

DIGILEVEL - SECTION 1

Environmental Monitoring System User's Manual



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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. However, 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).....	0-10 mWC
Proof pressure.....	30 mWC
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.....	-60-65°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 on the dongle per Appendix A. Note the warning regarding connection sequence.
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" elsewhere 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, nonrepeatability 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 EC 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 offset 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.

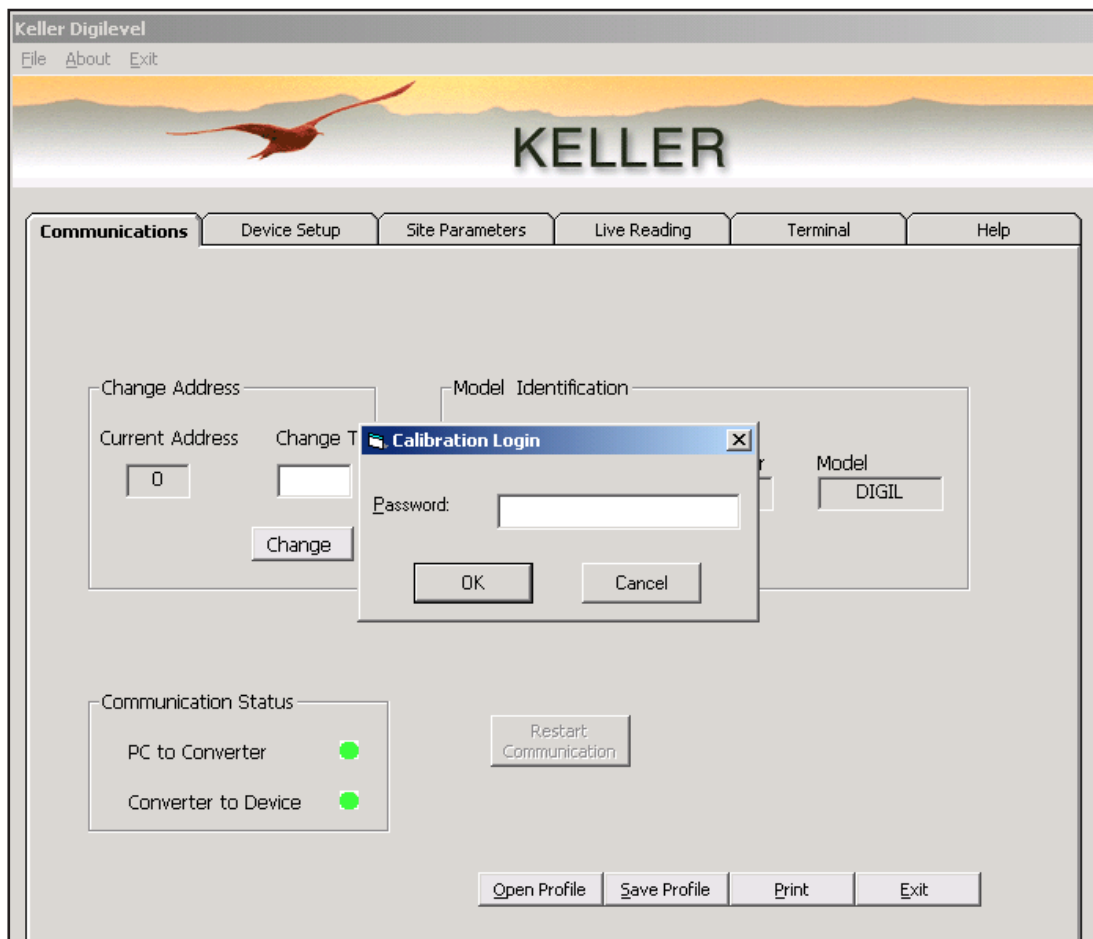


Figure 1 - Login

- 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.

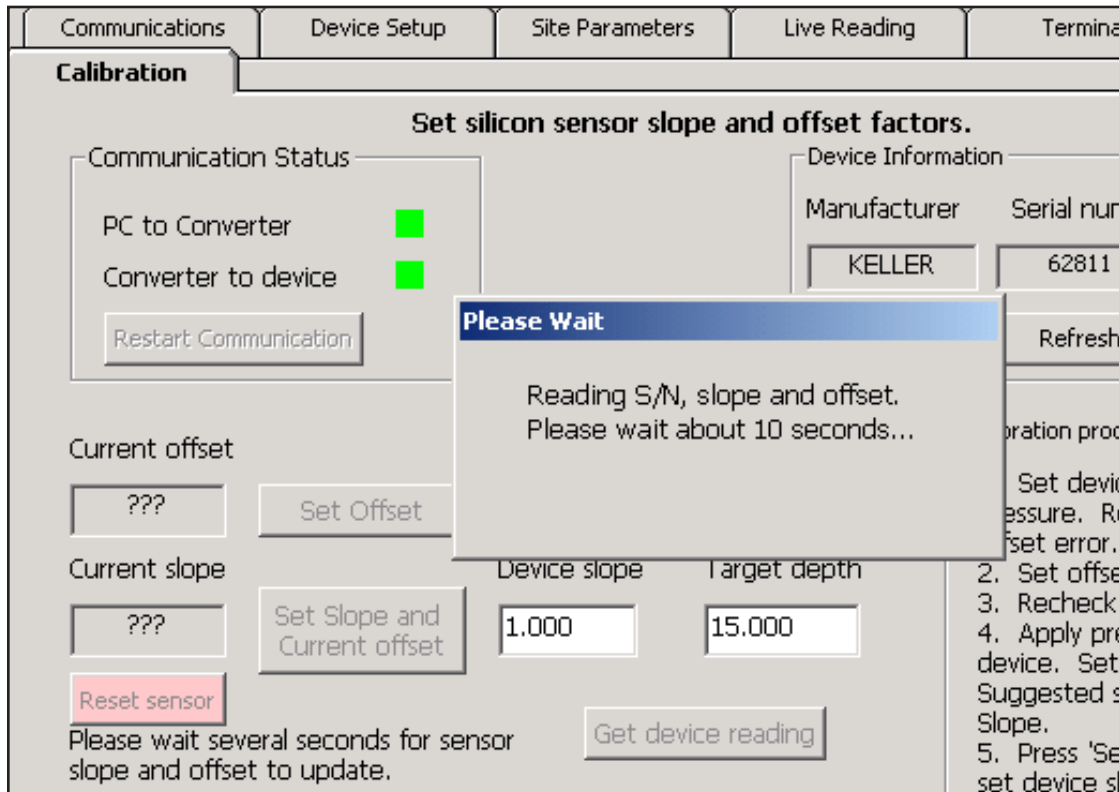


Figure 2 - Opening calibration Message

- 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.
- 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.

- 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:

$$-1 * (\text{current reading} - \text{current Digilevel probe offset})$$

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:

$$\text{Slope} = (\text{Actual_measurement} * \text{Digilevel_slope}) / \text{reading}$$

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 stuff). 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



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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, Pressure Systems/MSI 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: PSI

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

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 Keller Command Set

Command To Probe	Immediate Response	Response to D0 Commands	Description
?!	a (address of device)	a (address of device)	Wild card address
0A1!	1	1	Change address
aD0!	a+23.4+0	N/A	Request for data
al	a13--KELLER--30--1.0-62811	(address)	Identification of device
aM0! or aM!	a0024	a+0.080+0+ 22.655+0	Request depth/pressure and optionally temperature (depends upon XUM command setting)
aM1!	a0111	a+0.035	Request pressure as PSI. No offsets calculated by XE and XS commands are used.
aM2!	a0112	a+23.055+0	Request temperature and units of measure. Temperature always returned with 3 decimal digits
aM3!	a0013	a+2.307300+ 0.000000+ 0.000000	Request user slope, user offset, and XE/XS offset in PSI
aM4!	a0012	a+1.000000 +0.000000	Request standards lab slope and XE/XS offset in PSI
aM5!	a0012	a+23.173+0	Request temperature and units of measure

Command To Probe	Immediate Response	Response to D0 Commands	Description
aM6!	a0011	a+9.9	Request battery voltage
aM7!	a0114	a+0.082+0 +23.356+0	Request pressure and units and temperature and units of measure
aM8!	a0011	a+0	Return temperature units of measure
aM9!	a0013	a+1+0+0	Return same parameters as V command.
aR!	a	a	Continuous measurement of Depth/pressure and temperature
aV!	a0013	a+1+4+1	Return error status
aXC+0.02	a0012	a+1.000000 +0.03250	Force silicon sensor offset.
aXE+0.01 +1!	a0011	a+0.01000	Sets silicon sensor offset. This offset is added to silicon reading before any conversion to other units of measure takes place.
aXRM!	a0011	a+10	Requests number of samples used for averaging. Device performs 10 readings/second. Highest and lowest values are thrown away.
aXRO!	a0011	a+1.2345	Requests Offset set by XU or XWO command
aXRS!	a0011	a+1.0000	Requests slope set by XU or XWS command
aXS!	a0111	a-0.030850	Measure current pressure (device is as atmospheric pressure) and use that value as an offset to future readings. Command corrects for silicon offset.
aXS+1.5+0!	a0021	a+0.6175	Removes silicon sensor offset (as opposed to stage) from future measurements and add in requested offset in specified units of measure. Assumes device is vented to atmosphere. This command corrects for any drift in the silicon device from future measurements
aXSCS+4.5!	a0011	a+0.042696	Removes silicon sensor offset (as opposed to stage) from future measurements and add in requested offset in feet of water. Assumes device is vented to atmosphere. This command corrects for any drift in the silicon device from future measurements

Command To Probe	Immediate Response	Response to D0 Commands	Description
aXT+1!	a0011	a+10	Set averaging time, in seconds. Keller sensor reads 10 times/second. Highest and lowest values are thrown away
aXUM!	a0011	a+0	Requests measurement mode of M/M0/C/C0
aXUM+1!	a0011	a+1	Sets measurement mode of M/M0/C/C0
aXUP+3+5	a0012	a+3+5	Sets pressure units and # of decimal digits. Decimal digits is optional.
aXUT+0!	a0011	a+0	Set temperature units. 0 = C, 1 = F
aXUU+1.5 +3.56!	a0012	a+1.50000 +3.56000	Sets user slope and offset for pressure reading. Valid only when user units selected via XUP command
aXWCO+2!	a0011	0+0	Configure Keller device to emulate KPSI series 500, Water Log H-312, or DISI-1210
aXWMC+100!	a0011	a+110	Set number of samples for averaging. Number is converted to seconds of sampling time by the following formula: $(n/10)+1$
aXWO+1.5!	a0011	a+1.50000	Set stage offset to be used for future measurements. This value is used only when command XUP requests future M/M0/C/C0 or other depth/pressure measurement commands in user units.
aXWRM+15!	a0011	a+15	Put Keller device in continuous read mode for 'R' commands.
aXWRM!	a0011	a+9	Return number of minutes left for continuous read mode.
aXWS+2.345!	a0011	a+2.345000	Set stage slope to be used for future measurements. This value is used only when command XUP requests future M/M0/C/C0 or other depth/pressure measurement commands in user units.
aXV!	a0011	a+8.000	Requires minimum battery voltage to return valid depth/pressure.
aXV+8.5!	a0011	a+8.5	Sets minimum battery voltage for operation.

Additional Notes

All 'aMn!' and 'aCn!' commands support CRC when data is returned when using D0!. Simply add a 'C' before the command number. For example, M3 temperature measurement to unit 3, with CRC in return measurement, is: 3MC3! When 3D0! is sent to the probe, a CRC is appended just before the <CR><LF> sequence. Extended commands ('X' prefix) do not support CRC.

2.10 Extended Command Set

Commands listed below are not a part of the standard SDI-12 command set. These commands generally configure the probe for customized operation or return data.

Command to probe	Probe response	Description
aXEou!	a0011	Set new field calibration offset 'o' in 'u' units of measure (values 0-9, per below). This value is added to or subtracted from pressure sensor. Stage/offset values are not affected.
aD0!	a	Service response.
	add	Returns signed offset value in PSI, regardless of units of measure set above or by XUP command.
aXRCO!	a0011	Reads probe configuration as follows:
aD0!	a	Service response
	ad	Returns probe configuration. +0 = Digilevel mode +1 = Emulate Waterlog H-312 M! return values
aXRMC!	a0011	Request number of measurement (samples) to average depth/pressure readings.
aD0!	a	Service response.
	add	Returns number of depth/pressure measurements used for averaging. See "Averaging" below.
aXRO!	a0011	Request user offset. This command is short version of M3!.
aD0!	a	Service response.
	add	Returns user offset set by XWSd! or aXUUs! or aXWod! commands.
aXRS!	a0011	Request user slope. This command is short version of M3!.
aD0!	a	Service Response
	add	Returns user slope set by XWSd! or aXUUs! commands. aXS!

Command To Probe	Probe Response	Description
aXS! or aXSdu!	a0011	Probe makes a measurement and recalculates field offset to ensure subsequent depth/pressure readings are zero.
aD0!	a add	Service response. Returns new field offset in PSI units, regardless of units of measure used above or by XUP command.
aXSCSd!	a0011	Take a measurement and set stage/depth/offset to 'd'. Variable 'd' is in feet units of measurement.
aD0!	a add	Service response. Returns new field offset in PSI.
aXTt!	a0011	Set averaging time. If t = +0, then no averaging is performed. This command affects any command that requests a depth/pressure measurement. See table and averaging section above.
aD0!	a add	Service response. Returns number of samples used for sampling. Keller Digilevel probe samples at 10 times/second.
aXUM! or aXUMm!	a0011	Request to read M, MC, C, or CC measurement mode.
aD0!	a am	Set M, MC, C, or CC measurement mode to return depth/pressure only (m = +0) or include temperature data like M7/C7/MC7/CC7. Service request Return condition. When m = +1, depth/pressure only. When m = +1, return depth/pressure and temperature.
aXUPu! or aXUPud!	a0012	Set units of measure when depth/pressure command is issued.
aD0!	a aud	Set units of measure when a depth/pressure command is issued and set number of digits to right of decimal. Number of digits is from +0 to +7. Service response Returns +units of measurement selected and +number of digits to right of decimal point.

Command To Probe	Probe Response	Description
aXUTu!	a0011 a	Set temperature units of measurement. +0 = Celsius, +1 = Fahrenheit. Service response
aD0!	au	Returns temperature units of measurement.
aXUUso aD0!	a0012 a aso	Set user slope and offset. Subsequent depth/pressure measurement commands output = (psi)* user_slope + user_offset. NOTE: Be sure units of depth/pressure in XUP command are set to user units. Service response. Returns slope and offset. Example: aXUU+12.34+56.7 Sets slope to 12.34 and adds in offset of 56.7.
aXWCod! aD0!	a0011 a ad	Sets/configures probe as follows: When d = +0 Digilevel mode +1 Emulate Waterlog H-312 M! return values +2 Reset offsets and slope in EEPROM to factory default values. This includes reconfiguring to Keller Digilevel mode. Service response Returns probe configuration.
aXW0d!	a0011	Write user offset. Note that command XUU is similar in that it also writes slope. Service response Returns user offset 'd'. Example: aXWO+3.21! Send offset 3.21 a Service response aD0! Request reading of data sent a+3.21

Command to Probe	Probe Response	Description
aXWSd! aD0!	a0011 a ad	<p>Write user slope. Note that command XUU is similar in that it also writes offset.</p> <p>Service response</p> <p>Returns user slope 'd'.</p> <p>Example:</p> <p>aXWS+3.453! Send slope 3.453</p> <p>a Service response</p> <p>aD0! Request reading of data sent</p> <p>a+3.453</p> <p>This value is read by the XRS! command also</p>
aXWMCd! aD0!	a0011 a ad	<p>Write number of samples to average depth/pressure readings. This command is similar to XT command. Digilevel measures 10 times/second when averaging.</p> <p>Service response</p> <p>Returns number of samples for depth/pressure measurements. This same number is returned using the XRMC command.</p>

2.11 Emulation Mode Operation

The Keller Digilevel SDI probe can operate in “emulation modes” that enable the Digilevel to respond appropriately to extended commands normally endemic to the Design Analysis H-312, the Pressure Systems/MSI Series 500 and the Tavis DISI-1210. A complete cross-reference of all commands is provided on CD and is entitled Command Cross Reference. The example shown below is a cross reference for the Design Analysis H-312 only. The Keller probe enters this mode when the aXWCO+1! command is sent to the probe. When this happens, the probe resets to default parameters described in “Factory Default Parameters” above.

Primary differences between the Digilevel and H-312 mode is in what data is returned in response to M, M1-M5 and C, C1-C5 commands.

2.12 Overlapping Commands

There are a few commands that perform similar operations.

S-30 Commands	H-312 Commands	Description
XSdu	XSCSd	Take measurement and set stage/depth
XUUso	XWSd	XWSd sets user slope only. XUU sets offset as well in one command.
XUUso	XWod	XWod sets user offset only. XUU sets slope as well in one command.
M3	XRS	XRS returns user slope only. M3 returns offset as well. Use D0! to retrieve data.
M3	XRO	XRO returns user offset only. M3 returns slope as well. Use D0! to retrieve data.
XT	XWMC	XWMC sets the number of samples to average. XT sets the number of seconds to average. Digilevel probe always samples at 10 times/second.
M9/C9	V	All 3 of these commands perform the same probe verification.

2.13 Keller Digilevel and H-312 Operating Mode Differences

The Digilevel can be programmed to emulate a DAA/Waterlog H-312 probe. There are differences in the way the Digilevel and H-312 respond to SDI-12 commands and in the type of data returned.

The Digilevel probe operates in strict accordance to SDI-12 protocol. When sending a numerical value as part of a command, the polarity is required on the Digilevel probe. Polarity is optional when operating as an H-312. If polarity is omitted, '+' is assumed.

Example:

OXSCS23.4!	Note no polarity for 23.4. Valid in H-312 mode only.
OXSCS+23.4!	Polarity for 23.4 value. Required in Digilevel mode.

Returned values for commands M, M1, M2, M3, and M4 are different. These are listed below under Digilevel Probe SDI-12 Command Set. In H-312 mode, commands C, C1, C2, C3, and C4 will return the same 'M' series commands.

2.14 H-312 mode commands

When in the H-312 mode, the following commands operate differently than those listed above. These commands relate to the measurement mode.

Command to probe	Probe response	Description
aC!	attt4	Perform measurement. Time 'ttt' depends upon XWMC command.
aD0!	a+sss+ppp+cc+dd	Subsequent to the aC! command, data request is sent via aD0! command. Data returned is stage (sss), pressure (ppp), temperature (in C) (cc), and sensor voltage (dd).
aC1!	attt4	Perform temperature and pressure measurement. For compatibility only.
aD0!	aptpt	Returns pressure and temperature twice. "Raw" data is not returned. Same information is returned.
aC2!	a0011	Request temperature measurement.
aD0!	at	Returns temperature in C
aC3!	attt1	Request pressure measurement. Time depends upon setting in XWMC command Default is 11 seconds.
aD0!	ap	Returns pressure measurement in PSI.
aC4!	a0011	Request battery voltage at probe.
aD0!	av	Returns battery voltage.
aM!	attt4	Perform measurement. Time 'ttt' depends upon XWMC command.
aD0!	s a+sss+ppp+cc+dd	Service request. Subsequent to the aM! command, data request is sent via aD0! command. Data returned is stage (sss), pressure (ppp), temperature (in C) (cc), and sensor voltage (dd).
aM1!	attt4	Perform temperature and pressure measurement. For compatibility only.
aD0!	a aptpt	Service request Returns pressure and temperature twice. "Raw" data is pressure without stage/offset.
aM2!	a0011	Request temperature measurement.
aD0!	a at	Service request Returns temperature in C.

Command To Probe	Probe Response	Description
aM3!	attt1	Request pressure measurement. Time depends upon setting in XWMC command Default is 11 seconds.
	a	Service request
aD0!	ap	Returns pressure measurement in PSI.
aM4!	a0011	Request battery voltage at probe.
	a	Service request
aD0!	av	Returns battery voltage.
aV!	a0013	Initiate verify command.
	a	Service request
aD0!	a+d+d+y	Always returns +123.456+78.9+. Last number is either a 0 or 1. If 1, means all is OK. If 0, then there was a problem with the sensor head. All errors are cleared with the V command. The next V command issued should return a 1. If not, then the probe is probably bad.
aXRO!	a0011	Request stage/offset setting
	a	Service request
aD0!	ad	Returns offset/stage in feet. It is used to calculate the first parameter in the M! command.
aXRS!	a001	Request stage slope.
	a	Service Request
aD0!	ad	Returns slope value programmed by XWO!. This number multiplies the PSI reading to convert to user units. For feet, this is 2.306. It is used to calculate the first parameter in the M! command.