MagnaRod

User Manual

04-2023 - 01-01-000

HYQUEST SOLUTIONS
KISTERS GROUP

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I Disclaimer

The information provided in this manual was deemed accurate as of the publication date. However, updates to this information may have occurred.

This manual does not include all of the details of design, production, or variation of the equipment nor does it cover every possible situation which may arise during installation, operation or maintenance. HyQuest Solutions shall not be liable for any incidental, indirect, special or consequential damages whatsoever arising out of or related to this documentation and the information contained in it, even if HyQuest Solutions has been advised of the possibility of such damages.

Any errors found in any HyQuest Solutions product should be reported to HyQuest Solutions where every effort will be made to quickly resolve the problem.

This document is public.

II Scope of Delivery

- Rod segments, graduated
- Handle with bulls eye
- MagnaRod computing device
- Canvas carry bag

III Safety Instructions

- Read the user manual including all operating instructions prior to installing, connecting and powering up the HyQuest Solutions MagnaRod. The manual provides information on how to operate the product. The manual is intended to be used by qualified personnel, i.e. personnel that have been adequately trained, are sufficiently familiar with installation, mounting, wiring, powering up and operation of the product.
- Keep the user manual on hand for later reference!
- If you encounter problems understanding the information in the manual (or part thereof), please consult the manufacturer or its appointed reseller for further support.
- HyQuest Solutions MagnaRod is intended to be used in hydrometeorological or environmental monitoring applications.
- Before starting to work, you have to check the functioning and integrity of the system.
  - Check for visible defects on the MagnaRod, this may or may not include any or all of the following mounting facilities, connectors and connections, mechanical parts, internal or external communication devices, power supplies or power supply lines, etc.
  - If defects are found that jeopardize the operational safety, work must be stopped. This is true for defects found before starting to work as well as for defects found while working.
- Do not use the HyQuest Solutions MagnaRod in areas where there is a danger of explosion.
- The present user manual specifies environmental/climatic operating conditions as well as mechanical and electrical conditions. Installation, wiring, powering up and operating the HyQuest Solutions MagnaRod must strictly comply with these specifications.
- Perform maintenance only when tools or machinery are not in operation.
- If guards are removed to perform maintenance, replace them immediately after servicing.
- Never make any electrical or mechanical diagnostics, inspections or repairs under any circumstances. Return the product to the manufacturer's named repair centre. You can find information on how to return items for repair in the relevant section of the HyQuest Solutions website.
-  Disposal instructions: After taking the HyQuest Solutions MagnaRod out of service, it must be disposed of in compliance with local waste and environmental regulations. The HyQuest Solutions MagnaRod is never to be disposed in household waste!
-  Inputs and outputs of the device are protected against electric discharges and surges (so-called ESD). Do not touch any part of the electronic components! If you need to touch any part, please discharge yourself, i.e. by touching grounded metal parts.

1 Introduction

Thank you for choosing our product. We hope you will enjoy using the device.

HyQuest Solutions manufactures, sells, installs and operates quality instrumentation, data loggers and communication technology. Products are designed with passion for environmental monitoring and with a deep understanding of the quality, accuracy and robustness needed to fulfil the requirements of measurement practitioners in the field.

The present User Manual will help you understand, install and deploy the device. If, however, you feel that a particular information is missing, incomplete or confusing, please do not hesitate to contact us for further support!

HyQuest Solutions' MagnaRod takes all the headaches out of current meter gauging: It is the all-in-one solution for measurement of stream velocity and discharge by wading. It bundles a robust, lightweight and convenient rod with a counter device and additionally offers the possibility to attach various current meters.

After selecting "Bed" then "Surface" the water depth is displayed along with the % depth as the rod is moved up and down so you can easily find 0.2, 0.4, 0.6, 0.8 or anything in between. Then with the press of a button it converts to a Current Meter Counter equivalent to our existing CMCsp, with automatic calculation and display of 'point velocity' and current meter revolutions after a pre-set time interval. The device also offers a Bluetooth wireless interface feature for compatible PDA or Pocket PC (compatible software also required). This measures flow velocity from almost any mechanically rotating current meter. A feature of the device is its ability to "clean" the signal and interface directly to a compatible PDA, PocketPC, or other computing device and provide serial data that can be used by the external device to compute discharge. Current Meters fitted with a cat whisker ball and wire contact to perform a mechanical switch closure can be used with the unit to produce a clean, noise-free signal. The water velocity is directly computed and displayed on the LCD. The **MagnaRod** supports up to 6 current meters with each meter having up to 3 rating equations and 3 rotations/sec ranges.

The **MagnaRod** counter operates with 3 x AA alkaline 1.5V batteries and comes in a robust waterproof enclosure. The commands are identical to the **CMCsp** commands, so existing third party compatible software that has been developed, can be used to perform a measurement and make operating selections. The **MagnaRod** can operate with current meter velocities from less than 0.05 ft/sec to more than 20 ft/sec for a Price AA meter. The **MagnaRod** also provides a slow-speed mode to improve measurements with extremely slow rotating current meters [velocities less than 0.25 ft/sec]. The **MagnaRod** does not need to be connected to an external device to operate. The visual indicators, LCD and internal buzzer of the MagnaRod can be used to make a conventional current meter measurement and compute water velocity using look up tables if required.

As you continue to read this manual, many features and operating capabilities of the MagnaRod will be revealed and described. The **MagnaRod** is extremely easy to use and yet versatile enough to offer selections to operate in a wide variety of scenarios and field settings.

As an added benefit, whenever the **MagnaRod** is inactive, it will automatically turn itself OFF after a preselected period to help conserve the batteries. To turn it ON, simply press the 2 buttons together and all previous settings are restored ready for the user to begin a measurement.

The **MagnaRod** also has an internal serial port that can be used to upgrade the firmware as new features become available.

Product Overview

The **MagnaRod** can measure depth, and also indicate when a current meter is at 0.2, 0.4, 0.6… of the water depth.Any pulse type current meter can be connected, and after entering the pulse to velocity equations, it can display the

measured velocity directly. Velocity can be either displayed in feet/sec (ft/sec) or metres/second (m/sec) and is chosen by the user in a menu. When a measurement is being made, the **MagnaRod** counts contact closures, measures elapsed time, and computes velocity to a precision of 0.01 ft/sec or 0.001 m/sec. The velocity is computed based on the selection from up to 6 entered meter ratings, again chosen from a menu. During a measurement, the **MagnaRod** sends through the Bluetooth serial port the number of accumulating meter contact closures and elapsed time at 1-second intervals.

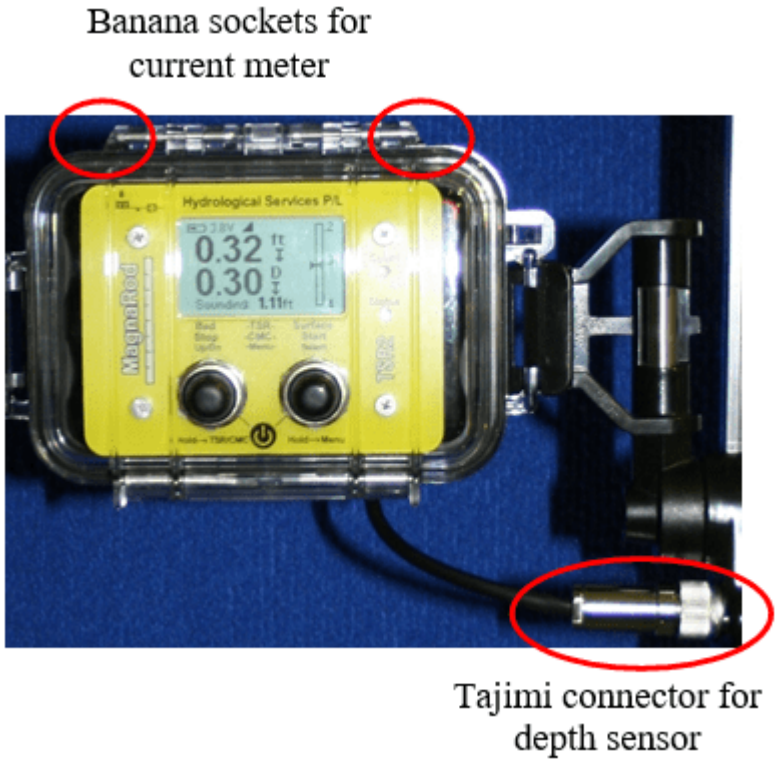
An important operating feature of the **MagnaRod** is the ability to signal process each contact closure. Contact closures from any type of meter are inherently noisy causing miscounting or double counting. The **MagnaRod** samples the input signal from the connected meter and examines the signal to determine if a contact closure has occurred and if successive signals are of the same characteristics. The **MagnaRod** then determines contact closure conditions and either counts the signal closure or eliminates the condition as a noise pulse and does not count the signal. For cat's whisker contacts, this becomes extremely important since cat's whisker contacts offer the poorest quality for marking and counting rotations.

The **MagnaRod** offers (2) modes of operation for a cat whisker type meter - FAST and SLOW speed mode. FAST is selected for meter rotations >0.25 ft/sec while SLOW mode is for velocities below 0.25ft/sec. To improve noise rejection, the sample rate of the input signal at the SLOW speed mode (lower velocities) is 1/10 of the sampling rate that occurs during FAST mode. This slower sampling rate improves performance for back rotations and corroded whisker contacts at extremely low meter cup rotations. It is important to know that the **MagnaRod** offers operational overlap at this 0.25 ft/sec velocity selection in either mode and therefore it is not necessary for the operator to know precisely the velocity of water for selecting either mode.

2 Installation

Hardware Connections

1. When the MagnaRod is clipped into the cradle, the Tajimi connector must be screwed into the mating part in the handle – this connects the sensor used for depth measurement.
2. The current meter is connected through the 2 banana type sockets at the top of the MagnaRod.



3 Operation

This chapter contains the following subsections:

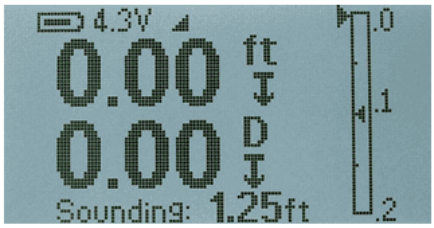
3.1 Navigating Screens

The MagnaRod has two front panel buttons that are used to turn power ON and OFF, view menus, and choose operating settings. The labeling on the MagnaRod gives you a reminder of the button functions:

Power ON – Press and hold both buttons to turn on the MagnaRod.

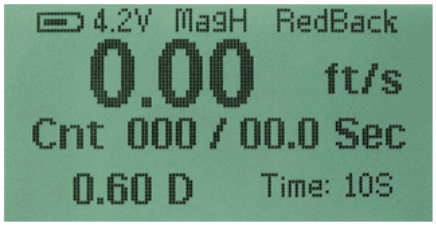
Power OFF - Press and hold both buttons again to turn off the MagnaRod.

Left Button		Right Button	
Bed Stop Up/Dn	-TSR- -CMC- -Menu-	Surface Start Select	
Hold→TSR/CMC		Hold→Menu	

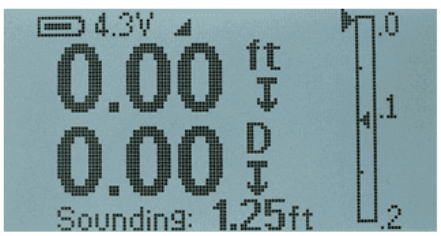


Top Set Rod (TSR) Display

Press and HOLD **Left Button** to toggle between the TSR and CMC Displays

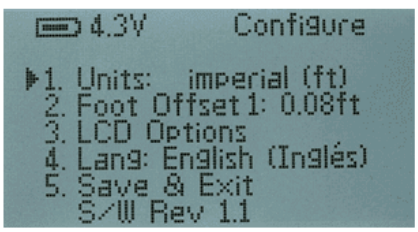


Current Meter Counter (CMC) Display

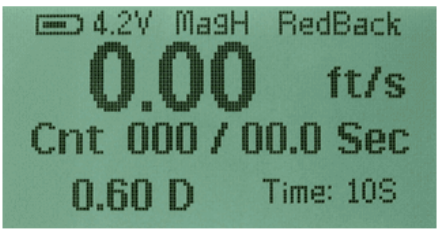


Top Set Rod (TSR) Display

Press and HOLD **Right Button** to select the TSR menus

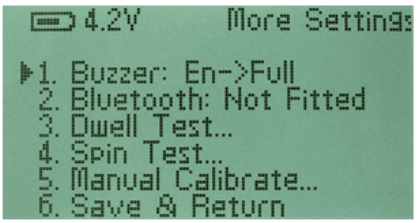


TSR Menus



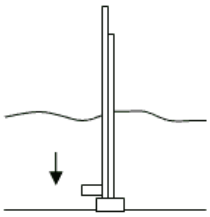
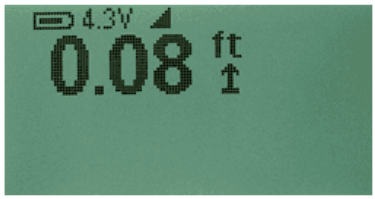
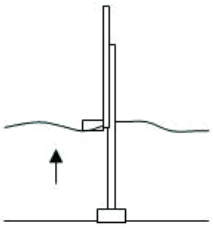
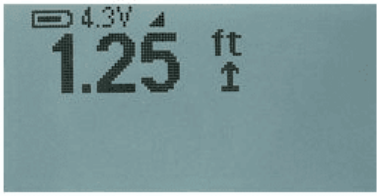
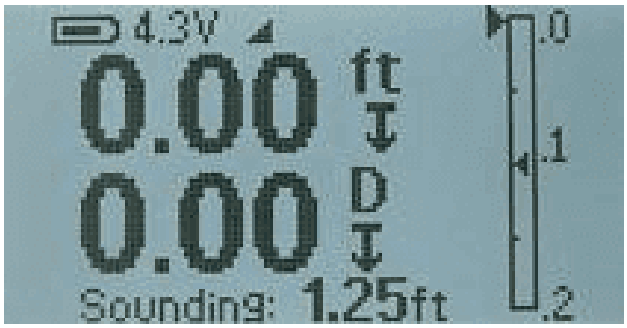
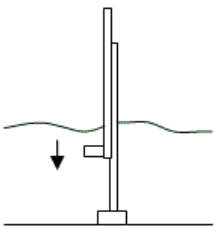
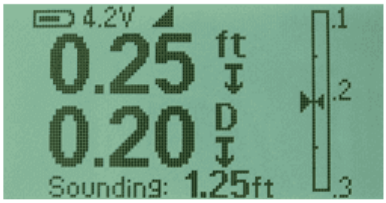
Current Meter Counter (CMC) Display

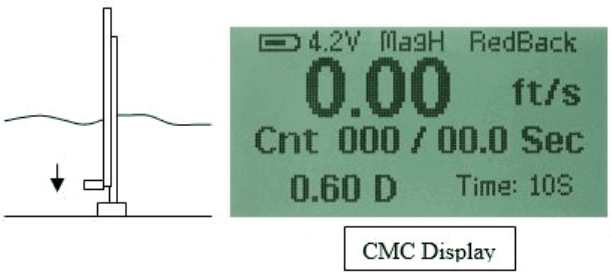
Press and HOLD **Right Button** to select the CMC menus



CMC Menus

3.2 Top Set Rod Operation

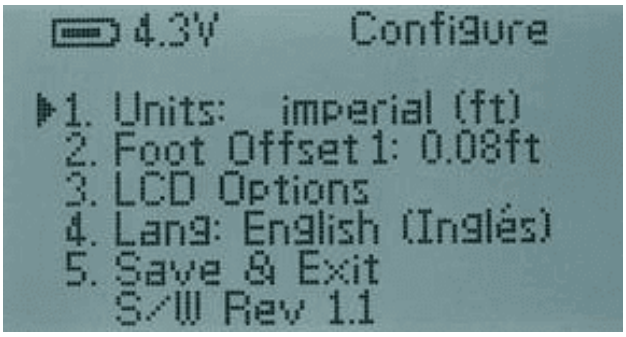
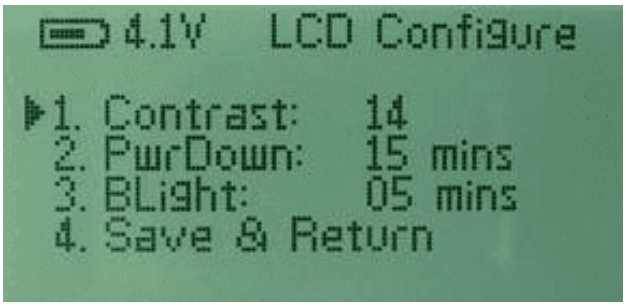
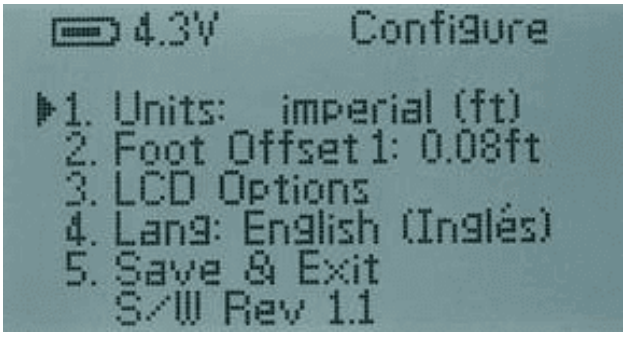
1. Move the Rod to its lowest position and press "**Bed**" (Left Button) The display will indicate the preset offset from the stream bed to the current meter position. ("**Sensor Err**" indicates the Tajimi connector is not screwed in)	TSR Display  
2. Move the Rod so the centre of the current meter mounting bracket is at the water surface. The water depth is shown with the ↥ symbol indicating the measurement is from the stream bed to the surface.	 
3. Press "Surface" (Right Button) and a scale will appear on the right hand side of the display. The Depth is also displayed, initially indicating 0.00D. The ↧ symbol also indicates that the distance and depth is being measured from the surface down to the current meter. The total water depth (or Sounding) is displayed on the bottom of the screen. ("**Depth too small**" indicates you have moved the rod less than 0.02ft (5mm) which is not enough)	
4. Slide the Rod down to the required percentage depth D. The display on the right shows 0.20 of sounding as measured from the water surface, 0.20D The vernier scale on the right of the display indicates the exact depth when the two arrows line up (0.25ft).	 
5. Change to the CMC display by pressing and holding the Left Button. Perform a velocity measurement at this point of the vertical (See Top Set Rod Menus 11 for details on measuring velocity).	

6. Keep sliding the Rod down to the next required depth, say 0.60D. There is no need to return to the TSR Display, as the depth 0.60D is displayed on the bottom of the CMC Display.	 CMC Display

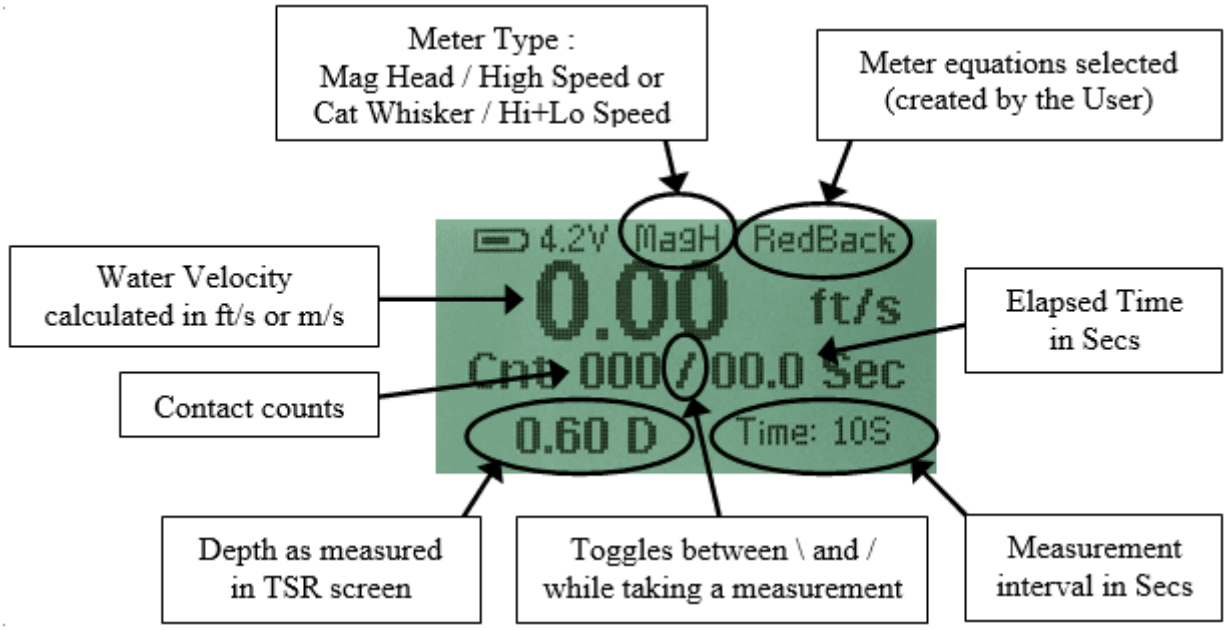
Repeat this complete process at each vertical where measurements are taken.

3.3 Top Set Rod Menus

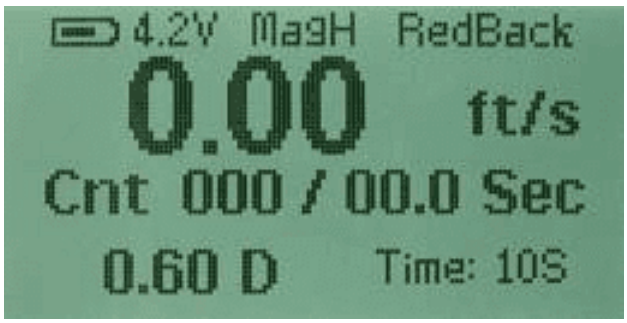
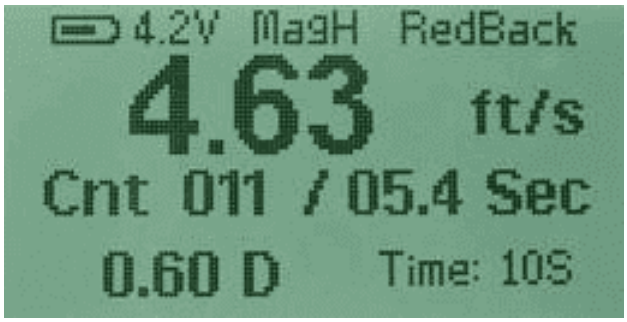
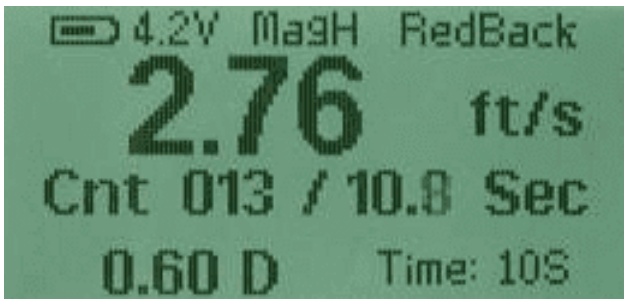
While in the Top Set Rod (TSR) display press and hold the right hand button to enter the TSR Menu's. Pressing "Up/Dn" (left hand button) will move the triangle pointer down through the menus, and pressing "Select" (right hand button) will toggle the option, or select the item.

1. The Units selection can be imperial (ft) or metric (m). Note that these units are the measurement units for the Top set Rod and also for the Current Meter Counter ft/s and m/s. 2. The Foot Offset selects the reference position when the "Bed" button is pressed. This is the distance from the river bed to the current meter shaft when the Top Set Rod is in the lowest position.	
3. LCD Options allows 3 more LCD selections to be chosen. The contrast can vary between 6 (light) and 24 (dark) and may only need changing at the extremes of ambient temperature. The Power Down time can be set to 15, 20, 25, 30, 35,… ..60 mins. If no buttons are pressed, the MagnaRod will power down automatically after this time. The BackLight time can be set to 1,2,3,4,5,6…14,15 mins or Off. This is the time the backlight stays on after a button is pressed – when operating in daylight, it is best to set the BackLight Off as this will conserve power and the batteries will achieve considerably longer life.	
4. Language can be set to English or Spanish. (The translation is about 90% complete at this time!) 5. The Software Revision is displayed at the bottom of this screen.	

3.4 Current Meter Counter Operation



The Current Meter screen data is presented as shown above.

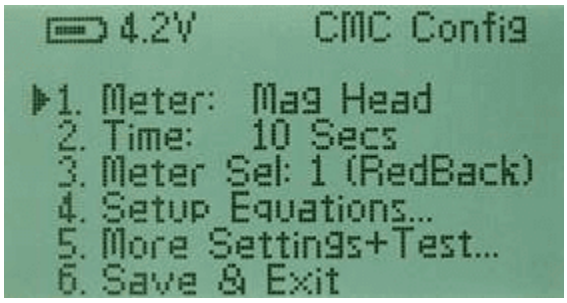
1. Press "Start" (right hand button) and the count, elapsed time and velocity will be zero'd. The / will start toggling between / and \.	
2. When the first meter pulse is detected, the elapsed timer will start. The count and velocity will also be updated as pulses are detected.	
3. When the elapsed timer exceeds the measurement interval, and a meter pulse is detected, the timer will be stopped. The final count, elapsed time and the calculated velocity are all displayed.	

4. If "Stop" (left hand button) is pressed during a measurement, the count, elapsed time and velocity are frozen at that point.	

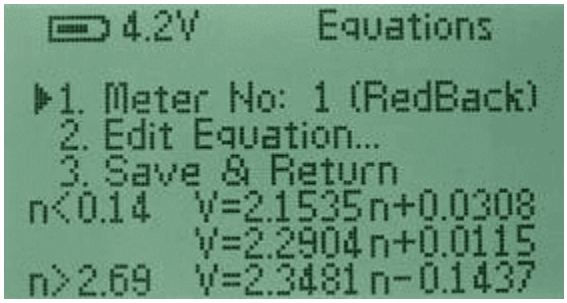
3.5 Current Meter Counter Menus

While in the Current Meter Counter (CMC) display press and hold the right hand button to enter the CMC Menu's. Pressing "Up/Dn" (left hand button) will move the triangle pointer down through the menus, and pressing "Select" (right hand button) will toggle the option, or select the item.

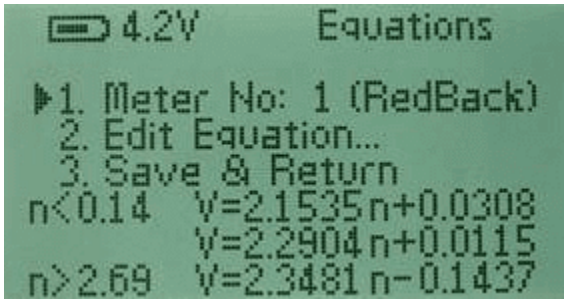
1. The "**Meter**" type can be Mag Head, Cat Whisker Fast, or Cat's Whisker Slow.



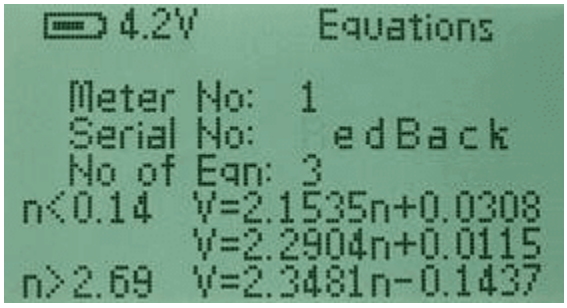
   In Mag Head mode the Status LED is Green.
   In Cat Whisker Fast the Status LED is Red.
   In Cat Whisker Slow the Status LED is off.
   One important operating features of the **MagnaRod** is the ability to signal process each contact closure. Contact closures from any type of meter are inherently noisy causing miscounting or double counting. The **MagnaRod** samples the input signal from the connected meter and examines the signal to determine if a contact closure has occurred and if successive signals are of the same characteristics. The **MagnaRod** then determines contact closure conditions and either counts the signal closure or eliminates the condition as a noise pulse and does not count the signal. For Cat's Whisker contacts, this becomes extremely important since Cat's Whisker contacts offer the poorest quality for marking and counting rotations.
   In Cat's Whisker mode there are 2 speed settings. FAST is selected for meter rotations >0.25 ft/sec while SLOW mode is for velocities below 0.25ft/sec. To improve noise rejection, the sample rate of the input signal at the SLOW speed mode (lower velocities) is 1/10 of the sampling rate that occurs during FAST mode. This slower sampling rate improves performance for back rotations and corroded whisker contacts at extremely low meter cup rotations. It is important to know that the MagnaRod offers operational overlap at this 0.25 ft/sec velocity selection in either mode and therefore it is not necessary for the operator to know precisely the velocity of water for selecting either mode. When in SLOW mode, the status LED flickers, and the sounder beeps longer whenever the whisker contacts are made.
2. The "**Time**" is the CMC elapsed time and can be set to 10, 20, 30, 40, …..90 Secs
3. Up to 6 different Meters can be selected – the Meters and their equations are entered in the Setup Equations… option.
4. When Setup Equations… is selected, the Meter name and the respective equations are displayed.
   When the triangle is at item 1, and "Select" is pressed, the Meter No is stepped through. The equations for the selected meter are displayed at the bottom of the screen.



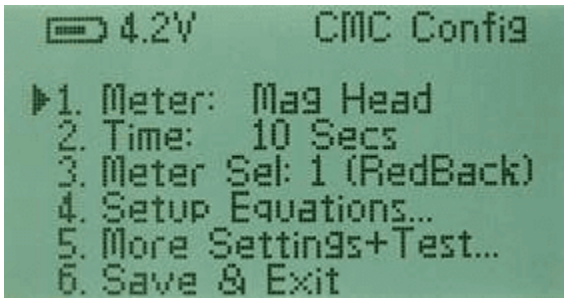
5. To Edit a selected Meter, step to item 2 and press "Select"



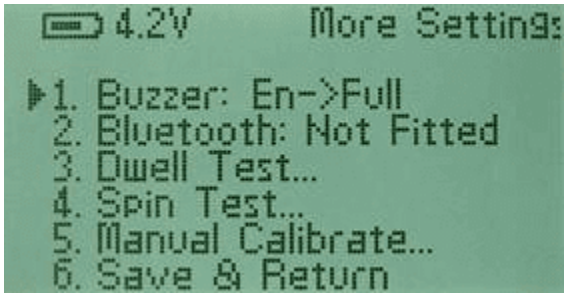
The Meter Serial No (or name), the number of equations (1, 2 or 3), and the equations themselves will be displayed. The first character of the Serial No will be flashing. Press "Up/Dn" (left hand button) to change the character, and press "Select" (right hand button) to select this character and move to the next character. Repeat these steps so the equations on the screen match the equations on your Current Meter calibrations sheets.



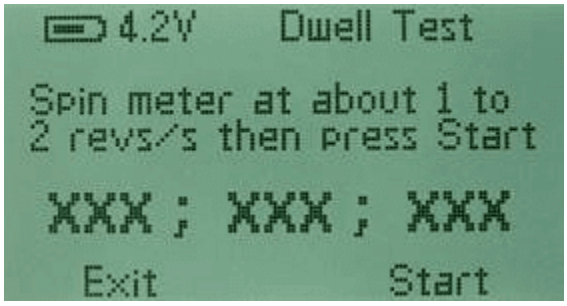
6. Select "Save and Return" to go back to the previous menu.
7. When More Settings + Test is selected, 5 more selections become available.



8. The Buzzer can be set to Disable, En→Full, and En→Mom. (When set to En→Full, the buzzer beeps while the contacts are detected as closed) When set to En→Mom, the buzzer beeps only momentarily as the contacts close)

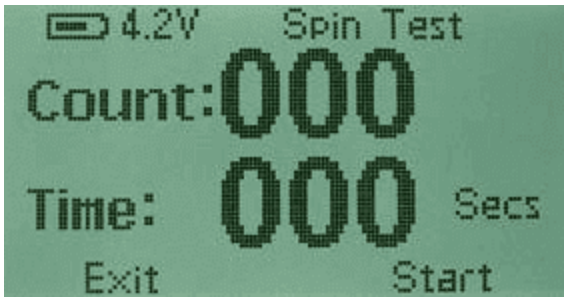


9. If the Bluetooth module is not detected, it will display "Not Fitted", otherwise it can be set to Disable, En→CMC or En→Full. At this time both these options provide the same set of Bluetooth commands – a new set of commands will be available for En→Full in the future.
10. The Dwell Test measures the rotational angle that the contact is closed on the Meter head.



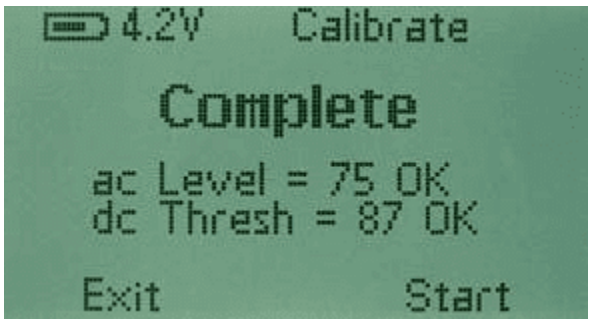
Spin the meter by hand at about 1 to 2 revs per second and press "Start". The bottom of the display will show "Rdy" while it is waiting for a contact closure, and the Start button function will change to "Stop". When the 3 angles are measured, the display will indicate "Done" and the angles will appear across the screen.
This function measures the dwell angle (ratio of meter contact time to the total time for a single rotation) for a meter contact and is useful for making adjustments to a cat whisker type meter in the field. For a cat whisker contact head, the optimum adjustment is 60º or a single meter cup width (US Geological Survey Price AA or Pygmy meter). A variation to an adjustment of +/- 10% is acceptable. The measure of dwell angle for the magnetic head contact does not apply but can be performed.

11. The "Spin Test" is an elapsed time measurement from the time a meter is spun to when rotation of the meter stops.



Press "Start" and the display will indicate Rdy, then the first contact closure will start the time and subsequent closures will increment the count. This will continue until no closures are detected for 10 a second period – indicating the meter has stopped. Note that the time will then jump back 10 secs as the display shows the total count and the elapsed time up to the last count.
Press "Stop" if you wish to terminate the test earlier.

12. The "Manual Calibrate" menu allows the analog ac Level and dc Threshold to be measured and displayed. (Everytime the display changes from the TSR menu to the CMC menu, a calibrate is automatically performed – as indicated by the Status LED flashing green and red.) This calibrate process allows the circuitry to take into account the water salinity when measuring the contact closures from the meter. This menu is for testing only.



dc Thresh = 87 (fresh water or air)
dc Thresh = 26 (extremely salty water)

3.6 Indicator LEDs

The **MagnaRod** provides two LED indicators to show the unit is operating and to indicate current meter contact closures. The following is a brief description for each indicator.

COUNT (Orange LED)—This indicator will flash whenever a contact closure from the meter has been detected.

OPERATING STATUS (Green/Red/Blue LED)—This indicator remains illuminated whenever the **MagnaRod** is turned On and showing the operating status mode. The LED has three colors showing the type of meter (Magnetic Head or Cat's

Whisker Head) selected as well as Bluetooth® operational status. Green indicates the Magnetic Head is selected and red indicates the Cat's Whisker Head Fast is selected. The indicator also shows the operating mode.

The indicator will flash Blue while searching for a Bluetooth connection, and be Blue steady when a connection is established.

3.7 Bluetooth® Communications

Bluetooth® provides for a wireless link to an external device such as a PocketPC (PDA) or laptop. **Bluetooth®** is a wireless standard (IEEE 802.14) that offers a transparent serial port protocol for communication. When the **MagnaRod** is turned On, the **MagnaRod** determines if **Bluetooth®** is installed. If available, **Bluetooth®** can be enabled and 'discovered' by another **Bluetooth®** device to establish a connection. Set the external device's communication protocol in the following manner:

Baud Rate:	19200
Data bits:	8
Stop bits:	1
Parity:	None
Flow control:	None

When this display is presented, the STATUS indicator will be blue and flashing. When another **Bluetooth®** compatible device is in proximity of the **MagnaRod**, and the devices application requests a connection, each automatically establishes the **Bluetooth®** serial interface protocol. When the connection has been established, the STATUS indicator will show a solid blue color continuously.

When making a connection with another **Bluetooth®** device for the first time, first examine and prepare the required enabling features of the external device for **Bluetooth®** connection. Enable the **MagnaRod Bluetooth®** function and allow the external device to 'discover' the **MagnaRod**. When the external device makes 'discovery', the user must select the **MagnaRod** within the device's menu setup and enable the connection. The external device should respond with a 'connected' message. The **MagnaRod** can now be used in a normal manner. All serial data sent from the **MagnaRod** will be transmitted via **Bluetooth®**. The connection can be disengaged by selection in the 'Bluetooth' menu. The operator must monitor the integrity of the connection from the external device. If the connection becomes broken, the **MagnaRod** will revert back to **Bluetooth®** DISCOVER mode. The blue flashing LED will alert the operator of a disconnection between the **MagnaRod** and the external device. Connection will have to be rediscovered by the external device. Any active measurement occurring during a broken communications link will terminate and the measurement will need to be retaken. The **MagnaRod** will not automatically power down when **Bluetooth®** is enabled and connected.

For more information, see the following subsections:

- Serial Communications Interface 16
- Data Conversion Example 18
- Operating the Special Functions Using Serial Communications 19

3.7.1 Serial Communications Interface

The **MagnaRod** can be connected to a hand-held or notebook computer or any device that can transmit and receive serial communications using **Bluetooth®** using an application such as HyperTerm. Commands can be sent to the **MagnaRod** to perform special functions or select operating modes. The following describes the serial data requirements, commands, and data formats that are used for the serial communications interface:

Baud Rate:	19,200
Format:	8 data bits, no parity, 1 stop bit

Flow Control:	None

The following list shows the commands and functions that can be performed through the serial communications interface.

Command	Function Performed
S	Start a measurement
T	Terminate the measurement
I	Abort the measurement
R	Resend the last data string (** not implemented yet **)
U	Buzzer ON
Z	Buzzer OFF
H	Cat Whisker Speed Select, set to Fast
L	Cat Whisker Speed Select, set to Slow
M	Select Magnetic Head meter processing
C	Select Cat Whisker Head meter processing (Fast)
P	Start a measurement without performing a calibration
Q	Start a measurement with no time limit (continuous measure)
V	Software Version

Note: Commands sent to the MagnaRod are case sensitive – and must be upper case only.

When the commands '**S**', '**T**', and '**I**' are received by the **MagnaRod** from an externally connected device, the **MagnaRod** sends an acknowledge character '**A**' back to the device. For the '**S**' command, the **MagnaRod** sends acknowledge character '**A**' after the **MagnaRod** performs and completes the calibration. **Note** that invalid or unrecognized commands will result in a '**?**' being transmitted through the Bluetooth port.

S	**Start a measurement**: Begins a measurement at the first contact closure detected. Number of contact closures and elapsed time counts are accumulated. At the first contact closure, the **MagnaRod** begins sending the accumulated contact closures and elapsed time counts through the serial port every second. The first data string transmitted through the serial port begins the start of the measurement interval with the meter contact closure count tally and elapsed time tally of '0'. Note that when this command is received by the **MagnaRod**, it automatically performs a calibration then monitors the input for meter contact closures. Following is the output data format sent to the externally connected device at the 1-second output rate: `dnn,xxxx_` `d` = preamble for indicating display data `nn` = number of meter contact closures, transmitted in HEX ASCII (hexadecimal notation)(i.e. 0-9,A-F)

	`,` = delimiter `xxxx` = counts of elapsed time measured as 0.003333 seconds/count, transmitted in HEX ASCII (i.e. 0-9,A-F) while in Normal mode and 0.03333 seconds/count while in Slow mode. `_` = space This data format that is transmitted to the externally connected device can be used to display elapsed time and velocity while the measurement is being performed. At the end of the measurement interval or if the '**T**' command is received, the **MagnaRod** sends the last tally of accumulated counts and time in the following format: `fnn,xxxx` or `enn,xxxx` `f` = final data, no detected faults `e` = final data, error detected during measurement; restart the measurement The measuring interval is based on the user selected measurement time. When the measuring interval has been reached, (or the T command is received) the **MagnaRod**, upon the next meter contact closure, will send the final data for that measurement. If there is no contact closure detected when the measurement interval has been reached, the **MagnaRod** will continue to send data and the user must send the '**I**' command to abort the function. Note that the meter contact number, nn, is limited to a total of 255 counts (hexadecimal notation '**FF**'). If more than 255 counts are detected throughout the measurement interval, the count will rollover to '00' and continue to accumulate counts. No fault condition is set if this occurs. This allows for continuous counting in excess of 255 counts occurring during the measuring interval. External processing software can easily detect this condition and process total meter counts when the measuring interval is completed. The same condition occurs for the elapsed time tally. This permits an elapsed time count of 218 seconds for a measuring interval before the count rolls over to '0000'.
T	**Terminate the measurement**: **MagnaRod** stops the measurement at the next contact closure and, at the next contact closure (which is counted), sends the last tally of accumulated counts and elapsed time as previously described.
I	**Abort the measurement**: The **MagnaRod** aborts the measurement. No final measurement data is transmitted.
P	**Start a measurement without doing a calibration**: This command is used to begin a measurement without performing a calibration. The command should only be used for a high velocity measurement that does not allow a calibration to be performed due to the rapid rotation of the meter cups.
Q	**Continuous measurement**: This command is used to continuously output a 1-second data display without a time limit. The '**T**' or '**I**' command must be used to terminate the operation.
V	The software version of the MagnaRod is sent in the following manner: vX.X Example: v1.0

3.7.2 Data Conversion Example

The data format of the **MagnaRod** is transmitted in HEX ASCII (base 16 numbers using the ASCII code which is displayable on any terminal) to provide efficiency in the number of data characters sent through the serial interface. Following is an example of the interpretation of the data.

Example: `d0C,0AF6`

Accumulated meter counts = $0C_{16} = 12_{10}$

Elapsed time = $0AF6_{16}$ = 2806_{10} = (2806 counts x 0.003333 sec/count) = 9.35 secs

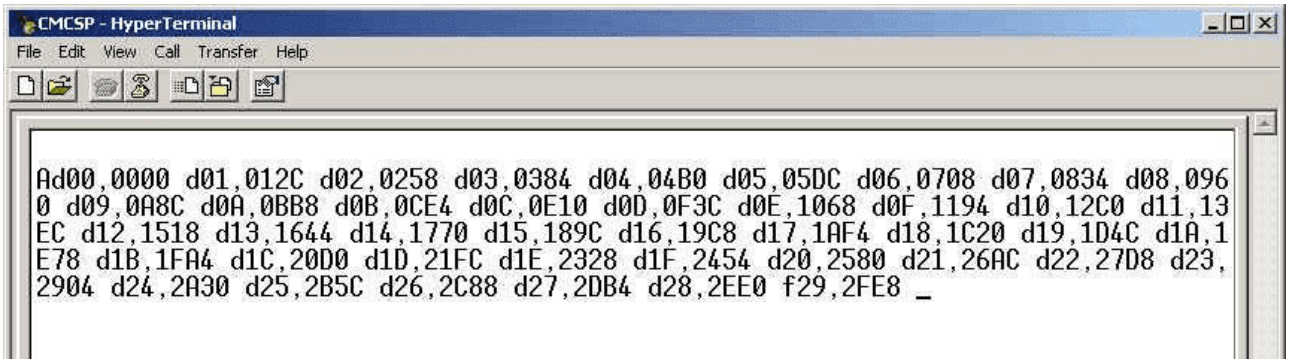
The data format says a total of 12 meter counts have been accumulated in 9.35 seconds.

Shown below is a simple Excel program that easily converts hexadecimal numbers to decimal (base 10) numbers. The column 'Decimal Conversion' shows the Excel formula.

	A	B
0	**Hexadecimal Number**	**Decimal Conversion**
1		
2		
3	1F	=hex2dec(A3)

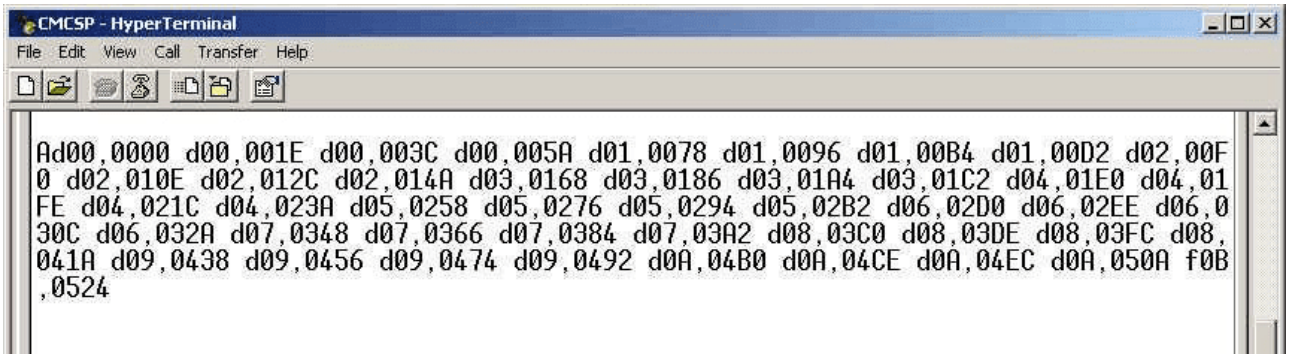
Data Format Notes

The data format presented by the **MagnaRod** during a measurement provides for displaying a computed velocity by an external device at a 1-second rate. The accumulating contact closure counts and time interval counts can be used in a rating equation to display velocity. At the end of the measuring interval, a final total of contact closures and interval time is then used to compute the measured velocity. For the Normal mode, the 1-second output data format displays the accumulating time interval counts based on a 300 Hz sample rate. The following example below shows how it would be presented using the 'HyperTerminal' program: NORMAL mode, 300 Hz sample rate, counts accumulating at a 1 Hz rate.



For Slow Speed mode operation, the display of the accumulating time interval counts differs in that the value is based on a 30 Hz sample rate. The following example below shows how it would be presented in the Slow Speed mode:

30 Hz sample rate, counts accumulating at a 0.25 Hz rate (1 count every 4 seconds)



3.7.3 Operating the Special Functions Using Serial Communications

The special function 'SPIN Test' can be operated using the serial communications interface. A laptop, desktop PC, or PocketPC using a terminal emulating package or Microsoft®'s HyperTerminal can be used to invoke the function. No menu selections in the **MagnaRod** are needed. The selection of the meter type and turning the buzzer On and Off can all be done using the serial communications interface. These functions can also operate using **Bluetooth®**.

The following list shows the commands and functions that can performed through the serial communications interface.

Command	Function Performed
N	Spin Test
S	Start Spin Measurement (subcommand in 'Spin Test')
A	Stop Spin Measurement (subcommand in 'Spin Test')
U	Buzzer ON
Z	Buzzer OFF
M	Magnetic Head Meter
C	Cat Whisker Head Meter
I	Abort function

When the 'N' command is received by the MagnaRod from an externally connected device, the MagnaRod echoes acknowledge character 'N' back to the device.

Refer to Appendix Capturing a Spin Test 26 for details in using the Spin Test and capturing a 'spin test file'.

4 Maintenance

There is no specific maintenance for the **MagnaRod**. As with any electronic device, care must be taken to insure minimal exposure to moisture, dirt, or other contaminants. The unit is splash proof; however, it is not waterproof. If the unit becomes submerged in water, remove the batteries and any remaining water. Allow the unit to dry out completely before reinstalling the batteries.

There are no user serviceable parts inside the **MagnaRod**. If the unit does not function properly, the unit must be returned to Hyquest Solutions for component repair.

The **MagnaRod** does not require any calibration or adjustments. The **MagnaRod** is self-calibrating and will perform this operation whenever the unit is turned on and whenever "Manual Calibrate" is selected via the menu, or whenever a start measurement command ('**S**') is received through the serial communications interface.

For more information, see the following subsection:

- Changing the Batteries 21

4.1 Changing the Batteries

Note: For optimum performance, the batteries should always be replaced with three good quality AA alkaline 1.5V batteries !!

Simply lift the clip at the bottom of the front face, and lift the front cover upwards.

Insert the new batteries taking care of the battery orientation – which is stamped on the bottom of the battery enclosure.

Please Note: Installing the batteries backwards will not damage the **MagnaRod**.

5 Repair

HyQuest Solutions precision instruments and data loggers are produced in quality-controlled processes. All HyQuest Solutions production and assembly sites in Australia, New Zealand and Europe are ISO 90001 certified. All equipment is factory tested and/or factory calibrated before it is shipped to the client. This ensures that HyQuest Solutions products perform to their fullest capacity when delivered.

Despite HyQuest Solutions most rigorous quality assurance (QA), malfunction may occur within or outside of the warranty period. In rare cases, a product may not be delivered in accordance with your order.

In such cases HyQuest Solutions' return and repair policy applies. For you as a customer, this means the following:

1. Contact HyQuest Solutions using the Repair Request Form made available online:
   https://cdn.hyquestsolutions.eu/fileadmin/Services/Downloads/HS-RepairRequestForm_EU.pdf
   In response you will receive a reference number that must be referenced on all further correspondence and on the freight documents accompanying your return shipment.
2. Please provide as much information and/or clear instructions within the return paperwork. This will assist our test engineers with their diagnosis.
3. Please do not ship the goods prior to obtaining the reference number. HyQuest Solutions will not reject any equipment that arrives without reference number; however, it may take us longer to process.

Custom requirements for items sent to HyQuest Solutions for warranty or non-warranty repairs: Check with your national customs/tax authorities for details, processes and paperwork regarding tax exempt return of products. Typically, special custom tariff codes are available (such as HS Code = 9802.00) that verify the item is being returned for repair and has no commercial value. Please note that the customs invoice / dispatch documents should also clearly state: "Goods being returned to manufacturer for repair – No Commercial value". It is mandatory to have any returned goods accompanied by a commercial invoice on headed paper. HyQuest Solutions reserves the right to charge the customer for time spent rectifying incorrect customs documents.

Note: Please ensure that your goods are packed carefully and securely. Damage that occurs during transit is not covered by our warranty and may be chargeable.

6 Technical Data

Measurement Range	Velocity: ▪ 0.05 ft/sec to 20 ft/sec (with a Price AA meter) ▪ Low-speed mode to improve measurements with extremely slow rotating current meters (velocities less than 0.25 ft/sec)
Materials	▪ Rods: anodized aluminum ▪ Mounting adaptors: steel ▪ Fasteners: stainless steel ▪ Connectors: brass ▪ Graduated ruler: aluminum ▪ Synthetic components: impact resistant UV-stabilised acetal plastic
Level	Bull eye integrated into handle
Power Supply	3 × 1.5 V AA Alkaline batteries
Dimensions	▪ 1600 × 300 × 140 mm (5.3’ × 1’ × 0.5’) ▪ Valid for standard rod length of 1.2 m (4 ft); other sizes available on demand
Weight	3 kg (for 1.2 m or 4 ft)
Operating Time	▪ 43 hrs use (with backlight on), 233 hrs use (with backlight off) ▪ Low-power operation due to auto turn-off feature
Protection Class	IP66

7 Obligations of the Operator and Disposal

This chapter contains the following subsections:

7.1 Obligations of the Operator

European Union

In the Single European Market it is the responsibility of the operator to ensure that the following legal regulations are observed and complied with: national implementation of the framework directive (89/391/EEC) and the associated individual directives, in particular 2009/104/EC, on minimum safety and health requirements for the use of work equipment by employees at work.

Worldwide

Regulations: If and where required, operating licences must be obtained by the operator. In addition, national or regional environmental protection requirements must be complied with, regardless of local legal provisions regarding the following topics:

- Occupational safety
- Product disposal

Connections: Local regulations for electrical installation and connections must be observed.

7.2 Dismantling / Disposal

When disposing of the units and their accessories, the applicable local regulations regarding environment, disposal and occupational safety must be observed.

Before dismantling

- Electrical Devices:
  - Switch off the units.
  - Disconnect electrical appliances from the power supply, regardless of whether the appliances are connected to the mains or to another power source.
- Mechanical devices:
  - Fix all loose components. Prevent the device from moving independently or unintentionally.
  - Loosen mechanical fastenings: Please note that appliances can be heavy and that loosening the fastenings may cause them to become mechanically unstable.

Disposal

Operators of old appliances must recycle them separately from unsorted municipal waste. This applies in particular to electrical waste and old electronic equipment.

Electrical waste and electronic equipment must not be disposed of as household waste!

Instead, these old appliances must be collected separately and disposed of via the local collection and return systems.

Integrated or provided batteries and accumulators must be separated from the appliances and disposed of at the designated collection point. At the end of its service life, the lithium-ion battery must be disposed of according to legal provisions.

EU WEEE Directive

As players in the environmental market, KISTERS AG and HyQuest Solutions are committed to supporting efforts to avoid and recycle waste. Please consider:

- Avoidance before recycling!
- Recycling before disposal!

This symbol  indicates that the scrapping of the unit must be carried out in accordance with Directive 2012/19/EU. Please observe the local implementation of the directive and any accompanying or supplementary laws and regulations.

8 Appendices

This chapter contains the following subsections:

8.1 Capturing a Spin Test

The spin test function allows the user to perform a simple spin test of the meter. The **MagnaRod** outputs a character string representing the meter count and elapse time. Whenever the 'spin test' measurement begins, the **MagnaRod** will output through the serial data port a character string at every contact closure. This character string is of the following format:

`nxxx,tttt[cr][lf]`

`n` = preamble for indicating contact closure data

`xxx` = number of meter contact closures, transmitted in decimal (i.e. 001, 002, 003, etc)

`,` = delimiter

`tttt` = counts of elapse time measured as 0.00666 second counts(150 Hz), transmitted in HEX ASCII (i.e. 0-9,A-F)

`[cr]` = carriage return (ASCII '0D')

`[lf]` = line feed (ASCII '0A')

At the end of the spin test, the **MagnaRod** sends a final data string that displays the total number of counts and total time all shown in decimal notation. This format makes it easy to copy the final total number of counts and total elapse time information onto a form. Total time is given in seconds and displays the time to a tenth of a second. The format is shown below.

`dxxx,ttt.t[cr][lf]`

`d` = preamble for indicating spin measurement data in decimal

`xxx` = number of meter contact closures, transmitted in decimal (i.e. 001, 002, 003, etc)

`,` = delimiter

`ttt.t` = total seconds of elapse time displayed to a tenth of a second

`[cr]` = carriage return (ASCII '0D')

`[lf]` = line feed (ASCII '0A')

Shown below is an example of both formats, as they would be displayed using the HyperTerminal program.

N	← Perform 'Spin Test'
n000,0000	← First contact closure
n001,0013	
n002,0027	
n003,003A	
.	
.	

.	
n162,427A	
n163,4607	← Final contact closure
n163,4736	← Data string when “Stop Spin” executed
d163,121.4	← Final meter counts and time (in seconds)
A	← **MagnaRod** initialization completed

The following information details some specifics about each format, specifically the limitations and alternate characters that may be presented.

1) The maximum time that can be displayed, during the measurement, is ‘$FFFF_{16}$’. If the measurement continues beyond the maximum data form available, the count ‘rolls over’ and begins from ‘0’. When this occurs, the delimiter character ‘,’ is replaced by the ‘>’ character to indicate the rollover condition. When the data is transferred to a spreadsheet, the character, ‘>’, can be easily detected and used to add ‘65535’ (= $FFFF_{16}$) to the elapse time tally. No further change in the delimiter character occurs if the accumulating time continues to further rollover.
2) The maximum time that can be displayed as given by the final data string is 436.4 seconds as displayed ($FFFF_{16}$ x 0.00666 seconds). This equates to 7 minutes and 16.4 seconds. If the accumulating time continues during the measurement (as discussed above), the final count tally will reflect a calculated value rolled over and beginning from ‘0’. If this occurs, the delimiter character ‘,’ is replaced by the ‘>’ character to indicate a rollover. To determine the total accumulated time from the roll over condition, simply add 436.4 seconds to the total number displayed.
3) The maximum number of measured meter contact closures (clicks) is 999. If the accumulating contact closures continues beyond the maximum data form, the count ‘rolls over’ and the most significant digit position number is replaced by the colon (‘:’) character. If the count continues, other characters will replace the most significant digit position number. Meter counts should not exceed 999, however a detection scheme is provided if such an occurrence happens.

The “Spin Test” has three subcommands as follows:

S – Start spin measurement.

A – Stop spin measurement, transmit final results, then quit.

I – Abort or quit the “Spin Test” function. No final data is transmitted.

The “Spin Test” is performed in the following manner (through the serial interface) :

1. Before entering the “Spin Test” function, select the type of meter, i.e. Cat’s Whisker Head, or Magnetic Head Meter. Also enable or disable the buzzer.
2. Press “**N**” on the computer keyboard to enter the “Spin Test”. The **COUNT** LED will become illuminated. The **OPERATING STATUS** indicator will illuminate green if the meter is selected for a Magnetic Head and red if Cat’s Whisker Head is selected. The **MagnaRod** echoes with ‘**N**’.
3. Depress the letter “**S**” on the computer keyboard or press the SELECT button on the **MagnaRod**. The **OPERATING STATUS** indicator will turn off.
4. When the meter is spun, the **OPERATING STATUS** indicator will blink when a contact closure is detected.
5. The **MagnaRod** will output through the serial port a character string (as described previously) every time there is a meter contact closure. At the first contact closure, the **MagnaRod** outputs the first contact closure as the start of the measurement. The number of meter contact closures begins with “zero” and the counts of elapsed time begins with “zero.” Contact closures and counts of elapsed time will begin to increment following every contact closure until the “A” command is sent or the SELECT button is pressed. The **MagnaRod** then sends the final data string (in decimal) followed by the **MagnaRod** reinitializing. The character ‘A’ is sent when the **MagnaRod** completes a calibration cycle, as it initializes.

Sending the ‘I’ command anytime before or during the test aborts (or quits) the “Spin Test” function. The **MagnaRod** sends the character ‘A’ to acknowledge exiting. When the **MagnaRod** exits, the **MagnaRod** reinitializes with a calibration. When the calibration has been completed, the **MagnaRod** sends the character ‘A’ again, and then goes to normal operation mode.

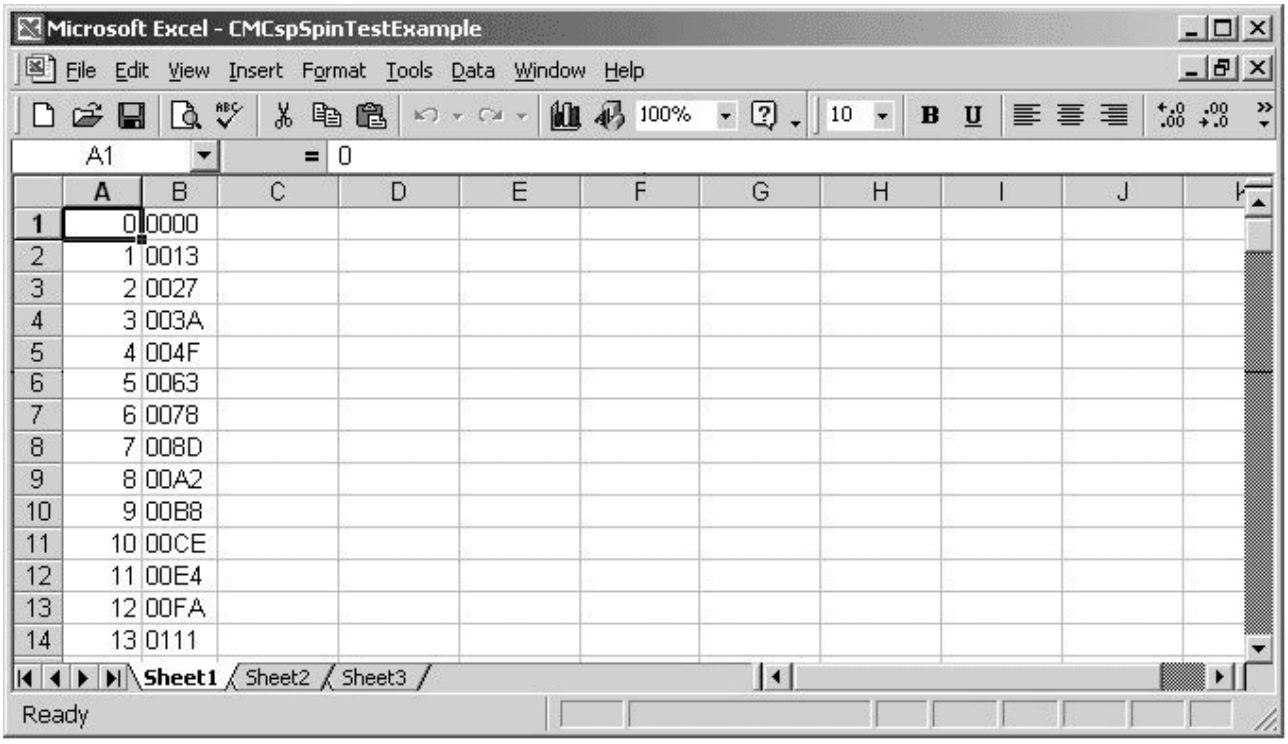
Capturing a "Spin Test" file

"Spin test" transmitted data can be saved by using the options in the HyperTerminal program. HyperTerminal is a program that can be found on most computers in the 'Accessories' folder listed in the Programs list on the desktop. Within HyperTerminal and before spinning the meter, select "Capture Text" found in the Windows label "Transfer" tab. When the "Capture Text" tab is clicked, Windows will ask for a file name. The file name extension will be ".txt". Select a file name, then click "Start" to save the screen results. After completing the spin test, select "Capture Text" again under the "Transfer" tab. Click "Stop". The file will be saved under the file name given. The file can be opened using Windows "NotePad" or "WordPad" and can be easily imported into Excel for analysis.

To better align the data being displayed, the **MagnaRod** will respond to the Carriage Return key, CR. Entering a CR, the **MagnaRod** will send a CR followed by a Line Feed, LF. This will cause the display cursor to return to the left most position on the display and move down the page by one line position.

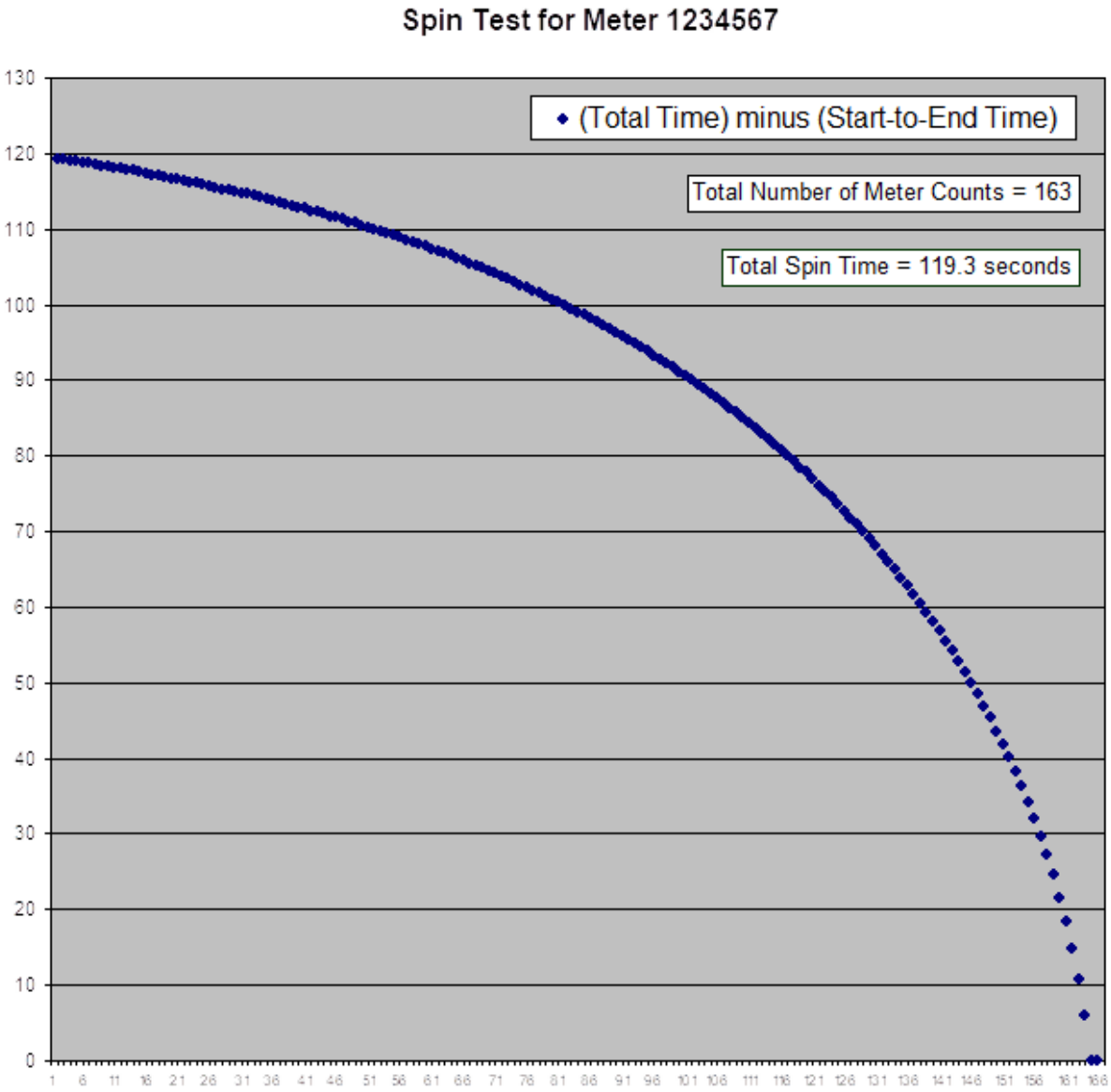
Use the following steps to import a text file into Excel. This procedure uses Microsoft Excel 2000.

1. Open up Excel for Windows.
2. Under the 'Data' tab, select 'Get External Data'.
3. Within 'Get External Data', select 'Import Text File'.
4. Select the location of the text file and click 'Import'.
5. The 'Text Import Wizard' pops up with the 'Delimited' radio button on. Also, a portion of the actual text file is shown at the bottom of the window.
6. Click up the 'Start import at row:' tab to start at row 2.
7. Click 'Next' at the bottom to go to Step 2 of the Wizard.
8. In the 'Delimiters' window,
   a. deselect 'Tab',
   b. select 'Comma',
   c. select 'Other', then type 'n' in the box next to 'Other'.
   The text file preview should show a vertical line separating the meter counts column data and the time data column.
9. Click 'Next', this will bring you to Step 3 of the Wizard.
10. In Step 3 window, click 'Do not import column (skip)' in the 'Column data format' window. This will show 'Skip' in the column 1 heading.
11. Click on column 3 (where the Time data is shown in HEX-ASCII) and change in the 'Column data format' window from 'General' to 'Text'.
12. In the 'Data Preview' window, the columns should show the following selections on the column heading:
    a. 'Skip' for column 1
    b. 'General' for column 2—Current meter counts
    c. 'Text' for column 3—Time
13. Click 'Finish', and then click 'OK' to import data into the existing worksheet.
14. Save the workbook under a file name.
15. Shown below is an example of an imported 'Spin Test' file.



	A	B
1	0	0000
2	1	0013
3	2	0027
4	3	003A
5	4	004F
6	5	0063
7	6	0078
8	7	008D
9	8	00A2
10	9	00B8
11	10	00CE
12	11	00E4
13	12	00FA
14	13	0111

Shown in the figure below is an example of a graph showing the response of a current meter created from data in a "Spin Test" file.



8.2 Measuring Meter Dwell

The meter dwell measurement function performs a measure of the contact time in relation to a single rotation of the meter. For the cat's whisker contact, it is the measure of the cat's whisker contact time on the cam lobe. The resulting measurement is called "dwell". Dwell is expressed in terms of degrees and for a cat's whisker contact; the contact time should be adjusted to be the width of a single cup. This adjustment results in the dwell angle of 60º for a meter with 6 cups and represents optimum performance. The magnetic contact meter (Mag Head) requires no adjustment and therefore measuring the meter dwell angle does not apply but can be performed. When a meter dwell measurement is performed, the **MagnaRod** takes three measurements and displays the result on the LCD after each measurement, as shown.

The "Dwell Angle" can be computed by using the following simple formula:

$$Dwell\ Angle = \frac{(Contact\ time)x360}{(Total\ Time)}$$

The contact time and total time shown above in the formula are expressed in terms of the number of samples measured at a sample rate of 1200 Hz as it is measured by the **MagnaRod**. A high sample rate is used to reflect a more accurate measure of the contact time and total time measured. The repeatability and variability in measuring the dwell is directly related to mechanical factors such as the condition of the pivot bearings, and the cat whisker wire contact

surface and cam lobe. Wide variations in readings reflect conditions that may require further inspection of the meter and its mechanical parts. Some variation in readings is acceptable and represents proper adjustment; however there should be no more than a 10% difference between all the readings. Optimal setting is near 60º (a single meter cup width). High conductivity of >25,000 micro Siemens can affect the operating performance of the **MagnaRod** and should a current meter be required to operate in high conductivity water, a lower dwell angle setting should be used. A setting of not less than 20º for higher velocities (>2 ft/sec or 0.65 m/sec) is suggested.

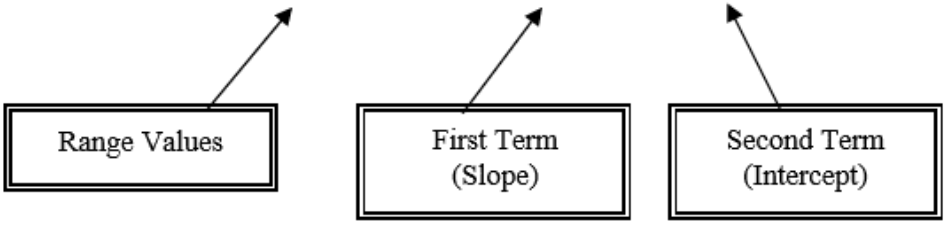
8.3 Example Calibration Certificate

HYQUEST SOLUTIONS PTY. LTD., AUSTRALIA

CERTIFICATE OF CALIBRATION Date: 27/4/06

Current Meter Model: xxxxxx — Serial No. 91655
Fan No. 1 — Serial No. 165435
Diameter: 125mm — Pitch: 0.25m
Type of Support:
Method of Calibration: Average Value Equation

```
        n < 0.42    V = 0.2190 n +0.0153 m/s
0.42 < n < 3.73     V = 0.2459 n +0.0041 m/s
        n > 3.73    V = 0.2508 n -0.0142 m/s
```



Starting Velocity = 0.025 m/s
Maximum Velocity = 5.000 m/s

Note: 'n' denotes the number of revolutions of the propeller per second
'V' is the water velocity in meters per second.

Date: 27/4/06 — INSPECTED:_____

Anthony Gemayel
(Mechatronics Engineer)

The above meter has been calibrated in accordance with AS 3778.6.3-1992. This standard is identical with and has been reproduced from ISO 3455:1976.
The clause below has been printed with the permission of Standards Australia from AS 3778.6.1-1992. This standard is identical with and has been reproduced from ISO 2537:1988.
Clause 7.6 Recalibration. Meters shall be recalibrated whenever their performance is suspect. In practice for individually rated meters, recalibration is sometimes carried out at yearly intervals or after 300 hours of use, whichever is the shorter.

D127.08.00

Contact Data

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04/04/2023

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