Model
H-334

Absolute Shaft Encoder with
LCD Display & 4-20mA Output

WATERLOG® SERIES

Owner's Manual
Version 1.0

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Chapter 1
Introduction

1.0 Introduction

The ***WATER*LOG®** H-334 is a digital shaft encoder which measures water depth by monitoring the position of a float and pulley. The H-334 is easy to use and works with any SDI-12 data recorder. The "Serial-Digital Interface" is ideal for data logging applications with the following requirements:

- Battery powered operation with minimal current drain
- Multiple sensors on a simple three-wire cable
- Up to 250 feet of cable between a sensor and the data recorder
  (Use of H-423, SDI-12 to RS485 converter extends the range to 1000's of feet)

The H-334 has the following features:

- Non-contact optical encoder
- Absolute, shaft position is not lost if the power fails or is disconnected
- High resolution (65,536 counts/rev)
- ±32,768 max turns
- Zero backlash
- Scales the encoder position into user units of feet, meters, etc.
- Precision ball bearing design with special low temperature lubricant
- Threaded shaft compatible with older mechanical shaft encoders
- Sealed enclosure protects from moisture and dirt
- Low current operation (less than 150 microamps typical standby)
- Water resistant connector provides easy hookup
- Continuous display readout always shows last measured value.
- 'Read' button causes the H-334 to continuously update the display while the button is pressed
- Front panel adjustment for manually setting the stage
- Front panel control for setting the SDI-12 address

1.1 Operation

The H-334 is a precision shaft encoder with a resolution of 65,536 counts per revolution (.000015 feet with 1.0 ft circumference pulley). Internally the H-334 has two non-contact encoders mounted on the same shaft. An optical encoder measures the shaft angle and a magnetic turns counter counts the number of revolutions. The optical rotary position sensor measures the shaft angle within a 360° range. As opposed to incremental encoders, the optical encoder measures the absolute position rather than the change in position. Internally, an infrared LED flashes through a circular bar code onto a linear array sensor. A microcontroller decodes the image into a unique position. Due to manufacturing tolerances of the bar code, the accuracy is less than the resolution; 4096 counts per revolution (.00024 feet with 1.0 ft circumference pulley). The turn counter monitors complete revolutions of the shaft and can count up to ±32,768 revolutions. Together the encoders provide an "absolute" measurement. The shaft position will not be lost if the power is removed, even if the shaft rotates while the power is off.

During normal operation, the SDI-12 data recorder sends an address together with a command to the H-334. The H-334 wakes up from its low power sleep mode, converts the shaft position into feet, meters or other units and stores this data in its data buffer. Once the data is ready, the data recorder collects the data from the H-334's data buffer.

1.2 LCD Display

The H-334 has a 4-1/2 digit LCD display which shows the last measured value. The display uses negligible power and is always visible. The display will show either ±199.99 or ±19999 digits depending on how the H-334 is configured.

1.3 'Read" Button

When pressed, the 'Read' button causes the H-334 to continuously make measurements and update the display. The "±" sign flashes while making measurements indicating the display is being updated even if the value is not changing. When the button is released the display will hold the last measured value. Measurements initiated from an attached SDI-12 data logger will also cause the display to update.

1.4 Using the Adjust Knob to Change the Stage

The offset adjustment is a rotary digital encoder which is accessed by removing the attached dust cover. The encoder has a slot and is easily rotated with a screwdriver or other flat blade tool. Replace the dust cap whenever the adjustment is not being used.

While the 'Read' button is pressed, the Adjust screw may be turned to increase or decrease the current *Stag*e reading. Turn the adjustment screw clock-wise to increase the *Stage* and counter-clock wise to decrease the *Stage*. Turning the adjust screw slowly will change the hundredths digit while turning the screw fast changes the tenths digit. This allows one control to make both fine and course adjustments.

1.5 Using the Adjust Knob to Change SDI-12 Address

If the 'Read' button is held down while the H-334 is being powered up, the display will show the H-334's current SDI-12 address. The SDI-12 address may be changed using the Adjust screw. Turning the Adjust screw will change the address in the range of 0 to 9. When the Read button is released, the new SDI-12 address is saved and the display switches to the normal stage readout. To change the SDI-12 address again, the power must be disconnected and the special power-up sequence repeated. The H-334's address may also be changed with an extended SDI-12 command (See Chapter 3).

1.6 4-20mA Output

The H-334 has a 12-bit digital-to-analog converter (DAC), precision voltage reference and a 4-20mA current transmitter. The SDI-12 and 4-20mA sections are isolated from each other with a high voltage digital opto-coupler. The *Stage* is scaled into a 12-bit value and loaded into the digital-to-analog converter to control the current transmitter.

The 4-20mA output is updated whenever a measurement is made. If no measurements are made, the 4-20mA output becomes "stale". For industrial applications where the H-334 is connected to a SCADA or PLC system and low-power is not of concern, the H-334 can be programmed to make continuous measurements. See Chapter 3 for details. The H-334 comes from the factory with the power mode set to the *Sleep* mode.

Note: When the H-334 is first powered up, the output current is set to 4.0mA. It remains at 4.0mA until the first measurement sequence. The digital-to-analog converter is powered from the loop side of the opto-isolator. If the loop power is disconnected or is applied after the SDI-12 side is powered up, the data in the digital-to-analog converter will be lost. When the loop power is restored, the 4-20mA output will be at an unknown value. Once a fresh SDI-12 measurement is made, the digital-to-analog converter will be loaded with new valid data.

Chapter 2
H-334 Installation

2.0 Installation

The H-334 is suitable for outdoor environments but must be installed in a protective enclosure or gauge house. Normally, the H-334 is screwed or bolted to a shelf in the gauge station with the pulley and tape protruding over the edge of the shelf above the water. Make certain the housing is level and the pulley and tape do not rub on any obstructions.

2.1 Making Output Connections to the H-334

The H-334 is a SDI-12 V1.2 compliant sensor. It connects directly to any data recorder with SDI-12 capability. In addition, the H-334 has an optically isolated, 4-20mA output.

The power for the H-334 is supplied by the SDI-12 +12V input. Table 1 shows the proper connections. Refer to the wiring diagram printed on the H-334's product label. A 7-conductor cable is supplied with the H-334.

Table 1
Cable Connections

Pin	Wire	Name
1	Red	+12Volt DC
2	Black	Ground
3	Green	Ground
4	Yellow	SDI-12 Data
5	Orange	4-20mA +
6	Brown	4-20mA -
7	Blue	N/C
8		N/C
9		N/C

2.2 4-20mA Output

Current loop sensors output a current rather than a voltage. The 4-20mA output will drive standard industrial telemetry and process control instrumentation. Since the signal to noise margin of 4-20mA is not large, take care to protect the wiring from noise and interference. The loop power supply must be sufficient to maintain 8.5 to 35V across the H-334's output terminals, in addition to whatever voltage is needed to maintain 20mA across the loop receiver and interconnect wiring. The +12.0V SDI-12 power source will work if the resistance of your loop receiver and wiring is less than 150 ohms.

8.5V + (150ohms * 20mA) = 11.5V

The 4-20mA output is reverse diode protected.

- Make certain there is 8.5 to 35V across the 4-20mA output terminals.
- Make certain the H-334 is receiving +12V power from the SDI-12 bus.
- Use shielded 4-20mA cables in noisy environments.

2.3 Programming Your Data Recorder

You must prepare your data recorder to receive and record the H-334 data. Since data recorders differ widely, refer to your recorder manufacturer's directions. In general, program the data recorder to input three values via the SDI-12 port. Usually only one or two of the parameters is actually recorded. Your data recorder must issue an "aM!" command, then collect the data with a "aD0" command, as explained in Chapter 3. The H-334 places three parameters in its data buffer:

a+BB.BBB+CC.CCC+D

Where:

a	= Is the SDI-12 address 0-9, A-Z
BB.BBB	= *Stage* in user units of Feet, Meters etc.
CC.CCC	= Raw encoder position in units of revolutions (turns)
D	= Encoder status:

0 = no error
1 = not enough light
2 = too much light
3 = misalignment or dust
4 = misalignment or dust
5 = misalignment or dust
6 = hardware problem
7 = fast mode error
8 = multi turn position not initialized
15 = no response from the encoder (data is unusable)
16 = turn counter error (data is unusable)

2.4 Programming the H-334

The H-334 comes from the factory with the following settings:

SDI Address:	0
StageSlope:	1.00
StageOffset :	0.000
LCD_Digits:	2 = "±199.99"
Power_Mode:	0 = "Sleep"
4-20mA_Hi:	20.0
4-20mA_Lo:	4.0

With these values the data will be in units of feet when used with a pulley having a circumference of 12 inches. The slope can be changed to accommodate other pulley circumferences or to change the data to other engineering units such as inches or Meters. The setups are stored in EEPROM within the H-334 and will not be lost if the power is disconnected. The extended commands for changing these setups are described in detail in Chapter 3.

2.5 Programming the SDI-12 Address

If more than one sensor is to be connected to the SDI-12 bus, make certain each sensor has a different sensor address. The H-334 comes from the factory with its address set to "0". The address can be programmed with either an extended SDI-12 command (see Chapter 3) or using the offset adjust control on the H-334's faceplate. To change the address with the adjust control, press and hold the 'Read' button while the H-334 is being powered up, the display will show the H-334's current SDI-12 address. The SDI-12 address may be changed in the range of 0 to 9 using the adjust screw. When the Read button is released the new SDI-12 address is saved and the display switches to the normal stage readout. To change the SDI-12 address again, the power must be disconnected and the special power-up sequence repeated.

2.6 Setting the Stage

Many applications use the shaft encoder to monitor water in a stilling well. A float and pulley translate the water level to rotation of the encoder's shaft. Because the H-334 is an absolute encoder, the turn count and shaft angle cannot be "reset". When the H-334 is first installed, you will want to adjust the *StageOffset* such that the LCD display and SDI-12 data correspond to the current water elevation or stage as determined with a staff gauge or other datum.

With the shaft pointing toward you, rotating the encoder shaft clockwise produces an increasing (positive) shaft position value. If this is backwards from your needs, either program the *StageSlope* with a negative value, or exchange the float and counter weight on the pulley.

To adjust the *Stage,* press the "Read" button and rotate the Adjust screw on the faceplate. Turn the adjustment screw clock-wise to increase the Stage and counter-clock wise to decrease the Stage. Turning the adjust screw slowly will change the hundredths digit while turning the screw fast changes the tenths digit. This allows one control to make both fine and course adjustments.

Alternatively, an extended SDI-12 command is convenient to quickly set the H-334's *Stage* reading to match the current water level. The "aXSCSdd.d!" command causes the H-334 to make a fresh measurement and automatically update the *Offset* as needed to produce the desired *Stage*. See Chapter 3 for details.

Example of a H-334 Extended "Set Current Stage" command:

Command	Response	Time	Values	Description
"aXSCS2.3!"	"a0021<cr><lf>"	2 sec	1	Set the *Stage* to 2.3

Subsequent Command	Response	Description
"aD0"	a+12.80<cr><lf>	The new *Offset*

2.7 Programming the 4-20mA Output

The H-334 scales the current *Stage* data to drive the 4-20mA output. The *4-20mA_Hi* and *4-20mA_Lo* settings control how the *Stage* data is processed. The *4-20mA_Lo* should be set to the desired *Stage* corresponding a 4.00mA output. The *4-20mA_Hi* should be set to the desired *Stage* corresponding to a 20.00mA output. For testing purposes, the H-334 comes from the factory with *4-20mA_Hi* = 20.0 and *4-20mA_Lo* = 4.00. See Chapter 3 for details on programming these settings.

The extended "aXS!" command allows convenient testing of the 4-20mA output. This command allows the user to temporarily force the *Stage* to a test value. For example, the user can force the shaft position (*Stage*) to several different values while calibrating or monitoring the attached 4-20mA instrumentation. Once a fresh measurement is made via a SDI-12 measurement or by pressing the "Read" button, the temporary *Stage* data is overridden.

2.8 Testing

After completing the installation, test the encoder by manually rotating the pulley. Press and hold the "Read" button to observe the *Stage* data. Make certain the readout matches the expected measurement.

Chapter 3
SDI-12 Command and Response Protocol

3.0 SDI-12 Command and Response Protocol

This is a brief description of the Serial Digital Interface (SDI-12) Command and Response Protocol used by the ***WATER*LOG®** Series Model H-334 sensor. Included is a description of the commands and data format supported by the H-334.

Refer to the document "A SERIAL DIGITAL INTERFACE STANDARD FOR HYDROLOGIC AND ENVIRONMENTAL SENSORS." Version 1.2 April 12, 1996 Coordinated by the SDI-12 Support Group, 135 East Center, Logan, Utah.

During normal communication, the data recorder sends an address together with a command to the H-334 *SDI-12* sensor. The H-334 then replies with a "response." In the following descriptions, SDI-12 commands and responses are enclosed in quotes. The SDI-12 address and the command/response terminators are defined as follows:

"a" Is the sensor address. The following ASCII Characters are valid addresses: "0-9", "A-Z", "a-z", "*", "?". Sensors will be initially programmed at the factory with the address of "0" for use in single sensor systems. Addresses "1 to 9" and "A to Z" or "a to z" can be used for additional sensors connected to the same SDI-12 bus. Address "*" and "?" are "wild card" addresses which select any sensor, regardless of its actual address.

"!" Is the last character of a command block.

"<cr><lf>" Are carriage return (0D) hex and line feed (0A) hex characters. They are the last two characters of a response block.

Notes:

- All commands/responses are upper-case printable ASCII characters.
- Commands must be terminated with a "!" character.
- Responses are terminated with <cr><lf> characters.
- The command string must be transmitted in a contiguous block with no gaps of more than 1.66 milliseconds between characters.

3.1 Measure Command

The Measure Command causes a measurement sequence to be performed. Data values generated in response to this command are stored in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another "M", " C", or "V" command is executed.

Command	Response	Description
"aM!"	"atttn<cr><lf>"	Initiate measurement

Where:

a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
M	is an upper-case ASCII character
ttt	is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have measurement data available in its buffer.
n	is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands.

Upon completion of the measurement, a service request "a<cr><lf>" is sent to the data recorder indicating the sensor data is ready. The data recorder may wake the sensor with a break and collect the data any time after the service request is received or the specified processing time has elapsed.

Example of a H-334 "aM!" command:

Command	Response	Time	Values	Description
"aM!"	"a0023<cr><lf>"	2 sec	3	Make measurement

Subsequent Command	Response
"aD0"	a+AA.AAA+BB.BBB+CC<cr><lf>

Where:

AA.AAA = Stage
BB.BBB = Raw Encoder Position (turns)
CC = Encoder Status**:**

0 = no error
1 = not enough light
2 = too much light
3 = misalignment or dust
4 = misalignment or dust
5 = misalignment or dust
6 = hardware problem
7 = fast mode error
8 = multi turn position not initialized
15 = no response from the encoder (data is unusable)
16 = turn counter error (data is unusable)

3.2 Concurrent Measurement Command

This is a new command for the Version 1.2 SDI-12 Specification. A concurrent measurement is one which occurs while other SDI-12 sensors on the bus are also taking measurements. This command is similar to the “aM!” command, however, the nn field has an extra digit and the sensor does not issue a service request when it has completed the measurement. Communicating with other sensors will NOT abort a concurrent measurement. Data values generated in response to this command are stored in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another "M", "C", or "V" command is executed.

Command	Response	Description
"aC!"	"atttnn<cr><lf>"	Initiate measurement

Where:

- a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
- C is an upper-case ASCII character
- ttt is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have measurement data available in its buffer.
- nn is a two digit integer (00-99) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands.

The data recorder may wake the sensor with a break and collect the data anytime after the specified processing time has elapsed.

3.3 Send Data Command

The Send Data command returns sensor data generated as the result of previous "aM!", "aC!", or "aV!" commands. Values returned will be sent in 33 characters or less. The sensor's data buffer will not be altered by this command.

Command	Response
"aD0!" through "aD9!"	"apd.d ... pd.d<cr><lf>"

Where:

a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
D0..D9	are upper-case ASCII characters.
p	Is a polarity sign (+ or -)
d.d	represents numeric digits before and/or after the decimal. A decimal may be used in any position in the value after the polarity sign. If a decimal is not used, it will be assumed to be after the last digit. For example: +3.29 +23.5 -25.45 +300

If one or more values were specified and a "aD0!" returns no data (a<CR><LF> only), it means that the measurement was aborted and a new "M" command must be sent.

Example of a H-334 "aD0!" command:

Previous Command	Response
"aM!"	"a0023<cr><lf>"

Subsequent Command	Response
"aD0"	a+AA.AAA+BB.BBB+CC<cr><lf>

Where:

AA.AAA	= Stage
BB.BBB	= Raw Encoder Position
CC	= Encoder Status *(see aM! command)*

3.4 Continuous Measurements

This is a new command for the Version 1.2 SDI-12 Specification. Sensors that are able to continuously monitor the phenomena to be measured, such as a cable position, do not require a start measurement command. They can be read directly with the R commands (R0!...R9!). The R commands work exactly like the D (D0!...D9!) commands. The only difference is that the R commands do not need to be preceded with an M command.

The H-334 **DOES NOT** support the aR0! continuous measurement commands.

3.5 Send Acknowledge Command

The Send Acknowledge Command returns a simple status response which includes the address of the sensor. Any measurement data in the sensor's buffer is not disturbed.

Command	Response
"a!"	"a<cr><lf>"

Where: a Is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

3.6 Initiate Verify Command

The Verify Command causes a verify sequence to be performed. The result of this command is similar to the "aM!" command except that the values generated are fixed test data and the results of diagnostic checksum tests. The data generated in response to this command is placed in the sensor's buffer for subsequent collection using "D" commands. The data will be retained in the sensor until another "M", "C", or "V" command is executed.

Command	Response	Description
"aV!"	"atttn<cr><lf>"	Initiate verify sequence

Where:

a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").

V is an upper-case ASCII character.

ttt is a three digit integer (000-999) specifying the maximum time, in seconds, the sensor will take to complete the command and have data available in its buffer.

n is a single digit integer (0-9) specifying the number of values that will be placed in the data buffer. If "n" is zero (0), no data will be available using subsequent "D" commands

Example of a H-334 "aV!" command:

Command	Response	Time	Values	Description
"aV!"	"a0013<cr><lf>"	1 sec	3	Return fixed data and diagnostic data for testing purposes.

Subsequent Command	Response
"aD0"	a+123.456+78.9+y<cr><lf>

Key	Description	Units
+123.456	Fixed test data	
+78.9	Fixed test data	
y	ROM checksum test	0 = Failed, 1 = Passed

3.7 Send Identification Command

The Send Identification Command responds with sensor vendor, model, and version data. Any measurement data in the sensor's buffer is not disturbed.

Command	Response
"aI!"	"allcccccccccmmmmmmvvvxx...xx<cr><lf>"

Where:

a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
I	is an upper-case ASCII character.
ll	is the SDI-12 version compatibility level, e.g. version 1.2 is represented as "12".
cccccccc	is an 8 character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation.
mmmmmm	is a 6 character field specifying the sensor model number.
vvv	is a 3 character field specifying the sensor version number.
xx...xx	is an optional field of up to a maximum of 13 characters to be used for serial number or other specific sensor information not relevant to operation of the data recorder.

Example of a H-334 "aI!" command:

"a12 DAA H-334vvvS#nnnnnnVkkk<cr><lf>"

H-334 implementation of the optional 13 character field:
S#nnnnnnVkkk (12 bytes total)

Where:

"nnnnnn"	is a six character sensor serial number
"kkk"	is a three digit sensor firmware revision level

3.8 Change Sensor Address

The Change Sensor Address Command allows the sensor address to be changed. The address is stored in non-volatile EEPROM within the sensor. The H-334 will not respond if the command was invalid, the address was out of range, or the EEPROM programming operation failed.

Command	Response	Description
"aAn!"	"n<cr><lf>"	Change sensor address

Where:

a — is the current (old) sensor address ("0-9", "A-Z", "a-z", "*", "?"). An ASCII "*" may be used as a "wild card" address if the current address is unknown and only one sensor is connected to the bus.

A — is an upper-case ASCII character.

n — is the new sensor address to be programmed ("0-9", "A-Z", "a-z", "*", "?").

NOTE: To verify the new address use the "Identify Command."

Example of a "Change Sensor Address" command:

Command	Response	Description
"aA2!"	"2<cr><lf>"	Change sensor address to "2"

3.9 Extended Set_Stage

This command is used for convenience in testing the 4-20mA output. This command allows the user to temporarily force the *Stage* to a test value. For example, the user can force the shaft position (*Stage*) to several different values while calibrating or monitoring the attached 4-20mA instrumentation. Once a fresh measurement is made via a SDI-12 measurement or by pressing the "Read" button, the temporary *Stage* data is overridden.

Example of a H-334 Extended "Set Stage" command:

Command	Response	Time	Values	Description
"aXS2.3!"				Set the *Stage* to 2.3

3.10 Extended Set_Current_Stage

The H-334 processes the raw shaft position with a *Stage* = mX+b equation. During installation it is convenient to quickly set the H-334's *Stage* reading to match the current stage or elevation of the water as determined by a staff gauge or other datum. This command causes the H-334 to make a fresh measurement and automatically update the *Offset* (b) term as needed to produce the desired *Stage*.

Example of a H-334 Extended "Set Current Stage" command:

Command	Response	Time	Values	Description
"aXSCS2.3!"	"a0021<cr><lf>"	2 sec	1	Set the *Stage* to 2.3

Subsequent Command	Response	Description
"aD0"	a+12.80<cr><lf>	The new *Offset*

3.11 Extended Read/Write *Stage_Offset* and Read/Write *Stage_Slope*

The H-334 processes the raw shaft position with a *Stage* = mX+b equation. The *Slope* (m) and *Offset* (b) terms are programmable, allowing the user to scale the reading into other engineering units. These commands allow the user to read or write (change) the *Stage_Slope* and *Stage_Offse*t terms. The slope is set to 1.00 and the offset to 0.00 at the factory. With the *Stage_Slope* set to 1.00 the *Stage* will be in units of shaft revolutions (1 rev =1.0). The new values are stored in non-volatile EEPROM within the sensor. Once the new *Stage_Slope* or *Stage_Offset* value is written to the EEPROM, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "D" command. To verify these settings any other time, use the "XRSS" or "XRSO" commands.

Command	Response	Description
"aXRSS!"	"a0011<cr><lf>"	Read *StageSlope*
"aXRSO!"	"a0011<cr><lf>"	Read *StageOffse*t
"aXWSSddd!"	"a0011<cr><lf>"	Write *StageSlope*
"aXWSOddd!"	"a0011<cr><lf>"	Write *StageOffset*

Where:	a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
	XRSS	are upper case characters.
	XRSO	are upper case characters.
	XWSS	are upper case characters.
	XWSO	are upper case characters.
	ddd	is the new slope or offset value (For example: 20.0 0.195 -500)

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the slope or offset.

Example of a H-334 Extended "Read *Stage_Slope*" command:

Command	Response	Time	Values	Description
"aXRSS!"	"a0011<cr><lf>"	1 sec	1	Read *StageSlope*

Command	Response	Description
"aD0!"	"a+1.00<cr><lf>"	*StageSlope* is 1.00

Example of a H-334 Extended "Write *Stage_Slope*" command:

Command	Response	Time	Values	Description
"aXWSS1.234!"	"a0011<cr><lf>"	1 sec	1	Write *StageSlope*

Command	Response	Description
"aD0!"	"a+1.234<cr><lf>"	*StageSlope* is 1.234

3.12 Extended Read/Write *4-20mA_Hi* and Read/Write *4-20mA_Lo*

The H-334 scales the current *Stage* data to drive the 4-20mA output. The *4-20mA_Hi* and *4-20mA_Lo* settings control how the *Stage* data is processed. The *4-20mA_Lo* should be set to the desired *Stage* corresponding a 4.00mA output. The *4-20mA_Hi* should be set to the desired *Stage* corresponding to a 20.00mA output. These settings are stored in non-volatile EEPROM within the sensor. Once the new value is written to the EEPROM, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "D" command. To verify these settings any other time, use the "XRIH" or "XRIL" commands. For testing purposes, the H-334 comes from the factory with *4-20mA_Hi* = 20.0 and *4-20mA_Lo* = 4.00.

Command	Response	Description
"aXRIH!"	"a0021<cr><lf>"	Read *4-20mA_Hi*
"aXRIL!"	"a0021<cr><lf>"	Read *4-20mA_Lo*
"aXWIHddd!"	"a0021<cr><lf>"	Write *4-20mA_Hi*
"aXWILddd!"	"a0021<cr><lf>"	Write *4-20mA_Lo*

Where:	a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
	XRIH	are upper case characters.
	XRIL	are upper case characters.
	XWIH	are upper case characters.
	XWIL	are upper case characters.
	ddd	is the new value.

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the slope or offset.

Example of a H-334 Extended "Read 4-20mA_Hi" command:

Command	Response	Time	Values	Description
"aXRIH!"	"a0011<cr><lf>"	1 sec	1	Read *4-20mA_Hi*

Command	Response	Description
"aD0!"	"a+20.00<cr><lf>"	4-*20mA_Hi* is 20.00

Example of a H-334 Extended "Write 4-20mA_Hi" command:

Command	Response	Time	Values	Description
"aXWIH30.0!"	"a0011<cr><lf>"	1 sec	1	Write *4-20mA_Hi*

Command	Response	Description
"aD0!"	"a+30.0<cr><lf>"	*4-20mA_Hi* is 30.00

3.13 Extended Read *LCD_Digits* and Write *LCD_Digits*

The LCD display can display the *Stage* in one of two formats: ±199.99 or ±19999. This command is used to change the format. The default 2-digit format (±199.99) is used when displaying the shaft position in units of feet or inches. The 0-digit format (±19999) format is useful for display in millimeters (0 thru 19.999 meters).

Once a new value is written, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "D" command. To read or verify the value any other time, use the "XRLCD" command.

Command	Response	Description
"aXRLCD!"	"a0011<cr><lf>"	Read *LCD_Digits*
"aXWLCDn!"	"a0011<cr><lf>"	Write *LCD_Digits*

Where:	a	is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
	XRLCD	are upper case characters.
	XWLCD	are upper case characters.
	n	is the new setting (0 or 2)
		0 = ±19999.
		2 = ±199.99

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-334 Extended "Read *LCD_Digits*" command:

Command	Response	Time	Values	Description
"aXRLCD!"	"a0011<cr><lf>"	1 sec	1	Read *LCD_Digits*

Command	Response	Description
"aD0!"	"a+2<cr><lf>"	Format is ±199.99

Example of a H-334 Extended "Write *LCD_Digits*" command:

Command	Response	Time	Values	Description
"aXWLCD0!"	"a0011<cr><lf>"	1 sec	1	Write *LCD_Digits*

Command	Response	Description
"aD0!"	"a+0<cr><lf>"	Format is ±19999.

3.14 Extended Read *Power_Mode* and Write *Power_Mode*

The 4-20mA output is updated whenever a measurement is made. For industrial applications where the H-334 is connected to a SCADA or PLC system and low-power is not of concern, the H-334 can be programmed to make continuous measurements. This command is used to change the power mode. The H-334 comes from the factory with the power mode set to the *Sleep* mode.

Once a new value is written, a copy is sent to the sensor data buffer for verification. This data can be viewed by using a subsequent "D" command. To read or verify the value any other time, use the "XRPMD" command.

Command	Response	Description
"aXRPMD!"	"a0011<cr><lf>"	Read *Power_Mode*
"aXWPMDn!"	"a0011<cr><lf>"	Write *Power_Mode*

Where: a is the sensor address ("0-9", "A-Z", "a-z", "*", "?").
XRPMD are upper case characters.
XWPMD are upper case characters.
n is the new setting (0 or 1)
0 = Sleep between measurements
1 = Make continuous measurements

This command takes 001 seconds to complete and places 1 value in the data buffer. Use the "aD0" command to collect and view the current value.

Example of a H-334 Extended "Read *Power_Mode*" command:

Command	Response	Time	Values	Description
"aXRPMD!"	"a0011<cr><lf>"	1 sec	1	Read *Power_Mode*

Command	Response	Description
"aD0!"	"a+0<cr><lf>"	Mode = Sleep

Example of a H-334 Extended "Write *Power_Mode*" command:

Command	Response	Time	Values	Description
"aXWPMD1!"	"a0011<cr><lf>"	1 sec	1	Write *Power_Mode*

Command	Response	Description
"aD0!"	"a+1<cr><lf>"	Mode = Always On

3.15 Extended "XTEST"

This command is used for installation or production testing and requires the use of a H-419 Sidekick interface and a PC. This command causes the H-334 to transmit unsolicited real-time data for testing purposes. The test mode is used to help troubleshoot the installation by providing a continuous readout of shaft position. This is not compliant with the SDI-12 specification and is not used with data loggers.

To activate the test mode, send the command "aXTEST!" from the PC. The H-334 will enter the test mode and automatically display 3 new measurements per second. The test mode is exited by sending a break or any new command on the SDI-12 bus. It may take a few tries to exit if the command is sent at the same time data is being sent from the H-334. Removing power from the H-334 also causes it to exit this mode.

Format= *SensorAddress*+*Stage*+*RawShaftPosition*+*EncoderStatus*

"aXTEST" displays the following data:

```
a +1.202 +3.222 +0
a +1.212 +3.232 +0
a +1.222 +3.342 +0
a +1.232 +3.352 +0
a +1.232 +3.352 +0
```
etc.

Appendix A
Specifications

General

Input:	Shaft angle + Turn count
Encoder:	Absolute, non-contact (optical & magnetic)
Outputs:	SDI-12 & 4-20mA
Display:	4-1/2 digits x .4 in characters (±199.99 or ±19999.)
Resolution:	65,536 (16-bit) counts/rev
Accuracy:	1/4096 (.00024 rev)
Max Turns:	±32,768 rev
Max Rotation Speed:	20 rev/sec
Offset Adjust:	SDI-12 or front panel adjust

4-20mA Output

Type:	4-20mA, optically isolated
Loop Voltage:	8.0V min, 35V max, loop powered
Resolution:	4μA (12-bit DAC)

SDI-12 Output

Baud Rate:	1200
Protocol:	SDI-12, 7-bit even parity, 1 stop bit
Output Voltage Levels:	
Minimum high level:	3.5 volts
Maximum low level:	0.8 volts
Maximum Cable Length:	250 ft.

Power Requirements

Voltage Input:	9.6 to 16.0 Volts DC
Current:	150μA typical (sleep mode)
	40mA typical (making measurement)
Turn Count Battery (internal):	
Type:	CR-1/3N (3.3V, 160mAh, lithium)
Lifetime:	10 years

Environmental

Operating Temperature:	-40 to 60 °C
Storage Temperature:	-40 to 70 °C
Humidity:	0 to 100%

Mechanical

Bearing:	Double bearing with external seal
Starting Torque:	0.15 oz·in typical
	0.50 oz·in max over temperature
Standard Shaft:	5/16" dia x 1.25" long with setscrew flat
Optional Threaded Shaft:	5/16" dia x 1.75" long 24-threads per inch x 0.75"
Material:	Anodized Aluminum
Size:	5.25 in. wide (housing)
	7.0 in. wide (mount flange)
	4 in. deep (not incl. shaft or connectors)
	4.25 in. high (not including adjust knob)

Connector

H-334:	AMP 206486-1	(9-Pin male)
Cable:	AMP 206485-1	(9-Pin female)
	(One cable provided with the H-334)	

Warranty

***WATER*LOG®** H-334 is warranted against defects in materials and workmanship for one year from date of shipment.