MAST
OPERATING
INSTRUCTIONS

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INTRODUCTION

The **M**obile **A**dvanced **S**tep **T**ester, has been designed to remotely measure, display and store the average flow or pressure in water pipe lines.

The primary function of MAST is the rapid identification of high consumption areas within "waste zones" via the basic concept of traditional "step testing" methods utilising reduced manpower and time.

Originally "step tests" were performed using "the man at the meter" method with one man monitoring the meter whilst, usually, two men operate the valve. Changes in flow are relayed to the operators via the voice radio network. The introduction of wax charts and then data loggers eliminated the "man at the meter" and provided greater accuracy. However, the operators were not aware of the flow changes until the end of a test or next day. A major disadvantage of this latter technique is, if high consumption had been identified during the first part of the test, further time spent closing valves is unnecessary, expensive and caused extensive disruption to customers.

MAST combines these two methods and relays the information constantly to the operator, (as with the man at the meter method), whilst providing the accuracy of a data logger.

The system consists of two units. A transmitter unit that is attached to the incoming zone meter. This unit measures the flow and transmits the data at the end of a user selectable logging interval.

A receiver unit that displays the flow rate immediately for operator inspection, and stores the reading, see figure no 1.

By moving through the zone and operating the test valves, the operator is always aware of the flow status. The loss associated with these valves is immediately indicated by the changes in flow.

MAST TRANSMITTER UNIT

ANTENNA

PRESSURE INPUT
(4-20 mA, 0-1 V, 0-2V)
(FOR VER NO.4, 4-20 mA FLOW SENSOR INPU)

FLOW + CHARGER INPUT
(PU10,PU100,CH10,OPTO, NEPTUNE)

ON / OFF SWITCH

LOGGING PERIOD LEDS

MAST RECEIVER UNIT

ANTENNA

PC COMMUNICATIONS + CHARGER INPUT

DISPLAY

ON / OFF SWITCH

KEYPAD
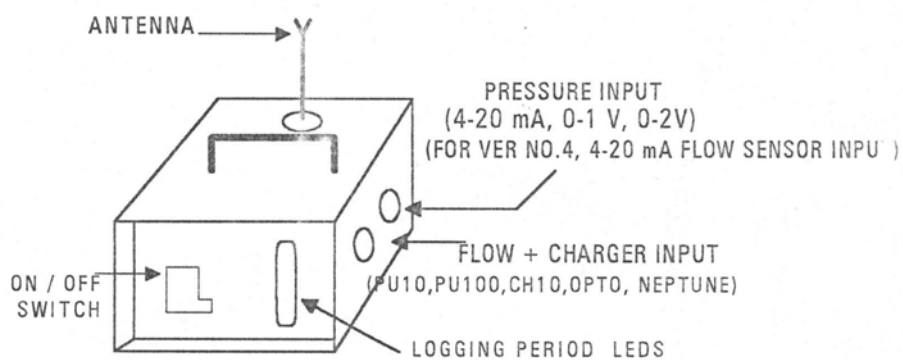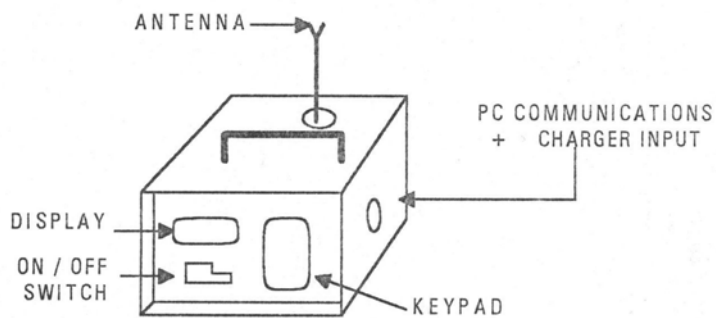
FIGURE NO.1 MAST SYSTEM

SETTING UP MAST SYSTEM

For correct operation and setting up of the MAST the operator should know the version number of the software installed in the MAST receiver unit. The operator can determine the version number installed by carrying out the following procedure.

- Switch the receiver unit OFF.

- Press key '6'[Test], keep this key pressed and switch the unit ON.

- The display will display the version number once and flash the message C-d.

- Make a note of the number, for future reference.

Please note that MAST version no. 1 does not have the facility to display the version number. There are four software version numbers, 1,2 are the standard, 3 is with pressure upgrade, and 4 is with pressure and flow transducer (with 4-20mA output signal) upgrade. When reading the version number of the display, any number greater than 2 and less than 3 means the software version number is 2.0. Any number greater than 3 and less than 4, indicates its version no.3, and so on. Please follow the setting up instructions provided for each version number.

IMPORTANT NOTES FOR ALL VERSION NUMBERS

- Its is recommended that the receiver unit is set up first.

- Ensure that the time and date on the receiver unit are correct, more details on setting the time and date later.

- Do not change the time on the receiver unit during a step test.

- Do not store district numbers 0 or 9999 – these are used by the system.

- Best data reception occurs when the receiver unit is stationary.

- Data corruption will occur if a MAST with the same ID number is being used locally at the same time.

- Do not turn OFF PC or reset it while a MAST receiver unit is connected to it through the interrogation cable.

- Ensure good battery charge on both units before commencing the step test. Do not switch OFF the transmitter unit or change the logging interval during a step test.

- Always ensure that enough memory bytes are available to store your data before the start of the session.

SENSOR RANGE

The MAST system can operate with an extensive range of sensors depending on its version. Table no. 1 below illustrates the range of sensors that are used with each version number.

Version No.	Flow Sensors	Pressure Sensor
STANDARD	PU10,100, CH10, NEPTUNE, OPTO 06	NONE
+ PRESSURE UPGRADE	AS ABOVE	4-20mA, 0, 0-1V,0-2V
+ FLOW SENSOR UPGRADE	AS ABOVE+ 4-20mA	AS ABOVE

Table no. 1

Consult PALMER Environmental before using a pressure sensor with 0-1V and 0-2V output signal, or a flow transducer with 4-20mA output signal. This is to ensure compatibility with the MAST transmitter unit.

STANDARD PROCEDURE FOR SETTING UP MAST RECEIVER UNIT

Always ensure that enough room is available in memory to store data. The following check can not be carried out before the setting of the zone/district, when the receiver is set to measure pressure. This check is carried out by switching the unit ON and pressing key 6 [Test]. The unit will sequentially display three parameters those are:

- ID number of the unit, this would be any value between 0-F.

- The number of memory stores available.

- The result of a memory check, (carried out by the unit), which should display OK

If the second parameter reads zero, then the memory must be cleared. The only way to clear the memory is by using the MAST software. The software is a recommended accessory for every unit. The use of the MAST PC software will be shown later.

WARNING: All data will be erased if the memory is cleared. To clear the memory please refer to 'Programming the Mast' on page 16.

For correct operation always select the unit of the measured variable and enter the HEAD & METER type before the transmitter unit is switched ON. These parameters are used to calculate the flow.

SETTING THE MEASUREMENT UNIT

Version one receiver unit displays the flow in two units, litres / second (l/s) or cubic meters / hours (m³/h). Version two can also display the flow in cubic gallons per hour (g³/h). To select the required units proceed as follows,

1   Press [Enter] key.
2   Press '1'[Head] key for (l/s), or '2'[Set Ref] key for (m³/h), or '3'[Time] key for (g³/h).
3   Press [Enter] key.

Note: For systems with an upgrade, the receiver may display "Err.d", the operator may ignore this message and continue with the procedure.

SETTING THE METER TYPE

Assuming the receiver unit is ON, proceed as shown below,

1   Press key '0' [Meter]. The display flashes "l-r" prompting the operator to enter the meter scale factor in litre per revolution, eg 10, 100, etc
2   Enter the correct constant using the key pad.
3   Press [Enter] key.

SETTING THE HEAD TYPE

The head type is determined by the type of pulse generating head being used, eg

TYPE	PULSES
PU100	100
PU 10	10
CH 100	100
NEPTUNE	10
MEINECKE OPTO 06	1000

The MAST is usually supplied with PU 100.

1   Press '1' [Head], the display will flash "HEAd"
2   Enter the head constant using the keypad
3   Press [Enter] key.

The receiver unit is now ready for operation.

NOTE: Errors in head and meter inputs can be corrected by use of '.' Key. Pressing the key once will display a decimal point, but upon the second press the display will be cleared.

STANDARD PROCEDURE FOR SETTING UP MAST TRANSMITTER UNIT

The procedure does not apply for systems with pressure (in the pressure mode), and 4-20mA flow transducer upgrades, (when the 4-20 mA transducer is selected).

Switch the unit ON, the logging interval LED's will scan every five seconds. The required logging interval is selected using the arrow up key. The selected logging interval is locked into the transmitter after 10 seconds and the LED starts flashing as logging commences.

The pulse head should be connected to the first input on the side of the transmitter (nearest the fascia). The MAST will automatically distinguish between contact closure and optically driven heads.

SETTING UP MAST SYSTEM WITH PRESSURE UPGRADE

For this system the operator must set the receiver unit for either flow or pressure measurement. For flow measurement, please follow the standard procedure described earlier. For pressure measurement see appendix A.

SETTING UP MAST SYSTEM WITH 4-20mA FLOW TRANSDUCER UPGRADE

For this version, the operator not only has to set the unit for flow measurement but also set the type of output signal produced by the flow sensor. This system can handle a flow transducer with 4-20mA output signal, as well as the other sensors shown in table no. 1. The operator can also set the unit for pressure measurement.

The operator can select any of the following settings in conjunction with the [Enter] key on the receiver unit.

Key Description	Application	Set Unit
'1'[Head]	Flow Measurement	Litres/sec
'2' [Set Ref]	Flow Measurement	m³/hour
'3' [Time]	Flow Measurement	g³/hour
'4' [Store]	Pres. Measurement	Bar
'5' [Print]	Pres. Measurement	Psi
'6' [Test]	Pres. Measurement	Meter-head
'7' [Ref]	Pres. Measurement	Feet-head
'8' [Flow]	Select flow sensor	Output: 4-20mA
'9' [Step]	Select flow sensor	Output: pulses eg pu 100

Table no. 2

SETTING THE RECEIVER UNIT FOR FLOW MEASUREMENT

The following procedures are for setting the receiver unit for flow measurement with a transducer that produces a pulse signal, (such as, PU10, PU100, OPTO 06, etc…), or a transducer that produces a 4-20mA signal.

A PULSE SIGNAL

Please proceed as follows:

        1   Switch the unit ON
        2   Press [Enter] key
        3   Press '9' [Step] key
        4   Press [Enter] key

The operator can now follow the standard procedure for setting up the system.

4-20mA SIGNAL

Please proceed as follows:

        1   Switch the unit ON
        2   Press [Enter] key
        3   Press '8' [Flow] key
        4   Press [Enter] key

The operator can now follow the standard procedure for setting up the **receiver unit**, and appendix B to set up the **transmitter unit**.

SETTING THE RECEIVER UNIT FOR PRESSURE MEASUREMENT

Please refer to appendix A

OPERATION

DATA TRANSMISSION

The data is transmitted at the pre-defined logging intervals, or at 30 second intervals, whichever is the shorter. The 30 second time between transmissions is to help the operator if he is in a black spot where it is not possible to receive data. The operator will know that there is 30 seconds between transmissions so he can change location until an area of good reception is identified.

DATA RECEPTION

When data is being received by the MAST receiver unit, the "Data" LED will light. If the data is accepted, then the internal buzzer will sound.

The flow or pressure reading will be displayed, and the "Flow" LED will be lit. The reading will be continually displayed until new data from the next logging interval is received.

SETTING ZONE / DISTRICT REFERENCE [SET REF]

Key '2' [Set Ref] allows the operator to enter a zone / district reference for subsequent hard copy recognition. By pressing key '2' [set ref], the display will flash "dist". The zone / district number may then be entered. The current flow / pressure becomes the reference flow / pressure and is displayed on the screen and the "Ref" LED lit. Key '8' [Flow] must then be pressed to allow the flow / pressure rates to be updated.

All step calculations are then based upon this initial flow / pressure reference. Any combination of the numeric keys are allowed for the zone / district reference except '0000', no action and '9999' which is reserved for printing routines. The flow / pressure reference can be displayed at any time by pressing key '7' [Ref]

AUTO DATA STORAGE

Once the zone/district is set, all the transmitter flow / pressure rates are automatically stored to enable graphical hard copy information. If a new zone / district is to be tested then a new HEAD or METER type, in the case of flow, or transducer range or output signal, in the case of pressure measurement **must** be entered. This will enable a new reference to be set even if the new variables are the same as the former variables.

FLOW / PRESSURE

Key '8' [Flow] is used to display the current flow / pressure on the screen. While it is being displayed the "Flow" LED is lit. Flow / pressure rates are displayed in the unit selected during the setting up procedure. It is possible to change the unit of the displayed readings during the step test without affecting the operation of the system. Depending on the version installed in the system, the operator can change the unit in 3 steps:

1 Press [Enter] key
2 Check table no.2, press the required key
3 Press [Enter] key

REFERENCE [Ref.]

The '7' [Ref] key is used to display the reference flow/pressure. The "Ref" LED is lit when the reference is displayed. The reference is set automatically upon the zone / district setting. The reference can not be set manually, but stores the received reference level.

STEP

The step, i.e. difference in flow / pressure rate, can be displayed by pressing key '9' [Step]. A negative number indicates that the flow / pressure is greater than the reference flow / pressure. All step values are calculated by deducting the current flow / pressure rate from the reference flow / pressure.

STORE

This key provides a convenient means of identifying valve operations upon subsequent interrogation of the unit. When a valve has been closed and the flow/pressure data has been satisfactorily received.

1 Press '4' [Store] key, the display will flash "F.rEF", fitting reference
2 Enter the valve number, using the keypad
3 Press [Enter] key. This will save the valve number in memory.

This key will not operate if a zone / district has not been set previously

SYSTEM PARAMETERS

The system incorporates a number of helpful keys to the operator. Restrictions on the use of any key will be stated accordingly.

[.] key

The [.] key can be used to display sequentially and check the previously entered meter and head type, (in the case of flow), or the transducer's range and output signal, (in the case of pressure), as well as the reading unit. For version 4 software, it will also display the transducer's output signal type for the case of flow measurement. That is if the receiver is set to receive data from a transducer with an output of 4-20mA, or pulse output.

This key can be used at any time during the setting up or the step test. There are no restrictions on the use of this key. To use, simply press [.] key, and the receiver unit will scan through the parameters automatically, and in the order mentioned above.

TEST KEY

The operator can use '6' [Test] key to display the information he/she requires to ensure correct operation of the system. Three items are shown when this key is pressed. The first item is the ID number. This is a number built into the MAST receiver and transmitter units. This number must be the same for both units for data to be accepted. This facility allows MAST systems to operate in proximity without the receivers being "confused".

The second item displayed is the figure for the amount of free data stores in memory. This figure assumes that no more zone/district or fitting references will be entered, otherwise the number of stores will be reduced. For version one software, the indicated number will be in the range 3358, for no data, to zero, for full stores. For version 2, 3 and 4 the range is between 3200 – 0.

The third item is the result of a check carried out by the system on the memory, which ensures the system is operating correctly. The result is either a "PASS" or "FAIL". In the case of a fail occurring, the MAST should be returned to PALMER Environmental for checking.

RESTRICTION: This key can not be used to perform the above mentioned functions when the system is set for pressure measurement. This key is used for recalibrating the pressure transducer for atmospheric pressure. However, once the district / zone is set the key can be used to display the items mentioned above.

TIME

Integral to the functioning of the MAST is the real time clock (RTC). Stored data is logged with real time information for effective management control and correct interpretation of subsequent hard copy / PC results. The time can be displayed by pressing key '3'[Time], and updated every second on the display. To modify the time, which is based on the 24 hour clock, when the time is displayed.

1   Press '3'[time] key
2   Enter the new time, four digits must be entered for correct operation.
3   Press [Enter] key.

Note: the operator can not modify the date using the keypad. This is only possible though a PC and the PC software.

WARNING: THE OPERATOR <u>MUST NOT</u> MODIFY THE TIME DURING A STEP TEST, THAT IS WHEN A ZONE / DISTRICT IS SET AND THE TEST IS UNDERWAY. THIS WILL PREVENT THE LOGGED DATA FROM BEING DOWN LOADED CORRECTLY TO THE PC AND THE OPERATOR WILL DEFINITELY LOSE THE LOGGING SESSION DATA.

PRINT

Key '5' [Print] is a print key.   When this key is pressed the MAST checks the status of its communication port to see if an output device is available. If such a device is present, the status of the internal memory is checked to see if any data is present. If both of these conditions are met, then it is possible to print out data.

The operator will be prompted to enter the district number he/she wishes to print. The MAST will check its memory to locate the entered district, prior to printing.

It is also possible to print all the data stored in memory by simply entering "9999" as the district number when prompted by the MAST. Entering "0000" has no function.

PC SOFTWARE

PALMER Environmental have written special software designed to provide a convenient means for display and archiving of step tests.

SOFTWARE INSTALLATION

The software must be installed correctly in order to function properly. The software is supplied on either 3.5 or 5.25 inch diskettes. The MAST program requires 540K of available RAM and DOS 3.3 or greater. For optimum use, a colour screen (EGA or better) and a hard disk should be used.

The software installation procedure is indicated below:

- Insert the disk into the appropriate drive and log onto that drive.

- Type in INSTALL C:

- Press the ENTER key

The software will then be installed onto your hard disk (on drive C:) Alternative drives may be specified. A PALMER directory is created that contains the executable code and a batch file (called MAST.BAT) is created in the root directory of drive C: to allow the user easy access to the software.

RUNNING THE SOFTWARE

After booting your computer, the software can be executed by typing MAST <enter> from drive C:

The <u>PRIMARY MENU</u> will be displayed, detailing the options available to the operator:

     F1   DETAILED HELP
     F2   INTERROGATE M.A.S.T.
     F3   DATA DIRECTORY
     F4   FILE ROUTINES
     F5   REPROGRAM M.A.S.T.
     F6   CONFIGURE
     F7   PROGRAM M.A.S.T. RTC

CONFIGURING THE MAST

The PC must be configured correctly to ensure reliable operation. Press F6. The following options will be displayed:-

        M.A.S.T. PORT   = COM1
        PLOTTER PORT   = COM1
        PLOTTER SIZE   = A4
        GRAPH TO PLOTTER
        SCREEN   = MONO
        PARALLEL PRINTER

The arrowed option indicates the current selected parameter. Press SPACE to change. The cursor up and down keys move to the next/previous parameter.

<u>Press F1 for HELP, F5 to save the configuration and F10 to quit without saving.</u>

The COM ports can be set to either COM1 or COM2. If the wrong port is specified then the system will either not work at all, or incorrect values will be read. In either case change the port setting.

The facility for sending the graph to a plotter is also available. This gives the operator a larger output for report generation. The plotter may be connected to either COM1 or COM2. Data is sent to the plotter at 9600 bits per second with 8 data bits NO parity and 2 stop bits. Control protocol is HP7475 compatible.

Plotter size is selectable between A3 or A4.

Plot output may also be sent to a printer. This may be either a parallel or serial printer (1200 bits per second, 8 data bits NO parity 1 stop bit). The printer must be a dot matrix type capable of executing EPSON ESC sequences.

For colour screen, press the cursor down key until the arrows point to the SCREEN=MONO option and press SPACE. The display will then change to a colour display.

The printer may be either parallel, or serial. When a serial printer is specified, the processor type and speed must also be selected so that the character rate can be adjusted so that codes are not misread by the printer.

The current program version number is displayed on the screen. Press F5 to save the configuration on disk. F10 will quit without saving.

PROGRAMMING THE MAST

For the MAST to operate in its PC communication mode**, with the MAST to PC interrogate cable in place**, supplied with the unit, switch the MAST receiver unit ON. The display will show "PC" to indicate to the operator that it's in PC mode. The MAST keyboard is disabled until the unit is turned OFF and the serial connector removed.

Press F5 to enter the programming screen. MAST details are read into the PC and the current head and meter type are displayed (**please note, this option can not be used to program the pressure transducer's range and output signal, this can only be achieved manually through the MAST receiver unit)**. The operator can then change these details to whatever is required using cursor UP and DOWN keys.

Check the logger TIME and DATE (displayed along the top of the screen). If these are incorrect then press F10 (return to primary menu), and F7 (program MAST RTC). Press F5 to return to the reprogram screen. If the time and date are still incorrect then ensure that the time on your PC is correct and repeat the steps mentioned.

Pressing F5 will program the information into the logger. **ALL DATA PREVIOUSLY STORED IN THE MAST WILL BE ERASED. DISCONNECT THE MAST FROM THE PC.**

THE MAST CAN NOW BE USED

INTERROGATING THE MAST

When a step test has been completed, connect the MAST to the PC as when the system was programmed.

Press F2 (INTERROGATE LOGGER). The message "READING DATA" will be displayed as the data is first read in from the MAST. The message "READING DATA. BLOCK #?" and "(number of blocks=??)" gives the user an indication of how long the down loading will take.

After the data has been read, it is sorted into districts. For each district the operator **must enter a district name** (up to 8 digits) and zone/field details consisting of a graph title and two lines of comments. The cursor keys can be used to select the data to be edited, and the back space key to delete data to the left of the cursor.

Once the data has been entered, key F5 is pressed and the data is stored to disk.

If only one district is stored in the MAST and down loaded, the graphical data is calculated and the graph screen is displayed.

For multiple districts, the operator **must enter a name** and if required zone/field details for each district. Once all the districts are downloaded and saved, the operator can recall the required data file from the DATA DIRECTORY function after exiting the other primary menu.

NOTE: for version three and above, when the data is being downloaded from the MAST, the program **will not** distinguish between data gathered for a pressure step test or a flow step test. The operator must remember the sequence of the tests carried out, in order to name each data file with its appropriate name.

If no data is present inside the MAST, no further action is taken by the PC. An error message is displayed indicating that no data is in the MAST.

GRAPHIC DISPLAY

The flow is represented on the vertical axis and time on the horizontal axis. The screen shows the DISTRICT, FITTING and START DATE along the top of the display. The upper left portion shows the MAXIMUM, MINIMUM, and REFERENCE flows. Below them the HEAD type, METER type, the LOGGING INTERVAL, and the STEP are displayed. AT bottom left, the INSTANTANEOUS FLOW and its associate TIME and DATE, controlled by the cursor position.

Underneath the flow is the zoom factor, which indicates how compressed the graph is. The maximum compression is 1:12 and maximum magnification is 8:1. The actual graph data is shown as white line. For periods when no data was collected (i.e. receiver switched OFF, radio blackspot, etc.), the line changes to a red colour on a colour monitor, and no line at all on a mono monitor.

Where the operator has manually stored a fitting reference, a vertical dotted line is displayed for easy indication of valve closures.

Several options are available to the operator:

F1   HELP
F2   PLOTTER/PR. PLOT (AS DETERMINED BY THE CONFIGURATION)
F3   TABLE
F4   (UNITS) CHANGE MODE?
F5   PRINTER
F6   EDIT COMMENTS

Some additional keys are also used:

- CURSOR LEFT
- CURSOR RIGHT
- CURSOR UP
- CURSOR DOWN

The cursor LEFT and RIGHT keys move the cursor (a vertical line) along the graph. The instantaneous values will change according to the value of the flow. If a numeric keypad is used, then by pressing SHIFT and the cursor key the cursor will move faster, alternatively "4" is fast left and "6" is fast right. The cursor UP key zooms IN on the data with the current cursor position placed at the centre of the screen (except in the case where the cursor is close to one end - in this case the maximum data is displayed and the cursor position adjusted to keep on the same data point). The maximum zoom ratio is 8:1. Cursor DOWN decreases the display scale until all of the collected data is displayed.

DISTRICT: PHASE 4   FITTING: START   DATE: 14:23:91

MAX.:3.02
MIN.:0.00
NET.:2.97   3.2
HEAD
100   p/r
METER
100   1/r   2.4

FLOW
(1/S)

STEP:0.00   1.6

LOGGING INT.
00:01:00

INST. VALUE   0.8
at 08:40:18
on 14/03/91
FLOW:2.97   0.0
ZOOM 4:1
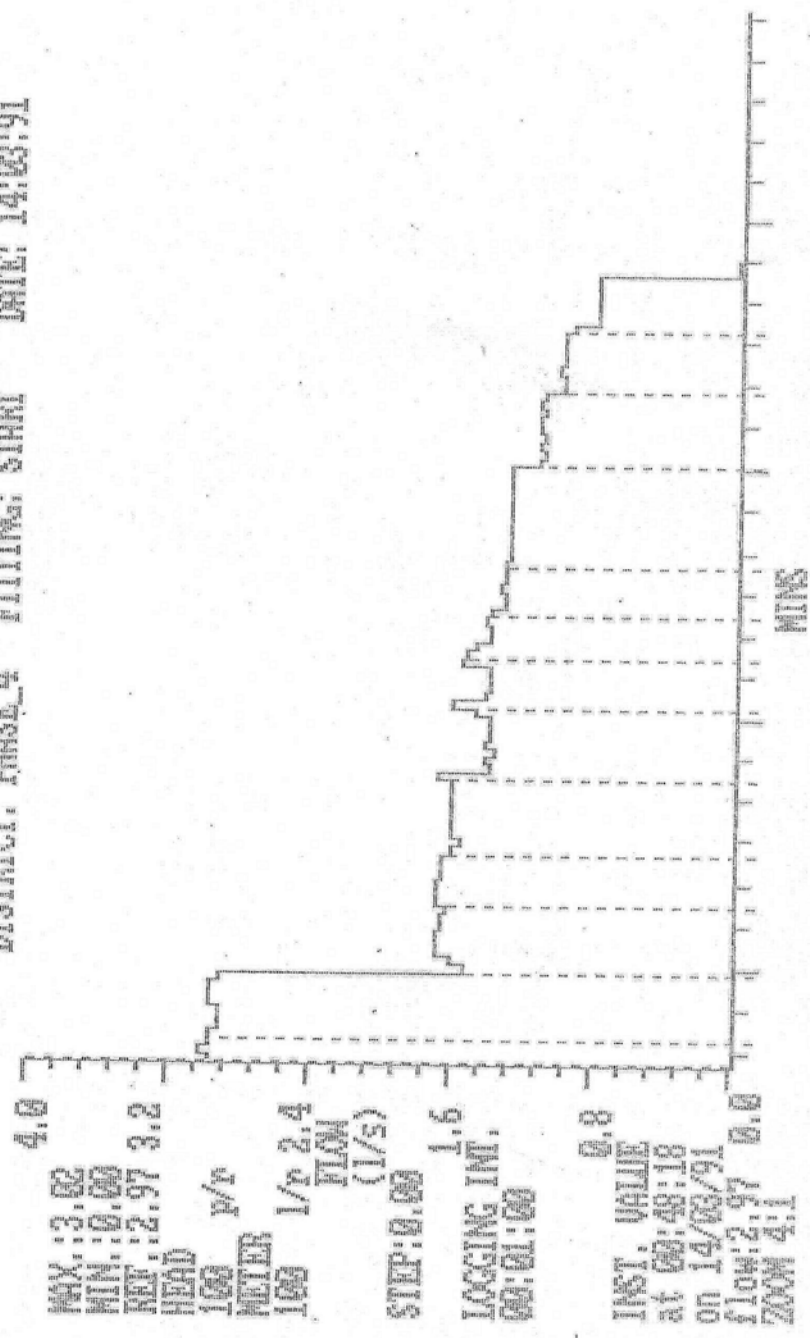
MTRS

F2 PLOT / PR. PLOT

F2 will send a copy of the graph to either a plotter or to a printer. The plotter may be connected to either COM1 or COM2 (as determined by the configuration). Data is sent to the plotter at 9600 bits per second with 8 data bits NO parity and 2 stop bits. Control protocol is HP7475 compatible. Only the graph is sent to the plotter – not the tables.

Plot output may also be sent to a printer. This may be either a parallel or serial printer (1200 bits per second, 8 data bits NO parity 1 stop bit). The printer must be a dot matrix type capable of executing EPSON ESC sequences.

The time taken to perform any print operation is dependent upon the hardware used.

F3 TABLE

The Table is a tabular formatting of the data with the FITTING REFERENCE, TIME, DATE, FLOW, and STEP displayed. Pressing SPACE will advance to the next page. F5 will dump the current screen to the selected printer.

A sample page is shown below…

```
                          HETEN ACOUSTICS H.A.S.1

      DISTRICT      HEAD(p/r)     METER(1/r)    MAX.        MIN.        REF.
      PHASE_4       100           100           3.02        0.00        2.97

      FITTING REF.     TIME         DATE         FLOW(1/s)       STEP(1/s)
        00000        00:48:18     14/03/91        2.97            0.00
        00000        00:49:18     14/03/91        3.02            0.05(-)
        00000        00:50:18     14/03/91        2.97            0.00
        00001        00:51:18     14/03/91        2.97            0.00
        00001        00:52:18     14/03/91        2.92            0.05
        00001        00:53:18     14/03/91        2.92            0.05
        00001        00:54:18     14/03/91        2.92            0.05
        00001        00:55:18     14/03/91        2.97            0.00
        00001        00:56:18     14/03/91        2.97            0.00
        00001        00:57:18     14/03/91        2.97            0.00
        00001        00:58:18     14/03/91        2.92            0.05
        00002        00:59:18     14/03/91        1.52            1.40
        00002        01:00:18     14/03/91        1.62            1.30
        00002        01:01:18     14/03/91        1.70            1.22
        00002        01:02:18     14/03/91        1.70            1.22
        00002        01:03:18     14/03/91        1.70            1.22
        00002        01:04:18     14/03/91        1.67            1.25
        00002        01:05:18     14/03/91        1.67            1.25
        00002        01:06:18     14/03/91        1.63            1.28
        00003        01:07:18     14/03/91        1.70            0.07(-)
        00003        01:08:18     14/03/91        1.70            0.07(-)
        00003        01:09:18     14/03/91        1.70            0.07(-)
        00003        01:10:18     14/03/91        1.67            0.03(-)
        00003        01:11:18     14/03/91        1.67            0.03(-)
        00003        01:12:18     14/03/91        1.67            0.03(-)
        00004        01:13:18     14/03/91        1.60            0.07
        00004        01:14:18     14/03/91        1.57            0.10
        00004        01:15:18     14/03/91        1.60            0.07
        00004        01:16:18     14/03/91        1.62            0.05
        00004        01:17:18     14/03/91        1.62            0.05
        00004        01:18:18     14/03/91        1.62            0.05
        00004        01:19:18     14/03/91        1.62            0.05
        00004        01:20:18     14/03/91        1.60            0.07
        00004        01:21:18     14/03/91        1.62            0.05
        00005        01:22:18     14/03/91        1.70            0.08(-)
        00005        01:23:18     14/03/91        1.40            0.22
        00005        01:24:18     14/03/91        1.42            0.20
        00005        01:25:18     14/03/91        1.37            0.25
        00005        01:26:18     14/03/91        1.42            0.20
        00005        01:27:18     14/03/91        1.40            0.22
        00005        01:28:18     14/03/91        1.40            0.22
        00005        01:29:18     14/03/91        1.40            0.22
        00005        01:30:18     14/03/91        1.47            0.15
        00006        01:31:18     14/03/91        1.60            0.13(-)
        00006        01:32:18     14/03/91        1.42            0.05
        00006        01:33:18     14/03/91        1.40            0.07
        00006        01:34:18     14/03/91        1.40            0.07
        00006        01:35:18     14/03/91        1.40            0.07
        00006        01:36:18     14/03/91        1.57            0.10(-)
        00007        01:37:18     14/03/91        1.52            0.05
        00007        01:38:18     14/03/91        1.47            0.10
        00007        01:39:18     14/03/91        1.40            0.17
        00007        01:40:18     14/03/91        1.40            0.17
```

F4 CHANGE MODE

For a graph displaying a flow step test data, the standard unit of display is litres per second (L/sec). However, by pressing F4 repeatedly, the display mode will change to cubic gallons per hour (g³/h), and cubic metres per hour (m³/h), respectively. All subsequent calculations are done on that basis until the graphical screen is re-entered.

For a graph displaying a pressure step test data, the standard unit of display is bar. However, by pressing F4 repeatedly the display mode will change to pounds per square inch (psi), meter head (mh), and feet head (fh) respectively. All subsequent calculations are done on that basis until the graphical screen is re-entered.

F5 PRINTER

The data will be printed, in tabular format, on either a serial or parallel printer, depending upon the setting in the configuration option.

F6 EDIT COMMENTS

The graph title and comments can be edited if the operator wants to change them.

DATA DIRECTORY

The data directory (from the primary menu), displays a list of all DISTRICTS logged. Use the cursor UP, DOWN, LEFT and RIGHT to select a district, or F5 to SORT the directory into ascending alphanumeric order. Press ENTER when the appropriate district has been found.

If there is more than one data file in any district, a list of dates will be displayed representing the number of times a step test was carried out on the particular district and their associated dates. A number or letter is tagged to the date, this is the ID number of the MAST. This provides a convenient means of differentiating between MAST systems operating on the same date.

In the case of one date being present, the program will automatically read in the data for that particular date and display it on the screen.

Use the same keys as before to select a fitting and press ENTER.

FILE ROUTINES

The FILE ROUTINES gives the operator control over the files stored on the disk several options are available. **UNDER NO CIRCUMSTANCES USE DOS FUNCTIONS TO TRANSFER OR DELETE FILES, THIS WILL SERIOUSLY AFFECT FUTURE OPERATIONS.**

    F1   DETAILED HELP
    F2   TRANSFER FILES
    F3   READ DATA FROM
    F4   WRITE DATA TO
    F5   DELETE FILES

In order to transfer files, the source and destination drives must be selected.

Press F3 followed by the letter of the source drive followed by F10 to select. Only valid drives associated with your system will be allowed. The selected drive will be used for all read operation.

Press F4 followed by the letter of the destination drive followed by F10 to select. Only valid drives associated with your system will be allowed. The selected drive will be used for all write operations except those that have a data set associated (such as edit comments). Any new data read from a MAST will be written to this drive.

Having selected the source and destination drives, press F2 to start the transfer. The DISTRICT is selected as for the DATA DIRECTORY. When the data has been read in it is written to the DESTINATION DISK.

To delete a file from your drive press F5. Press F5 again to confirm. Select the data set as for recall/transfer. Press F5 to delete from the disk.

RUNNING FROM WITHIN WINDOWS

The MAST program can be executed from within WINDOWS as a DOS program. To add the function (having previously installed the software on disk).

- Click on Windows function (Alt W)

- Select the desired program group

- Click on FILE (Alt F)

- Select New

- Program Item

- Enter a Description (eg Step Test)   [TAB]

- Command line is MAST.EXE   [TAB]

- Working directory is C:\PALMER   [TAB]
  (or drive on which the MAST program was installed)

- Choose a SHORT CUT key

- ENTER

The MAST program has now been added to WINDOWS.

When executing the program under WINDOWS, COM1 cannot be used for the MAST or for the PLOTTER since WINDOWS uses COM1 for mouse support (this does not apply if there is a dedicated mouse port on your PC).

If your PC has only one communication port, then de-select your mouse driver (refer to your WINDOWS manuals).

CHARGING

The battery is charged by using the charge cable and charger supplied with the system.

Plug the 6 pin binder charge cable into the interrogate plug of the MAST.

Turn OFF the charger.

Connect the RED plug into the RED socket of the charger, connect the BLACK plug into the BLACK socket of the charger. Both the transmitter and the receiver may be plugged into one charger.

Turn on the charger

The time taken to charge depends upon the charge level in the MAST and the number of MASTs plugged into the charger. Typically a fully discharged set will require 5 hours to be fully charged.

Lead acid batteries do not suffer from a memory effect and may be 'topped up' at any time.

Always check the battery status before deployment.

APPENDIX A

SETTING MAST RECEIVER UNIT FOR PRESSURE MEASUREMENT

Note: When the MAST is set to measure pressure, the operator **must calibrate** the unit for ATMOSPHERIC PRESSURE. This procedure is described on page 27.

SETTING THE PRESSURE READING UNIT

This procedure will also set the receiver unit for pressure measurement.

Assuming the receiver unit is ON

1 Press [Enter] key. The display will flash "dISP"
2 Press either one key from table no. 3 below

Key Description	Selected Unit
'4'[Store]	bar
'5'[Print]	psi
'6'[Test]	meter head
'7'[Ref]	feet head

Table no. 3

3 Press [Enter] key

Note: At this stage the receiver unit may display "Err.d". The operator is advised to ignore this message and continue with the setting up procedure.

ENTERING TRANSDUCER'S PRESSURE RANGE

Proceed as shown below

1 Press key '1' [Head]. The display flashes "bArS" prompting the operator to enter the pressure range of the transducer in bars. Please note, pressure transducer supplied by PALMER Environmental has a range of 0-10 bars.
2 Enter 10 using the keypad
3 Press [Enter] key

ENTERING TRANSDUCER'S OUTPUT SIGNAL TYPE

Although the MAST can handle a number of transducer signals (see table no 1), the operator must always enter the 4-20mA, as this is the output signal of the transducer supplied by PALMER Environmental. Each signal type has a code that is identified by the receiver unit, and the readings are calculated upon this code. Therefore, it is essential to enter the correct code for the transducer being used. Table no 4 below illustrates the transducer type and the associated code.

Transducer Type	Associated Code
4-20 mA	1
0-1 Volt	2
0-2 Volts	3

Table no. 4

NOTE: The operator **must** contact PALMER Environmental if he/she wishes to use another transducer not supplied by PALMER, so that compatibility with the MAST is maintained.

Proceed as shown below in order to enter the transducer type

1   Press '0' [Meter] the display will flash "t.O-P", prompting the user to enter transducer code.
2   Press '1' [head] key using the keypad.
3   Press [Enter] key

NOTE: Errors in inputting data can be corrected by use of '.' key. Pressing the key once will display a decimal point, but upon the second press the display will be cleared.

SETTING UP MAST TRANSMITTER UNIT FOR PRESSUE MEASUREMENT

Setting the transmitter unit for pressure measurement varies slightly from setting it to flow measurement. Proceed with the unit being switched OFF.

1. Plug the binder of the pressure transducer into the second input on the transmitter unit, (furthest from the fascia).
2. Press the On/Off key to switch the unit ON.
3. The logging interval LED's will scan every 5 minutes. There are 5 logging intervals for pressure measurements – these are 5, 10, 15, 30 and 60 seconds. Press the arrow head key repeatedly in order to select the required logging interval.
4. The selected logging interval is locked into the transmitter after 10 seconds and the LED starts flashing as logging commences.

IMPORTANT: AT THIS STAGE THE OPERATOR SHOULD CALIBRATE THE MAST FOR ATMOSPHERIC PRESSURE VARIATIONS, AS DESCRIBED BELOW.

CALIBRATION PROCEDURE

This procedure must be followed through at the beginning of each and every step test session, especially if another logging period is used.

1. With the transducer open to atmosphere, not connected to the hydrant cap, wait for the first readings to be displayed on the receiver unit, say 2 readings.
2. Press'6'[Test] key. The receiver will display "hOld", then it will display zero when the first reading is received.
3. Continue to monitor the receiver's display for a number of readings, (say 3, or 4 readings), the incoming data may vary from zero by a very small amount. This variation is displayed for example as:

   - "0.00x" (where x represents any number between 1-9), this case is acceptable. The operator can plug the transducer into the hydrant cap and start the step test session.

   - "Err.F", which indicates under range reading, this case is also acceptable, but only if this reading is interchanging with case one above, otherwise repeat the procedure.

"0.0XX", (WHERE XX REPRESENTS ANY NUMBER BETWEEN 10-99), REPEAT PROCEDURE

APPENDIX A2

SETTING MAST RECEIVER UNIT FOR FLOW MEASUREMENT (4-20 mA)

SETTING THE FLOW SIGNAL TYPE

Please follow the 4 steps outlined on page 9 under heading 4-20 mA SIGNAL

SETTING THE MEASUREMENT UNIT

Please follow the 3 steps outlined on page 6 under heading SETTING THE MEASUREMENT UNIT

SETTING THE METER TYPE

1   Press key '0'[Meter]. The display flashes "l-r" prompting the operator to enter a value. The value must correspond to the maximum flow in Litres which correspond to 20mA, eg if 4mA – 20 mA = 0 – 50 Litres then the operator must enter 50.
2   Press [Enter] key

SETTING THE HEAD TYPE

1   Press '1'[Head], the display will flash "HEAd"
2   Enter 800, using the keypad. This is a default constant, must not be changed.
3   Press [Enter] key

The receiver unit is now ready for operation.

APPENDIX B

SETTING UP MAST TRANSMITTER UNIT FOR 4-20mA TRANSDUCER OUTPUT

Important: The operator is advised to contact PALMER Environmental before using any transducer with 4-20mA output, to ensure compatibility of the transducer with the transmitter unit. PALMER Environmental do not supply any transducers that produce 4-20mA output for the measurement of flow. However the company can recommend, advise, or carry out customised work on customer's transducers to ensure compatibility with the company's equipment.

Assuming the flow sensor is already connected to the meter, and the transmitter unit is switched OFF.

1. Insert the binder from the transducer into the SECOND input (furthest from the fascia, see figure no 1 on page 2), on the transmitter unit
2. Switch the transmitter unit ON
3. Select the logging interval by pressing the arrowhead repeatedly until the required logging interval is lit. The operator has a choice of five logging interval 5, 10, 15, 30, and 60 seconds.

The unit will start transmitting data after 10 seconds.

APPENDIX C

ERROR MESSAGES PRODUCED BY THE MAST RECEIVER UNIT

ERR.1

NO DATA TO STORE. An attempt was made to store data before any data was received.

ERR.2

DATA STORE FULL. There is no more memory to store data. Use the PC to read in all the data from the MAST. Reprogram the MAST to clear all of the memory locations.

ERR.3

RAM CHECK FAIL. Internal failure, arrange with PALMER Environmental to return the system.

ERR.4

TIME SET INCORRECTLY. The time is set upon the 24 hour clock. Hours are in the range of 00-23, the minutes between 00-59.

ERR.5

REFERENCE NOT SET. An attempt was made to store data before the reference was set. Please enter a reference.

ERR.6

NO DATA RECEIVED. The reference can not be set until data has been received.

ERR.7

NUMERIC OVERFLOW. An internal self check failure. The display can not handle the size of number generated by the MAST. Reduce the logging period to decrease the number of pulses in any period, or use a head with fewer pulses per revolution.

ERR.8

PRINTER ERROR.   The printer is not connected.

ERR.9

NO DATA. There is no data inside the MAST to print.

ERR.A

NO SUCH DISTRICT. The district selected by the operator has not been found in the internal memory.

ERR.C

REFERENCE ALREADY SET. The reference can only be set once at the start of logging.

ERR.d

INCORRECT SETUP. The MAST is set up to receive flow data and it is receiving pressure data, or vice versa.

ERR.E

HARDWARE FAULT. Error in the received data. The receiver is set to receive data from a 4-20mA transducer, yet the transmitter is transmitting zeros. Either faulty sensor, or receiver not set correctly. Call PALMER Environmental to confirm error.

ERR.F

READING IS UNDER RANGE. The measured reading is lower than zero. This only occurs when the receiver is set to receive data from a 4-20mA transducer.

ERR.g

READING IS OVER RANGE. The measured reading is higher than the maximum range of a 4-20mA transducer. This only occurs when the receiver is set to receive data from a 4-20mA transducer.

PROBLEMS WITH PC SOFTWARE?

GARBLED GRAPH

If a garbled graph is output to a dot matrix printer, then modify your printers' CARRIAGE RETURN – LINE FEED translation to ON. Turn your printer OFF and back ON after a few seconds.

OUT OF ENVIRONMENT SPACE (DOS ERROR)

From DOS type in SET <enter> (this will display your environment table)

Reduce the size of your PATH variable to eliminate unused directories

Reduce the size of any prompt settings if possible

Remove any unnecessary variables

Modify your Autoexec.bat to include the line

Command/e:1000/p

This allocated 1000 bytes for the environment table. If there is a setting for this already defined then increase the value (maximum = 32768).

INSUFFICIENT MEMORY

There is no easy solution to this one. The MAST program requires 540K of program memory in which to run. If your PC has less than this, consider the following steps:

CONFIG.SYS MODIFICATIONS

1   Upgrade your version of DOS to 5.0 or greater
2   If using DOS 6 use MEMMAKER to maximise memory. (Your PC must be 386 or greater).
3   Set DOS=HIGH in config.sys (DOS V5 or 6)
4   Reduce the value of buffers (10 or 15 is adequate)
5   Reduce the maximum number of open files (10 or 15 is normally adequate)
6   Use to LOADHI command as often as possible

Autoexec.bat modifications

Reduce the number of entries allocated for FASTOPEN (if installed)

Other options

Use QEMM or other memory management system to maximise memory usage.

Do not use code page switching unless absolutely necessary.

Free a many TSR (terminate and stay resident programs) as possible.

APPENDIX D

TECHNICAL SPECIFIATION

TRANSMITTER UNIT

80C31 Microprocessor
1.8432MHz crystal
8K bytes EPROM
REAL TIME CLOCK
Logging interval variable. 5s, 10s, 15s, 30s, 1m, 2m, 5m, 10m, 15m, 30m.
Pulse counting, Interval timing, 4-20mA
Display: High intensity LED for good day and night time vision,
Flow sensors: All contact closure or zero volt connection types
(PU10, PU100, OPTO, CH100, Neptune, 4-20mA etc….)
Identifier: 4 bit data selector / scrambler pre-set to prevent misinterpretation of results from other systems.
Data entry: custom membrane switch panel
Transmitter module: 5 Watt VHF for large area coverage, pulsed operation.
Power supply: internal 12V 3,4 AH lead acid battery.

RECEIVER UNIT

80C31 Microprocessor
11.0592 MHz crystal
32K bytes EPROM
32K bytes battery backed RAM
REAL TIME CLOCK. Battery backed for automatic annotation of stored data.
Display: 4 digit high intensity LED for good day and night time vision.
Identifier: 4 bit data selector / de-scrambler pre-set to prevent misinterpretation of results from other systems. Will only accept data from corresponding transmitter.
Data entry: custom membrane switch panel.
Receiver module: high sensitivity (<=0.3uV) UHF.
Power supply: internal 12V 3.4 AH lead acid battery

PALMER ENVIRONMENTAL

WARRANTY

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CABLES AND BATTERIES ARE NOT COVERED IN THIS WARRANTY

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