MAST-II User Manual

Date 16/08/17

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Warnings

MAST II Unit Batteries

The batteries supplied and fitted to the MAST-II unit are re-chargeable lithium-ion type.

Do not short circuit or overcharge these batteries. Misuse of these batteries may result in explosion or fire. They must not be used in any other application or used with any other equipment. Only batteries supplied by HWM Water Ltd must be used.

The MAST-II transmitter and receiver is powered by a rechargeable battery pack. The battery pack cannot be removed from the unit. Battery life is approx. 7 hours minimum at a 15 second sample period. Longer sampling periods will result in longer transmission intervals which will increase the battery life whilst shorter sampling periods given shorter transmission intervals will decrease battery life proportionally. Battery exchange can be arranged by return to HWM for servicing.

Used batteries must be disposed of according the manufacturer's instructions.

The MAST-II units use high power components, please do not operate the units without the antenna connected as this can cause internal damage.

Other Warnings

- Always set up the receiver prior to turning on the transmitter.
- Ensure the time and date on the receiver is correct prior to step testing.
- Do not attempt to change the time on the receiver unit during a step test.
- Do not store district numbers 0 or 9999 as these are used by the system.
- Data corruption will occur if another MAST or MAST-II system is in use locality.
- Do not turn off the PC or reset it while the MAST-II receiver unit is connected.
- Ensure good battery charge on both units before commencing the step test.
- Do not switch off the transmitter unit during a step test.
- Do not change the sampling period during a step test.
- Always ensure enough memory is available to store results prior to testing.
- DO NOT disconnect the aerials/antennae whilst the Transmitter or Receiver is powered on. Failure to observe this instruction is likely to cause internal failure to the units. The transmitter MUST NOT be operated without an antenna connected. Failure to observe this precaution may result in transmitter failure.
- DO NOT use the units less than 10 meters (approximately 30 feet or less) apart. Failure to observe this instruction is likely to cause internal damage to the units.
- The Mast-II charger MUST NOT be used on original Mast Units as potentially damage may be caused.
- Mast-II units on 77.5MHz are not compatible with 153.1MHz units.

Introduction

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

The primary function of MAST-II is the rapid identification of high consumption areas within "waste zones" via the basic concept of traditional "step testing" methods.

Originally "step tests" were performed using the "man at the meter" method with one person monitoring the meter whilst, usually, two people operate the valves. Changes in flow are relayed to the operators via a voice radio network (mobile phone, walkie-talkie), this proved a timely and costly method of analysis.

The introduction of wax charts and data loggers, eliminated the "man at the meter" method and provided greater accuracy, however, the operators were not aware of the flow changes until the end of a test or the following 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 consumers. MAST-II combines the two methods and relays the information constantly to the operator 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 and a receiver unit. The transmitter measures the flow for a pre-defined sampling period then transmits the data to the receiver. By moving through the zone with the receiver 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.

Benefits

Step testing is an effective, flow based method of localising water loss within a zoned distribution system. It is particularly suited to identifying areas of high leakage and to use on plastic pipe materials, where leak noise is absorbed and conventional acoustic methods are less effective.

MAST-II (Mobile Advanced Step Tester-II) is a radio based system that has the ability to monitor water flow. Data is transferred via the radio link over distances of up to 10 miles (line of sight). The MAST-II system displays the data on the LCD screen and calculates immediate flow variation arising from valve operation.

Key features include:

- Water Loss Localised to a Specific Area
- Minimum Consumer Disruption.
- Radio Coverage up to 10 miles (line of sight).
- Interface to Standard Meter Types.
- Instant Response to Flow Changes.

Performing a step test is one of the most effective ways of identifying a high leakage area within a water distribution network. It requires the establishment of zones where water can be supplied through a single meter, after all boundary and circulation valves have been closed. Step testing is usually carried out at night since this is the time when consumption is lowest and most stable. Disruption to consumers is also minimised.

The MAST-II system comprises two instruments, a transmitter unit with high power radio transmitter and a portable flow indicator/data logger with integral radio receiver. All received data is automatically stored and may be subsequently transferred to a PC for storage or graphical representation.

MAST-II Equipment

The MAST-II system is supplied with all the cables and accessories required for normal operation.

The standard kit includes: -

- MAST-II Transmitter
- MAST-II Receiver
- Mains Chargers
- Pulse-head Flow Sensor
- Tripod Antenna
- Antenna Extension
- PC Software (CD)
- Hard Carry Case

MAST-II Transmitter Features

The various features of the MAST-II transmitter unit are identified below.

1) Charging Connection

2) Antenna Connection

3) Sample Period LED Indicators

4) Sample Period Selector Button

5) ON/OFF Button

6) Battery Level Indicator

7) Carry Handle

8) Extruded Corrosion Resistant Aluminium Casing

MAST-II Receiver Features

The various features of the MAST-II receiver unit are identified below.

1) Charging/PC Download Connection

2) Antenna Connection

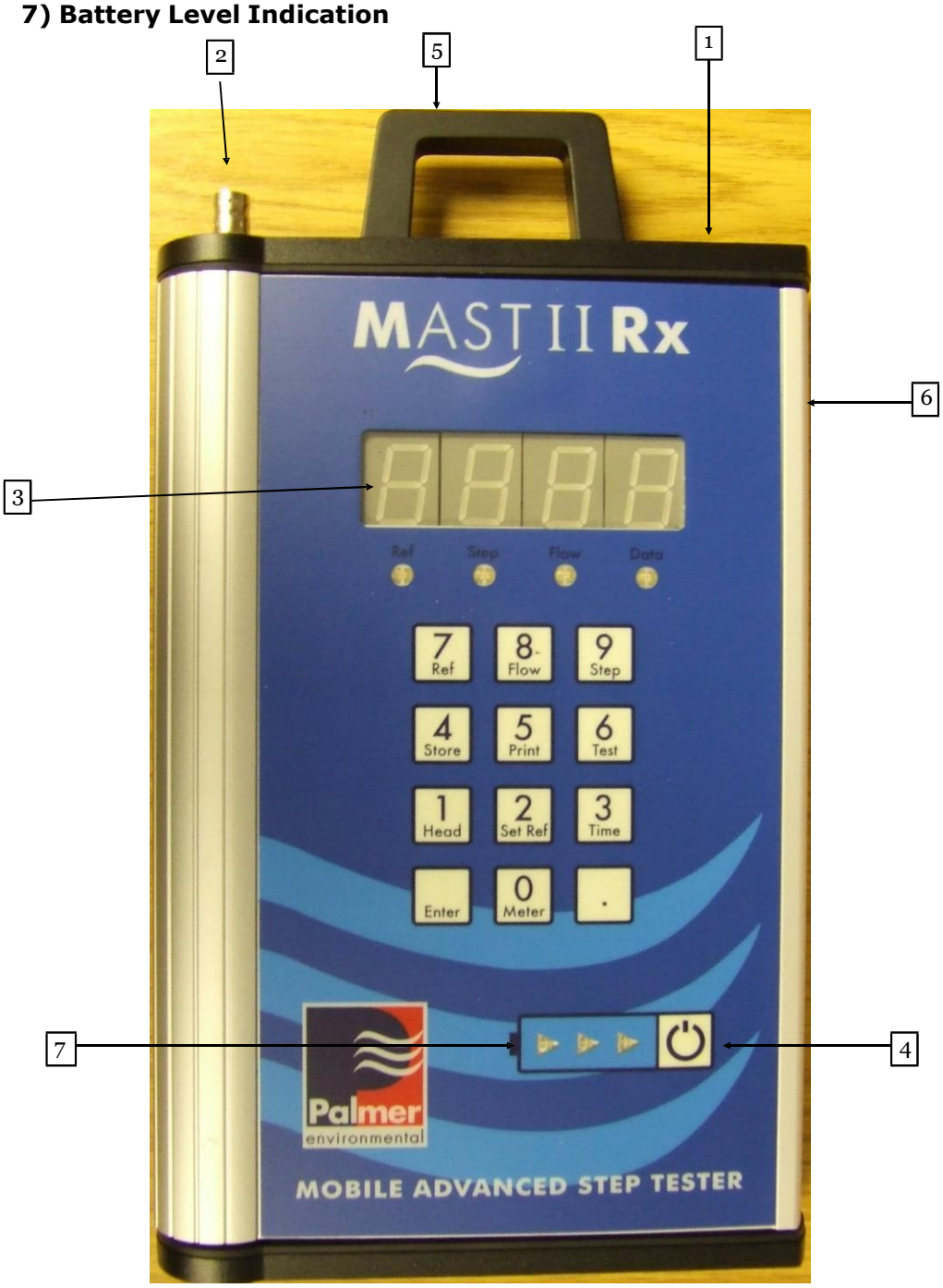
3) LED Display

4) ON/OFF Button

5) Carry Handle

6) Extruded Corrosion Resistant Aluminium Casing

7) Battery Level Indication



Sensor Range

The MAST II system can operate with a range of flow sensors including

PU10, 100

CH10

Neptune

OPTO 06

Notes on the MAST-II System

For correct operation and setting up of the MAST-II system, the operator should know the version number of the software installed in the MAST-II receiver unit.

The operator can determine the version number installed by carrying out the following procedure:

- Switch the receiver unit OFF
- Press and hold KEY "6 (TEST)" and turn the unit on
- The display will show the version number once and flash the message "C-d".
- Make a note of the number for future reference.

Important Note 1:

There are two software versions available, 1.x & 2.x are the standard versions.

Please follow the instructions provided for each version of the software.

Important Note 2:

Mishandling of the cables and antenna may cause degradation of performance. The units are shipped as a tested pair, should degradation occur and return to HWM Water Ltd becomes necessary then antennas should also be returned.

Other Important Notes:

No matter what version of the software you are running, please adhere to the following guidelines for the correct operation of the MAST-II system:

- Always set up the receiver prior to turning on the transmitter
- Ensure the time and date on the receiver is correct prior to step testing
- Do not attempt to change the time on the receiver unit during a step test
- Do not store district numbers 0 or 9999 as these are used by the system
- Data corruption will occur if another MAST or MAST-II system is in use locally
- Do not turn off the PC or reset it while the MAST-II receiver unit is connected
- Ensure good battery charge on both units before commencing the step test
- Do not switch off the transmitter unit during a step test
- Do not change the sampling period during a step test
- Always ensure enough memory is available to store the results prior to step testing
- DO NOT disconnect the aerials whilst the Transmitter or Receiver is powered on. Failure to observe this instruction is likely to cause internal damage to the units
- DO NOT use the units less than 10 meters (approximately 30 feet or less) apart. Failure to observe this instruction is likely to cause internal damage to the units
- Misuse of the batteries may result in explosion or fire. They must not be used in any other application or used with any other equipment. Only batteries supplied by HWM Water Ltd must be used.

Setting up the MAST-II Receiver

Always ensure that enough memory is available to store data prior to carrying out the step test.

To check the available memory, switch the unit on and press key 6 (Test). The unit will sequentially display three parameters. These are:

1. ID number of the unit. This is normally a value between 0-F
2. The number of memory stores available*
3. The result of a memory check (carried out by the unit) which will display "PASS" upon successful testing of the memory

*If the second parameter (number of memory stores) reads zero, then the memory must be cleared prior to step testing. The only way to clear the memory is by the use of the MAST PC software, this is detailed on page 21.

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

Setting the Measurement Unit

Version 1 of the receiver software displays the flow in two units, Litres/Second (l/s) or Cubic Meters/Hour (m3/h).

Version 2 of the receiver software shows both l/s and m3/h but can also show the flow in Cubic Gallons/Hour (g3/h). To select the required units:

- Turn the receiver unit on and press the "Enter" key.
- Press "1" (Header) key for l/s, press "2" (Set Ref) key for m3/h or "3" (Time) key for g3/h)
- Press the "Enter" key to apply selection

Note:

For systems with software Version 2.x, the receiver may display "Err.d", the operator may ignore this message and continue with the selection.

Setting the Meter Type

Assuming the receiver is switched on:

- Press "0" (Meter). The display flashes "l-r" prompting the operator to enter the meter scale factor in litre per revolution, E.G 10, 100 etc...
- Enter the correct value using the numeric keypad
- Press the "Enter" key to apply selection

Setting the Head Type

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

E.G.:-

Type	Pulses
PU100	100
PU10	10
CH100	100
Neptune	10
Meinecke OPTO 06	1000

By default the MAST-II system is supplied with PU100.

- Press "1" (Head). The display flashes "HEAD" prompting the operator to enter the pulse value
- Enter the correct value using the numeric keypad E.G 10, 100 etc...
- Press the "Enter" key to apply selection

The receiver is now ready for operation.

Note:

Errors in head and meter inputs can be corrected by use of the "." key. Pressing the key once will display a decimal point, by pressing the key again, clears the display allows the operator to enter the correct information.

Setting the Receiver Unit for Step flow Measurement

Please proceed as follows:

1. Switch the unit ON
2. Press the "Enter" key
3. Press "9" (Step) key
4. Press "Enter" key

MAST-II Setup—Transmitter

Switch the transmitter unit on by pressing and holding the power button until the sample period LEDs begin an up/down pattern sequence. The MAST is now in the pre select mode. If no button is pressed the up/down pattern will continue once every 10 seconds. While in this mode the transmitter will not collect or transmit any data.

To set the desired sampling period press the selector button to step through each pre defined time until the desired sampling period is reached. The LED will be a solid light, indicating that the sample period has not yet been locked into the transmitter. This allows for the sample period to be changed again if needed.

To lock the sample period the selector button must not be pressed for a duration of 10 seconds. The LED will then begin flashing indicating the selected sampling period is now locked into the transmitter. Once the LED starts flashing the transmitter will begin collecting and transmitting data. The sample period can no longer be changed after it has been locked.

If the sample period needs to be changed after it has been locked the transmitter must be switched off and then back on to return to the pre select mode.
Note that switching off a transmitter during a step test will result in a valid test.

Note:
The pulse head should be connected to the input on the end/top of the transmitter. The MAST-II transmitter will automatically distinguish between contact closure and optically driven heads.

Sample Period

The MAST-II transmitter has 10 possible pre-defined sampling periods.

These are:-

5 Seconds
10 Seconds
15 Seconds
30 Seconds
1 Minute
2 Minutes
5 Minutes
10 Minutes
15 Minutes
30 Minutes

Defining the sample period allows the user to select how long the transmitter collects data before each transmission. The sample rate is set depending on the expected flow rate being monitored. Most flow rates will allow for 5, 10 or 15 second sample periods. However for low flow rates then longer sample rates may need to be used. To ensure the MAST unit accurately obtains the flow rate the sample period must be set to allow for at least 2 pulses to be counted during 1 sample period.

E.g If the flow rate being measured gives a pulse rate of 1 pulse every 10 seconds then the sample rate must be set to at least 30 seconds to allow for two pulses to be counted.

Data Reception

MAST-II transmitter will operate in one of two modes. What data is transmitted and how often the data is transmitted is dependant on what mode the MAST-II transmitter is in. The mode selected cannot be setup directly by the user but is dependant on the sample period selected. The receiver unit will automatically detect which mode the transmitter is operating in. No user intervention is needed to account for mode selection.

Standard Logging Mode

If the sampling period selected is set to 30 seconds or less, the MAST-II transmitter will operate in standard logging mode. This mode is designed to collect readings on low pulse rates either because of low flow or a short sampling period. Data will not be sent to the receiver until a sampling period is completed. Each reading that is received will be acknowledged by the data LED flash on the receiver unit accompanied by an audible beep. Any invalid data received (e.g. from an unmatched transmitter) will cause the data LED to flash but no audible beep will sound.

Extended Logging Mode

For sampling periods of 1 minute or greater the transmitter will operate in extended logging mode. This mode is designed to deal with large pulse counts either from high flow or long sampling periods. Transmission to the receiver unit will begin only after the first sampling period has completed. During the next sampling period the transmitter will transmit every 30 seconds. This will cause the data LED to flash on the receiver unit but no audible beep will sound. The data displayed will not change. The purpose of this is to indicate to the user that they are still in range of the transmitter when using long sampling periods. When a sampling period completes new data will be sent to the receiver. This will be acknowledged by the data LED flash accompanied by an audible beep on the receiver unit

Once data has been received by the MAST-II receiver. The "Flow" LED will be lit. The reading will be continually displayed until new data from the next sampling period 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 using the numeric keypad.

All step calculations are then based upon this initial flow 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 reference can be displayed at any time by pressing key "7" (Ref). Once the zone/district is set, all the transmitter flow 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, 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

Key "8" (Flow) is used to show the current flow on the display. While it is being displayed the "Flow" LED is lit. Flow 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 simple steps:

1. Press the "Enter" key
2. Check table below
3. Press the "Enter" key to apply selection

Key Description	Set Unit
1 Head	Litres/sec
2 Set Ref	M3/hour
3 Time	g3hour

Reference (Ref.)

Key "7" (Ref.) is used to display the reference flow. 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 rate) can be displayed by pressing key "9" (Step). A negative number indicates that the flow is greater than the reference flow. All step values are calculated by deducting the current flow rate from the reference

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 data has been satisfactory 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.

Note:

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 , as well as the reading unit.

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 the "." key and the receiver unit will scan through the parameters automatically, in the order mentioned above.

"Time" Key

Integral to the functioning of the MAST-II 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 updates every second on the display. To modify the time (which is based on a 24 clock):

1. Press "3" (Time) key
2. Enter new time, four digits must be entered for correct operation.
3. Press "Enter" key.

Note:

The operator cannot modify the date using the keypad. This is only possible though a PC via the MAST software application.

Warning:

The operator MUST NOT modify the time during a step test that has a zone/district set. This will prevent the logged data from being downloaded correctly to the PC and the operator will lose the logging session data.

"Test" Key

The operator can use the "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-II receiver and transmitter units. This number must be the same for both units for data to be accepted. This facility allows MAST-II 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 1 software, the indicated number will be in the range 3358 for no data, to 0 for full stores. For versions 2, 3 & 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-II should be returned to HWM Water Ltd for diagnoses.

"Print" Key

Key "5" (Print) is a print key. When this key is pressed the MAST-II checks the status of its communication port to see if an output device is available. If such 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 it is possible to print the data.

The operator will be prompted to enter the district number he/she wishes to print. The MAST-II 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. Entering "0000" has no function.

PC Software

The MAST-II PC software is a convenient means for displaying and archiving of steps tests.

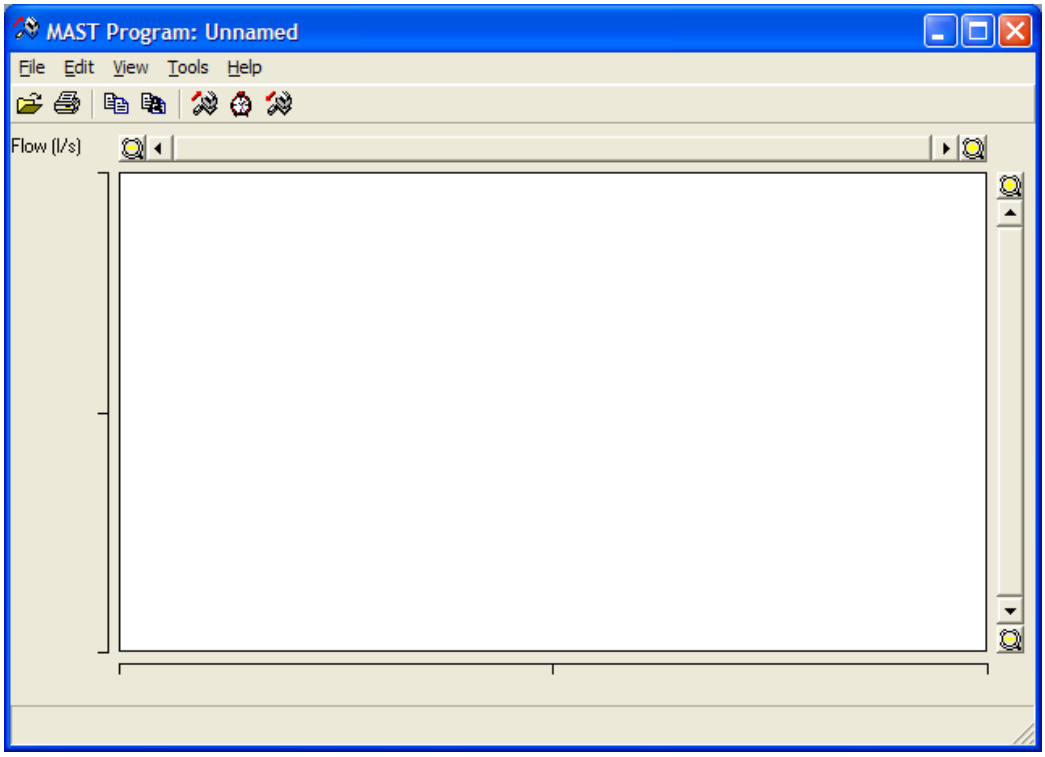
To download the latest version of the software, please visit www.hwm-water.com/

Software Installation

The software must be installed correctly in order to function properly. The software is supplied on CD or can be downloaded from the Palmer website.

Running the Software (Windows XP screenshot)

To



Start the MAST application, click Start—All Programs-MAST.

Programming the MAST-II

Access to PC Communication Mode by plugging in the PC comms cable (supplied with the system) into the MAST unit. The user can interrogate the MAST system by first plugging in the PC cable then turning the unit MAST receiver ON.

The display will show "PC" to indicate to the operator that its in PC mode. The MAST keyboard is disabled until the unit is turned OFF and the serial connector removed.

Check the logger TIME and DATE (displayed along the top of the screen). If these are incorrect, adjustment can be made via "Tools", "Comms" then "Program MAST RTC".

Note:
Please ensure your current PC TIME and DATE is correct prior to programming the TIME and DATE on the MAST unit.

If you need to clear memory this can be achieved by selecting the clear memory button in the reprogram mast window, which is opened with "Tools", "Comms" then "Reprogram MAST".

Interrogating the MAST II

When a step test has been completed, connect the MAST to the PC using the supplied cable. Click "Tools", "Comms" then "Interrogate MAST".

The message "Reading Data" will be displayed as the data is first read in from the MAST.

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.

If only one district is stored in the MAST and downloaded, 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 at a later date by clicking "Open" from the "File" menu.

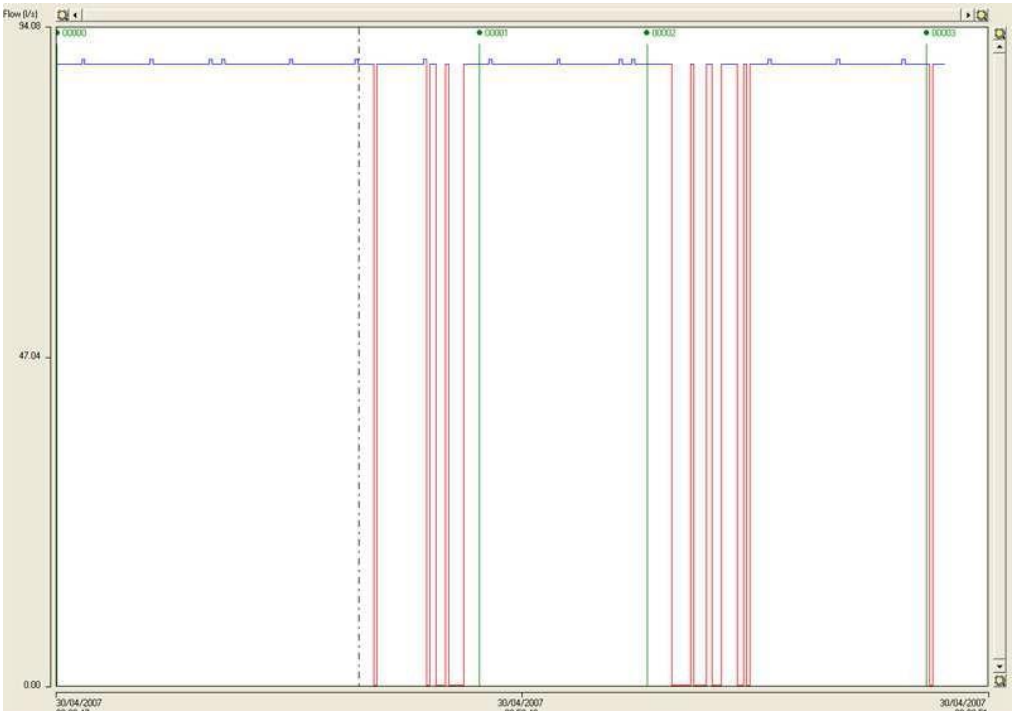
Graphic Display

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, Logging Interval and Step are displayed. At the bottom left, the Instantaneous Flow and its associated Time and Date, are 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 a white line. For periods when no data was collected (i.e. receiver switched off, radio blackspot etc…) the line changes to a red colour.

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

Moving the mouse cursor along the graph will change the instantaneous values according to the value of the flow.

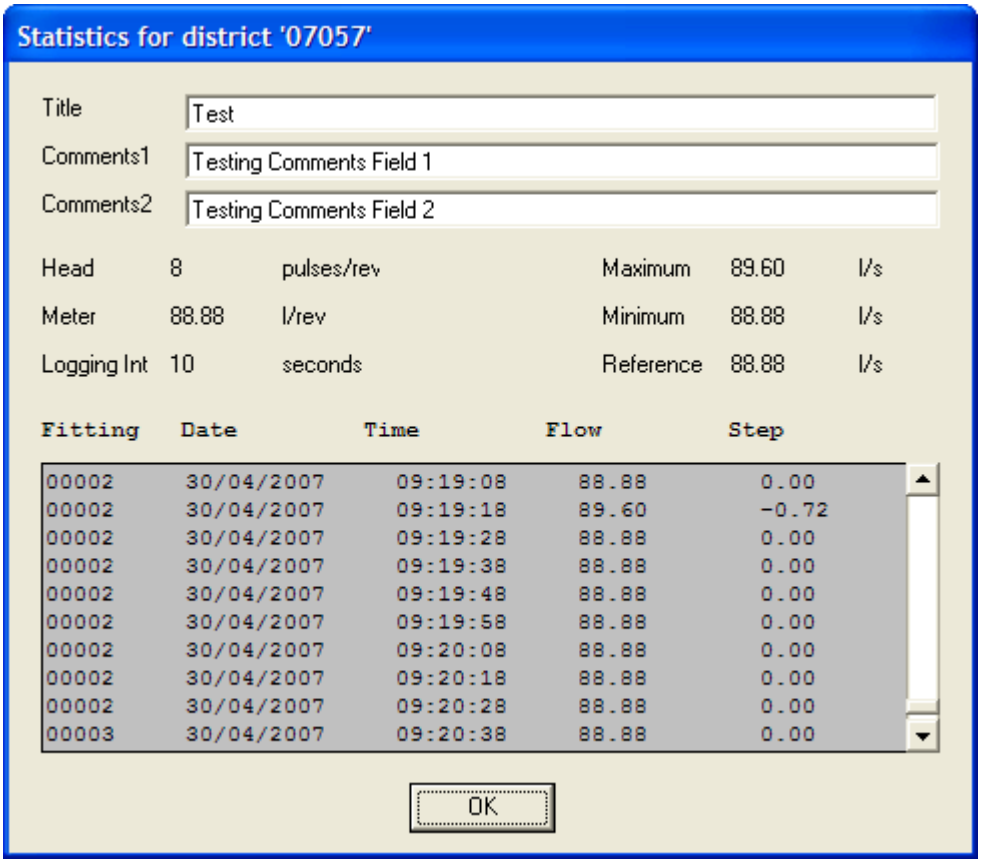


To change the display units from Litres/Second, Meters Cubed/Hour and Gallons/Hour, click “Tools”, “Units” then select the desired.

Table Display

To view the data in table format, click "View" then "Stats". You can give this a title as well as add comments. Click "OK" to save any changes.

The table is a tabular format of the data with the Fitting Reference, Time, Date, Flow and Step details displayed. Using the scroll bar on the right hand side to scroll through the data.



This data can also be exported to a CSV file which the operator can import into Excel for custom formatting.

Charging

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

Turn OFF the charger.

Plug the 6-pin Binder charge cable into the MAST unit.

Turn ON the charger.

The time taken to charge depends on the charge level in the MAST units and the number of units on charge (both the Transmitter and Receiver may be plugged into the same charger).

Typically a fully discharged unit will require 5 hours to be fully charged.

Always check the battery status before deployment.

Appendix A

Error Messages Produced by the MAST-II Receiver Unit

Err.1

No Data to Store. An attempt was made to store the 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 to return the system for diagnostic repairs.

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 the 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 cannot 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.

Error Messages Produced by the MAST-II Receiver Unit (continued)

Err.A

No Such District. The district selected has not been found in the units memory.

Err.C

Reference Already Set. The reference can only be set once at the start of logging.

Err.d

Reserved—If displayed ensure that either Flow or Step are selected

Err.E

Hardware Fault.

Technical Specification

Transmitter Unit:

Sample Period Variables: 5s, 10s, 15s, 30s, 1m, 2m, 5m, 10m, 15m, 30m.
Pulse Counting, Interval Timing,
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).
Identifier: 4 bit data selector/scrambler pre-set to prevent misinterpretation of results from other systems.
Data Entry: Custom Membrane Switch Panel, with luminous keys.
Transmitter Module: up to 5W VHF for large area coverage, pulsed operation.*
Power Supply: Internal Lithium-Ion re-chargeable Battery.

Receiver Unit:

Secondary PIC microprocessor for data access
Real Time Clock. Battery backed for automatic annotation stored data.
Display: 4 digit high intensity LED for good day and night vision.
Identifier: 4 bit data selector/descrambler pre-set to prevent misinterpretation from other systems. Will only accept data from corresponding transmitter.
Data Entry: Custom Membrane Switch Panel, with luminous keys.
Receiver Module: High sensitivity VHF custom receiver module.
Power Supply: Internal Lithium Ion rechargeable Battery.*

*OFCOM Licence Number: 0285988/1 Area Defined Business Radio
Operating on 153.100000 MHz
Channel Width 25.00000 kHz
Licenced in Scotland, Wales, Northern Ireland and England.

SIMPLIFIED DECLARATION OF CONFORMITY

This simplified EU declaration of conformity referred to in article 10(9) shall be provided as follows:

Hereby, HWM Ltd declares that the radio equipment type transceiver is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at www.hwmglobal.com

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