1	1	1	0	0	1	1
0 - 1000ºF K-TC	- offset	0	0	0	0	0	1	0	0	0	1	1	1	0	0	1	1

Table 4.6 - Typical Calibration Settings.

THERMOCOUPLE CARD SPECIFICATIONS

Input Impedance(mV input)	Greater than 15 M ohms
Input Source Current	16 nA, max.
Input mV Span	2 to 126 mV selectable (S2: Pos. 8 -- OFF) 40 to 2400 mV selectable (S2: Pos. 8 -- ON)
Input Offset	± 0.5 to 63.5 mV selectable
TC break indication	Up or Down scale, selectable
Input resistance (Current Input)	5 ohms (0.1 V at 20 mA)
Current Input Span	0.5 to 150 mA
High Level Signal	10 VDC to 100 VDC max. (300 VDC/ High Voltage Option)

TC cold junction compensation resolution : 0.02ºC

TYPE	Defined for	Resolution	Nonlinearity
J	-328, 1377ºF -200, 747ºC	0.10ºC, span < 700ºF 0.23ºC, span > 700ºF	0.10ºC
K	-436, 2432ºF -260, 1333ºC	0.15ºC, span < 1174ºF 0.38ºC, span > 1174ºF	0.15ºC
E	-407, 1832ºF -244, 1000ºC	0.12ºC, span < 917ºF 0.30ºC, span > 917ºF	0.12ºC
T	-409, 752ºF -245, 400ºC	0.06ºC, span < 475ºF 0.15ºC, span > 475ºF	0.06ºC
B	500, 3308ºF 260, 1820ºC	0.15ºC, span < 1150ºF 0.38ºC, span > 1150ºF	0.15ºC
R	32, 3200ºF 0, 1760ºC	0.17ºC, span < 1300ºF 0.42ºC, span > 1300ºF	0.17ºC
S	32, 3200ºF 0, 1760ºC	0.17ºC, span < 1300ºF 0.42ºC, span > 1300ºF	0.17ºC
C	32, 4208ºF 0, 2320ºC	0.23ºC, span < 1710ºF 0.56ºC, span > 1710ºF	0.23ºC

Table 4.7 - Accuracy for Thermocouple Inputs.

RTD, mA INPUT CARD

The RTD input card can accommodate single or dual RTD's, strain gauge, potentiometer, and 4/20 mA inputs. Select the type of input and then refer to table 4.8 for instructions.

INPUT	**SELECTIONS**
SINGLE RTD	S2 Position 1 is OFF; See Table 4.9
DUAL RTD	S2 Position 1 is ON; See Table 4.9
4/20 mA	S1 Positions 1 through 8 are OFF S2 Positions 1, 6 & 7 are ON, 2 through 5 are OFF
STRAIN GAGE	S1 Positions 1 through 8 are OFF S2 Position 1 is ON; 6 &7 are OFF; See Table 4.9
Potentiometer	Consult Factory

Table 4.8 - Calibration Instructions for RTD, mA Card.

Note that '1' is ON, '0' is OFF.

Resistance Change	DIP Switch. S1								DIP Switch. S2							
(Span) in Ohms	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
5 / 10	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	(*)
11 / 20	0	0	0	0	1	1	0	0	0	0	0	0	1	0	1	(*)
21 / 40	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	(*)
41 / 80	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	(*)
81 / 150	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	(*)

(*) - Refer to Table 4.8

Table 4.9 - Switch settings for different RTD resistance spans

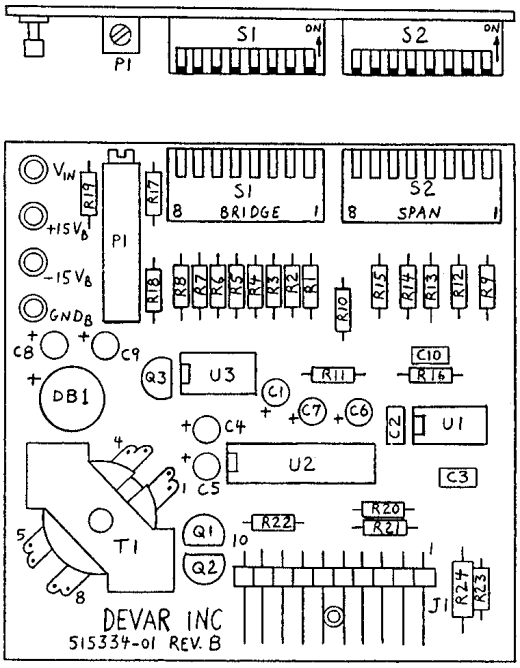


FIG 4.2 - RTD, mA INPUT CARD ASSEMBLY

Dip switch positions 2 through 5 set the gain of the amplifier. Table 4.10 shows the switch settings for different mV input spans. This information is needed when calibrating for strain gage inputs. Note that input spans should not exceed 30 mV. This will produce an output voltage greater than 10 volts which will not be recognized by the recorder.

Input Span	**DIP SWITCH S2**							
(mV)	1	2	3	4	5	6	7	8
0 / 10	0	0	1	0	1	*	*	0
0 / 20	0	1	0	1	0	*	*	0
0 / 30	*	0	0	0	0	*	*	0

* - Refer to Table 4.8

Table 4.10 - Switch setting for different mV input spans

Potentiometer P1, see Fig. 4.2, provides ± 20% zero adjustment. The purpose of trimmer P1 is to adjust the bottom of the range to provide a slight positive voltage at the output of the card. Negative voltages are not recognized by the recorder. The following procedure describes how to set the trimmer P1:

* Set DIP switches S1 and S2 based on the input type and range.

* Configure and calibrate the recorder for the input channel.

* Start recording. Display the input channel to be calibrated, on the screen.

If the wrong printer is selected chances are the printout will not look correct.

* Set the input to the bottom of the range.

* Turn pot. P1 in the clockwise direction until the amplitude on the screen just starts moving. The point at which the screen output begins to respond is the point at which the output voltage has become positive.

* If the screen responds immediately, turn the pot in the counter clockwise direction until the screen stops responding, then in a clockwise direction until the screen just begins to respond.

* The pot is now set.

* Go back into configuration and recalibrate the channel.

An Alternative way of setting the pot is to measure the output voltage directly. Connect a voltmeter to the test point of the channel being calibrated. The test point is located on the interconnect board. This is the board into which the input board is plugged, see Fig 4.3. Set the input signal to the bottom of the range and adjust the pot for an output of about + 20 mV. Once the pot is set go into configuration and calibrate the channel.

SPECIFICATIONS RTD CARD

Input Types	Single and Dual RTD (Platinum RTD, 100 ohms at 0º C) (Nickel RTD, 120 ohms at 0ºC) Strain Gauge, Potentiometer, 4/20 mA
Total Bridge Current	0.4 to 4 mA, selectable
RTD span	5 to 150 ohms (12 to 410ºC)
Zero Adjustment	(±20%)
Potentiometer	10 K ohms, max
Current Input	1 ohm shunt (20 mV at 20 mA)
Excitation Voltage	10 VDC at 35 mA

TYPE	Defined for	Resolution	Nonlinearity
PLATINUM	-238 to 1202ºF -175 to 650ºC	0.08ºC, span < 608ºF 0.20ºC, span > 608ºF	0.08ºC
NICKEL	–94 to 575ºF -70 to 300ºC	0.05ºC, span < 272ºF 0.10ºC, span > 272ºF	0.10ºC

Table 4.11 - Resolution and Linearity For RTD, mA Card

FREQUENCY INPUT CARD

The SMART CHART recorder can be used to measure frequency input as well as other standard input ranges. This requires the installation of a frequency input card. Frequency Input Cards can only be plugged in positions 1 and 2 on the interconnect board, see Fig. 4.3. This means that only channels 1 and 2 of the SMART CHART can be used for frequency inputs.

Once the Frequency Input Cards have been installed the SMART CHART will accept frequency inputs with spans of 10 Hz to 59 KHz. Inputs may be in the form of dry contacts or voltages ranging from 50 mV to 50 Volts. Input pulses must be at least 8 microseconds wide, however the shape of the pulse is not important. As with all SMART CHART inputs, the Frequency Input Cards provide complete input isolation.

The Frequency Input Card must be set up to accept either voltage or contact closure inputs. For voltage inputs one jumper will be installed between pins 3 and 4 on the PC board (see Fig. 4.4) and for contact closure inputs two jumpers will be installed between pins 1 and 6 and between pins 2 and 5. Threshold adjustment of 0 to 1 volt is provided on pot P1 on the Frequency Input Card (see Fig. 4.4). The input pulse must go above and beyond the threshold voltage before it can be detected by the SMART CHART. The threshold voltage should therefore, be set below the maximum input voltage but above the input noise level. If the threshold voltage is set too high the input will not be detected, if set too low input noise may be detected as signal, producing erroneous readings.

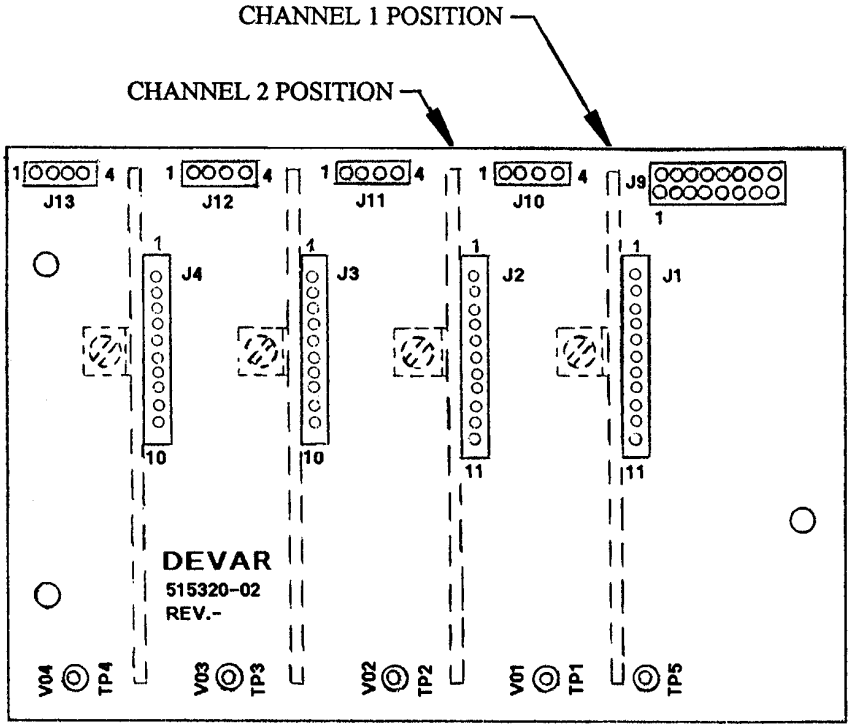


Fig. 4.3 INTERCONNECT BOARD

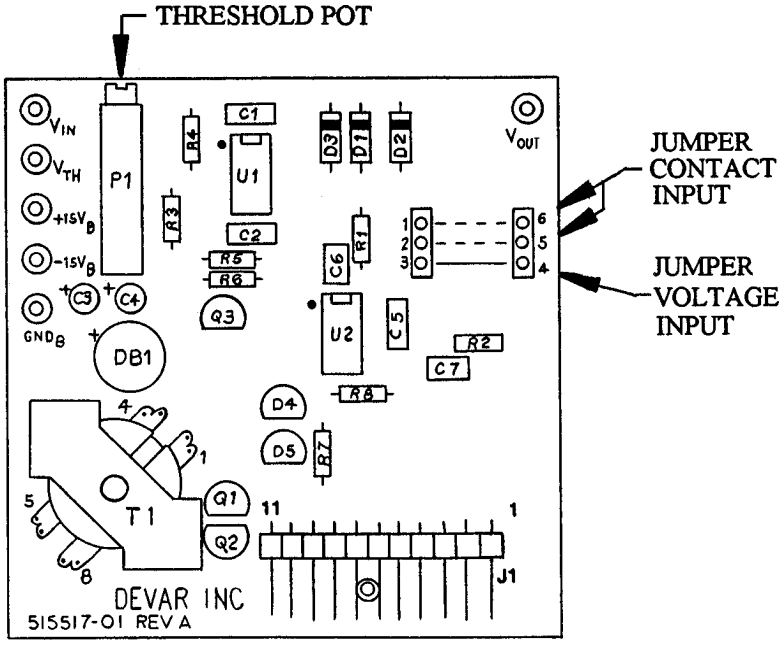
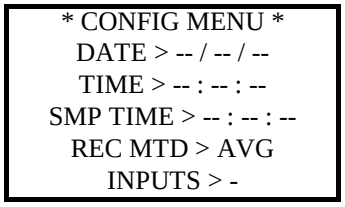


Fig. 4.4 FREQUENCY INPUT CARD

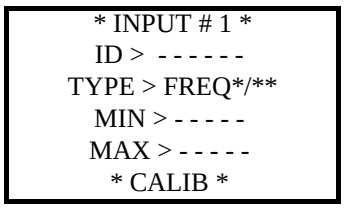
CONFIGURATION



After the frequency input board has been installed, the input channel must be configured.

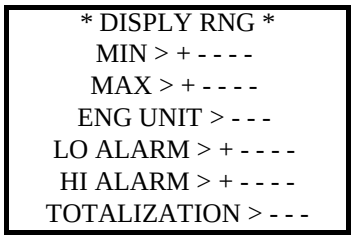
The first configuration screen will appear as follows. Note that when using the frequency input option, the *AVERAGE RECORDING METHOD MUST ALWAYS BE SELECTED.*

The next configuration screen appears as follows:



On this screen FREQUENCY is selected as the input type and the MAXIMUM and MINIMUM input frequencies are specified. Note that while the minimum input frequency will most often be zero (it does not have to be). *Unlike other input types, frequency input does not require calibration, therefore after entering the MIN and MAX input frequencies press EXIT and move on to the next screen.*

The next configuration screen appears as follows:



This screen is used to specify how input data will appear on the SMART CHART screen. For example:- a maximum input frequency of 8372 on the preceding screen might be displayed as 8372 Hz or it might be displayed as 275 GPM. It should be noted that while five digits are provided on the previous screen for specifying the input range only four digits are provided on this screen for displaying the data. This difference should be considered, particularly when data is being displayed as a frequency. For example, a maximum input of 52,325 could not be displayed properly. In a case like this the MAX input should be set to 53000 and the MAX display range to 0053 and the ENG units to KHz. The screen will display 53.00 KHz.

SPECIFICATIONS

Input Range	10 Hz to 59 KHz
Input Amplitude	50 mV to 50 Volts
Threshold Voltage	0 to 1 Volt
Isolation	Optical Coupling
Calibration	Set via keyboard, Frequency source not required

Accuracy and Delay Time			
Input Span		Accuracy	Delay
Greater Than	Less Than		
32 KHz	59 KHz	± 8.0 Hz	0.125 sec
1 KHz	32 KHz	± 1.0 Hz	1.0 sec
10 Hz	1 KHz	± 0.1 Hz	10.0 sec

Table 4.12 - Accuracy and Delay For Frequency Input

pH INPUT CARD

Option 65, when provided enables the SMART CHART to monitor signals from a pH or ORP (Oxidation Reduction Potential) electrode. This option adds BNC connectors, for the electrodes, to the back of the plate of the recorder and also adds pH input cards, one for each electrode input. The pH input card must be setup for the required input type and the range. To calibrate for a pH input set switch S3 to pH input, see Table 4.15. Using Table 4.16 find the millivolt output from the electrode at 25 ^{O}C; and set the millivolt offset switches and the millivolt span switches using Table 4.13 and Table 4.14.

To calibrate for an ORP input set switch S3 to ORP input, then go directly to Tables 4.13 and 4.14 for the millivolt span and offset switch positions.

Example : Input range 0 to 14 pH

0 pH = 414.12 mV

14 pH = -414.12 mV

Offset = +414.12 mV

Span = 828.24 mV

Electrode temperature compensation: Manual

* Set Switch S3B for pH input

* Set Switch S1 for a 408 mV offset. Positions 1,2,5 and 6 are ON; 3,4, and 7 are OFF (Round positive offsets up and negative offsets down)

* Set switch S3A for positive offset

* Set switch S2 for an 820 mV span. Positions 1,4 and 6 are ON; 2,3 &5 are OFF. (round spans up)

* Set switch S1 position 8 OFF for manual temperature compensation.

DIP SWITCH S1: INPUT OFFSET								
POS 1	POS 2	POS 3	POS 4	POS 5	POS 6	POS 7	POS 8	
OFF adds zero, ON changes offset by:							temp. compensation	
8 mV	16 mV	32 mV	64 mV	128 mV	256 mV	512 mV	Auto	Manual

Table 4.13 - Offset Switch Selection For pH Card

DIP SWITCH S2: SPAN							
POS 1	POS 2	POS 3	POS 4	POS 5	POS 6	POS 7	POS 8
OFF adds zero, ON increases span by:							
20 mV	40 mV	80 mV	160 mV	320 mV	640 mV	-NA-	-NA-

Table 4.14 - Span Switch Selection For pH Card

DIP SWITCH S3			
POS A: OFFSET		**POS B: INPUT TYPE**	
Depress Top	Depress Bottom	Depress Top	Depress Bottom
Negative	Positive	pH INPUT	ORP INPUT

Table 4.15 - Input Type and Offset Polarity Selection For pH Card

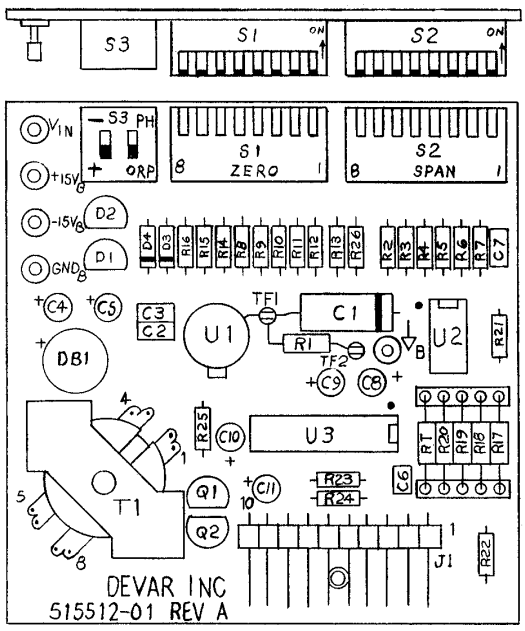
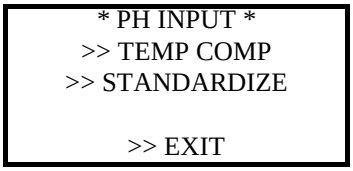


Fig 4.5 pH Input Card Assembly

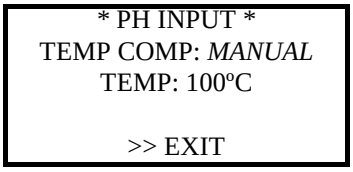
Once the dip switches are set, the SMART CHART needs to be configured for a pH or ORP input. In the case of an ORP input select "MV/V " as the input type on CONFIGURATION *SCREEN 1* of the configuration menu. Select a "pH " input only if a pH input probe is connected to the SMART CHART. SMART CHART's ordered with pH inputs will be factory calibrated for 0 to 14 pH. The SMART CHART allows the user to "Temperature Compensate" and/or "Standardize" the electrode during the recording mode. **This is done using pull down menus**. While viewing a pH input on the screen, press the MENU key. The parameters selected from the menu will pertain only to the channel being viewed. When the MENU key is pressed the following screen appears.



Use the NEXT key to move to the next selection on the menu and the SET key to select the option. While this menu is up on the screen, recording is not interrupted even though it is not visible. Select EXIT to return to viewing recorded data.

TEMPERATURE COMPENSATION

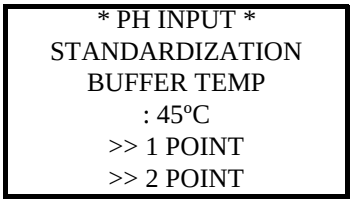
Selecting TEMP COMP from the preceding menu produces the following screen. Select manual temperature compensation. *Note that the correct dip switch setting on the pH input card is required for correct operation*. Use this screen to enter the temperature of the solution. Temperature selections range from 0 to 149ºC.



Use the NEXT key to move to the next selection on the menu and the SET key to select the option. Select EXIT to return to the preceding menu.

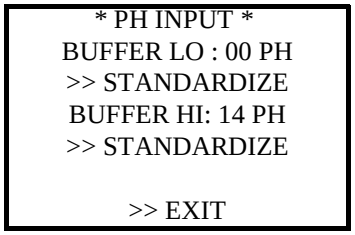
STANDARDIZATION

Selecting STANDARDIZE from the preceding menu produces the following screen. Use this screen to select between a one point and a two point standardization.



The buffer temperature applies to both modes of standardizing and appears when the user is involved with manual temperature compensation. A 1 point standardization is an offset adjustment. A 2 point standardization is an offset and gain adjustment. The 2 point standardization provides a more accurate correction for errors in the pH electrode.

Selecting a 2 point standardization leads to the following screen. The screen for the 1 point and 2 point standardization's are very similar. The obvious difference is the number of standard buffers.



Input the pH value of the first buffer solution (the lower pH). Then insert the probe into the standard buffer and allow a few minutes for the probe to stabilize before selecting the STANDARDIZE option. At this point the SMART CHART reads the input and records this value. Repeat the operation for the second buffer. After standardizing with the standard buffer solution exit the screen by selecting the EXIT option. This takes the user back to the first screen. Exit this screen to go back to recording. The SMART CHART will now automatically correct for errors in the pH electrode.

Note : *The above screens apply to a specific input(displayed input) and thus the temperature compensation and standardization correction apply only to that input. Also, these corrections apply only to the real time data. Data collected previously is not affected by these corrections.*

pH	Temperature ºC								
	5	15	*25*	35	45	55	65	75	85
0.0	386.34	400.23	414.12	428.01	441.89	455.78	469.67	483.56	497.45
1.0	331.15	343.05	354.96	366.86	378.77	390.67	402.58	414.48	426.38
2.0	275.96	285.88	295.80	305.72	315.64	325.56	335.48	345.40	355.32
3.0	220.77	228.70	236.64	244.58	252.51	260.45	268.38	276.32	284.26
4.0	165.58	171.53	177.48	183.43	189.38	195.34	201.29	207.24	213.19
5.0	110.38	114.35	118.32	122.29	126.26	130.22	134.19	138.16	142.13
6.0	55.19	57.18	59.16	61.14	63.13	65.11	67.10	69.08	71.06
7.0	0	0	0	0	0	0	0	0	0
8.0	-55.19	-57.18	-59.16	-61.14	-63.13	-65.11	-67.10	-69.08	-71.06
9.0	-110.38	-114.35	-118.32	-122.29	-126.26	-130.22	-134.19	-138.16	-142.13
10.0	-165.58	-171.53	-177.48	-183.43	-189.38	-195.34	-201.29	-207.24	-213.19
11.0	-220.77	-228.70	-236.64	-244.58	-252.51	-260.45	-268.38	-276.32	-284.26
12.0	-275.96	-285.88	-295.80	-305.72	-315.64	-325.56	-335.48	-345.40	-355.32
13.0	-331.15	-343.05	-354.96	-366.86	-378.77	-390.67	-402.58	-414.48	-426.38
14.0	-386.34	-400.23	-414.12	-428.01	-441.89	-455.78	-469.67	-483.56	-497.45

Table 4.16. Millivolts Versus pH From 5 to 85ºC

pH	Temperature ºC								
	5	15	25	35	45	55	65	75	85
0.0	0.47	0.23	0.0	-0.23	-0.47	-0.70	-0.94	-1.17	-1.41
1.0	0.40	0.20	0.0	-0.20	-0.40	-0.60	-0.80	-1.01	-1.21
2.0	0.34	0.17	0.0	-0.17	-0.34	-0.50	-0.67	-0.84	-1.01
3.0	0.27	0.13	0.0	-0.13	-0.27	-0.40	-0.54	-0.67	-0.80
4.0	0.20	0.10	0.0	-0.10	-0.20	-0.30	-0.40	-0.50	-0.60
5.0	0.13	0.07	0.0	-0.07	-0.13	-0.20	-0.27	-0.34	-0.40
6.0	0.07	0.03	0.0	-0.03	-0.07	-0.10	-0.13	-0.17	-0.20
7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.0	-0.07	-0.03	0.0	0.03	0.07	0.10	0.13	0.17	0.20
9.0	-0.13	-0.07	0.0	0.07	0.13	0.20	0.27	0.34	0.40
10.0	-0.20	-0.10	0.0	0.10	0.20	0.30	0.40	0.50	0.60
11.0	-0.27	-0.13	0.0	0.13	0.27	0.40	0.54	0.67	0.80
12.0	-0.34	-0.17	0.0	0.17	0.34	0.50	0.67	0.84	1.01
13.0	-0.40	-0.20	0.0	0.20	0.40	0.60	0.80	1.01	1.21
14.0	-0.47	-0.23	0.0	0.23	0.47	0.70	0.94	1.17	1.41

Table 4.17 - pH Error Versus pH From 5 To 85ºC

CHAPTER 5
DATAREADER

THE CARDREADER

Data stored on a memory card can be read into the computer using a CARDREADER. The CARDREADER provides a serial port at the back which connects to the serial port of a personal computer via a RS232 cable, see Fig. 5.1. This cable connects between the serial port of the computer and the CARDREADER port.

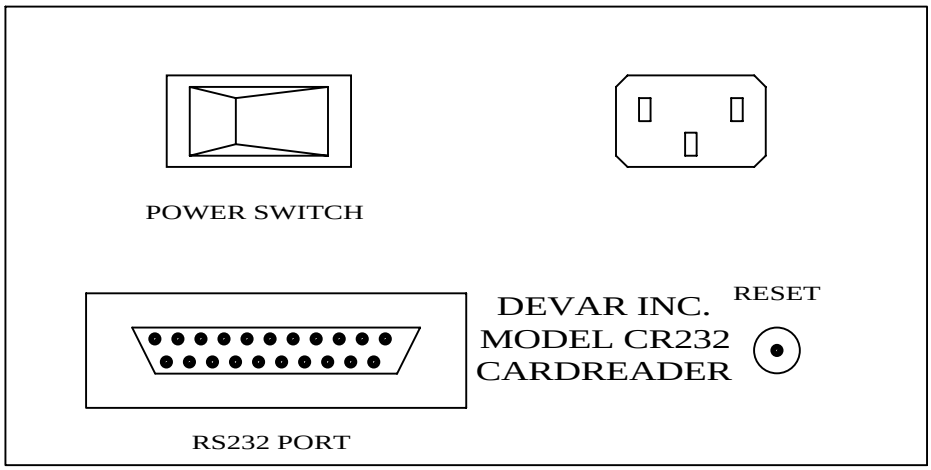


Fig. 5.1 - CARDREADER Back Panel

There are 3 LED's located on the front panel of the CARDREADER. They are labeled READ, LOW BATT and POWER, see Fig. 5.2. Turning the power switch 'ON' will illuminate the POWER LED. If the memory card being used has a low battery in it then the LOW BATT LED will illuminate soon as the memory card is inserted. The READ LED illuminates when data is being read from the memory card.

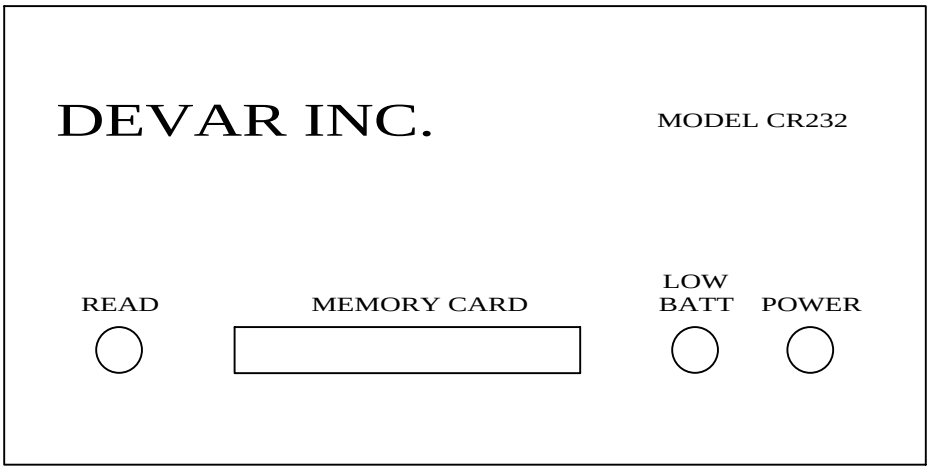


Fig. 5.2 - CARDREADER Front Panel

DATAREADER SOFTWARE

Using the DATAREADER software the user can read data from a memory card (using a CARDREADER) or directly from a SMART CHART recorder. Data is read one channel at a time. Therefore, to read data from all the channels on a two channel memory card (or SMART CHART) two read operations have to be performed. Data read from a memory card (or SMART CHART) is stored in a binary data file in the computer. The DATAREADER program enables the user to read data, view/analyze the data and also obtain a hard copy (print out) of any portion of this data file. The program also allows the user to obtain an ASCII file of any portion of the data for further analysis using a spreadsheet program.

SYSTEM REQUIREMENTS

The following are the system requirements to run the DATAREADER software :

COMPUTER	The DATAREADER program is designed to run on the IBM PC XT/AT and other compatible computers.
OPERATING SYSTEM	The software runs on a DOS Version 2.0 or later.
GRAPHICS CARD	The software requires an EGA or VGA color monitor.
MEMORY	At least 1Mbyte of memory is needed to run the program.
DISK DRIVE	The disk drive must have at least 360 Kbytes of memory space available. However, 1 Mbyte of memory space is recommended (the software occupies about 200 Kbytes of memory and each data file occupies 64 Kbytes of memory).

INSTALLING THE SOFTWARE

The DATAREADER installation program INSTALL, is designed to copy (from the floppy disk) all files and programs necessary to run the DATAREADER software, onto the C drive (hard disk) of the computer. It is generally a good idea to make a separate directory for the DATAREADER software on your hard disk. If you do not wish to make a separate directory skip Steps 1 and 2 and go directly to Step 3.

Step 1 At the 'C' prompt : Type "**mkdir card**" and press enter.
This creates a directory called 'card' (or Use any other 6 letter name instead of 'card').

Step 2 Type "**cd card**" and press enter.
You are now in the 'card' directory (this is where INSTALL is going to copy all the DATAREADER files and programs).

Step 3 Insert the 'Installation Disk' floppy in drive 'A'. Type "**a**:" and press enter.
You should now be at the 'A' prompt.

Step 4 Type "**install**" and press Enter.

You have now started the INSTALL program. It will copy all the files and programs from the floppy disk, in drive 'A', onto the hard disk.

Step 5 Type "**C:**" and press enter.

You are now back at the 'c:\card' prompt

Step 6 Remove the floppy disk from drive 'A' and store it in a safe place. As soon as installation is complete you will be able to run the DATAREADER software.

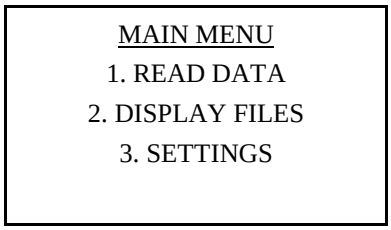
NOTE:

To run the program from a floppy disk, make a backup copy of the installation disk, using the diskcopy command and use this disk to run the program. In a two floppy drive computer , insert the source disk in drive 'A' and the backup disk in drive 'B' and type "**diskcopy a: b:**" and press enter. This will copy the source disk onto the backup disk. Use the backup disk to run the DATAREADER program. There is no need to go through the installation process.

GETTING STARTED

Once the program is installed, the DATAREADER software can be run a) from the HARD DISK - by typing READDATA at the 'C' prompt and b) from the FLOPPY DISK - by typing READDATA at the 'A'(or 'B') prompt.

READING DATA

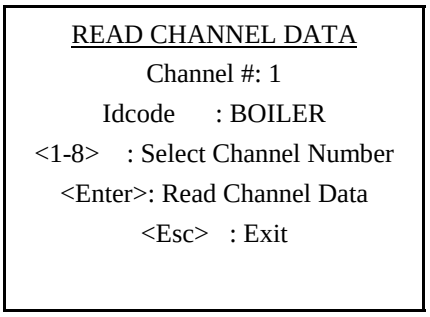


This is the first screen that appears when the program is run. This screen has four options. Use the UP and DOWN arrow keys to move to an option. To select a highlighted option just press Enter. An option may also be selected by pressing the option number. For example:- In order to select the DISPLAY FILES option either press 2 or move to the option using the arrow key and press Enter.

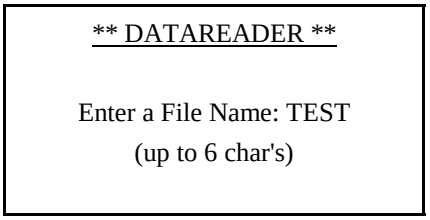
The first option, READ DATA, allows the user to read data into the computer either from a CARDREADER or from a SMART CHART recorder. The second option, DISPLAY FILES, allows the user to view/analyze and print previously stored data files. The third option, SETTINGS, allows the user to change either the COM port or the BAUD rate or the PRINTER. The fourth option, QUIT, allows the user to leave the DATAREADER program and return to DOS.

Before selecting the first option make sure the RS232 cable is properly connected. If the computer is connected to a SMART CHART, make sure the recorder is in RS232 communications mode. To do so press the SET key in the main menu. The main menu appears when the SMART CHART recorder is first powered up or is reset. Refer to Chapter 2 for details on recorder menus.

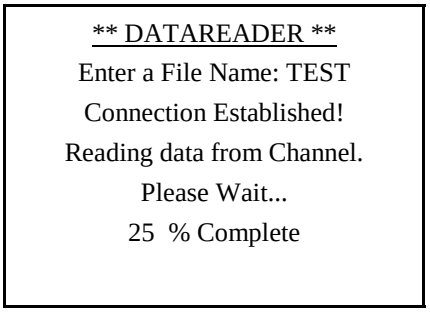
When the first option, READ DATA, is selected from the MAIN MENU the following screen appears.



At this point the program reads the ID codes of all the channels and comes up with the above screen. The user can now select a channel to read data, simply by typing in the channel number. The user can identify each channel by looking at the ID codes. After selecting the desired channel, press Enter and this will now initiate the reading of data from the channel into the computer. This leads to a new screen.



At this point the user is prompted to enter a file name. The data that will be read from the channel will be stored in the computer under this file name. Enter a file name, say TEST, and press Return.



As data is being read, the program indicates how much data has been read. After reading all the data the program returns to the MAIN MENU. The user may select the READ DATA option again, to read data from another channel or select the DISPLAY FILES option to view data that has already been read.

DISPLAY FILES

Select DISPLAY FILES from the MAIN MENU to view previously read data file. Selecting this option leads to a directory listing of all the data files in the working directory.

DIRECTORY LISTING

DATA FILES	DATA FILES
BOILER	
CUST1	
PRESS	
FILE01	
FILE02	
FILE05	
OVEN3	
OVEN4	
OVEN6	
PROC-1	
PROC-2	
TEST	

<Esc> : Exit <Enter> : Select

Use the arrow keys to move through the directory listing. To display a highlighted file press Enter. To exit the directory listing screen press the Escape key. The program returns to the MAIN MENU.

NOTE:

To delete a data file, exit the program and return to DOS. Type "delete *filename*.crd" and press Enter. For example to delete the data file 'test', type "delete test.crd". Note that all DATAREADER files have a ".crd" extension.

GRAPH DISPLAY

When a data file is selected for display the SMART CHART will present a graphical representation of the entire data file on the very first screen. This is an XY plot of amplitude on the Y axis versus time on the X axis. Refer to Fig 5.3. Time on the X axis advances from left to right. There is a header information box on top of the graph. The header box contains information about the data file such as file name, sampling time, Id code, input range, alarm points and the time scale. The vertical line that appears in the middle of the graph is the Cursor.

Range:

The amplitude on the Y axis is scaled in terms of percentage. The exact value in engineering units corresponding to 0 and 100 % are indicated in the header box under 'RANGE'. The vertical resolution of the graph (on the computer) is 0.3% which is 5 times better than the vertical resolution of the SMART CHART recorder.

Amplitude, Time and Date:

The time and amplitude at the cursor is displayed in the header box under 'Amp., Time and Date'. Therefore, by moving the cursor to any desired location on the graph the exact amplitude and time at that point can be determined.

Scroll Keys:

Move the cursor across the page by using the arrow keys. Use the page up and page down keys to jump to the next or the previous page of the graph. If an attempt is made to move the cursor beyond the first(or the last) data point on the page, the program will slide a half page of data from the left(or right), onto the screen.

Alarms:

The High and Low alarm points are indicated in engineering units in the header information box. They are also graphically located along the Y axis by two arrow heads.

Time:

The first and the last time markings on the X axis locate the beginning and ending times of the data currently being viewed. Time marks in between these two end points are scaled to increment by whole numbers, which may be in seconds, minutes, hours, days or months depending on the sampling time and the Zoom level. The time interval is between divisions on the X axis, is indicated in the header information box as the X-Scale. The time and date in the header box indicates the exact time and date at the cursor. Notice that as you Zoom in the X-Scale decreases and you Zoom out the X-Scale increases.

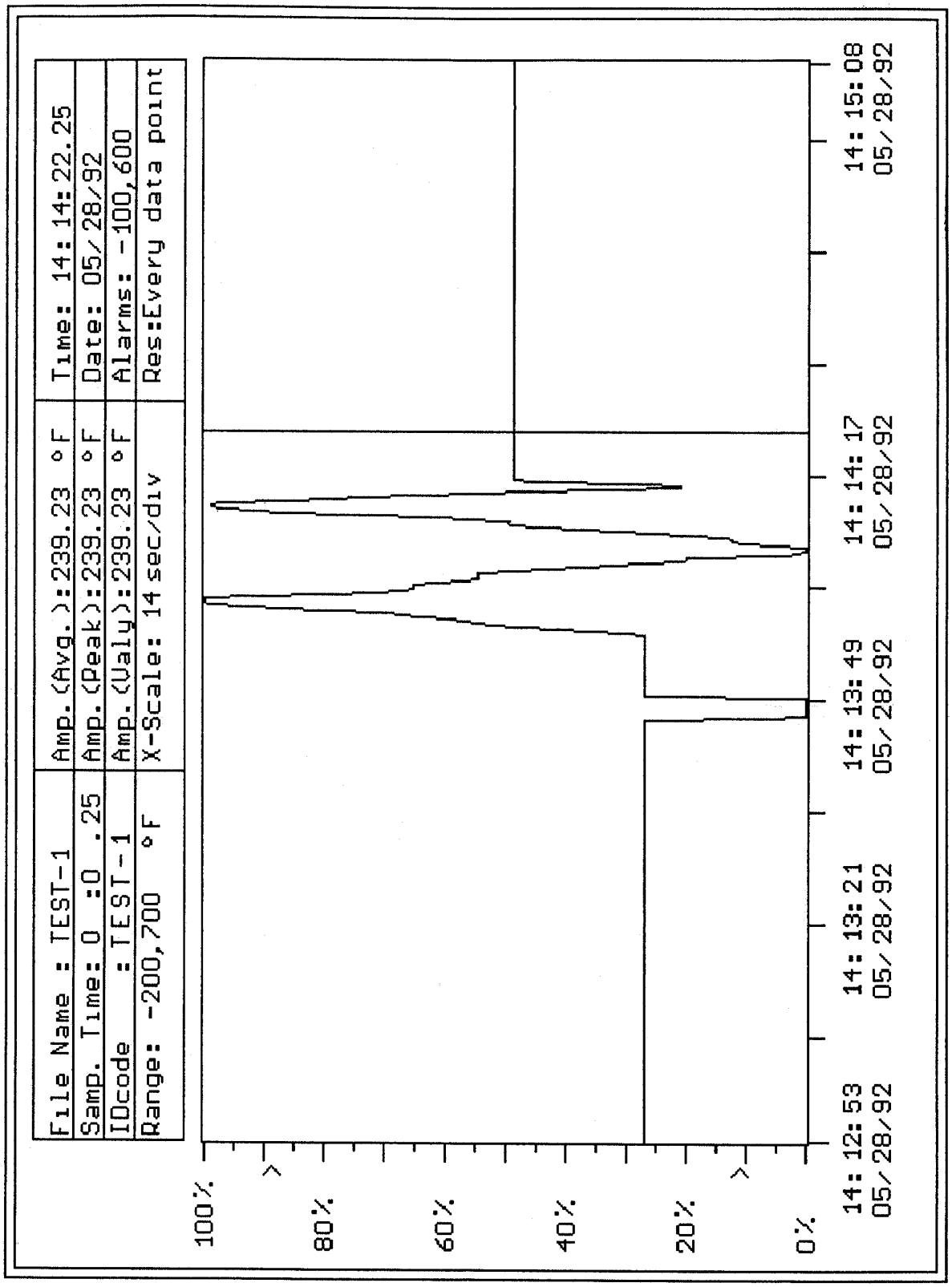


Fig. 5.3 - Typical Display

ZOOM FEATURE

The very first screen that appears when a data file is selected is a graphical display of the entire data file. At this zoom level the resolution is every 61st (or every 21st data point when in the combined recording mode) data point. To view a more detailed graph the user has to zoom in. The user can zoom in and out either horizontally (time scale) or vertically (amplitude scale). **Zoom in using F3 and Zoom out using F2**. Every time the zoom in or zoom out keys are pressed there is an option to zoom either vertically or horizontally. Using the arrow keys move to either option and press Enter.

Horizontal Zoom has 5 levels and at each level of magnification the resolution is indicated in the header box. The cursor jumps a certain number of data points at each level until at the maximum magnification the cursor moves one data point at a time and it is not possible to zoom in any further. Zooming in or Zooming out is always with respect to the cursor, therefore move the cursor close to the region of interest and zoom.

Zooming in vertically is accomplished by defining the area of interest using the two arrow heads along the right side of the graph. The arrow heads enable the user to define the area of the graph to be enlarged. As soon as vertical zoom in option is selected the selection at the bottom of the graph changes to "upper level", "low level" and "zoom now". Use the arrow keys to choose the option and also to move the arrow heads up or down. When the "high level" option is highlighted the upper arrow head can be moved and when the "low level" option is highlighted the lower arrow head can be moved. After selecting the region of interest move to the "zoom now" selection and press Enter. This process can be repeated any number of times until the desired level of magnification is reached. Vertical Zoom out returns the graph to normal resolution.

ASCII FILES

Data read from the memory card or the SMART CHART recorder is stored in the computer as a binary data file. The user can convert an entire binary data file or just a portion of the data file into an ASCII file for further analysis in a spreadsheet program. The portion of the binary data being converted into ASCII may be fit into one or more files, depending on the amount of data being converted. For example: An entire data file (in the average recording mode) will fit into 8 ASCII files. These files will have the same name as the binary data file except they will have different extensions. Consider a data file 'test.crd'. When the ASCII files are created they will be named "*test.ac1, test.ac2, test.ac3*....". The first ASCII file contains header information concerning the data file such as: sampling time, Id code, recording mode, alarms, range and resolution. This is followed by three columns of ASCII data, consisting of Amplitude, Time and Date respectively.

" Idcode : ","HORTON"

" Samp. Time: ","0:0.50"

" Resolution: ","Every Data Point"

" Rec. Mode: ","Comb."

" Range: ","1475 to 1825"

" Alarms: ","8 , 16 øF"

"Avg. ","Peak ","Valy."," Time"," Date"

1653.8,1658.7,1649.7,"12:15:59.50","10/05/91"

1660.5,1665.4,1655.7,"12:16:00.0"

1659.4,1667.6,1655.7,"12:16:00.50"

1661.3,1667.6,1657.6,"12:16:01.0"

1658.7,1661.6,1655.7,"12:16:01.50"

1664.3,1670.6,1659.8,"12:16:02.0"

1657.2,1662.0,1654.2,"12:16:02.50"

1657.2,1659.8,1653.5,"12:16:03.0"

Fig. 5.3 - Example of an ASCII file

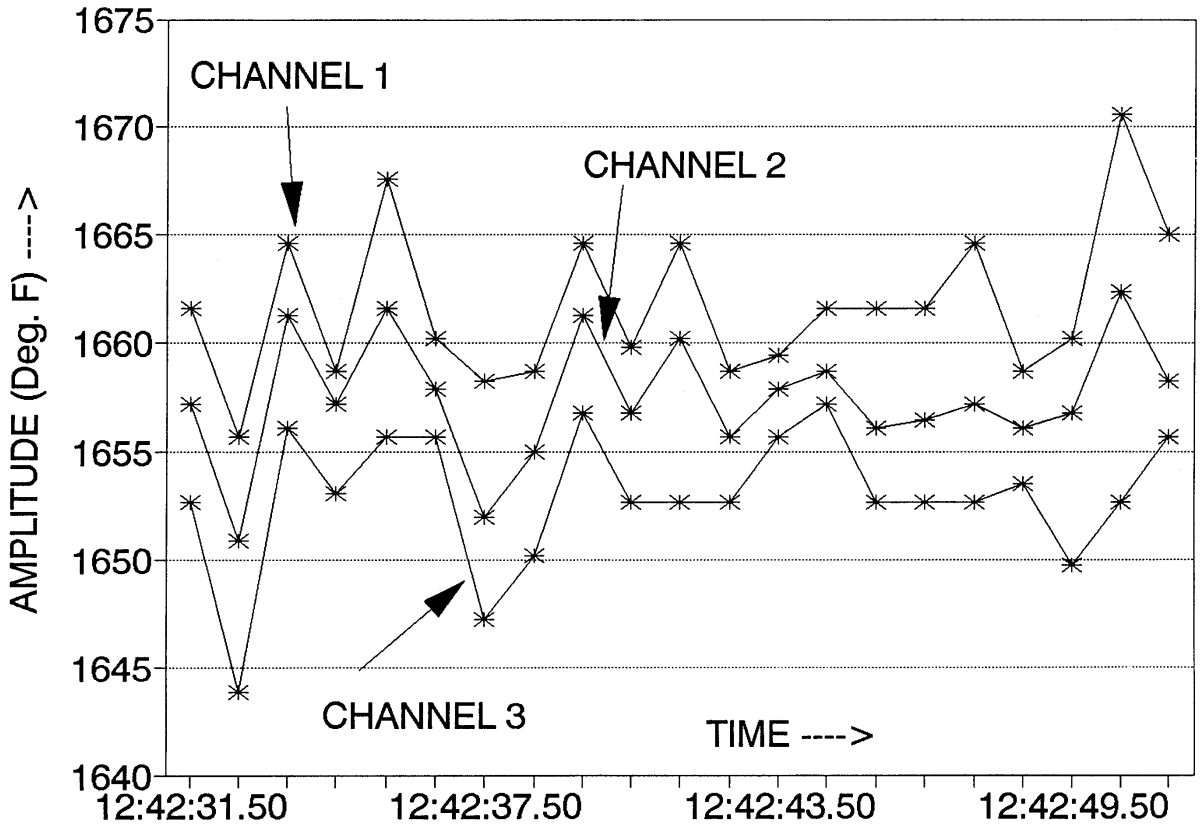


Fig. 5.4 - DEMO ASCII FILE

A sample printout of an ASCII file is presented in Fig. 5.3. If this ASCII file were to be imported as a "Comma & Quote delimited" in Quattro Pro or as "Text and Numbers file" in Lotus, then each entity, (amplitude, time and date) would appear in different columns. From within a spreadsheet program the user can plot multiple channels on the same graph.

Amplitudes are presented in engineering units and the Time format is "*hours:minutes:seconds.hundreths of a second*" and the date format is "*month/day/year*". Date is repeated only when it changes, in order to conserve memory. Each ASCII file can hold upto 4096 data points and the size of the entire file would be approximately 100 Kbytes

CREATE ASCII FILES

At any time while viewing graphic data on the screen, the user can create an ASCII file of any portion of the displayed data by pressing F4. When F4 is pressed the following window appears on the screen.

```
===>> Convert Data To ASCII <<===
            Starting      Ending
  Time:     12:59:07      13:35:52
  Date:     5/24/92       5/24/92
<<Esc>: Exit; <Enter>: Continue
```

The starting and the ending times defines the portion of data that will be converted into ASCII. The starting time, by default, corresponds to the first point on the graph (on the screen) and the ending time corresponds to the cursor point. Both, starting and ending times, can be changed at this point to redefine the region of interest. Use the arrow keys to highlight either the starting or the ending time. *Use the up or down arrow keys to increment or decrement time*. Time will increment or decrement by one sampling time (one data point). *Hold down the control key ,"Ctrl", while pushing the up or down arrow for a faste*r increment/decrement. Once the starting and the ending times are set, press Enter to continue. Press Escape if the 'create ASCII files' option is to be aborted. When Enter is pressed a new screen appears:

```
>>>> Create An ASCII File <<<<
Resolution: Store every 21st data point
Number of Files: Create 1 File(s)
Total memory: 16 K bytes
<Enter>: Create ASCII File(s)
<up/down arrow>: Change resolution
<Esc>: Exit
```

The resolution of the ASCII file that initially appears in this window is the same as the display graph resolution. In the above example, the ASCII file will start from the starting time and store every 21st data point until the ending time is reached. The user, however, has the option of changing the resolution by using the up and down arrow keys. There are 5 resolution levels corresponding to the 5 zoom levels of the graph. The resolution and the amount of data being stored will determine the Number of files created. In the above example 1 file will be created which will occupies approximately 16 Kbytes of Total memory. Once the resolution is set press Enter to create an ASCII file.

PRINTING

At any time, while looking at a graph on the screen press F5 to obtain a printout of what is on the display. Make sure a printer has been selected prior to doing this. Printer selection needs to be done only once even if the program is run several times. The program stores the selected printer name in a file, '*Printr.Cng*', on the disk. Every time F5 is pressed the program refers to this file for the printer selection. Once printing has commenced, a prompt at the bottom of the screen "Please Wait ...Printing in progress", will appear. The user should wait for completion of printing before entering any new key strokes. Refer to the "Printer Selection" section under "Settings" for more details.

SETTINGS

When option 3 in the MAIN MENU is selected the following screen appears. The baud rate, serial port and printer selections have to be set at least once. Once set, they are retained in memory.

SETTINGS

1. SET BAUD RATE/PORT
2. SELECT PRINTER
3. ----
4. MAIN MENU

The program is generally preset to communicate at a baud rate of 9600 bits per second with the serial port COM 1. The CARDREADER and SMART CHART recorder are also preset to these settings.

BAUD RATE/SERIAL PORT

When option 1 in the SETTINGS menu is selected the following screen appears.

SET BAUD/PORT

1. 9600 bps(Fact. Set)
2. 4800 bps
3. SERIAL PORT: COM 1
4. EXIT

The first two options indicate the baud rate selections. The selected baud rate is highlighted in white color. To change the setting simply move to the desired baud rate option and press Enter.

Note that a*ny change in baud rate has to be made in two places.* One is in the program, as described above, the second is on the dip switch settings. Refer to the following table for dip switch changes.

Set SW1 Position 2 for SmartChart 8100	Baud	4800	9600
Set SW2 Position 1 for CardReader	Set	ON	OFF

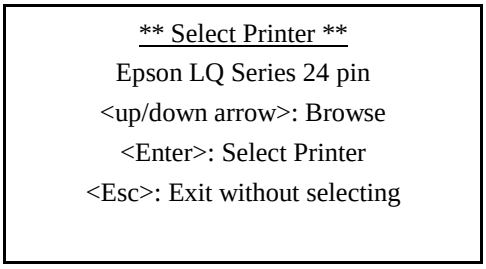
Table 5.1 - Baud Rate Switch Setting

NOTE : Please make sure that power is turned off before you open the CARDREADER or the SMART CHART.

The third option allows the user to select the serial communications port. A computer may have two serial ports, COM 1 and COM 2. Use either of these ports to connect your RS232 cable to the CARDREADER or the SMART CHART recorder. To change port selection simply press Enter at this option. The port selection changes back and forth between COM 1 and COM 2 each time Enter is pressed. *Changing a serial port selection does not require changes inside of the CARDREADER or the SMART CHART recorder.*

PRINTER SELECTION

When option 2 on the SETTINGS menu is selected the following screen appears.



If a printer had been previously selected the screen will display that printer name otherwise it will display the first printer name from the list of supported printers. Using the up and down arrow keys scroll through the list of printers that are supported by this program. To select a printer simply press Enter when the printer name appears in the box. After selecting the printer the program automatically returns to the SETTINGS menu. If the user does not intend to select a printer press the Escape key and the program will return to the SETTINGS menu without selecting a new printer.

This program supports an entire range of dot matrix and Laser printers. Most dot matrix printers either emulate an *Epson or an IBM proprinter*, and most Laser printers emulate the *HP Laser Jet*. Therefore, if the user has a printer that is not listed in the program select from one of the above. If the wrong printer is selected chances are the printout will not look correct. A list of all the supported printers is stored in a file 'PRX_TBL.BIN' and is required for printing. This file is copied onto the disk during installation.

CHAPTER 6
TROUBLESHOOTING

The DATAREADER program appears to have established communication with the SMART CHART (CARDREADER) and gets stuck after reading 25 % of the data and the screen is frozen.

This is most probably a memory contention problem. The DATAREADER program may contend with installed drivers when both of them try to use the same high memory. Disabling these drivers will normally alleviate the problem. Typical drivers are smrtdrv, network manager and memory manager programs.

In most cases it is the *smrtdrv.exe* program in the *autoexec.bat* file. This is a disk-caching program provided with Windows. In the default mode it enables a read and write cache feature. Disable the write cache feature by adding the drive letter to the line. If the line in *autoexec.bat* file is 'c:\windows\smrtdrv.exe' change it to 'c:\windows\smrtdrv.exe **c:**'. Reboot the computer and try reading data. Please refer to the Windows 3.1 manual for details about the *smrtdrv* program.

Input does not appear to be linear.

Linearity problems may be due to incorrect dip switch settings on the input card, causing the output of the card to go above 5 volts at the top of the range or below 0 volts at the bottom of the range. This could be tested by viewing the display as you slowly approached the top or bottom of the input range. If the display stops responding before the input signal has reached the end of its range, then the output of the input card has exceeded the 0 to 5 volt limit. The voltage output of the input card could also be measured directly using a voltmeter and measuring on the test points located on the interconnect board, see Fig. 4.3.

Time information in the SMART CHART does not appear to be correct.

The SMART CHART does not record time information with every data point but calculates it based on the time the last data point was recorded. Therefore, any time the machine is turned off and then back on, the time information on the previously recorded data will be in error by the length of time the machine was turned off. To prevent loss of time information, download data into a memory cardor into a computer before turning the machine off. If the SMART CHART has been turned off, data may still be retrieved without loosing the time information, by downloading the data into a computer using RS232 communications option. Note that this must be done before recording has been resumed.

The SMART CHART shuts down while operating on battery power.

The SMART CHART will operate on battery power any time AC power is absent. See specifications for battery life. Once the main battery voltage becomes low a warning light, on the front of the recorder will turn on. If AC power is not restored the recorder will continue to operate for a short time, then it will shut itself down. This is done to protect the main battery. Data collected by the SMART CHART is not lost due to this. However, the only way data can be retrieved, is by downloading the data into a computer using the RS232

option. The main battery is under charge any time AC power is connected to the recorder, regardless of whether the recorder is turned on or off.

Ambient temperature compensation for thermocouple input does not appear to be correct.

Once the SMART CHART has been calibrated for a specific temperature inputs, the recorder may be turned off and turned on again without losing the calibration. However, if after turning on the SMART CHART you do not go directly into recording, but go into configuration and do not recalibrate the inputs, there may be an error in the temperature compensation. This error would be approximately equal to the difference in ambients between the time of calibration and the time of reconfiguration. This applies only to thermocouple inputs.

Error Messages

Error: Check Connection/Baud/RS232 Mode

This error message may come up for a number of reasons. It comes up if

a) there is no physical connection from the SMART CHART/CARDREADER to the computer

b) the RS232 cable is connected to the wrong serial port

c) the Baud Rate selection on the SMART CHART/CARDREADER and the computer is not the same

d) the SMART CHART is not in 'RS232 Communications Mode'.

The user may either correct the problem and the program continues or abort the process and press the Escape key.

Error: Invalid Data File

This message comes up if the user tries to read an empty data file.

CHAPTER 7
ILLUSTRATIONS

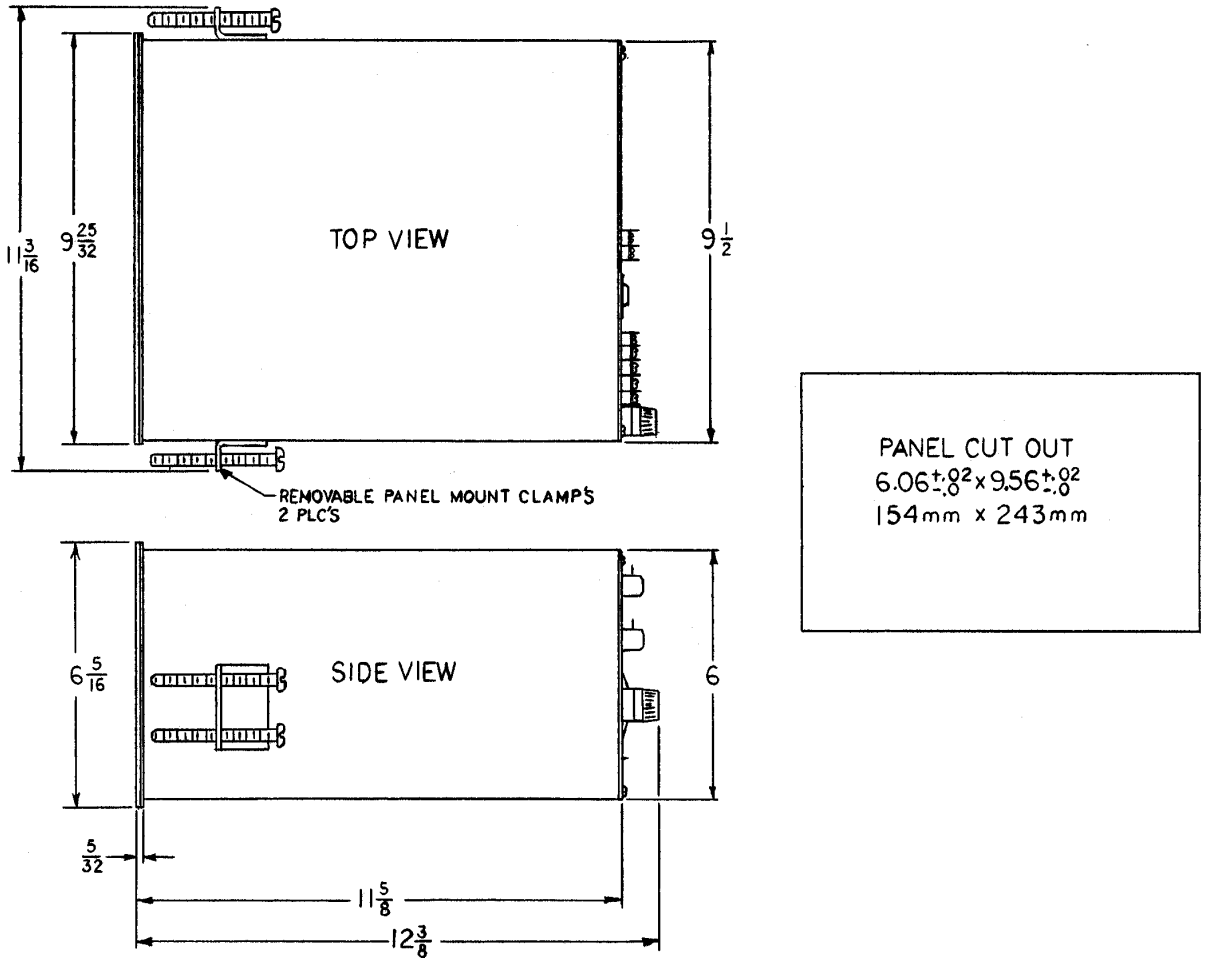


Fig. 7.1 - GENERAL DIMENSIONS

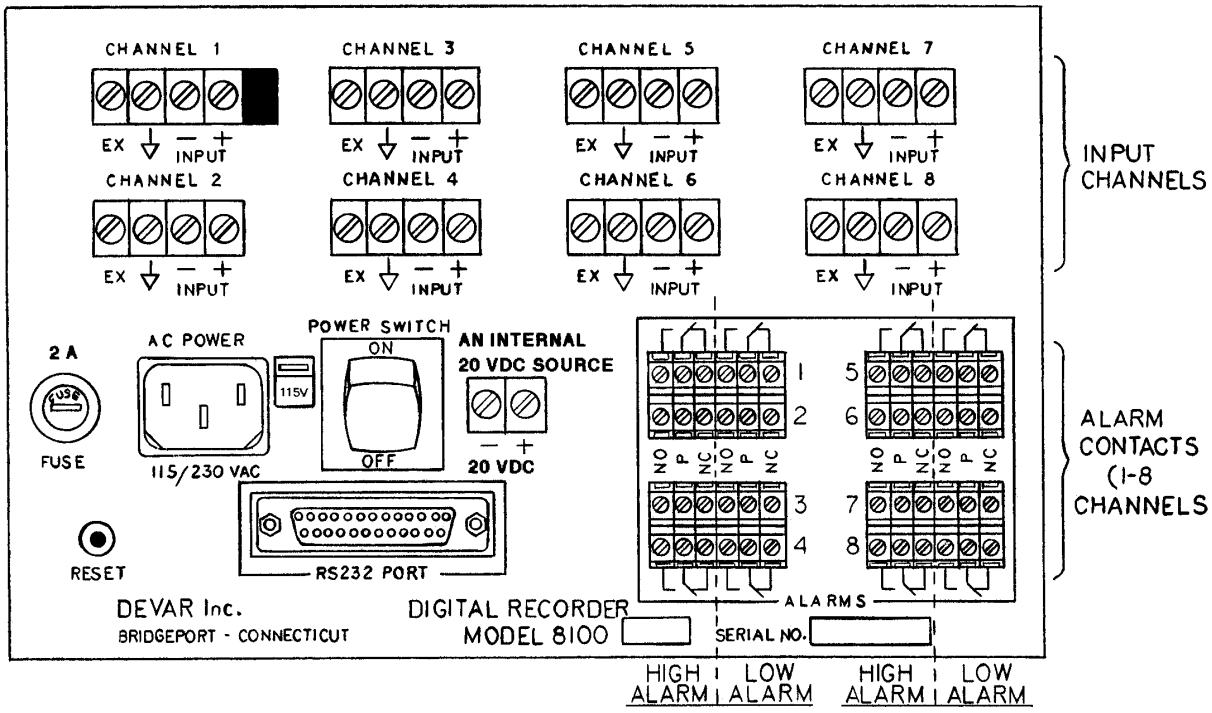


Fig. 7.2 - BACK PLATE

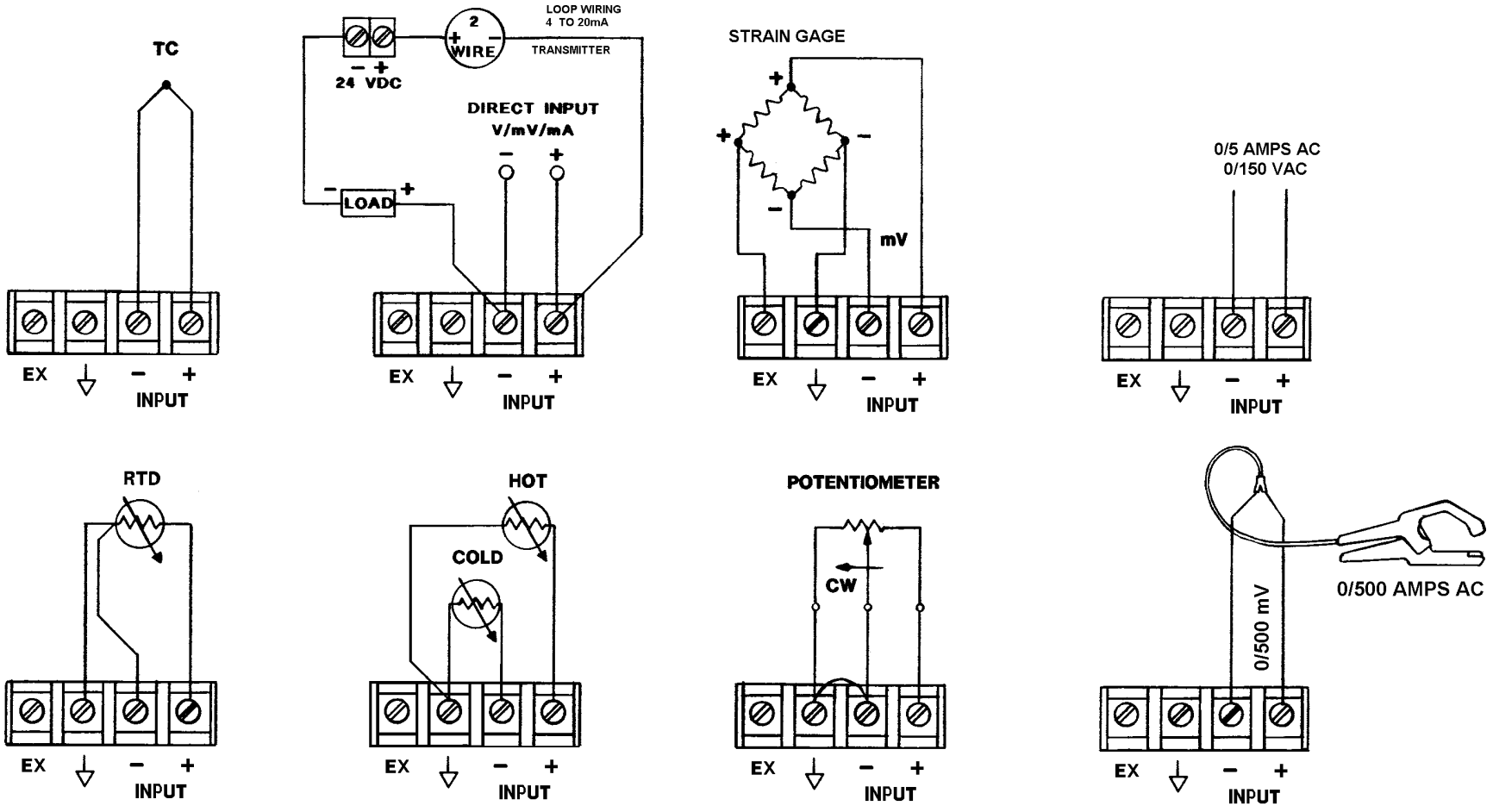


Fig. 7.3 - WIRING DIAGRAM

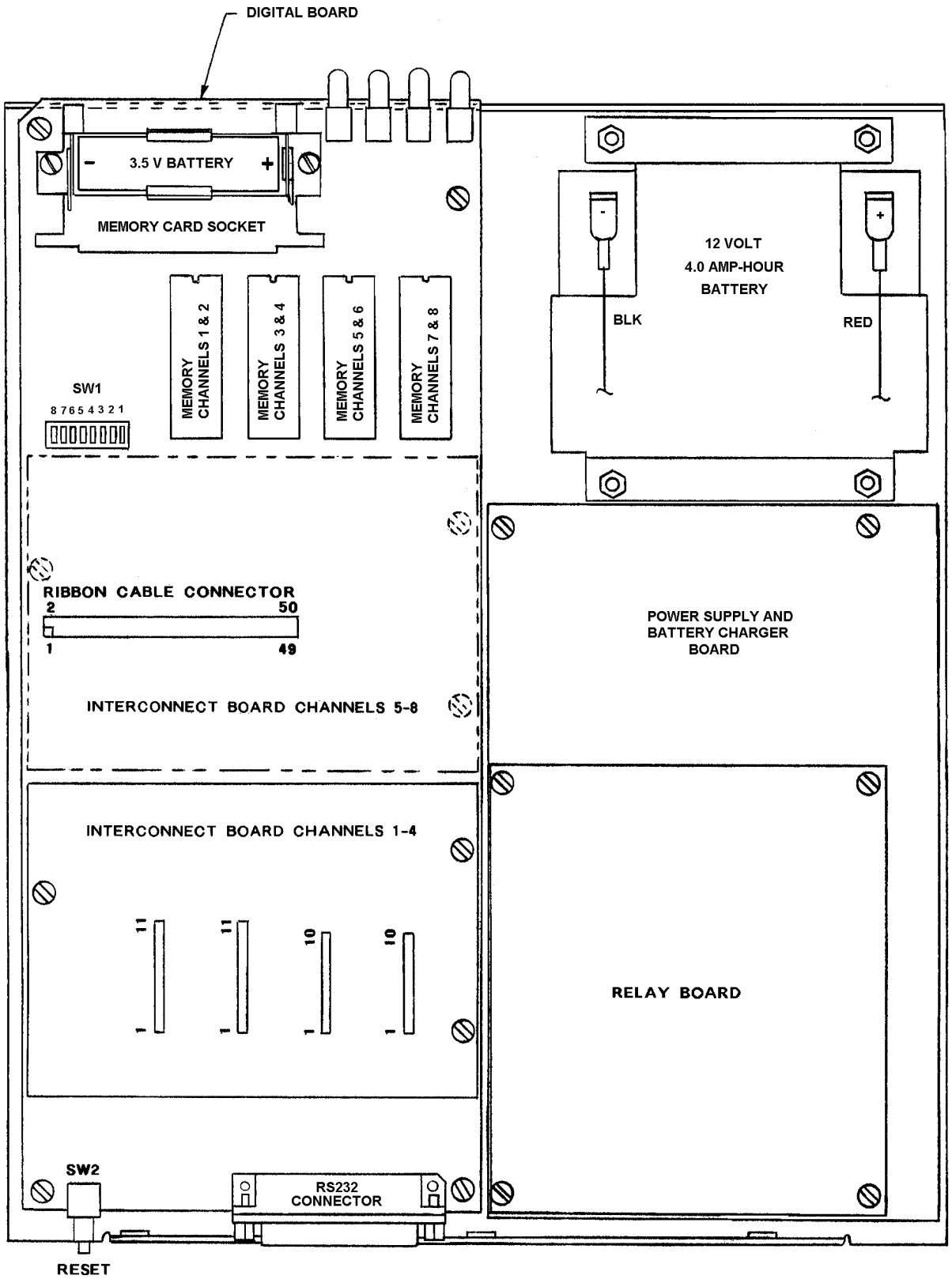


Fig 7.4 - TRAY ASSEMBLY