MT-9500
Operations
Manual

Astro-Med
Part Number
22834-117

Serial Number: _____

Issued To: _____

Limited Warranty

Recorder Identification Data

Congratulations. Your Astro-Med purchase is an investment in the finest of state-of-the-art recorder technology. The information provided below lists the model number, serial number, and firmware version of your recorder. Verify that the software configuration number (SCN) that appears on the LED display of your recorder after it has been powered-up exactly matches the firmware version given below. The firmware version recorded below is the most current firmware version available for your recorder. As noted below, the firmware version number represents the firmware as originally installed in your instrument. Any upgrades of the recorder's resident firmware should be noted in the space provided. If, for any reason, it should be necessary for you to contact Astro-Med regarding your purchase, please refer to the following:

Model Number:_____

Serial Number:_____

Firmware Version:_____
(original installation)
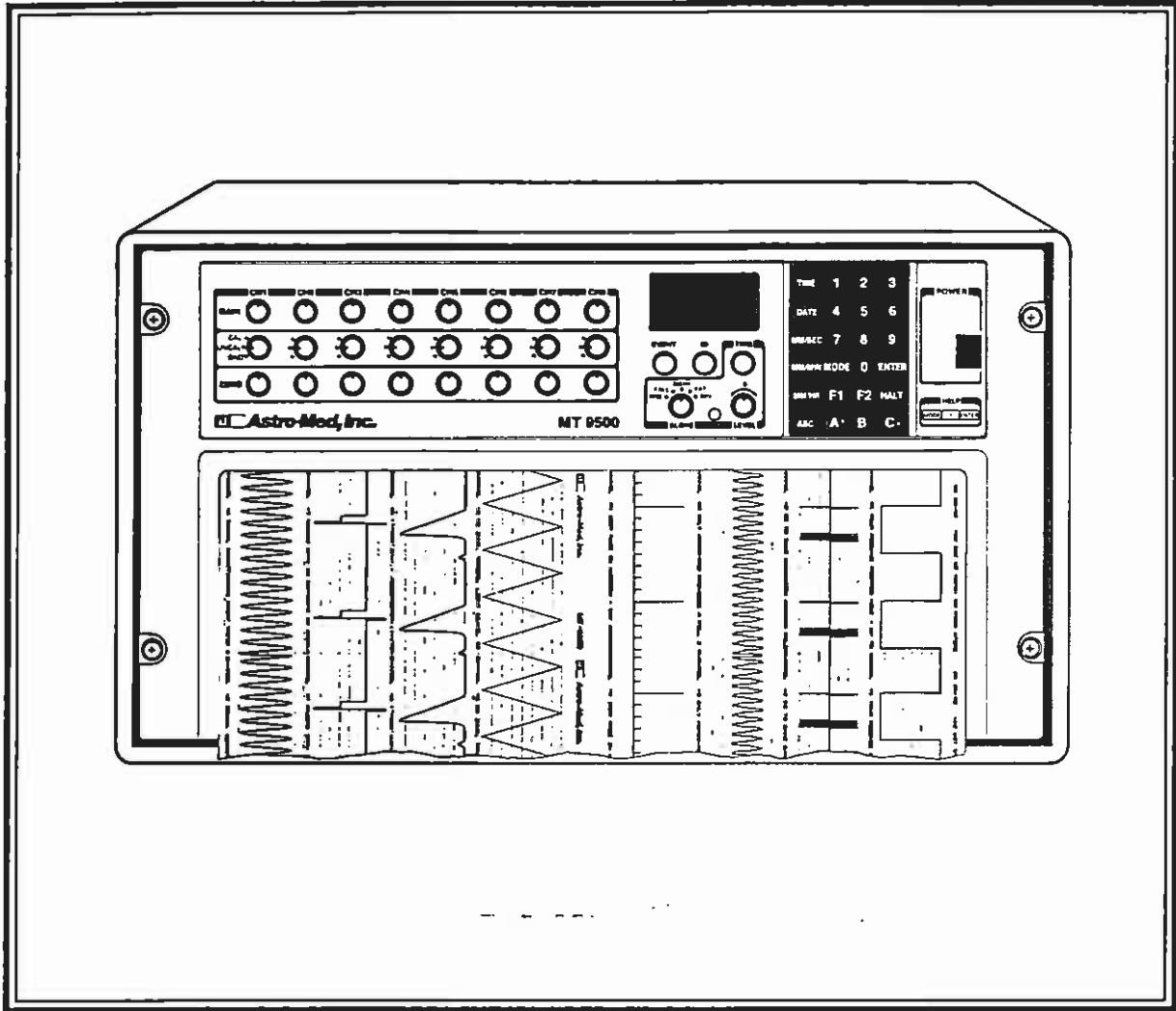

Upgraded Firmware Version:_____
(date installed: __/__/__)

Upgraded Firmware Version:_____
(date installed: __/__/__)

Upgraded Firmware Version:_____
(date installed: __/__/__)

The Astro-Med MT-9500 Recorder

Quick Guide to Recorder Operation

Please note that Astro-Med's MT-9500 oscillographic recorder is protected by U.S. Patent 4,739,344. Foreign patents are pending.

If you are an experienced user of oscillographic recorders or an adventurer who just likes to jump right in, this quick guide will acquaint you with some of the basic operations of the MT-9500 recorder. The quick guide is not meant to be a substitute for the full Operations Manual. You must read the Operations Manual to get the maximum performance from your new recorder. The quick guide will give you a glimpse at a few of the recorder's sophisticated capabilities. Have fun and take a look. When you begin to see the MT-9500's versatility, you will want to familiarize yourself will the rest of this manual to take full control of this extraordinary, new-technology instrument.

Setup the Recorder

1.   When you have unpacked your recorder and have it in place, connect the AC power cord:

   • *first to the rear-panel power input receptacle (lower left corner of the rear panel as you view it)*

   • *then to a power outlet.*

2.   Open the paper-chamber door and load the recorder with Z-fold thermal chart paper. Put the paper pack into the paper chamber with the "THIS SIDE UP AND IN FIRST" stamp pointing to the rear of the recorder. Feed the top sheet of paper into the slot beneath the rubber covered driver roller (platen) and gently push the paper through until it exits above the drive roller. Close the paper-chamber door. (If you wish, see section 3, paragraph 3-4.1 for a detailed description of this procedure.)

3. Push the POWER switch into the "on" position . The recorder will perform a series of self-tests during which the front-panel LED display will show <SELFTEST>, <PASSED>, <SCN xx.x>, and <READY>. Your recorder is ready to operate when <READY> appears on the front-panel LED display.

If you want to test the functioning of the waveform recording capabilities of your MT-9500, you can do so now. The simplest way to accomplish this is to use BNC cables to connect one or more (to a maximum of eight) signal sources to the recorder's rear-panel analog-input BNC connectors (see 3-3.12). These connectors are labeled "CH8," "CH7," etc.

See your signal conditioner manual for detailed information regarding signal conditioner/recorder connections. You should be aware that the MT-9500 is available with either of two basic analog input sensitivities. The recorder's standard A/D circuit board has a factory-set full-scale sensitivity range of ±200 mV to ±2.5 V. An optional A/D circuit board with a full-scale sensitivity range range of ±2 V to ±5 V is available.

Ask The Recorder For Help

Your recorder will give you a one page, built-in "Condensed Operations Manual" any time you ask for one. The condensed manual is very handy because it contains a great deal of valuable information. Among other things, it tells you all current parameter settings, function and mode keying sequences, operating guidelines, and firmware options installed. Lets take a look at a condensed manual.

1. Press the [MODE] key.

2. Press the [8] key.

3. Press the [ENTER] key.

When you press [ENTER], the LED display reads <HELP>. The recorder immediately form-feeds a blank sheet of chart paper and then prints a dual-sheet condensed manual. Among other things, the condensed manual will tell you the factory-installed options that your recorder contains. Check it to verify that you have received everything that you ordered. When it's finished printing, the recorder returns to a neutral state and the LED display reads <READY>. Figure QG-1 is a sample Condensed Operaations Manual.

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                    MT-9500 CONDENSED OPERATIONS MANUAL

              (Refer to your manual for complete instructions)

                                    HOW TO ACTIVATE:        NOW PROGRAMMED:
OPERATION DESIRED:                  ----------------        ---------------
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1. REAL TIME MODES

   8 CHANNEL REAL TIME RECORDER........ [MODE] [0] [ENTER]      -----
   OVERLAP REAL TIME RECORDER.......... [MODE] [1] [ENTER]      -----
   DUAL SPEED OPERATION=............... [MODE] [4] [ENTER]      OFF
                                                               TIME 1:00:00
                                                               SPD 1:025 MM/S
                                                               TIME 2:00:00
                                                               SPD 2:050 MM/S

   DATALOGGER.......................... [MODE] [9] [ENTER]
                                        CH1 LS=+0200 EE=+0; RS=-0200 EE=+0
                                        CH2 LS=+0200 EE=+0; RS=-0200 EE=+0
                                        CH3 LS=+0200 EE=+0; RS=-0200 EE=+0
                                        CH4 LS=+0200 EE=+0; RS=-0200 EE=+0
                                        CH5 LS=+0200 EE=+0; RS=-0200 EE=+0
                                        CH6 LS=+0200 EE=+0; RS=-0200 EE=+0
                                        CH7 LS=+0200 EE=+0; RS=-0200 EE=+0
                                        CH8 LS=+0200 EE=+0; RS=-0200 EE=+0

2. REAL TIME SET UPS:

   TIME................................ [TIME] [HH MM] [ENTER]     14:30:08
   DATE................................ [DATE] [MM DD YY] [ENTER]  02/04/88
   SPEED............................... [MM/Y] [X] [ENTER]         025 MM/S
   INSTA-SPEED BUTTONS................. [ABC] [MM/Y] [X] [ENTER]   A=001 MM/S
                                                                  B=025 MM/S
                                                                  C=050 MM/S

   TIMED OPERATION=.................... [F2] [3] [ENTER]          OFF
   EVENT OR ANNOTATION................. [F1] [2] [ENTER]          AAAAAAAA
   ANNOTATION ENTRY=.................... [F2] [0] [ENTER]         See next page
   SIGNAL CONDITIONER PRINT STATUS..... [F2] [8] [ENTER]         NNNNNNNN
   GRID PRINTING ON/OFF............... [F1] [1] [ENTER]          ON
   CHANNEL ORDER SET................... [F1] [0] [ENTER]         12345678
   SIGNAL POLARITY REVERSE............. [F1] [7] [ENTER]         NNNNNNNN



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OPERATION GUIDELINES:
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HALT KEY

Besides starting and stopping the MT-9500, the [HALT] key is used as an ESCAPE
key when programming various modes and set ups.  If you get "stuck" in any
menu, simply press [HALT] to escape.

MISCELLANEOUS

* Several functions offer a number of choices.  To see them, press either the
[A] or [C] keys.  When the format you want appears in the display, press
[ENTER].  Modes or functions that require the [A] or [C] key are marked on
this sheet with an (*) asterisk.

Several of the functions listed are optional.  If an option is not ordered,
the MT-9500 will display "NOT USED" for functions related to the option.
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Figure QG-1. Example of Condensed Operations Manual

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OPERATION DESIRED:                          HOW TO ACTIVATE:        NOW PROGRAMMED:
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3. DATA CAPTURE MODES

    AQUIRE SINGLE SNAPSHOT.............[MODE] [5] [ENTER]           -----
    PLAYBACK SINGLE SNAPSHOT...........[MODE] [6] [ENTER]           -----
    CONTINUOUS SNAPSHOT (untriggered)...[MODE] [2] [ENTER]         -----
    CONTINUOUS SNAPSHOT (triggered).....[MODE] [3] [ENTER]         -----

4. DATA CAPTURE SET UPS:

    ACQUISITION*......................[F1] [6] [ENTER]             CHANNELS: 8
                                                                  WINDOW: 08 K/CH
                                                                  TMEBSE:001MS/MM
    PLAYBACK*.........................[F1] [4] [ENTER]             FORMAT:   X-Y
                                                                  START AT:99%
                                                                  EXPANSION:25X
    TRIGGER CHANNEL AND LOCATION*......[F1] [3] [ENTER]            TRIGGER ON: CH 1
                                                                  WINDOW:START
    TRIGGER ON/OFF....................[F2] [4] [ENTER]             ON
    X AND Y CHANNEL SELECT............[F1] [5] [ENTER]             X=1
                                                                  Y=2

5. EXTERNAL CONTROL FUNCTIONS:

    LOCAL OR HOST CONTROL SET*.........[F2] [6] [ENTER]            LOCAL

6. OPTIONS INSTALLED IN THIS RECORDER:
AP-95    DC-95
RD-95    EM-95
IRIG     OM-95
DL-95    DI-488-95
**********************************************************************************

ANNOTATION GUIDELINES:
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Text annotation is entered by first pressing [F2] [ENTER]. Now enter the
channel number (1-8),[ENTER].  The display now contains this message: 00 67 C.
This means you are looking at location 00, at which there is an ASCII code 67,
which is an upper case "C".  To step through the buffer, press [C] to
advance, or [A] to reverse.  To jump quickly to a location, press [ABC]
then the location [00-99],[ENTER].  When editing is completed, press [ENTER].
If you edit the middle of a word or sentence, press [HALT] to escape, since
pressing [ENTER] erases anything to the right of what is in the display.

The ASCII codes supported by local text entry are as follows: (x) indicates
character not shown on display.

32   (space)   45   -      58   : (x)    71   G      84   T
33   ! (x)     46   .      59   ; (x)    72   H      85   U
34   "         47   /      60   < (x)    73   I      86   V
35   # (x)     48   0      61   =        74   J      87   W
36   $         49   1      62   > (x)    75   K      88   X
37   %         50   2      63   ?        76   L      89   Y
38   &         51   3      64   @        77   M      90   Z
39   '         52   4      65   A        78   N      91   [
40   ( (x)     53   5      66   B        79   O      92   \ (x)
41   ) (x)     54   6      67   C        80   P      93   ]
42   *         55   7      68   D        81   Q      94   ^ (x)
43   +         56   8      69   E        82   R      95   _
44   ,         57   9      70   F        83   S
```

Figure QG-1. Example of Condensed Operations Manual (continued)

4-QG

Try Some Real-Time Recording

1.   **Press the [MODE] key on the recorder's front-panel keypad.**

     *When you press the [MODE] key, the LED display reads <8 CH RT>
     indicating that the MT-9500 is ready to begin eight-channel real-
     time recording.*

2.   **Press the [ENTER] key.**

     *The recorder immediately begins recording eight channels of
     real-time analog waveform data. The MT-9500 has numerous
     factory-set default operational parameters that you can alter.
     Right now, the recorded charts will reflect the factory default
     parameter settings. When the MT-9500 begins recording, the
     front-panel LED display will show the time in 24-hour format.
     (You may need to set the clock to the correct time. That process
     is described a little further below.)*

3.   **If you want to stop the recorder while it is operating,
     press the [HALT] key.**

     *The LED display will read <HALTED>. Chart paper will stop
     coming out of the recorder and the instrument will wait in a
     neutral state.*

4.   **If you want to resume recording, press the [HALT] key
     again.**

     *Again, the recorder will immediately begin to perform eight-
     channel real-time recording. The LED display will show a time
     reference in 24-hour format.*

5.   **Let's suppose you have noticed some data that interests you
     and you would like to mark the chart quickly to examine the
     data later. Press the front-panel EVENT pushbutton.**

     *The recorder automatically prints an event marker on the far
     right side of the chart as viewed from the front of the instrument.
     When you press the EVENT pushbutton, the event marker deflects
     to the left and stays deflected until you release it. This is a fast,
     simple method to note interesting data.*

6. Want to stop the recorder and exit the eight-channel real-time mode (Mode 0)? If so, press the [HALT] key and then press [ENTER]. If the recorder is already halted, just press the [ENTER] key.

    The recorder will stop running and the LED display will read <READY> indicating that MT-9500 is ready for another use.

Try A Little More Recording

If your recorder is equipped with the Overlap option (OM-95), you can easily overlap the eight individual channels of analog waveforms in two channels each containing four waveforms. Let's see what overlapped recording looks like.

1. Press the [MODE] key.

2. Press the [1] key. Notice that the LED display reads <OVLAP RT> indicating overlap real-time recording.

3. Press the [ENTER] key.

    The recorder immediately begins to produce two groups of over lapped waveforms with four channels in each group.

    You can quickly and easily identify each waveform by pressing the front-panel ID pushbutton. Each time you press the ID button, the recorder marks each waveform with its channel number. You never have to be confused by an overlapping chart.

4. Press the [HALT] key to stop the recorder and press the [ENTER] key to exit the mode while halted. You can always use the [HALT] / [ENTER] sequence to exit the mode.

If your recorder is equipped with the Datalogger option (DL-95), you can have your analog waveform data converted and played out as engineering units of your choice. Use the steps below to have the recorder produce datalogger charts.

1. Press the [MODE] key.

2.   Press the [9] key. Notice that the LED display reads
     <DATA LOG> indicating that you are about to enter the
     Datalogger mode.

3.   Press the [ENTER] key.

     *The recorder immediately produces eight columns of numbers
     instead of analog waveforms.*

4.   Use the [HALT] / [ENTER] sequence to exit the mode.

Set The Recorder's Clock and Calendar

It is easy to set the recorder's clock and calendar to the current time and
date. This will give all of the recorder's functions an accurate time
reference.

1.   To set the clock:

     •   press the [TIME] key on the front-panel keypad

     •   press any four numeric keys on the keypad to represent
         the current time in 24-hour (24:00) format.

         *In 24-hour format, midnight has a value of 24:00 and noon
         has a value of 12:00. So, for example, 1:00 am would be
         01:00 in 24-hour format. 2:45 pm would be 14:45, etc.*

     •   press the [ENTER] key

2.   To set the calendar:

     •   press the [DATE] key

     •   press any six numeric keys (use leading zeros as necessary)
         on the keypad to represent the current date in
         standard American form: month/day/year (mm/dd/yy)

     •   press the [ENTER] key

Get Caught Speeding

You can change the chart-paper speed anytime during real-time recording. You can also make use of three "insta-speeds" that you can program and invoke when you desire. Let's try altering chart-paper speed.

1. Press [MODE] and then [ENTER] to start eight-channel real-time recording.

2. While the recorder is either running or halted, press the [MM/SEC] key on the front-panel keypad. Notice that the LED display shows the current speed in millimeters per second, <MM/S>.

3. Press up to three numeric keys to represent the chart speed in millimeters per second that you want. Currently, a maximum speed of 200 mm/s is standard on the MT-9500. A maximum speed of 500 mm/s is available as an option.

4. Press the [ENTER] key.

   The chart paper immediately begins to run at the speed you just programmed.

If you desire, customize the settings of the [MM/MIN] and [MM/HR] keys in the same way.

You can also make use of three preset insta-speeds. These are accessed through the [A], [B], and [C] keys of the front-panel keypad. Whenever you are recording in real-time, just press any of these keys to change chart paper speeds. The [A], [B], [C] keys are preset to speeds of 1, 25, and 50 mm/s respectively. You can change them to speeds of your preference by following the steps below.

1. While the recorder is either halted or running in a real-time mode, press the [ABC] key. This is the single key with three letters on it.

   The LED display will read <A, B OR C>.

2. Press the individual insta-speed key, [A], [B], or [C], that you want to reprogram.

3. Press either the [MM/MIN] or [MM/HR] keys if you want
    your charts to run in millimeters per minute or hour instead
    of millimeters per second. The recorder is preset to run
    charts in millimeters per second.

4. Press any three numeric keys to specify the new speed you
    want to enter.

5. Press the [ENTER] key. The insta-key you chose has been
    reprogrammed. If you desire, follow the same procedure to
    change the other insta-speed keys.

Annotate Your Charts

There is space for an annotation buffer between each of the recorder's
eight channels. If your recorder has the Alphanumeric Printing option
(AP-95), you can enter 100 characters of text into each of these individual
interchannel buffers to custom "label" them or annotate them in any way
that is useful to you. You can annotate interchannel buffers in any of
three ways:

- with Astro-Med's optional keyboard accessory (KB-220)
- through the controls of a host computer
- through the recorder's front-panel keypad

Let's use the front-panel keypad to enter some text into an interchannel
buffer.

1. Press the [F2] key and notice that the LED display reads
    <EDIT CH>. You are about to edit a buffer by entering it
    and changing its content.

2. Press the [ENTER] key and the display reads <BUFFER ?>.
    What buffer do you want to edit? Let's try buffer 1.
    Press numeric key [1].

3. The LED display now reads <BUFFER 1>. Press the [ENTER]
    key to access the buffer. The display changes when you
    press [ENTER] and now reads <00 67 C>. Each buffer is
    preset to print a channel label: "CHANNEL 1,"
    "CHANNEL 2," etc.

<00 67 C> is actually just a simple message. The recorder is telling you that you have arrived at location 00 of buffer 1. This is the first location of the buffer. (Each buffer has a hundred buffer locations from 00 to 99.) The second number, 67, tells you that ASCII code 67 is in buffer location 00. The third character, C, is the letter that ASCII code 67 stands for. This character, C, will be printed in the buffer 1 at location 00.

The idea is that you can access each buffer location and put in the letter, number, or symbol of your choice. The only restriction is that you have to choose your alphanumerics from the list of ASCII codes and their character equivalents in the Condensed Operations Manual.

4. **Let's change the "C" in location 00 to a "T". Look at the list of ASCII codes on the Condensed Operations Manual and see that ASCII code 84 equates to the letter T. Press numeric keys [8] and [4]. Notice that the LED display has changed to read <00 84 T>. The letter T will now be printed as the first character in buffer 1.**

5. **Lets go to buffer 1 locations 01, 02, and 03 and change them to spell the word "TEST." To go to the next buffer location you can either press the [C] key to advance space by space through the buffer or press the [ABC] single key. (You can scroll backwards space by space through the buffer by pressing the [A] key.)**

When you press the [ABC] key, the display reads <GO TO 00>. Just press the number(s) of the location you want to go to. In this case press [1] and then press [ENTER]. When you press [ENTER], the LED display shows you buffer location 01 and the ASCII code and character currently there.

When you get to location 01, press numeric keys [6] and [9] to enter ASCII code 69 in the location. This equates to the letter <E>.

Use either the [C] or [ABC] key to go to location 02 in the buffer. Press keys [8] and [3] and the letter <S> is shown.

Use either the [C] or [ABC] key to go to location 03 in the buffer. Press keys [8] and [4] and the letter <T> is shown.

You have just spelled the word "TEST" in the first four character spaces of buffer 1. You can access every location of every channel in the same way. Just use the same procedure and edit away. When you're finished editing, press the [ENTER] key and your data are entered and saved. If you press [MODE] [ENTER] and print some waveforms, you will see your annotations on the chart in buffer 1.

About Taking A Data Snapshot

Your recorder needs the Data Capture option (DC-95) to capture, store, and replay waveform data (take a data snapshot). This option enables the recorder to store and replay a maximum of 128,000 sample points of waveform data.

The Data Capture mode is extremely powerful and useful. There are actually four data-capture modes. Because it can do so much, it is difficult to summarize its many features and the procedures by which they can be accessed and used. There is just too much information to be usefully abbreviated.

Instead, let's outline:

- the kinds of information you have to enter into the recorder to take a data-snapshot and

- the format options available when captured data are replayed.

Before you can take a data snapshot, you have to tell the recorder:

- the conditions that will cause a snapshot to be taken

- the size of the snapshot you want taken

- the format in which you want the snapshot printed out

To do this, use the [F1] and [F2] function keys. If you press either the [F1] or [F2] keys and then successively press numeric keys [0] through [9], the LED display will show a variety of operational parameters. For data capture, the most important parameters include:

<DEF TRIG>	[F1] [3] [ENTER]
<DEF PLAYBACK>	[F1] [4] [ENTER]
<SET X - Y>	[F1] [5] [ENTER]
<DEF SAVE>	[F1] [6] [ENTER]
<TRIGGER>	[F2] [4] [ENTER]

These parameters let you:

- define the trigger
- define the playback
- select two channels to be presented as an X - Y plot or a two channel snapshot
- define the "save" (the snapshot window)
- turn the trigger on or off

When you have set all of these parameters, the recorder recognizes what you want captured and how you want the playback to look.

The MT-9500 can replay snapshots in any of four formats:

Eight separate channels of analog waveforms

X - Y plots of any two waveforms

Eight separate channels of numeric tables scaled from the analog waveform signals (DL-95 required)

Two wide grids each containing four overlapped waveforms (OM-95 required)

Let's take a look at one kind of data capture: continuous untriggered snapshots. In this mode the recorder will continuously capture and playback data snapshots according to the setups that you have established. Because we haven't defined any setups, the recorder will operate using factory-set defaults.

1.   Press [MODE].

2.   Press the [2] key. Notice that the LED display reads
      <CON SS U> indicating that the recorder is about to enter
      the "continuous snapshot untriggered" mode.

3.   Press the [ENTER] key. As soon as you press [ENTER], the
      LED display will read <ACQUIS> meaning that the
      recorder is performing a snapshot acquisition.

      *After the snapshot has been taken, the recorder will
      automatically replay the data. The LED will change to read
      <PLAYBACK>.*

      *After playback, the recorder will perform another acquisition and
      another playback. With each cycle, data from the previous capture is
      replaced by data from the new capture. This cycle will continue until
      you press [HALT].*

      *Halt the recorder any time by pressing the [HALT] key. Exit the
      mode by using the [HALT] / [ENTER] sequence. The LED display
      will read <READY> and the recorder will wait for further operating
      instructions.*

Read Your Full Operations Manual

The MT-9500 makes all of its functions available with pushbutton ease.
However, you do have to know what buttons to push and why you are
pushing them. The Operations Manual has been written to give you this
information clearly and concisely. Please take the time to read it as you
acquaint yourself with your recorder. When you have read the manual,
the recorder will become a powerful and versatile work partner.

Section 1
Introduction

1-1 About This Manual

The purpose of this manual is to provide you with all the information required to operate your Astro-Med Multi-Task MT-9500 recorder as a stand-alone instrument. Control of your recorder through a remote host computer is discussed in the <u>MT-9500/MT-8800 Host-Control Operations Manual</u>. Maintenance of your recorder is detailed in the <u>MT-9500 Maintenance and Service Manual.</u>

This manual discusses all of the functions, features, and capabilities of your recorder. Separate sections of the manual discuss recorder installation, operation, and theory of operation. Appendix C of the manual presents a group of schematic and dimensional diagrams.

1-2 Highlights of Recorder Operation

A true New-Technology recorder, Astro-Med's MT-9500 digitally processes incoming analog data with 12-bit accuracy. The recorder's high-resolution dual thermal printheads replace inks and mechanical styli. The elimination of mechanical components and inks results in printed waveforms that precisely reflect the original signals. Recording directly onto Z-fold thermal-paper packs or thermal-paper rolls, the printheads create any of several possible grids as they simultaneously print waveforms. The simultaneous printing of both waveform and grid results in total correlation between recorded waveforms and the selected grid. Chart drift error is simply eliminated.

Sampling analog-signal inputs at the rate of 30 kHz per channel, the recorder can represent signals as short as 200 microseconds. Uniform amplitudes and sharp waveform traces are recorded in each channel over the recorder's impressive DC to 5 kHz real-time frequency-response range. The MT-9500 uses a sophisticated crystal-referenced stepper motor drive system to advance the chart paper through the recorder. The stepper motor provides a wide variety of chart-paper speeds. Chart-paper speeds from 1 mm/ through 100 mm/hour, minute, or second can be selected. A maximum paper speed of 200 mm/s is standard on MT-9500 recorders. If ordered as an optional feature, an enhanced maximum chart-paper speed of 500 mm/s is available.

Uncommon versatility and user-friendliness result from your ability to toggle rapidly between the recorder's extensive functions. A digital data input connection eliminates any need for analog-to-digital (A/D) converters and, in host-control, permits recording of a maximum of 32 digital waveforms. Standard RS-232 and IEEE-488 ports facilitate control of most recorder capabilities either by host computer or by optional keyboard.

1-2.1 General Real-Time Recording Features

The MT-9500 is an exceptionally versatile digital, high-speed oscillographic recorder and data-capture system. The functions of the recorder are performed in either of two primary operational modes: *Real-Time Recording* or *Data Capture and Playback*. Operating with state-of-the-art electronics, high-resolution dual thermal printheads, and powerful proprietary software, the recorder is equipped with the following real-time operating modes:

Eight-channel, real-time recording. Produces eight 40 mm-wide channels of analog waveforms.

Dual-speed recording. Toggles between two predefined chart speeds.

Formfeed the chart paper. Advances chart paper to the next sheet.

Help mode. Produces an MT-9500 Condensed Operations Manual.

These capabilities can be greatly expanded by the addition of the options and accessories discussed throughout this manual and, in particular, in paragraphs 1-5 and 1-6. In all cases where option-dependent recorder modes and functions are discussed in this manual, the required options or accessories are clearly identified. A full description of real-time recorder operation is contained in paragraph 3-5.

Please be aware that this manual discusses all recorder modes and functions including all optional modes and functions. Your recorder will perform only the modes and functions for which it has been equipped. Obviously, if you have not ordered the required option, your recorder will lack the particular mode or feature being described.

1-2.2 General Data Capture and Playback Features

The data-capture mode requires installation of the Data-Capture option, DC-95.

The recorder is impressive in its capacity to capture and instantly replay transient data. In the data-capture mode, waveform data are stored in the MT-9500's 128k data-sample random access memory (RAM). When the memory is filled, data are printed at speeds much slower than the original signal. The result is a slow-motion waveform replay allowing thorough examination of high frequency waveform data.

Data capture results from either a user-initiated, on-demand "immediate snapshot" or from a user-defined, automatic "triggered snapshot."

Immediate-snapshot data capture is accomplished manually by pressing the front-panel trigger button.

Triggered-snapshot data capture is performed by adjusting the recorder's convenient front-panel slope and sensitivity controls to respond to a preset voltage and waveform edge. You can specify the capture of pre-trigger, post-trigger, or center-trigger data. In addition, you can specify window time, buffer size, 2 or 8 channel data format, and replay mode.

The data-capture modes are listed below. These modes and their associated functions are fully discussed in paragraph 3-6.

Acquire Single Snapshot. The recorder captures one snapshot.

Playback Single Snapshot. The recorder replays a single snapshot in any of several playback formats.

Continuous Untriggered Snapshot. The recorder continuously and automatically captures and prints snapshots without reference to triggers.

Continuous Triggered Snapshot. The recorder continuously and automatically captures and prints snapshots whenever user-defined triggers are detected.

1-3 Recorder Configurations

The MT-9500 recorder is generally furnished in one of the following three configurations:

MT-9500R   Rack-mounting. The recorder is provided with the rack slides and mounting hardware required for installation in standard 19-inch rack-mount cabinets. No recorder case is provided with this model.

MT-9500   Cased. The recorder is installed in a protective, portable bench-top case.

MT-9500C   Cased with card cage. The recorder and a companion signal conditioner card cage are provided in a configuration specifically designed to integrate both units in a single protective bench-top case.

Naturally, you are not limited to chosing from these three recorder configurations. Any combination of recorders, signal conditioners, cases, etc. can be ordered. When this manual refers to the "MT-9500", it is referring to the generic recorder and not to any particular recorder configuration.

All models of the MT-9500 recorder have the features listed below.

- Eight 50-division channels
- System channel
- One event marker
- Channel ID pushbutton
- IEEE-488 and RS-232 computer interfaces
- Nonvolatile random access memory (NVRAM) for backup of functions and text only
- Battery back-up for time and date
- Technical documentation supporting Operation, Maintenance, and Host-Control Operation
- Operating diskette for host-control operation
- Dual Speed Mode
- Condensed Operations Manual printout feature
- Full two-year warranty

1-4 MT-9500 Physical/Functional Specifications

Table 1-1 lists the principal physical and functional characteristics of the MT-9500 recorder.

1-5 Options

The versatility of the MT-9500 recorder can be enhanced by the addition of any of a variety-of optional features. Table 1-2 is a complete list of options available for the recorder. The options listed below and their functions are discussed more fully in section 3 of this manual, "Operation." Hardware accessories for the instrument are discussed in paragraph 1-6, "Accessories."

1-6 Accessories

The MT-9500 is supported by a variety of functional, durable, and attractive hardware accessories. With the equipment discussed below, you can adapt your instrument to the specific requirements of your recording environment. Table 1-3 lists and briefly describes each accessory. Individual accessories are defined in greater detail in the subparagraphs that follow. Please consult the individual user manuals that are supplied with Astro-Med signal conditioners and signal-conditioner card cages for information regarding the use of these products with the MT-9500 recorder. Appendix A provides a list of Astro-Med signal conditioners and their specifications.

Table 1-1. MT-9500 Physical/Functional Specifications

Dimensions	Bench version: 20" (508mm) wide x 11-1/2" (292mm) high x 18-1/2" (470mm) deep
	Rack-mount version: 19" (483mm) wide x 10-1/2" (266.7mm) x 17-1/2" (445 mm) deep
Weight	65 pounds (29.5 kg)
Power Requirements	Line: 95 - 132 VAC 190 - 264 VAC 48 - 440 hertz* 600 watts *Consult factory for operation above 66 hertz.
	Fuse: 120 volts, 6 amperes (250 V) 240 volts, 3 amperes (250 V)
Recording Method	Direct-writing thermal array Resolution: 200 dots/inch across paper width
Paper	Low-cost, permanent, black-imaging thermal paper
Paper Width	15.3 inches (388 mm)
Paper Length	Z-Fold Pack: 500 sheets (458 ft/140 m), individually numbered in descending order
	Roll: 500 foot (Rewinder accessory required)
Trace Width	0.01 inch nominal (2 dots)
Paper Travel Direction	Top to bottom
Paper Exit	Front

Table 1-1. MT-9500 Physical/Functional Specifications (continued)

Number of Channels	Analog Waveform: 8 Digitized Waveforms (optional): 32 Alphanumeric Annotation (optional): 8 System Log: 1
Channel Grid Format (Analog)	Eight 40 mm or two 160 mm grids (optional) corresponding to mode selection. Printed simultaneously with waveform data.
Frequency Response	DC to 3 khz, down 1 dB DC to 5 khz down < 3 dB, full scale
A/D Resolution	12 bit
Analog Input	10 mV per division ±5 V full scale max without signal conditioners (optional)
Digitized Input (optional)	Digital input on rear panel. For complete information, see the MT-9500 Host Control Operations Manual.
Operating Modes	Real Time (a) 8 channels on individual 40 mm grids (b) 2 sets of 4 channels, each overlapped on two 160 mm grids (optional) (c) Datalogger numeric values of wave forms calibrated in user-specified engineering units (optional) Data Capture (optional) (a) On-demand "snapshot" from front panel pushbutton. (b) Transient capture triggered by voltage level external TTL low or switch closure.

Table 1-1. MT-9500 Physical/Functional Specifications (continued)

Operating Modes (continued)	*(c)* Memory size: 128k samples total (16k/channel for 8, 64k/channel for 2) Time base ranging from 1 to 100 ms/mm *(d)* Trigger/Window: variable from 1% to 100% for complete pre- or post-trigger viewing of data Memory type: circular buffer Resolution: 12 bit <u>Data Playback Choices (optional)</u> *(a)* 8 signals on separate 40 mm-wide grids *(b)* 4 signals overlapped on 160 mm-wide grids *(c)* Any 2 signals as X-Y plot *(d)* Datalogger numeric values of waveforms calibrated to your engineering units
System Log Channel	Automatically prints hour, minute, second, day, month, year, chart speed, and time scale in ms/mm. Prints recording mode on each page.
Annotation (optional)	8 annotation channels to identify waveforms. 100 character buffer provides 40 characters for signal conditioner reporting and 60 characters for customer use.
LED Waveform Display (optional)	Displays signal positions of all 8 channels Standard: 19"(483 mm) Rack mounting: 1.75"(44.4 mm) high
Event Markers	1 standard, 8 optional
IRIG Time Code (optional)	Accepts modulated or demodulated IRIG A,B,H, and NASA 36. Prints IRIG time (in place of internal clock) in system log channel
Computer Interfaces	RS-232 and IEEE 488

Table 1-1. MT-9500 Physical/Functional Specifications (continued)

Signal Polarity Inversion	Polarity reverse of channels controllable from the front panel
Front Panel Controls	*(a)* "Zero," "Gain," "Cal" for 8 waveform channels *(b)* "Help" keys print condensed operating instructions on demand *(c)* Event marker push-button *(d)* ID push-button to identify overlap or separate channels by number on the waveform *(e)* Data capture controls for "Trigger," "Slope," and "Level" *(f)* Keypad for setting time, date, speeds, text entry, modes, and functions. *(g)* Power On/Off
Paper Speeds	Every integer from 1 to 100 in mm/s, mm/min, mm/hr and 200 mm/s by means of a crystal-reference stepper motor. 500 mm/s available on special order.

Table 1-2. Options for the MT-9500 Recorder

Option	Description
DC-95	**Data Capture option.** This option provides memory for the acquisition and storage of 128,000 (128k) sample waveform-data points.
AP-95	**Alphanumeric Printing option.** This option provides eight 100-character text buffers for chart annotation and enables signal conditioner reporting.
EP-95	**Enhanced Performance option.** This option increases the waveform density that can be printed full scale simultaneously in all eight channels.
EM-95	**Event Marker option.** This option provides eight TTL-low/switch-closure event channels in addition to the recorder's standard single event marker capability (9 total).
OM-95	**Overlap Mode option.** This option allows the recorder's eight channels to be overlapped four each on two expanded grids.
OG-95	**Optional Grid.** This option provides 50-division grids in 8-channel mode instead of the recorder's standard 40-division grids.
IRIG-95	**IRIG option.** The IRIG option allows the recorder to decode modulated or demodulated IRIG A, B, H, or NASA 36 time codes and print text on chart.
DI-488-95	**Digital Interface option.** This option allows the recorder to accept and record a maximum of thirty-two digitized waveforms through its standard rear-panel IEEE-488 interface.
DL-95	**Datalogger option.** This option enables the recorder to scale waveforms into tabular lists of user-specified engineering units.

Table 1-3. Accessories for the MT-9500 Recorder

Accessory	Description
LA-95	A light-emitting diode (LED) display that presents the positions of all eight analog inputs in real-time. Allows precise calibration of waveform zero position.
RW-95	A chart rewinder that provides a 500-foot roll chart supply and take-up reel. Self-contained motor and power supply. Separate AC power cord.
WT-95	A sloped-front writing surface that attaches to the recorder to facilitate handwritten annotations to and viewing of recorded chart data.
PT-200	A rack-mounting, 5 1/4-inch paper take-up drawer for use with Z-fold paper. Includes slides and mounting hardware.
RC-95	A roll-around cart.
AN-95	A common-carrier rated travel case.
KB-220	A full size QWERTY keyboard with right side numeics and 2-x 40 character LCD. Connects to RS-232 port. Facilitates entry of annotation text and command of operational controls.
TC-2500	A powerful, high performance 8-channel data capture system. 4-megabyte memory. Sample rate of 2 megahertz per channel. Host programmable.
ASC Series Signal Conditioners	A complete family of Astro-Med signal conditioners adapts the MT-9500 to specific applications. Each conditioner is complete with all controls required for its particular function. See appendix A for a complete list of Astro-Med signal conditioners and their specifications.

Table 1-3. Accessories for the MT-9500 Recorder (continued)

Accessory	Description
C-950 Card Cage	A stand-alone, portable benchtop enclosure that accepts a maximum of eight ASC series plug-in signal conditioners. The signal conditioners are not included.
C-950R Card Cage	A stand-alone, 19" rack-mounting version of the C950 card cage. Accepts a maximum of eight ASC series plug-in signal conditioners. The signal conditioners are not included.

1-6.1 LED Display (LA-95)

The LED Display (LA-95 option) is a light emitting diode (LED) array that presents a dynamic display of signal frequency and amplitude for each of the MT-9500's eight channels. The accessory is 19-inches wide, 1 3/4-inches high, and 7-inches deep.

As shown in figure 1-1, the LA-95 consists of two rows of channel indicators. Each row has four channel indicators. Each channel indicator is made up of 30 individual LEDs. Channel indicators 1, 3, 5, and 7 are above and indented to the left of the lower row of indicators for channels 2, 4, 6, and 8.

The LA-95 accessory connects to the MT-9500 through the recorder's LA-95 jack. This connection powers the accessory and carries the logic levels that drive each LED channel indicator. Because the LED displays use the same data as the recorder's digital printhead, a fixed relationship exists between charted waveform traces and their positions on the LED displays.
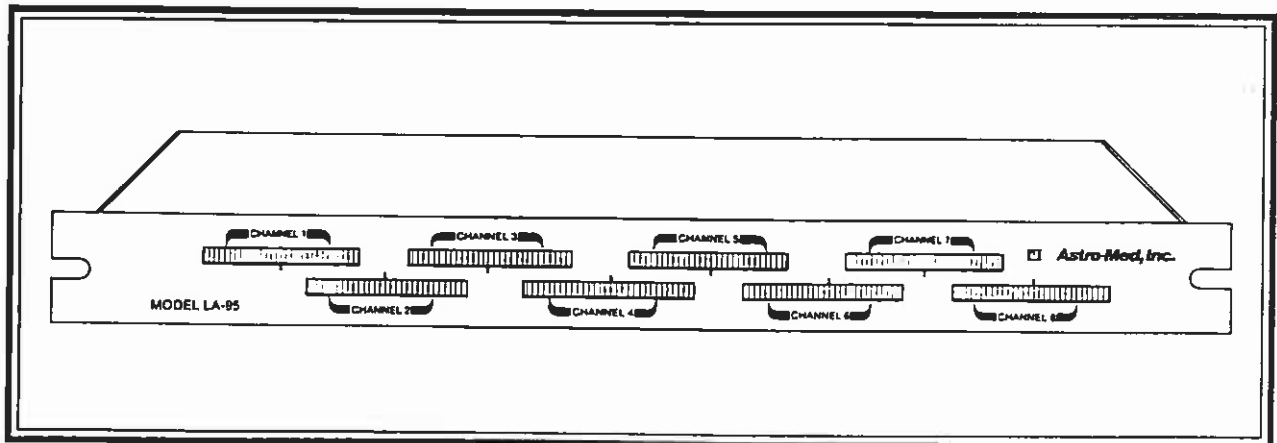

Figure 1-1. LA-95 Accessory (LED Display)

In certain respects, the channel indicators of the LA-95 actually provide more waveform information than charted waveforms. The first three LEDs and the last three LEDs of each channel indicator register waveform signals that are off (left or right) of the corresponding chart-paper channel. This allows you to see where waveform data are going off-scale and, consequently, where signal gain or zero adjustment may be necessary. In addition, the channel indicators of the LA-95 can be used to center waveform trace outputs in each of the recorder's eight channels. This is accomplished easily by using either of two methods.

The recorder's ZERO controls can be used to move the signals until LEDs 15 and 16 of the selected channel indicator are equally illuminated and slightly flickering. This will center the waveform trace. Alternatively, the panel above the LEDs is screened with a scale that identifies each channel midpoint as well as channel extremes. This provides a visual reference for centering the waveform.

1-6.2 Rewinder (RW-95)

The Rewinder (RW-95 option) is a spooling device that automatically winds chart paper maintaining proper paper-tension as chart paper exits the recorder. The rewinder is a self-contained assembly that mounts directly to the underside of the recorder. The attached recorder and rewinder can be used with or without bench or rack enclosures.

Figure 1-2 illustrates the Rewinder option. The rewinder is 21 1/4-inches deep, 17 1/2-inches wide, and 5 1/4-inches high. The take-up reel of the rewinder accepts a maximum of 500 feet of chart paper. Power is supplied to the accessory through a 115-volt line connection. An on/off pushbutton is located on the lower-left front corner of the rewinder. The on/off pushbutton illuminates when depressed. The rewinder has a constant-torque motor that applies a constant tension to the chart paper. The motor is compatible with all recorder chart-paper speeds.
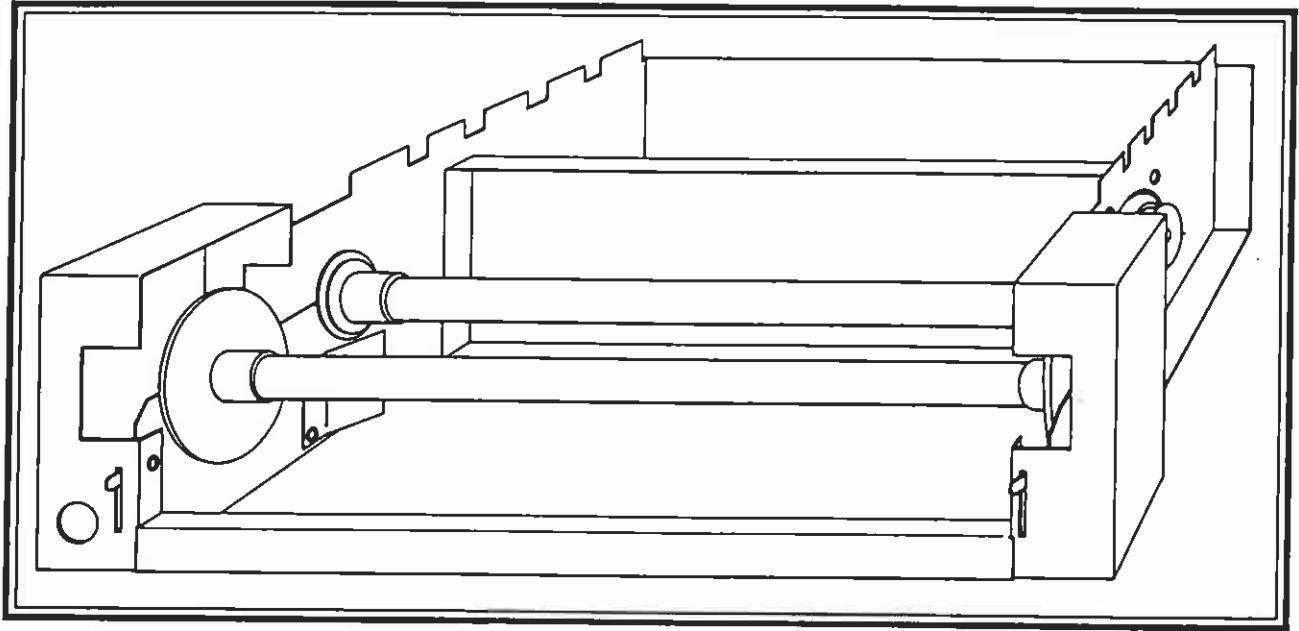
Figure 1-2. RW-95 Accessory (Rewinder)

1-6.3 Writing Table (WT-95)

The Writing Table (WT-95 option) is an easily attached or removed sloped-front chart-annotation surface. Triangular in profile (figure 1-3), the Writing Table is 18 7/8-inches wide and 7 1/4-inches deep. Four bracket supports secure the writing table to the MT-9500 front panel. The front edge of the writing table consists of a 16 1/4-inch roller 3/4-inch in diameter. When used with the Rewinder (RW-95 option) the writing table's front roller ensures a smooth flow of chart paper onto the Rewinder's take-up spool. If the writing table is used without the Rewinder option, the chart paper is discharged across the writing surface and accumulates either on the floor or, if supplied, in a paper take-up drawer (PT-200).
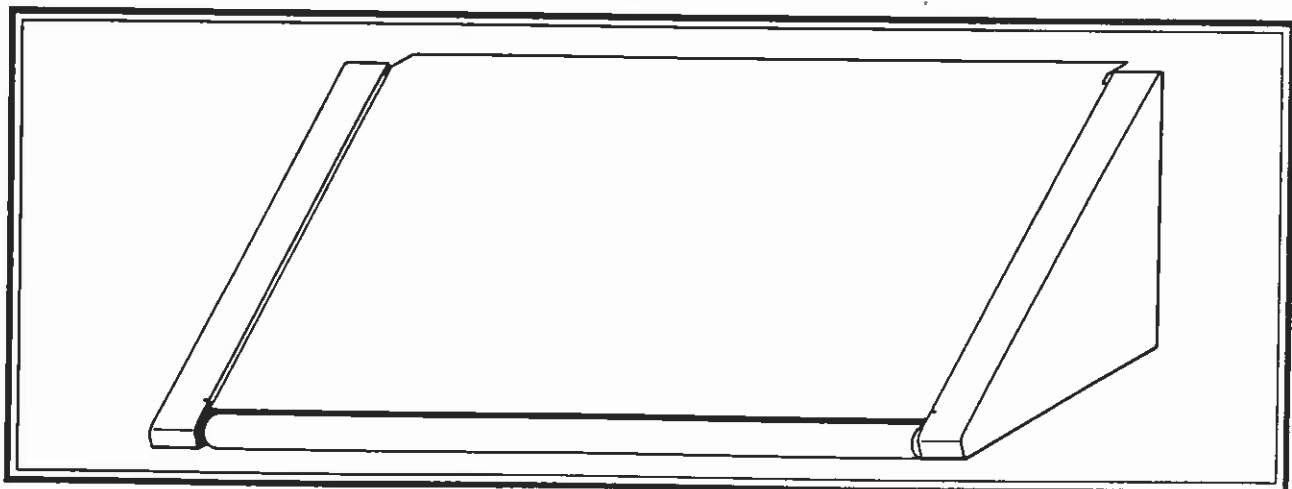

Figure 1-3. WT-95 Accessory (Writing Table)

1-6.4 Paper Take-Up Drawer, Rack Mount (PT-200)

Designed for use with any of Astro-Med's rack-mounted recorder
configurations, the Paper Take-Up Drawer (PT-200 option) is used for the
accumulation and storage of thermal Z-fold chart paper as it is discharged
from the recorder. The drawer (shown in figure 1-4) is 19-inches wide,
5 3/16-inches high, and 17-inches deep. The accessory is provided with the
slides, screws, and nuts required for attachment to a variety of 19-inch
racks. When in use, the drawer opens to 12 inches to catch and store the
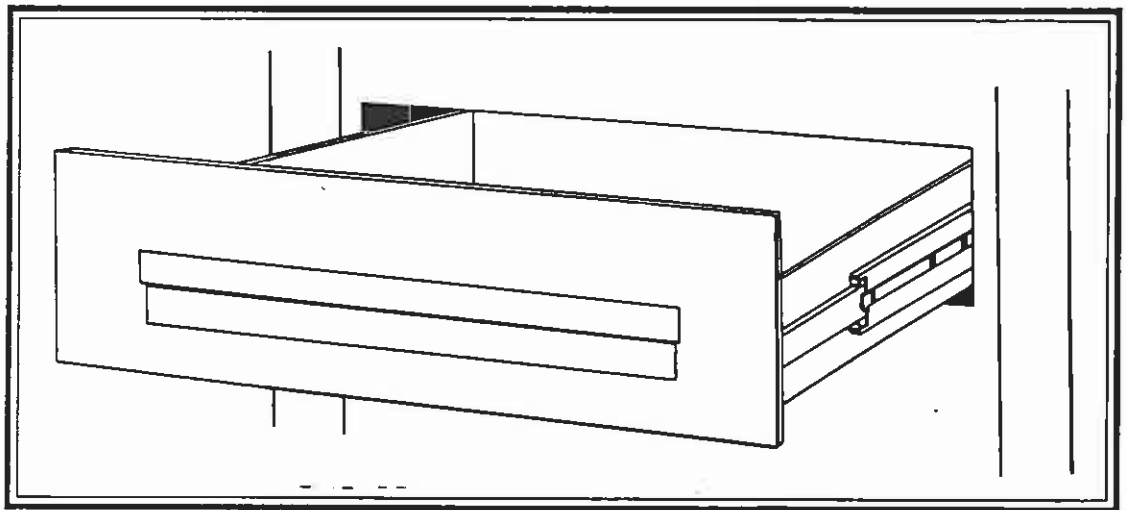exiting Z-fold chart paper.

Figure 1-4. PT-200 Accessory (Paper Take-Up Drawer)

1-6.5 Roll-Around Cart (RC-95)

The RC-95 option is a sturdy, moveable cart with 5" caster wheels. It is
equipped with drawers and is designed to hold the MT-9500 recorder
(in its bench-top case). The drawers can either be used for storage or for
paper take-up.

1-6.6 Travel Case (AN-95)

The AN-95 option is a rugged carrying case designed for transporting the
MT-9500 in the recorder's uncased configuration (MT-9500R). The travel
case is 24-inches long, 21-inches wide, and 15-inches high. The top and
bottom of the case are hinged at the rear. When closed, the case is secured
with two front latch mechanisms. All exterior corners and seams of the case
are reinforced with heavy-gauge aluminum sheathing. The case can be lifted
or positioned using any of five handles. One handle is located on the front of
the case. The right and left sides of the case eachfeature two adjacent
handles. All interior surfaces of the AN-95 are lined with two inches of
cushioning foam custom fitted to the profile of the recorder.

1-6.7 Rack Enclosures

To satisfy the diverse requirements of our customers' many recorder/
peripheral equipment configurations, Astro-Med offers a varied line of
rack enclosures. From the 79.7-inch tall FME-10 to the 62.3-inch tall
FME-5, Astro-Med rack enclosures can accommodate virtually any
equipment combination. Astro-Med installs all internal rack-hardware as
required by the equipment choices of the specific customer order. Please
contact us with regard to your particular enclosure requirements and we
will be happy to suggest the protective enclosure that may best suit your
needs.

1-6.8 Test and Calibration Diskette

A test and calibration diskette is packaged with your manual. A hardcopy
playout of the contents of the diskette is also included. These items comprise
appendix D of this manual. The diskette is written in BASIC and contains
two files. The diskette provides a means for checking the functionality of the
RS-232 and IEEE-488 computer interfaces. Recorder calibration through
host control is also addressed on this diskette. These materials are essentially
relevant to host-control operation of the MT-9500. Please refer to the
MT-9500 Host Control Operations Manual for further information regarding
these items.

1-7 Getting Started

The powerful functions of the MT-9500 are easily accessed through the recorder's front-panel keypad. However, before proceeding to the operation of the recorder, it is first necessary to unpack and set-up/install your unit. These procedures are presented in detail in the next section of this manual, "Installation."

Section 2
Installation

2-1 Setup Upon Receipt

Whether your Astro-Med MT-9500 is to be rack mounted or installed in a bench-top cabinet, the recorder requires minimal setup upon receipt. If you have ordered a rack-mount or benchtop cabinet configuration of the recorder, note that the recorder is packaged separately from its enclosure. Installing your recorder in a rack or cabinet is straightforward and is fully described in paragraphs 2-2 through 2-2.11 below.

At this point, let's discuss unpacking the recorder and its associated hardware.

The recorder is double boxed. It is protected in the inner box by a "sandwich" of foam packing. The recorder's associated hardware is located along each side of the inner box in convenient spaces created by the foam packing material. The associated hardware shipped with the recorder consists of:

- one grounded power cord
- one 500-sheet packet of Z-fold thermal paper
- one MT-9500 Operations Manual
  (with test and calibration diskette insert)
- one MT-9500 Host-Control Operations Manual
- one MT-9500 Maintenance and Service Manual
- two rack slide assemblies with mating rails*

*If you ordered an Astro-Med rack or a cabinet with your recorder, these are already installed in the enclosure.

- a small plastic bag containing:

  - four 1/2-in #10 flat-head, Phillips-head screws*
  - four 1-in #10 Phillips-head screws with four nylon washers*
  - four 3/4-in #10 Phillips-head screws with four nylon washers*
  - four #10 U retaining nuts*
  - four #10 cap U-shape nuts*
  - two bar nut rack slides*
  - one 25-pin D-shell connector with screws
  - one 15-pin D-shell connector with screws

  *If you ordered an Astro-Med rack or a cabinet with your recorder, these are already installed in the enclosure.

1. Remove the materials listed above from around the recorder and set them aside.

2. Remove the foam packing to uncover the recorder.

3. Remove the recorder from the packing box and place it on a table or workspace in accordance with the MT-9500's unpacking instructions.

4. Examine the recorder's condition and verify that no obvious shipping damage has occurred.

5. After your recorder has been examined, connect the AC power cord:

   - first to the rear-panel power input receptacle (lower left corner of the rear panel as you view it)

   - then to a power outlet.

```
┌─ NOTE ─────────────────────────────────────────────┐
│                                                      │
│  Line voltage requirements and fuse specifications   │
│  for the MT-9500 are:                                │
│                                                      │
│            Line:  95 - 132 VAC                       │
│                   190 - 264 VAC                      │
│                   48 - 440 hertz*                    │
│                   600 watts                          │
│                   *Consult factory for operation     │
│                   above 66 hertz.                    │
│                                                      │
│            Fuse:  120 volts, 6 amperes (250 V)       │
│                   240 volts, 3 amperes (250 V)       │
│                                                      │
└──────────────────────────────────────────────────────┘
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6. **Load the recorder with the pack of Z-fold thermal paper. Open the paper-chamber door and insert the chart paper. Put the paper pack into the paper chamber with the "THIS SIDE UP AND IN FIRST" stamp pointing to the rear of the recorder. Feed the top sheet of paper into the slot beneath the driver roller and gently push the paper through until it exits above the drive roller. Close the paper-chamber door. (A much more detailed description of this procedure in given in paragraph 3-4.1.)**

7. **Push the POWER switch into the "on" position. The recorder will perform a series of self-tests during which the front-panel LED display will show <SELFTEST>, <PASSED>, <SCN 12.7>*, and <READY>. Your recorder is ready to operate when <READY> appears on the front-panel LED display.**

    *The software configuration number (SCN) displayed by your recorder may be higher than software version in use when this manual was printed.

During the recorder's self-test sequence, error codes may appear on the front-panel LED display. These "error codes on wake-up" are defined in table 2-1.

Table 2-1. MT-9500 Error Codes On Wake-Up

Error Code*	Description	Possible Cause**
01	Keypad CPU cannot communicate with main CPU	Bad I/O board or CPU board
02	Read/write error while testing main memory	Bad CPU board
03	CPU board error	Bad CPU board
04	I/O board error	Bad I/O board
05	Interlock error	No paper. Door open. Sensor problem.
06	Master controller error	Bad master controller or related cable
07	Slave Controller error	Bad slave or related cable
08	A/D board error	Bad A/D board
No display or erroneous display	Keypad CPU failed to wakeup	Bad I/O board or power problem

*These are not hexadecimal codes. They appear on the recorder LED only as a result of error conditions after MT-9500 power-up.

**This column highlights sources of error that are most frequently encountered. Sources of error other than those listed may exist.

Often, a number of these errors can be corrected by checking the input AC voltage level and the cable connections. Error 5 is usually caused either by the chart paper running out or by the paper-chamber door being partially open. If you encounter any error code that you cannot resolve, please call our customer service department at 1 (401) 828-4000.

If you want to test the functioning of the waveform recording capabilities of your MT-9500, you can do so now. The simplest way to accomplish this is to use BNC cables to connect one or more (to a maximum of eight) signal sources to the recorder's rear-panel analog-input BNC connectors (see 3-3.12). These connectors are labeled "CH8," "CH7," etc.

See your signal conditioner manual for detailed information regarding signal conditioner/recorder connections.

Either of two basic analog input sensitivities is available with the MT-9500. The recorder's standard A/D circuit board has a full-scale sensitivity range of ±200 mV to ±2.5 V. An optional A/D circuit board with a full-scale sensitivity range of ±2 V to ±5 V is available.

2-2 Installation Alternatives

You have just unpacked, setup, and applied power to the recorder. You now need to prepare the equipment configuration in which the recorder will be used. Is your recorder to be used without a case? Will your recorder be used with Astro-Med's Rewinder option (RW-95)? Is your recorder going to be mounted in a rack or in a case? Will you be using the Writing Table option (WT-95) with your recorder? Each of these possibilities is discussed below.

2-2.1 Astro-Med Rack-Mount and Case Enclosures

Astro-Med recognizes that its recorders are used in many different recording environments and in many different equipment configurations. In response, Astro-Med offers a varied line of enclosures to accommodate the MT-9500 and its accessories. Astro-Med rack-mount and case enclosures offer protection, durability, and color-coordinated good looks. In addition, Astro-Med enclosures offer the time-and-labor saving advantage of being preconfigured for recorder and accessory installation. Rack-mount enclosures contain AC power strips to ensure that the recorder and its peripheral equipment have easy access to power connections. The cumbersome work of installing interior rack-slides is expertly performed in our factory. All you need to do when you receive your recorder is to slide it into place and secure it with four screws and their accompanying washers. Astro-Med also offers customized rack configurations for unique recording requirements.

2-2.2 Recorder Without Case

Operation of the recorder does not require a case or rack. When you have followed the instructions of paragraph 2-1, all you have to do is ensure that the recorder is on a stable surface. The instrument's full range of installed features is available for use.

2-2.3 Recorder In an Astro-Med Enclosure

After you have unpacked and set-up your MT-9500, disconnect any power cords or signal connection cords before installing the recorder in an Astro-Med enclosure or any other enclosure. Reestablish these connections when the installation process has been completed.

If you have purchased an Astro-Med rack-mount or case enclosure, it has already been equipped with properly positioned and installed rack slide assemblies. Follow the procedure below to install the recorder in an Astro-Med enclosure.

WARNING

The recorder is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder required during installation. **Always** lift the MT-9500 using the slide rails attached to the recorder's left and right sides. **Never** use the front panel or rear-panel controls when lifting the instrument. The controls cannot support the recorder's weight and, consequently, they will be damaged.

---

1.   Facing the recorder's front panel, grasp the slide-mount rail
        supports located on the left and right sides of the recorder.

2.   Position the recorder's slide-mount rails to mate with the
        inner rack slide assemblies already installed in your
        enclosure.

3.   Slide the recorder onto the inner rack-slide assembly mount
        and carefully push the unit onto the rack slides until the
        recorder is fully seated in the enclosure.

CAUTION

Never force the recorder into the enclosure. You may damage
both the enclosure and the MT-9500 if you attempt to force
the recorder into position. If you encounter resistance when
sliding the recorder into place, remove the instrument from
the enclosure and try again. When properly mated with the
enclosure's rack slide assemblies, the recorder will slide easily
into position.

---

4.   Using four 1-inch #10 Phillips-head screws and four nylon
        washers that are supplied with your recorder, secure
        the recorder in the enclosure.

        *You will find the screw holes necessary for securing the MT-9500
        approximately 1-1/2-inch from each of the corners of the recorder's
        front panel.*

5.   Establish power and signal input connections to the
        recorder.

Power is applied to the recorder in a number of ways depending on the
particular rack or case being used. To facilitate power and signal input,
smaller cases may have no back panel. In these instances, connections are
made directly to the rear-panel of the enclosed recorder. Larger enclosures
may have a lockable rear door that both protects and provides convenient
access to the rear of the recorder and its accessories. Larger cases may
also have an interior AC power strip allowing the recorder and peripher-
als to be plugged in within the enclosure itself. You will need to examine
your recorder/enclosure configuration to determine how power and signal
connections will be established.

2-2.4 Recorder in Customer-Furnished Enclosure

If your enclosure has not been supplied by Astro-Med, it may require installation of the rack slide assemblies supplied with the recorder. Follow the procedure below to install the rack slide assemblies that support the MT-9500 when it is used in any enclosure.

1. **Determine where in the enclosure you want to mount the recorder.**

   Rack-mounting enclosures are equipped with interior frames to which you must attach the rack slide assemblies needed to hold the recorder. These interior supports have regularly spaced holes along their length to accommodate the mounting screws that will secure the rack slide assemblies and the recorder in the locations that you choose.

   Obviously, where you mount your rack slides determines where your recorder will be positioned. As shown in figure 2-1, the recorder is 10-1/2-inches high. A slide rail is mounted to each side. Running the length of the recorder, the mid-line of each rail is located 1-3/4 inches from the recorder's bottom and 8-3/4 inches from the recorder's top. You need to use these measurements to determine where in the enclosure you want to mount the rack slides. Decide where you want the recorder positioned and then either measure down 8-3/4 from where the top of the recorder will be or up 1-3/4 inches from where the bottom of the recorder will be.

   Mark the enclosure's interior frame with a pencil. You have just marked the mid-line of the recorder's slide rails. Either of these measuring approaches will allow you to position the rack slides and, consequently, the recorder in the position you desire. Figure 2-1 illustrates one of many possible rack-mount configurations and shows the measurement relationships discussed above. Figures 2-2a through 2-2f illustrate significant individual details of the rack-mount process.
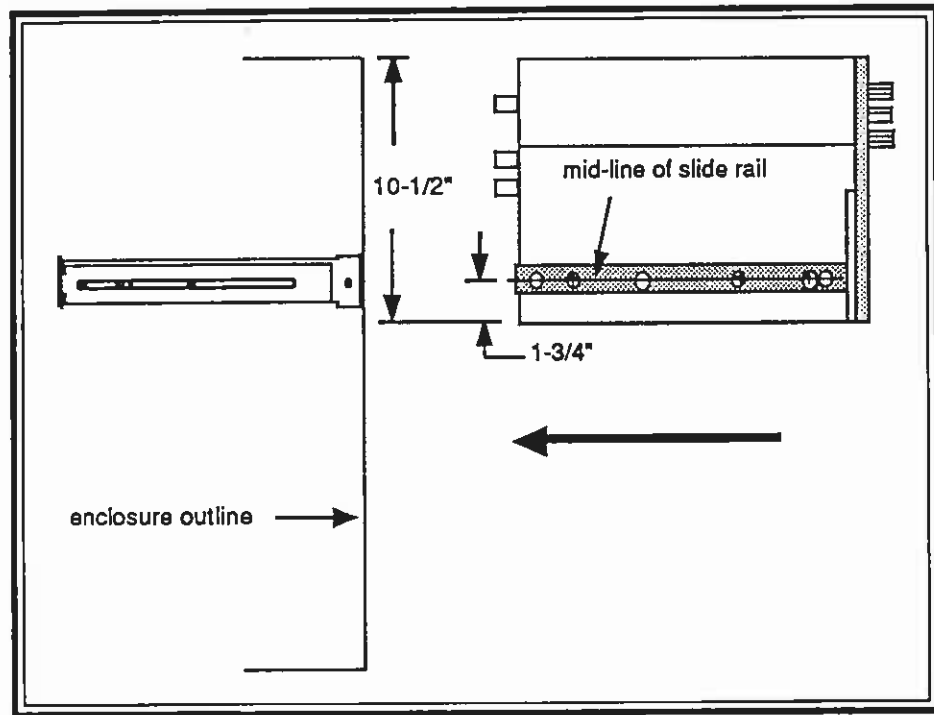
Figure 2-1. Example of Rack Mount/Recorder Installation Relationship

2.   Remove the masking tape that holds the two rack slide
       assemblies together and separate them.

       Figures 2-2a through 2-2c show the rack slide assemblies. Refer to
       these illustrations when following the steps below.

3.   Loosen the three Phillips-head screws (figure 2-2c) that
       allow adjustment of the length of the rack slide.

4.   Pull on the rack slide to lengthen or shorten the assembly
       to match the depth of your enclosure. The maximum
       extension of the rack slide assemblies is 24 inches.

5.   When the rack slide has been adjusted to the proper length,
       tighten the three Phillips-head screws to "freeze" the rack
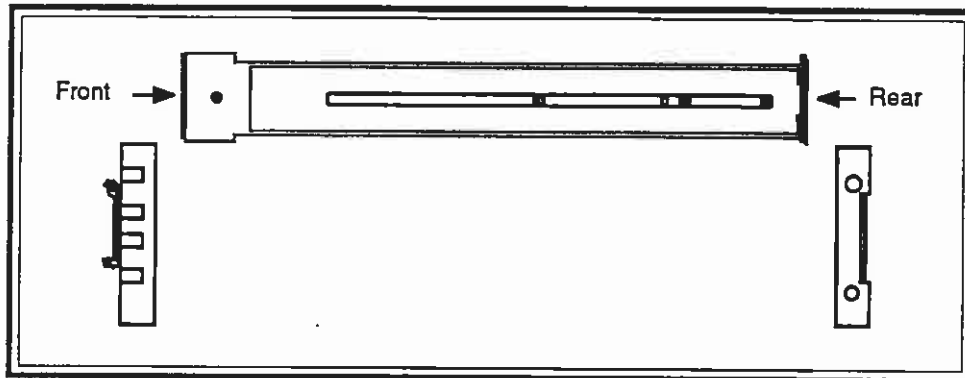   slide at the adjusted length.

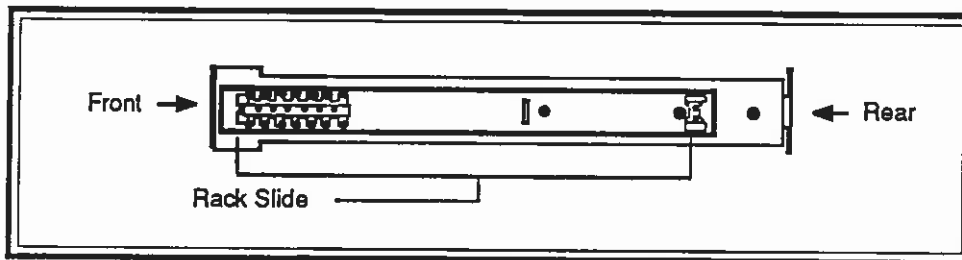Figure 2-2a. Rack Slide Assembly (faces enclosure side)

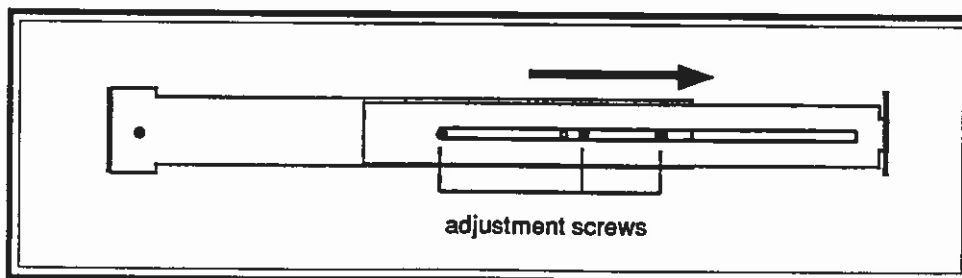Figure 2-2b. Rack Slide Assembly (faces recorder)

Figure 2-2c. Rack Slide Assembly Adjustment

6. **Attach the front end of one of the rack slides to either the left or right side (it doesn't matter which) of the enclosure as viewed from the front.**

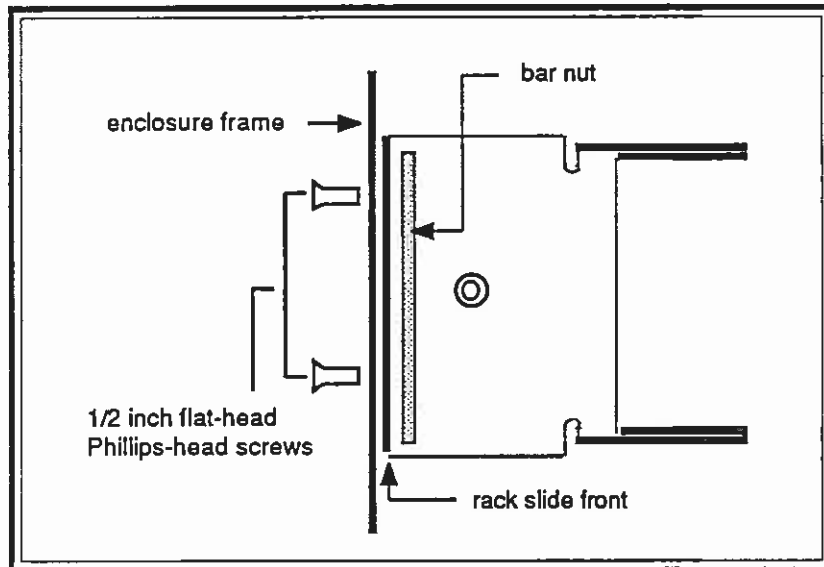*Use two 1/2-inch flat-head, Phillips-head screws and one bar nut as shown in figure 2-2d.*

Figure 2-2d. Attaching Rack Slide Front to Enclosure

7. **Attach the rear end of the rack slide to the interior frame.**

Use two 3/4-inch Phillips-head screws and two U-shaped clip nuts as shown in figure 2-2e.
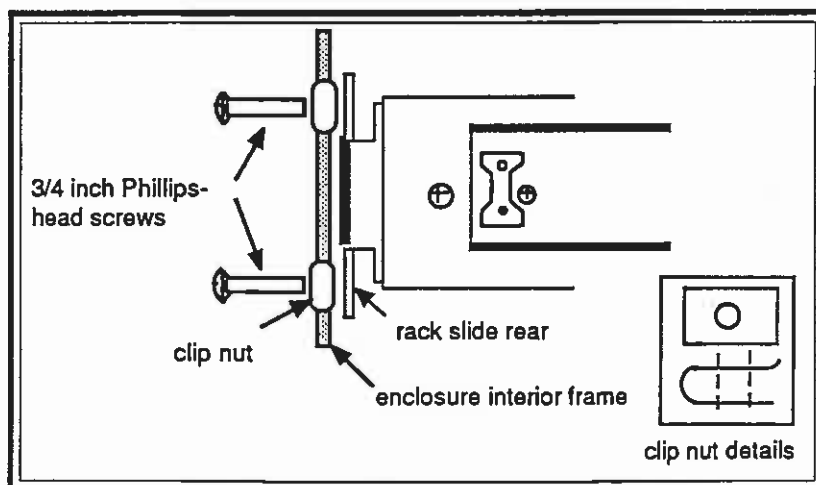

Figure 2-2e. Attaching Rack Slide Rear to Enclosure

8. **Repeat steps 1 through 7 for the remaining rack slide assembly.**

    When a rack slide assembly is properly oriented:

    *   *the inner rack slide (figure 2-2b) faces the recorder.*

    *   *the four slots at the front end of the rack slide align with screw holes on the front opening of the enclosure's interior support frame.*

    *   *the two screw holes at the rear end of the rack slide assembly align with two screw holes on the rear of the enclosure's interior support frame.*

9. **Facing the recorder's front panel, grasp the slide-mount rail supports located on the left and right sides of the recorder.**

    WARNING

    The recorder is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder required during installation. Always lift the MT-9500 using the slide rails attached to the recorder's left and right sides. Never use the front panel or rear-panel controls to lift the recorder. The controls cannot support the recorder's weight and, consequently, they will be damaged.

    ---

10. **Position the recorder's slide-mount rails to mate with the inner rack slide assemblies you just installed.**

11. **Slide the recorder onto the inner rack-slide assembly mount and carefully push the unit onto the rack slides until the recorder is fully seated in the enclosure.**

> **CAUTION**
>
> Never force the recorder into the enclosure. You may damage
> both the enclosure and the MT-9500 if you attempt to force the
> recorder into position. If you encounter interference when sliding
> the recorder into place, remove the instrument from the enclosure
> and try again. When properly mated with the enclosure's rack
> slide assemblies, the recorder will slide easily into position.

12.   **Using the four 1-inch #10 Phillips-head screws, four nylon
        washers, and four U-nuts that are supplied with your
        recorder, secure the recorder in the enclosure. Figure 2-2f
        illustrates the correct mounting-hardware configuration.**

        *You will find the screw holes necessary for securing the
        MT-9500 approximately 1-1/2-inches from each of the corners of
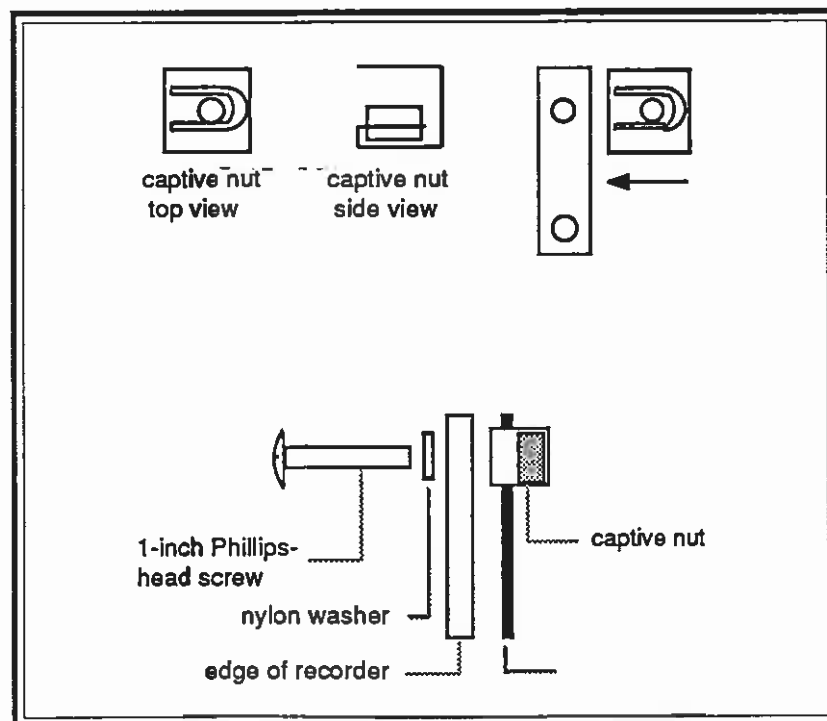   the recorder's front panel.*

Figure 2-2f. Attaching Recorder to Enclosure

13. Establish power and signal input connections to the recorder.

2-2.5 Recorder and Rewinder Without Case

If you are using the recorder with the Rewinder option (RW-95), you need to attach the rewinder to the recorder before the MT-9500 is installed in a rack or case. After the components have been attached to one another, they can either be used immediately as a unit or they can be installed as a combination into any suitably configured rack or case.

Use the following procedure to connect a rewinder to your recorder.

1. **Facing the recorder's front panel, grasp the slide-mount rail supports located on the left and right sides of the recorder.**

2. **Carefully lift the recorder and place it on top of the rewinder.**

   There are five screw holes in each side of the recorder. The holes are located just above the bottom edge of each side.

   WARNING

   The recorder is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder required during installation. Always lift the MT-9500 using the slide rails attached to the recorder's left and right sides. Never use the front panel or rear-panel controls to lift the recorder. The controls cannot support the recorder's weight and, consequently, they will be damaged.

   ---

3. **Position the recorder on the rewinder so that the recorder's preconfigured drill holes are matched to those on each side of the rewinder.**

   When the recorder is properly positioned, its attaching screw-holes align with those of the rewinder and the take-up reel of the rewinder extends approximately 5 inches in front of the recorder's front panel.

4.   Attach the recorder to the rewinder using the screws and washers supplied with the rewinder.

For attachment to the recorder, the rewinder is supplied with:

- *Ten 5/16-inch #6 screws*
- *Ten flat washers*
- *Ten split washers*

5.   Using the power cord supplied with the rewinder, connect the rewinder to any AC power receptacle.

When the rewinder has been attached and loaded with roll thermal paper (3-4.2), the units are ready to be turned on and used.

2-2.6 Recorder and Rewinder In Astro-Med Rack-Mount or Case Enclosure

Follow the directions of paragraph 2-2.5 above. When the recorder and rewinder have been joined, they can be installed in any case or rack configuration that has sufficient space to accommodate them.

If you have purchased an Astro-Med rack-mount or case enclosure, the rack or case has already been equipped with properly positioned and installed rack slide assemblies. Follow the procedure below to install the recorder/rewinder combination in an Astro-Med enclosure:

1.   Facing the recorder's front panel, grasp the slide-mount rail supports located on the left and right sides of the recorder.

> **WARNING**
>
> The recorder/rewinder combination is heavy. It is recommended that two individuals perform the lifting and positioning of the recorder/rewinder required during installation. Always lift the recorder/rewinder combination using the slide rails attached to the recorder's left and right sides. Never use the recorder's front panel or rear-panel controls to lift the recorder/rewinder. The controls cannot support the recorder's weight and, consequently, they will be damaged.

2. Position the recorder's slide-mount rails to mate with the inner rail mount already installed in your enclosure.

3. Slide the recorder/rewinder combination onto the inner rail mount and carefully push the units onto the rack slides until the units are fully seated in the enclosure.

> **CAUTION**
>
> Never force the recorder/rewinder into the enclosure. You may damage both the enclosure and the recorder/rewinder if you attempt to force the units into position. If you encounter interference when sliding the recorder/rewinder into place, remove them from the enclosure and try again. When properly mated with the enclosure's slide rack assemblies, the units will slide easily into position.

4. Using the four 1-inch #10 Phillips-head screws and four nylon washers that are supplied with your recorder, secure the recorder to the enclosure. The rewinder does not require individual attachment to the recorder. It is secured because it is attached to the recorder.

   You will find the appropriate-screw holes approximately 1-1/2-inch from each of the corners of the recorder's front panel.

5. Establish power and signal input connections to the recorder/rewinder.

2-2.7 Recorder and Rewinder in Customer-Furnished Rack Mount or Case Enclosure

Use the following procedure to install the recorder/rewinder combination in an enclosure that you have supplied.

1.   Attach the rewinder to the recorder as described in paragraph 2-2.5.

2.   As necessary, install the rack slide assemblies in your enclosure as described in paragraph 2-2.4.

3.   Using the four 1-inch #10 Phillips-head screws and four nylon washers that are supplied with your recorder, secure the recorder/rewinder to the enclosure. The rewinder does not require individual attachment to the enclosure. It is secured because it is attached to the recorder.

     You will find the appropriate screw holes approximately 1-1/2-inch from each of the corners of the recorder's front panel.

4.   Establish power and signal input connections to the recorder/rewinder.

2-2.8 Attachment of Writing Table (WT-95) to Recorder

For attachment to the recorder, the writing table is supplied with the following hardware items:

- left and right support brackets
- four 1/2-inch black screws
- four 1/2-inch washers

Figure 2-3 shows some of this hardware. Refer to this illustration when performing the procedure below.

1. Remove the four rounded plastic plugs (they each consist of two pieces) that occupy the mounting holes for the writing table on the recorder's front panel.

2. Secure either the left or right support bracket to the recorder's front panel using two of the screws and two of the washers supplied.

3. Secure the remaining support bracket in the same manner.

4. Slip the writing table assembly into place on the support brackets.

```
┌─ NOTE ──────────────────────────────────────────────┐
│                                                      │
│  If you use the writing table in conjunction with the recorder/  │
│  rewinder combination, you will need to remove the writing   │
│  table from its support brackets when loading the rewinder   │
│  with roll thermal paper.                            │
│                                                      │
└──────────────────────────────────────────────────────┘
```
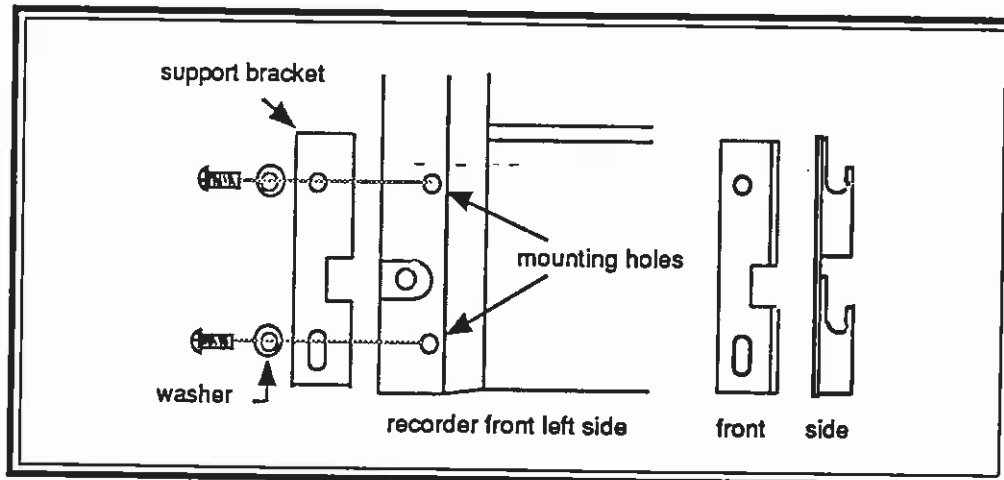

Figure 2-3. Attaching Writing Table Mounting Brackets

2-2.9 Using the LA-95 Option With the Recorder

> **CAUTION**
>
> Power to both the recorder and the LA-95 must be **OFF** before connecting the LED array to the MT-9500. The LA-95 could suffer electrical damage if this caution is not strictly observed.

The LED Array option (LA-95) is generally mounted above the recorder in a rack mount or case configuration. Because the LA-95 is light-weight, it does not require rack slide assemblies for support. Instead, this accessory is held in place and supported by two 3/4-inch Phillips head screws and their associated washers and captive nuts. All you have to do is determine where in the enclosure you want to mount the LA-95, measure as required to position the device, and secure the accessory as shown in figure 2-4.

When the LA-95 has been secured in place, you are ready to connect it to the recorder using the attaching cable supplied with the array.
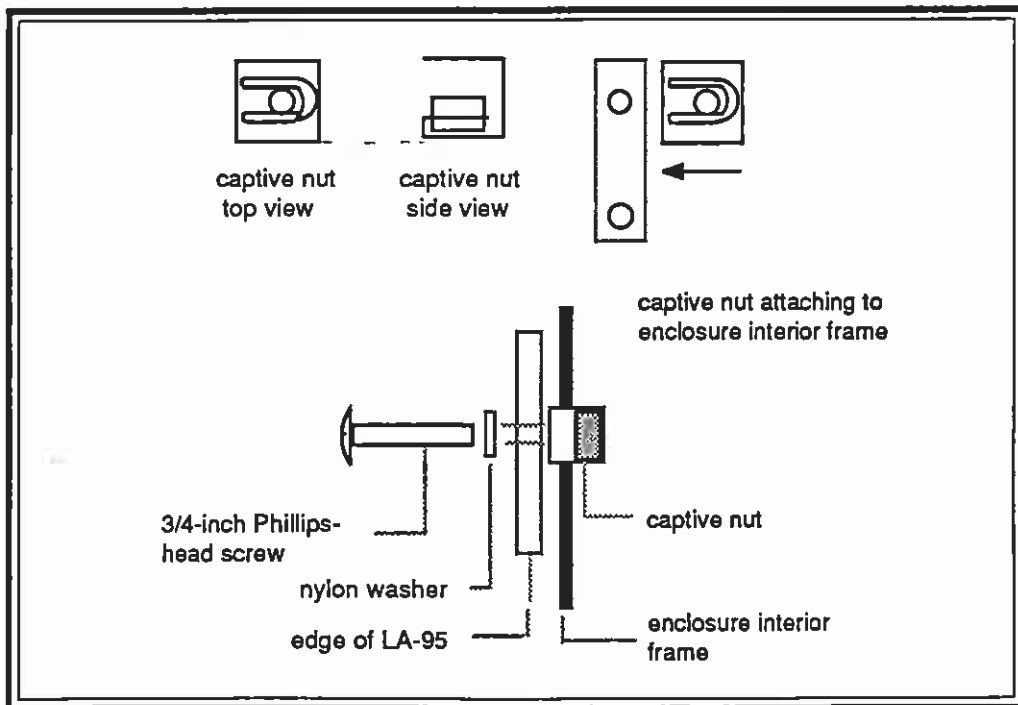

Figure 2-4. Mounting LA-95 to Enclosure

CAUTION

Power to both the recorder and the LA-95 must be **OFF** before connecting the LED array to the MT-9500. The LA-95 could suffer electrical damage if this caution is not strictly observed.

The attaching cable has a 15-pin D-shell connector at each end. Each of these D-shells has captive attachment screws. With power to the recorder turned off, attach one D-shell to the input on the rear of the LA-95. Attach the remaining D-shell connector to the LA-95 (AUX DISPLAY) input (3-3.4) on the rear panel of the MT-9500. This completes attachment of the accessory to the recorder.

2-2.10 Paper Take-Up Drawer in Astro-Med Enclosure

The Paper Take-Up Drawer (PT-200) is a rack-mounting 5-1/4" deep drawer for collecting thermal Z-fold chart paper as it exits the recorder. If you ordered an Astro-Med enclosure in which the drawer will be used, the rack slide assemblies that hold the drawer have already been installed. All you need to do is mate the slide rails attached to the drawer with the rack slide assemblies already installed in the enclosure. Carefully slide the drawer into the enclosure until it is fully seated. When properly seated, the drawer will open and close smoothly. - - - -

CAUTION

Never force the drawer into the enclosure. You may damage both the enclosure and the drawer if you attempt to force the drawer into position. If you encounter interference when sliding the drawer into place, remove the accessory from the enclosure and try again. When properly mated with the enclosure's slide rack assemblies, the recorder will slide easily into position.

2-2.11 Paper Take-Up Drawer in Customer-Furnished Enclosure

If you are mounting the take-up drawer in your own enclosure, you will need to install the rack slide assemblies supplied with the drawer. The installation procedure for the rack slide assemblies is identical to the procedure given in paragraph 2-2.4, "Recorder in Customer-Furnished Enclosure." Please refer to paragraph 2-2.4 to install your paper take-up drawer.

2-3 Line Voltage Selection

The MT-9500 can be operated in either of two voltage ranges:

- 90 - 132 VAC or
- 180 - 264 VAC

Unless otherwise specified, the voltage range is factory preset for the standard North American voltage requirement of 120 VAC. In recorders carrying serial numbers before 8J264, this setting can be changed by accessing a voltage selector module built into the AC Input receptacle. (Look for the module to the right of the three-pronged AC power cord connection.) If you want to change the standard voltage range, use a small screwdriver to remove the fuse holder cover. Extract the printed circuit card mounted to the right of the fuse. Move the white plastic indicator to the opposite side of the card and reinstall it. You will also need to change the fuse to the appropriate value screened onto the rear panel of the recorder. Finish this process by reinstalling the fuse holder cover. The tip of the white plastic indicator should protrude from the fuse holder cover through one of two holes labeled either 120 V or 240 V.

Line voltage selection in recorders with serial numbers of 8J264 or greater is accomplished by using a slide switch mounted on the rear panel to the right of the AC Input receptacle. To change the voltage range in these recorders, use a screwdriver blade to select the appropriate, clearly labeled switch position: either 115 V or 230 V . You will also need to change the fuse value as described above.
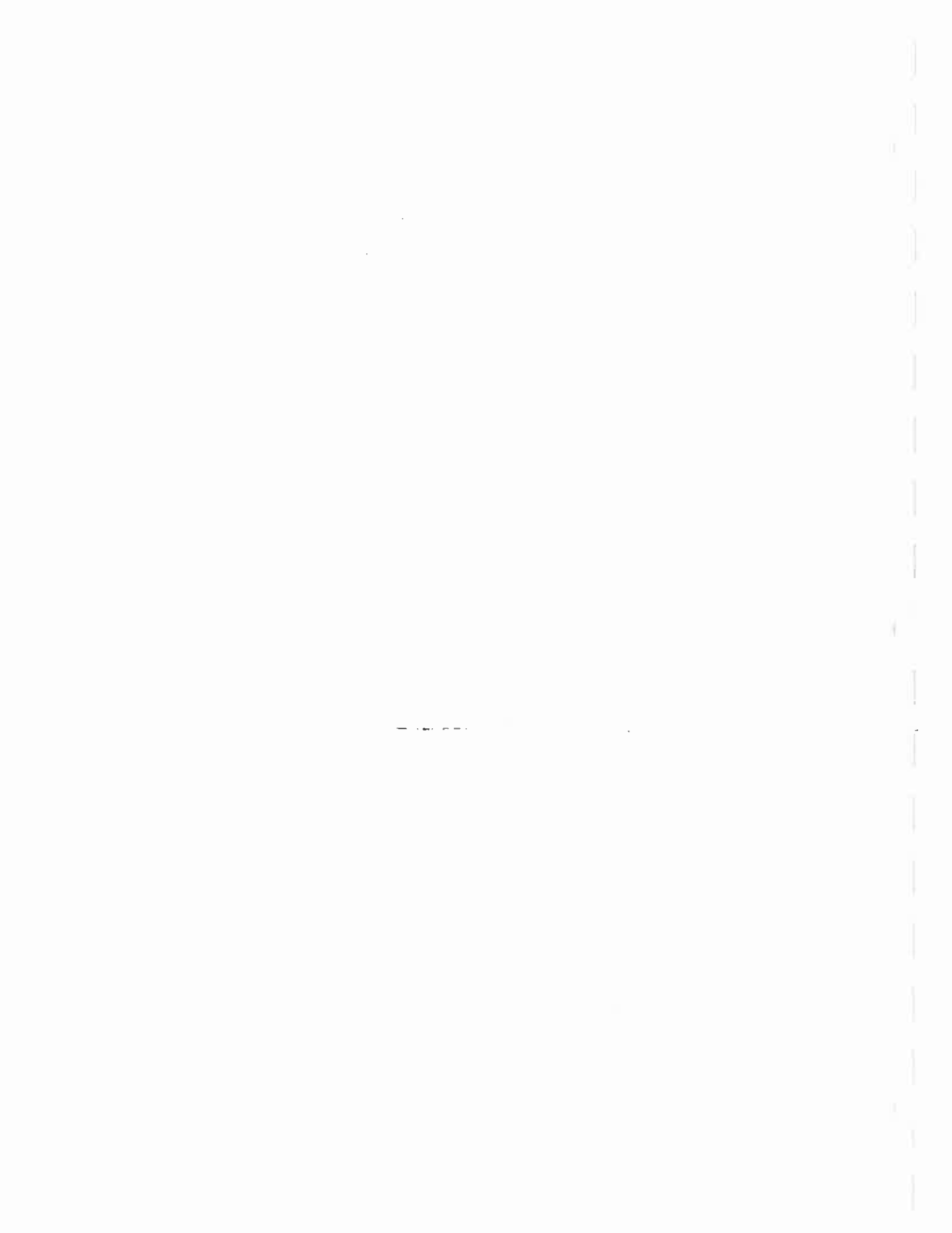
Section 3
Operation

3-1 General Information

Your recorder is factory equipped with a standard operational mode: *Real-time Operation.* A second operational mode, *Data Capture and Playback*, is available when the Data-Capture option (DC-95) is ordered. These modes are fully discussed in paragraphs 3-5 and 3-6, respectively.

Before actually employing your recorder in any given task, however, it is necessary to familiarize yourself with the MT-9500's physical controls, indicators, and connections. Paragraphs 3-2 and 3-3 introduce you to these fundamental hardware features. Understanding the purpose and function of each control will allow you to quickly master this versatile and remarkably user-friendly machine.

3-2 Front Panel Controls and Indicators

The front panel of the MT-9500 is illustrated in figure 3-1. You should refer to this figure throughout this discussion of the front panel controls. All of the recorder's functions and parameters can be accessed and changed by using the controls resident on the front panel. Essentially, the front panel can be described as having the following groupings:

- Data-Entry Keypad
- Signal-adjustment group (ZERO, GAIN, CAL/UNCAL/GND)
- Trigger definition group (TRIG, SLOPE, LEVEL)
- Event and ID group
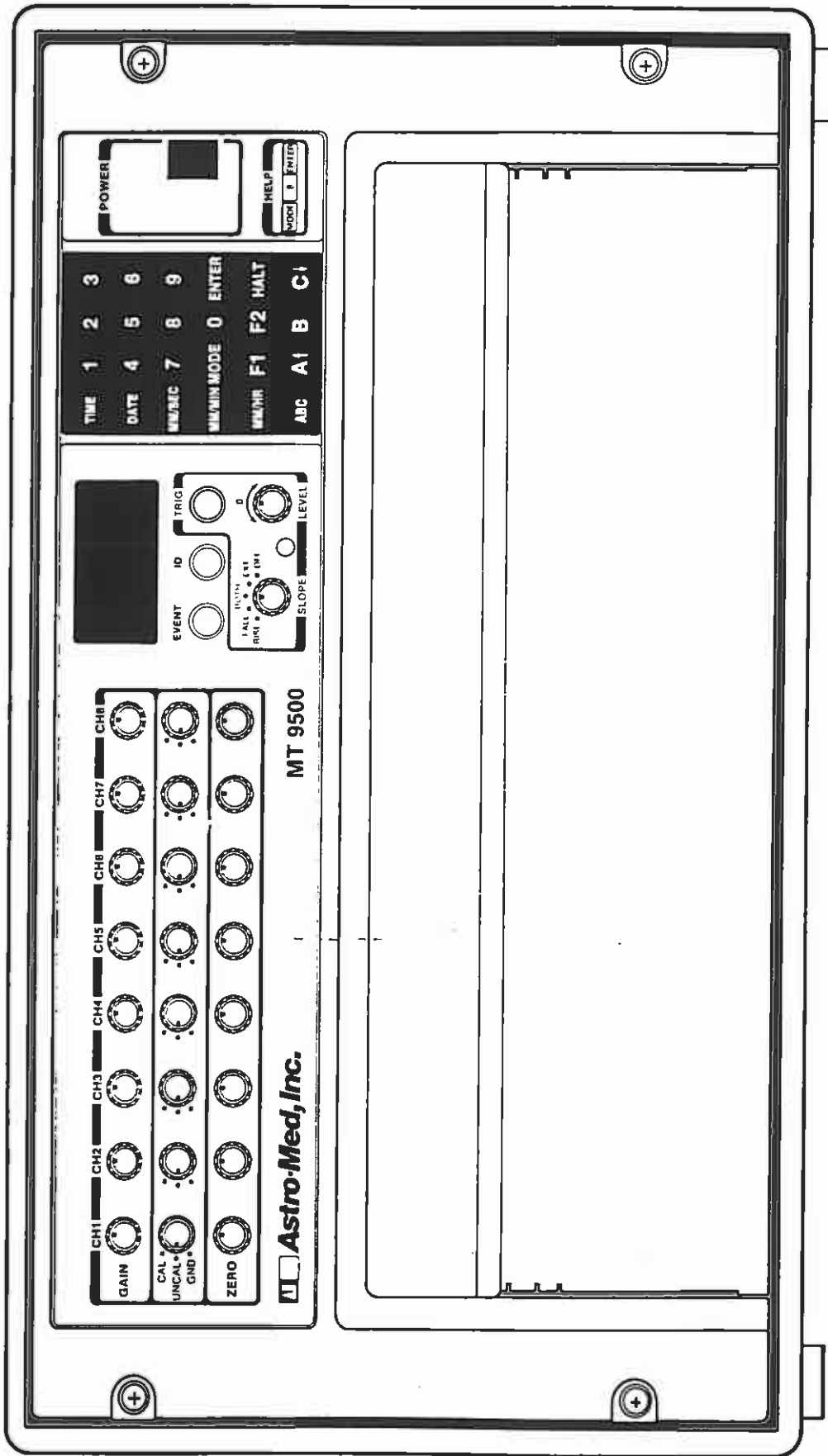- Light Emitting Diode (LED) Display
- Power Switch

Figure 3-1. MT-9500 Front Panel Controls

3-2.1 Data-Entry Keypad

The front panel data-entry keypad is the most fundamental tool for communicating with and controlling the activities of the MT-9500 recorder. The keypad is used:

- To enter or change all real-time setup information (time, date, chart speed, and insta-speeds)

- To command the recorder to enter, halt, or exit any function or mode of operation

- To change recorder modes and functions

- To view and check the status of recorder real-time set-up information without entering or changing data

- To view and check the status of each mode or function installed in the recorder without entering or changing data

The keypad contains twenty-four pushbuttons in four columns of six. For ease of discussion, we will refer to these pushbuttons as keys throughout this manual. When the keypad is used, the modes and functions that are accessed and the data that are entered appear on the front-panel LED display (paragraph 3-2.2). Figure 3-2 depicts the keypad. Refer to this figure in following the discussion below. This paragraph provides a brief introduction to the keypad and its uses. Paragraphs 3-5 and 3-6 fully describe the keypad in relation to real-time operation and data capture/ playback.

The [MODE] key, [F1] and [F2] function keys, and the real-time setup keys are used in association with the numeric keys [0] through [9] and the [ENTER] key to define and implement each recorder capability.

The real-time setup keys of the left-most column of the keypad are labeled (from top to bottom): [TIME], [DATE], [MM/SEC], [MM/MIN], [MM/HR], and [ABC].

Each is discussed below.

The [MODE] key is used in conjunction with numeric keys [0] through [9] to enter the recorder into a desired operational mode. Table 3-1 is a list of all modes available on recorders equipped with all firmware options.

Generic keying sequence: [MODE] [X] [ENTER]
Example: HELP mode   [MODE] [8] [ENTER]

The [F1] and [F2] keys are used in conjunction with numeric keys [0] through [9] to enter the recorder into a desired function. Table 3-2 is a list of all functions available on recorders equipped with all firmware options.

Generic keying sequence: [F1 or F2] [X] [ENTER]
Example: define trigger   [F1] [3] [ENTER]

The [ENTER] key is pressed to conclude mode, function, or data-input keying sequences and to instruct the recorder to accept them. The [ENTER] key is also used to escape modes and functions. When operating the recorder, press [HALT] and/or [ENTER] to escape the ongoing mode or function.

The [HALT] key is pressed to stop and restart printing of recorder output and to escape from various modes and functions.

In addition to using the keypad for entering or changing data, you can use the data-entry keypad to instruct the recorder:

- To present the real-time setup parameters
  ([TIME], [DATE], [MM/SEC], [MM/MIN], [MM/HR], [ABC])
  on the LED display so that they can be reviewed

- To present the installed modes and functions on
  the LED display so that they can be reviewed

It is easy to use the keypad to view recorder setups, modes, and functions. Simply punch-in the keying sequence of the mode, function, or parameter you wish view without pressing the [ENTER] key. The recorder's LED display will then show the mode or function that has been keyed-in. When you are through with your review, press the [HALT] key to return the recorder to a <READY> state. For example, pressing [MODE] [1] will cause <OVLAP RT> to be displayed informing you that Mode 1 is the real-time overlap mode. Pressing [MODE] [2] will cause <CON SS U> to be displayed informing you that Mode 2 is the continuous untriggered snapshot mode. Each of the recorder's modes, functions, and setups can be reviewed in this way.

Table 3-1. MT-9500 Modes of Operation

Mode	Keying Sequence	Definition
Mode 0	[MODE] [ENTER]	8-channel real-time recording
Mode 1	[MODE] [1] [ENTER]	Overlap real-time recording
Mode 2*	[MODE] [2] [ENTER]	Continuous untriggered snapshot
Mode 3*	[MODE] [3] [ENTER]	Continuous triggered snapshot
Mode 4	[MODE] [4] [ENTER]	Dual Speed real-time recording
Mode 5*	[MODE] [5] [ENTER]	Acquire single snapshot
Mode 6*	[MODE] [6] [ENTER]	Playback single snapshot
Mode 7	[MODE] [7] [ENTER]	Formfeed: advance chart paper to next index mark
Mode 8	[MODE] [8] [ENTER]	HELP: provides playout of Condensed Operations Manual
Mode 9	[MODE] [9] [ENTER]	Datalogger: waveform data as tabular list of user-specified engineering units

*Available during Data Capture and Playback operation.

This table applies to a recorder equipped with all firmware options.

Other modes, such as line printing, plotter, and digital data transfer are available only through host control.

Table 3-2. MT-9500 Function Commands

Keying Sequence	Definition
[F1] [ENTER]	Define channel order
[F1] [1] [ENTER]	Grid printing on/off
[F1] [2] [ENTER]	Annotation/Event Marker definition
[F1] [3] [ENTER]*	Define trigger information
[F1] [4] [ENTER]*	Define playback information
[F1] [5] [ENTER]*	Set X and Y channel choices
[F1] [6] [ENTER]*	Define acquisition information
[F1] [7] [ENTER]	Define signal polarity reversal
[F1] [8] [ENTER]	Set calibration for Datalogger mode
[F2] [ENTER]	Edit interchannel buffers
[F2] [1] [ENTER]	Not used
[F2] [2] [ENTER]	Set factory defaults
[F2] [3] [ENTER]	Enter timer operation
[F2] [4] [ENTER]*	Trigger enable/disable
[F2] [5] [ENTER]	Define snapshot sample rate clock source
[F2] [6] [ENTER]	Set communication type (local or host)
[F2] [7] [ENTER]**	Define real-time motor speed source
[F2] [8] [ENTER]	Define signal conditioner report status

*Available when using Data Capture and Playback features.
**RD-95 option required.

This table applies to a recorder equipped with all firmware options.

3-2.2 Signal-Adjustment Group

The signal-adjustment group provides real-time waveform trace position controls and signal-strength controls for the MT-9500's eight recording channels. Each channel has three individual controls placed one above the other in the following order: GAIN, CAL/UNCAL/GND, and ZERO. The controls for each channel are adjacent to one another creating three horizontal rows each consisting of eight control knobs.

For each channel, the controls of the signal adjustment group:

- Position the real-time trace within the the channel

- Establish the calibration frame of reference for the real-time waveform trace

- Vary the gain applied to the signal on the trace to expand or reduce the appearance of the real-time trace. This affects the recorded waveform rather than the input signal.

ZERO   The ZERO control is used to shift the real-time waveform trace of an input signal to any position within the selected channel. In using this control, you will probably want to ground the incoming signal to obtain a flat-line trace. You can do this by setting the CAL/UNCAL/GND switch to GND. The zero-baseline trace can then be easily centered or shifted by rotating the ZERO control knob in the direction of the desired left or right shift. When you have positioned the zero baseline, you can recover the real-time waveform trace by adjusting the CAL/UNCAL/GND switch and, if appropriate, the GAIN control.

CAL/
UNCAL/
GND   The CAL/UNCAL/GND switch either puts the waveform trace on ground level or establishes the real-time waveform in a channel grid that can be calibrated or uncalibrated.

    When switched to GND, the waveform trace is put on ground level and a flat-line trace is obtained.

When set to CAL, the switch causes a precise, factory-set gain to be applied to the input signal. Because the gain has been fixed to a known quantity, each block of the grid that is printed with the real-time waveform takes on precise value. In effect, the grid becomes calibrated. In the MT-9500, the CAL position sets the sensitivity to 10 mV per division. Astro-Med will alter the factory-set gain to customer specifications to record a maximum of 10 volts full scale. *Please be aware that - if you requested it - the factory-set gain on your recorder has been changed to your specifications.* As described in paragraph 3-3.16, you can also recalibrate the preset gain yourself.

When set to UNCAL, there is no preset gain. Instead, you can rotate the GAIN control to adjust the appearance of the real time waveform trace.

GAIN   The GAIN control applies a variable fractional gain to the signal on the trace, that is, the GAIN control affects the recorded waveform rather than the input signal. As gain is increased or decreased, the appearance of the real-time waveform trace expands or contracts. The GAIN control is active only when the CAL/UNCAL/GND switch is set to UNCAL.

3-2.3 LED Display

The front-panel LED display provides a visual readout of all front-panel keypad data entries and carries recorder-generated error messages when errors are encountered during either recorder power-up or operation. A list of error messages that you might encounter when using the recorder is given in paragraph 3-4, "Recorder Setup."

3-2.4 EVENT and ID Pushbuttons

The EVENT and ID pushbuttons are adjacent to one another immediately below the LED display. Their functions are described below.

EVENT   The EVENT pushbutton provides a simple, manual front-
               panel control for noting real-time waveform data of interest
               to you. The recorder continuously prints a System Event
               Marker line on the right-most side of the chart paper as
               viewed from the front of the recorder. When the EVENT
               pushbutton is pressed, the event marker deflects to the left
               where it remains until the pushbutton is released. When
               released, the event marker returns to its right-most position.

ID   When pressed, the ID pushbutton labels the real-time
               waveforms within each recorder channel with the
               appropriate channel numbers. This is a particularly useful
               feature when in the recorder's overlap mode of operation.
               Overlapped waveforms are quickly and easily differentiated
               by their clearly printed corresponding channel numbers.
               See figure 3-8.

3-2.5 Trigger Definition Group

The trigger definition group consists of three controls labeled TRIG,
SLOPE, and LEVEL and a trigger lamp that illuminates whenever a
trigger is detected. Together, the SLOPE and LEVEL controls define
trigger points within an input signal. The SLOPE switch defines the
portion of an input signal within which a trigger will be recognized. The
LEVEL dial specifies a voltage that, if present in the selected portion of
the input signal, constitutes a trigger. A trigger is nothing more than a
signal level that, when met or exceeded in the specified portion of the
input signal, causes the recorder to do either of the following:

•   Acquire waveform data and store it for replay in any of the
        MT-9500's varied playback formats

•   Toggle between two preset speeds when in the dual speed
        mode

To accomplish triggered data captures, your recorder must be equipped
with the Data Capture option (DC-95). This option enables the recorder to
acquire, store, and playback waveform data.

The controls of the trigger definition group are used to initiate, define, or
monitor triggers as described below.

TRIG   This control allows you to initiate triggers manually. Manual triggers result in either on-demand data captures or toggling between the two speeds you have predefined for the dual-speed mode. SLOPE and LEVEL settings are irrelevant to manually initiated triggers.

SLOPE   This rotary switch has five settings: RISE, FALL, BOTH, EXT, and OFF. These settings define that portion of the input signal from which the trigger is to be derived.

If set to RISE, the trigger will be defined as occurring on the positive-going (rising) slope of the triggering signal.

If set to FALL, the trigger will be defined as occurring on the negative-going (falling) slope of the triggering signal.

If set to BOTH, triggers will be defined as occurring on the rising or falling slope (whichever occurs first).

If set to EXT, the data-capture or speed-toggling functions of the recorder will be initiated by a triggering signal introduced from an external source through the recorder's rear-panel BNC connector labeled TRIG or through the rear-panel UTILITY PORT.

If set to OFF, no trigger levels can be recognized by the recorder. The trigger function is disabled.

LEVEL   The LEVEL control is a rotary dial that sets the level of voltage (either positive or negative) which, when present in the selected portion of an input signal, constitutes a trigger. The LEVEL control has three markings: 0, +, and -. When the dial is at 0 (zero), the voltage level is zero. As the dial is rotated clockwise (right, +), positive triggering voltages are set. As the dial is rotated counterclockwise (left, -) negative triggering voltages are set. The positive or negative voltage settings progressively increase as the control is rotated toward its left or right limits.

LAMP   The trigger lamp is an unlabeled, circular LED indicator
           located between the SLOPE and LEVEL controls. The lamp
           illuminates each time a trigger is sensed. When the SLOPE
           switch is set to OFF, the trigger lamp will illuminate only as
           a result of manual triggers.

The use of triggers in relation to the MT-9500's data capture and playback
capabilities is discussed in detail in paragraph 3-6 of this manual.

3-2.6 Power Switch

The black rocker switch labeled POWER is used to turn your recorder on
and off. If you are using a signal conditioner card cage with the your
recorder, the card cage can also be turned on or off through the recorder's
POWER switch.

3-3 Rear Panel Input/Output Connections

The rear panel of the MT-9500 provides numerous interfaces for commu-
nicating with and controlling the recorder through a variety of peripheral
devices and accessories. Figure 3-3 shows the MT-9500 rear panel. Refer
to this figure in following the discussion below. Rear panel features
include:

- Power Input receptacle
  (male receptacle accepts MT-9500 power cord)

- AUXILIARY AC POWER receptacle
  (female receptacle accepts accessory power cord)

- Fan vent

- LA-95 (AUX DISPLAY)
  (15-pin D-shell connector)

- ANALOG INPUT
  (25-pin D-shell connector)

- TALKING SIGNAL CONDITIONER
  (37-pin D-shell connector)

- IRIG OPTIONS
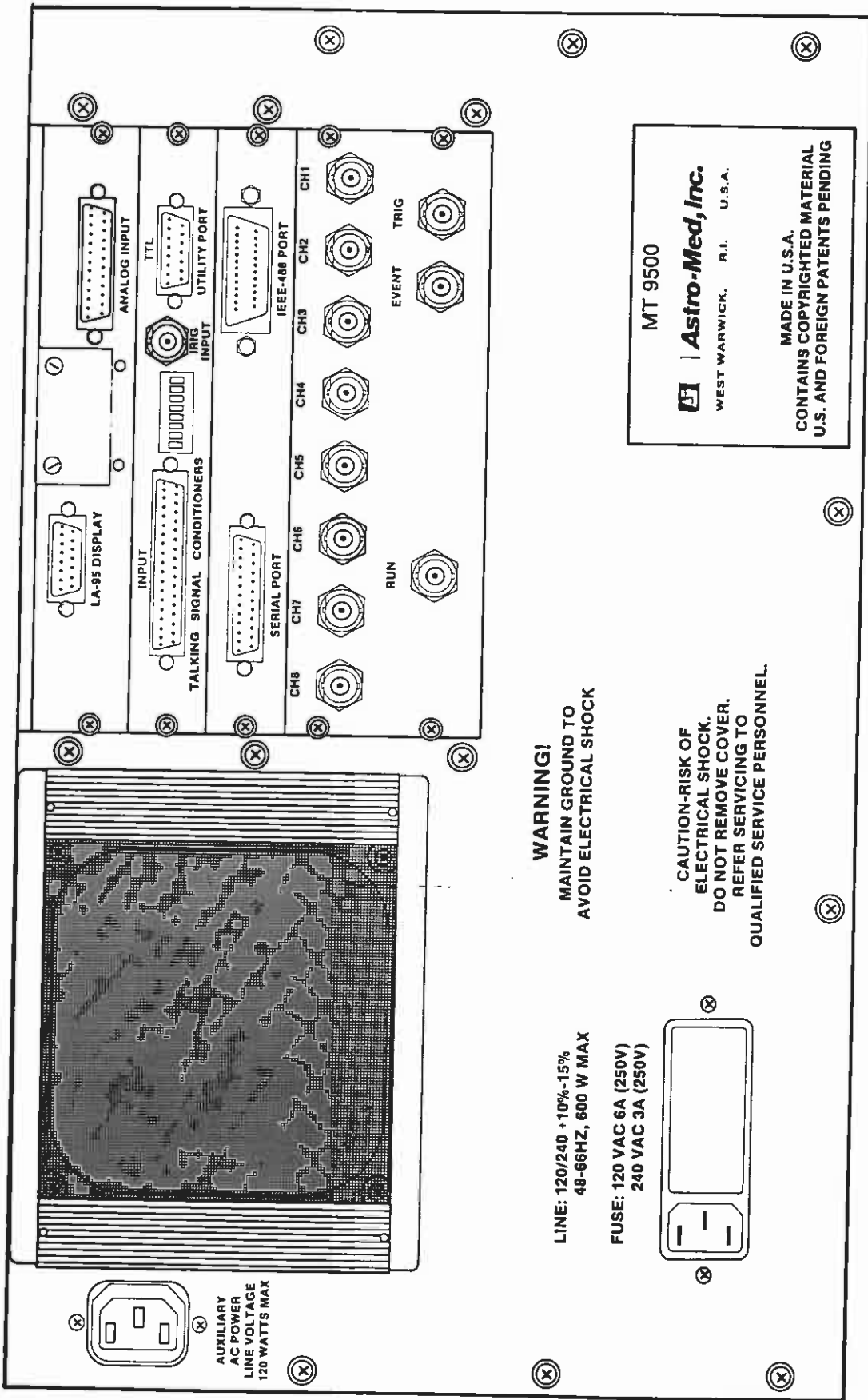 (8 DIP switches)

Figure 3-3. MT-9500 Rear Panel Connections

- IRIG INPUT
  (BNC connector)

- UTILITY PORT
  (15-pin D-shell connector)

- SERIAL PORT
  (25-pin D-shell connector)

- IEEE-488 PORT
  (25-pin connector)

- CH1 through CH8
  (eight analog input BNC connectors)

- RUN
  (BNC connector)

- EVENT
  (BNC connector)

- TRIG
  (BNC connector)

Each rear panel feature is discussed below.

3-3.1 Power Input Receptacle

The power input receptacle is a male connector consisting of three pro-truding contacts. The female end of the MT-9500's power cord is pushed onto these contacts and seated. The male end of the power cord is then inserted into an electrical outlet to supply power to the recorder. The power input receptacle is located in the lower left corner of the rear panel.

<u>Power Requirements</u>

Line:
95 - 132 VAC
190 - 264 VAC
48 - 440 hertz*
600 watts

*Consult factory for operation
 above 66 hertz.

Fuse:
120 volts, 6 amperes (250 V) 1 each
240 volts, 3 amperes (250 V) 1 each

3-3.2 Auxiliary AC Power Receptacle

The AUXILIARY AC POWER receptacle is a standard female electrical connector (120 W max) which is intended to accommodate the power cords of the card cage. It cannot be used for any other purpose. The receptacle is located in the upper left corner of the rear panel.

3-3.3 Fan Vent

The fan vent is a wire-mesh screened area through which air circulated by the ventilation fan enters the recorder.

3-3.4 LA-95 (Aux Display)

The LA-95 (AUX DISPLAY) receptacle is a 15-pin D-shell connector to which the interface cable of the LA-95 accessory (LED Display, paragraph 1-6.1) attaches.

CAUTION

Power to both the recorder and the LA-95 must be OFF before connecting the LED array to the MT-9500. The LA-95 could suffer electrical damage if this caution is not strictly observed.

3-3.5 Analog Input

The ANALOG INPUT receptacle is a 25-pin D-shell connector used to input analog data into the recorder. This D-shell connector can be used in place of the eight BNC analog connectors discussed in 3-3.12 below.

ANALOG INPUT Receptacle Pin Connections

Description		Pin #		Description		Pin #
Channel	1+	2		Channel	6+	12
Channel	1-	3		Channel	6-	13
Channel	2+	4		Channel	7+	14
Channel	2-	5		Channel	7-	15
Channel	3+	6		Channel	8+	16
Channel	3-	7		Channel	8-	17
Channel	4+	8		Trigger		18
Channel	4-	9		Trigger Common		19
Channel	5+	10		Marker		20
Channel	5-	11		Marker Common		21

3-3.6 "Talking" Signal Conditioner

The TALKING SIGNAL CONDITIONER receptacle is a 37-pin D-shell connector used exclusively with the Astro-Med C-950 Signal Conditioner Card Cage to provide the recorder with signal conditioner status data. The data transmitted can be printed with the recorder's waveform trace outputs. Option AP-95 must be ordered to enable printing of signal conditioner status.

3-3.7 IRIG Options

The IRIG time communication option of the MT-9500 recorder is called IRIG-95. The IRIG-95 option allows the recorder to decode modulated or demodulated NASA 36 and IRIG A, B, H time codes. When set to IRIG time, the recorder's internal time and date clock is overridden.

The IRIG OPTIONS control is a series of eight DIP switches that are individually set to establish IRIG time within the recorder. The switches are "on" when they are positioned "up" in their slots. The switches are "off" when they are positioned "down" in their slots. The DIP switches are used in association with the IRIG INPUT BNC connector discussed in paragraph 3-3.8.

DIP switch settings for the IRIG options are:

	S1	S2	S3	S4	S5	S6	S7	S8
Normal Time	on	on	*	off	off	*	X	X
IRIG A	off	on	*	off	off	*	X	X
IRIG B	on	off	*	off	*	*	X	X
IRIG H	off	off	*	off	off	*	X	X
NASA 36	on	on	*	on	*	*	X	X
Remote Start/Stop:								
enable	*	*	on	*	*	*	X	X
disable	*	*	off	*	*	*	X	X
System Log Print Control:								
synchronized††					on	*	X	X
unsynchronized†	-	- - -			off·	*	X	X
Communications Setup:								
original GPIB or RS-232	*	*	*	*	*	off	X	X
enhanced GPIP	*	*	*	*	*	on	X	X

X = switches reserved for future use. They should be placed in the "off" position. ††IRIG B and NASA 36 only. †All time codes.

3-3.8 IRIG Input

IRIG INPUT is a BNC connector used to input IRIG signals into the recorder for decoding by the IRIG-95 option. This connector is used with the appropriately set DIP switches (3-3.7 above) to implement the desired IRIG time code.

3-3.9 Utility Port

The UTILITY PORT receptacle is a multipurpose 15-pin D-shell connector used to communicate various externally generated commands to the recorder. The UTILITY PORT receptacle provides an alternative to the input functions of numerous rear-panel BNC connectors. This port enables you to input the following functions:

- System Event
  (Provides alternative to EVENT BNC connector)

- Eight independent channel events

- Remote start/stop
  (Provides alternative to RUN BNC connector)

- External trigger
  (Provides alternative to TRIG BNC connector)

- Sample clock input
  (Controls either motor speed or data-capture rate)

UTILITY PORT Receptacle Pin Connections

Description*	Pin #	Description	Pin #
/System Event	1	/Event 8 (optional)	9
/Event 1 (optional)	2	Remote Start/Stop	10
/Event 2 (optional)	3	Reserved	11
/Event 3 (optional)	4	External Trigger	12
/Event 4 (optional)	5	Ground	13
/Event 5 (optional)	6	Reserved	14
/Event 6 (optional)	7	Sample Clock	15
/Event 7 (optional)	8		

*The symbol "/" indicates a TTL active low.

3-3.10 Serial Port (RS-232 Interface)

The SERIAL PORT receptacle is a 25-pin D-shell connector that is used as the RS-232 communications interface between the MT-9500 and various host-computer configurations. Control of the MT-9500 by host computer is documented in the MT-9500/MT-8800 Host-Control Operations Manual. Pin connection data for the SERIAL PORT interface are provided in the table below.

SERIAL PORT Receptacle Pin Connections

Description	Pin #	Source
RXD	2	Host
TXD	3	MT-9500
CTS	4	*
RTS	5	*
DTR**	6	MT-9500
Common	7	-
Reserved***	10	-
Reserved***	12	-
Reserved***	13	-
Reserved***	14	-
Reserved***	16	-
DSR**	20	Host
Reserved***	23	-
Reserved***	24	-

8 bits, no parity, 2 stop bits
(Baud rate 300, 1200, 9600, 19.2k)

*Pins 4 and 5 are connected internally.

**DTR is asserted by the MT9500 when the recorder is ready to recieve data from the host. DSR must be asserted to assure that no data are lost. In certain cases, the MT9500 may be run at 300 Baud with DTR and DSR shorted at the recorder and host. This is not generally recommended and is not supported but may operate on some systems.

***Reserve pins may have active voltage. Do not use.

3-3.11 IEEE-488 Port

The IEEE-488 PORT is a connector that is used as the IEEE communications interface between the MT-9500 and various host-computer configurations. Control of the MT-9500 by host computer is documented in the MT-9500/MT-8800 Host-Control Operations Manual. Pin connection data for the IEEE-488 PORT interface are provided in the table below.

IEEE-488 PORT Receptacle Pin Connections

Description	Pin #	Description	Pin #
DIO1	1	DIO5	13
DIO2	2	DIO6	14
DIO3	3	DIO7	15
DIO4	4	DIO8	16
EOI	5	REN	17
DAV	6	GROUND (6)	18
NRFD	7	GROUND (7)	19
NDAC	8	GROUND (8)	20
IFC	9	GROUND (9)	21
SRQ	10	GROUND (10)	22
ATN	11	GROUND (11)	23
SHIELD	12	GROUND LOGIC	24

GROUND (X) = the signal ground return of the referenced contact.

3-3.12 CH1 Through CH8 BNC Connectors

The rear panel of the recorder contains eight individual analog input-signal BNC connectors arranged in a horizontal row. From right to left, these BNC connectors are labeled:

CH8, CH7, CH6, CH5, CH4, CH3, CH2, CH1.

The connectors can be used in place of the 25-pin ANALOG INPUT receptacle to input analog waveform data. Do not use the these BNC connectors and the ANALOG INPUT receptacle at the same time.

3-3.13 Run

The RUN BNC connector permits you to turn the recorder on or off from an external source. The on or off action can be initiated either by a switch closure or a TTL low.

3-3.14 Event

The EVENT BNC connector enables you to mark a system event through an external source when your MT-9500 is operating in the real-time mode. The on or off action can be initiated either by a switch closure or a TTL low.

3-3.15 Trig

The TRIG BNC connector allows you to implement a trigger from an external source through a switch closure or TTL Low when the front-panel trigger slope is set to EXT (external). The trigger can be used to initiate either a data capture or dual-speed toggling.

3-3.16 Trimmer Potentiometers

Eight trimmer potentiometers (figure 3-4) allow you to change the factory-preset gain of each channel of your recorder. The eight potentiometers are located immediately to the left of the rear-panel ANALOG INPUT. They are behind a small (approximately 1 1/2 inch by 1 inch), unmarked plate. The plate is secured at its top by two screws. The potentiometers are arranged in a horizontal line and consecutively labeled in descending order CH8, CH7, ... CH1. Using the procedure given below, each potentiometer can be used to adjust the gain for its corresponding channel to a maximum of +/- 2 volts full scale.

> **NOTE**
>
> The output of Astro-Med signal conditioners has been calibrated to 10 mV per grid division to ensure total compatibility with the CAL settings of the MT-9500. If you alter the gain on any of the recorder's eight recording channels, the compatibility between the recorder's gain settings and the signal conditioner settings is lost for the altered channel. Therefore, **signal conditioners will not provide valid data** if you alter the gain as described below.
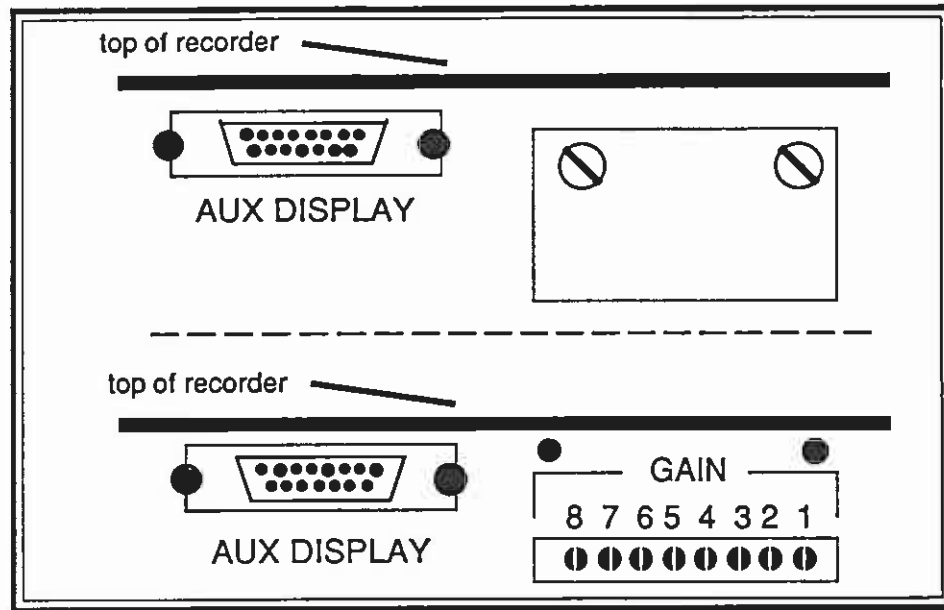
Figure 3-4. Rear-Panel Trimmer Potentiometers (covered and exposed)

1.   Remove the two screws securing the trimmer potentiometer cover plate. Set the screws and the plate aside.

The trimmer potentiometers are now exposed and can be turned to adjust individual channel gain.

2.   Turn the recorder on and place it into eight-channel real-time operation.

If your recorder is equipped with the Overlap Mode option (OM-95), you can place the recorder into the Overlap mode to increase the accuracy of this gain-adjustment procedure.

3.   On the channel you wish to adjust, set the CAL/UNCAL/GND switch to GND.

The trace signal is brought to ground level resulting in a flat-line trace.

4.   Using the ZERO control of the channel you wish to adjust, align the flat-line trace with the right border of the channel grid (as viewed from the recorder's front).

5. After aligning the trace to the right, set the CAL/UNCAL/GND switch to CAL.

6. Connect a calibrated DC voltage source either to

   - the recorder's 25-pin analog input D-shell connector, or

   - any of the eight analog input BNC connectors (CH1 - CH8)

   ┌─ **NOTE** ───
   │
   │ The accuracy of the this gain-adjustment procedure is
   │ directly dependent on the the accuracy of the calibrated
   │ DC voltage source.
   │
   └──

7. Set the full scale calibrated DC voltage to the level you desire (±2 volts max.).

8. Use a small screwdriver to rotate the adjustment screw of the trimmer potentiometer corresponding to the channel you wish to adjust. Turn the adjustment screw until the calibrated DC signal trace aligns with the left border of the channel grid (as viewed from the recorder's front).

   The full scale gain calibration of the selected channel has been ajusted when the calibrated DC signal trace aligns with the left border of the channel grid.

9. With the trimmer potentiometer cover plate removed, repeat steps 2 through 8 for each channel you wish to adjust.

10. Disconnect the calibrated DC voltage source from the input receptacle (ANALOG INPUT D-shell or BNC connector).

11. Reattach the trimmer potentiometer cover plate with its two screws.

3-4 Recorder Setup

Before entering your recorder into any mode of operation, you must complete all of the applicable installation procedures described in section 2, "Installation". When you have finished installing your MT-9500 and have familiarized yourself with its connections and controls, you can prepare the instrument for recording. To prepare for recording: (1) load the recorder with Z-fold thermal paper or with roll thermal paper if the recorder is being used with the rewinder accessory (RW-95), (2) turn the recorder on, (3) set the time and date of the instrument's internal clock, (4) establish the desired recorder setups, and (5) enter the unit into the desired operational mode. Each of these setup procedures is described below.
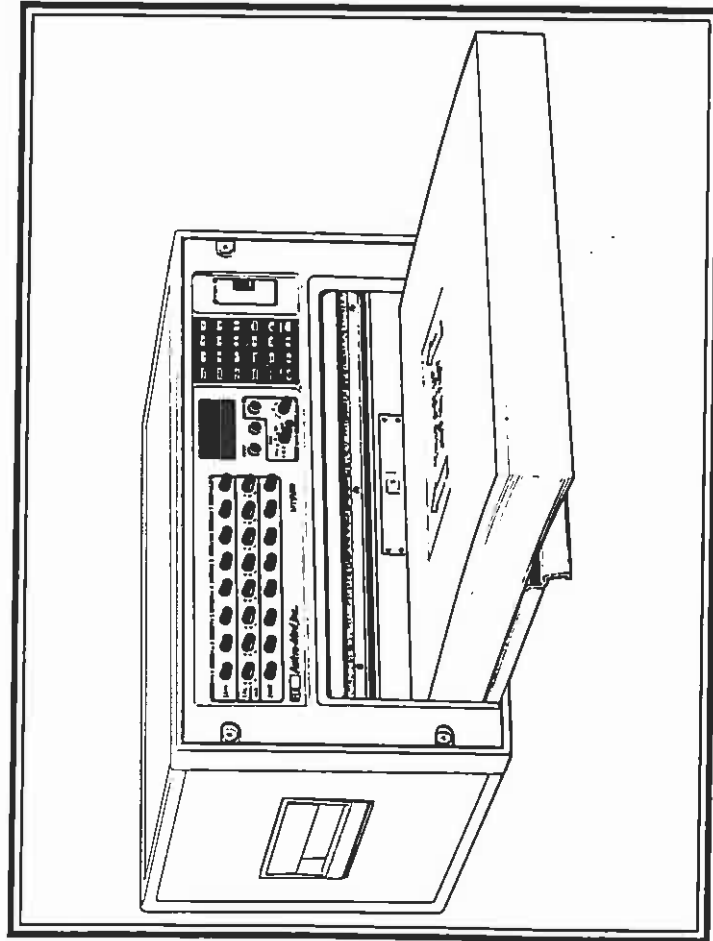
3-4.1 Loading Z-Fold Thermal Paper

Please note that some thermal papers can leave a residue which will eventually clog the recorder's printheads. Astro-Med chart paper is manufactured to exacting standards that eliminate this potential problem. For best results, consider using Astro-Med thermal Z-fold chart paper regularly.

Figure 3-5 illustrates the process of loading the recorder with a 500-sheet pack of Z-fold thermal paper. The recorder can be either on or off during this paper loading procedure. Follow the step by step instructions below to insert and position the paper for data recording.

1.   **Remove the Z-fold thermal paper from its box and locate the "THIS SIDE UP AND IN FIRST" stamp at the top of the paper. Note the two directional arrows on the stamp.**

      Each sheet of Z-fold chart paper is marked with a black rectangle referred to as the index mark or top-of-form mark. This is used by the recorder to position the paper to a point just below the Z-fold perforation.

2.   **Take hold of the lip of the paper-chamber door and pull downward until the door is fully open (horizontal to the surface on which the recorder rests).**

insert paper lead beneath drive roller

position paper for insertion

Figure 3-5. Loading Z-Fold Thermal Paper

fully insert paper pack; close door
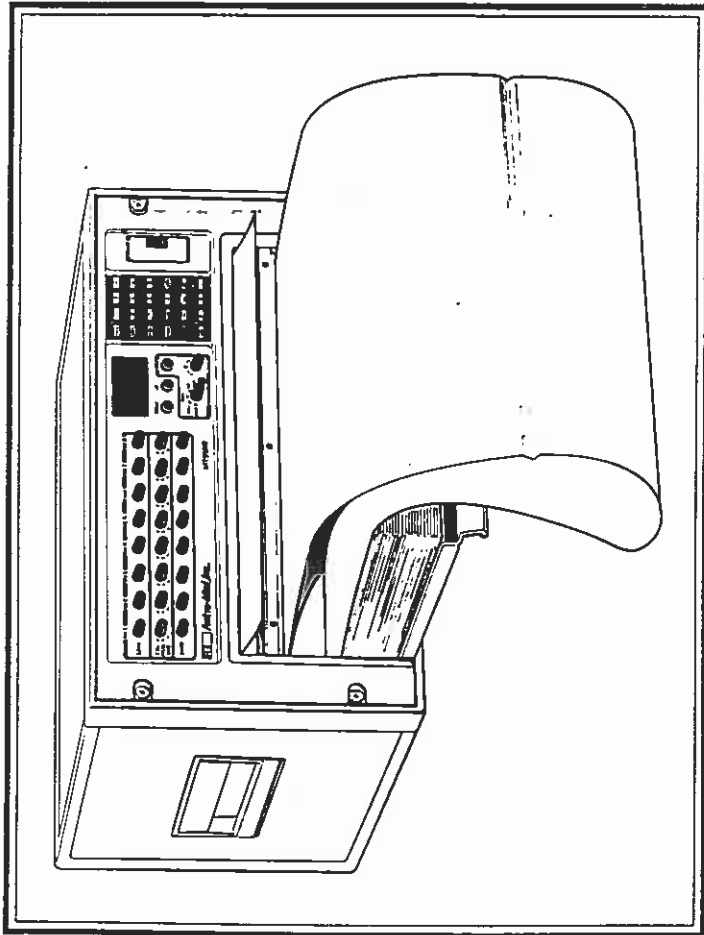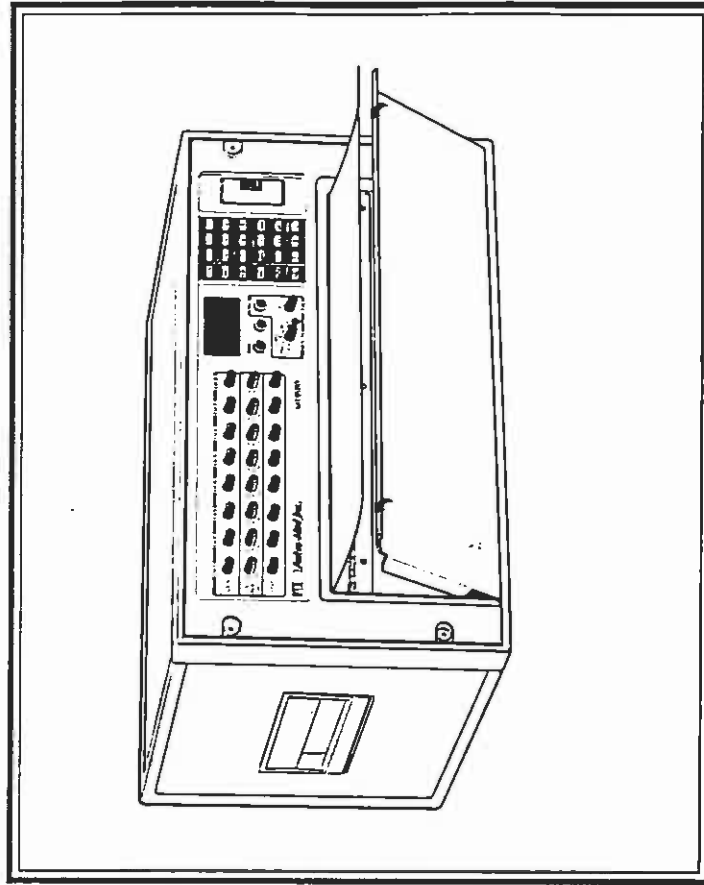
paper lead exits <u>above</u> drive roller

Figure 3-5. Loading Z-Fold Thermal Paper (continued)

3. Place the paper into the paper chamber making sure that the stamped directional arrows point to the rear of the paper chamber.

4. Pull the stamped top sheet of the paper pack out of the recorder.

5. Insert the top sheet (arrows pointing to the rear of the recorder) into the slot <u>beneath</u> the drive roller.

   The drive roller is located directly under the front panel controls. Refer to figure 3-5 for a picture of this process.

6. Manually feed the paper into the recorder and around the drive roller by carefully sliding the paper forward.

7. Push the paper forward until it passes around the drive roller and begins to exit the recorder at the slot <u>above</u> the drive roller.

8. When the paper begins to exit the recorder, evenly pull out a length of approximately six inches or more.

9. Ensure that the chart-paper pack is fully inserted into the paper chamber by pushing it to the rear of the chamber.

10. Hold the six-inch paper lead out of your way and close the paper-chamber door.

    You will hear a slight click when the door closes and feel it snap secure. The recorder is now loaded with a pack of thermal Z-fold chart paper.

11. If you have loaded the paper with the recorder turned off, turn the recorder on by flicking the POWER rocker switch to the "on" position.

The sheets of the paper pack are numbered in descending order from 500 to 1. The page numbers appear along the center line of the chart paper. This keeps you exactly informed about the number of chart-paper sheets remaining in the recorder.

If no paper is in the recorder or if the paper pack has been incorrectly inserted, the recorder will display an <INTRLOCK> error message on its LED display after it has been turned on. An <INTRLOCK> error will also occur if the chart paper runs out during recording. The recorder will not function during an <INTRLOCK> error. To correct this error and return the recorder to a <READY> operational condition, either:

• Insert chart paper into the empty recorder following steps 1 through 10 above, or

• Remove the incorrectly installed chart paper and properly reinsert it following steps 1 through 10 above.

3-4.2 Loading Roll Thermal Paper

Please note that some thermal papers can leave a residue which will eventually clog the recorder's printheads. Astro-Med chart paper is manufactured to exacting standards that eliminate this potential problem. For best results, consider using Astro-Med thermal roll chart paper regularly.

Figure 3-6 illustrates:

• Loading the Rewinder accessory (RW-95) with a roll of thermal paper

• Threading the roll thermal paper through the recorder

• Securing the paper to the rewinder's take-up spool for automatic collection

Roll thermal paper can only be used by the recorder when the recorder is equipped with the Rewinder accessory. The roll paper supply is located in the rewinder. The instructions provided below assume that your MT-9500 and a Rewinder accessory have been correctly attached to one another. If your recorder is being used with the Writing Table accessory (WT-95), the writing table must be removed before the chart paper can be loaded. In the steps given below, "left" refers to the left of the rewinder as you view it from the front. "Right" refers to the right of the rewinder as viewed from the front.

1. Remove the Writing Table accessory if present.
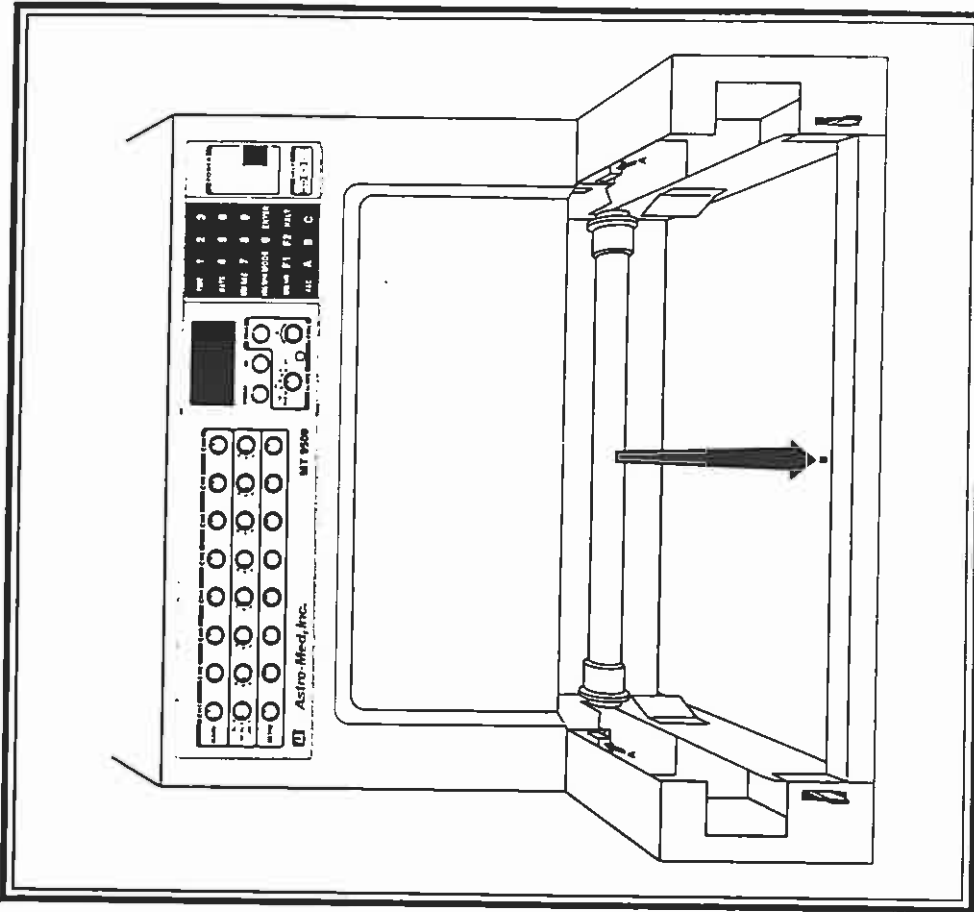
remove paper-supply reel

remove paper-takeup reel

Figure 3-6. Loading Roll Thermal Paper

feed paper lead through recorder

insert loaded paper-supply reel

Figure 3-6. Loading Roll Thermal Paper (continued)

attach paper lead to paper-takeup reel

pull paper to paper-takeup reel

Figure 3-6. Loading Roll Thermal Paper (continued)

2. As described below, remove the rewinder's chart paper take-up reel by individually lifting the exterior latches that visibly protrude from the slots in the rewinder's left and right fron tcorner covers. These latches secure the chart paper take-up reel to the rewinder. The take-up reel is the rewinder's front-most reel.
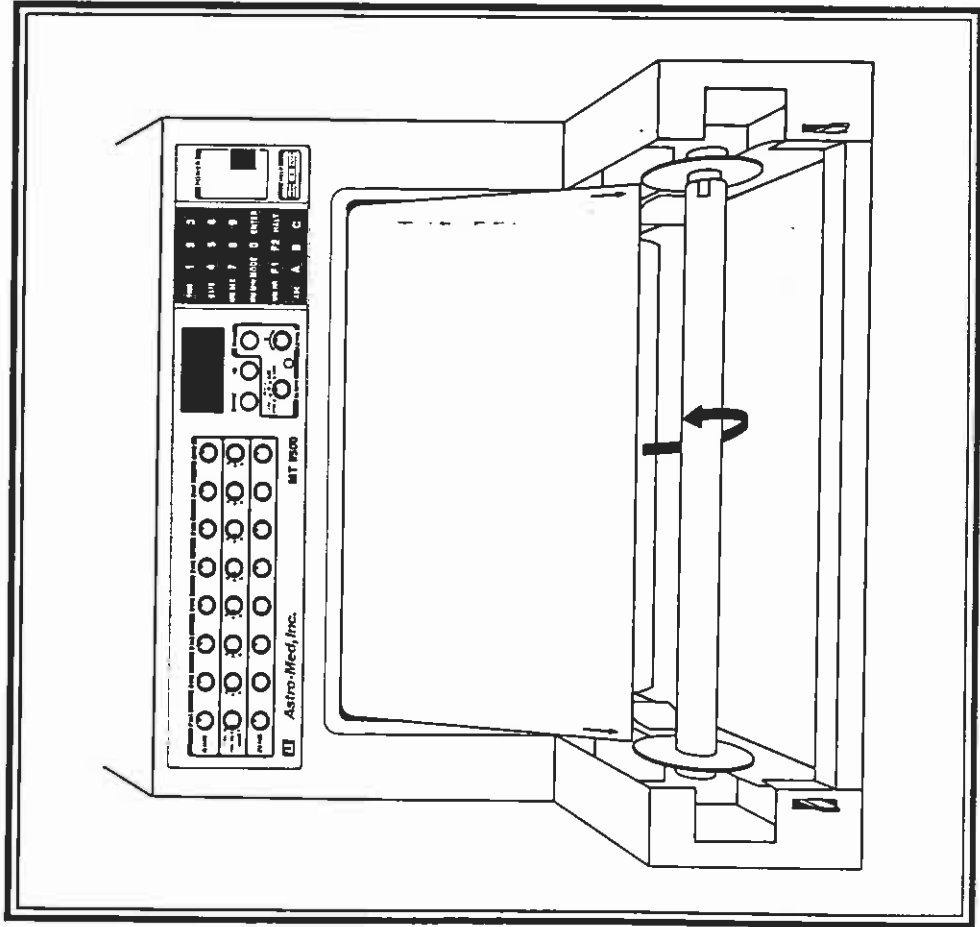
   - Continuously lift the left exterior latch, grasp the left hub of the core of the take-up reel, and pull the core toward you. This will free the left hub of the take-up reel.

   - Continuously lift the right exterior latch, grasp the right hub of the core of the take-up reel, and pull the core toward you. This will free the right hub of the take-up reel.

   - Grasp the freed take-up reel and remove it from the rewinder.

3. Remove any chart paper accumulated on the take-up reel.

   This is done by grasping, pulling, and removing the circular left hub of the take-up reel. The left hub of the reel does not have a gear on it. The right hub of the reel has a gear on it. The spooled paper will have been rewound onto a cardboard tube core. Slide the rewound paper / core off the take-up reel.

4. Place an empty cardboard core on the take-up reel and reinstall the circular left hub of the take-up reel. Set the take-up reel aside.

5. Unlatch the supply reel for removal from the rewinder.

   Reach inside the front of the rewinder and find the latches that secure the chart-paper supply reel. The supply reel is the rewinder's inner-most reel. The latches that secure the supply reel are located near the upper left and upper right sides of the rewinder's interior. You can feel these inner latches extending toward the front of the rewinder. The latches are spring loaded and their tips are bent to form a flat surface for pushing. Individually push each latch back and down. The latches will snap into place and free the supply reel for removal.

6. Reach into the interior of the rewinder and remove the supply reel.

7. The supply reel has one removable hub. Try each hub of the supply reel and remove the detachable hub.

   Remove and save the empty core. You will be able to use the empty core on the rewinder's take-up reel. When you reinsert the supply reel (steps 8 - 10), the removable hub can be positioned on either the left or right side of the rewinder. However, the roll thermal paper must be oriented as described in steps 8 and 9 below.

8. Place a roll of thermal paper on the supply reel and reinsert the removed hub of the reel.

   The roll thermal paper carries a stamp reading "THIS SIDE UP AND IN FIRST." Two directional arrows are also on the stamp. Make sure that the "THIS SIDE UP AND IN FIRST" stamp is right-side up and readable. The two directional arrows must point to the interior of the rewinder. Each sheet of Z-fold chart paper is marked with a black rectangle referred to as the index mark or top-of-form mark. This is used by the recorder to position the paper to a point just below the Z-fold perforation. Roll thermal paper has an index mark every 280 mm.

9. Place the supply reel with its new roll of thermal paper horizontally into the rewinder resting across the interior rails.

   Make sure that the "THIS SIDE UP AND IN FIRST" stamp is right-side up and readable. The two directional arrows must point to the interior of the rewinder.

10. Slide the loaded supply reel into the interior of the rewinder along the rails on which it rests until the reel drops into place.

    You will feel the hubs of the reel drop into place when the reel has been inserted as far as it will go.

11. When the supply reel has dropped into place, individually press and slightly push up the left and right interior latches that secure the reel.

    When pressed and slightly pushed upwards, the latches will snap forward into place and hold the reel in proper position.

12. Take the end of the thermal roll and unwind six to twelve inches of paper. Slide the paper through the space available at the bottom of the paper-chamber door.

    The paper chamber door is hinged at the bottom. When the door is partially opened, space is created and the paper can be fed through easily.

13. With the paper chamber door open, slide the end of the paper into the slot beneath the recorder's drive roller.

14. Push the paper forward until it passes around the drive roller and begins to exit the recorder at the slot above the drive roller. Close the paper-chamber door.

15. Reinsert the paper take-up reel with its empty core (step 5 above) by placing it horizontally in front of the left and right take-up reel latches (step 1) near the front of the rewinder. The gear on the take-up reel must be to the right as you face the rewinder. Push the take-up reel against the latches. The latches will rise and the take-up reel will fall into position as the latches snap down to secure it.

16. Pull the paper through the slot above the drive roller and down to the rewinder's take-up reel. Pass the paper behind and under the core of the take-up reel. Bring the paper up to the front of the take-up reel. Fold the paper back several inches and manually tuck the creased paper around the take-up reel to secure the paper on the core. As necessary, use your hand to turn the take-up reel to wind several inches of paper securely onto the core.

17. Press the circular power button on the front left panel of the rewinder to turn the accessory on.

18. Turn the recorder on.

You are now ready to use the rewinder to spool chart paper as it exits the recorder. The rewinder has a constant-torque motor that applies proper tension to the chart paper. The rewinder works with all recorder chart-paper speeds.

The paper roll is marked into lengths numbered in descending order from 500 to 1. The numbers appear along the center line of the chart paper. This helps to keep you informed regarding the amount of chart paper remaining in the recorder.

If no paper is in the recorder or if the paper roll has been incorrectly inserted, the recorder will display an <INTRLOCK> error message on its LED display after it has been turned on. An <INTRLOCK> error will also occur if the chart paper runs out during recording. The recorder will not function during an <INTRLOCK> error.

To correct this error and return the recorder to a <READY> operational condition, either:

- Insert chart paper into the empty recorder following steps 1 through 18 above, or

- Remove the incorrectly installed chart paper and properly reinsert it following steps 1 through 18 above

3-4.3 Time and Date: Setting the Recorder's Internal Clock and Calendar

The front-panel keypad is used to set the time and date of the MT-9500's internal clock. The recorder's internal clock determines the time and date that appear on the system log and serves as the reference point for all recorder activities that require time/date data.

<u>**To set the recorder's internal clock**</u>

1. Press the [TIME] key on the front-panel keypad.

The LED display will read <00.00> or will reflect the time based on the last setting of the clock.

2. **Press numeric keys [0] through [9] as required to set the clock to the current time.**

    As the numbers are pressed, they are displayed on the front-panel LED display. The time must be entered in 24-hour format. For example, 3:32 pm is 15:32 hours. Use leading zeros as necessary.

3. **Press the [ENTER] key after you have input the current time.**

    The LED display reads <READY>. You can proceed. (The data have been accepted and retained.)

If you have accidently entered a combination of numbers representing a numerically impossible time (e.g., 13:99), the display will briefly read <INVALID> and will revert to the previouly entered time. Enter the appropriate time to correct this condition.

The battery that powers the recorder's internal clock may become depleted if the recorder is shut off for a number of consecutive days. This could invalidate the time and date information stored in the recorder. If this occurs, simply reset the time and date upon recorder power-up.

To set recorder's internal date

1. **Press the [DATE] key on the front-panel keypad.**

    The LED display will read <01/01/88> or will display a date reflecting the last setting of the internal calendar.

2. **Press numeric keys [0] through [9] as required to set the recorder to the current date.**

    As the numbers are pressed, they are displayed on the front-panel LED display. Use leading zeros as required; for example, 03 / 25 / 88.

3. **Press the [ENTER] key after you have input the current date.**

    The LED display reads <READY>. You can proceed. (The data have been accepted and retained.)

If you have accidently entered a combination of numbers in the month or day number positions of the LED display (MM/DD/YY) that represents a numerically impossible date (e.g., 13/48/88), the display will briefly read <INVALID> and will revert to the previouly entered date. Enter the current date to correct this condition.

The battery that powers the recorder's internal clock may become depleted if the recorder is shut off for a number of consecutive days. This could invalidate the time and date information stored in the recorder. If this occurs, simply reset the time and date upon recorder power-up. The battery will gradually recharge during operation.

3-4.4 Entering Operational Modes

If you have followed the procedures given to this point, you are now ready to define the recorder's operational setup functions and to enter the recorder into an operational mode. In accomplishing these tasks, you will make extensive use of the recorder's front-panel data-entry keypad (3-2.1).

Your recorder is equipped with a standard operational mode: *Real-Time Operation*. If you have ordered the Data Capture option (DC-95), your recorder will have an additional operational mode: *Data Capture and Playback*. These two operational modes and the capabilities they provide are discussed in the paragraphs that follow. We begin with the recorder's basic and versatile capability: *Real-Time Operation*.

3-5 Real-Time Operation

In the real-time operational mode, the MT-9500 functions as a real-time, high-speed, analog oscillographic recorder. Three modes are available to you during real-time operation of the recorder:

Eight-Channel Real-Time Recording	MODE 0
Overlap Real-Time Recording	MODE 1
Dual Speed Operation	MODE 4

If the Datalogger option (DL-95) is installed in your recorder, a fourth mode is available during real-time operation: MODE 9.

The Datalogger option enables the recorder to convert waveform data into tables of engineering units that you specify.

Before discussing the individual real-time recording modes, it is necessary to discuss a number of real-time recording setups. The waveform output of the real-time recording modes is affected by each real-time recording setup. If you do not enter your own setups, the recorder will use the pre-established, factory-default setups of table 3-3.

Paragraph 3-5.1 defines the MT-9500's real-time recording setups.

3-5.1 Real-Time Recording Setups

Table 3-3 lists the MT-9500's real-time recording setups and their generic keying sequences. Each of the setups will be individually discussed in the paragraphs that follow. Notice that each recording setup has an influence on the recorder's output. Using the real-time setups, you can, for instance: turn the grid on or off; set the recorder's channel order; reverse an input signal's polarity; set the desired chart-paper speed; and much more.

Table 3-4 lists the factory default real-time setups of the recorder. If you do not wish to key-in your own setups, the recorder will automatically use the factory defaults.

> **NOTE**
>
> It is always sensible to establish your initial recording setups before using your recorder in a task. However, you can access and alter your setups **at any time during real-time operation.** You can change modes, functions, recorder speeds, etc. instantly simply by entering the keying sequences described below.

3-5.1.1 Time Setup. Refer to paragraph 3-4.3 for an explanation of setting the recorder's internal clock.

3-5.1.2 Date Setup. Refer to paragraph 3-4.3 for an explanation of setting the recorder's internal date.

Table 3-3. Recorder Real-Time Setups

Setup	Keying Sequence
Time	[TIME] [H] [H] [M] [M] [ENTER]
Date	[DATE] [M] [M] [D] [D] [Y] [Y] [ENTER]
Speed	[MM/SEC] or [MM/MIN]or [MM/HR] [X] [X] [X] [ENTER]
Insta-Speeds	[ABC] [A] or [B] or [C] [MM/SEC] or [MM/MIN] or [MM/HR] [X] [X] [X] [ENTER]
Channel Order Set	[F1] [0] [ENTER]
Grid Printing On/Off	[F1] [1] [ENTER]
Event or Annotation	[F1] [2] [ENTER]
Signal Polarity Reverse	[F1] [7] [ENTER]
Annotation Entry	[F2] [0] [ENTER]
Factory Defaults	[F2] [2] [ENTER]
Timed Operation	[F2] [3] [ENTER]
Snapshot Sample Rate Clock Source	[F2] [5] [ENTER]
Communications Type (local or host)	[F2] [6] [ENTER]
Real-Time Motor Speed Source	[F2] [7] [ENTER]
Signal Conditioner Print Status	[F2] [8] [ENTER]

Table 3-4. Factory Default Real-Time Setups

Setup	Factory Default Setting*
Time	00.00
Date	01/01/88
Speed	025 mm/sec
Insta-Speeds	A = 001 mm/s B = 025 mm/s C = 050 mm/s
Channel Order Set	12345678**
Grid Printing On/Off	On
Event or Annotation	AAAAAAAA**
Signal Polarity Reverse	NNNNNNNN**
Annotation Entry	First eight buffer spaces of each channel programed to read: CHANNEL X (x = appropriate channel number)
Timed Operation	Off
Snapshot Sample Rate Clock Source	INTERNAL
Communications Type (local or host)	KEYPAD
Real-Time Motor Speed Source	INTERNAL
Signal Conditioner Print Status	NNNNNNNN**

*This list applies to a recorder equipped with all firmware options.

**The eight characters of the display represent each of the recorder's eight channels.

3-5.1.3 Speed Setup. The speed setup establishes the speed at which chart paper runs.

Either accept the factory default listed in table 3-2 by pressing [ENTER] or follow the steps given below to set the chart speed. The data you enter will appear on the front-panel LED display.

1. **Press the [MM/SEC], [MM/MIN], or [MM/HR] key to specify whether you want the chart paper to be output in millimeters per second, per minute, or per hour.**

   The LED display will read the factory default or as last set.

2. **Press three numeric keys from [0] through [9] to specify the speed at which you want the paper to run. Use leading zeros as necessary.**

3. **Press the [ENTER] key to instruct the recorder to accept the data you just entered.**

   The LED display reads <READY>. The data have been accepted and you can proceed.

4. **Program each of the remaining keys ([MM/SEC], [MM/MIN], or [MM/HR]) following steps 1 through 3 above.**

3-5.1.4 Insta-Speed Setups. The insta-speed setup allows you to preprogram three chart-paper speeds. You can then instantly access these speeds by pressing the keypad's [A], [B], or [C] keys.

Either accept the factory defaults listed in table 3-2 or follow the steps given below to set the insta-speeds. The data you enter will appear on the front-panel LED display.

1. **Press the [ABC] (single) key.**

   The front panel LED displays reads: <A, B OR C>.

2. **Press the [A] key.**

   The LED display will either show the factory default or read as last set. Press [ENTER] to accept the setting or set the [A]-key insta-speed as described below.

3.   Press [MM/SEC], [MM/MIN], or [MM/HR] to specify the speed
      range at which you want the chart paper to run.

      The LED display changes to reflect your selection: [MM/SEC],
      [MM/MIN], [MM/HR]. The recorder defaults to [MM/SEC].

4.   Press three numeric keys from [0] through [9] to specify the
      speed at which you want the paper to run.

      The LED display will change to show the input speed.

5.   Press the [ENTER] key.

      The LED display reads <READY>. The data have been accepted
      and you can proceed.

6.   Repeat steps 1 through 5 for keys [B] and [C].

3-5.1.5 Timed Operation Setup. The timed-operation setup allows you
to program the recorder (1) to start recording at a predetermined time,
(2) to run the chart-paper at a predetermined speed, and (3) to stop
recording at a predetermined time. This permits real-time recording
without the presence of an operator.

The factory default sets-timed operation to <TIMEROFF>. After you have
accessed the timed-operation set-up, either:

•   accept the factory default by repeatedly pressing
      [ENTER] to scroll through the setup until the LED
      reads <READY> or

•   follow the steps given below to set timed operation of the
      recorder to your requirements.

The data you enter will appear on the front-panel LED display.

1.   Press the [F2] key.

      The LED display reads <EDIT CH>.

2.   Press the [3] key.

      The LED display reads <TIMER>.

3. **Press the [ENTER] key.**

*The recorder will display the default setting, <8 CH RT>, or the
last setting. If the Overlap Waveform option (OM-95) is not
installed, the overlap waveform feature, <OVLAP RT>, will not
be available.*

*If your recorder is equipped with the Overlap Waveform option, the
LED display will read <8 CH RT> or <OVLAP RT> depending on the
last setting. If the display reads <8 CH RT>, this indicates that the
recorder is set for eight-channel real-time recording and that recorder
output will be formatted as eight individual 40 mm channels.
Press [ENTER] if you desire eight-channel format.*

*If you wish recorder output to be in overlapped format, press either the
[A] or [C] key. The LED display will read <OVLAP RT>. (Pressing either
the [A] or [C] key causes the recorder to toggle between the <8 CH RT>
format and the <OVLAP RT> format.) Press the [ENTER] key when the
LED displays reads <OVLAP RT> to establish overlap format for recorder
output. Two expanded grids each containing four overlapping waveforms
are output.*

4. **Press the [ENTER] key.**

*The LED display will read <ST 00.00> or the last start time entered.
Either accept the displayed start time by pressing [ENTER] or set the
desired start time as described in step 5. (If you press [ENTER], the LED
display will change to <SP 00.00> to allow you to set recording stop time.)*

5. **Press four numeric keys from [0] through [9] to enter the desired
   start time in 24-hour format. Use leading zeros as necessary.**

The LED display shows the numbers you enter.

6. **Press the [ENTER] key.**

*The LED display will read <SP 00.00> or the last stop time entered.
Either accept the displayed stop time by pressing [ENTER] or set the
desired stop time as described in step 7. (If you press [ENTER], the LED
display will read either <TIMEROFF> or <TIMER ON>.)*

7.   Press four numeric keys from [0] through [9] to enter the desired stop time in 24-hour format. Use leading zeros as necessary.

The LED display shows the numbers you enter.

8.   **Press the [ENTER] key.**

The LED display will read <TIMEROFF>.

9.   **Press either the [A] key or the [C] key.**

The display will switch between <TIMEROFF> and <TIMER ON> as you press the key. When the display reads as you desire, press the [ENTER] key.

If you entered <TIMER ON> and pressed the [ENTER] key, the LED display will alternately flash <ON AT> and the start time in 24-hour format that you entered in step 5 above. Confirm your start time and press [HALT]. The LED display reads <READY>. The data have been accepted and you can proceed.

If you entered <TIMEROFF> and pressed the [ENTER] key, the LED display will read <READY> indicating that the recorder is ready to be placed into the mode or function of your choice. Because you entered <TIMEROFF>, timed operation of the recorder will not take place.

3-5.1.6 Event or Annotation Setup.

The event or channel annotation setup is available only on those recorders equipped with both the Alphanumeric Printing option (AP-95) and the Event Marker option (EM-95).

The event or annotation setup allows you to specify whether event markers or alphanumeric data will be printed in the interchannel buffer spaces to the right of each channel.

┌─ **NOTE** ──┐

This setup only establishes whether event markers or alphanumeric
data will appear in the interchannel buffers. It **does not** specify the
content of the buffers, that is, it does not specify what alphanumeric
data will be printed in the buffers. The Annotation Entry setup
(paragraph 3-5.1.7) allows you to specify the alphanumeric data that
will be printed in the buffers.

└──┘

The factory default sets the LED display of the event or annotation setup to
<AAAAAAAA> indicating that each of the eight recording channels will print
alphanumeric content rather than event markers in the interchannel buffers.
Either accept the factory defaults by pressing [ENTER] or follow the steps
given below to set each channel to the desired status. The data you enter will
appear on the front-panel LED display.

1. **Press the [F1] key.**

   The LED display reads <CH.ORDER>.

2. **Press the [2] key.**

   The LED display reads <EVT/TEXT>.

3. **Press the [ENTER] key.**

   The LED display reads the default, <AAAAAAAA>, or as last set.

4. **Press numeric keys [1] through [8]. (Pressing either the zero [0]
   key or the [9] key has no affect.)**

   *Each digit represents its corresponding recording channel. As you
   press each key, the display for that channel will switch between:*

   < A > Indicating alphanumerics will be printed in the channel

   < E > Indicating an event marker will be printed in the channel

   *Switch each channel to the setting of your choice. Each channel can be
   individually and independently set.*

5. **Press the [ENTER] key.**

   The LED display reads <READY>. The data have been accepted and you can proceed.

3-5.1.7 Annotation Entry Setup.

The annotation entry setup is available only on those recorders equipped with the Alphanumeric Printing option (AP-95).

The annotation entry setup allows you to specify the characters that will be printed in the interchannel buffer of each recording channel when that channel has been set to alphanumeric printing as described in paragraph 3-5.1.6 above.

Each of the eight interchannel buffers contains 100 character spaces that can be individually changed. The 100 character spaces of each buffer can be scrolled through and changed as described below.

Suggestion: If you have the Keyboard accessory (KB-220), you can enter alphanumeric text directly into the interchannel buffers very conveniently without the necessity of performing the character-by-character process described below. If your work requires much alphanumeric entry, the KB-220 accessory can be a great help.

Factory defaults set the first ten character spaces of each interchannel buffer to read "CHANNEL #X" (where X is one number from 1 through 8). The procedure for changing these defaults is provided below. The data you enter will appear on the front-panel LED display.

1. **Press the [F2] key.**

   The LED display reads <EDIT CH>. This means that you have accessed the capability to edit (annotate) the alphanumeric content of the interchannel buffers.

2. **Press the [ENTER] key.**

   The display reads <BUFFER ?>.

3. **Press numeric keys [1] through [8] individually to access the interchannel buffer of your choice.**

   As each numeric key is pressed, the corresponding buffer number is shown on the LED display.

4. **Press the [ENTER] key.**

   The recorder accesses the selected buffer and the LED display reads <00 67 C> or as last set. Initially, the recorder always accesses location 00 of the selected buffer.

   The display will always consist of five characters: two first numbers, two middle numbers, and a final character. For instance, the factory default, <00 67 C>, indicates that location 00 (first two numbers) within the selected buffer contains ASCII code 67 (middle two numbers). ASCII code 67 equates to the displayed upper-case "C" (final character). Therefore, upper-case "C" will be printed at this location within the selected buffer when hardcopy recorder output is obtained. Table 3-5 contains a complete list of the ASCII codes and their alphanumeric equivalents pertinent to MT-9500 operation.

   By following steps 5 and 6, you can now:

   - scroll through and edit locations 00 through 99 of each interchannel buffer

   - access and edit the ASCII code that determines what character will be printed at the selected location within each buffer.

5. **Either accept the displayed location within the selected buffer (the first two digits of the LED display) or change the location. Change location within the buffer by scrolling through or by directly accessing the buffer using any of the following methods.**

   a. Press the [C] key to scroll forward and advance through each buffer location of the channel to a maximum location of 99.

      The first two digits of the LED display will change as the [C] key is pressed to display the current location within the interchannel buffer.

Table 3-5. Editing Interchannel Buffers: ASCII Codes (Decimal) and Character Equivalents

ASCII Code	Character	ASCII Code	Character
32	(space)	65	A
33	! (x)	66	B
34	"	67	C
35	# (x)	68	D
36	$	69	E
37	%	70	F
38	&	71	G
39	'	72	H
40	((x)	73	I
41	) (x)	74	J
42	*	75	K
43	+	76	L
44	,	77	M
45	-	78	N
46	.	79	O
47	/	80	P
48	0	81	Q
49	1	82	R
50	2	83	S
51	3	84	T
52	4	85	U
53	5	86	V
54	6	87	W
55	7	88	X
56	8	89	Y
57	9	90	Z
58	: (x)	91	[
59	; (x)	92	\ (x)
60	< (x)	93	]
61	=	94	^ (x)
62	> (x)	95	_
63	?		
64	@		

(x) The character for this ASCII code does not appear on LED display.

This table reflects the ASCII characters available under local control. Additional characters are available during host-control operation.

The middle two digits of the LED display will change as the [C] key is pressed to show the ASCII code present at the displayed location.

The final character of the display will change as the [C] key is pressed to show the character equivalent of the displayed ASCII code.

If the character equivalent of the ASCII code is a blank space (ASCII code 32) or a character that the LED display can't create, the final character of the display will not be shown.

Stop at the buffer location you wish to change. The first two digits of he LED display will not change after they reach 99.

b.　Press the [A] key to scroll backward and reverse your way through the locations within the selected buffer from the maximum location of 99 down to 00.

The first two digits of the LED display will change as the [A] key is pressed to display the current location within the interchannel buffer.

The middle two digits of the LED display will change as the [A] key is pressed to show the ASCII code present at the displayed location.

The final character of the display will change as the [A] key is pressed to show the character equivalent of the displayed ASCII code.

If the character equivalent of the ASCII code is a blank space (ASCII code 32) or a character that the LED display can't create, the final character of the display will not be shown.

Stop at the buffer location you wish to change. The first two digits of the LED display will not change after they reach 00.

c.　Press the [ABC] (single) key to immediately access the buffer location of your choice without scrolling.

*The LED display reads <GO TO 00>. Press any two numeric
keys from [0] to [9] to specify the location of your choice within
the buffer. Press [ENTER]. The LED display instantly shows:
your choice of location within the buffer (the first two digits),
the ASCII code (the last two digits) currently programmed for
that location, and the character equivalent of the ASCII code
(final character).*

*If the character equivalent of the ASCII code is a blank space
(ASCII code 32) or a character that the LED display can't
create, the final character of the display will not be shown.*

6. **Either accept the ASCII code displayed for the location
    within the buffer (the second two digits of the LED) or
    change the code by:**

    •   **referring to table 3-3 for the two digit code of the
        letter, number, or character you wish to enter**

    •   **using keys [1] through [9] to enter the selected
        ASCII code**

    *The LED display will show the digits you enter as they are pressed.
    The character-equivalent of the input ASCII code will appear as the
    final character of the display.*

    *If the character equivalent of the ASCII code is a blank space
    (ASCII code 32) or a character that the LED display can't create,
    the final character of the display will not be shown.*

7. **Press the [HALT] key to instruct the recorder to accept
    the data you just entered without clearing the remainder of
    the buffer locations.**

    *The LED display reads <READY>. The data have been accepted
    and you can proceed.*

Pressing the [HALT] key is the preferred method for finalizing data entry when defining the annotation entry setup. It is important to note that using the [HALT] key enters the data you changed and preserves the data in the buffer locations that you left unchanged.

8. **Press the [ENTER] key to instruct the recorder to accept the data you just entered and to clear all data from the remaining buffer locations.**

   The LED display reads <READY>. The data have been accepted and you can proceed.

   When you press the [ENTER] key, the data you just entered are accepted and retained. However, be very aware that when you use the [ENTER] key to finalize your data entry in this function, the data in all remaining buffer locations within that channel are cleared.

3-5.1.8 Signal Conditioner Print Status Setup.

The signal conditioner print status setup is available only on those recorders equipped with the Alphanumeric Printing option (AP-95). This setup is only applicable when the recorder is used in conjunction with signal conditioners and a signal-conditioner card cage.

The signal conditioner print status setup allows you to enable or prohibit printing of signal conditioner status data in the last 40 character spaces of each interchannel buffer. In the factory default condition, the printing of signal conditioner status information is disabled. Either accept the factory defaults or enable signal conditioner printing status by performing the steps below.

1. **Press the [F2] key.**

   The LED display reads <EDIT CH>.

2. **Press the [8] key.**

   The LED display reads <SIG COND>.

3. **Press the [ENTER] key.**

   The LED display reads <NNNNNNNN> (the factory default) or as last set. <N> signifies no signal conditioner reporting for each channel.

4. Either accept the factory defaults or previous settings by pressing the [ENTER] key or activate the reporting status of each channel as described in step 5.

5. Press eight numeric keys from [1] through [8].

    Each number key represents its corresponding recording channel. As each key is pressed, the reporting status of the channel switches between <N> and <Y>. Press keys [1] through [8] until the reporting status of each channel reads as you desire. <Y> indicates YES, signal conditioner status will be recorded in the interchannel buffer.

6. Press the [ENTER] key.

    The LED display reads <READY>. The data have been accepted and you can proceed.

3-5.1.9 Channel Order Setup. The channel order setup allows you to specify the playout order of the recorder's eight channels. This is a particularly helpful feature if you wish to perform comparisons between waveform data that are not in adjacent recording channels. With this setup, channel order can be changed quickly to any arrangement that you desire. Each channel is paired with an interchannel annotation buffer. The interchannel buffer moves with its associated channel whenever the channel order is changed.

The channel order established by the factory default setting is <12345678>. This means that, as viewed from the recorder's front, the left-most channel is channel 1 with the remaining channels progressively numbered from 2 through 8 across the chart.

Either accept the factory defaults or change the channel order setup as described below.

1. Press the [F1] key.

    The LED display reads <CH. ORDER>.

2. Press the [ENTER] key.

    The display reads either the factory default, <12345678>, or as last set.

3. **Press numeric keys [1] through [8] in the channel order you desire.**

The first number entered appears on the right side of the display and moves left as additional numbers are entered. The number in the left-most position of the display corresponds to the channel printed in the left-most position on the chart paper. Each succeeding number represents an adjoining channel progressing to the right-most channel of the chart.

4. **Press the [ENTER] key.**

The display reads <READY>. The channel order you entered has been accepted and you can proceed.

3-5.1.10 Grid Printing On/Off Setup. The grid printing on/off setup allows you to specify whether or not a grid will be printed with the recorder's waveform output. The factory default sets the grid-printing setup to <GRID ON>.

Either accept the factory default or change the grid printing setup as described below.

1. **Press the [F1] key.**

The LED display reads <CH_ORDER>.

2. **Press the [1] key.**

The LED display reads <GRID>.

3. **Press the [ENTER] key.**

The LED display reads either the factory default, <GRID ON>, or <GRID OFF>.

4. **Press either the [A] or [C] keys.**

The display will switch between <GRID ON> and <GRID OFF> as either key is pressed. Press either key until the LED display reads as you desire.

5.   Press the [ENTER] key.

The LED display reads <READY>. The choice you selected has been accepted and you can proceed.

3-5.1.11 Signal Polarity Reverse Setup. The MT-9500 inputs are preset to the industry standard polarity:

Positive signals move toward the left edge of the grid

Negative signals move toward the right edge of the grid

However, as a result of the inconsistencies of certain transducers or for purposes of comparison, it can be useful to reverse standard polarity. The signal polarity reverse setup allows you to specify the polarity of each channel without rewiring signal input connections. The factory default for this setup is <NNNNNNNN>. This indicates that the polarity of of each channel is non-inverted, <N>. The polarity of each channel can be inverted, <I>, by using the procedure given below.

Either accept the factory default or change the signal polarity setup for each channel as described below.

1.   Press the [F1] key.

The LED display reads <CH. ORDER>.

2.   Press the [7] key.

The display reads <INVERT>.

3.   Press the [ENTER] key.

The display reads either the factory default, <NNNNNNNN>, or as last set.

4.   Press any numeric keys from [1] through [8] corresponding to the channel(s) whose signal polarity you want to change.

As each key is pressed, its corresponding indicator on the LED display will switch between <N> (noninverted) and <I> (inverted). Press each numeric key until each channel reads <N> or <I> according to your preference.

5. **Press the [ENTER] key.**

The display reads <READY>. The signal inversion set-ups you entered were accepted and you can proceed.

3-5.1.12 Real-Time Motor Speed Source Setup. *The Remote Drive option, RD-95, is required for this function.* Data recorded by the MT-9500 are printed at a rate referenced to the recorder's internal clock. The recorder's stepper motor advances the chart paper in relation to time. You may wish to reference stepper motor speed to a factor other than time, for example, distance. The real-time motor speed source setup allows you to control the speed of the stepper motor by means of a pulse train that you supply rather than the recorder's internal clock. In other words, this setup allows you to control the speed of the stepper motor clock through an external speed source. (Consult the MT-9500/MT8800 Host-Control Operations Manual for a description of how this is accomplished using a host computer.) Connection of your TTL pulse train signal to the MT-9500 is made through pin 15 of the recorder's rear-panel UTILITY PORT receptacle. The pulse rate of the input signal must be between 0 - 800 Hz. A handy formula for deriving chart speed when using this setup is:

$$\text{Speed} = \text{frequency} / 16 \quad \text{For example, } 800 / 16 = 50 \text{ mm/s}$$

> **NOTE**
>
> When the recorder is set for external stepper-motor speed control, the MT-9500 will print and advance the chart paper only in relation to the pulse train you supply. If no pulse is present, the recorder will not print and will not advance the chart paper.

Follow the procedure presented below to implement the real-time motor speed source setup.

1. **Press the [F2] key.**

The LED display reads <EDIT CH>.

2. **Press the [7] key.**

   The display reads < MCLK SRC>. This means that you are about to select a stepper motor clock source.

3. **Press the [ENTER] key.**

   The display will read either <EXTERNAL> or <INTERNAL> depending upon on how it was last set. <EXTERNAL> references the stepper motor to your input pulse train. <INTERNAL> references the stepper motor to the recorder's internal clock.

4. **Press either the [A] key or the [C] key.**

   The display will switch between the <EXTERNAL> and <INTERNAL> displays. Stop when the LED display shows the setting that you desire.

5. **Press the [ENTER] key.**

   The displays reads <READY>. The motor speed source option that you selected has been entered. You can proceed.

3-5.1.13 Set Communications Type Setup. The set communications type setup allows you specify whether the recorder will be operated:

- under local control through the MT-9500 front-panel keypad or

- under host control by connecting the MT-9500 to a host computer using the recorder's rear panel's SERIAL PORT receptacle or UTILITY PORT receptacle.

Follow the procedure below to implement the set communications type setup.

1. **Press the [F2] key.**

   The display reads <EDIT CH>.

2. **Press the [6] key.**

   The display reads <SET COMM>.

3. **Press the [ENTER] key.**

   The display will read <KEYPAD> or as last set.

4. **Press either the [A] key or [C] key to scroll through the three available communications settings: <KEYPAD>, <RS232>, and <GPIB>.**

   The display will show each of the communications settings as the key is pressed. Stop when the display shows the setting of your choice.

5. **Press the [ENTER] key.**

   If you chose the <KEYPAD> setting, the display will briefly show the word <WAIT> and will then read <READY>. The recorder has been placed into local (keypad) control. You can proceed.

   If you chose the <RS232> setting, the display will read <BR   300> or as last set. You must now scroll through the four baud rate (BR) settings and select the baud rate of your choice.

   - **Press either the [A] key or the [C] key to view the available settings.**

     As either key is pressed, the display will show the following settings: <BR   300>, <BR   1200>, <BR   9600>, <BR   19200>.

   - **Stop at the baud rate setting of your choice and press the [ENTER] key. The display reads <RS232   .>.**

     Note that the display contains a blinking red dot indicating that the recorder has been placed under host computer control and is awaiting RS232 communications.

   - **Consult your <u>MT-9500/MT8800 Host-Control Operations Manual</u> for further host-control operational instructions.**

*If you chose the <GPIB> setting, the display will read <GPIB 05>
or as last set. This indicates the current GPIB address.*

- **Change the GPIB address by pushing any two numeric
  keys of your choice. Valid addresses are between 00
  and 30.**

  The display will change to show the numbers you entered.

- **When you have selected a GPIB address, press the
  [ENTER] key.**

  *The display will read <GPIB XX.> showing the numbers
  you entered and a blinking red dot. This indicates that the
  recorder has been placed under host computer control and is
  awaiting GPIB communications at the displayed address.*

- **Consult your <u>MT-9500/MT8800 Host-Control
  Operations Manual</u> for further host-control
  information.**

Use the procedure below to return the recorder to local control from either
of the host control communications options.

1. **While the recorder is in either the <RS232 .> setting or the
   <GPIB XX.> setting, press the [F2] key.**

   The display reads <SET COMM>.

2. **Press the [ENTER] key.**

   *The display will change to show the current host control
   communications setting.*

3. **Press either the [A] key or the [C] key to display the three
   communications settings: <KEYPAD>, <RS232>, and <GPIB>.
   Stop when the display reads <KEYPAD>.**

4. **Press the [ENTER] key.**

   *The display will briefly read <WAIT> and will then read <READY>.
   The recorder has been returned to local (front-panel keypad) control.
   You can proceed.*

3-5.1.14 Set Factory Defaults Setup. The set factory defaults setup is used to return the existing values of all function command settings to their respective factory default values. Use the procedure given below to implement this setup.

1. **Press the [F2] key.**

   The LED display reads <EDIT CH>.

2. **Press the [2] key.**

   The display reads <DEFAULTS>.

3. **Press the [ENTER] key.**

   The display will read either <FULL> or <PARTIAL> depending on how the recorder was last set.

4. **Press either the [A] key or the [C] key to switch between the two settings. When the display reads as you desire, press the [ENTER] key.**

   - *If you selected the <FULL> defaults option and pressed [ENTER], the display will read <READY>. Full factory default setup values have been implemented and you can proceed.*

   - *If you selected the <PARTIAL> defaults option and pressed [ENTER], the display will read <READY>. All factory default setup values have been implement except that no interchannel buffer data are affected.*

3-5.1.15 Define Snapshot Sample Rate Clock Source Setup. *The Data Capture option (DC-95) is required for this function.* Just as the speed of the stepper motor can be controlled from an external source (3-5.1.11), the sample rate at which data are obtained during data capture acquisitions can be externally controlled. Rather than use the the acquisition setup (3-6.1.1), you may wish to impose an externally regulated sample rate. The snapshot sample rate clock source setup allows you to input a TTL pulse train from an external source to establish the sample rate of snapshot data acquisitions. Connection of your TTL pulse train signal to the MT-9500 is made through pin 15 of the recorder's rear-panel UTILITY PORT receptacle. The pulse rate of the input signal must be between 0 - 8 kHz.

Follow the procedure presented below to implement this setup.

1.   **Press the [F] key.**

      The LED display reads <EDIT CH>.

2.   **Press the [7] key.**

      The display reads < SAMP CLK>. This means that you are about to select a sample rate clock source.

3.   **Press the [ENTER] key.**

      The display will read either <EXTERNAL> or <INTERNAL> depending upon on how it was last set. <EXTERNAL> references the sample rate to your input pulse train. <INTERNAL> references the sample rate to the recorder's internal clock.

4.   **Press either the [A] key or the [C] key.**

      The display will switch between the <EXTERNAL> and <INTERNAL> displays. Stop when the LED display shows the setting that you desire.

5.   **Press the [ENTER] key.**

      If you selected <EXTERNAL>, the recorder waits in a ready state and, when a data acquisition occurs, samples data at a rate established by your pulse train. If no pulse train is present, data will not be sampled. If you selected <INTERNAL>, the sample rate will be in accordance with the settings of the acqisition setup (3-6.1.1). In either case, after the [ENTER] key has been pressed, the LED display reads <READY> and you can proceed.

3-1.5.16 Setup Summary. Each of the setups described in paragraphs 3-5.1.1 through 3-5.1.14 has its own influence on the real-time recording of the MT-9500. Each real-time setup is defined either by the factory defaults or by incorporating the settings of your choice. When the setups have been established, the recorder is ready to be placed into any of its operational modes.

The paragraphs that follow discuss each of the following real-time operational modes:

Eight-channel recorder operation

Overlap recorder operation

Dual-speed recorder operation

Datalogger recorder operation

3-5.2 Eight-Channel Real-Time Recording: Mode 0

The eight-channel real-time recording mode enables the recorder to print a maximum of eight simultaneous 40 mm-wide channels of real-time analog waveform data. Figure 3-7 is an example of eigh-channel real-time recording.

This mode is perhaps the most basic use of the recorder. As with all real-time modes, you should first define each of the setups already discussed above. You should, for instance, decide what chart paper speed you want, whether or not you want a grid, what will be printed in the interchannel buffers, what order the channels will be printed in, etc.

To make the importance of establishing your operational setups very clear, generic setups will be presented when each mode is discussed. They emphasize the point that the content and appearance of your charts always reflect your setup choices.
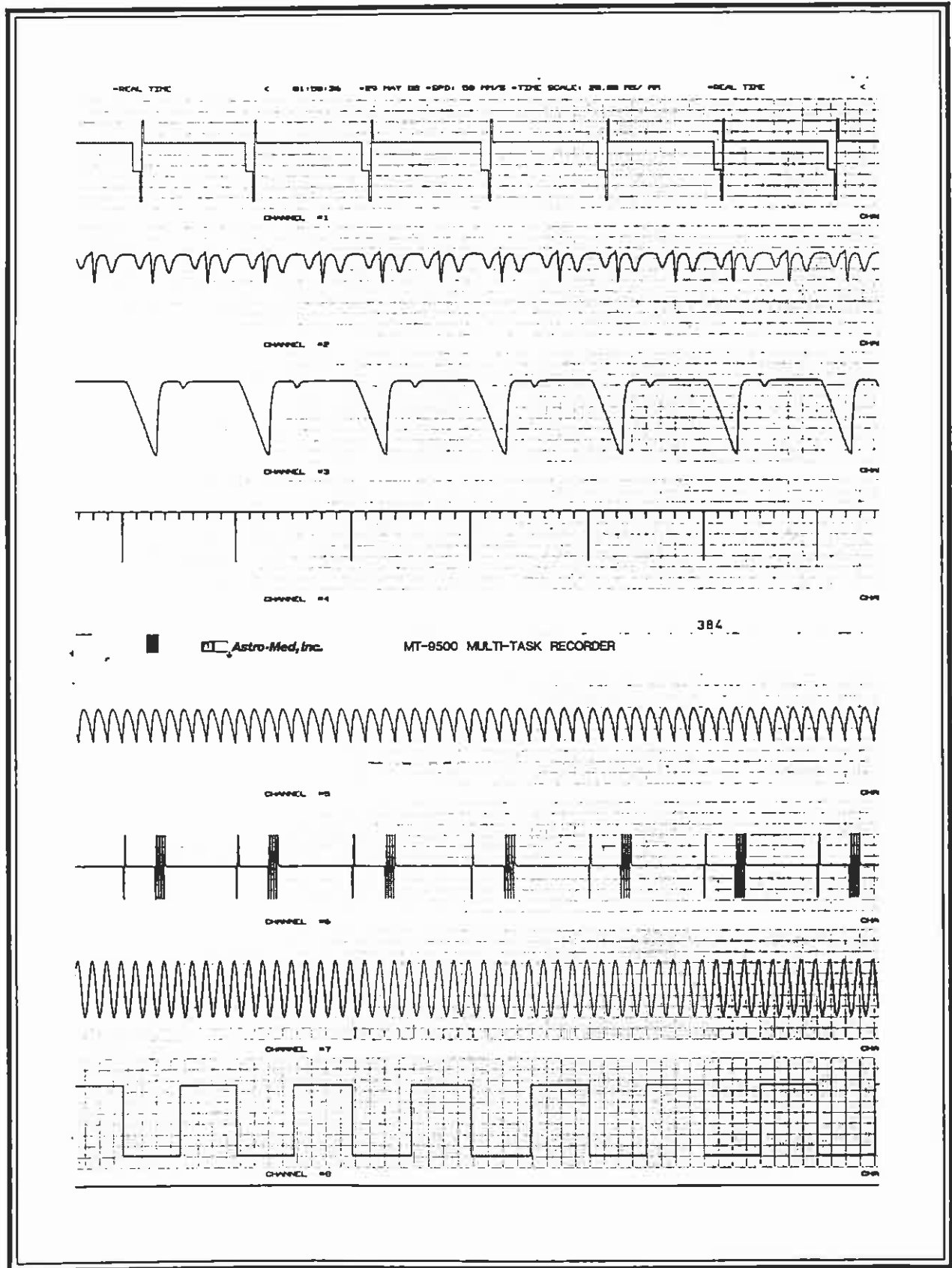
Figure 3-7. Sample Chart: Eight Channel Real-Time Recording

Establish Your Setups

Time	[TIME] [HH MM] [ENTER]
Date	[DATE] [MM DD YY] [ENTER]
Chart speed	[MM/SEC, MM/MIN, MM/HR] [XXX] [ENTER]
Insta-speeds	[ABC] [A, B, or C] [XXX] [ENTER]
Timed operation	[F2] [3] [ENTER]
Event or Annotation	[F1] [2] [ENTER]
Annotation entry	[F2] [0] [ENTER]
Signal Conditioner	
Print Status	[F2] [8] [ENTER]
Grid printing on/off	[F1] [1] [ENTER]
Channel order	[F1] [0] [ENTER]
Signal polarity reverse	[F1] [7] [ENTER]
Motor Speed Source*	[F2] [7] [ENTER]
Local or Host Control	[F2] [6] [ENTER]
Factory Defaults	[F2] [2] [ENTER]
Sample Rate Clock**	[F2] [5] [ENTER]

*RD-95 option required.
**DC-95 option required.

Remember that setups can be accessed and changed at any time during 8-channel real-time operation.

Enter the Mode

1. Press the [MODE] key.

The LED display reads <8 CH RT> indicating that you are about to access the eight-channel real-time recording mode.

2. Press the [ENTER] key.

The MT-9500 immediately begins real-time recording in each of its eight channels. The content of the channels and the interchannel buffers will reflect your setup choices.

3. **To halt recorder printing, press the [HALT] key.**

The recorder stops printing but does not exit the eight-channel real-time recording mode.

4. **To resume recorder printing, press the [HALT] key again.**

Pressing the [HALT] key a second time causes the recorder to resume printing in the eight-channel real-time mode.

5. **To exit the eight-channel real-time recorder mode:**

   • **Press the [HALT] key and then**

   • **Press the [ENTER] key**

The LED display reads <READY>. The recorder has exited the mode. You can proceed.

Alternatives Within the Mode

You can use several operational alternatives within the 8-channel real-time mode to influence the recording of the MT-9500. The information below lists those alternatives. Use the list to remind yourself of the functional choices you have when operating within this mode.

• Alter any of the recorder's operational setups.

• Mark any data of interest to you by pressing the front-panel EVENT pushbutton.

The recorder continuously prints a System Event Marker baseline on the right-most side of the chart paper as viewed from the front of the recorder. When the EVENT pushbutton is pressed, the event marker line deflects to the left where it remains until the pushbutton is released. When released, the event marker line returns to its right-most position.

- Identify each waveform by channel number by pressing the front-panel ID pushbutton.

  When the recorder is operating in the overlap mode, pressing the ID pushbutton causes the real-time waveforms within each recorder channel to be labeled with the appropriate channel numbers.

  When the recorder is operating in the 8-channel real-time mode, pressing the ID pushbutton causes the appropriate channel number to be printed in the center of each channel.

- Initiate a manual trigger by pressing the front-panel TRIG pushbutton.

  Your recorder must be equipped with the Data Capture option, DC-95, to have this capability. A manual trigger results in an on-demand, "start-trigger" data capture/playback. This means that the only data captured are data received after the trigger. No pre-trigger data are captured.

- Receive a data-capture playback resulting from a trigger that you have predefined.

  Your recorder must be equipped with the Data Capture option, DC-95, to have this capability. When a trigger is detected in any input signal, data will be captured and played back as set by the trigger definition group (paragraph 3-2.5).

  This is not a real-time recorder action. When a predefined trigger is detected, the recorder will temporarily cease 8-channel real-time recording. The recorder will then enter the Data Capture and Playback mode to display the captured information. When the information has been replayed, the recorder will automatically return to 8-channel real-time operation.

- Use the controls of the signal adjustment group (paragraph 3-2.2) to:

  - Position the real-time trace within the the channel.

  - Set the calibration for the real-time waveform trace.

- With the CAL/UNCAL/GND switch set to CAL, vary the
  gain applied to the signal on the trace to reduce the
  appearance of the real-time trace.

- Use the recorder's rear-panel connectors to:

  - Turn the recorder on or off from an external source
    through the RUN BNC connector. The on or off action can
    be initiated either by a switch closure or a TTL low.

  - Mark a system event through an external source through the
    EVENT BNC connector.

  - Initiate a trigger from an external source through the
    TRIG BNC connector. The trigger can result from a switch
    closure or TTL Low when the front-panel trigger slope is set
    to EXT (external).

- Change recorder operation from current mode to any other mode
  resident in the recorder.

3-5.3 Overlap Real-Time Recording: Mode 1

The overlap real-time recording mode enables you to record two groups of
overlapped analog waveforms. Each group consists of four overlapped
waveforms on a 160 mm-wide grid. You can use the channel order setup
(3-5.1.9) to choose the specific channels you wish to be printed in each of
the two overlap grids and to suppress the printing of channels you may
not want.

This mode is particularly useful for waveform comparisons. Differences
between waveforms may become more apparent when the waveforms are
overlaid. Figure 3-8 is an example of overlap real-time recording. To use
the overlap real-time recording mode, follow the procedures given below.

Figure 3-8 Sample Chart Overlay Real Time Record

Establish Your Setups

Time	[TIME] [HH MM] [ENTER]
Date	[DATE] [MM DD YY] [ENTER]
Chart speed	[MM/SEC, MM/MIN, MM/HR] [XXX] [ENTER]
Insta-speeds	[ABC] [A, B, or C] [XXX] [ENTER]
Timed operation	[F2] [3] [ENTER]
Event or Annotation	[F1] [2] [ENTER]
Annotation entry	[F2] [0] [ENTER]
Signal Conditioner	
Print Status	[F2] [8] [ENTER]
Grid printing on/off	[F1] [1] [ENTER]
Channel order	[F1] [0] [ENTER]
Signal polarity reverse	[F1] [7] [ENTER]
Motor Speed Source*	[F2] [7] [ENTER]
Local or Host Control	[F2] [6] [ENTER]
Factory Defaults	[F2] [2] [ENTER]
Sample Rate Clock**	[F2] [5] [ENTER]

*RD-95 option required.
**DC-95 option required.

Remember that setups can be accessed and changed at any time during real-time operation.

Enter the Mode

1. Press the [MODE] key.

The LED display reads <8 CH RT>.

2. Press the [1] key.

The display reads <OVLAP RT> indicating that you are about to access the overlap real-time recording mode.

3. **Press the [ENTER] key.**

   The recorder immediately begins overlap real-time recording.
   Two identical grids are created and four waveforms are overlapped
   within each grid. Two interchannel buffers are printed to the left
   and right of each grid. The LED displays the current time.

4. **To halt recorder printing, press the [HALT] key.**

   The recorder stops printing but does not exit the overlap real-time
   recording mode.

5. **To resume recorder printing, press the [HALT] key again.**

   Pressing the [HALT] key a second time causes the recorder to
   resume printing in the overlap real-time recording mode.

6. **To exit the overlap real-time recorder mode:**

   • **Press the [HALT] key and then**

   • **Press the [ENTER] key**

     The LED display reads <READY>. The recorder has exited the
     mode. You can proceed.__ _

Alternatives Within the Mode

You can use several operational alternatives within the overlap real-time
mode to influence the recording of the MT-9500. The information below lists
those alternatives. Use the list to remind yourself of the functional choices
you have when operating within this mode.

• Alter any of the recorder's operational setups.

• Mark any data of interest to you by pressing the front-panel EVENT
  pushbutton.

  The recorder continuously prints a System Event Marker on the
  right-most side of the chart paper as viewed from the front of the
  recorder. When the EVENT pushbutton is pressed, the event marker
  line deflects to the left where it remains until the pushbutton is released.
  When released, the event marker line returns to its right-most position.

- Identify each waveform by channel number by pressing the front-panel ID pushbutton.

  When the recorder is operating in the overlap mode, pressing the ID pushbutton causes the real-time waveforms within each recorder channel to be labeled with the appropriate channel numbers.

  When the recorder is operating in the 8-channel real-time mode, pressing the ID pushbutton causes the appropriate channel number to be printed in the center of each channel.

- Initiate a manual trigger by pressing the front-panel TRIG pushbutton.

  Your recorder must be equipped with the Data Capture option, DC-95, to have this capability. A manual trigger results in an on-demand, "start-trigger" data capture/playback. This means that the only data captured are data received after the trigger. No pre-trigger data are captured.

- Recieve a data-capture playback resulting from a trigger that you have predefined.

  Your recorder must be equipped with the Data Capture option, DC-95, to have this capability. When a trigger is detected in any input signal, data will be captured and played back as set by the trigger definition group (paragraph 3-2.5).

  This is not a real-time recorder action. When a predefined trigger is detected, the recorder will temporarily cease 8-channel real-time recording. The recorder will then enter the Data Capture and Playback mode to display the captured information. When the information has been replayed, the recorder will automatically return to 8-channel real-time operation.

- Use the controls of the signal adjustment group (paragraph 3-2.2) to:

  - Position the real-time trace within the the channel.

  - Set the calibration for the real-time waveform trace.

- With the CAL/UNCAL/GND switch set to CAL, vary the gain applied to the signal on the trace to reduce the appearance of the real-time trace.

- Use the recorder's rear-panel connectors to:

  - Turn the recorder on or off from an external source through the RUN BNC connector. The on or off action can be initiated either by a switch closure or a TTL Low.

  - Mark a system event through an external source through the EVENT BNC connector.

  - Initiate a trigger from an external source through the TRIG BNC connector. The trigger can result from a switch closure or TTL Low when the front-panel trigger slope is set to EXT (external).

- Change recorder operation from current mode to any other mode resident in the recorder.

3-5.4 Dual Speed Real-Time Recording: Mode 4

The dual speed real-time recording mode of the MT-9500 provides two methods to toggle automatically between two preset chart speeds: *timed dual-speed recording* and *triggered dual-speed recording*.

No triggers are involved in placing the recorder into timed dual-speed recording. However, as the name implies, triggers are used to actuate triggered dual-speed recording.

When the operating parameters of either of the dual-speed mode alternatives have been set, the recorder will perform its dual-speed functions automatically. Except to halt or stop recorder operation, no operator intervention is necessary.

Timed dual-speed recording causes the instrument to toggle continuously between two preset chart speeds that you define. The recorder will operate at each speed for the specific period of time that you define. Therefore, in timed dual-speed operation, you must:

- set the speeds you want the recorder to toggle between (speed 1 and speed 2)

- set the length of time you want the recorder to remain at each speed before toggling to the other (time 1 and time 2)

When placed into timed dual-speed operation, the recorder will toggle immediately and continuously between the two user-defined speeds at the time intervals that you specify.

When a trigger is detected, triggered dual-speed recording causes the instrument to switch between an initial speed that you define and an alternate speed that you define.

NOTE

Use the front-panel controls of the trigger definition group (paragraph 3-2.5) to define the trigger that will initiate triggered dual-speed recording.

In triggered dual-speed recording, you must:

- set the base chart-paper speed (speed 1) at which the recorder will operate in the absence of triggers

  Notice that no-time-length is defined for speed 1. The recorder will operate at speed 1 indefinitely until a trigger is sensed.

- set the timed dual-speed/triggered dual-speed alternative to TRIGGER on the LED display

- set the alternate chart-paper speed (speed 2) at which the recorder will operate when a trigger is detected

- set the length of time after a trigger has been detected that the recorder will remain at speed 2 before it toggles back to the base chart-paper speed (speed 1)

Use the procedure given below to place the recorder into either timed dual-speed operation or triggered dual-speed operation.

Establish Your Setups

Time	[TIME] [HH MM] [ENTER]
Date	[DATE] [MM DD YY] [ENTER]
Chart speed	[MM/SEC, MM/MIN, MM/HR] [XXX] [ENTER]
Insta-speeds	[ABC] [A, B, or C] [XXX] [ENTER]
Timed operation	[F2] [3] [ENTER]
Event or Annotation	[F1] [2] [ENTER]
Annotation entry	[F2] [0] [ENTER]
Signal Conditioner	
Print Status	[F2] [8] [ENTER]
Grid printing on/off	[F1] [1] [ENTER]
Channel order	[F1] [0] [ENTER]
Signal polarity reverse	[F1] [7] [ENTER]
Motor Speed Source*	[F2] [7] [ENTER]
Local or Host Control	[F2] [6] [ENTER]
Factory Defaults	[F2] [2] [ENTER]
Sample Rate Clock**	[F2] [5] [ENTER]

*RD-95 option required.
**DC-95 option required.

Remember that setups can be accessed and changed at any time during real-time operation.

Enter the Mode

1. **Press the [MODE] key.**

   The LED display will read <8 CH RT>.

2. **Press the [4] key.**

   The display will read <DUAL SPD>.

3.   **Press the [ENTER] key.**

*The display will read either <8-CHNLS> or <OVERLAP>
depending on how last set. <8-CHNLS> indicates that recorder
output will be in 8 individual channels. <OVERLAP> indicates
that recorder output will be two individual expanded grids each
containing four overlapped waveforms.*

4.   **Press either the [A] key or the [C] key.**

*As the keys are pressed, the display will switch between
<8-CHNLS> and <OVERLAP>. Press either key until the
display reads the format you desire.*

5.   **Press the [ENTER] key.**

*The LED display will read <S1 025/S> (the factory default) or the
chart-paper speed last set. <S1 025/S> indicates that speed 1 is set
for 25 mm per second.*

6.   **Either accept the displayed speed by pressing the [ENTER]
key or change the speed by pressing any three numeric keys
from [0] through [9] to specify the chart speed you desire.**

The LED display will change to reflect the digits entered.

7.   **Press either the [MM/SEC], [MM/MIN], or [MM/HR]
real-time setup keys to indicate the speed at which you
want the chart   paper to run.**

The display will change to reflect the time rate that you enter.

8.   **Press the [ENTER] key.**

*The display will read either <T1 00.00> (or as last set) or
<TRIGGER>.*

*<T1 00.00> is the factory default for time 1. It indicates the amount
of time the recorder will run at speed 1 before automatically
toggling to speed 2. The factory default time 1 setting disables
timed dual-speed operation.*

*<TRIGGER> indicates that the dual speed mode is set for triggered
dual-speed recording.*

```
┌─ NOTE ──────────────────────────────────────────────┐
│                                                      │
│  You are now ready to chose between timed dual-speed │
│  recording and triggered dual-speed recording. Follow the │
│  steps below to initiate the alternative you desire and to input │
│  the set-up data your choice requires.               │
│                                                      │
│    •      Follow steps 10 through 19 under "If You Have Chosen │
│           Timed Dual-Speed Recording" to initiate timed │
│           dual-speed operation.                      │
│                                                      │
│    •      Follow steps 10 through 18 under "If You Have Chosen │
│           Triggered Dual Speed Recording" to initiate triggered │
│           dual-speed operation.                      │
│                                                      │
│  The steps are clear-cut but follow them carefully to avoid │
│  confusion between the alternatives.                 │
│                                                      │
└──────────────────────────────────────────────────────┘
```

9. **Press either the [A] or [C] keys.**

    *The display will switch between the factory-default time 1
    (or the last-set time) and the word <TRIGGER>. Press either
    key until the LED display indicates the dual-speed alternative
    that you desire.*

If You Have Chosen Timed Dual-Speed Recording

10. **The display reads <T1 00.00> or as last set. Press any four numeric
    keys from [0] through [9] to set the time period for which the
    recorder will operate at speed 1 before toggling to speed 2.**

    The LED display will change to reflect the digits entered.

11. **Press the [ENTER] key.**

    *The LED display will read <S2 050/S> (the factory default) or the
    chart-paper speed last set. <S2 050/S> indicates that speed 2 is set
    for 50 mm per second.*

12. Either accept the displayed speed by pressing the [ENTER] key or change the time by pressing any three numeric keys from [0] through [9] to specify the speed you desire.

The LED display will change to reflect the digits entered.

13. Press either the [MM/SEC], [MM/MIN], or [MM/HR] real-time setup keys to indicate the speed at which you want the chart paper to run.

The display will change to reflect the speed that you enter.

14. Press the [ENTER] key.

The display reads <T2 00.00> or as last set.

15. Press any four numeric keys from [0] through [9] to set the time period for which the recorder will operate at speed 2 before toggling back to speed 1.

The LED display will change to reflect the digits entered.

16. Press the [ENTER] key.

The recorder will immediately enter timed dual-speed recording. The recorder will toggle continuously between the chart-paper speeds that you have specified. Toggling will occur at the time intervals you have established. The LED display will be dynamic and will show the durations of time 1 and time 2 in "countdown" fashion. The changing LED display will show you the amount of time remaining to the next toggle action.

17. To halt the recorder, press the [HALT] key.

The recorder will stop recording but remain in the dual speed mode. The dynamic countdown shown on the LED display will stop and remain unchanged.

18. To resume recording, press the [HALT] key again.

The recorder immediately resumes recording and reinitiates the remainder of the countdown to the next toggle action.

19. To exit the dual speed mode, press the [ENTER] key.

   The LED display reads <READY>. You can proceed.

   <u>If You Have Chosen Triggered Dual Speed Recording</u>

   ┌─ **NOTE** ──┐
   │   │
   │ Use the front-panel SLOPE and LEVEL controls of the trigger │
   │ definition group (3-2.5) to specify the trigger conditions you │
   │ desire.   │
   │   │
   └──┘

10. The LED display reads <TRIGGER>. Press the [ENTER] key.

   The display reads the factory default <S2 050/S> or as last set. This
   means that the default value sets speed 2 of the dual-speed mode to
   50 mm/s. Speed 2 is the speed to which the recorder will toggle when
   a trigger is detected.

11. Either accept the displayed speed by pressing [ENTER] or press
    any three numeric keys from [0] through [9] to specify the speed
    you desire.

   The LED display will chānge tō reflect the digits entered.

12. Press either the [MM/SEC], [MM/MIN], or [MM/HR] real-time
    setup keys to indicate the speed at which you want the chart
    paper to run.

   The display will change to reflect the speed that you enter.

13. Press the [ENTER] key.

   The display reads the factory default, <T2 00.00>, or as last set.

14. Press any four numeric keys from [0] through [9] to set the
    amount of time the recorder will run at speed 2 (step 11)
    before toggling back to speed 1.

15. **Press the [ENTER] key.**

    The display reads <TRIGGER> and the recorder immediately begins to run at speed 1.

    The recorder will remain in operation at speed 1 until a trigger is detected. When a trigger is detected, the recorder will toggle to speed 2 for the duration of time 2.

    When a trigger has caused the recorder to toggle to speed 2, the LED display will dynamically show the duration of time in "countdown" fashion. The countdown shows the time elapsing until the recorder returns to operation at speed 1 to await another tigger.

16. **To halt the recorder, press the [HALT] key.**

    The recorder stops. The fact that recorder has been halted is indicated by the presence of a period in the LED display: <TRIGGER . >. You can halt recorder operation at any time.

17. **To resume recorder operation, press the [HALT] key again.**

    The recorder immediately returns to operation at the point at which it was halted. If halted while awaiting a trigger, the recorder returns to operation at speed 1. If halted after having been toggled to speed 2, the recorder will resume the time-2 countdown, conclude the countdown, and toggle to operation at speed 1.

18. **To exit the dual speed mode:**

    •   **Press the [HALT] key and then**

    •   **Press the [ENTER] key**

    The LED displays <READY>. You can proceed.

Alternatives Within the Mode

You can use several operational alternatives within the dual speed real-time mode to influence the operation of the MT-9500. The information below lists those alternatives. Use the list to remind yourself of the functional choices you have when operating within this mode.

- Alter any of the recorder's operational setups.

- Mark any data of interest to you by pressing the front-panel EVENT pushbutton.

  The recorder continuously prints a System Event Marker baselines on the right-most side of the chart paper as viewed from the front of the recorder. When the EVENT pushbutton is pressed, the event marker line deflects to the left where it remains until the pushbutton is released. When released, the event marker line returns to its right-most position.

- Identify each waveform by channel number by pressing the front-panel ID pushbutton.

  When the recorder is operating in the overlap mode, pressing the ID pushbutton causes the real-time waveforms within each recorder channel to be labeled with the appropriate channel numbers.

  When the recorder is operating in the 8-channel real-time mode, pressing the ID pushbutton causes the appropriate channel number to be printed in the center of each channel.

- Initiate a manual trigger by pressing the front-panel TRIG pushbutton.

  Your recorder must be equipped with the Data Capture option, DC-95, to have this capability. A manual trigger results in an on-demand, "start-trigger" data capture/playback. This means that the only data captured are data received after the trigger. No pre-trigger data are captured.

- Receive a data-capture playback resulting from a trigger that you have predefined.

  Your recorder must be equipped with the Data Capture option, DC-95, to have this capability. When a trigger is detected in any input signal, data will be captured and played back as set by the trigger definition group (paragraph 3-2.5).

  This is not a real-time recorder action. When a predefined trigger is detected, the recorder will temporarily cease 8-channel real-time recording.The recorder will then enter the Data Capture and Playback mode to display the captured information. When the information has been displayed, the recorder will automatically return to 8-channel real-time operation.

- Use the controls of the signal adjustment group (paragraph 3-2.2) to:

  - Position the real-time trace within the channel.

  - Set the calibration for the real-time waveform trace.

  - With the CAL/UNCAL/GND switch set to CAL, vary the gain applied to the signal on the trace to reduce the appearance of the real-time trace.

- Use the recorder's rear-panel connectors to:

  - Turn the recorder on or off from an external source through the RUN BNC connector. The on or off action can be initiated either by a switch closure or a TTL Low.

  - Mark a system event through an external source through the EVENT BNC connector.

  - Initiate a trigger from an external source through the TRIG BNC connector. The trigger can result from a switch closure or TTL Low when the front-panel trigger slope is set to EXT (external).

- Change recorder operation from current mode to any other mode resident in the recorder.

3-5.5 Datalogger Real-Time Recording: Mode 9

The Datalogger option (DL-95) is required to operate the recorder in Datalogger mode.

The datalogger real-time recording mode enables the recorder to convert analog waveforms into eight tabular columns of calibrated, numeric engineering units that you specify. Figure 3-9 is an example of datalogger recording.

With this option, you can switch recorder operation almost instantly between waveform presentation of your data and the equivalent numeric values of that data calibrated to your requirements. Positive numbers, negative numbers, and exponents can be used to express the selected conversion factors.

After you have entered the conversion factors you desire, they are backed-up in the recorder's nonvolatile random access memory (RAM). The recorder's Condensed Operations Manual feature ([MODE] [8] [ENTER]) lists the datalogger conversion factors and can be used as a handy reference to monitor current settings.

The Datalogger mode differs from all of the other modes because it presents data as numbers rather than as analog waveforms. Because of this, the Datalogger mode has a group of setups that differs from the modes already discussed. Only four setups apply to the Datalogger mode: time, date, channel order, and datalogger (cal log). The Datalogger (Cal Log) set-up is used only with the Datalogger mode and is separately discussed below.

Follow the procedure below to use the recorder's optional Datalogger mode. The data you enter will appear on the LED display.

Figure 3-9. Sample Chart: Datalogger Recording

Establish Your Setups

Time*	[TIME] [HH MM] [ENTER]
Date*	[DATE] [MM DD YY] [ENTER]
Channel order	[F1] [0] [ENTER]

*If recording is configured for IRIG time codes, [TIME] and [DATE] will not function.

Remember that setups can be accessed and changed at any time during 8-channel real-time operation.

Define the Datalogger Setup

The Datalogger setup is used to set the left-side (LS) and right-side (RS) conversion factors of each recording channel. Follow the steps below to specify the desired left side and right side Datalogger values.

1. **Press the [F1] key.**

   The LED display reads <CH. ORDER>.

2. **Press the [8] key.**

   The LED display reads <CAL LOG>.

3. **Press the [ENTER] key.**

   The display reads <CHANNEL ?>.

4. **Press any single numeric key from [1] through [8] to specify the channel you want to access.**

   The display reads <CHANNELX> where X is the channel you have chosen.

5. **Press the [ENTER] key.**

   The display reads the factory default <LS= 0200> or as last set. LS indicates the left side (limit) of the conversion range.

6.   Either accept the displayed value by pressing the [ENTER]
      key or press any four numeric keys from [1] through [8] to
      specify the left side conversion limit. Use leading zeros as
      necessary.

      The display will show the digits that you enter.

7.   Press either the [A] or [C] keys.

      When either key is pressed, a mathematical negative sign (-) is
      added to or removed from the display. This allows you to specify
      whether the conversion factor that you entered will have positive or
      negative mathematical value. When the negative sign is not present
      in the display, a positive value is assumed and no mathematical
      sign is shown. Press the key until the display reads as you desire.

8.   Press the [ENTER] key.

      The display will read the factory default <RS= - 0200> or as
      last set. RS indicates the right side (limit) of the conversion
      range. Notice that the factory default for the right side has a
      negative value.

9.   Either accept the displayed value by pressing the [ENTER]
      key or press any four numeric keys from [1] through [8] to
      specify the right side conversion limit. Use leading zeros
      as necessary.

      The display will show the digits that you enter.

10.   Press either the [A] or [C] keys.

      When either key is pressed, a mathematical negative sign (-) is
      added to or removed from the display. This allows you to specify
      whether the conversion factor that you entered will be of positive or
      negative mathematical value. When the negative sign is not present
      in the display, a positive value is assumed and no mathematical
      sign is shown. Press the key until the display reads as you desire.

11.   Press the [ENTER] key.

      The display reads <EXP= 0> or as last set. This indicates that the
      exponent applied to the conversion values.

12. Either accept the displayed exponent by pressing the [ENTER]
    key or press any single numeric key from [0] to [4] to select the
    exponential value you want applied to the data.

    The digit in the display will change to show the number you entered.

13. Press either the [A] or [C] keys.

    *When either key is pressed, a mathematical negative sign (-) is
    added to or removed from the display. This allows you to specify
    whether the chosen exponent will have positive or negative
    mathematical value. When the negative sign is not present in the
    display, a positive value is assumed.*

14. Press the [ENTER] key.

    The display will read <CHANNEL ?>.

15. Press any single numeric key from [1] through [8] to select
    another recording channel for which you want to define the
    Datalogger left-side/right-side calibration settings.

16. Repeat steps 4 through 13 above for each channel of
    interest to specify its Datalogger left-side/right-side
    calibration settings.

17. When you have established the Cal Log settings of your
    choice for each recording channel, exit the Cal Log setup
    by pressing the [HALT] key.

    *The display reads <READY>. You are now ready to enter the
    Datalogger mode.*

Enter the Mode

1. Press the [MODE] key.

   The LED display reads <8 CH RT>.

2. Press the [9] key.

   The display reads <DATA LOG>.

3.   **Press the [ENTER] key.**

     The MT-9500 immediately begins recording eight channels of numeric data. The LED display shows the current time in 24-hour format.

┌─ **NOTE** ──┐

"Sample period" refers to the Datalogger parameter that specifies how frequently a waveform will be printed. Of course, this then determines the frequency response of the system.

The factory-set default for the sample period is 175 milliseconds. The sample period is the line printing speed. For example, a sample period of 175 ms indicates that a line of data is printed every 175 milliseconds (175 ms/line).

You can change the sample period any time after you have entered the Datalogger mode. Sample periods from 175 ms/line to 999 min/line are possible. Follow step 4 below to specify the sample period/line printing speed of your choice.

└──┘

4.   **If you desire, change the sample period/line printing speed as described below:**

     •   **While the recorder is operating in or has been halted in the Datalogger mode, press either the [MM/SEC], [MM/MIN], or [MM/HR] keys.**

         The LED display will read the factory default <175 MS/L> or as last set.

     •   **Press any three numeric keys from [0] through [9] to specify the speed you desire.**

         The display will change to show the digits you entered.

- Press either the [A] or [C] keys to specify the time rate you desire.

  The LED display will change as the key is pressed to <MS/L>, <S/L>, or <M/L> giving you the option of choosing milliseconds/line, seconds/line, or minutes/line.

- Press the [ENTER] key.

  The recorder almost instantly begins sampling and printing at the new rate. The LED display will show the current time in 24-hour format.

5. Press the [HALT] key to stop recorder printing.

   The display reads <HALTED> and the recorder stops printing.

6. Press the [HALT] key again to resume printing.

   The LED display shows the current time in 24-hour format and the recorder resumes printing.

7. To exit the Datalogger mode:

   - Press the [HALT] key and then
   - Press the [ENTER] key

   When you press the [HALT] key, the recorder will cease printing and the LED display will read <HALTED>. When you press the [ENTER] key, the the display will read <READY>. You can proceed.

The Datalogger Printout

In addition to the eight channels of tabulated data, the Datalogger printout contains a variety of useful alphanumeric information. For your benefit, this information is explained below.

Channel Tags: The bottom of each column of data is labeled with with the word CHANNEL and a number specifying the channel number, i.e., CHANNEL 1.

Real-Time Data: Beneath the channel tags and across the left side of the chart, a line is printed with the following information.

REAL TIME DATA This simply reminds you that the recorded data represents real-time information.

SAMPLE PERIOD: XXX xx This lists the current rate at which waveform data are being sampled and printed. XXX represents values from 175 through 999 and xx represents ms (milliseconds), s (seconds), or m (minutes).

DATE: dd mm yy This specifies the day, month, and year of the recording.

Time Increments: Time increments presenting the hour, minute, and second in the generic 24-hour format hh:mm:ss are printed opposite every 16th line of data on the far left side of the chart. This provides a convenient time-frame reference.

┌─ **NOTES** ───┐

If the recorder is halted during Datalogger recording, the time increment will be printed immediately after Datalogger operation is resumed.

Whenever Datalogger is halted and any operational parameter is changed, the **REAL-TIME DATA** header will be revised and reprinted immediately after Datalogger recording is resumed.

└──┘

Alternatives Within the Mode

You can use the two operational alternatives listed below to influence the recording of the MT-9500 within the Datalogger real-time mode.

- Alter any of the recorder's operational setups.

- Change recorder operation from current mode to any other mode resident in the recorder.

3-6 Data Capture/Playback Operation

Your recorder must be equipped with the Data Capture option (DC-95) to operate in any of the data-capture/playback modes.

In addition to real-time operation, the MT-9500 offers exceptional performance as a data-capture and replay instrument. Four modes are available to you during data capture/playback operation of the recorder:

Acquire Single Snapshot	MODE 5
Playback Single Snapshot	MODE 6
Continuous Snapshot (Untriggered)	MODE 2
Continuous Snapshot (Triggered)	MODE 3

Before discussing the individual data capture/playback modes, it is necessary to discuss the recording setups that apply to the data capture/ playback mode.

The real-time setups listed below are also applicable to the Data Capture mode. These setups have already been defined. Refer to the respective paragraphs of section 3-5 to refresh your memory regarding these real-time setups.

> Event or Annotation Setup
> Annotation Entry Setup
> Grid Printing On/Off Setup
> Channel Order Setup
> Signal Polarity Reverse Setup

The setups detailed in the paragraphs below are unique to the Data Capture mode. These setups specify trigger data and acquisition/playback data. *Consequently, the setups should be established before you enter and use the Data Capture mode.*

3-6.1 Data-Capture Recording Setups

Table 3-6 lists the MT-9500's data-capture recording setups and their generic keying sequences. Each of the setups will be individually discussed below. Notice that these recording setups define:

* the circumstances under which data capture will occur

* the characteristics of the playback

Table 3-7 lists the factory default data capture setups. If you do not wish to key-in your own setups, the recorder will automatically use the factory default values.

3-6.1.1 Acquisition Setup. The acquisition setup is used to define three parameters that specify how data snapshots will be acquired and saved. These parameters are (1) the number of channels from which data will be acquired and replayed, (2) the time base of the playback, and (3) the number of kilosamples to be acquired in each channel.

Time base refers to the sample period per millimeter represented on the chart. Time base is equivalent to sample rate.

Window size is a term that refers to the number of kilosamples to be stored in memory per snapshot acquisition. For an eight-channel snapshot, 1 through 16 kilosamples per channel can be selected. For a two-channel snapshot, 1 through 64 kilosamples can be selected.

Either accept the factory defaults or define the acquisition setup using the procedure below.

1. **Press the [F1] key.**

   The LED display reads <CH. ORDER>.

2. **Press the [6] key.**

   The display reads <DEF SAVE>.

3. **Press the [ENTER] key.**

   The display reads <USE 8 CH> *or as last set.*

Table 3-6. Data-Capture Setups

Setup	Keying Sequence
Acquisition	[F1] [6] [ENTER]
Playback	[F1] [4] [ENTER]
Trigger Channel and Location	[F1] [3] [ENTER]
Trigger On/Off	[F2] [4] [ENTER]
X and Y Channel Select	[F1] [5] [ENTER]
Sample Rate Clock	[F2] [5] [ENTER]

Table 3-7. Factory Default Data-Capture Setups

Setup	Factory Default Setting
Acquisition	
Channels	8
Time Base	001 ms/mm
Window	8 kilosamples/channel
Playback	
Format	8 channels
Start Trigger Percentage	00%
Expansion Factor	01X
Trigger Channel and Location	
Trigger Channel	CH 1
Type of Trigger	Start
Trigger/Window Percentage	01%
Trigger On/Off	On
X and Y Channel Select	X = 1 / Y=2
Sample Rate Clock	Internal

4. **Either accept the current setting by pressing the [ENTER] key or change the setting by pressing either [A] or [C] keys.**

    The display will switch between <USE 2 CH> and <USE 8 CH> indicating that data will be acquired from either 2 channels or 8 channels. Press either key until the display reads as you desire.

5. **Press the [ENTER] key.**

    The display will read <001MS/MM> or as last set.

6. **Either accept the current setting by pressing the [ENTER] key or change the setting by pressing any three numeric keys from [0] through [9].**

    The three digits of the LED display will change to show the new data being entered.

7. **Press the [ENTER] key.**

    The display will read <08 KSMP> or as last set.

8. **Either accept the current setting by pressing the [ENTER] key or press any two numeric keys from [0] through [9] to specify the number of kilosamples to be acquired from each channel per snapshot.**

    If you are recording a two-channel snapshot, you can select from 1 to 64 kilosamples.

    If you are recording an eight-channel snapshot, you can select from 1 to 16 kilosamples.

    If you mistakenly enter an invalid kilosample choice, the LED display will momentarily read <INVALID> and will revert to its previous reading.

9. **Press the [ENTER] key.**

    The display reads <READY>. The data you entered have been accepted and you can proceed.

3-6.1.2 Playback Setup. When a data snapshot has been acquired, the playback setup allows you to specify numerous playback parameters that determine the playout format of your data. Define the playback setup by using the procedures listed below.

1. Press the [F1] key.

The LED display reads <CH. ORDER>.

2. Press the [4] key.

The display reads <DEF PLBK>.

3. Press the [ENTER] key.

The display reads <8-CHNLS> or as last set.

4. Press either the [A] or [C] keys.

As the key is pressed, the display will scroll through four selections: <8-CHNLS>, <OVERLAP>, <X-Y>, and <NUMERIC>. This will specify the format of the output data. Press the key until the display reads as you desire.

<8-CHNLS> indicates that-data playback will consist of eight individual 40 mm channels of analog waveforms.

<OVERLAP> indicates that data playback will consist of two channels each containing four overlapped waveforms.

<X-Y> indicates that data playback will consist of two analog waveforms plotted as an X-Y graph.

<NUMERIC> indicates that data playback will consist of Datalogger output: eight channels of tabular, numeric lists.

5.   **Press the [ENTER] key.**

The display reads <ST 00%> or as last set. This indicates the "start percentage" or the start point of your playback. This parameter allows you select the start point of the playback. The percentage shown is the percentage of data that will be suppressed during the playback. The data are not deleted. They are simply not printed when the snapshot is printed. Thus, if you specify 25%, the last 75% of the snapshot data will be replayed. In effect, you can narrow the window of your snapshot to examine only those data of interest to you.

6.   **Press any two numeric keys from [0] through [9] to specify the percentage of the snapshot window to be suppressed when the snapshot is printed.**

The display will change to show the digits entered.

7.   **Press the [ENTER] key.**

The display reads <EX BY 01> or as last set. This indicates the expansion factor that will be applied to the snapshot data. The recorder uses linear interpolation to expand the output presentation from 1 to 25 times.

8.   **Press any two numeric keys from [0] through [9] to specify the expansion factor you desire.**

The display will change to show the digits entered.

9.   **Press the [ENTER] key.**

The display reads <READY>. You can proceed.

3-6.1.3 Trigger Channel and Location Setup. Data snapshots can be obtained either on-demand or as a result of certain predefined conditions (triggers). The trigger channel and location setup allows you to specify (1) the channel in which a trigger will occur, (2) the type of trigger (start, center, end), and (3) the trigger/window relationship. Only one trigger channel can be active at any given time.

Either accept the defaults provided for this setup or enter the trigger data you desire by following the procedure given below.

1. Press the [F1] key.

The LED display reads <CH. ORDER>.

2. Press the [3] key.

The display reads <DEF TRIG>.

3. Press the [ENTER] key.

The display reads <TR CH 1> or as last set. This display indicates the current trigger channel.

4. Either accept the setting by pressing the [ENTER] key or change the setup by pressing any single numeric key from [1] through [8].

The display will change to show the digit entered.

5. Press the [ENTER] key.

The display will read <START> or as last set.

6. Press either the [A] or [C] keys.

The display will scroll through four settings: <START>, <CENTER>, <END>, and <T/W 01%> to specify the desired trigger position.

<START> indicates a start trigger. Data acquisition begins when a trigger is sensed. No pretrigger information is acquired.

<CENTER> indicates a center trigger. When a trigger is sensed, equal amounts of pretrigger and post-trigger data are stored. This is useful if you want to view data acquired before the trigger occurred.

<END> indicates an end trigger. When a trigger is sensed, only pretrigger data are acquired. Again, this is useful if you want to view data acquired before the trigger occurred.

<T/W 01%> *indicates a percentage trigger. When a trigger is sensed, specified percentages of pretrigger and post-trigger data are obtained. For example, <T/W 25%> indicates that the snapshot window will consist of 25% pretrigger data and 75% post-trigger data.*

Stop scrolling when the LED display reads as you desire.

7. **If you chose <START>, <CENTER>, or <END>, press the [ENTER] key.**

    The display will read <READY>. The setup is complete and you can proceed.

8. **If you chose <T/W 01%>, either accept the default value by pressing [ENTER] or specify the placement of the trigger within the window by pressing any two numeric keys from [0] through [9].**

    The display will change to show the digits entered.

9. **Press the [ENTER] key.**

    The displays reads <READY>. The data have been accepted and you can proceed.- - -

3-6.1.4 Trigger On/Off Setup. The trigger on/off setup allows you to specify whether or not a particular channel will sense a predefined trigger. The factory default sets this condition to ON.

Either accept the default condition or change it using the procedure given below.

1. **Press the [F2] key.**

    The LED display reads <EDIT CH>.

2. **Press the [4] key.**

    The display reads <TRIGGER>.

3. **Press the [ENTER] key.**

   The display reads <TRIG ON> or as last set.

4. **Press either the [A] or [C] keys.**

   The display will toggle between <TRIG ON> and <TRIG OFF>.
   Press either key until the LED display reads as you desire.

5. **Press the [ENTER] key.**

   The display reads <READY>. Your choice has been accepted and
   you can proceed.

3-6.1.5 X and Y Channel Select Setup. The X and Y channel select
setup allows you to specify two analog data channels to be printed as an X-Y
plot. These two channels would also be used by the recorder during a two-
channel snapshot. This set-up defaults to channel 1 (X) and channel 2 (Y).

Accept the default settings by pressing the [ENTER] key repeatedly. This will
scroll through and accept each default setting. Select the X and Y channels of
your choice by following the steps given below.

1. **Press the [F1] key.**

   The LED display reads <CH. ORDER>.

2. **Press the [5] key.**

   The display reads <SET X-Y>.

3. **Press the [ENTER] key.**

   The display reads <X IS 1> or as last set.

4. **Press any single numeric key from [1] through [8] to**
   specify the channel you desire represented along the X axis
   of the plot.

   The display will change to show the digit you entered.

5.   Press the [ENTER] key.

       The display reads <Y IS 2> or as last set.

6.   Press any single numeric key from [1] through [8] to
       specify the channel you desire represented along the Y axis
       of theplot.

       The display will change to show the digit you entered.

7.   Press the [ENTER] key.

       *The LED display reads <READY>. The selections you made have
       been accepted and you can proceed.*

3-6.2 Acquire Single Snapshot: Mode 5

The acquire single snapshot mode enables the recorder to capture a
single "snapshot" of data. The recorder captures data snapshots from the
channels defined by the acquisition setup (3-6.1.1): either 2 specified
channels or all 8 channels. Event markers are not captured in this mode.
It is important to note that this mode performs only one function: it
captures data. You must use the playback single snapshot mode (3-6.3)
to replay the captured data. To access this mode, establish your setups
and follow the procedure presented below.

Data Capture Setups	
Acquisition	[F1] [6] [ENTER]
Playback	[F1] [4] [ENTER]
Trigger Channel and Location	[F1] [3] [ENTER]
Trigger On/Off	[F2] [4] [ENTER]
X and Y Channel Select	[F1] [5] [ENTER]
Sample Rate Clock	[F2] [5[[ENTER]
Real-Time Setups Applicable to Data Capture	
Event or Annotation	[F1] [2] [ENTER]
Annotation Entry	[F2] [0] [ENTER]
Grid Printing On/Off	[F1] [1] [ENTER]
Channel Order	[F1] [0] [ENTER]
Signal Polarity Reverse	[F1] [7] [ENTER]

Enter the Mode

1. **Press the [MODE] key.**

   The LED display reads <8 CH RT>.

2. **Press the [5] key.**

   The display reads <SING SS> indicating that you are about to enter the single snapshot mode.

3. **Press the [ENTER] key.**

   The display reads <ACQUIS> indicating that the recorder is awaiting a single snapshot acquisition. The recorder waits in a neutral state until a trigger is sensed. A trigger can be caused in one of three ways:

   - manually through the front-panel TRIG pushbutton (3-2.5)

   - externally through the rear-panel TRIG BNC connector (3-3.15)

   - manually by adjusting the SLOPE and LEVEL controls of the front-panel trigger definition group (3-2.5)

   When a trigger is sensed, the trigger LED momentarily illuminates and the single snapshot is captured. The LED display then reads <READY>. The recorder is ready to playback the snapshot.

When the recorder is operating in a real-time mode, a snapshot can be initiated by any of the methods outlined in step 3 immediately above. Although you can initiate a snapshot data acquisition when the MT-9500 is operating in real-time, the characteristics of these data snapshots differ significantly from those of the recorder's single snapshot mode (Mode 5). The MT-9500 leaves real-time operation when the snapshot is taken and replayed. The differences between these two kinds of snapshot data acquisition are described below.

A snapshot initiated while the recorder is operating in real time can be characterized as follows:

- Data capture is always presented as a "START" trigger. Only post-trigger data are acquired.

- Data playback is automatic and immediately follows the acquisition.

- When the data are replayed, real-time recording is immediately resumed and the captured data in RAM memory are lost.

An acquire-single-snapshot (Mode 5) data acquisition can be characterized as follows:

- Data capture can be specified as START, CENTER, END, or TW 01% (3-6.1.3) in accordance with your preference.

- Data playback is not automatic. Playback must be initiated through the playback mode (Mode 6).

- Data are retained after acquisition and can be replayed as often as desired. Playback modes can be varied.

- Data are not lost-until the recorder enters another mode, the recorder is powered down, or default values are selected.

3-6.3 Playback Single Snapshot: Mode 6

The playback single snapshot mode enables the recorder to playback a snapshot resulting from a Mode 5 (acquire single snapshot) data acquisition. To access this mode, follow the procedure presented below.

Establish Your Setups

Data Capture

Acquisition	[F1] [6] [ENTER]
Playback	[F1] [4] [ENTER]
Trigger Channel and Location	[F1] [3] [ENTER]
Trigger On/Off	[F2] [4] [ENTER]
X and Y Channel Select	[F1] [5] [ENTER]

Real-Time Setups Applicable to Data Capture

Event or Annotation	[F1] [2] [ENTER]
Annotation Entry	[F2] [0] [ENTER]
Grid Printing On/Off	[F1] [1] [ENTER]
Channel Order	[F1] [0] [ENTER]
Signal Polarity Reverse	[F1] [7] [ENTER]

Enter the Mode

1. Press the [MODE] key.

The LED display reads <8 CH RT>.

2. Press the [6] key.

The display reads <PLAYBACK>.

3. Press the [ENTER] key.

The LED display reads <PLAYBACK> and the recorder immediately begins to replay the captured data. When the snapshot has been replayed, the recorder ceases operation and the display reads <READY>. The playback is complete and you can proceed.

Playback Alternatives

The format alternatives listed below are available when replaying data obtained in single snapshot acquisition.

- Replay data as separate channels

- Replay data as overlapping channels (OM-95 required)

- Replay data as tabular, numeric lists (DL-95 required)

- Replay data as an X - Y plot

3-6.4 Continuous Snapshot (Untriggered): Mode 2

The continuous snapshot (untriggered) mode enables the recorder to enter a continuous cycle of automatic, untriggered data captures and playbacks. When this mode is initiated, the cycle will continue until halted by operator intervention. Remember that the type of snapshots that the recorder acquires are defined by the acquisition and playback setups. Snapshot playback is automatic and the waveform playout cannot be altered. Captured data are lost from the recorder's RAM immediately upon playback. To access this mode, follow the procedure presented below.

Establish Your Setups

Data Capture

Acquisition	[F1] [6] [ENTER]
Playback	[F1] [4] [ENTER]
X and Y Channel Select	[F1] [5] [ENTER]

Real-Time Setups Applicable to Data Capture

Event or Annotation	[F1] [2] [ENTER]
Annotation Entry	[F2] [0] [ENTER]
Grid Printing On/Off	[F1] [1] [ENTER]
Channel Order	[F1] [0] [ENTER]
Signal Polarity Reverse	[F1] [7] [ENTER]

Enter the Mode

1. **Press the [MODE] key.**

   The LED display reads <READY>.

2. **Press the [2] key.**

   The display reads <CON SS U>.

3. **Press the [ENTER] key.**

   The display will briefly read <ACQUIS> indicating that the recorder is acquiring data.

   The display will then change to read <PLAYBACK> and the recorder will playout the captured data.

   The recorder will toggle indefinitely between the <ACQUIS> state and the <PLAYBACK> state. When in the <PLAYBACK> state, the recorder will playout all captured data.

   Each time a playback occurs, the recorder's RAM is cleared to facilitate the next snapshot acquisition.

4. **To halt the recorder, press the [HALT] key.**

   The recorder will wait in a neutral state. The LED display will read either <ACQUIS> or <PLAYBACK> depending on when the recorder was halted.

5. **To resume recorder operation, press the [HALT] key again.**

   The recorder will resume the operating condition in which it was functioning before being halted. Operation of the recorder will toggle between <ACQUIS> and <PLAYBACK> and the LED display will switch to show this. Data playout will occur each time the recorder cycles to <PLAYBACK>.

6. To exit the mode:

    *   Press the [HALT] key and then
    *   Press the [ENTER] key.

    The LED display will read <READY>. You can proceed.

3-6.5 Continuous Snapshot (Triggered): Mode 3

The continuous snapshot (triggered) mode enables the recorder to enter a continuous cycle of automatic, triggered data captures and playbacks. When this mode is initiated, the cycle will continue until halted by operator intervention. Remember that the type of snapshots that the recorder acquires are defined by the acquisition, playback, and trigger setups. Snapshot playback is automatic and the waveform playout cannot be altered. Captured data are lost from the recorder's RAM immediately upon playback. To access this mode, follow the procedure presented below.

<u>Establish Your Setups</u>

Data Capture	
Acquisition	[F1] [6] [ENTER]
Playback	[F1] [4] [ENTER]
Trigger Channel and Location	[F1] [3] [ENTER]
X and Y Channel Select	[F1] [5] [ENTER]
Real-Time Setups Applicable to Data Capture	
Event or Annotation	[F1] [2] [ENTER]
Annotation Entry	[F2] [0] [ENTER]
Grid Printing On/Off	[F1] [1] [ENTER]
Channel Order	[F1] [0] [ENTER]
Signal Polarity Reverse	[F1] [7] [ENTER]

<u>Enter the Mode</u>

1. Press the [MODE] key.

    The LED display reads <8 CH RT>.

2. **Press the [3] key.**

    The display reads <CON SS T>.

3. **Press the [ENTER] key.**

    *The recorder enters a neutral state. The LED display reads
    <ACQUIS> indicating that the recorder is waiting to perform
    an acquisition when a trigger is sensed.*

    *The recorder will wait in the <ACQUIS> condition until a trigger
    that meets the parameters you have already defined is sensed. When
    a trigger is sensed:*

    *   *the recorder acquires a data snapshot*

    *   *the recorder automatically and immediately begins
        playback of the snapshot data*

    *   *the LED display changes to read <PLAYBACK> during the
        playback portion of the continuous cycle*

    *   *the recorder's RAM is immediately cleared at the conclusion
        of the playback to facilitate the next snapshot acquisition*

    *   *the recorder returns to a neutral state and waits for another
        trigger immediately after <PLAYBACK> is complete*

    *   *the LED display changes to read <ACQUIS> while the
        recorder waits for a trigger that will initiate the acquisition
        of another snapshot.*

    *The recorder will toggle between the <ACQUIS> state and the
    <PLAYBACK> state each time a trigger is sensed. This will continue
    indefinitely until recorder operation is changed by operator
    intervention. When in the <PLAYBACK> state, the recorder will
    playout each captured snapshot.*

4. **To halt the recorder, press the [HALT] key.**

   The recorder will wait in a neutral state. The LED display will read either <ACQUIS> or <PLAYBACK> depending on when the recorder was halted.

5. **To resume recorder operation, press the [HALT] key again.**

   The recorder will resume the operating condition it was functioning in when halted. Operation of the recorder will toggle between <ACQUIS> and <PLAYBACK> and the LED display will switch to show this.

6. **To exit the mode while the recorder is in the <ACQUIS> state, press the [HALT] key.**

   The LED display will read <READY>. You can proceed.

7. **To exit the mode while the recorder is in the <PLAYBACK> state:**

   - **Press the [HALT] key and then**
   - **Press the [ENTER] key.**

   The LED display will read <READY>. You can proceed.