RIEKER inc.

User Programmable
Digital RS485
Current 0..24mA
Voltage 0..10V
Open Collector Switch
Dual & Single Axis
Up to 360º

2019

Flex™ H6 User Guide

Sensor Specifications, Installation, & Wiring

Flex™ H6 User Guide

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Sensor Description

The Flex™ H6 inclinometer provides highly accurate, dual axis inclination over a range of ±180°. These sensors incorporate MEMS accelerometers referenced to gravity with integrated temperature compensation over the full industrial operating range of -40° to +85°C for absolute accuracy. They have both digital RS485 and analog outputs. Both outputs are linear with respect to the input angle directly.

The digital RS485 output uses two-wire, half duplex communication, along with a Rieker specific protocol. This protocol can be used to measure the angle of both axes, as well as configure the various digital and analog parameters of the sensor.

The H6 provides two continuous, fully configurable, analog outputs. These outputs can be individually set to current, voltage or open collector switch modes. Each analog output can be mapped to either axis.

The voltage output can be set to any value between 0V and 10V and to any angle range between ±180°. The current output can be set to any value between 0mA and 24mA and to any angle range between ±180°. The open collector switch output connects to signal common and can be set to trip above, below, between, or outside any angle threshold or window range. Each open collector switch can drive up to 250mA (to be used directly or to drive an external relay).

Also as an optional enhancement, the H6 has to ability to log angle data to a microSD card.

Updates & Revision History

The information in this guide may be subject to change. Please visit www.riekerinc.com for latest version of this document.

TABLE 1: REVISION HISTORY		
REV	**DATE**	**DESCRIPTION**
A	3/14/2018	Initial Release

Sensor Specifications

INPUT PARAMETERS			
SUPPLY VOLTAGE	+11..36 VDC Non-Regulated		
SUPPLY CURRENT[1]	22mA @ 24VDC (Digital Output only)		
	30mA nominal @ 24VDC (Analog Output - no load)		
	75mA max @ 24VDC (Analog and Digital Outputs enabled)		
	85mA max @ 12VDC (Analog and Digital Outputs enabled)		
ANALOG MEASURING RANGE	Scalable within 360°		
DIGITAL MEASURING RANGE	±180°		
INPUT PROTECTION	Reverse Polarity, ESD & Surge Protected		
ABSOLUTE ACCURACY OVER FULL OPERATING TEMPERATURE			
RANGE: ±180°	±0.1º typical, ±0.2º absolute max		
RESOLUTION	0.05º		
RESPONSE TIME	6 user-configurable options from 4Hz to 0.3Hz		
CURRENT & VOLTAGE OUTPUT PARAMETERS			
OUTPUT RANGES	Current	4..20 mA, 0..20 mA (Configurable within 0..24mA)	$R_{sense} \leq \frac{V_{supply} - 2.5}{0.020} - R_{wire}$
	Voltage	0..5 V, 0..10V (Configurable within 0..10V)	1kΩ load min.
SENSITIVITY[2]	Relative to Scaled Range		
NULL (0º)	Fully Configurable		
SWITCH OUTPUT PARAMETERS			
OUTPUT MODE	Open Collector Switch to Signal Common		
TRIP MODES	Fully Configurable (Window, Threshold, etc.)		
SWITCH CAPABILITY	250mA @ 36V max		
DIGITAL OUTPUT PARAMETERS			
OUTPUT TYPE	RS-485 Half Duplex (2-wire)		
INCLINATION OUTPUT	32-Bit IEEE Packetized Float		
BAUD RATE	125K Default (Configurable from 9600 to 250K)		
INFORMATION RATE	Polled (up to 20 times/sec)		
LOGGING CAPABILITY (OPTIONAL)			
SUPPLY CURRENT	Additional 20mA @24VDC		
LOGGING RESOLUTION	Configurable in one minute increments		
CARD TYPE	µSD		

Notes:

1. Supply Current varies depending on outputs connected. Digital output only assumes analog output section is always active however current loop is not connected.
2. See **Sensitivity & Zero Angle Calculation (Voltage and Current Outputs Only)**

Sensor Specifications, Continued

TEMPERATURE RANGES	
OPERATING TEMPERATURE	-40ºF..+185ºF (-40ºC..+85ºC)
STORAGE TEMPERATURE	-49ºF..+194ºF (-45ºC..+90ºC)
MECHANICAL CHARACTERISTICS	
HOUSING	Aluminum, IP68, All-weather, Submersible
WEIGHT	18.6 oz. (525 Grams)
MOUNTING HOLES	Accept #8 or M4.5 screws (See Dimensional Drawing)
MOUNTING PLANE	Flat Horizontal or Vertical Surface
OUTLINE DIMENSIONS	4.34” x 3.26” x 1.8” [110mm x 82.8mm x 45.7mm]
ELECTRICAL CONNECTION	See Electrical Connection Drawing

H6 Installation and Wiring

Notes:

- The factory default settings for mounting position (either horizontal or vertical) must be selected at time of order.
- Default output polarity shown is configurable at the factory (defined at time of order) or by the end user via the Flex Dev Kit that includes Rieker Flexware app, sold separately.
- Special H6-MM Multi-Mount model (available exclusively through Digi-Key) allows the end user to select between horizontal and vertical mounting positions via a special Flex Dev Kit that includes Rieker Flexware app, sold separately through Digi-key.

1. On the mounting plane, prepare surface with three tapped holes 3.815" [96.9mm] apart for #9 mounting screws. NOTE that the single hole on side with the two slots is not meant to be used for mounting
2. Mount inclinometer to mounting plane using #9 mounting screws.

FIGURE 1: **H6 Dimensions and Mounting (Inches [Mm])**

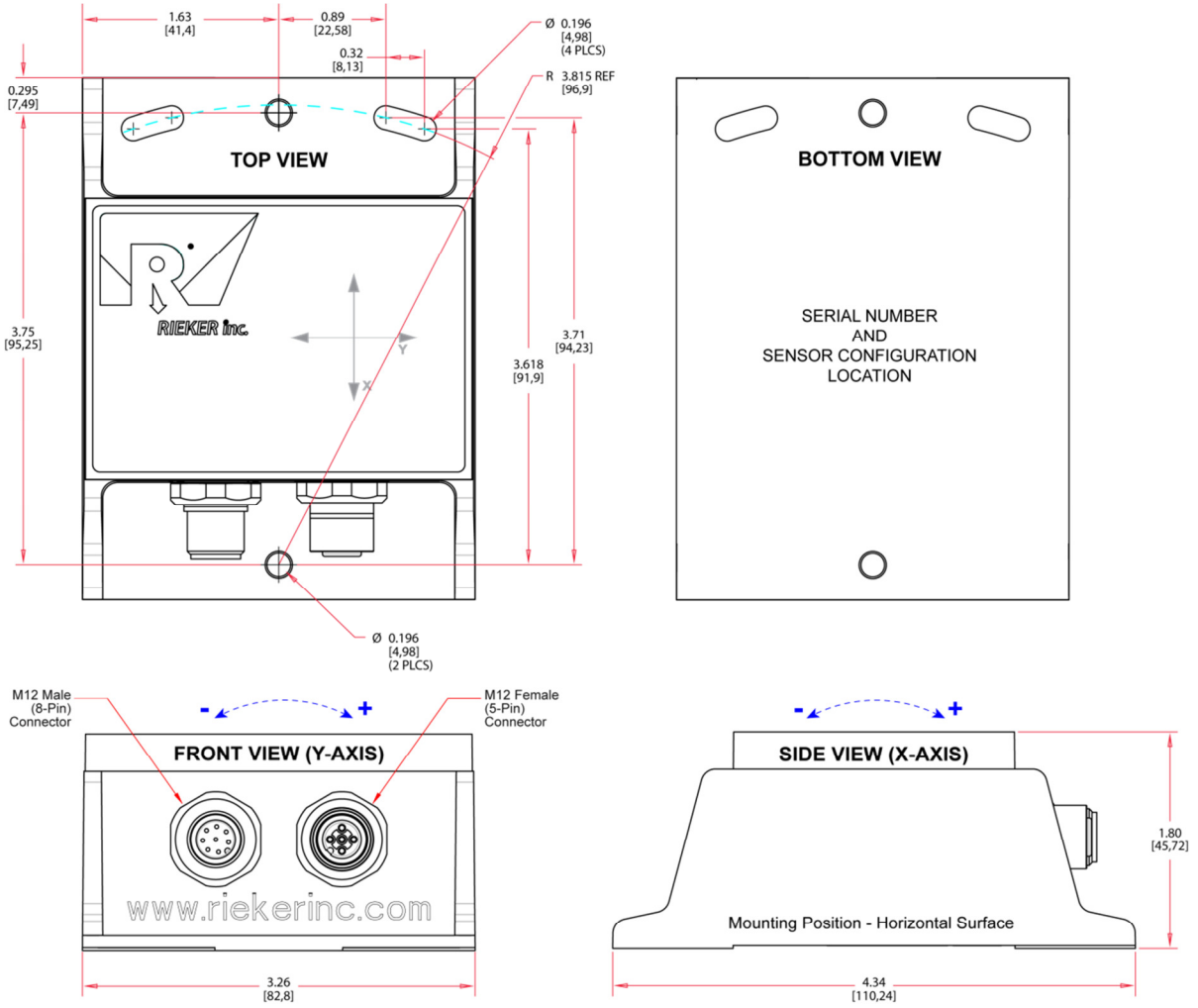
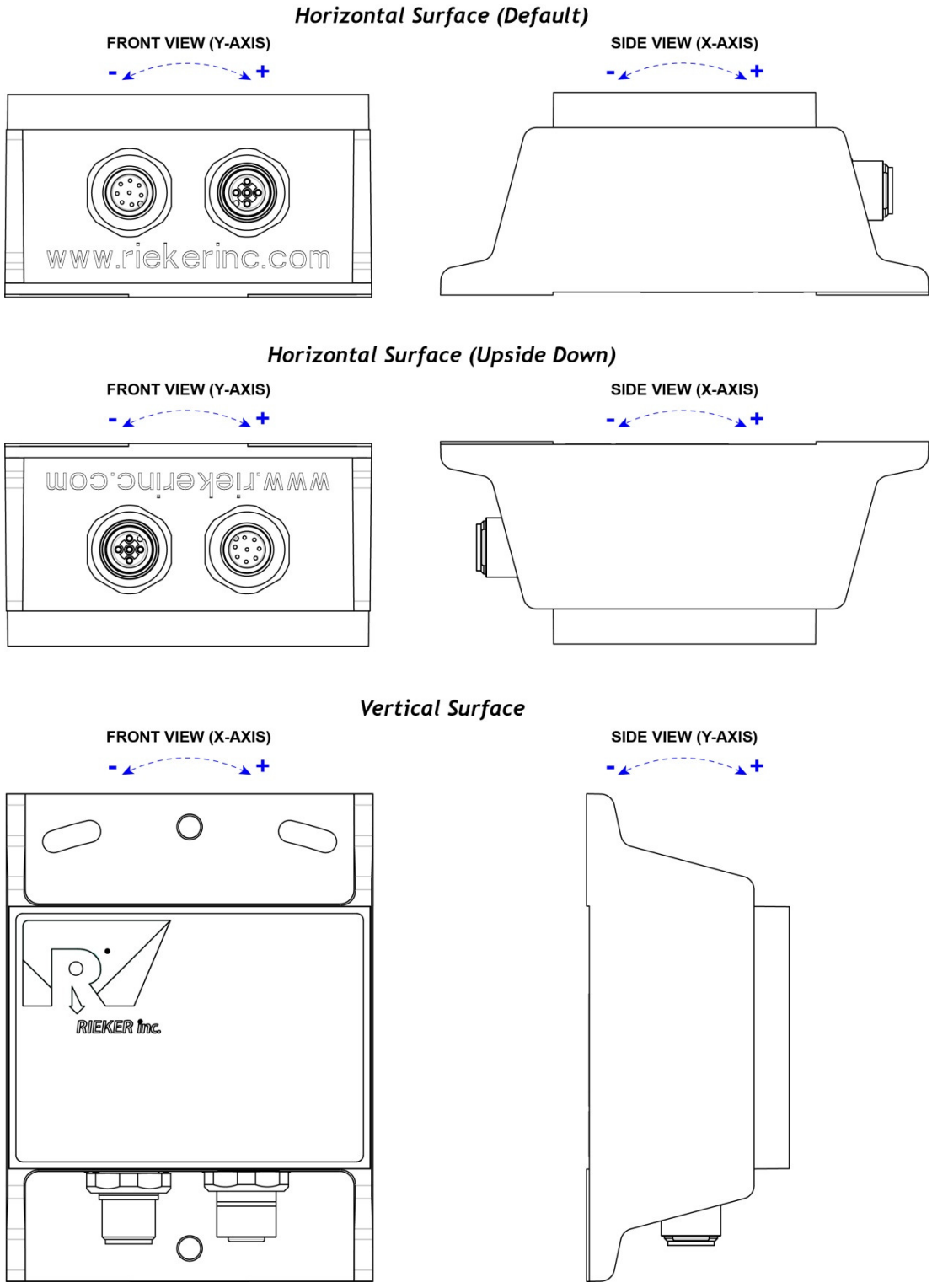


FIGURE 2: **Mounting Positions**



Horizontal Mount Axis Orientations

As shown in the top drawing of *Figure 2:* **Mounting Positions**

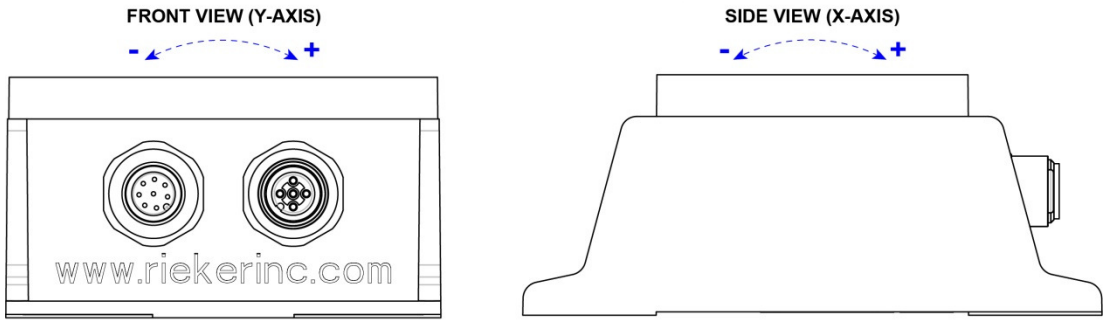
NOTE: The 0° orientation for a horizontal mount H6 is a desktop level position.

- For the X-axis, looking at the unit from the side with the connector facing to the right, a clockwise rotation from the zero position is considered positive and a counter-clockwise rotation from the zero position is considered negative.
- For the Y-axis, looking at the unit from the front with the connector facing towards you, a clockwise rotation from the zero position is considered positive and a counter-clockwise rotation from the zero position is considered negative.

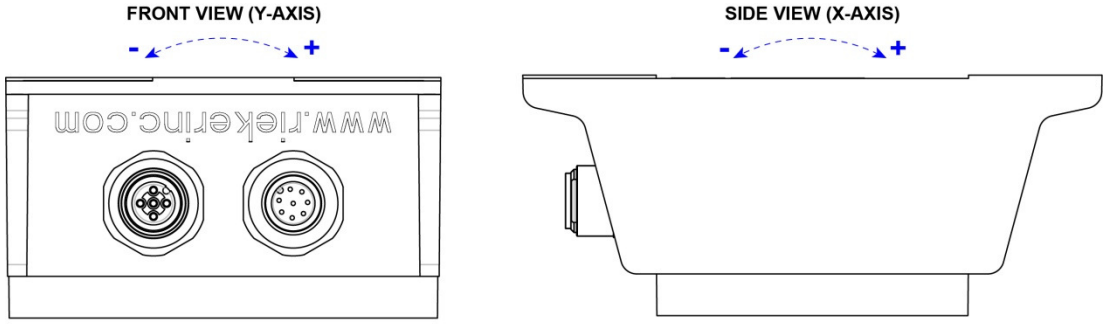
Vertical Mount Axis Orientations

As shown in the bottom drawing of *Figure 2:* **Mounting Positions**

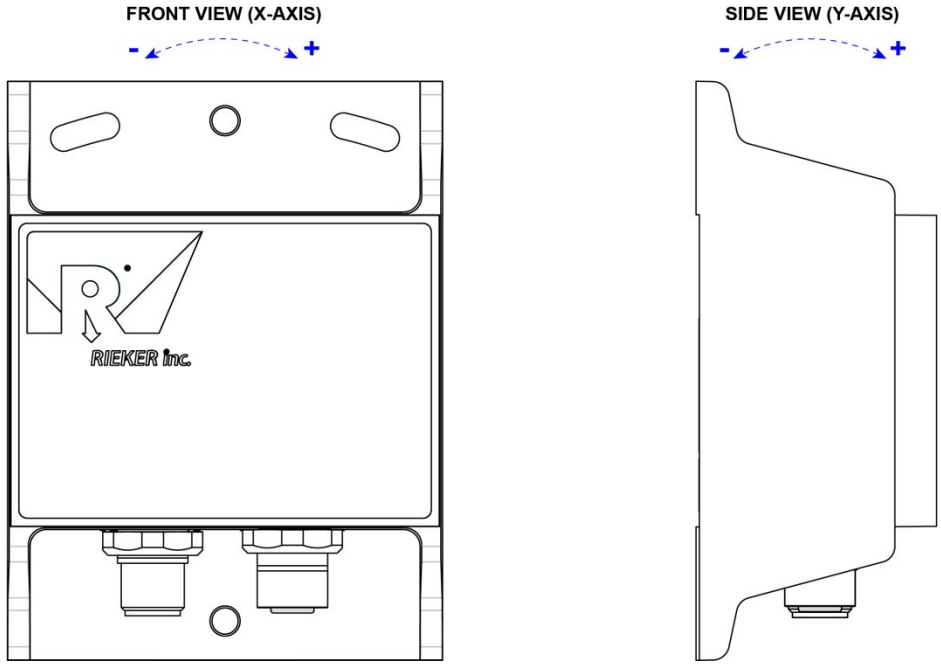
Horizontal Surface (Default)



Horizontal Surface (Upside Down)



Vertical Surface

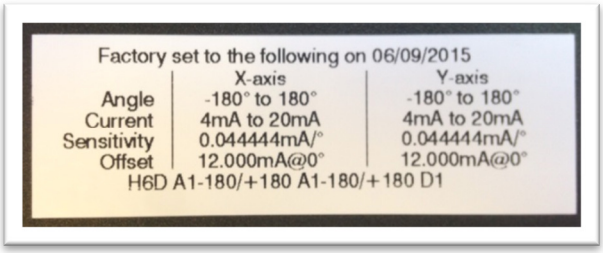


NOTE: The 0° orientation for a vertical mount H6 is with the connector facing down.

- For the X-axis, looking at the unit from the top with the connector facing down, a clockwise rotation from the zero position is considered positive and a counter-clockwise rotation from the zero position is considered negative.
- For the Y-axis, looking at the unit from the side with the top facing to the right and the connector facing down, a clockwise rotation from the zero position is considered positive and a counter-clockwise rotation from the zero position is considered negative.

FIGURE 2: **Example of Serial Number and Factory Default Configuration Label**

NOTE: Located on the bottom of the h6 sensor, the label provides the factory configured defaults and serial number.

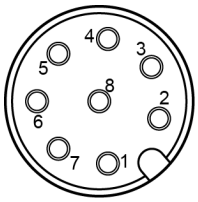


H6 Connector Wiring Tables

TABLE 2: H6 MALE 8-PIN INPUT CONNECTOR WIRING		
PIN	**FUNCTION**	**TERMINATION**
1	SUPPLY VOLTAGE +11.. +36VDC	WHITE
2	POWER / SIGNAL COMMON	BROWN
3	RS485 D+	GREEN
4	RS485 D-	YELLOW
5	NO CONNECTION	GRAY
6	ANALOG OUTPUT 1 (DEFAULT: X AXIS)	PINK
7	ANALOG OUTPUT 2 (DEFAULT: Y AXIS)	BLUE
8	NO CONNECTION	RED

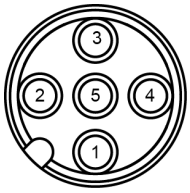
NOTES:

- The front and back of the connector may not have any pin markings in the actual connector. The user will need to look at the front-side keyway (see drawing) to determine pin outs.
- The termination wire colors reference the cable sold by Rieker.



M12 (male 8-pin)
Pin Assignment
FRONT VIEW

TABLE 3: H6 FEMALE 5-PIN DIGITAL OUTPUT DAISY CHAIN CONNECTOR WIRING	
PIN	**FUNCTION**
1	NO CONNECTION
2	SUPPLY VOLTAGE +11..+36VDC
3	POWER COMMON
4	RS-485 D+
5	RS-485 D-



M12 (female 5-pin)
Pin Assignment
FRONT VIEW

NOTE: The H6 Sensor's Chassis Ground is NOT the same as the signal ground for the current output return. The current output return must be connected to the POWER/SIGNAL COMMON (pin 2).

H6 RS485 Bus Wiring Configurations

When using the digital output, the H6 sensor can be connected as a single sensor or can be connected to other sensors in a bus configuration. The following figures show three possible configurations for using the H6 sensor with the digital output.

FIGURE 3: **Single H6 Sensor**

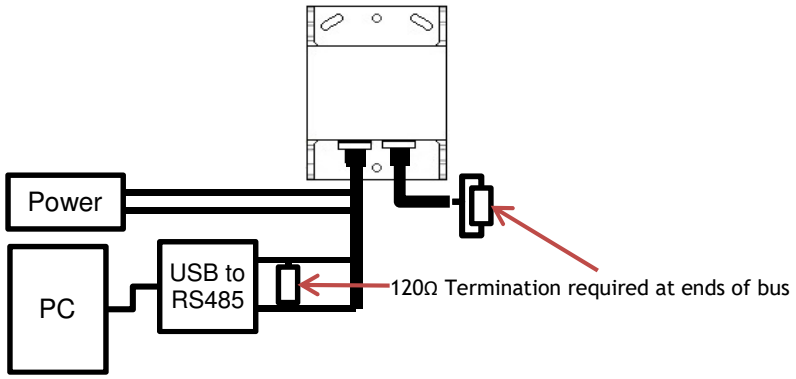


FIGURE 4: **Multiple Daisy-Chain H6 Sensors**

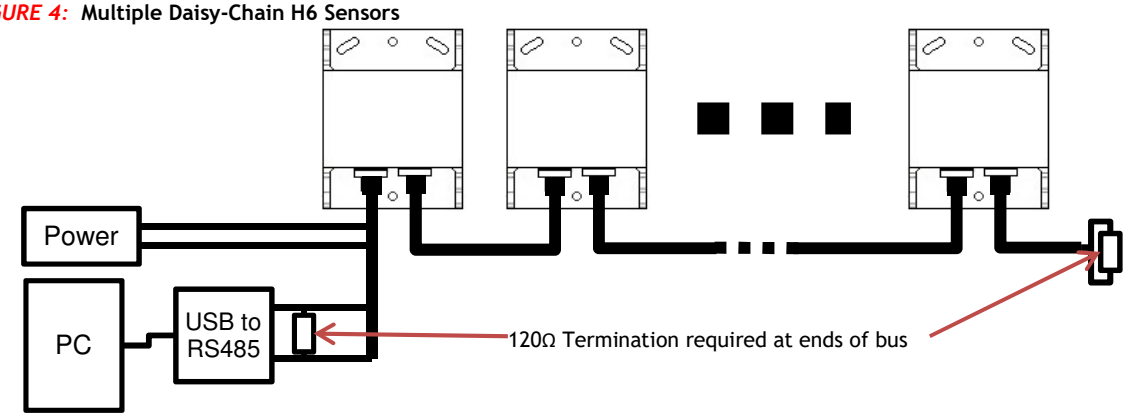


FIGURE 5: **Multiple Multi-Drop H6 Sensors**

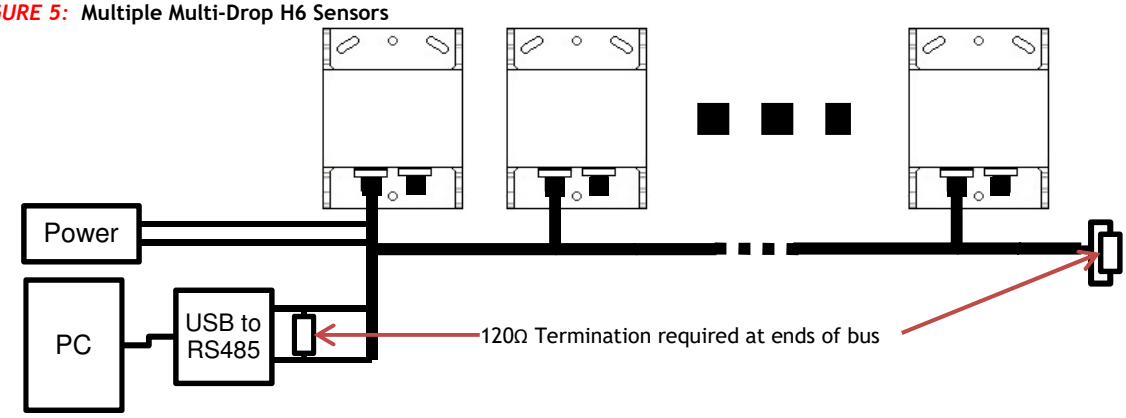
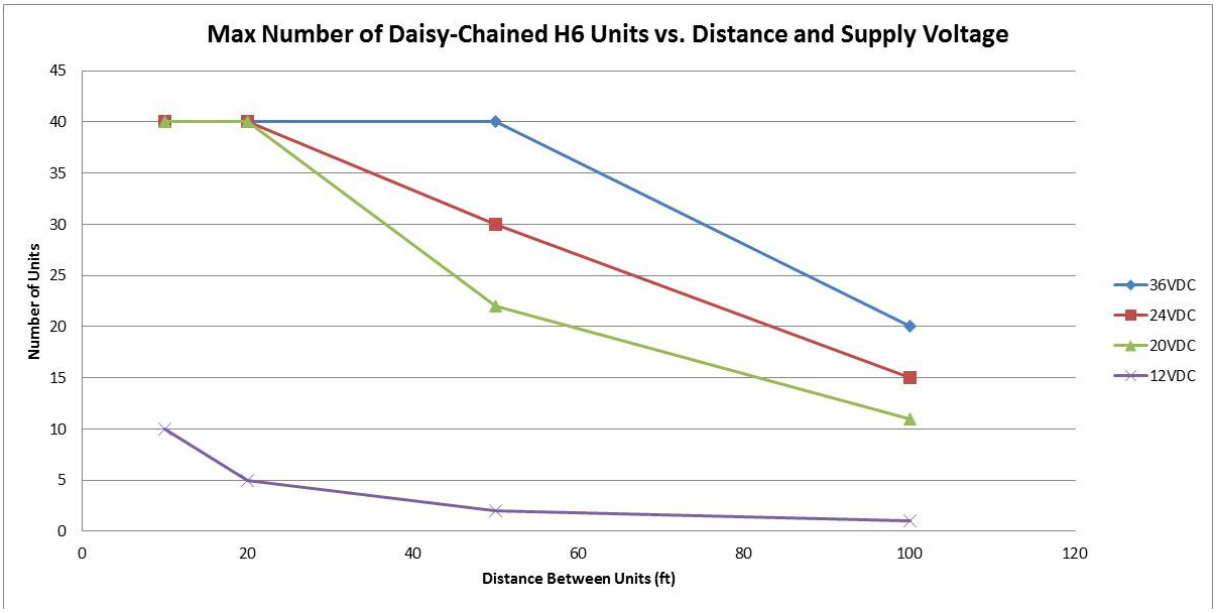


FIGURE 6: **Max Number of Daisy Chain H6s Graph**



NOTE: This graph is based on 22AWG wire as the daisy-chain between sensors. Also note that by using a multi-drop configuration, additional sensors may be added, up to a maximum of 60 units due to bus loading.

Analog Outputs

The H6 sensor comes with two, continuous, fully configurable, analog outputs. The analog outputs are directly related to the input angle and will match the angle for any configured range. The factory default output parameters for each analog output can be separately reconfigured at time of order, and/or can be fully reconfigured by the end user when using the Dev Kit and Flexware™ Sensor Configurator (sold separately).

CAUTION: The Flex™ series of sensors are manufactured to allow end user adjustments of the analog and digital output parameters. Purchaser assumes the responsibility of ensuring that the settings are appropriate for their specific application. IN NO EVENT WILL RIEKER BE LIABLE FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES OF ANY KIND.

Output Axis Mapping

Each analog output can be individually mapped to correspond to either axis (X or Y). The default is that output 1 corresponds to the X-axis and output 2 corresponds to the Y-axis.

Output Types

Each analog output can be individually set to one of three analog output types: Current, Voltage, or Switch.

Current Output

An output configured for current has four configurable parameters: minimum current, maximum current, minimum angle, and maximum angle. Min and max current each can be set to any range within 0mA and 24mA, where max must be greater than min. The most common option is Min = 4mA and Max = 20mA.

Min angle is the angle corresponding to minimum current. Max angle is the angle corresponding to maximum current. Min and max can each be set to any angle range within the entire ±180° operating range. A reversed polarity is achieved by setting min angle greater than max angle.

Voltage Output

An output configured for voltage has four configurable parameters: minimum voltage, maximum voltage, minimum angle, and maximum angle. Min and max voltage each can be set to any range within 0V and 10V, where max must be greater than min. Two common option are Min = 0V & Max = 5V and Min = 0V & Max = 10V.

Min angle is the angle corresponding to minimum voltage. Max angle is the angle corresponding to maximum voltage. Min and max can each be set to any angle range within the entire ±180° operating range. A reversed polarity is achieved by setting min angle greater than max angle.

Switch Output

Each switch output is an open collector, NPN transistor switch. An output configured for switch has three configurable parameters: trip mode, hysteresis, and delay in addition to either one or two trip angles.

Trip Mode

Trip mode explains the switch output trip conditions. It can be set to one of four configurations:

- **Window Open**: The output state is set to off/high between the adjustable Upper and Lower Trip

Angles and opposite (on/low) outside the window. (External relay will activate outside of window)

- **Window Closed**: The output state is set to on/low between the adjustable Upper and Lower Trip Angles and opposite (off/high) outside the window. (External relay will activate inside of window)
- **Threshold Open**: The output state is set to off/high below the adjustable Trip Angle and opposite (on/low) above or equal to the Trip Angle. (External relay will activate above the Trip Angle)
- **Threshold Closed**: The output state is set to on/low below the adjustable Trip Angle and opposite (off/high) above or equal to the Trip Angle. (External relay will activate below the Trip Angle)

Hysteresis

The hysteresis value is the additional angle change needed for a switch output to return to the untripped state from the tripped state. For window configurations, the Upper and Lower hysteresis values can be set individually.

Delay

The delay value is the time (in tenths of seconds) that a trip condition must be met before the switch output is actually set/unset to the new condition.

Sensitivity & Zero Angle Calculation (Voltage and Current Outputs Only)

The output sensitivity is calculated as follows: $\frac{[Max\ Analog - \ Min\ Analog]}{[Max\ Angle - Min\ Angle]}$

For **Symmetrical** input ranges (i.e. ±60˚), the zero degree angle output is at the midpoint of the input analog range: $[Max\ Analog\ +\ Min\ Analog]/2$. For **Non-symmetrical** input ranges (i.e. -10 to +90°), the zero degree angle output is calculated as follows: $Min\ Analog + \left((0° - Min\ Angle) * Sensitivity\right)$

- Examples
  - Output with a ±60˚ range (symmetrical) with a 4 to 20mA output:
    - Sensitivity = $\frac{(20mA-4mA)}{60°-(-60°)} = \frac{16mA}{120°} = 0.133\,{}^{mA}/_{°}$
    - Zero Degree Angle Output = $12mA$
  - Output with a -10 to +90˚ range (non-symmetrical) with a 2 to 20mA output:
    - Sensitivity = $\frac{(20mA-2mA)}{90°-(-10°)} = \frac{18mA}{100°} = 0.180\,{}^{mA}/_{°}$
    - Zero Degree Angle Output = $2mA + \left((0° - (-10°)) * 0.180\,{}^{mA}/_{°}\right) = 3.8mA$
  - Output with a ±90˚ range (symmetrical) with a 0 to 5V output:
    - Sensitivity = $\frac{(5V-0V)}{90°-(-90°)} = \frac{5V}{180°} = 0.0277\,{}^{V}/_{°}$
    - Zero Degree Angle Output = $2.5V$
  - Output with a -30 to +70˚ range (non-symmetrical) with a 0 to 10V output:
    - Sensitivity = $\frac{(10V-0V)}{70°-(-30°)} = \frac{10V}{100°} = 0.100\,{}^{V}/_{°}$
    - Zero Degree Angle Output = $0V + \left((0° - (-30°)) * 0.100\,{}^{V}/_{°}\right) = 3.0V$

Wiring Diagrams and Connection Procedures

Wiring for a Current Output

1. Connect the power (PIN 1) to an 11-36VDC supply and the ground (PIN 2) to the supply ground/common.
2. Connect the corresponding output (PIN 6 for output 1, PIN 7 for output 2) to the positive terminal of the measurement device, and the sensor ground (PIN 2) to the negative terminal/common of the measurement device.

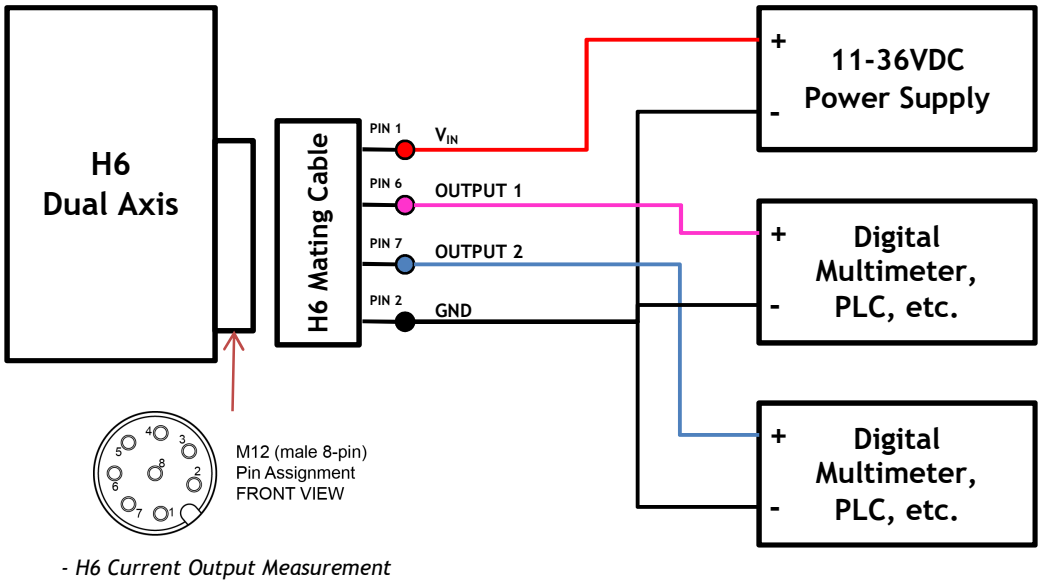
NOTE: Current outputs will not work using chassis ground. Unit ground (PIN 2) must be used.

3. To convert the current to a voltage output select an appropriate load resistor (Rsense) based on the equation defined in Table 4: H6 Current Sense

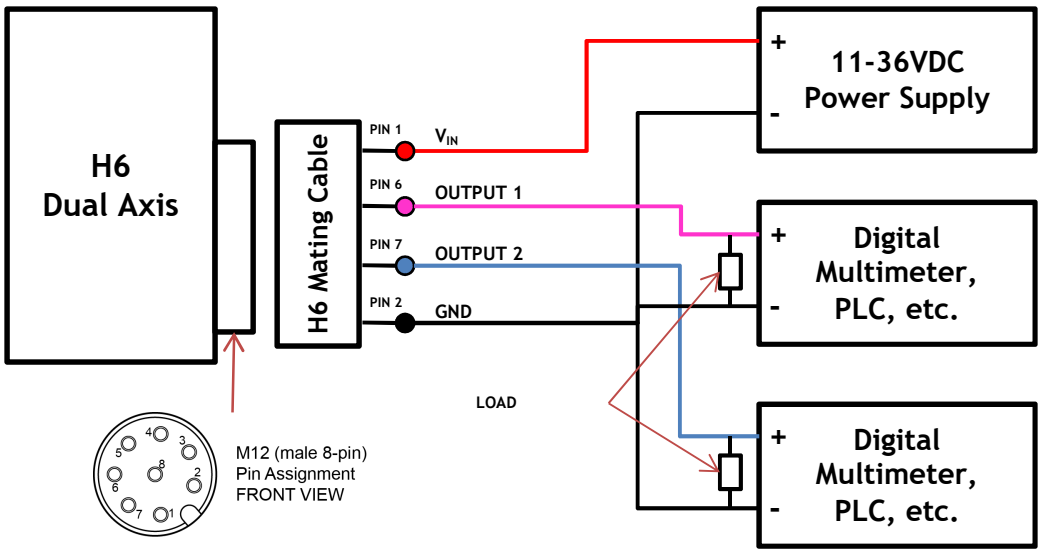
TABLE 4: H6 CURRENT SENSE

R_{sense} is dependent upon supply voltage and cable/wire resistance. Ensure the following equation is met: $R_{sense} \leq \frac{V_{supply} - 2.5}{0.020} - R_{wire}$	QUICK REFERENCE	
	SUPPLY VOLTAGE	**SENSE RESISTOR**
	12V	200-350 OHMS
	24V	200-1000 OHMS
	28V	200-1000 OHMS

FIGURE 7: CURRENT WIRING DIAGRAMS



- H6 Current Output Measurement



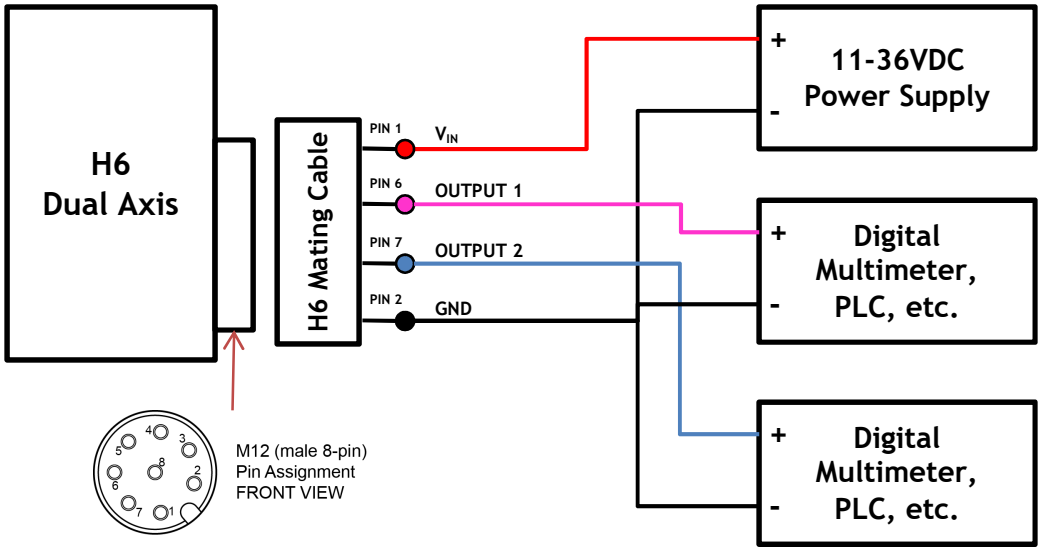
- H6 Current Conversion to Voltage Output Measurement

Wiring for a Voltage Output

1. Connect the power (PIN 1) to an 11-36VDC supply and the ground (PIN 2) to the supply ground/common.
2. Connect the corresponding output (PIN 6 for output 1, PIN 7 for output 2) to the positive terminal of the measurement device, and the sensor ground (PIN 2) to the negative terminal/common of the measurement device.

NOTE: Voltage outputs will not work using chassis ground. Unit ground (PIN 2) must be used.

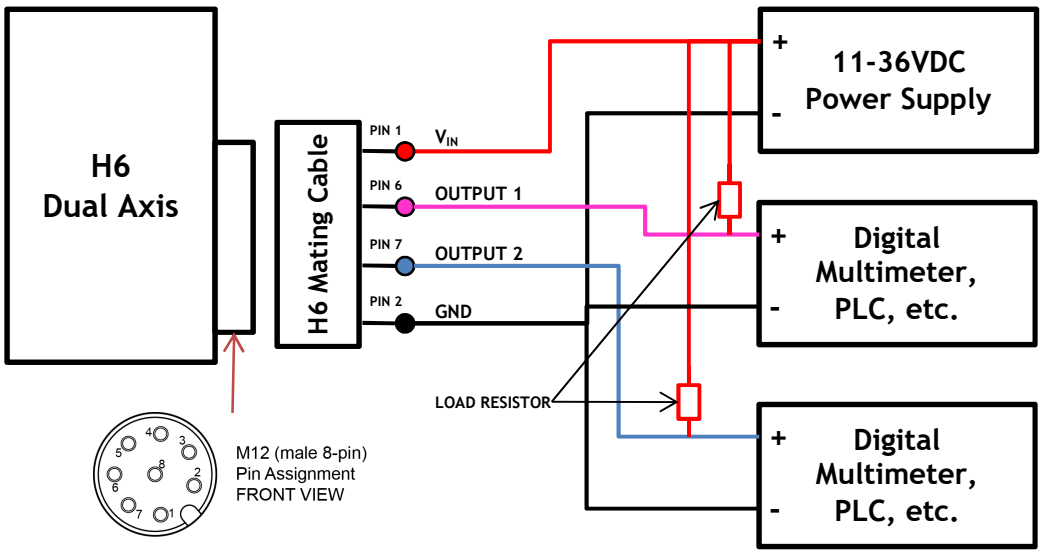
FIGURE 8: VOLTAGE WIRING DIAGRAMS



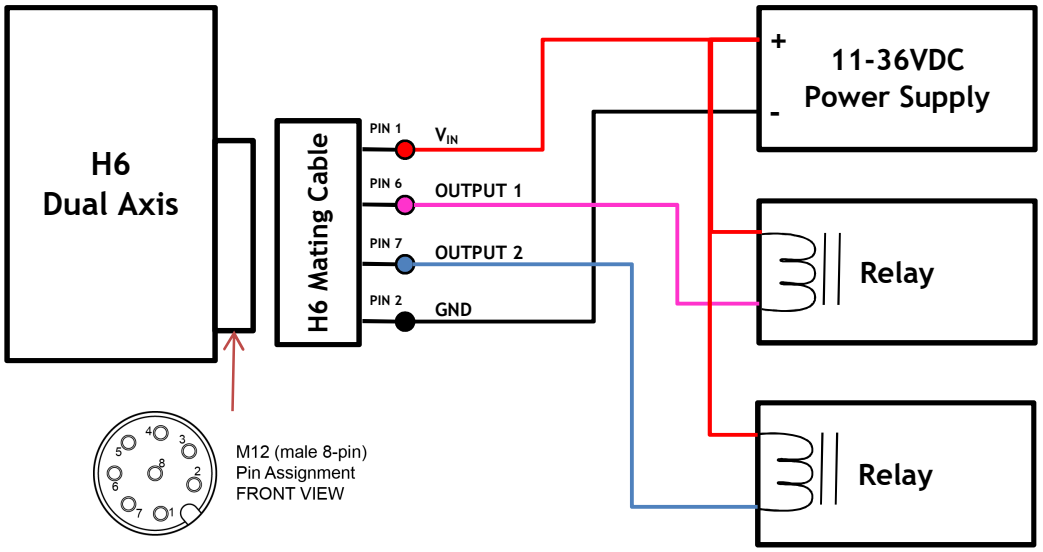
Wiring for a Switch Output

1. Connect the power (PIN 1) to an 11-36VDC supply and the ground (PIN 2) to the supply ground/common.
   a. For direct switching, connect the corresponding output (PIN 6 for output 1, PIN 7 for output 2) to both the positive terminal of the measurement device and power, and the sensor ground (PIN 2) to the negative terminal/common of the measurement device.
   b. For a relay, connect the corresponding output (PIN 6 for output 1, PIN 7 for output 2) to one side of the relay coil and connect the other side of the relay coil to power.

FIGURE 9: SWITCH WIRING DIAGRAMS



- H6 Switch Output Directly



- H6 Switch Output Relay Driver

Digital RS485 Communications

The H6 inclinometer communicates over a RS485 half-duplex communication bus using a Rieker-specific packet format which is described in this section. This communication can be used to read inclination angles from the device, as well as configure the various device settings.

The sensors are initially configured for RS485 communications at a baud rate of 125,000bps. The protocol is fixed at 8 data bits, No parity, 1 Stop bit, and No Flow Control. Each device has an address, and only responds to commands sent to that address, or to the BROADCAST address (0xFFFC). The BROADCAST address is used to send a single command to every sensor on the bus. The sensor address is initially set to 223 (0xDF), but can be configured to any number from 1-65000. Every sensor on the same RS485 bus must have a unique address.

RS485 Protocol

The protocol is set up in a Master/Slave configuration, where the sensors will not respond unless they are commanded to by a master device. The packets sent by the master are called commands. Sensors will respond to all commands that are specifically addressed to that sensor.

Packet Format

Commands and responses are sent in the following form: [DEST][SRC][FUNCT][DL][DATA][CRC]
where:

[DEST]	2 byte destination address. The address of the device to be communicated with.
[SRC]	2 byte source address. The address of the device sending the command.
[FUNCT]	2 byte command function ID. Refer to RS485 Command Functions for a list of functions.
[DL]	1 byte number of DATA bytes.
[DATA]	Data of length [DL] bytes.
[CRC]	16 bit checksum outputted in bytes.

Commands in this guide, unless otherwise stated, are displayed as a series of hexadecimal bytes.

CRC16

The sensor uses a 16-bit cyclic redundancy check in order to be sure a command was sent correctly and did not lose information on the way to the sensor. The polynomial and initial value for the CRC used are as follows:

Polynomial: $x^{16} + x^{15} + x^2 + 1$
Initial Value: 0x0000

- *Example CRC values for given input values:*

Input (hex)	Output (hex)
00	0000
FF	4040
ABCD	A5BE
123456	FB36
9876543210	E86E

For more information on the CRC and for a calculator visit:
http://www.lammertbies.nl/comm/info/crc-calculation.html

Packet Timing

Bytes in a packet must be less than 125 microseconds apart. Packets originating from the master must be separated by at least 1 millisecond. Sensors will respond to the master as fast as possible.

Protection Levels (lock)

The sensor has two lock levels (0 and 1) to protect against unwanted modifications to the sensor. Some functions work at all lock levels, while others will only work if the sensor is put into lock level 1 (Unlocked). Functions that modify sensor settings require lock level 1, while functions that are only reading data will work at either lock level 0 or 1.

When plugged in or reset, the sensor will always be at lock level 0 (Locked). The sensor will stay at a given lock level until the Change Lock command is sent or the sensor is reset or unplugged.

RS485 Command Functions

Table 5 shows a list of all the user functions for the H6 inclinometer, including the function ID, name, description of the function, and the lock level required to use that function.

The following pages give more details on each function, its format, expected response, and its use.

IDs not shown here are reserved for factory use only.

TABLE 5: RS485 FUNCTION LIST

ID	*Name*	*Description*	*Lock Required*
0	ACK	Acknowledge	0
1	NAK	No acknowledge	0
2	Set Address	Set sensor address	0
3	Get Address	Returns the sensor address	0
4	Check Address	Check for sensor at address	0
5	Get Angle	Returns the angle	0
10	Change Lock	Change lock level to 0 or 1	0
16	Restart Sensor	Restarts the sensor	0
25	Set Zero To Value	Set zero offset to float value sent	1
26	Set Zero To Angle	Set zero offset to current angle	1
28	Get Firmware Revision	Returns the firmware revision	0
30	Get Lock Level	Returns the lock level	0
37	Get Serial #	Returns the serial number	0
38	Set Baud Rate	Set the baud rate	1
41	Set Filter Response	Sets the response and filtering	1

Function Descriptions

0	ACK	ACKNOWLEDGE

Length: 0 bytes
Data: None
Lock Level Required: 0 or 1
Immediate Response: Not a query, no response
Info: Sent from sensor to master in acknowledgement of a completed command.

1	NAK	NO ACKNOWLEDGE

Length: 1 byte
Data: Error Code (Unsigned 8-bit Integer)
Lock Level Required: 0 or 1
Immediate Response: Not a query, no response
Info: Sent from sensor to master when the sent command cannot be executed due to an error, given by Error Code.

Error code	Error description
0	CRC failure
1	Unknown function
2	Function not valid for this sensor or mode of operation
3	Data invalid for given function
4	Invalid lock level to execute command
5	Sensor Busy. Wait and try again

2	SET ADDRESS	SET SENSOR ADDRESS

Length: 2 bytes
Data: Address (Unsigned 16-bit Integer)
Lock Level Required: 1
Immediate Response: Yes
Expected Response from sensor: ACK
Info: This function is used to change the sensor address. After sending this command, wait 50 milliseconds before issuing further commands.

Example Command Send/Receive:

```
Sent Command:       0065   0000  0002    02   00DF   F727
                   [DEST] [SRC] [FUNCT] [DL] [DATA] [CRC]
```

Set address of sensor at address 101 (0x0065) to 223 (0x00DF)

```
Received Command:   0000   0065  0000    00          CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA] [CRC]
```

ACK

3	GET ADDRESS	GET SENSOR'S ADDRESS

Length: 0 bytes
Data: None
Lock Level Required: 0 or 1
Immediate Response: Yes
Expected Response from sensor: Packet with the sensor's address in 2 data bytes, as an Unsigned 16-bit Integer.
Info: This function is useful when a sensor address is unknown and it is the only sensor on the bus. By issuing 'Get Address' to a broadcast address (0xFFFC), the sensor will respond with its address in the data field. CAUTION: Do not issue broadcast commands with multiple sensors on a bus. Their packets will collide, which can usually be detected by a failed CRC check (but not always).

Example Command Send/Receive:

```
Sent Command:       FFFC    0000   0003     00           C31B
                   [DEST] [SRC] [FUNCT] [DL] [DATA] [CRC]
```

Get address of sensor (broadcast command)

```
Received Command:   0000    00DF   0003     02    00DF    73F3
                   [DEST] [SRC] [FUNCT] [DL] [DATA] [CRC]
```

Sensor address is 223 (0x00DF)

4	CHECK ADDRESS	CHECK FOR SENSOR PRESENT AT AN ADDRESS

Length: 0 bytes
Data: None
Lock Level Required: 0 or 1
Immediate Response: Yes
Expected Response from sensor: ACK from sensor at address DEST
Info: A sensor with the targeted destination address will respond with an ACK. If no sensor has that address, there will be no response. CAUTION: If multiple sensors have that address, there may or not be a CRC error.

Example Command Send/Receive:

```
Sent Command:       00DF    0000   0004     00           AF11
                   [DEST] [SRC] [FUNCT] [DL] [DATA] [CRC]
```

Check for sensor at address 223 (0x00DF).

```
Received Command:   0000    00DF   0000     00           D43B
                   [DEST] [SRC] [FUNCT] [DL] [DATA] [CRC]
```

ACK

5	GET ANGLE	GET THE ANGLE OF A SENSOR

Length: 1 byte
Data: Type Code (Unsigned 8-bit Integer)
Lock Level Required: 0 or 1
Immediate Response: Yes
Expected Response from sensor: Packet with the sensor's measured angle(s) in 4 (or 8) bytes, as an IEEE-754 single precision floating point number, based on the sent type code.
NOTE: A change in angle will not display instantly due to filtering and smoothing in the sensor.

Type Code	Description
1	Single axis angle (4 bytes)
2	Dual X-axis angle (4 bytes)
3	Dual Y-axis angle (4 bytes)
4	Dual X and Y axis angles (8 bytes)

Example Command Send/Receive:

```
Sent Command:       0065   0000  0005    01   04      5425
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]
```

Get X and Y axis angles from sensor at address 101 (0x0065)

```
Received Command:  0000   0065  0005    08   BF4B 1C00 4193 8D00   71C8
                   [DEST] [SRC] [FUNCT] [DL] [DATA]               [CRC]
```

X-axis = (0xBF4B1C00) -0.79339599609375°; Y-axis = (0x41938D00) 18.44384765625°

10	CHANGE LOCK	CHANGE LOCK LEVEL

Length: 5 bytes
Data: Lock Level (Unsigned 8-bit Integer), Password, 12345678 (Unsigned 32-bit Integer)
Lock Level Required: 0 or 1
Immediate Response: Yes
Expected Response from sensor: ACK
Info: This function is used to change the lock level of the sensor. Can be changed to 0 (locked) or 1 (unlocked). Lock level 1 allows various sensor settings to be changed, while lock level 0 prevents changes to the sensor settings.

Example Command Send/Receive:

```
Sent Command:       0065   0000  000A    05   0100BC614E     E414
                   [DEST] [SRC] [FUNCT] [DL] [DATA]         [CRC]
```

Change lock level to 1

```
Received Command:  0000   0065  0000    00   00      CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]
```

ACK

16	RESTART	RESTARTS THE SENSOR

Length: 0 bytes
Data: None
Lock Level Required: 1
Immediate Response: Yes
Expected Response from sensor: ACK before resetting
Info: Stops and restarts the sensor. Similar to unplugging and plugging in the sensor.

Example Command Send/Receive:

```
Sent Command:       0065   0000  0010    00          3504
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]

Received Command:   0000   0065  0000    00   00     CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]
```

ACK

25	SET ZERO TO VALUE	SET ZERO OFFSET TO SENT VALUE (FLOAT)

Length: 5 bytes
Data: Axis Code (Unsigned 8-bit Integer), Offset (4 byte Float)
Lock Level: 1
Immediate Response: Yes
Expected Response from sensor: ACK
Info: This function is used to manually change the zero offset. The offset value is subtracted from every angle for the axis given by Axis Code (causing Offset to become the new zero value).
This lasts until a new offset is set or the sensor is reset to factory defaults.
NOTE: This can be used to remove any previous offsets by setting the value to 0.
NOTE: This function can be used to mount the sensor upside down by setting both values to 180.

Axis Code	Description
1	X-axis (or Single Axis)
2	Y-axis

Example Command Send/Receive:

```
Sent Command:       0065   0000  0019    05   0100000000   995A
                   [DEST] [SRC] [FUNCT] [DL] [DATA]       [CRC]
```

Set the X-axis zero of sensor 101 to 0˚.

```
Received Command:   0000   0065  0000    00   00     CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]
```

26	SET ZERO TO CURRENT ANGLE	SET ZERO OFFSET BASED ON MEASURED ANGLE VALUES

Length: 1 byte
Data: Type Code (Unsigned 8-bit Integer)
Lock Level: 1
Immediate Response: Yes
Expected Response from sensor: ACK
Info: This function is used to set the zero offset to the sensor's measured angle. Takes both axis angle measurements and subtracts the values from all subsequent angle readings (causing the current angle to become the new zero value).
If the Type Code is set to temporary, this offset only lasts until the sensor is powered off or reset. If the Type Code is set to permanent, this offset lasts until a new offset is set or the sensor is reset to factory defaults. This can be used to account for any installation errors (including mounting the sensor upside down) by mounting the sensor in the zero setting and sending the permanent command.

Type Code	Description
0	Temporary
1	Permanent

Example Command Send/Receive:

```
Sent Command:       0065   0000  001A    01   01      91D4
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]
```

Permanently set the zero of sensor 101 to the measured angles.

```
Received Command:   0000   0065  0000    00   00      CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]
```

28	GET FIRMWARE REV	GET THE FIRMWARE REVISION

Length: 0 bytes
Data: None
Lock Level Required: 0 or 1
Immediate Response: Yes
Expected Response from sensor: Packet with the sensor's firmware revision in 7 bytes, as an ASCII string.

Example Command Send/Receive:

```
Sent Command:       0065   0000  001C    00          3501
                   [DEST] [SRC] [FUNCT] [DL] [DATA]  [CRC]

Received Command:   0000   0065  001C    07   52657620412E38  CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA]          [CRC]
```

Sensor 101's firmware revision is "Rev A.8"

30	GET LOCK LEVEL	GET THE CURRENT LOCK LEVEL SETTING

Length: 0 bytes
Data: None
Lock Level Required: 0 or 1
Immediate Response: Yes
Expected Response from sensor: Packet with the sensor's current lock level (0 or 1), as one unsigned byte.

Example Command Send/Receive:

```
Sent Command:       0065    0000    001E    00          5500
                   [DEST]  [SRC]  [FUNCT]  [DL] [DATA]  [CRC]

Received Command:   0000    0065   001E     01   01      5EEC
                   [DEST]  [SRC]  [FUNCT]  [DL] [DATA]  [CRC]
```

Sensor 101 is at lock level 1.

37	GET SERIAL NUMBER	GET THE SENSOR'S SERIAL NUMBER

Length: 0 bytes
Data: None
Lock Level Required: 0 or 1
Immediate Response: Yes
Expected Response from sensor: Packet with the sensor's 10 digit serial number, as a 10-byte ASCII string.

Example Command Send/Receive:

```
Sent Command:       0065    0000   0025     00          6513
                   [DEST]  [SRC]  [FUNCT]  [DL] [DATA]  [CRC]

Received Command:   0000    0065   0025     0A   3936 3232 3835 2020 2020   DF6D
                   [DEST]  [SRC]  [FUNCT]  [DL] [DATA]                    [CRC]
```

Sensor 101's serial number is "962285".

38	SET BAUD	SET THE RS485 COMMUNICATION BAUDRATE

Length: 1 byte
Data: Type Code (Unsigned 8-bit Integer)
Lock Level Required: 1
Immediate Response: Yes
Expected Response from sensor: ACK in current baud rate.
Info: This function is used to change the sensor's communication baud rate, based on Type Code.
Requires a reset (or power off and on) to switch to the new baud rate.
Default is 3 (125,000 bps).

Type Code	Baud Rate
1	9600
2	38400
3	115200
4	125000
5	128000
6	250000
7	19200
8	62500

Example Command Send/Receive:

```
Sent Command:       0065    0000   0026     01    08       50CF
                   [DEST] [SRC] [FUNCT] [DL] [DATA]   [CRC]
```

Set the baud rate of sensor 101 to 62,500.

```
Received Command:   0000    0065   0000     00    00       CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA]   [CRC]
```

41	SET FILTER RESPONSE	SET THE RESPONSE AND FILTERING

Length: 1 byte
Data: Unsigned 8-bit Integer Type Code
Lock Level Required: 1
Immediate Response: Yes
Expected Response from sensor: ACK
Info: This function is used to change the filter response of the sensor, based on Type Code. This affects the instantaneous response of the sensor. Values range from 1 (low filtering) – 6 (high filtering).
1 has a faster response, but more noise. 6 has a slower response, but less noise. Default is 4.

Example Command Send/Receive:

```
Sent Command:       0065    0000   0029     01    02       9F64
                   [DEST] [SRC] [FUNCT] [DL] [DATA]   [CRC]
```

Set the filter response of sensor 101 to 2.

```
Received Command:   0000    0065   0000     00    00       CC1E
                   [DEST] [SRC] [FUNCT] [DL] [DATA]   [CRC]
```

Appendix A. Creating an H6 Development Cable

1. Connect D+ (pin 3) and D- (pin 4) to the D+ and D- pins on the RS485 device, respectively.
2. Connect the USB-RS485 adaptor to the computer via USB cable.
3. In order to measure the current output, connect the X-axis output (pin 6) or Y-axis output (pin 7) and the sensor ground (pin 2) to the measurement device. NOTE: the current outputs will not work using chassis ground.
4. Connect the power (pin 1) to 11-36VDC supply voltage and the ground (pin 2) to the power supply ground. Apply power.