DIGILEVEL - SECTION 1

Environmental Monitoring System
User's Manual

KELLERAMERICA

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Disclaimer: The Keller Digilevel water level transmitter is designed for data gathering applications. It is not intended for nor is it authorized for use in any life-support application.

1.1. Introduction

Thank you for your trust in Keller America. We are committed to providing our customers with the best value available today in level monitoring instrumentation. The Keller Digilevel SDI-12 Water Level Transmitter complies with all aspects of the SDI-12 Serial Digital Interface Standard for Microprocessor-Based Sensors, v 1.3. Combined with the 900001.0043 Dongle accessory and the SDI-12 GUI (Graphical User Interface), it is the easiest-to-operate of all currently available SDI-12 submersible level transmitters.

The Digilevel hardware is based upon state-of-the-art pressure sensing technology produced in-house by Keller, well known for accuracy and stability. The signal conditioning section utilizes advanced digital error correction and provides a high degree of immunity from ground transients as can be caused by nearby lightning strikes. The enclosure is designed to provide optimum protection from the environment as well as separate connections for SDI-12 communications and atmospheric reference vent.

The Digilevel firmware and software were carefully developed to exactly correspond to the SDI-12 v1.3 specification. Because most other SDI-12 compatible level transmitters previously available do not faithfully mirror the SDI-12 v1.3 specification, the Keller Digilevel has been designed with several emulate modes so that it is not necessary to rewrite the user's familiar command set. Even the extended commands specific to each manufacturer's product have been included. Further, the GUI supports all emulate modes.

The Keller Digilevel is designed to provide years of trouble-free service in the most demanding environments and carries a 2-year warranty covering all applicable parts and labor. Nonetheless, an instrument as sensitive and accurate as the Digilevel must also be handled wisely and certain cautions observed, including avoiding sharp impacts and making sure allowable operating conditions are not exceeded.

This manual was written with the goal of providing 100% sufficient and accurate information. If, however, there is a question that it does not address, or if an error is discovered, please contact us via e-mail at support@kelleramerica.com or by toll-free telephone at 877-253-5537.

1.2. Specifications

Pressure range(s)...Infinite from 0-3 to 0-900 ft WC
Proof pressure..2X basic range
Overall accuracy (Total Error Band over the compensated temperature range)...............<±0.1%FS
Supply...8...28 VDC
Current Consumption..<1mA quiescent
                                            max. 20mA active

Compensated temperature range..-10- +60°C
Operating temperature range...-20- +80°C
Storage temperature range..-60- +80°C
Communication protocol...SDI-12 ver. 1.3
Wetted materials...316L SS and fluorocarbon
Electrical connections...Red: + Supply
                                            White: Data
                                            Shield: Case Grnd
                                            Black: Circuit Grnd

1.3. Quick Start Guide

1. Remove the Digilevel from the factory packaging and inspect it for obvious damage. If none, proceed to (2). If damage from shipping is apparent, contact the shipper. Otherwise, contact Keller America at 877-253-5537.

2. If using the 900001.0043 Dongle, first connect the Digilevel to the Dongle via the binding posts starting with the ground (black) lead.

3. Install the GUI provided with the Digilevel on your computer. The GUI should be saved to a convenient directory as well as a shortcut to the GUI on your Desktop.

4. Connect the 900001.0043 Dongle, with the Digilevel connected to it, to a USB port on your PC or laptop.

5. Upon connection, communication between the GUI and the Digilevel will be established automatically.

6. For Users familiar with SDI-12 commands, click on the "terminal" tab and input SDI-12 commands.

7. For instructions on the proper use of the Calibration utility, see "Digilevel Calibration Screen Operation" else where in this manual.

1.4. General Operating Instructions

Construction details

The Keller Digilevel water level transmitter hardware is based upon components already proven to be reliable in the submersible environment.

The standard materials of construction are 316L stainless steel for all of the metal parts, including the housing and sensor. The sensor is sealed to the housing via a fluorocarbon o-ring.

The basic sensor is the piezoresistive silicon type, based upon over 30 years of development by Europe's premier producer of such sensors. Highly sensitive yet boasting very good long-term stability, it is protected from the media by a compliant, laser-welded sensing membrane.

The signal conditioning electronics feature the latest in digital hard- and firmware which utilize a mathematical modeling scheme to correct for static (nonlinearity, non-repeatability and hysteresis) as well as thermally-induced errors. Further, the user-interface section complies with all hard- and software requirements of SDI-12 Version 1.3, in addition to supporting several emulate modes for other popular SDI-12 water level probes. The user-interface of the signal conditioning electronics includes a parallel arrangement of avalanche diodes and gas-filled discharge tubes, proven to be very effective in protecting the transmitter from transient ground voltages such as are created by nearby lightning strikes. The electronics are potted into the housing in order to provide an additional layer of protection against moisture and shock/vibration. Regardless, avoid dropping the Digilevel onto hard surfaces. It is a precision instrument and can be damaged by severe impact with hard surfaces.

Cleaning Recommendations

Should pressure inlets on the Digilevel become fouled with silt or algae, it may be safely cleaned so long as caution is exercised. Keep in mind the sensing diaphragm resides just underneath the protective cap that is screwed onto the end of the Digilevel. This diaphragm must not be touched with anything except cleaning solution; i.e., contact with fingernails, brushes, pocket knives, etc can permanently damage the sensing diaphragm.

Fill a small container with water, also mild detergent if available. Carefully unscrew the end cap from the Digilevel and set aside. You will note there are two o-rings which help to retain the end cap to the housing. Do not attempt to remove the o-rings until all possible dirt and debris are removed. Lower the pressure sensing end of the Digilevel into the container filled with water/detergent and swish the Digilevel aggressively in order to dislodge contaminants from the sensing diaphragm, the o-rings and threaded area. Again, the temptation to scrub or scrape the sensing diaphragm must be resisted. Usually cleaning by the method described above will enable the Digilevel to resume providing accurate data.

Reassemble in the reverse order, taking care that the o-rings are free from dirt and debris before the end cap is reinstalled.

Calibration

A utility is provided in the Digilevel GUI program to facilitate adjustment of the Digilevel probe zero offset and sensitivity (gain) values. Instructions for the proper use of this utility are included in this manual. It is recommended that the User thoroughly familiarize his- or herself with this procedure before proceeding, as the result is to alter the factory calibration zero and sensitivity (span) settings.

1.5. Digilevel Calibration Screen Operation

WARNING!!!! Use of this utility will result in alteration of the factory calibration. Good metrological practice must be observed, including the use of calibrated instrumentation/pressure standards, otherwise the result will not be valid.

A Calibration tab is available in the Digilevel program. This tab is always hidden when the program first starts up. It is enabled under specific conditions described below in step 1. "Calibration" enables the user to adjust the zero off-set and/or sensitivity of the Digilevel.

Certain safeguards are made in the program to ensure that the Digilevel probe is properly calibrated. These are described below.

Operation

1. To enter and enable the Calibration, the Digilevel program must show the Communications tab. A Digilevel probe should be attached at this point. User then enters   <Ctrl><F3>   to display the login/pass word window. See Figure 1 below.
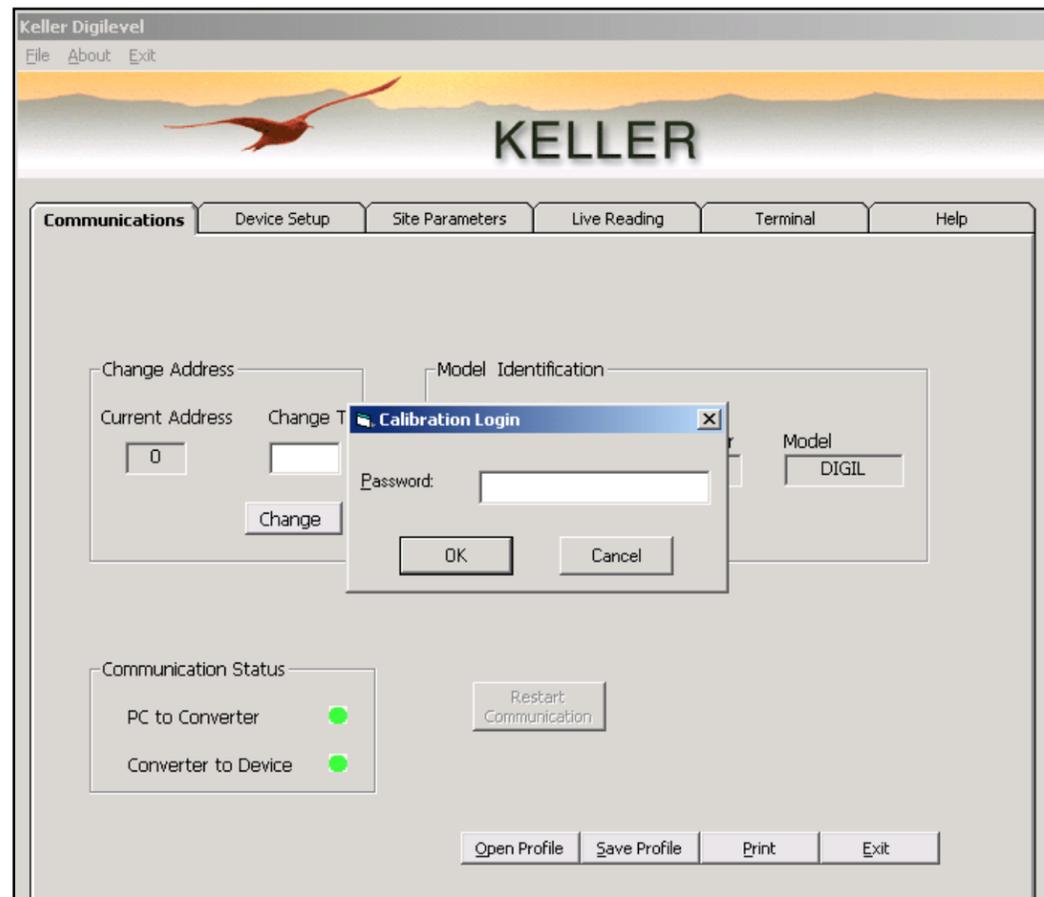
Figure 1 - Login

2. Enters password "keller-23606" to enable and enter Calibration tab. Calibration tab is enabled as long as current Digilevel program is running. If "OK" is not clicked within 20 seconds, the login window disappears.

    When "OK" is clicked and valid password is entered, the Calibration tab is shown. See Figure 2 below.
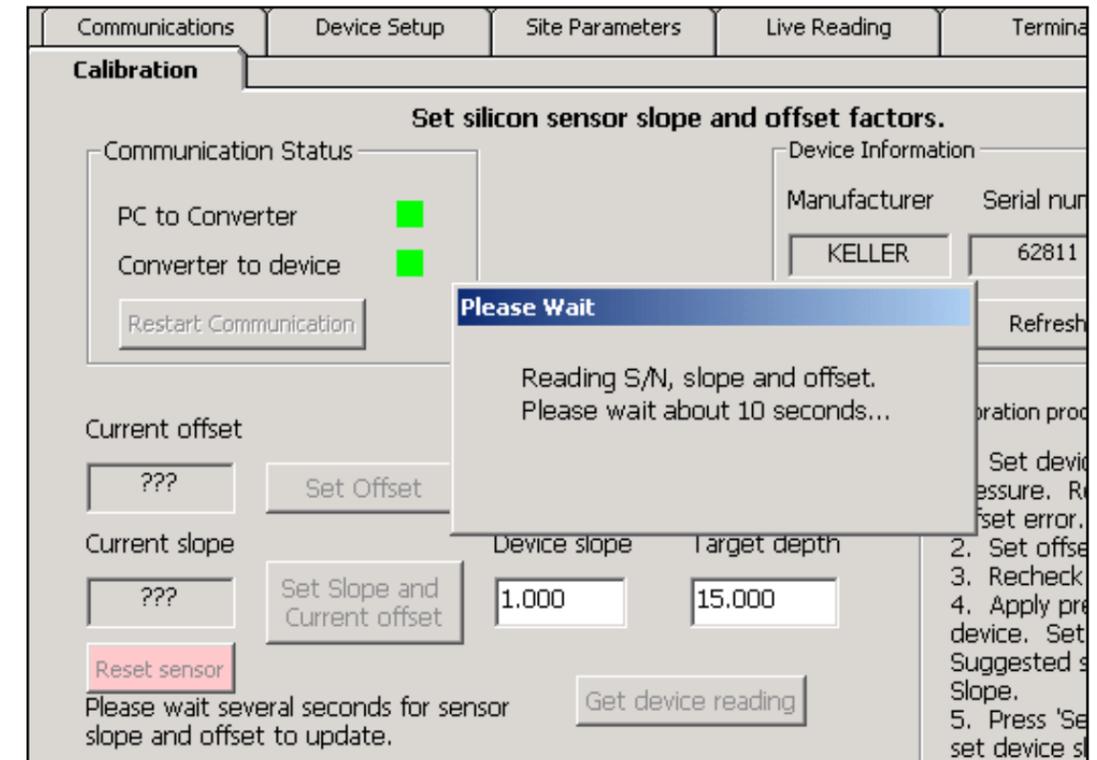
Figure 2 - Opening calibration Message

3. A box comes up informing the user that the Digilevel probe is getting queried for its ID, slope and offset. This takes less than 10 seconds. Box goes away when all information is collected.

4. The program will automatically attempt to communicate with the Digilevel probe and retrieve information, slope, and offset. If no Digilevel probe is detected, program will try to re-establish communications every second.

    Digilevel probe slope and offset are put into the "Current offset" and "Current slope" boxes.

5. The user now can start the calibration process. The process is iterative, since the offset and sensitivity adjustments are interactive. It is necessary to read the device, set offset, read device again, reset offset as necessary, apply pressure to device, set target depth/pressure, read the device, set the slope (and offset), read the device again, done. Each button is described below.

6. **Get device reading** - When this button is pressed, it changes to "Reading…". When done, it changes back. Units of measure and temperature is updated, much like live reading. Unlike live reading, only one measurement is taken.

    If the reading is less than one, the program assumes you are trying to do offset. Value of one works for most units of measurement except for mm of water. If the reading is less than one, then the "Enter offset in units of measure (below)" box is filled in with a calculated value. Its value is figured as follows:

    -1 * (current reading – current Digilevel probe offset)

    If current Digilevel probe offset is 0, then the negative value of the current reading is filled in. In any case, the user can put in any number desired.

    Another box, "Device slope" is also conditionally filled in. If the current reading is within 10% of the "Target depth", a slope is calculated. Suggested slope is calculated as follows:

    Slope = (Actual_measurement * Digilevel_slope) / reading

    Where: Actual measurement is value from that box.
    Digilevel probe slope is from "Current slope" box
    'reading', just below "get device reading" button, is what the Digilevel probe returns.
    A suggested slope is put into the "Device slope" box.   The user can enter any value they want in this box.

7. **Set offset** - This command sends the number in the "Enter offset in units of measure (below)" box to the Digilevel probe using the XC command. All revision levels support this command mode.

    The user can put in any value into this box before hitting the "Set offset" button.

    When the offset is programmed, the currently programmed offset is shown in the "Current offset" box.

8. **Set slope and current offset** - This command operates a bit differently. As the button states, a slope and offset are programmed into the Digilevel probe. Offset is always the value in the "Current offset" box. Offset can only be changed using the "Set offset" button.

    Suggested slope is calculated as in 6 above.

    When the set slope button is pressed, the Digilevel program sends the new XC command with offset and slope to the Digilevel probe.

9. **Reset sensor** - This button sets offset to 0.000 and slope to 1.000 in the Digilevel probe. It is kind of a one button version of set offset then set slope.

10. **Refresh** - This button is provided for one of two conditions. First is in the unlikely event that the Digilevel probe is changed and program did not detect it, you hit this button to get ID and offset information from the Digilevel probe. The second condition is just in case you are not sure what is in the Digilevel probe.

11. **Restart Communication** - Restart communication button is active when Digilevel program detects that the dongle is missing or hung up. Press this button to re-establish communication between PC and dongle.

12. **Calibration procedure guide** - This box is a quick summary of the calibration process.

     It is possible to seamlessly go between Calibration tab and any other tab. However, when you re-enter the calibration tab, Digilevel program will gather device ID, slope, and offset data.

     Most buttons and tabs are disabled while reading and updating the device. "Exit" is the only button always enabled.

Error Conditions

If the program starts without a dongle, you cannot enter calibration mode. While Digilevel program is running, you can insert a dongle and press the "Restart Communication" button. When Digilevel program detects the dongle, then you can enter the password and go on.

If you start the Digilevel program and no Digilevel probe is attached (dongle is attached and working), you can get into the calibration tab (after the login procedure). The box in Figure 2 comes up but for a shorter period of time. The Converter to Device LED will blink red, as in the communication tab. When you connect a Digilevel probe and the Digilevel program recognizes it, the program will automatically go out and get the device's ID, slope and offset.

You cannot have a negative number or zero for device slope. Slope values are not range checked, meaning you can have a correction factor of 2000 if you like. By design, slope factor is presented to 5 decimal places. The user can enter more digits (up to 6 decimal places) for slope and offset, if desired.

DIGILEVEL - SECTION 2

Keller Digilevel Command Set

KELLERAMERICA

Newport News, Virginia, U.S.A
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Appendix 1 - Keller Digilevel SDI-12 Command Set

2.1 Introduction

The Keller Digilevel SDI-12 probe has a number of command features that provide flexibility for use in just about any ground or surface water measurement application. The Digilevel is ready to use "out of the box". However, site situations usually require some customization in order to provide meaningful measurements. To facilitate this flexibility, many extended commands are provided.

These extended commands allow you to set units of measurement and adapt to site stage situations. Since site requirements vary widely, not all extended commands will be used. You should quickly review these extended commands to determine if any one of them is suitable for your needs.

Keller has a PC based probe setup program called Digilevel. An Dongle adapter connects to the USB port on your PC while 3 terminals connect to the probe. Software guides you through most all of the requirements you may encounter. A terminal program allows you to talk directly to the probe.

The Digilevel probe can be configured to emulate several other manufacturer's products, including Design Analysis, KPSI®$_1$ and Tavis. A listing of differences and supported commands are provided on CD entitled Command Cross Reference.

2.2 Preliminary Setup Commands

There are a few extended commands to consider when setting up your probe for a response. These commands determine units of measure for depth & pressure and temperature and decimal precision. Below table only lists a few of them. Generally, all extended (commands with prefix 'X') should be considered.

Command	Description
XUP	Set units of measure (pressure or depth) and number of places to right of decimal point.
XUT	Set temperature units (Celsius or Fahrenheit)
XT	Set averaging time

Most all extended commands affect depth/pressure readings. You should become familiar with them so you can set up your site in the most efficient manner possible.

2.3 Factory Default Parameters

The following are default settings for the Digilevel probe mode:

    Temperature: C
    Units of measure: Feet of water
    Number of decimal points:3
    XUU command slope: 1.000
    XUU command offset: 0.000
    XUM command measurement mode: 0 (return pressure only for measurement mode M or C)
    XT command averaging time: 10 seconds

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1. KPSI®, a Federally-registered trademark, and Series 500, a model designation, are owned by Measurement Specialties, Inc., a maker of level and pressure transducers.

2.4 Units of Measurement Note

A list of supported units of measurement are listed below. Internally, all units of measure for pressure/depth are measured in Bar. When a measurement request is made, the program reads the probe in Bar and then converts it to the desired units of measurement.

When user slope/offset command is enabled (through XUU and XUP commands), the measurement is converted into PSI first then multiplied by user slope.

Units of measurement are:

> +0 = feet of water
> +1 = PSI
> +2 = kilopascal
> +3 = cm of water
> +4 = meters of water
> +5 = mm of water
> +9 = user entered scale factors.

If field calibration offset (set by XE or XS commands) is not 0, add 10 to the above units of measure.

2.5 Offset Note

There are 3 kinds of offsets used to calculate readings. One offset, set by the XE command, is used to adjust the pressure sensor readings. This command is to compensate for sensor drift over time.

The second offset, set by the XS command, is for stage, gage, or offset. It is an add to or subtract from current reading, usually in feet, to return some level.

XS command can be used in one of two ways: With or without parameters. Its use is best illustrated by examples.

Suppose you place a probe in a body of water 15 feet down. You want the probe to return the change in the water level, using the current level as a reference. You would execute the XS command without any values. This would make the current level the zero, or reference level.

Next example supposes a probe is placed 15 feet down in a 20 foot deep body of water. You want to return the water level (in this case 20 feet). You would use the XS (or XSCS) command to tell the probe you want to measure the water level as if the probe is 20 feet down. You would send the probe
>   aXS+20+0!

The XSCS command assumes feet, so the probe is sent aXSCS+20!

Where 'a' is the probe address. '20' is the desired probe reading at this time. '0' is the units of measure parameter, in this case feet. You can specify other units of measure as described below.

There is an interaction between the XS, XSCS, and XE command. Execute just one. The XE command compensates for sensor drift. XS and XSCS is more for site setup. It not only takes into account sensor drift but also depth at the site. Executing one command replaces the value set by the others.

The 3rd offset is set by the XWO, or XUU command. Any one of the preceding commands will set the stage level. For example, if you use XUU to set the stage level (or offset) then use XWO to set another level (in feet), the XWO value will be used. You should only use one of these commands to set the offset, or stage.

2.6 Depth/Pressure Commands

There are a number of commands which affect depth/pressure measurements. These are primarily extended setup commands beginning with 'X'.

Commands that perform depth/pressure measurements are: M0!, MC0!, C0!, CC0!, M1!, MC1!, C1!, CC1!, M7!, MC7!, C7!, and CC7!.

2.7 Averaging

The Digilevel probe can take measurements 10 times/second after a 0.75 second warm up. Thus the first measurement is complete 0.85 seconds after the start of the SDI-12 request command. If the command requests a return of depth/pressure, and averaging is not 0, then averaging is performed. Commands that will average depth/pressure are: M0!, MC0!, C0!, CC0!, M1!, MC1!, C1!, CC1!, M7!, MC7!, C7!, and CC7!. Temperature is not averaged.

Minimum average is 10 samples, or 1 second.

Averaging is performed as follows: All readings are summed during the averaging period. The highest and lowest readings are also recorded. When a depth/pressure measurement is requested via the aD0! command, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples -2. The result is returned.

2.8 Nomenclature

The following nomenclature is used for the command set descriptions below.

a = address of probe
ddd = number data. Has '+' or '-' prefix sign.
c = signed field calibration (in PSI)
ccc = character data
m = mode, +0 or +1
n = single number
o = signed user offset
p = pressure. Has '+' or '-' prefix sign.
s = signed user slope
ttt = time, in seconds, for response
t = signed temperature or time (XT command)
u = units of measure, corresponding to the following
> +0 = feet of water
> +1 = PSI
> +2 = kilopascal
> +3 = cm of water

+4 = meters of water
+5 = mm of water
+9 = user entered scale factors.
If field calibration offset is not 0, add 10 to the above units of measure.
If following temperature data,
+0 = C
+1 = F
v = signed battery voltage.
<cr><lf> = ASCII 13 followed by 10

2.9 Command Set

Notes:
This list will frequently use the word "setup." During setup, the probe is configured. Configuration settings need to be done only once. All X and the A commands are generally executed once during setup.

Some commands have been broken out into separate pages, based upon emulation mode. The M command, for example, returns different data depending upon the operating mode (Keller, DISI, H312).

Some commands exceed 1 page due to their complexity.

It may be helpful to note that many commands not listed in DISI-1210 or H312 manuals are allowed when operating in these modes. Some commands from DISI-1210 and H312 work while operating in Keller and KPSI® modes. This results in command duplication/overlap.

Some DISI-1210 and H312 responses to commands do not conform to SDI-12 specifications. In any one of these two emulation mode, malformed messages are faithfully reproduced in order to simulate that probe's operation. Keller and KPSI® probes adhere to SDI-12 specifications.

Part of the preface for the user should note that M and C commands have an optional checksum as part of it. Under "Related" paragraph, these were not included in the interest of simplification. All M and C commands may have a CRC appended to the data.

Unless otherwise specified, defaults are always for Keller Digilevel.

COMMAND:	$
SYNTAX:	$!
IMMEDIATE RESPONSE:	a
Where:	a = address of probe
RESPONSE TO D0:	n/a
FUNCTION:	Return address of probe in DISI-1210 mode
EMULATION MODES:	DISI-1210
DESCRIPTION:	Probe responds to this command only when in DISI-1210 mode. It is ignored (no response) in other modes. Command is equivalent to SDI-12's address query command A?!. Only one probe should be connected to the recorder or Digilevel dongle when issuing this command. Any and all probes configured for DISI-1210 emulation mode will respond.
RELATED:	?
EXAMPLE:	Query a probe's address in DISI-120 mode.

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
$!		Send command
	2	Response is address 2 for this example. Any valid SDI-12 address is possible.

COMMAND:	?
SYNTAX:	?!
IMMEDIATE RESPONSE:	a
Where:	a = address of probe
RESPONSE TO D0:	n/a
FUNCTION:	Queries probe address.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Command queries probe address. This is useful when you do not know its address. Only one probe should be connected to the recorder or Digilevel dongle when issuing this command. Any and all probes connected will respond.
RELATED:	$ (for DISI-1210 only)
EXAMPLE:	Query a probe's address.

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
?!		Send command
	1	Response is address 2 for this example. Any valid SDI-12 address is accepted.

1. KPSI®, a Federally-registered trademark, and Series 500, a model designation, are owned by Measurement Specialties, Inc., a maker of level and pressure transducers.

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COMMAND:	A
SYNTAX:	aAb!
Where:	a = original probe address b = new probe address
IMMEDIATE RESPONSE:	b
RESPONSE TO D0:	n/a
FUNCTION:	Changes probe address.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Default probe address is 0. Each probe or SDI-12 compatible device must have a unique address when operating on a single bus. This command allows the Digilevel in any mode to change its address. Any SDI-12 address may be used. ASCII "0" through ASCII "9" are usually the first addresses used. If more than 10 devices are on a bus, then ASCII "A" through ASCII "Z" (decimal 65 through 90) and ASCII "a" through ASCII "z" (decimal 97 through 122) may be used.
RELATED:	none
EXAMPLE:	Change the address of a probe from "0" (ASCII zero) to "1".

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0A1!		Set address to 1
	1	Probe responds with new address

1. KPSI®, a Federally-registered trademark, and Series 500, a model designation, are owned by Measurement Specialties, Inc., a maker of level and pressure transducers.

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COMMAND: C   (Keller Digilevel and KPSI® modes only)

                              CC   (Keller Digilevel and KPSI® modes only)

SYNTAX: aC!

                              aC0!

                              aCC!

                              aCC0!

        Where: a = address of probe

IMMEDIATE RESPONSE: a01102   Default response to aC! or aC0! command

                              a01104   Default response to aC! or aC0! when probe setup to return temperature

RESPONSE TO D0:   a+p+u   Default response to aC!

                              a+p+uCRC   Default response to aCC! or aCC0!

                              a+p+u+t+U   Response when probe setup to return temperature via XUM command

                              a+p+u+t+UCRC   Response with CRC when "aXUM+1" executed during probe setup

        Where: a = probe address

                              p = pressure/depth

                              t = temperature

                              U = temperature units of measure

        Where: +0 = degrees C

                              +1 = degrees F

                              u = depth/pressure units of measure

                              +0 = feet of water

                              +1 = PSI

                              +2 = kPa

                              +3 = cm of water

                              +4 = meters of water

                              +5 = mm of water

                              +9 = user units

                              CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Command probe to perform a concurrent depth/pressure measurement. Depending upon configuration during probe setup, temperature may be returned also.

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: This is a measurement command. Response to this command depends upon emulation mode. Check on next pages for DISI-1210 and H312 for information while operating in those modes.

                       Number and type of data returned will depend upon configuration. By default, depth is returned as feet of water. Other units of measure can be returned by executing the XUP command at setup. Custom units of measure are setup by executing the XUU command during probe configuration (as are all X commands listed here).

Temperature is appended by executing XUM command at setup. Temperature units is set by XUT.

Averaging and response time is set by XT command.

Average depth/pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

There are many commands that affect offset. Differences between actual and reported probe depth, are set by XS command. Other offsets, such as XE and XWO, are used in calibration lab or user measurement modes. All offset commands can affect data returned to some degree and in some cases one offset command can overwrite another. These are explained in each of the offset commands.

RELATED: XS, XT, XUM, XUP, XUT, XUU

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C!		Request concurrent measurement
	001102	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request data
	0+1.33+0	Returns 1.33 feet of water
Suppose XUM+1 was executed during setup to return both depth and temperature, and XUP was executed to return depth as cm of water (XUP+3). Subsequent C data transactions will look like:		
0C!		Request concurrent measurement
	001104	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request depth and temperature
	0+24.22+3+27.65+0	Return depth as 24.22 cm of water and temperature as 27.65 degrees C

COMMAND: C   (DISI-1210 mode only)
                     CC   (DISI-1210 mode only)

SYNTAX: aC!
                     aC0!
                     aCC!
                     aCC0!

          Where: a = address of probe

IMMEDIATE RESPONSE: a01104   Default response

RESPONSE TO D0:   a+d+t   Response to aC! or aC0! command
                     a+d+tCRC   Response to aCC! or aCC0! command

          Where: a = probe address
                     d = depth in meters of water
                     t = temperature in degrees C
                     CRC = Cyclic Redundancy Check value as ASCII characters

RESPONSE TO D1:   **A+H+L**

          Where: a = probe address
                     h = High reading during measurement interval
                     l = Low reading during measurement interval

FUNCTION: Command probe to perform a depth measurement in meters of water and record
                     both high and low depths during the measurement.

EMULATION MODES: DISI 1210

DESCRIPTION: This is a measurement command. Response to this command depends upon
                     emulation mode. Check previous page for Keller Digilevel and next page for H312
                     for information while operating in those modes.

                     Depth returned is affected by values set by XWO, XWS, XUU and XS and XE as
                     shown in the equation depth = (PSI + XE_offset) * user_slope + user_offset

                     By default, user_slope = 0.70326, user_offset = 0.000, and XE_offset = 0.000.
                     (Multiply PSI by 0.70326 will return meters of water).

                     Offset set by XE and XS are the same. One will replace the other. Thus, XE_offset in
                     above equation is the same value set by XS.

                     Variable "probe" is depth in meters.

                     Silicon probe is the raw reading while XE_offset (also set by command XS)
                     accommodates for any probe drift (note that XE and XS are used in two different
                     conditions. Generally, use either one or the other).

XUU combines separate XWS, F, O, and XWO commands.

Commands aD0 and aD1 are required to return all data. aD0 returns only
depth and temperature.

High and low depth readings are not used for calculating the average unless they
occur more than once. The average is calculated by adding all of the readings
during the measurement interval. When measurement interval is complete, the
highest and lowest readings are subtracted from the sum. The sum is then divided
by the number of samples minus 2. Measurements are taken 10 times/second.

One of three commands may be used to set the measurement interval: L, XT and
XWMC

RELATED: F,L,O,XT, XWMC, XWO, XWS, XUU, XS, XE

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C!		Start a depth and temperature measurement
	001104	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request data
	0+0.102+27.9	Depth of 0.102 meters and temperature of 27.9 degrees C
0D1!		Request concurrent measurement
	0+0.110+0.098	Maximum depth of 0.110 and minimum of 0.098 meters

COMMAND: C   (H312 mode only)
                     CC   (H312 mode only)

SYNTAX: aC!
                     aC0!
                     aCC!
                     aCC0!

          Where: a = address of probe

IMMEDIATE RESPONSE: a00304   Default response

RESPONSE TO D0:   a+s+p+t+b   Response to aC! or aC0! command
                     a+s+p+t+bCRC   Response to aCC! or aCC0! command

          Where: a = probe address
                     b = battery voltage
                     p = pressure as PSI
                     s = stage
                     t = temperature in degrees C
                     CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Command probe to perform a depth, pressure, temperature, and battery voltage measurement.

EMULATION MODES: H312

DESCRIPTION: This is a measurement command. Stage level, pressure in PSI, temperature in degrees C, and battery voltage are measured. By default, averaging is over a period of 2 seconds. Use XT or XWMC commands to change the number of averaging seconds or samples.

                     Offset and/or slope are set by either XUU or XWO and XWS commands.

                     XE command is intended to correct for sensor drift. It should be executed in a laboratory or other controlled condition.

                     In H312 mode, stage is calculated as:
                     stage = (PSI + XE_offset) * XUU_slope + XUU_offset

                     By default, XUU_slope = 1.0000 and XUU_offset = 0.000. XWO may be used to set XUU_offset and XWS to set XUU_slope.

                     Pressure is returned as PSI. It is not affected by programming slope and offset. Pressure is affected by the XE offset command. Offset set by XE will be added to the current reading.

                     Average measurement interval is set by XT command.

Average depth/pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum.

The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

RELATED: XT,XUU, XE, XWO, XWS, XWMC, XRMC

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C!		Start depth, pressure, temperature, and voltage measurement
	000304	Data can be read in 3 seconds
After 3 seconds: 0D0!		Request data from measurement
	0-0.009-0.004+28.2+9.5	Stage is -0.009, PSI is -0.004. temperature is 28.2 degrees C, and battery voltage is 9.5 volts.

| **COMMAND:** | C1 | (Keller Digilevel and KPSI® modes only) |
| | CC1 | (Keller Digilevel and KPSI® modes only) |

| **SYNTAX:** | aC1! |
| | aCC1! |

| Where: | a = address of probe |

| **IMMEDIATE RESPONSE:** | a01101 | Default response |

| **RESPONSE TO D0:** | a+p | Response to aC1! command |
| | a+pCRC | Response to aCC1! command |

Where:	a = probe address
	p = pressure
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measure pressure as PSI

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: Measure as PSI. User offset and slope correction set by XE, XS, or other similar commands are not included. However, values set by the XC command are used. XC command should only be used in a calibration laboratory environment.

Readings are averaged over a period of 10 seconds by default. Readings are taken at a rate of 10 times per second. Averaging time can be changed using the XT command. High and low pressures are not used for calculating the average unless they occur more than once. The average is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2.

RELATED: XC, XT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C!		Start pressure measurement
	001101	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request data from measurement
	0+1.445	Returns 1.445 PSI

1. KPSI®, a Federally-registered trademark, and Series 500, a model designation, are owned by Measurement Specialties, Inc., a maker of level and pressure transducers.

| **COMMAND:** | C1 | (DISI-1210 mode only) |
| | CC1 | (DISI-1210 mode only) |

| **SYNTAX:** | aC1! |
| | aCC1! |

| Where: | a = address of probe |

| **IMMEDIATE RESPONSE:** | a01102 | Default response |

| **RESPONSE TO D0:** | a+p+t | Response to aC1! command |
| | a+d+tCRC | Response to aCC1! command |

Where:	a = address
	D = meters of water
	t = temperature in degrees C
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Returns depth as meters of water or user converted value and temperature in degrees C.

EMULATION MODES: DISI 1210

DESCRIPTION: Depth reading may be converted into user units and offset. By default, slope is 1.0000 and offset is 0.000. User slope and offset may be set using XUU command. Depth returned by D0 is computed as follows:

$$Return = (PSI + XE\_offset) * user\_slope + user\_offset$$

By default, user_slope = 0.70326, user_offset = 0.000, and XE_offset = 0.000. (Multiply PSI by 0.70326 will return meters of water).

Command F may be used to set user_slope while command O to set user_offset. It will have the same effect as using XUU.

XT command may be used to set averaging time. Average depth/pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second. Temperature is returned in degrees C.

RELATED: XC, XT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
1C1!		Start a depth and temperature measurement
	101102	Default response
After 11 seconds: 1D0!		Request measurement data
	1+2.001+25.7	Depth of 2 .001 meters, temperature is 25.7 C

COMMAND: C1   (H312 mode only)
                CC1   (H312 mode only)

SYNTAX: aC1!
             aCC1!

     Where: a = address of probe

IMMEDIATE RESPONSE: a00304   Default response

RESPONSE TO D0:   a+p+t+P+t   Response to aC1! command
                 a+p+t+P+tCRC   Response to aCC1! command

     Where: a = address of probe
                 p = Pressure as PSI, includes offset
                 P = Pressure as PSI, no offset
                 t = temperature in degrees C
                 CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measure pressure and temperature.

EMULATION MODES: H312

DESCRIPTION: Pressure as PSI and temperature are measured. D0 commands returns pressure and temperature twice.

First pressure returned includes any offset set by XE command. By default, this offset is 0.000. Second pressure is PSI without any XE offset.

First temperature returns a value with 3 digits after the decimal. Second temperature returns only 1 digit after the decimal.

XT command may be used to set averaging time. Default is 3 seconds.

Average pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second. Temperature is returned in degrees C.

RELATED: XE

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C1!		Start a depth and temperature measurement
	000304	Default response
After 3 seconds: 0D0!		Request measurement data
	0+1.203+26.130+1.201+26.1	Return pressure with offset included of 1.203 PSI, 26.130 degrees C, pressure without offset of 1.201.

COMMAND: C2   (Keller Digilevel and KPSI® modes only)
                CC2   (Keller Digilevel and KPSI® modes only)

SYNTAX: aC2!
             aCC2!

     Where: a = address of probe

IMMEDIATE RESPONSE: a01102   Default response

RESPONSE TO D0:   a+t+U   Response to aC2! command
                 a+t+UCRC   Response to aCC2 command

     Where: a = address of probe
                 t = temperature in degrees C
                 U = temperature units of measure
                     Where: +0 = degrees C
                                   +1 = degrees F
                 CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Return temperature in degrees and units of measure of that temperature.

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: Temperature is not averaged.

Temperature units of measure is changed using the XUT command. Default is degrees C.

RELATED: XUT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C2!		Start a temperature measurement
	001102	Default response
After 11 seconds: 0D0!		Request data
	0+26.256+0	Returns temperature of 26.256 degrees in Celsius.

COMMAND: C2   (DISI-1210 mode only)
           CC2   (DISI-1210 mode only)

SYNTAX: aC2!
           aCC2!

     Where: a = address of probe

IMMEDIATE RESPONSE: a01104   Default response

RESPONSE TO D0: a+d+t   Response to aC2! command
          a+d+tCRC   Response to aCC2!

     Where: a = address of probe
          d = depth in meters of water
          t = temperature in degrees C
          CRC = Cyclic Redundancy Check value as ASCII characters

RESPONSE TO D1: a+h+l
          a+h+lCRC

     Where: a = probe address
          h = High reading during measurement interval
          l = Low reading during measurement interval

FUNCTION: Measures depth in meters of water and temperature. D0 command returns average depth and temperature. D1 returns highest and lowest measurements during averaging period in meters of water.

        All depth readings can be converted into user units using the XUU command. By default, slope is 1.000 and offset is 0.000.

        Offset set by XE command is added to the initial depth. Formula is:
        Depth = (measurement +XE_offset) * XUU_slope + XUU_offset

EMULATION MODES: DISI-1210

DESCRIPTION: Offset set by XE command and slope and offset set by XUU. Depth formula is:
          Depth = (depth +XE_offset) * XUU_slope + XUU_offset

        Command F may also be used to set slope while command O may be used to set XUU_offset.

        Commands aD0 and aD1 are required to return all data. aD0 returns only depth and temperature.

        XT command may be used to set averaging time.

        High and low depth readings are not used for calculating the average unless they occur more than once. The average is calculated by adding all of the readings

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during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

RELATED: F, O, XE, XT, XUU

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C2!		Start measurements
	001104	Default response
After 11 seconds: 0D0!		Request depth and temperature
	0+2.435+26.5	Returns 2.435 meters at 26.5 degrees C
0D1!		Request high and low depths measured during averaging.
	0+2.439+2.430	Returns high depth of 2.439 meters and low depth of 2.430 meters.

COMMAND: C2   (H312 mode only)
               CC2   (H312 mode only)

SYNTAX: aC2!
               aCC2!

       Where: a = address of probe

IMMEDIATE RESPONSE: a00301   Default response

RESPONSE TO D0:   a+t   Response to C2! command
                      a+tCRC   Response to CC2! command

       Where: a = address of probe
               t = temperature in degrees C
               CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Return temperature in degrees C

EMULATION MODES: H312

DESCRIPTION: Temperature is returned in degrees C. It is not averaged.

                   XUT command will not change units into degrees F.

RELATED: (none)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C2!		Start a temperature measurement
	000301	Default response
After 3 seconds: 0D0!		Request data
	0+26.7	Return temperature of 26.7 degrees C

COMMAND: C3   (Keller Digilevel, KPSI®, and DISI-1210 modes)
               CC3   (Keller Digilevel, KPSI®, and DISI-1210 modes)

SYNTAX: aC3!
               aCC3!

       Where: a = address of probe

IMMEDIATE RESPONSE: a00103   Default response

RESPONSE TO D0:   a+s+o+c   Response to C3! command
                      a+s+o+cCRC   Response to CC3! command

       Where: a = address of probe
               c = Sensor offset set by XE command
               o = Offset set by XUU command
               s = Default slope or set by XUU command
               CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Command to retrieve current user slope, user offset, and offset set by XE command.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210

DESCRIPTION: Command allows retrieval of user slope, user offset, and sensor offset. User slope and offset are used only when user units of measure are enabled via XUP command when in Keller Digilevel or KPSI modes only.

                   User slope and offset are used for calculating depth/pressure in DISI-1210 mode when M, C, M1, C1, M2, and C2 commands are executed.

RELATED: F, O,XE, XUU, XUP, XWO, XWS

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C3!		Request slope and offset
	001030	Default response
After 1 second: 0D0!		Request data
	0+2.30730+0.00000+0.00000	Return slope of 2.30730 (convert PSI to feet of water), user offset of 0, and sensor offset of 0. Slope is different for different probe modes.

| **COMMAND:** | C3 | (H312 mode only) |
| | CC3 | (H312 mode only) |

| **SYNTAX:** | aC3! |
| | aCC3! |

| Where: | a = address of probe |

| **IMMEDIATE RESPONSE:** | a00301 | Default response |

| **RESPONSE TO D0:** | a+p | Response to C3! command |
| | a+pCRC | Response to CC3! command |

Where:	a = address of probe
	p = Pressure as PSI
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measure pressure as PSI. Do not include offsets.

EMULATION MODES: H312

DESCRIPTION: Pressure is measured in PSI. No offsets set by XWS or XE are used.

Averaging period is 2 seconds, or 20 measurements. This is changed using the XT or XWMC commands.

RELATED: XT, XWMC

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C3!		Start a pressure measurement
	000301	Default response
After 3 seconds: 0D0!		Request data
	0+1.234	Return 1.234 PSI

| **COMMAND:** | C4 | (Keller Digilevel, KPSI®, and DISI-1210 modes) |
| | CC4 | (Keller Digilevel, KPSI®, and DISI-1210 modes) |

| **SYNTAX:** | aC4! |
| | aCC4! |

| Where: | a = address of probe |

| **IMMEDIATE RESPONSE:** | a00102 | Default response |

| **RESPONSE TO D0:** | a+s+o | Response to C4! command |
| | a+s+oCRC | Response to CC4! command |

Where:	a = address of probe
	s = Standards lab slope
	o = Standards lab offset in PSI
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Requests slope and offset set by XC command. If XC command was not executed, default slope is 1.000 and offset is 0.000.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210

DESCRIPTION: Request slope and offset as set by XC command. XC command should be executed in a calibration lab environment. If XC command was not executed, then slope is 1.0000 and offset is 0.000.

This command is normally executed in conjunction with XC command during a calibration process in a laboratory environment. Use XE or XS commands to adjust offset in the field.

RELATED: XC, XE, XS

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C4!		Request slope and offset
	000102	Default response
After 1 second: 0D0!		Request data
	0+1.000000 0.035982	Return calibration lab slope of 1.000 and calibration lab offset of -0.035982 PSI.

COMMAND: C4   (H312 only)
                        CC4   (H312 only)

SYNTAX: aC4!
                        aCC4!

        Where: a = address of probe

IMMEDIATE RESPONSE: a00101   Default response

RESPONSE TO D0:   a+b   Response to C4! command
                        a+bCRC   Response to CC4! command

        Where: a = address of probe
                        b = battery voltage
                        CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measure voltage at probe.

EMULATION MODES: H312

DESCRIPTION: Measures voltage at probe.

RELATED: (none)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C4!		Measure battery voltage
	000101	Default response
After 1 second: 0D0!		Request data
	0+13.3	Return 13.3 volts.

COMMAND: C5
                        CC5

SYNTAX: aC5!
                        aCC5!

        Where: a = address of probe

IMMEDIATE RESPONSE: a00102   Default response

RESPONSE TO D0:   a+t+U   Response to aC5! command
                        a+t+UCRC   Response to aCC5! command

        Where: a = address of probe
                        t = temperature in degrees C or F
                        U = temperature units of measure
                                Where: +0 = degrees C
                                                 +1 = degrees F
                        CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Request temperature. D0! response will be in degrees F or C depending upon emulation mode and configuration.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Temperature is measured. Response will be in degrees C or F. By default temperature is degrees C. Temperature is always degrees C in DISI-1210 and H312 mode.

                        Use XUT to change temperature units in Keller Digilevel or KPSI® 500 mode.

RELATED: XUT (useful for Keller Digilevel or KPSI® 500 modes only)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C5!		Request temperature
	000102	Default response
After 1 second: 0D0!		Request data
	0+24.662+0	Return 24.662 degrees C

COMMAND:　　　　　C6
　　　　　　　　　　　　CC6

SYNTAX:　　　　　aC6!
　　　　　　　　　　　　aCC6!

　　　　Where:　　　a = address of probe

IMMEDIATE RESPONSE:　　a00101　　　　　Default response

RESPONSE TO D0:　　a+b　　　　　Response to aC6! command
　　　　　　　　　　　　a+bCRC　　　　　Response to aCC6! command

　　　　Where:　　　a = address of probe
　　　　　　　　　　　b = battery voltage
　　　　　　　　　　　CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION:　　　　Requests battery voltage.

EMULATION MODES:　　Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION:　　　Measures and returns battery voltage via D0! command.

RELATED:　　　　(none)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C6!		Request battery voltage
	000101	Default response
After 1 second: 0D0!		Request data
	0+12.9	Returns 12.9 volts

1. KPSI®, a Federally-registered trademark, and Series 500, a model designation, are owned by Measurement Specialties, Inc., a maker of level and pressure transducers.

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COMMAND:　　　　　C7
　　　　　　　　　　　　CC7

SYNTAX:　　　　　aC7!
　　　　　　　　　　　　aCC7!

　　　　Where:　　　a = address of probe

IMMEDIATE RESPONSE:　　a01104　　　　　Default response Keller, KPSI® and DISI mode
　　　　　　　　　　　　a00304　　　　　Default response in H312 mode

RESPONSE TO D0:　　a+p+u+t+U　　　　Response to aC7! command
　　　　　　　　　　　　a+p+u+t+U　　　　Response to aCC7! command

　　　　Where:　　　a = address of probe
　　　　　　　　　　　p = Pressure as PSI, includes offset
　　　　　　　　　　　t = temperature in degrees C
　　　　　　　　　　　u = depth/pressure units of measure
　　　　　　　　　　　　+0 = feet of water
　　　　　　　　　　　　+1 = PSI
　　　　　　　　　　　　+2 = kPa
　　　　　　　　　　　　+3 = cm of water
　　　　　　　　　　　　+4 = meters of water
　　　　　　　　　　　　+5 = mm of water
　　　　　　　　　　　　+9 = user units
　　　　　　　　　　　U = temperature units of measure
　　　　　　　　　　　　Where:　　+0 = degrees C
　　　　　　　　　　　　　　　　　+1 = degrees F
　　　　　　　　　　　CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION:　　　　Requests pressure and temperature with units of measure.

EMULATION MODES:　　Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION:　　　Requests a depth/pressure and temperature measurement. D0! returns depth/pressure and temperature with units of measure.

Default depth/pressure units of measure is feet of water for Keller, KPSI, and H312 mode. In DISI-1210 mode, depth measurement is in meters of water.

Default averaging time is 10 seconds for Keller, KPSI, and DISI modes. H312 mode is 3 seconds. (One second is needed for sensor stabilization.)

Averaging and response time is set by XT command. Use XWMC to set the number of samples.

Average depth/pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

This command can duplicate C and M in Keller Digilevel and KPSI modes. The difference is this command always returns depth/pressure while C and M may include temperature, depending upon XUM command setting.

Temperature is not averaged.

RELATED: XT, XWMC

EXAMPLE: Request concurrent depth/pressure and temperature in Keller Digilevel mode.

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C7!		Start a depth/pressure measurement
	001104	Default response
After 11 secondS: 0D0!		Request data
	0+2.101+0+25.886+0	Report 2.101 feet of water at 25.886 degrees C.

COMMAND: C8
                      CC8

SYNTAX: aC8!
                      aCC8!

                      Where: a = address of probe

IMMEDIATE RESPONSE: a00101   Default response

RESPONSE TO D0:   a+U   Response to aC8! command
                      a+uCRC   Response to aCC8! command

                      Where: a = address of probe
                                      U = temperature units of measure
                                            Where: +0 = degrees C
                                                            +1 = degrees F
                                      CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Requests temperature units of measure. Units of measure may be set by XUT command while in Keller Digilevel and KPSI modes only.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Returns temperature units of measure. Default is +0 (Degrees C).

RELATED: XUT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C8!		Request temperature
	00011	Default response
After 1 second: 0D0!		Request data
	0+0	Return 0, meaning degrees C.

COMMAND:	C9	
	CC9	
SYNTAX:	aC9!	
	aCC9!	
Where:	a = address of probe	
IMMEDIATE RESPONSE:	a00103	Default response
RESPONSE TO D0:	a+s+e+c	Response to aC9! command
	a+s+e+cCRC	Response to aCC9! command

Where: a = address of probe
s = response depends upon probe mode
      Where response will always be:
      Keller and KPSI = +1
      DISI-1210 = +48335.
      H312 = +123.456
      e = response depends upon probe mode
            Where:
            Keller and KPSI mode = 0 = OK, 1 = sensor error
            DISI-1210 =+ 58297. (always returned)
            H312 = +78.9 (always returned)
            c = response depends upon probe mode
                Where:
                Keller and KSPI mode, number of errors detected.
                DISI-1210 = +0 (always returned)
                H312 = +1 (always returned)
CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION:	Duplicates V command for sensor verification
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Keller Digilevel and KPSI modes will return the number and type of sensor errors detected. s parameter is always +1.

Third parameter, e, should be 0 to indicate no errors detected. A +1 is returned when a sensor error is detected.

Fourth parameter, c, returns the count, or number of errors detected since power up, M9, or V command was executed.

Errors are cleared when this command is executed.

While in DISI-1210 and H312 modes, responses will always be the same. DISI will always return a+48335.+58297.+0.780+0.   H312 mode will always return a+123.456+78.9+1.

A CRC is appended if C is included.

RELATED:	(none)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0C9!		Request status
	000103	Default response
After 1 second: 0D0!		Request data
	0+1+0+0	Return no problems in Keller mode.

COMMAND: D0
                     D1

SYNTAX: aD0!

            Where: a = address of probe

IMMEDIATE RESPONSE: (depends upon previously issued command)

RESPONSE TO D0:   n/a

FUNCTION: Requests data from previously issued command.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: D0 is used to retrieve data from all commands (except those that, by SDI-12 specification, return immediately) while in Keller Digilevel, KPSI® 500, and H312 mode.

                     While in DISI-1210 mode, D1 is used to return high and low depths when using commands C, CC, M, MC, C2, CC2, M2, and MC2 only.

RELATED: Virtually all commands

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M6!		Request to measure battery voltage
	00011	Default response
After 1 second: 0D0!		Request data
	0+12.8	Return battery voltage.

COMMAND: F   (DISI-1210 mode only)

SYNTAX: aF!   Request current slope
                     aFs!   Set slope

            Where: a = address of probe
                     s = signed slope

IMMEDIATE RESPONSE: a0011   Default response to either command

RESPONSE TO D0:   a+s   Returns slope to aF! or aFs! command

            Where: a = address of probe
                     s = signed slope

FUNCTION: Reads or sets slope factor in DISI-1210 mode only.

EMULATION MODES: DISI-1210

DESCRIPTION: In DISI-1210 mode only. Used to read current slope or set new one. By default, measurement is in meters of water. Use this command to change this unit of measure to something else.   The value from the current reading, without offset, will be multiplied by this slope factor. Default slope is +1.000.

                     Formula is: returned _data = Meters_of_water * slope + offset

                     Offset is set by the O command.

                     When this command is executed in any other mode, immediate response will be the probe's address. Slope may not be set or read.

RELATED: O,XWS, XRS, XUU

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0F!		Request current slope
	00011	Default response
After 1 second: 0D0!		Request data
	0+1.000000	Return slope as +1.000000

COMMAND:	I
SYNTAX:	aI!
Where:	a = address of probe
IMMEDIATE RESPONSE:	13 KELLER DIGIL v-s Immediate response
Where:	v = Digilevel software version s = 5 or 6 digit serial number
RESPONSE TO D0:	n/a
FUNCTION:	Immediately return probe information
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Probe will always respond with SDI-12 version (13, which is 1.3, unless there is a change to SDI-12 version) and KELLER-DIGIL- as description. Current version, 1.1, may change in the future. Last number is probe serial number. It will be a 5 or 6 digit number.
RELATED:	None

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0I!		Request probe information
	13-KELLER-DIGIL-1.1-21596	Immediate response

1. KPSI®, a Federally-registered trademark, and Series 500, a model designation, are owned by Measurement Specialties, Inc., a maker of level and pressure transducers.

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COMMAND:	J	(DISI-1210 mode only)
	J777	(DISI-1210 mode only)
SYNTAX:	aJ!	Pseudo command to lock probe
	aJ777!	Pseudo command to unlock probe
Where:	a = address of probe	
IMMEDIATE RESPONSE:	a	
RESPONSE TO D0:	n/a	
FUNCTION:	DISI-1210 compatible function to lock or unlock probe.	
EMULATION MODES:	DISI-1210	
DESCRIPTION:	Command is accepted, but not functional in DISI-1210 (and all other) modes. Address is always returned. Extended commands are always allowed and never locked.	
RELATED:	None	

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0J777!		Pseudo command to unlock probe
	0	Default response

COMMAND:	K	(DISI-1210 mode only)	
	Kn	(DISI-1210 mode only)	
SYNTAX:	aK!	Request current number of decimal digits	
	aKn!	Set number of decimal digits	
Where:	a = address of probe		
	n = number of decimal digits to display		
IMMEDIATE RESPONSE:	a003	Default response to aK! - number of digits	
	a00n	Default response to aKn! - number of digits	
RESPONSE TO D0:	n/a		

FUNCTION: K returns number of displayed digits to right of decimal for depth only. Kn sets number of digits to right of decimal.

EMULATION MODES: DISI-1210

DESCRIPTION: Maximum number of decimal digits to right of decimal is 4 for depth measurements. If n is 5 or more, only an address acknowledge is returned and the number of decimal digits is not set. When the number of digits is changed, the new value is stored in non volatile memory. Command need be executed only once during setup.

Number of decimal digits is immediately sent out after this command is issued. Issuing a D0! command will not return decimal digits.

Number of decimal digits displayed is not necessarily related to accuracy. Under low water conditions (>1 meter), calculations may be carried out to decimal 6 digits On the other hand, under very high water level conditions (100+ meters), accurate calculations are carried out to decimal 3 digits.

Temperature is not affected by this command.

When Keller probe is in any other mode than DISI-1210, response will be its address and will have no effect on number of decimal digits.

XUP command may also be used to set the number of decimal digits.

RELATED: XUP

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0K!		Request number of decimal digits.
	0003	Default response - 3 decimal digits are immediately sent out.

COMMAND:	L	(DISI-1210 mode only)	
	Lt	(DISI-1210 mode only)	
SYNTAX:	aL!	Request current averaging time	
	aL+t!	Set averaging time	
Where:	a = address of probe		
	t = averaging time in seconds		
IMMEDIATE RESPONSE:	a010	Default response, 10 seconds	
RESPONSE TO D0:	n/a		

FUNCTION: Returns or sets and returns averaging time.

EMULATION MODES: DISI-1210

DESCRIPTION: Returns or sets and returns averaging time for depth measurements. Data available time to a measurement command, such M, will be 1 second longer. Additional second allows for sensor warm up.

Number of seconds is immediately sent out after this command is issued. Issuing a D0! command will not return number of seconds..

XT command may also be used to set averaging time in seconds.

Temperature measurements are not affected by this command. Temperature is never averaged.

When Keller probe is in any other mode than DISI-1210, response will be its address.

Average depth is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

RELATED: XT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0L!		Request averaging time
	0010	Default response time is 10 seconds.

COMMAND: M   (Keller Digilevel and KPSI modes only)

                 MC   (Keller Digilevel and KPSI modes only)

SYNTAX: aM!

                 aM0!

                 aMC!

                 aMC0!

         Where: a = address of probe

IMMEDIATE RESPONSE: a0112   Default response to aM! or aM0!

                 a0114   Response to aM! or aM0! when probe setup to return temperature also

RESPONSE TO D0:   a+p+u   Default response to aM!

                 a+p+uCRC   Default response to aMC! or aMC0!

                 a+p+u+t+U   Response when probe setup to return temperature via XUM command

                 a+p+u+t+UCRC   Response with CRC when aXUM+1 executed during probe setup

         Where: a = probe address

                          p = pressure/depth

                          t = temperature

                          U = temperature units of measure

                               Where: +0 = degrees C

                                           +1 = degrees F

                          u = depth/pressure units of measure

                               +0 = feet of water

                               +1 = PSI

                               +2 = kPa

                               +3 = cm of water

                               +4 = meters of water

                               +5 = mm of water

                               +9 = user units

                          CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Command probe to perform a concurrent depth/pressure measurement. Depending upon configuration during probe setup, temperature may be returned also.

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: This is a measurement command. Response to this command depends upon emulation mode. Check on next pages for DISI-1210 and H312 for information while operating in those modes.

Number and type of data returned will depend upon configuration. By default, depth is returned as feet of water. Other units of measure can be returned by executing the XUP command at setup. Custom units of measure are setup by executing the XUU command during probe configuration (as are all X commands

---

listed here).

Temperature is appended by executing XUM command at setup. Temperature units is set by XUT.

Averaging and response time is set by XT command.

Average depth/pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

There are many commands that affect offset. Differences between actual and reported probe depth, are set by XS command. Other offsets, such as XE and XWO, are used in calibration lab or user measurement modes. All offset commands can affect data returned to some degree and in some cases one offset command can overwrite another. These are explained in each of the offset commands.

RELATED: XE,XS, XT, XUM, XUP, XUT, XUU

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M!		Request concurrent measurement
	00112	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request data
	0+1.33+0	Returns 1.33 feet of water
Suppose XUM+1 was executed during setup to return both depth and temperature, and XUP was executed to return depth as cm of water (XUP+3). Subsequent M data transactions will look like:		
0M!		Request concurrent measurement
	00114	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request depth and temperature
	0+24.22+3+27.65+0	Return depth as 24.22 cm of water and temperature as 27.65 degrees C

COMMAND: M   (DISI-1210 mode only)
                         MC   (DISI-1210 mode only)

SYNTAX: aM!
                         aM0!
                         aMC!
                         aMC0!

          Where: a = address of probe

IMMEDIATE RESPONSE: a0114   Default response to aM! or aMC!

RESPONSE TO D0:   a+d+t   Response to aM! or aM0! command
                         a+d+tCRC   Response to aMC! or aMC0! command

          Where: a = probe address
                         d = depth in meters of water
                         t = temperature in degrees C
                         CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Command probe to perform a depth measurement in meters of water and record both high and low depths during the measurement.

EMULATION MODES: DISI 1210

DESCRIPTION: This is a measurement command. Response to this command depends upon emulation mode. Check previous page for Keller Digilevel and next page for H312 for information while operating in those modes.

                         Depth returned is affected by values set by XWO, XWS, XUU and XS and XE as shown in below equation:

$$depth = (PSI + XE\_offset) * user\_slope + user\_offset$$

                         By default, user_slope = 0.70326, user_offset = 0.000, and XE_offset = 0.000. (Multiply PSI by 0.70326 will return meters of water).

                         Offset set by XE and XS are the same. One will replace the other. Thus, XE_offset in above equation is the same value set by XS.

                         Variable probe is depth in meters.

                         Silicon probe is the raw reading while XE_offset (also set by command XS) accommodates for any probe drift (note that XE and XS are used in two different conditions. Generally, use either one or the other).

                         XUU combines separate XWS, F, O, and XWO commands.

                         Commands aD0 and aD1 are required to return all data. aD0 returns only depth and temperature.

High and low depth readings are not used for calculating the average unless they occur more than once. The average is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

One of three commands may be used to set the measurement interval: L, XT and XWMC

RELATED: F,L,O,XT, XWMC, XWO, XWS, XUU, XS, XE

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M!		Start depth and temperature measurement
	00114	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request data
	0+0.102+27.9	Depth of 0.102 meters and temperature of 27.9 degrees C
0D1!		
	0+0.110+0.098	Maximum depth of 0.110 and minimum of 0.098 meters

COMMAND: M   (H312 mode only)

                     MC   (H312 mode only)

SYNTAX: aM!

                     aM0!

                     aMC!

                     aMC0!

         Where: a = address of probe

IMMEDIATE RESPONSE: a0034   Default response to aM! or aMC!

RESPONSE TO D0:   a+s+p+t+b   Response to aM! or aM0! command

                     a+s+p+t+bCRC   Response to aMC! or aMC0! command

         Where: a = probe address

                     b = battery voltage

                     p = pressure as PSI

                     s = stage

                     t = temperature in degrees C

                     CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Command probe to perform a depth, pressure, temperature, and battery voltage measurement.

EMULATION MODES: H312

DESCRIPTION: This is a measurement command. Stage level, pressure in PSI, temperature in degrees C, and battery voltage are measured. By default, averaging is over a period of 2 seconds. Use XT or XWMC commands to change the number of averaging seconds or samples.

Offset and/or slope are set by either XUU or XWO and XWS commands.

XE command is intended to correct for sensor drift. It should be executed in a laboratory or other controlled condition.

In H312 mode, stage is calculated as:

$$stage = (PSI + XE\_offset) * XUU\_slope + XUU\_offset$$

By default, XUU_slope = 1.0000 and XUU_offset = 0.000. XWO may be used to set XUU_offset and XWS to set XUU_slope.

Pressure is returned as PSI. It is not affected by programming slope and offset. It is affected by the XE offset command. Offset set by XE will be added to the current reading.

Average measurement interval is set by XT command.

Average depth/pressure is calculated by adding all of the readings during the

measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

RELATED: XT,XUU, XE, XWO, XWS, XWMC, XRMC

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M!		Start various measurements
	000304	Data can be read in 3 seconds
After 3 seconds: 0D0!		Request data from measurement
	0-0.009-0.004+28.2+9.5	Stage is -0.009, PSI is -0.004. temperature is 28.2 degrees C, and battery voltage is 9.5 volts.

COMMAND: M1   (Keller Digilevel and KPSI modes only)

                   MC1   (Keller Digilevel and KPSI modes only)

SYNTAX: aM1!

                 aMC1!

       Where: a = address of probe

IMMEDIATE RESPONSE: a0111   Default response to aM1! or aMC1!

RESPONSE TO D0:   a+p   Response to aC1! command

                   a+pCRC   Response to aCC1! command

       Where: a = probe address

                   p = pressure

                   CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measure pressure as PSI

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: Measure as PSI. User offset and slope correction set by XE, XS, or other similar commands are not included. However, values set by the XC command are used. XC command should only be used in a calibration laboratory environment.

                Readings are averaged over a period of 10 seconds by default. Readings are taken at a rate of 10 times per second. Averaging time can be changed using the XT command. High and low pressures are not used for calculating the average unless they occur more than once. The average is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2.

RELATED: XC, XT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M!		Start pressure measurement
	00111	Data can be read in 11 seconds
After 11 seconds: 0D0!		Request data from measurement
	0+1.445	Returns 1.445 PSI

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COMMAND: M1   (DISI-1210 mode only)

                   MC1   (DISI-1210 mode only)

SYNTAX: aM1!

                 aMC1!

       Where: a = address of probe

IMMEDIATE RESPONSE: a0112   Default response to aM1! or aMC1!

RESPONSE TO D0:   a+p+t   Response to aM1! command

                   a+d+tCRC   Response to aMC1! command

       Where: a = address

                   D = meters of water

                   t = temperature in degrees C

                   CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Returns depth as meters of water or user converted value and temperature in degrees C.

EMULATION MODES: DISI 1210

DESCRIPTION: Depth reading may be converted into user units and offset. By default, slope is 1.0000 and offset is 0.000. User slope and offset may be set using XUU command. Depth returned by D0 is computed as follows:

Return = (PSI + XE_offset) * user_slope + user_offset

                By default, user_slope = 0.70326, user_offset = 0.000, and XE_offset = 0.000. (Multiply PSI by 0.70326 will return meters of water).

                Command F may be used to set user_slope while command O to set user_offset. It will have the same effect as using XUU. XT command may be used to set averaging time.

                Average depth/pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second. Temperature is returned in degrees C

RELATED: F, O, XE, XT, XUU

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
1M1!		Start a depth and temperature measurement
	10112	Default response
After 11 seconds: 0D0!		Request measurement data
	1+2.001+25.7	Depth of 2 .001 meters, temperature is 25.7 C

COMMAND: M1   (H312 mode only)
                     MC1   (H312 mode only)

SYNTAX: aM1!
                     aMC1!

        Where: a = address of probe

IMMEDIATE RESPONSE: a00304   Default response to aM1! or aMC1!

RESPONSE TO D0:   a+p+t+P+t   Response to aM1! command
                     a+p+t+P+tCRC   Response to aMC1! command

        Where: a = address of probe
                     p = Pressure as PSI, includes offset
                     P = Pressure as PSI, no offset
                     t = temperature in degrees C
                     CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measure pressure and temperature.

EMULATION MODES: H312

DESCRIPTION: Pressure as PSI and temperature are measured. D0! commands returns pressure and temperature twice.

                     First pressure returned includes any offset set by XE command. By default, this offset is 0.000. Second pressure is PSI without any XE offset.

                     First temperature returns a value with 3 digits after the decimal. Second temperature returns only 1 digit after the decimal.

                     XT command may be used to set averaging time. Default is 3 seconds.

                     Average pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second. Temperature is returned in degrees C.

RELATED: XE
EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M1!		Start pressure and temperature measurements
	000304	Default response
After 3 seconds: 0D0!		Request measurement data
	0+1.203+26.130+1.201+26.1	Return pressure with offset included of 1.203 PSI, 26.130 degrees C, pressure without offset of 1.201.

COMMAND: M2   (Keller Digilevel and KPSI modes only)
                     MC2   (Keller Digilevel and KPSI modes only)

SYNTAX: aM2!
                     aMC2!

        Where: a = address of probe

IMMEDIATE RESPONSE: a0112   Default response to aM2! or aMC2!

RESPONSE TO D0:   a+t+U   Response to aM2! command
                     a+t+UCRC   Response to aMC2 command

        Where: a = address of probe
                     t = temperature in degrees C
                     U = temperature units of measure
                              Where: +0 = degrees C
                                         +1 = degrees F
                     CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Return temperature in degrees and units of measure of that temperature.

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: Temperature is not averaged.

                     Temperature units of measure is changed using the XUT command. Default is degrees C.

RELATED: XE

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M2!		Perform temperature measurement
	00112	Default response
After 11 seconds: 0D0!		Request data
	0+26.256+0	Returns temperature of 26.256 degrees in Celsius.

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| **COMMAND:** | M2 | (DISI-1210 mode only) |
| | MC2 | (DISI-1210 mode only) |

SYNTAX:	aM2!
	aMC2!
Where:	a = address of probe

| **IMMEDIATE RESPONSE:** | a0114 | Default response to aM2! or aMC2! |

RESPONSE TO D0:	a+d+t	Response to aM2! command
	a+d+tCRC	Response to aCC2!
Where:	a = address of probe
	d = depth in meters of water
	t = temperature in degrees C
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measures depth in meters of water and temperature. D0 command returns average depth and temperature. D1 returns highest and lowest measurements during averaging period in meters of water.

All depth readings can be converted into user units using the XUU command. By default, slope is 1.000 and offset is 0.000.

Offset set by XE command is added to the initial depth. Formula is:
    Depth = (measurement +XE_offset) * XUU_slope + XUU_offset

EMULATION MODES: DISI-1210

DESCRIPTION: Offset set by XE command and slope and offset set by XUU. Depth formula is:

    Depth = (depth +XE_offset) * XUU_slope + XUU_offset

Command F may also be used to set slope while command O may be used to set XUU_offset.

Commands aD0 and aD1 are required to return all data. aD0 returns only depth and temperature.

XT command may be used to set averaging time.

High and low depth readings are not used for calculating the average unless they occur more than once. The average is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

RELATED: F, O, XE, XT, XUU

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M2!		Start a measurement
	00114	Default response
After 11 seconds: 0D0!		Request depth and temperature
	0+2.435+26.5	Returns 2.435 meters at 26.5 degrees C
0D1!		Request high and low depths measured during averaging.
	0+2.439+2.430	Returns high depth of 2.439 meters and low depth of 2.430 meters.

COMMAND: M2   (H312 mode only)
              MC2   (H312 mode only)

SYNTAX: aM2!
            aMC2!

     Where: a = address of probe

IMMEDIATE RESPONSE: a00301   Default response to aM2! or aMC2!

RESPONSE TO D0:   a+t   Response to M2! command
           a+tCRC   Response to MC2! command

     Where: a = address of probe
           t = temperature in degrees C
           CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Return temperature in degrees C

EMULATION MODES: Return temperature in degrees C

DESCRIPTION: Temperature is returned in degrees C. It is not averaged.

       XUT command will not change units into degrees F.

RELATED: (none)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M2!		Start a measurement
	000301	Default response
After 3 seconds: 0D0!		Request data
	0+26.7	Return temperature of 26.7 degrees C

COMMAND: M3   (Keller Digilevel, KPSI, and DISI-1210 modes)
           MC3   (Keller Digilevel, KPSI, and DISI-1210 modes)

SYNTAX: aM3!
           aMC3!

     Where: a = address of probe

IMMEDIATE RESPONSE: a0013

RESPONSE TO D0:   a+s+o+c   Response to M3! command
           a+s+o+cCRC   Response to MC3! command

     Where: a = address of probe
           c = Sensor offset set by XE command
           o = Offset set by XUU command
           s = Default slope or set by XUU command
           CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Command to retrieve current user slope, user offset, and offset set by XE command.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210

DESCRIPTION: Command allows retrieval of user slope, user offset, and sensor offset. User slope and offset are used only when user units of measure are enabled via XUP command when in Keller Digilevel or KPSI modes only.

       User slope and offset are used for calculating depth/pressure in DISI-1210 mode when M, C, M1, C1, M2, and C2 commands are executed.

RELATED: F, O,XE, XUU, XUP, XWO, XWS

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M3!		Start a measurement(Keller mode)
	00013	Default response
After 1 second: 0D0!		Request data
	0+2.30730+0.00000+0.00000	Return slope of 2.30730 (convert PSI to feet of water), user offset of 0, and sensor offset of 0. Slope is different for different probe modes.

COMMAND:	M3	(H312 mode only)
	MC3	(H312 mode only)

SYNTAX:	aC3!
	aCC3!

Where:	a = address of probe

IMMEDIATE RESPONSE:	a00301	Default response to aM3! or aMC3!

RESPONSE TO D0:	a+p	Response to M3! command
	a+pCRC	Response to MC3! command

Where:	a = address of probe
	p = Pressure as PSI
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Measure pressure as PSI. Do not include offsets.

EMULATION MODES: H312

DESCRIPTION: Pressure is measured in PSI. No offsets set by XWS or XE are used.

Averaging period is 2 seconds, or 20 measurements. This is changed using the XT or XWMC commands.

RELATED: XT, XWMC

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M3!		Start a pressure measurement
	000301	Default response
After 3 seconds: 0D0!		Request data
	0+1.234	Return 1.234 PSI

COMMAND:	M4	(Keller Digilevel, KPSI, and DISI-1210 modes)
	MC4	(Keller Digilevel, KPSI, and DISI-1210 modes)

SYNTAX:	aM4!
	aMC4!

Where:	a = address of probe

IMMEDIATE RESPONSE:	a0012

RESPONSE TO D0:	a+s+o	Response to M4! command
	a+s+oCRC	Response to MC4! command

Where:	a = address of probe
	s = Standards lab slope
	o = Standards lab offset in PSI
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Requests slope and offset set by XC command. If XC command was not executed, default slope is 1.000 and offset is 0.000.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210

DESCRIPTION: Request slope and offset as set by XC command. XC command should be executed in a calibration lab environment. If XC command was not executed, then slope is 1.0000 and offset is 0.000.

This command is normally executed in conjunction with XC command during a calibration process in a laboratory environment. Use XE or XS commands to adjust offset in the field.

RELATED: XC, XE, XS

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M4!		Request slope and offset
	000102	Default response
After 1 second: 0D0!		Request data
	0+1.000000-0.035982	Return calibration lab slope of 1.000 and calibration lab offset of -0.035982 PSI.

COMMAND:	M4	(H312 only)	
	MC4	(H312 only)	
SYNTAX:	aM4!		
	aMC4!		
Where:	a = address of probe		
IMMEDIATE RESPONSE:	a00101	Default response to aM4! or aMC4!	
RESPONSE TO D0:	a+b	Response to M4! command	
	a+bCRC	Response to MC4! command	
Where:	a = address of probe		
	b = battery voltage		
	CRC = Cyclic Redundancy Check value as ASCII characters		
FUNCTION:	Measure voltage at probe.		
EMULATION MODES:	H312		
DESCRIPTION:	Measures voltage at probe.		
RELATED:	(none)		

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M4!		Measure battery voltage
	000101	Default response
After 1 second: 0D0!		Request data
	0+13.3	Return 13.3 volts.

COMMAND:	M5	
	MC5	
SYNTAX:	aM5!	
	aMC5!	
Where:	a = address of probe	
IMMEDIATE RESPONSE:	a0012	
RESPONSE TO D0:	a+t+U	Response to aM5! command
	a+t+UCRC	Response to aMC5! command
Where:	a = address of probe	
	t = temperature in degrees C or F	
	U = temperature units of measure	
	Where: +0 = degrees C	
	+1 = degrees F	
	CRC = Cyclic Redundancy Check value as ASCII characters	

FUNCTION: Request temperature. D0! response will be in degrees F or C depending upon emulation mode and configuration.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Temperature is measured. Response will be in degrees C or F. By default temperature is degrees C. Temperature is always degrees C in DISI-1210 and H312 mode.

Use XUT to change temperature units in Keller Digilevel or KPSI® 500 mode.

RELATED: XUT (useful for Keller Digilevel or KPSI® 500 modes only)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0MC5!		Start a temperature measurement
	00012	Default response
After 1 second: 0D0!		Request data
	0+26.003+0FFY	Return 24.003 degrees C

| COMMAND: | M6 |
| | MC6 |

| SYNTAX: | aM6! |
| | aMC6! |

| Where: | a = address of probe |

| IMMEDIATE RESPONSE: | a0011 |

| RESPONSE TO D0: | a+b | Response to aM6! command |
| | a+bCRC | Response to aMC6! command |

Where:	a = address of probe
	b = battery voltage
	CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Requests battery voltage.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Measures and returns battery voltage via D0! command.

RELATED: (none)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M6!		Measure battery voltage
	00011	Default response
After 1 second: 0D0!		Request data
	0+12.9	Returns 12.9 volts

| COMMAND: | M7 |
| | MC7 |

| SYNTAX: | aM7! |
| | aMC7! |

| Where: | a = address of probe |

| IMMEDIATE RESPONSE: | a0114 | Default response Keller, KPSI and DISI mode |
| | a0034 | Default response in H312 mode |

| RESPONSE TO D0: | a+p+u+t+U | Response to aM7! command |
| | a+p+u+t+U | Response to aMC7! command |

Where:	a = address of probe
	p = Pressure as PSI, includes offset
	t = temperature in degrees C
	u = depth/pressure units of measure

        +0 = feet of water
        +1 = PSI
        +2 = kPa
        +3 = cm of water
        +4 = meters of water
        +5 = mm of water
        +9 = user units

U = temperature units of measure
    Where: +0 = degrees C
                   +1 = degrees F

CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Requests pressure and temperature with units of measure.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Requests a depth/pressure and temperature measurement. D0! returns depth/pressure and temperature with units of measure.

Default depth/pressure units of measure is feet of water for Keller, KPSI®, and H312 mode. In DISI-1210 mode, depth measurement is in meters of water.

Default averaging time is 10 seconds for Keller, KPSI®, and DISI modes. H312 mode is 3 seconds. (One second is needed for sensor stabilization.)

Averaging and response time is set by XT command. Use XWMC to set the number of samples.

Average depth/pressure is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Measurements are taken 10 times/second.

This command can duplicate C and M in Keller Digilevel and KPSI modes. The difference is this command always returns depth/pressure while C and M may include temperature, depending upon XUM command setting.

Temperature is not averaged.

RELATED: XT, XWMC

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M7!		Start a depth/pressure and temperature measurement
	00114	Default response
After 11 seconds: 0D0!		Request data
	0+2.101+0+25.886+0	Report 2.101 feet of water at 25.886 degrees C.

1. KPSI®, a Federally-registered trademark, and Series 500, a model designation, are owned by Measurement Specialties, Inc., a maker of level and pressure transducers.

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COMMAND: M8
                          MC8

SYNTAX: aM8!
                          aMC8!

              Where: a = address of probe

IMMEDIATE RESPONSE: a0011

RESPONSE TO D0:   a+U   Response to aM8! command
                          a+uCRC   Response to aMC8! command

              Where: a = address of probe
                          U = temperature units of measure
                              Where: +0 = degrees C
                                            +1 = degrees F
                          CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Requests temperature units of measure. Units of measure may be set by XUT command while in Keller Digilevel and KPSI modes only.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Returns temperature units of measure. Default is +0 (Degrees C).

RELATED: XUT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M8!		Start a temperature measurement
	00011	Default response
After 1 second: 0D0!		Request data
	0+0	Return 0, meaning degrees C.

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COMMAND: M9
                             MC9

SYNTAX: aM9!
                             aMC9!

                  Where: a = address of probe

IMMEDIATE RESPONSE: a0013

RESPONSE TO D0:   a+s+e+c   Response to aM9! command
                             a+s+e+cCRC   Response to aMC9! command

                  Where: a = address of probe
                             s = response depends upon probe mode
                                    Where response will always be:
                                          Keller and KPSI® = +1
                                          DISI-1210 = +48335.
                                          H312 = +123.456
                             e = response depends upon probe mode
                                    Where:
                                          Keller and KPSI® mode = 0 = OK, 1 = sensor error
                                          DISI-1210 =+ 58297. (always returned)
                                          H312 = +78.9 (always returned)
                           c = response depends upon probe mode
                                    Where:
                                          Keller and KPSI® mode, number of errors detected.
                                          DISI-1210 = +0 (always returned)
                                          H312 = +1 (always returned)
                           CRC = Cyclic Redundancy Check value as ASCII characters

FUNCTION: Duplicates V command for sensor verification

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Keller Digilevel and KPSI modes will return the number and type of sensor errors detected. s parameter is always +1.

Third parameter, e, should be 0 to indicate no errors detected. A +1 is returned when a sensor error is detected.

Fourth parameter, c, returns the count, or number of errors detected since power up, M9, or V command was executed.

Errors are cleared when this command is executed.

While in DISI-1210 and H312 modes, responses will always be the same. DISI will always return a+48335.+58297.+0.780+0. H312 mode will always return a+123.456+78.9+1.

A CRC is appended if C is included.

RELATED: V

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M9!		Request status
	00013	Default response
After 1 second: 0D0!		Request data
	0+1+0+0	Return no problems in Keller mode.

COMMAND:	O	(DISI-1210 only)
	Os	(DISI-1210 only)
SYNTAX:	aO!	Request current offset
	aOs!	Set new offset.
Where:	a = address of probe	
	s = signed offset	
IMMEDIATE RESPONSE:	a0011	Default response to aO! or aOs!
RESPONSE TO D0:	as	Response to O! or Os!
Where:	a = address of probe	
	s = offset to 6 decimal places	
FUNCTION:	Requests current offset or sets new offset.	
EMULATION MODES:	DISI-1210	

DESCRIPTION: Command is useful only in DISI-1210 mode. All other modes will respond with address only and will have no effect on offset.

aO! requests current offset while aOs! sets a new offset.

Offset is added to the depth/pressure for M, C,M1, C1, M1, C1, M2, and C2 commands. It is also retrieved using M3, C3, and XRO commands.

This command will overwrite the value calculated if Z command was previously executed.

XUU command can also be used to set offset (and slope), and has the same effect as this command.

RELATED: XUU, Z

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0O+22.23!		Set offset for stage
	00011	Default response
After 1 second: 0D0!		Request data
	0+22.230000	Returns offset of 22.23.

COMMAND:	R0	(Keller mode only)
SYNTAX:	aR0!	
IMMEDIATE RESPONSE:	adutU	
Where:	a = address of probe	
	d = Depth/pressure	
	t = temperature	
	U = temperature units of measure	
	Where: +0 = degrees C	
	+1 = degrees F	
	u = depth/pressure units of measure	
	+0 = feet of water	
	+1 = PSI	
	+2 = kPa	
	+3 = cm of water	
	+4 = meters of water	
	+5 = mm of water	
	+9 = user units	
RESPONSE TO D0:	n/a (address only)	

FUNCTION: After command is issued, averaged depth/pressure, units of measure, temperature and temperature units are returned. A D0! command is not necessary to return data.

EMULATION MODES: Keller Digilevel

DESCRIPTION: Once the XWRM command has been issued, depth/pressure and temperatures may be returned immediately using the R0! command.

Depth/pressure are averaged. Averaging time is set by XT command.

Measurements are started immediately after the XWRMt command is executed. The recorder should wait for the time returned by the probe before the first query with R0!. The probe response indicates when the first valid measurement may be read, in seconds. If a measurement is not valid, +999.000 is returned.

Depth/pressure units is set with XUP command. Temperature units is set using XUT.

Data is updated every averaging period. If R0! is executed twice in one averaging period, the same data is returned.

Probe's address is returned when measurement time set by XWRM command has timed out.

This command does not work in other emulation modes other than Keller.

RELATED: XT, XUP, XUT, XWRM

EXAMPLE: **Issue XWRM to start continuous read for 10 minutes**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWRM+10!		Start continuous read for 10 minutes
	00011	Indicate 11 seconds before first valid data is available.
After 11 seconds: 0R0!		Request data
	0+1.081+0+24.872+0	Immediately returns 1.081 feet of water at 24.872 degrees C.
After 10 seconds: 0R0!		
	0+1.083+0+24.868+0	Immediately returns 1.083 feet of water at 24.868 degrees C

COMMAND: R1   (Keller mode only)

SYNTAX: aR1!

IMMEDIATE RESPONSE: adu

                Where: a = address of probe
                            d = Depth/pressure
                            u = depth/pressure units of measure
                                +0 = feet of water
                                +1 = PSI
                                +2 = kPa
                                +3 = cm of water
                                +4 = meters of water
                                +5 = mm of water
                                +9 = user units

RESPONSE TO D0:   n/a (address only)

FUNCTION: After command is issued, averaged depth/pressure and units of measure are immediately returned.

EMULATION MODES: Keller Digilevel

DESCRIPTION: Once the XWRM command has been issued, depth/pressure may be returned immediately using the R1! command after the time indicated by XWRM response. A D0! command is not necessary to return data.

                        Depth/pressure are averaged. Averaging time is set by XT command.

                        Measurements are started immediately after the XWRMt command is executed. The recorder should wait for the time returned by the probe before the first query with R0!. The probe response indicates when the first valid measurement may be read, in seconds. If a measurement is not valid, +999.000 is returned.

                        Depth/pressure units is set with XUP command.

                        Data is updated every averaging period. If R0! is executed twice in one averaging period, the same data is returned.

                        Probe's address is returned when measurement time set by XWRM command has timed out.

                        This command does not work in other emulation modes other than Keller.

RELATED: XT, XUP, XWRM

EXAMPLE: **Issue XWRM to start continuous read for 10 minutes**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWRM+10!		Start continuous read for 10 minutes
	00011	Indicate 11 seconds before first valid data is available.
After 11 seconds: 0R1!		Request data
	0+1.081+0	Immediately returns 1.081 feet of water
After 10 seconds: 0R1!		
	0+1.083+0	Immediately returns 1.083 feet of water

COMMAND: R2   (Keller mode only)

SYNTAX: aR0!

IMMEDIATE RESPONSE: atU

         Where: a = address of probe
         t = temperature
         U = temperature units of measure
         Where: +0 = degrees C
         +1 = degrees F

RESPONSE TO D0:   n/a (address only)

FUNCTION: After command is issued, temperature and temperature units are returned.

EMULATION MODES: Keller Digilevel

DESCRIPTION: Once the XWRM command has been issued, temperatures may be returned immediately using the R2! command after the time indicated by XWRM response. A D0! command is not necessary to return data.

Averaging time is set by XT command.

Measurements are started immediately after the XWRMt command is executed. The recorder should wait for the time returned by the probe before the first query with R0!. The probe response indicates when the first valid measurement may be read, in seconds. If a measurement is not valid, +999.000 is returned.

Temperature units is set using XUT.

Data is updated every averaging period. If R0! is executed twice in one averaging period, the same data is returned.

Probe's address is returned when measurement time set by XWRM command has timed out.

This command does not work in other emulation modes other than Keller.

RELATED: XT, XUP, XUT, XWRM

EXAMPLE: **Issue XWRM to start continuous read for 10 minutes**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWRM+10!		Start continuous read for 10 minutes
	00011	Indicate 11 seconds before first valid data is available.
After 11 seconds: 0R2!		Request temperature data
	0+24.872+0	Immediately returns + 24.872 degrees C.
After 10 seconds: 0R0!		
	0+24.868+0	Immediately returns +24.868 degrees C

COMMAND: V

SYNTAX: aV!
    Where: a = address of probe

IMMEDIATE RESPONSE: a0013

RESPONSE TO D0:   a+s+e+c

    Where: a = address of probe
s = response depends upon probe mode
Where response will always be:
    Keller and KPSI® = +1
    DISI-1210 = +48335.
    H312 = +123.456
e = response depends upon probe mode
Where: Keller and KPSI® mode = 0 = OK, 1 = sensor error
    DISI-1210 =+ 58297. (always returned)
    H312 = +78.9 (always returned)
    c = response depends upon probe mode
Where: Keller and KSPI® mode, number of errors detected.
    DISI-1210 = +0 (always returned)
    H312 = +1 (always returned)

FUNCTION: Sensor operation verification

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Keller Digilevel and KPSI® modes will return the number and type of sensor errors detected. s parameter is always +1.

Command is same as M9.

Third parameter, e, should be 0 to indicate no errors detected. A +1 is returned when a sensor error is detected.

Fourth parameter, c, returns the count, or number of errors detected since power up, M9, or V command was executed.

Errors are cleared when this command is executed.

While in DISI-1210 and H312 modes, responses will always be the same. DISI will always return a+48335.+58297.+0.780+0. H312 mode will always return a+123.456+78.9+1.

A CRC is appended if C is included.

RELATED: M9

EXAMPLE: **Issue XWRM to start continuous read for 10 minutes**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0V!		Request status
	00013	Default response
After 1 second: 0D0!		Request data
	0+1+0+0	Return no problems in Keller mode.

COMMAND: XCo   (Keller Digilevel mode only)
                       XCos   (Keller Digilevel mode only)

SYNTAX: aXCo!
                       aXCos!

           Where: a = address of probe
                       s = signed slope
                       o = signed offset

IMMEDIATE RESPONSE: a0012

RESPONSE TO D0:   aso

           Where: a = address of probe
                       o = sensor offset
                       s = sensor slope

FUNCTION: Set sensor offset and slope in calibration lab environment.

EMULATION MODES: Keller Digilevel

DESCRIPTION: The probe's sensor can be calibrated to account for accuracy and offset drift. Off
                           set, as used by this command, is not field or stage offset. Offset here is used to zero
                           out depth/pressure measurements. Slope is used to correct pressure readings at
                           some pressure, usually near the maximum.

                           Previous examples used the sensor depth/pressure reading as part of an equation
                           (see C, C1, M, and M1 for examples). Part of the equation included user slope and
                           offset. The offset and slope set by this command used before any user or field
                           slope and offsets. It is used as follows:

                           Sensor_reading = Raw_sensor_reading * XC_slope + XC_offset.

                           Calibration process should start by resetting the probe. This can be done by issuing
                           an aXWCO+1! command. After this command is issued, the probe's address will
                           reset to 0 (zero). User slope, offset, and units of measurement are also reset.
                           After issuing aXWCO+1!, the probe must be set up again.

                           Slope and offset may have been set by Keller at time of manufacture using this
                           command. Slope and offset set by XC command should be reset to 0.000 (offset)
                           and 1.000(slope). The following command should be issued.

                           0XC+0+1! - This command is issued multiple times until satisfactory results are
                           obtained.

                           Next, set the offset. Obtain the current reading (should be at atmosphere) using
                           the M! command. Take the current reading, negate it, and use it as the offset for
                           the next XC command. Issue the M! command and get the reading. Ideally, current
                           reading should be 0. If not, adjust offset as necessary.

When zero pressure is satisfactory, apply a known, calibrated pressure or place in a water column of known depth. If placing in water column, be sure to allow the probe to acclimate. Take a depth reading again. Compare it with the known pressure or depth reading. You will now calculate the slope to correct for any errors at depth/pressure.

XC_slope = Known_depth/pressure / Reported_depth/pressure

Use the same offset as previously used but now include the XC_slope.

After calibration, you can set units of measure and /or mode.

Keller Digilevel program has a means of calibrating the probe, which is described earlier in this manual.

RELATED: XWCO

EXAMPLE: **Sample shows calibration process.**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
2XWCO+1!		Reset board to Keller mode
	20011	2 default responses
	0	Probe address is now 0 (service request)
0XC+0+1!		Reset calibration offset to 0, slope to 1
	00012	Response to command
	0	Service request
0D0!		If desired, report offset and slope
	0+1.000000+0.000000	Probe response
0M!		Take reading to get current pressure/depth
	00112	Probe
Wait 11 seconds:0D0!		Request data
	0+0.076+0	Returns 0.076 feet of water
0XC-.076!		Set offset at -0.076 feet
	00012	Response to command
0D0!		Request slope and offset data
	0+1.000000-0.076000	Probe says calibration slope is 1 and offset is -0.076.
0M!		Perform another measurement
	00112	Probe to take 11 seconds for measurement
Wait 11 seconds:0D0!		Request data
	0+0.000+0	Offset now 0.

EXAMPLE: **Sample shows calibration process (continued).**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
Place probe at known depth/pressure and allow to acclimate.		
0M!		Take reading to get current pressure/depth
	00112	Probe response.
After 11 seconds: 0D0!		Request data
	0+11.006+0	Returns 11.006 feet of water
Assume depth is 11.000 feet. Using above formula: XC_slope = 11 / 11.006 XC_slope = 0.999455 Use offset (-0.076) and above slope in XC command		
0XC-.076+.999455!		Send offset of -0.076 and slope of 0.999455
	00012	Response to command
0D0!		Request slope and offset data
	0+0.999455-0.076000	Probe says calibration slope is .999455 and offset is -0.076.
Even though depth is reported to 3 decimal places, slope may be set to 6 decimal places for greatest accuracy.		
0M!		Take reading to get current pressure/depth
	00112	Probe response.
After 11 seconds: 0D0!		Request data
	0+11.000+0	Returns 11.000 feet of water

Slope does enter into the equation at all times. If calibrated slope is high (+/- 0.5%), it may be necessary to re-calibrate offset and repeat this process. This is because the offset at atmosphere is multiplied by the slope first before the XC_offset is added/subtracted.

COMMAND:	XEou
SYNTAX:	aXEou!
Where:	a = address of probe
	o = signed offset
	u = units of measure offset
Where:	+0 = feet of water
	+1 = PSI
	+2 = kPa
	+3 = cm of water
	+4 = meters of water
	+5 = mm of water
	+9 = user units
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+o
Where:	a = address of probe
	o = offset in PSI
FUNCTION:	Set field calibration offset.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION:

This command is used in the field when the probe is at atmosphere. Command is used to zero out readings. Offset set by this command is added/subtracted before conversion to other units of measure. This includes user slope and offset (XUU).

Generally, the depth/pressure returned by the probe uses this offset as follows:

Reported_depth = (sensor_value + XE_offset) * unit_of_measure_conversion_factor

Offset set by XE and XS are the same. One will replace the other. Thus, XE_offset in above equation is the same value set by XS.

If you have set your own user units, XE/XS offset is used as follows:

Reported_depth = (sensor_value + XE_offset) * XUU_slope + XUU_offset

You do not need to be too concerned about units of measure. Internally, all offsets in a unit of measure are converted first to bars. Then, when a measurement is taken, XE/XS offset is used (and was converted to bars) and a conversion factor is applied according to current units of measure in effect at the time.

In Keller Digilevel and KPSI modes, when XE command is executed with an offset other than 0, units of measure returned with M, C, and other similar measurement commands, a value of 10 will be added to the units of measure. This is to indicate that a field offset is included in the return. If this command is executed with an

offset of zero, then units of measure number will be between 0 and 9, per above table.

RELATED:	XS, XUU

EXAMPLE: **Probe has been acclimated to atmospheric conditions and you have taken a reading. Reading at atmosphere is 0.011 feet of water. To adjust this offset, negate the value as part of the XE command.**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XE-.011+0		Set offset
	00011	Default response
After 1 second: 0D0!		Request data
	0-0.011000	Return offset value
Install probe and perform a measurement		
0M!		Measure water level
	00112	
		Response
After 11 seconds: 0D0!		Request water level
	0+1.020+10	Water level is 1.020 feet, units of measure is water and a field offset was performed.

COMMAND:	XRCO
SYNTAX:	aXRCO!
Where:	a = address of probe
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+d

Where:	a = address of probe
	d = probe mode,
	Where: 1 = Keller Digilevel
	             2 = KPSI
	             3 = DISI-1210
	             4 = H312

FUNCTION:	Requests current probe configuration.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Keller Digilevel probes can be configured to emulate a number of other probes. This command returns its current mode. Last letter in command is letter O, not number zero.
RELATED:	XWCO

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XRCO!		Request current mode configuration
	00011	Default response
After 1 second: 0D0!		Request data
	0+1	Returns Keller Digilevel mode

COMMAND:	XRMC
SYNTAX:	aXRMC!
Where:	a = address of probe
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+d
Where:	a = address of probe d = number of samples for averaging
FUNCTION:	Requests number of pressure/depth samples used for averaging.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Pressure/depth measurements are taken 10 times / second. The average is computed first by summing each measurement. When the number of measurements is taken, the highest and lowest measurements are subtracted from the sum. This sum is then divided by number of measurements minus 2 to arrive at the average. XWMC may be used to set the number of samples. XT command is used to set the number of seconds for averaging.
RELATED:	XWMC, XT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XRMC!		Request number of samples
	00011	Default response
After 1 second: 0D0!		Request data
	0+100	Returns 100 samples

COMMAND:	XRO
SYNTAX:	aXRO!
Where:	a = address of probe
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+d
Where:	a = address of probe d = offset, as set by O, XWO and XUU
FUNCTION:	Request offset used for depth/pressure measurements.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Last character in command is letter O, not number zero. Offset is used in the following measurement commands in Keller Digilevel or KPSI® modes: M, C, O, XWO and XUU offset is used only when user units of measure (+9) is set by XUP in Keller Digilevel or KPSI® modes. Offset is used in the following measurement commands in DISI-1210 mode:M,C, M1, C1, M2, C2 Offset is used in the following measurement commands in H312 mode: M,C (first PSI parameter only). This offset is the last number added to the depth/pressure reading before it is sent out. Reported_reading = reading + offset The variable reading in this case is pressure, depth, or user units of measurement.
RELATED:	O, XUU, XUP

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XRO!		Request offset used
	00011	Default response
After 1 second: 0D0!		Request data
	0+0.000000	Return zero offset

COMMAND:	XRS
SYNTAX:	aXRS!
Where:	a = address of probe
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+d
Where:	a = address of probe d = slope, as set by F, XWS and XUU
FUNCTION:	Request slope used for depth/pressure measurements.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312
DESCRIPTION:	Slope is used in the following measurement commands in Keller Digilevel or KPSI® modes: M, C, F, XWS and XUU slope is used only when user units of measure (+9) is set by XUP in Keller Digilevel or KPSI® modes. Slope is used in the following measurement commands in DISI-1210 mode:M,C, M1, C1, M2, C2 Slope is used in the following measurement commands in H312 mode: M,C (first PSI parameter only). This slope is multiplied by the reading, and offset added before it is sent out. Reported_reading = reading * slope + offset The variable reading in this case is pressure, depth, or user units of measurement. Reading will vary in units of measure, depending upon emulation mode.
RELATED:	O, XUU, XUP

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XRS!		Request slope used
	00011	Default response
After 1 second: 0D0!		Request data
	0+1.000000	Return slope of 1

COMMAND: XRS

SYNTAX: aXRS!

         Where: a = address of probe

IMMEDIATE RESPONSE: a0011

RESPONSE TO D0:   a+d

         Where: a = address of probe

                   d = slope, as set by F, XWS and XUU

FUNCTION: Request slope used for depth/pressure measurements.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Slope is used in the following measurement commands in Keller Digilevel or KPSI® modes: M, C,

         F, XWS and XUU slope is used only when user units of measure (+9) is set by XUP in Keller Digilevel or KPSI® modes.

         Slope is used in the following measurement commands in DISI-1210 mode:M,C, M1, C1, M2, C2

         Slope is used in the following measurement commands in H312 mode: M,C (first PSI parameter only).

         This slope is multiplied by the reading, and offset added before it is sent out.

         Reported_reading = reading * slope + offset

         The variable reading in this case is pressure, depth, or user units of measurement. Reading will vary in units of measure, depending upon emulation mode.

RELATED: O, XUU, XUP

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XRS!		Request slope used
	00011	Default response
After 1 second: 0D0!		Request data
	0+1.000000	Return slope of 1

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COMMAND: XS

SYNTAX: aXS!

IMMEDIATE RESPONSE: a0111   Keller Digilevel and KPSI® response

                               a0111   DISI-1210 default response

                               a0031   H312 default response

RESPONSE TO D0:   ap

         Where: a = address of probe

                   p = offset in PSI

FUNCTION: Zero out sensor offset (not field or stage offset).

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Measures current pressure (device is at atmospheric pressure) and uses that value as an offset to future readings so they return 0. Command corrects for sensor offset, not stage or field offsets. Offsets set by O, XUU, XWO are not affected.

         Command measures current pressure for the averaging period (set by XT or XWMC). Default is 10 seconds.

         Sensor offset is also set by XE, XSdu, and Z commands. This command will replace any offset set by these commands. Sensor offset is used for most all depth/pressure calculations in all emulation modes. Only command that does not use this offset is in H312 mode, command M1/C1. The third parameter sent as part of a aD0! command is in PSI with out offset entering into the return.

         A simplified formula illustrates how sensor and stage offsets enter into reported depth/pressure calculation.

         reported_measurement = (measurement + sensor_offset) * XUU_slope + XUU_offset

         XUU_slope and XUU_offset may not enter into the equation. By default, XUU_slope is 1 while offset is 0. It is important to note that XUU_slope, if used, with sensor_offset can affect reported_measurement.

         In many ways this command is similar to XC. XC, however, is used in a calibration laboratory environment under controlled conditions.

         Command XSdu performs the same function as XS, except user offset is added.

RELATED: XE, XSCS, Xsdu, Z

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EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XS!		Zero out sensor
	00011	Default response
After 11 secondS: 0D0!		Request data
	0-0.001813	Returns -0.001813 PSI offset

COMMAND: XSdu

SYNTAX: aXSdu!

                   Where: a = address of probe
                                      d = signed offset
                                      u = offset units of measure
                                      Where: +0 = feet of water
                                                          +1 = PSI
                                                          +2 = kPa
                                                          +3 = cm of water
                                                          +4 = meters of water
                                                          +5 = mm of water
                                                          +9 = user units

IMMEDIATE RESPONSE: a0111   Keller Digilevel and KPSI default response
                                       a0111   DISI-1210 default response
                                       a0031   H312 default response

RESPONSE TO D0:   ap

                   Where: a = address of probe
                                        p = offset in PSI

FUNCTION: Zeros out sensor offset (not field or stage offset), then signed offset is used in future measurement commands.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Measures current depth/ pressure and computes an offset so future readings will return a value specified in variable d above. Command corrects for sensor offset, not stage or field offsets.

Offsets set by O, XUU, XWO are not affected.

Command measures current pressure for the averaging period (set by XT or XWMC). Default is 10 seconds for all modes except H312.

Sensor offset is also set by XE, XS, and Z commands. This command will replace any offset set by these commands. Sensor offset is used for most all depth/ pressure calculations in all emulation modes. Only command that does not use this offset is in H312 mode, command M1/C1. The third parameter sent as part of a aD0! command is in PSI with out offset entering into the return.

A simplified formula illustrates how sensor and stage offsets enter into reported depth/pressure calculation.

reported_measurement = (measurement + sensor_offset) * XUU_slope + XUU_ offset

XUU_slope and XUU_offset may not enter into the equation. By default, XUU_slope is 1 while offset is 0. It is important to note that XUU_slope, if used, with sensor_ offset can affect reported_measurement.

XUU slope and offset are not used in Keller Digilevel or KPSI modes unless user units is specified. They may be used in other modes, depending upon measurement command issued.

In many ways this command is similar to XC. XC, however, is used in a calibration laboratory environment under controlled conditions.

Command XS performs the same function as XSdu, except user specified depth/pressure is not used.

RELATED: O, XS, XSCS, XUU, XWO

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XC+2.35+0!		Start offset adjustment to force 2.35 feet
	00111	Default response
After 11 secondS: 0D0!		Request offset pressure
	0+0.000121	Return as 0.000121 PSI

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COMMAND: XSCS

SYNTAX: aXSCSd!
          Where: a = address of probe
                            d = signed offset in feet of water

IMMEDIATE RESPONSE: a0111   Keller Digilevel and KPSI default response
                           a0111   DISI-1210 default response
                           a0031   H312 default response

RESPONSE TO D0:   ap
          Where: a = address of probe
                           p = offset(stage) in PSI

FUNCTION: Zeros out sensor offset (not field or stage offset), then offset(or stage), in feet of water is added in future measurement commands.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Command is primarily used for H312 mode.

                           Measures current depth/ pressure and adds an offset(stage), in PSI. Future readings will add the a value specified in variable d above. Command corrects for sensor offset, not stage or field offsets.

                           This command is for H312 compatibility, but will work in other modes. It is similar to XSdu command above except that d units of measure is always PSI.

                           Offsets set by O, XUU, XWO are not affected.

                           Command measures current pressure for the averaging period (set by XT or XWMC). Default is 10 seconds for all modes except H312, which is 3 seconds.

                           Sensor offset is also set by XE, XS, and Z commands. This command will replace any offset set by these commands. Sensor offset is used for most all depth/ pressure calculations in all emulation modes. Only command that does not use this offset is in H312 mode, command M1/C1. The third parameter sent as part of a aD0! command is in PSI with out offset entering into the return.

                           A simplified formula illustrates how sensor and stage offsets enter into reported depth/pressure calculation.

                           reported_measurement = (measurement + sensor_offset) * XUU_slope + XUU_offset

                           XUU_slope and XUU_offset may not enter into the equation. By default, XUU_slope is 1 while offset is 0. It is important to note that XUU_slope, if used, with sensor_offset can affect reported_measurement.

                           XUU slope and offset are not used in Keller Digilevel or KPSI® modes unless user units is specified. They may be used in other modes, depending upon

measurement command issued.

In many ways this command is similar to XC. XC, however, is used in a calibration laboratory environment under controlled conditions.

Command XS performs the same function as XSdu, except user specified depth/pressure is not used.

Command XS performs the same function as XSdu, except user specified depth/pressure is not used.

RELATED: O, XS, XUU, XWO

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XCCS+4.35!		Start offset adjustment for 4.35 feet of water
	00031	Default response (H312 mode)
After 3 secondS: 0D0!		Request offset pressure
	0+0.000121	Return as 0.000121 PSI
Assume sensor is still at atmosphere and in H312 mode. Request a measurement and return result.		
0M!		Request measurement
	0034	Default response (H312 mode)
After 3 secondS: 0D0!		Request data from measurement
	0+1.886+1.886+13.4+12.1	Returns 1.886 PSI , 1.886 with user slope and offset at 1 and 0, temperature in degrees C (13.4) , and battery voltage (12.1).

COMMAND: XT

SYNTAX: aXTt!
        Where: a = address of probe
                    t = number of seconds

IMMEDIATE RESPONSE: a0012

RESPONSE TO D0:   a+s+t
        Where: a = address of probe
                    s = number of samples
                    t = time in seconds

FUNCTION: Set number of seconds to average depth/pressure measurements.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Measurement rate is 10 times/second. Default period is 10 seconds. Averaging is disabled when t = 0. This will return the fastest measurement time.

A pressure/depth average is calculated by adding all of the readings during a measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2. Temperatures are not averaged, but the time to request only temperature (see C7, M7, and R2 commands) is subject to this time interval.

Only whole numbers are allowed. Any time with a decimal is rounded down.

All depth/pressure and temperature commands are subject to this command. Continuous read (R0, R1, and R2) update measurements based on this time.

XWMC affects time interval. XWMC sets number of samples, which determines the number of seconds for averaging.

RELATED: XWMC, XRMC

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XT+5!		Set measurement interval to 5 seconds
	00012	Default response
After 1 second: 0D0!		Request data
	0+50+5.000000	Return 50 samples over 5 seconds.

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COMMAND:	XUM
	XUMn
SYNTAX:	aXUM!
	aXUMn!
Where:	a = address of probe
	n = measurement mode
Where:	+0 = return pressure/depth only
	+1 = include temperature and unit of degrees
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+n
Where:	a = address of probe
	n = measurement mode, per above
FUNCTION:	Sets or requests how much data is returned in M or C command.
EMULATION MODES:	Keller Digilevel, KPSI® 500
DESCRIPTION:	Command is useful only in Keller Digilevel and KPSI® modes.
	XUM requests current measurement mode. By default, only depth/pressure is returned (n = +0).
	Temperature may be appended to M and C measurement requests by setting (n = +1).
	M7 and C7 commands always return depth/pressure and temperature. This command only affects M and C commands.
RELATED:	M, C
EXAMPLE:	

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0M!		Request measurement
	00112	Default response
After 11 seconds: 0D0!		Request measurement
	0+1.234+0	Returns 1.234 feet of water
0XUM+1!		Command to include temperature as part of M and C commands.
	00011	Default response
After 1 seconds: 0D0!		Request data
	0+1	Return +1 to indicate temperature returned
0M!		Request measurement
	00114	Default response. Note 4 parameters now returned.
After 11 seconds: 0D0!		Request measurement
	0+1.234+0+10.060+0	Returns 1.234 feet of water(+0) at 10.060 degrees C (+0)

COMMAND:	XUP	
SYNTAX:	aXUPu[d]!	
Where:	a = address of probe	
	u = Pressure / depth units of measure	
	Where:	+0 = Feet of water
		+1 = PSI
		+2 = kilopascal
		+3 = cm of water
		+4 = meters of water
		+5 = mm of water
		+9 = User units of mesure
	d = [optional] display number of decimal numbers for pressure/depth units of measure	
IMMEDIATE RESPONSE:	a0012	
RESPONSE TO D0:	aud	
Where:	a = address of probe	
	u = pressure / depth units of measure per above	
	d = displayed number of decimal numbers for pressure/depth units of measure	
FUNCTION:	Change reported units of measure and displayed number of digits to right of decimal.	
EMULATION MODES:	Keller Digilevel, KPSI® 500	
DESCRIPTION:	When a measurement command is executed (such as M!), the result returned using D0! is in feet of water by default. This can be changed using this command.	
	When user units of measure are desired, both XUP and XUU must be executed.	
	Number of digits to right of decimal is 3 by default. This parameter is optional and the number can be changed if desired.	
	This command will not have an effect in returning other units of measure in DISI 1210 and H312 modes	
RELATED:	M, C, M3, C3, M7, C7, R0, R1, XC	
EXAMPLE:		

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XUP+1!		Set units of measure to PSI
	00112	Default response
After 1 second: 0D0!		Request data
	0+1+3	Return unit of measure as 1 and 3 for number of digits to right of decimal.

COMMAND:	XUT

SYNTAX: aXUTu!

       Where: a = address of probe
                   u = Temperature units
       Where: +0 = degrees Celsius
                    +1 = degrees Fahrenheit

IMMEDIATE RESPONSE: a0011

RESPONSE TO D0:   au
       Where: a = address of probe
                   u = Temperature units, per above

FUNCTION: Changes temperature units of measure.

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: Temperature units are returned as Celsius by default. Degrees Fahrenheit may also be returned by setting this command.

Command does not affect other operating modes where temperature is always returned in degrees C.

RELATED: M, C, M2, C2, M5, C5, M7, C7, R0, R2

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XUT+1!		Request temperatures in degrees F
	00011	Default response
After 1 second: 0D0!		Request data
	0+1	Return 1, signals degrees F

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COMMAND:	XUU

SYNTAX: aXUUso!

       Where: a = address of probe
                   s = signed slope
                   o = signed offset

IMMEDIATE RESPONSE: a0012

RESPONSE TO D0:   aso
       Where: a = address of probe
                   s = signed slope
                   o = signed offset

FUNCTION: Sets slope and offset values to be used when taking a reading in custom units of measurement. These values are stored in non-volatile memory and need to be programmed only once (but can be reprogrammed if necessary).

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI 1210, H312

DESCRIPTION: Sometimes custom units of measure are required. This command sets the constants necessary to convert a measurement from PSI into custom units of measure. When a measurement command is requested (M, M0, M1, etc.), the Keller Digilevel applies slope and offset according to the following formula:

reported value = (PSI) * user_slope + user_offset

The XUP command must be executed prior to retrieving a custom measurement. XUP must be configured for user units of measurement. XUP command sets units of measure and number of decimal places and are stored in non-volatile memory and need to be programmed only once.

When operating in Keller Digilevel and KPSI® 500 modes, default values are 1 for slope, 0 for offset. Slope and offset set by XUU in Keller Digilevel and KPSI®-500 modes are not used until XUP sets measurement mode to user units (+9).

XUU, XWS, XWO, F, and O slope and offset commands are used in the following measurement commands while in DISI-1210 mode: M, C, M1, C1, M2, and C2.

XUU, XWS, XWO, F, and O slope and offset commands are used in the following measurement commands while in H312 mode: M and C.

RELATED: XUP, M, C, M1, C1, R0, R1, XWRS, F, O

EXAMPLE: **Suppose your probe is in a stilling well and you must measure in inches of water. PSI is converted into inches of water by multiplying 27. 6799. 27.6799 becomes the slope. If the probe is situated above the bottom of the well, you can add in offset also. An offset is required, even if it is 0.**

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
aXUU+27.6799+3.05!		Will convert PSI into inches/water and add offset of 3.05 inches for this example.
	a0012	Response to command. Will return service response address.
aD0!		Request programmed data
	a+27.679900+3.050000	Response to D0 command
Use XUP command to use values set by XUU. Also set number of decimal places returned.		
aXUP+9+3!		Return depth/pressure measurements in user units to 3 decimal places.
XUP command can be executed before or after XUU. Refer to XUP command for more information.		

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COMMAND: XWCO

SYNTAX: aXWCOm!
Where: a = address of probe
m = Probe mode
Where: +1 = Keller Digilevel
+2 = KPSI® 500
+3 = Tavis DISI 1210
+4 = Water Log/DA H312

IMMEDIATE RESPONSE: a0011

RESPONSE TO D0: a+m
Where: a = address of probe
m = Probe mode, per above

FUNCTION: Configures probe to operate or emulate product specific commands for recorder compatibility.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Keller Digilevel can emulate one of 3 probes. The probe will respond to some commands listed in this manual in different ways. Other commands only work in specific emulation modes.

Generally, measurement commands M, C, M1, C1, M2, and C2 respond with different data, depending upon the mode it is in. For example, in Keller Digilevel mode, M returns feet of water. In DISI 1210 mode, meters of water are returned. In H312, PSI is returned. Temperature may or may not be returned, depending upon mode and configuration.

RELATED: (depends upon mode)

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWCO+3!		Configure for DISI-1210
	00011	Default response
Wait 1 second: 0D0!		Request data
	0+3	Return mode number 3, which is DISI-1210

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COMMAND:	XWMC
SYNTAX:	aXWCn!
Where:	a = address of probe
	n = number of samples
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+n
Where:	a = address of probe
	n = number of samples + 10
FUNCTION:	Set number of samples for averaging.
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Sets number of samples to take for averaging. Samples must be in multiples of 10. Default is 100 samples. Measurements are taken 10 times/second.

10 samples are always added to the number requested. For minimum number of samples, use aXT+0!. This will take 1 sample and not average.

This command is similar to XT. XT sets the number of seconds to sample. Sampling rate is always 10 times/second.

Readings are averaged over a period of 10 seconds. High and low pressures are not used for calculating the average unless they occur more than once. The average is calculated by adding all of the readings during the measurement interval. When measurement interval is complete, the highest and lowest readings are subtracted from the sum. The sum is then divided by the number of samples minus 2.

Number of samples may be retrieved using XRMC.

RELATED: XRMC, XT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWMC+30!		Set 30 samples. Will be 40 samples
	00011	Default response
Wait 1 second: 0D0!		Request data
	0+40	Return 40 samples

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COMMAND:	XWO
SYNTAX:	aXWOo!
Where:	a = address of probe
	o = signed offset
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+o
Where:	a = address of probe
	o = offset
FUNCTION:	Writes user offset, used for pressure/depth calculations
EMULATION MODES:	Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Sets user offset.

Useroffset is used in Keller Digilevel and KPSI® modes only when user units of measure is selected. In other modes, default units of measure is multiplied by this number according to the general formula:

Reported_measurement = measurement * user_slope + user_offset

user_slope is set by XWS command.

Default value for user_slope is 1 and user_offset is 0.

Note that user slope and offsets are used only in certain modes and measurement commands. Refer to the specific measurement command (M, C, M1, etc) for more information.

XUU command sets both offset and slope. user_offset may be read by XRO.

RELATED: O, XRO, XUU, Z

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWO+3.5!		Add offset of 3.5 to measurement
	00011	Default response
Wait 1 second: 0D0!		Request data
	0+3.5	Return offset of 3.5

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COMMAND: XWRM   (Keller Digilevel mode only)
                        XWRMt   (Keller Digilevel mode only)

SYNTAX: aXWRM!
                        aXWRMt!
        Where: a = address of probe
                        t = number of minutes in continuous measurement mode

IMMEDIATE RESPONSE: a0011

RESPONSE TO D0:   a+t
        Where: a = address of probe
                        t = number of minutes left in continuous measurement mode

FUNCTION: Requests or sets number of minutes in continuous measurement mode

EMULATION MODES: Keller Digilevel

DESCRIPTION: Command enables continuous measurements. Depth/pressure and temperature measurements are made using R0, R1, and R2 commands. The probe is on for the number of minutes specified. If 0 minutes is the time, continuous measurements are stopped.

Measurements are updated every averaging period. By default, this is 10 seconds. Using the XT command, averaging intervals can be changed.

XWRMt sets the number of minutes in continuous measurement mode. XWRM retrieves the number of minutes.

RELATED: R0, R1, R2, XT

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWRM+5!		Start continuous measurement for 5 minutes
	00011	Default response
Wait 11 seconds: 0R0!		Request data
	0+1.081+0+24.872+0	Immediately returns 1.081 feet of water at 24.872 degrees C.
Wait 10 seconds: 0R0!		
	0+1.083+0+24.868+0	Immediately returns 1.083 feet of water at 24.868 degrees C

COMMAND: XWS

SYNTAX: aXWSs!
        Where: a = address of probe
                        s = signed slope

IMMEDIATE RESPONSE: a0011

RESPONSE TO D0:   a+s
        Where: a = address of probe
                        s = user slope

FUNCTION: Set user slope.

EMULATION MODES: Keller Digilevel, KPSI® 500, DISI-1210, H312

DESCRIPTION: Sets user slope.

User slope is used in Keller Digilevel and KPSI® modes only when user units of measure is selected. In other modes, default units of measure is multiplied by this number according to the general formula:

Reported_measurement = measurement * user_slope + user_offset

user_offset is set by XWO command.

Default value for user_slope is 1 and user_offset is 0. user_slope may be read by XRS.

Note that user slope and offsets are used only in certain modes and measurement commands. Refer to the specific measurement command (M, C, M1, etc) for more information.

XUU command sets both offset and slope.

ELATED: XUU, XRS

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XWS+1.42!		Change slope to 1.42 (Meter of water to PSI)
	00011	Default response
Wait 1 second: 0D0!		Request data
	0+1.42	Returns user_slope of 1.42

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COMMAND:	XV
	XVd
SYNTAX:	aXV!
	aXVd!
Where:	a = address of probe
	v = minimum operating voltage
IMMEDIATE RESPONSE:	a0011
RESPONSE TO D0:	a+v
Where:	a = address of probe
	v = minimum operating voltage

FUNCTION: Requests and optionally sets minimum supply voltage to make depth/pressure measurements. When command is issued without supply voltage, current minimum supply voltage is returned in response to D0!.

EMULATION MODES: Keller Digilevel, KPSI® 500

DESCRIPTION: Command is valid only for Keller Digilevel and KPSI modes.

Default minimum voltage is 8.0.

Depth/pressure will return -999 if supply voltage is below limit. Temperature, if part of the measurement command, is valid. Minimum voltage specified in this command must be greater than 15 volts to be accepted. Keller Digilevel will work to about 6.6 volts, possibly lower.

Current battery voltage is measured by the M6 or C6 commands.

ELATED: M, C, M6, C6, M7, C7, R0, R1

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0XV+7.5!		Set minium operating voltage
	00011	Default response
Wait 1 second: 0D0!		Request data
	0+7.5	7.5 volts is minimum operating voltage

COMMAND:	Z	(DISI-1210 mode only)
	ZX	(DISI-1210 mode only)
SYNTAX:	aZ!	
	aZX!	
Where:	a = address of probe	
IMMEDIATE RESPONSE:	a0010	Default response in DISI-1210 mode
	a	All other modes
RESPONSE TO D0:	a	
Where:	a = address of probe	

FUNCTION: Valid for DISI-1210 mode only. Command >aZ!= zeros out water level reading by reading current level (assumed to be at atmospheric conditions), negating it, and using that as the offset for future readings. Command >aZX!= restores offset to a value of 0.

EMULATION MODES: DISI-1210

DESCRIPTION: Valid for DISI-1210 mode only. Other modes will return an address only.

aZ! is meant to eliminate any offset errors or changes in offset due to sensor changes. Command assumes sensor is at atmospheric conditions. An average reading is made. That level, with current slope, is negated and used as user_offset in future readings. General formula for measurements (commands M, C, M1, C1, M2, C2) is:

Measurement_result = level * user_slope + user_offset

Variable user_offset can be changed by XUU, O, and XWO commands.

This command is virtually the same as XS.

Command aZX! forces user_offset to zero. It has the same effect as executing aXWO+0! and aO+0!.

ELATED: O, XS, XUU, XWO

EXAMPLE:

COMMUNICATION		DESCRIPTION & COMMENTS
From Recorder	From Probe	
0Z!		Zero out pressure measurements
	0010	Default response (DISI-1210 mode only)
Wait 1 second		
A D0! command may be executed, but only its address is returned.		