M2000-16
Thermal Chart Recorder
User Guide

SECTION 1 - INTRODUCTION

This manual has been produced to allow the User to make full use of the Micro Movements M2000-16 Recorder. It is not intended that the User should undertake major maintenance, for which the Recorder should be returned to Micro Movements. Consequently some of the technical descriptions and maintenance procedures are not explained in full.

For further details on Maintenance and Fault Finding please refer to the Service Manual.

This manual is divided into 4 main sections, which cover:

Description

Set Up

Operation

Communications

WARNING

HEALTH AND SAFETY AT WORK

MICRO MOVEMENTS DIVISION HAVE ENSURED THAT, AS FAR AS PRACTICABLE, ANY PERSON CARRYING OUT NORMAL MAINTENANCE OPERATIONS ON THE ABOVE SYSTEM IS NOT EXPOSED TO ANY UNDUE HAZARD FROM ELECTRIC SHOCK OR PERSONAL INJURY.

HOWEVER, MAINTENANCE AND/OR SERVICING OPERATIONS MAY INVOLVE REMOVAL OF COVERS OR DISASSEMBLY OF COMPONENTS. UNDER SUCH CONDITIONS THE INTEGRITY OF THE EQUIPMENT MAY BE IMPAIRED. **MICRO MOVEMENTS** THEREFORE RECOMMEND THAT MAINTENANCE IS ONLY CARRIED OUT BY A COMPETENT PERSON OR PERSONS CONVERSANT WITH THE HAZARDS OF WORKING WITH ELECTRO-MECHANICAL SYSTEMS.

SECTION 2 - DESCRIPTION

2.1 General Description

The M2000-16 Recorder is designed to accept signals from virtually any type of sensor such as Pressure Transducers, Thermocouples, Strain Gauges, Flow Meters, or Accelerometers, and to present these signals in a form suitable for analysis. The signals may also be recorded digitally for final output to analysis equipment via an RS232c port. There is also a connection for remote operation, while an internal back up supply allows the memory to store data for up to 12 hours.

The Recorder can accept up to 16 signals and present them on heat sensitive paper. The traces may be fully overlapping (i.e. each channel can write across the full chart width), or non-overlapping, on roll paper.

The Recorder may be installed either for dedicated use, or be used for visual data analysis during testing of systems on site. The internal memory is equivalent to up to 32 metres of recording paper on all channels (with full extended memory).

2.2 Detailed Description

The M2000-16 Recorder may be divided into 3 major parts. These are:

- The Signal Conditioning Modules which receive the analog signals from the external transducers, and transmit these to:
- The Data Acquisition/Analysis modules which convert these signals into digital form which can be processed and transmitted to:
    a) External Devices. e.g. Computers
    b) The paper chart
- The Mainframe, which houses the above.

2.2.1 Description of Modules

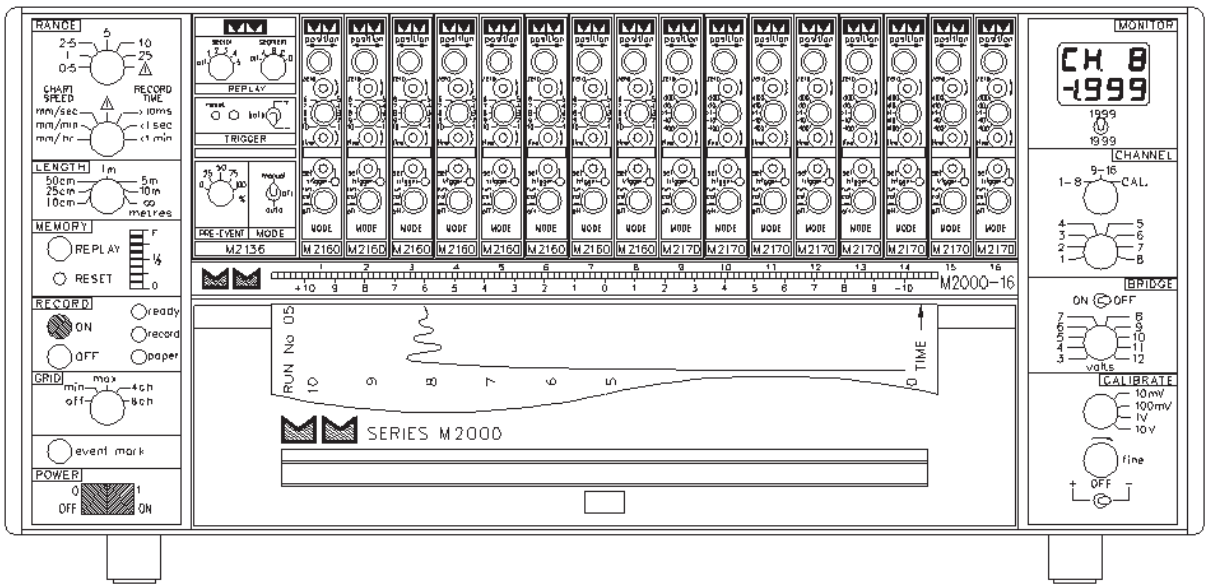


Figure 2-1 Layout of Front Face of Recorder

Signal Conditioning Modules

These are “plug in” units located in the central section above the paper chart at the front of the Recorder (see Figure 2-1) and are configured to condition a signal direct from the transducer, to a voltage level which can be handled by the recorder. The Recorder will operate on those channels for which Signal Conditioning modules are installed. It is not necessary to have a full complement of modules in order for the recorder to operate. (See individual Module Users Guides for detailed operation of each signal conditioning function).

Data Acquisition Modules

The Data Acquisition/Analysis Modules are “plug in” units located within the Recorder.

These modules multiplex the high-level output from each of four signal conditioning modules into a high speed analog to digital converter. This enables the signals on each channel to be processed digitally.

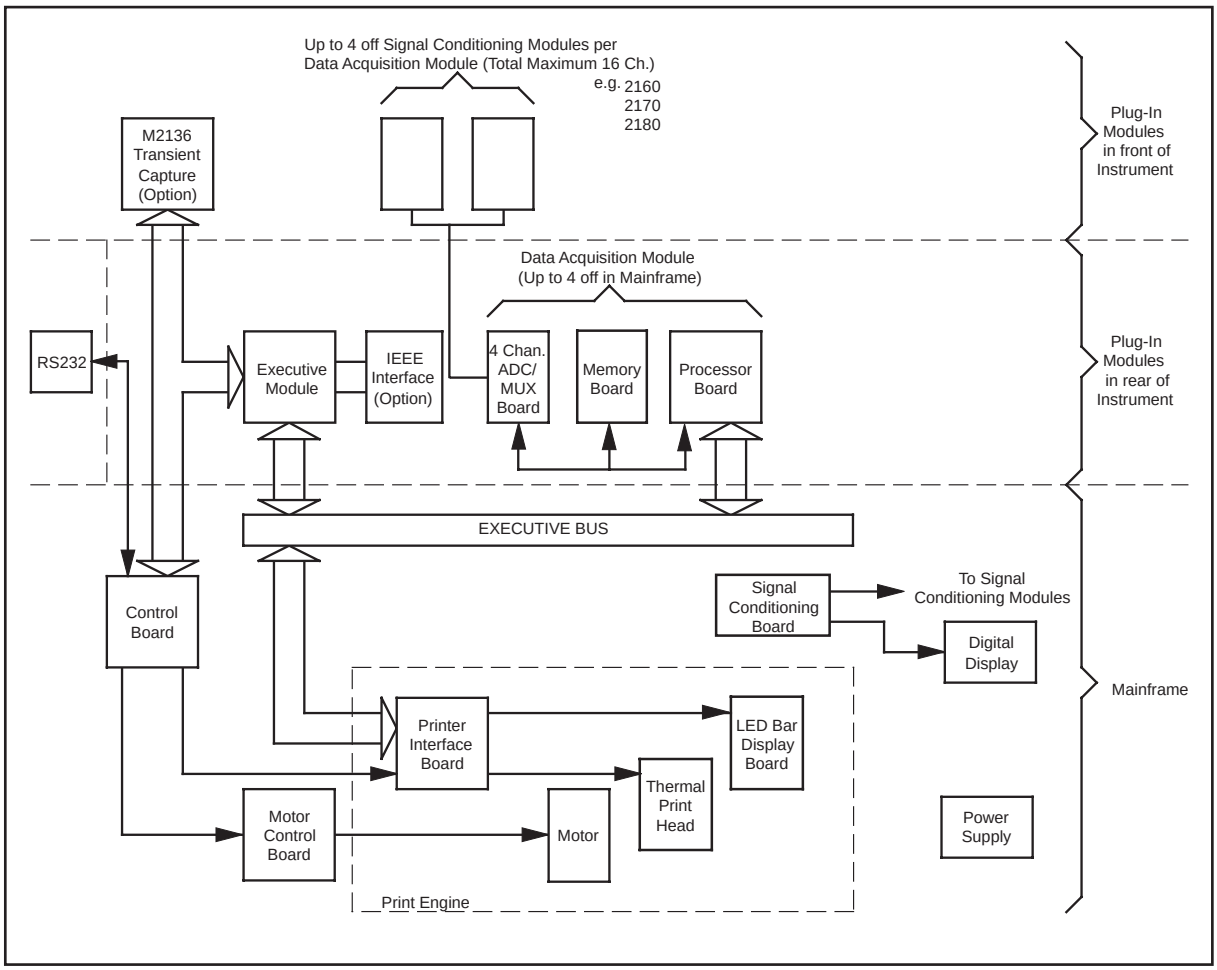


Figure 2-2 Block Schematic of Recorder

The Data Acquisition Module consists of three printed circuit boards:

- 4-Channel ADC/MUX

  This board accepts 4 separate analog inputs, multiplexes these to a high speed 12 bit A/D converter and contains all the housekeeping logic for the module.

- Memory

  Standard - 512 k-bytes providing 64k samples per channel.
  Extended - up to 2 M-bytes of battery backed-up static RAM, partitioned to provide up to 256k samples per channel.

- Processor

This contains the embedded controller and PROM's which implement the required program for locally controlling i) and ii) above and transferring information between them on the Module Data Bus. This board also interfaces with the Mainframe Executive Bus, enabling full communication throughout the instrument.

One Data Acquisition Module will control up to 4 Signal Conditioners. To control all sixteen channels, four Data Acquisition Modules are required.

Mainframe

The Mainframe consists of three main operating sections. These are:

- Executive Module

  The Executive Module is a "plug in" unit located at the rear of the Recorder, which controls the flow of data on the executive bus.

Note. The Recorder will not operate with this module removed.

- Print Engine

  The Print Engine is at the front of the Recorder and has a front-opening cassette which houses the paper. The printer receives signals from the Mainframe Executive Bus and prints out the results on thermal paper.

- Controls

  The main controls for operation are on the front face of the Recorder; those on the left-hand side are for setting the operation, while those on the right-hand side are for calibration and setting the signal trace. These controls are described in Section 4. Controls for the power supply are on the rear face (see Section 3).

SECTION 3 - SET UP

3.1 Installation

The M2000-16 Recorder is portable and therefore is not dedicated to one installation point. During use there are some simple precautions to follow if the recorder is to operate safely and correctly.

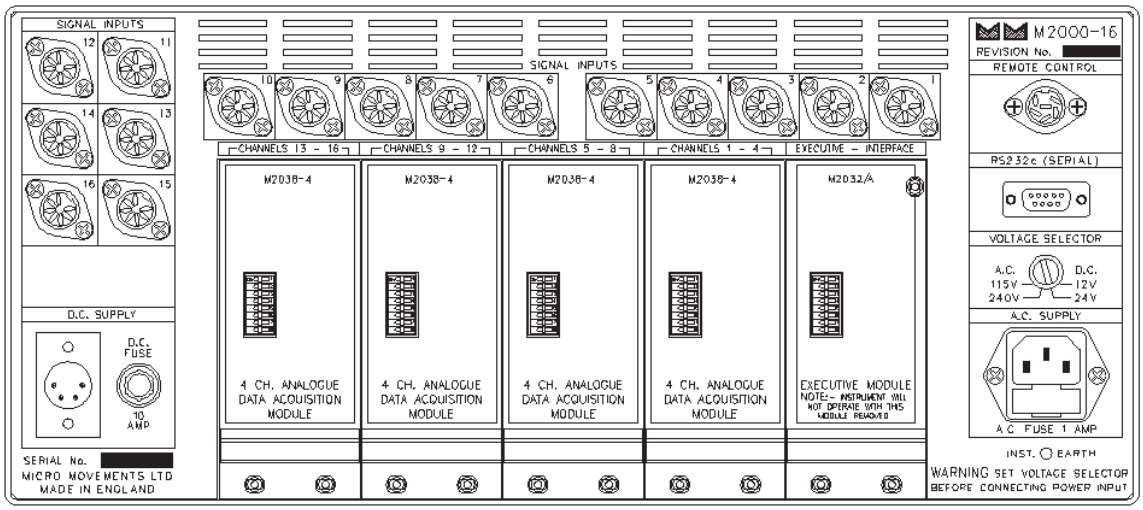


Figure 3-1 Rear View of M2000 Recorder (shown with A6 inverter).

a) The dust cover must always be fitted when the recorder is not in use. Dirt and dust will cause undue wear on moving parts.

b) The recorder must always be mounted on a secure flat surface, with sufficient space left at the rear, so that cooling air can escape from the vents, which are below the signal connection points. (see Figure 3-1)

c) Always disconnect all the input connections, especially the power supply, before removing the recorder from its case. The recorder should not be removed from its case, except by properly qualified personnel.

3.2.2 Module DIL switches

The mode of operation of the recorder is determined by the positions of the DIL switches on the following board:

(a) Channel Processor board

The DIL switches determine the channel number printed on the paper output. These are set up when the recorder is supplied to correspond to the channel input numbers.

	SW1	**SW2**
Channels 1-4	OFF	OFF
Channels 5-8	ON	OFF
Channels 9-12	OFF	ON
Channels 13-16	ON	ON

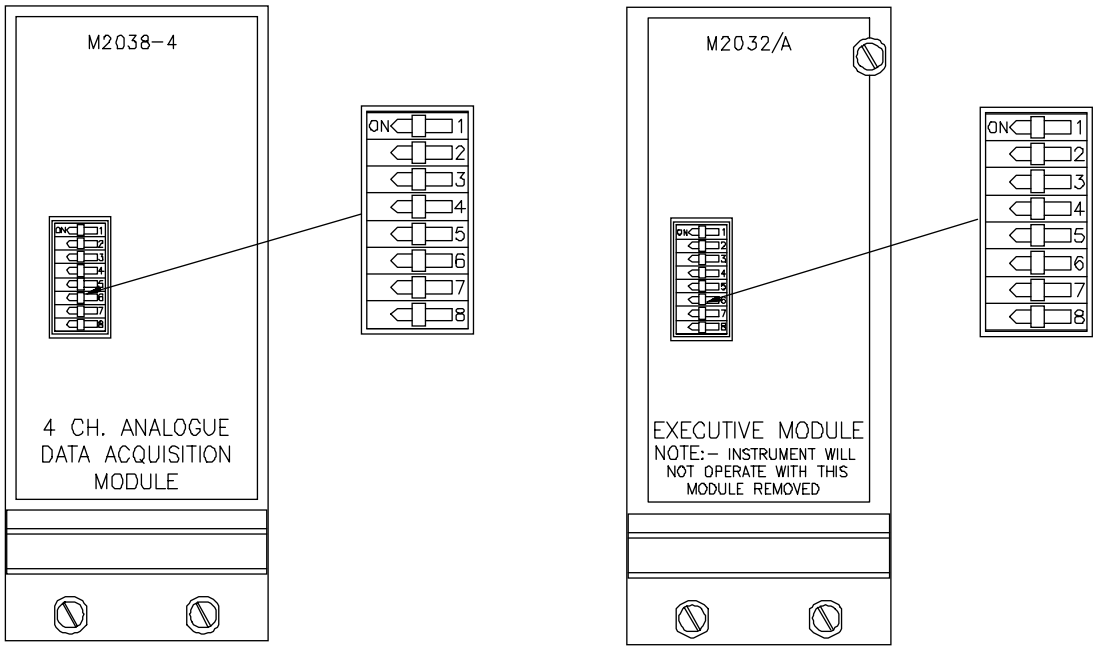


Figure 3-2 Executive and Channel Processor Module DIL switch location

(c) Control board

The DIL switches on the control board set up the baud rate for communication to an external computer. This is normally set up to 9600 baud and the switches can be found on the control board.

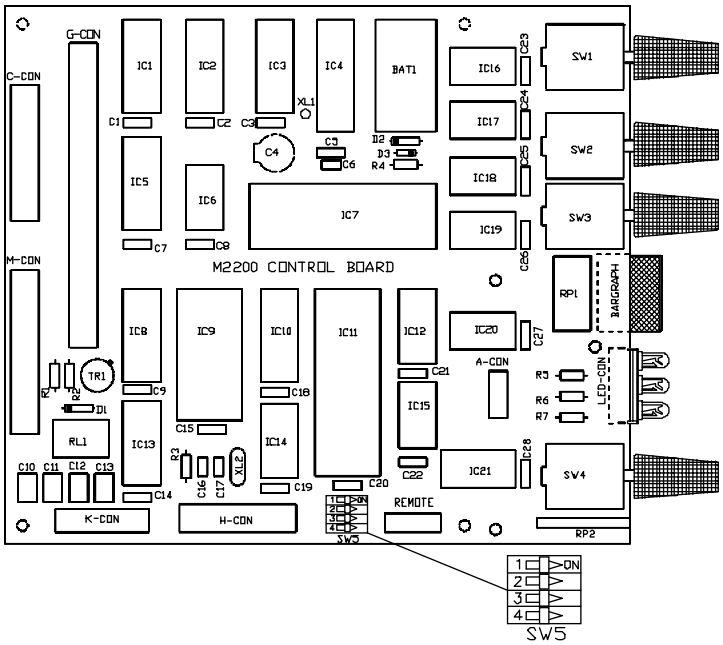


Figure 3-3 Control board DIL switch location

Baud Rate	SW1	SW2	SW3	SW4
19200	ON	ON	ON	ON
9600	OFF	ON	ON	ON
4800	OFF	ON	ON	OFF
2400	OFF	OFF	ON	ON
1200	OFF	ON	OFF	OFF

SECTION 4 - OPERATION

The Recorder is set to suit the particular needs of the job before starting to record data. The controls described in this section are adjusted to set the recorder for use. Their operation in most cases is self evident, however some details need explanation. A simple guide to the operation of the recorder is given in the following paragraphs. More detailed information on the operation of the controls can be found later in the section. Figure 4-1 shows the front view of the recorder.

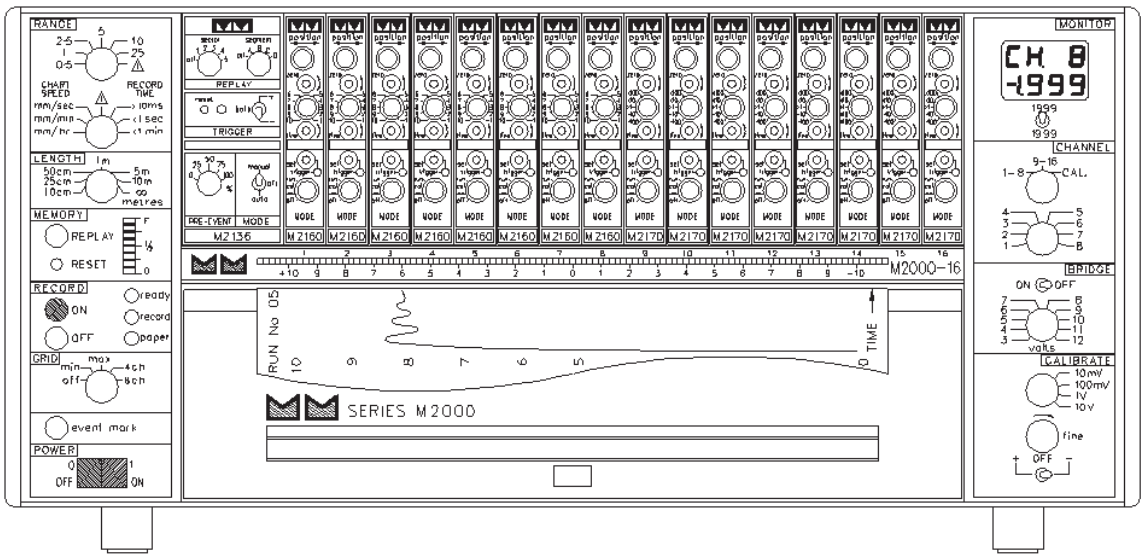


Figure 4-1 Front Panel of Recorder

4.1 Basic Operation

The M2000 Thermal Printer Recorder can operate in two clearly defined modes, Real Time mode and Record Time (storage) mode, with some overlapping facilities. In Real Time mode data is gathered and printed simultaneously. In Record Time mode data is gathered and stored for later analysis.

In Real Time mode, after the Record ON button has been pressed the recorder will automatically start to gather data and print. In Record Time mode, when the Record ON button has been pressed data is gathered for the set Record Time and, when this is complete, automatically printed. In each case pressing the REPLAY button will print out the data stored in memory.

4.1.2 Record Time Operation

a) Select the required record time.

The Range/Mode selector switch is set to one of the switch positions marked 'RECORD TIME' (x10 ms, x1 sec or x1 min). In these three positions data is captured in memory for subsequent replay to the Chart or to an external device, e.g. a Computer. There are a total of 18 Record Time Data Capture positions ranging from 5 millisecs to 25 minutes. The sampling frequency and stored data rate is shown in Tables 4-4 and 4-5.

b) Select the printing length.

The Chart length switch is set to the approximate length required for the recording. The recorder automatically selects a suitable scale and prints the chart length to suit the memory size and sampling rate. The maximum length of paper printed out is 50cm.

c) Set the signal conditioning controls.

These settings depend on the type of signal conditioning modules fitted and the results required. A quick guide to setting the signal conditioning controls is given in Section 4.1.3. Details of the mainframe controls used are given in this section while details of the module controls are given in the module user guide.

d) Press Record ON.

The recorder operates for the selected time, storing data in memory. The minimum sampling rate is 16kHz, resulting in a minimum bandwidth of 2kHz. The maximum sample rate is 80kHz, giving a bandwidth of 10kHz. The data is stored in memory (see Section 4.3 for further details) and can be replayed and expanded on to paper, or downloaded to a host computer as described in Section 5 (or both if required).

4.1.3 Setting the Signal Conditioning Modules

Each Signal Conditioning module has to be set for the particular sensor which is being monitored. The following paragraphs describe, in general terms, the sequence of operations required when setting up a signal conditioning module. Further details on individual module controls and calibration method are given in the module user guides.

Note. As each Signal Conditioning Module is set up for its connected sensor, it is important that the connection cables are labelled to make sure that future reconnections are made correctly. This ensures that only minor adjustments are required for calibration.

m) Adjust the ZERO control on the module to give a reading of 0.00V on the monitor (offset zero).

4.1.4 Paper Loading

When the PAPER lamp is lit, to indicate that the paper has run out, the printer operation is inhibited. After a new roll of paper has been loaded, pressing the REPLAY button allows the printing operation to be completed.

IMPORTANT – The thermally sensitive paper must be carefully stored away from heat and light, so that it remains in first class condition for use.

a) Press the button at the bottom of the drawer, which allows the drawer to spring open slightly. Pull the drawer fully open.

b) Remove the old paper spool.

c) Drop in the new paper roll and pull out a length of paper, so that it projects over the lip of the drawer.

Note: that the spool is positioned so that the thermally sensitive (glossy) side of the paper is uppermost.

d) Close the drawer until it clicks shut. The PAPER lamp is extinguished and the READY lamp is lit.

To tear off the paper, pull the paper upwards against the cutting edge of the fascia.

4.1.5 Messages

The messages which are automatically printed on the paper, are:

a) Run number - Each run of printing is sequentially numbered along the left edge of the paper. The numbering is reset to start at run no. 1, when the recorder is switched on, or when the RESET button has been pressed.

b) Chart Time Base - The chart speed as selected by the SPEED controls, is printed alongside the grid lines on the left edge of the paper in time base format. e.g. 1 sec/cm.

c) Date/Time - The date and time of the run is shown along the left edge of the paper. The internal battery maintains the date/time information for over 6 months when the mains power has been removed.

d) User Messages - A message can be printed along the right edge of the paper. This may consist of any 70 characters alpha/numeric title such as the company name, location, etc. The message is entered via the RS232c port on the back of the recorder. (see section 5).

Range Multiplier Switch

This is a 7 position switch used in conjunction with the Range Selector switch. Position 7 of the switch is not used. The range steps available are, 0.5, 1, 2.5, 5, 10 and 25.

Range/Mode Selector Switch

This is a 7 position switch used in conjunction with the Range Multiplier Switch. This switch gives:

3 Chart Speed ranges for real time recording (mm/sec, mm/min, mm/hr)
1 Spare position. (marked '!')
3 Record Time ranges for high speed data capture (x10 ms, x1 ms, x1 min)

Using this switch with the Range Multiplier switch the following ranges can be selected:

Switch Position	Mode/Range selected
1 (mm/hr)	Real Time Chart Recorder 0.5 to 25mm/hr
2 (mm/min)	Real Time Chart Recorder 0.5 to 25mm/min
3 (mm/sec)	Real Time Chart Recorder 0.5 to 25mm/sec
4 (!)	Not Used
5 (x10 msec)	Record Time Capture Mode - 5 to 250 millisecs.
6 (x1 sec)	Record Time Capture Mode - 0.5 to 25 secs.
7 (x1 min)	Record Time Capture Mode - 0.5 to 25 mins.

Chart Length Switch

This switch controls the Chart length of a record. This is a 7 position switch, the lengths available are:

Switch Pos.	Compression Ratio
10cm	10:1
25cm	5:1
50cm	2:1
1m	1:1
5m	1:2
10m	1:4
Infinity	1:4

Reset Push Button

This is a recessed push button, that will clear the memory when pressed.

Record Box

This box contains the Record ON and OFF buttons and the three LED indicators:

Ready - A green LED that indicates the recorder is ready to record.

Record - A red LED that indicates a recording is in progress.

Paper - A red LED that indicates the paper requires changing.

The Record ON button starts the recording in either Real time or Record time modes. The Record OFF button stops the recording immediately in either mode, although this function is not generally used for record times of less than 5 seconds.

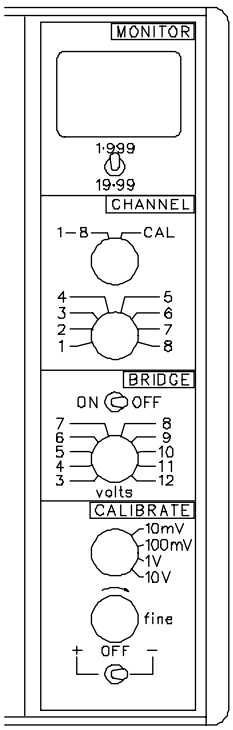
When the Record ON button is pressed in record time mode, the Record LED lights up and the memory starts to fill up. The recorder stays on for the time set by the combination of the range multiplier switch and the range/mode selector switch, (unless the record is interrupted by the Record OFF function). After the ON time has elapsed, all LED's will be illuminated, showing that the memory is full, and the green 'ready' LED will illuminate. To output the paper, the required length is set, and the REPLAY button pressed. The recorder will automatically set the required scale to fit the stored data into the selected paper length. If the auto replay DIP switch (on the Executive board) is enabled the stored data is printed out immediately after the memory is filled.

Grid

The 5 position grid switch provides the following selection of grids:

Switch Position	Function Legend	
1	off	Grid Off.
2	min	Fine 1cm grid with 2mm divisions all 16 channels overlapping.
3	max	Heavy 1cm grid with 2mm divisions all 16 channels overlapping.
4	4 ch	Print out channels 1-4 split into 4 sections.
5	8 ch	Print out channels 1-8 split into 8 sections.

Stored data can be replayed with any selected grid.



Monitor

Channel switches

Bridge controls

Calibration controls

Figure 4-3 Right Hand Side Front Panel

Channel Switches

The top rotary switch is a 3 position switch, the first two positions select the channel display 1 - 8 or 9 - 16, and the third position selects the calibrate display. The bottom rotary switch is an 8 position switch, which selects the channel number to be displayed when the top switch is in one of the first two positions. When in the 9 - 16 position, 8 must be added to the channel number selected on the lower switch. The Channel number is displayed on the LED display.

Bridge Controls

This function injects a transducer power supply into the channels. The toggle switch turns this feature ON and OFF.

The rotary switch selects an accurate known voltage, from 3 to 12 volts DC, which is routed via the signal conditioning modules to energise external transducers.

4.3 Sampling, Storage and Replay Rates

4.3.1 Real Time Mode

In Real Time mode the sampling frequency and rate of data storage depends on the CHART SPEED switch settings as shown in Table 4.1. The replay characteristics are shown in Tables 4.2. and 4.3.

CHART SPEED	INPUT SAMPLING	DATA RATE TO MEMORY	DATA RATE TO PAPER	TIME TO FILL MEMORY
mm/sec	**KHz**	**Samples/sec**	**Dots/sec**	**Mins**
25	6.25	800	200	2.67
10	6.25	320	80	6.67
5	6.25	160	40	13.33
2.5	6.25	80	20	26.67
1	6.25	32	8	66.67
0.5	6.25	16	4	133.33
mm/min		**Samples/min**	**Samples/min**	**Hours**
25	6.25	800	200	2.67
10	6.25	320	80	6.67
5	6.25	160	40	13.33
2.5	6.25	80	20	26.67
1	6.25	32	8	66.67
0.5	6.25	16	4	133.33
mm/hr		**Samples/hr**	**Samples/hr**	**Days**
25	6.25	800	200	6.67
10	6.25	320	80	16.67
5	6.25	160	40	33.33
2.5	6.25	80	20	66.67
1	6.25	32	8	166.67
0.5	6.25	16	4	333.33

Table 4-1 Real time sampling frequencies and stored data rates

When running in Real-time the memory fills with four data points for every one printed on the paper. The memory fills until 4 Metres of paper are printed (32K of memory). The memory then starts overprinting while the paper continues printing in Real-time. Thus after 4 metres is printed the memory always holds the last 4 metres available for replay.

4.3.2 Record Time Mode

In Record Time mode the sampling frequency and rate of storage of data in memory is chosen by the recorder to maximise the bandwidth for the selected record interval. To achieve this two methods of storage are used:

a) Direct storage mode

b) Compressed storage mode

Direct storage mode

With this method all samples are stored directly in memory. Thus the sampling rate is the same as the data to memory rate. All samples are stored and the sampling rates are from 5 msecs to 5 secs (10 secs with extended memory).

Direct storage mode applies to shorter record times. As the record time increases, the amount of memory required to hold the samples exceeds the available memory. Compressed storage mode is then used.

Compressed storage mode

In this mode the sample rate is at a constant 16kHz, but the data is compressed before being stored in memory. This method ensures that a high bandwidth is retained at longer record times without overflowing the available memory.

Data compression is achieved by recording the maximum and minimum sample values over a defined period. This period is variable depending on the record time selected. Each maximum/minimum value is known as a data point. These data points are stored in memory.

The sampling rate is always 16kHz but the number of samples used to form a data point is variable depending on the record time selected. For longer record times more samples are used to calculate one data point otherwise the memory would overflow. Alternatively, the time period over which the samples values are collated is extended. Thus for long record times the rate of storage of data points to memory is reduced preventing memory overflow.

Table 4-5 Record time sampling frequencies and stored data rates for extended memory recorders

From the tables it can be seen that the system can be considered to operate in four bands. Extended memory figures are in brackets.

Band 1. 5 msecs to 0.5 secs(5 msecs to 2.5 secs) - Maximum Sampling Frequency (80kHz). All samples stored.

Band 2. 1 sec (5 secs) - Reduced Sampling Frequency (40kHz). All samples stored.

Band 3. 2.5 secs (10 secs) - Reduced Sampling Frequency (16kHz). All samples stored.

Band 4. 5 secs to 25 mins (25 secs to 25 mins) - Fixed sampling frequency of 16kHz samples compressed to give a lower data rate to memory whilst retaining the bandwidth.

The minimum sampling rate is 16kHz, resulting in a minimum bandwidth of 2kHz. The maximum sample rate is 80kHz, giving a bandwidth of 10kHz. The data is stored in memory as defined in Tables 4.4 and 4.5, and can be replayed and expanded on to paper, as defined in Tables 4.6 and 4.7, or downloaded to a host computer as described in section 5 (or both if required).

Record Switch Setting	**Compression on Replay Chart Length Switch Setting**						
	10cm	**25cm**	**50cm**	**1M**	**5M**	**10M**	**Infinity**
5 ms	1	1	1	1	1	1	1
10 ms	1	1	1	1	1	1	1
25 ms	2	1	1	1	1	1	1
50 ms	5	2	1	1	1	1	1
100 ms	10	4	2	1	1	1	1
250 ms	25	10	5	2	1	1	1
0.5 sec	50	20	10	5	2	1	1
1 sec	50	20	10	5	2	1	1
2.5 sec	40	20	10	4	2	1	1
5 sec	25	10	5	2	1	1	1
10 sec	40	20	8	4	2	1	1
25 sec	20	10	5	2	1	1	1
0.5 min	20	10	5	2	1	1	1
1 min	25	10	5	2	1	1	1
2.5 min	20	10	4	2	1	1	1
5 min	20	10	5	2	1	1	1
10 min	25	10	5	2	1	1	1
25 min	20	10	4	2	1	1	1

Table 4-6 Record time replay compression characteristics for standard memory

Tables 4.6 and 4.7 show the degree of data compression on replay depending upon the CHART LENGTH switch position. The figures show the number of data points in the memory that are compressed to form each point or line printed each $^{1}/_{8}$ mm.

No further expansion is possible once the compression is 1. Selecting a longer paper length will not result in more paper being printed out. For short record times little or no compression is performed as the memory holds a limited number of samples.

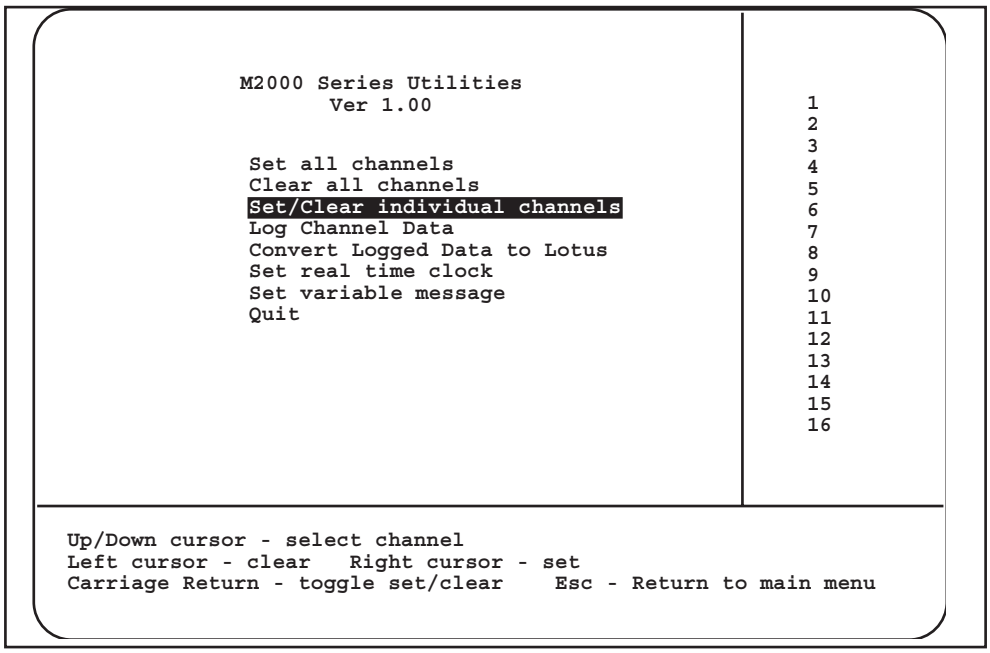


Figure 5-1 M2000 Series Utilities menu

Clear all channels

Clears the Set all channels selection.

Set/Clear individual channels

When this option is selected individual channels can be set or cleared in the left hand section of the screen. The cursor keys are used to select or set/clear the channels, the Carriage Return (ENTER) key used to toggle selection and the Esc key used to return to the main menu.

Log Channel Data

Once the required channels have been selected this option downloads the channel data to the PC hard disk in a binary format. The PC files are labelled CH**.BIN, where ** is the channel number.

Convert Logged Data to Lotus

This option converts the channel data files on the PC hard disk to a print file format that can be imported into Lotus 123. Each sample is followed by CR and LF which produces a single column of data suitable for conversion into a graphic representation of the chart printout. All existing channel data files are converted. The converted files are labelled CH**.PRN.

*RDT - Log data

This command controls the M2000 to start sending data from the channel selected with the SCH command. The M2000 immediately starts sending data in the following format.

Firstly an ASCII value is sent which is the interval between samples, the reciprocal of this being the sample frequency. This is followed by the data values, each value represented by a binary pair, with the least significant byte being sent first. When all data has been sent an ETX(03 hex) terminator character is sent.

As the data is sent in binary format for maximum speed the condition may occur where the value may equal the ETX character or several other control characters at present unused. If this should happen the following procedure is taken. A data link escape (DLE) character (10 hex) is sent followed by the actual byte of data logically ORed with 10 hex.

The receiving software must therefore detect the DLE character and reconstruct the next character by setting bit 4 to zero, unless the next character is a 10h then bit 4 is not set to zero.

e.g. The character 03h needs to be sent

send first 10 hex (00010000 bin)

then 13 hex (00010011 bin) (bit four set)

To reconstruct bit 4 is set to zero.

The two eight bit bytes should be joined to form a 16 bit word of which the least significant 12 bits represent the value as follows

0000 hex = -10.00 volts

03ff hex = 00.00 volts

0fff hex = 10.00 volts

5.2 IEEE 488

The IEEE 488 remote communication link is facilitated by a special Executive Module. This will normally be factory fitted but is simple enough to be fitted on site by a qualified engineer. The protocol and facilities available are identical to those on the RS232c.

The Executive Module will have the IEEE 488 connector mounted on the rear panel. A 24 way Delta connector.

