# NILE RADAR SERIES

MODELS 502, 504, AND 517

**YSI**

a **xylem** brand

# CONTENTS & WARRANTY

This user manual is a guide for the Nile 502, 504, and 517 Radar Series. For more information, updated manuals, brochures, technical notes, and supporting software on the Nile Radar Series, please refer to *ysi.com/nile* or contact your sales representative.

For additional assistance, please contact us at +1.435.753.2212 or info@ysi.com

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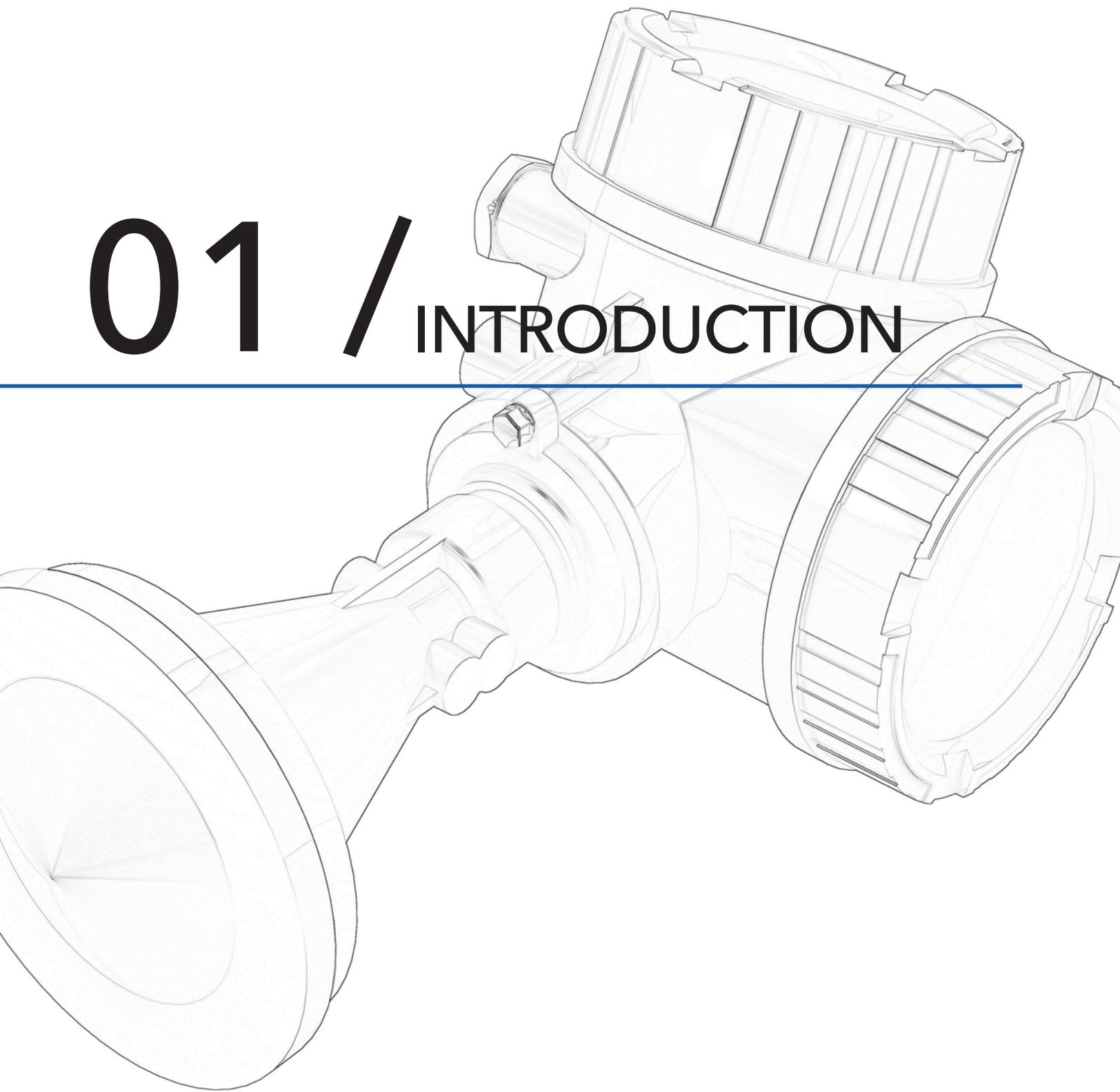
# 01 / INTRODUCTION

The Nile Series consists of the Nile 502, 504 and 517 models. These rugged sensors accurately measure river, lake, reservoir, well, ocean, and wastewater levels through continuous, non-contact microwave transmission. They are ideal for even difficult to reach sites. The sensor makes multiple distance measurements, averages the results and converts the measurement data into Water Level in units of feet, meters, or other units.

The Nile Series is easy-to-use, works with any master Serial-Digital Interface (SDI-12) protocol  data recorder/logger and RS-232 device, and is powered from +12V wire of the 3-wire SDI-12 bus.

All Nile Series products are:
- Simple to install, use, and maintain
- A solution for sites with ice, logs or other debris that could damage an instrument
- Suitable for outdoor installations
- Compatible with RS-232 devices

Key features include:
- Low power operation
- Multiple sensors on a simple three-wire cable
- Non-contact level measurement that eliminates the need for stilling wells and other infrastructure
- Multi-echo tracking, the ability to learn the path to the water surface cancelling out false echoes.
- SDI-12 V1.3 Compliant
- Set current water elevation extended SDI-12 command
- Built in "NOAA" mode measurements.
- RS-232 Data Output
- FCC approval for outdoor applications and all open environments
- Optional LCD keypad display for monitor and set up (removable to use in each site)
- Capped antenna (Nile 502/504, 20m/40m distance) or open stainless steel horn antenna (Nile 517, 70m distance)
- Heavy-duty plastic housing
- Surge protection
- Continuous operation, No warm-up of "lock on"

*Nile 502 / 504*

*Nile 517*

# INTRODUCTION

The standard Nile models come with:
- Nile Radar Sensor
- Screw Driver (not included with M12 models)
- Leveling Bubble
- Quick Start Guide

Optional items:
- LCD Display (PN: Nile KPD)
- 4-conductor shielded cable
- (PN: H-SDI-CABLE-x)
- 10-conductor shielded cable
- (PN: 10-CON-CABLE-x)
- Collar clamp mounting bracket (PN: Nile FL)
- Side mounting bracket (PN: Nile MB)
- M12 connector and cable
    (PN: H-3611-M12CORDSET-15      15 Meter Signal Cable with M12 Connector
         H-3611-M12CORDSET-25     25 Meter Signal Cable with M12 Connector
         H-3611-M12CORDSET-35     35 Meter Signal Cable with M12 Connector
         H-3611-M12CORDSET-5     5 Meter Signal Cable with M12 Connector
         H-3611-M12CORDSET-50     50 Meter Signal Cable with M12 Connector)

## Description

The Nile level sensor consists of a "downward looking" integrated microwave transmitter and sensor together with a closed horn antenna (stainless steel open horn on Nile 517). The horn antenna focuses the transmitted signal and receives the reflected echo. A built-in interface provides SDI-12 and RS-232 communications.

The distance D to the water surface is proportional to the time of flight t of the impulse:

$D = c \cdot t/2$, with c being the speed of light.

The Nile is equipped with special functions to suppress interference echoes known as multi-echo tracking. Multi-echo tracking algorithms ensure that interference echoes (i.e. from bridges, piers, and riverbanks) are not interpreted as level echo.

## General Overview

Cable Fittings

Housing

Antenna Horn

# 02 / CONNECTIONS / BENCH TEST
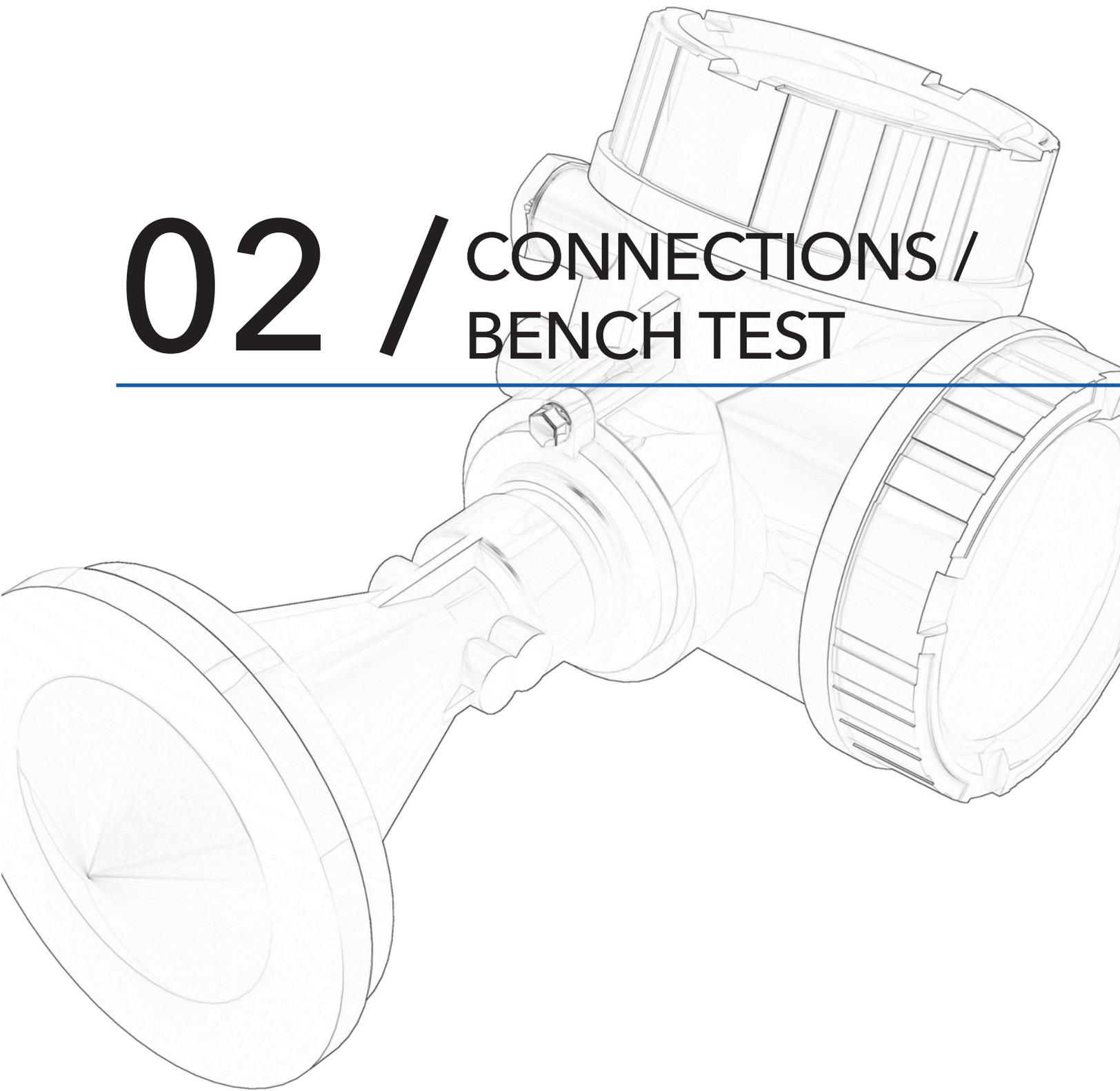
# CONNECTIONS

The Nile Radar sensor is a stand-alone instrument that provides an SDI-12 output for communications with a data logger and an RS232 output for communications with a PC or other serial device. The sensor routes cables through a liquid-tight fitting on the instrument housing. All cables for communication between the devices are available separately.

This manual was written with the intent of the sensor being configured and verified prior to installation in the field. Begin the bench test by accessing the Nile connections.

## Accessing Nile Connections

Step1. Disconnect the power supply.

Step2. Unscrew and remove the housing cover taking care not to contaminate or dislodge the O-ring seal in the cover.

Step3. Loosen the nut on the liquid tight connector and unseat (loosen) the rubber grommet to install cable through and connect to the circuit board.

Step4. The onboard connector should look like the connector shown below.

The wire pinout for the Nile Radar sensors is shown below:



*Circuit board connector for the Nile Radar Series*
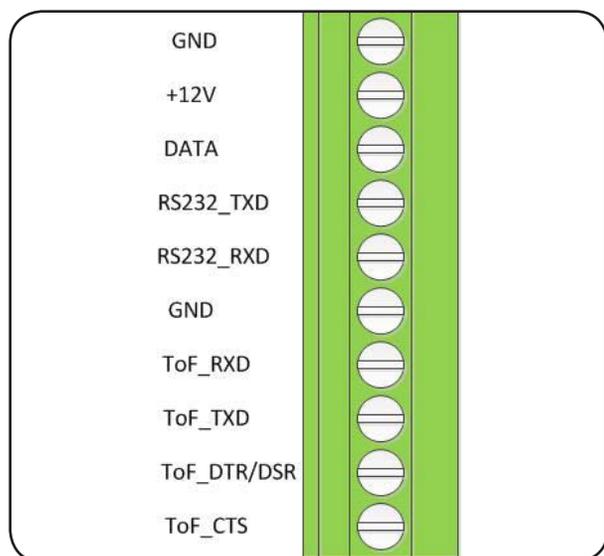
| Connections | Description |
|---|---|
| GND | Power Ground Input |
| +12V | +10V to +16V DC Input |
| DATA | SDI-12 Data Input |
| RS232_TXD | RS232 Transmit Output |
| RS232_RXD | RS232 Receive Input |
| GND | Digital Ground Input |
| ToF_RXD | E&H Software Receive Input |
| ToF_TXD | E&H Software Transmit Output |
| ToF_DTR/DSR | E&H Software DTR/DSR Input |
| ToF_CTS | E&H Software CTS Output |

## SDI-12

The Nile is an SDI-12 V1.3-compliant sensor that connects directly to any data recorder with SDI-12 capability. Use a 1/8-inch screwdriver to attach wires to the connectors.

## SDI-12 Connections

| Nile | Description | Data Logger (Storm 3) |
|---|---|---|
| GND | Connect to power source ground, typically a ground connection on the data recorder. | Gnd |
| +12V | Connect to power source – The Nile needs +10 to 16 Volts DC with at least 25mA current to function properly. Take into account voltage loss in the wire when using extended cable lengths more than 200 ft. | +12V out |
| DATA | Connect to SDI-12 Serial Data Port–When connecting multiple SDI-12 sensors to the data logger, connect one at a time and verify the SDI-12 addresses are NOT the same to avoid conflicts resulting in bad or no data. | SDI Data |

## SDI-12 Interface Setup

The following commands will ensure that your Nile SDI-12 sensor is set up properly.
[Note: More detailed information on Command and Response formats is available in Chapter 5.

Step 1. Double check all wiring connections–Connect the Nile to your data recorder and apply +12V power.

Step 2. Verify SDI-12 Communication–The Nile comes from the factory with its SDI-12 address set to "0". Verify the Nile is responding by issuing a "0I!" Send Identification command. If more than one sensor is to be connected to the SDI-12 bus, make certain each sensor has a different sensor address. If needed, the address can be changed with an SDI-12 command (see Chapter 5). The command and response should look similar to the following:

**Data logger Command:**       0I!
**Nile Sensor Response:**       013 DAA NILE 00AS#001234V030

Step 3. Make a Measurement– The Nile measures the distance from the reference point to the target (water). Knowing the correct reference point on the sensor is important to determine if the correct reading is being received. The Reference Point of the Nile 502 and Nile 504 both are located at the outer edge of the antenna horn. The Reference point for the Nile 517 is located at the inner edge of the antenna horn. Aim the Nile at a solid reflective surface that will mimic the water.Using the SDI-12 data logger, initiate a Nile radar sensor measurement. This will prepare your data recorder to receive and record the Nile data. Since data recorders differ widely, refer to your data recorder manufacturer's directions. In general, program the data recorder to input four values via the SDI-12 port. Usually only one or two of the parameters are actually recorded. Your data recorder must issue an "aM!"
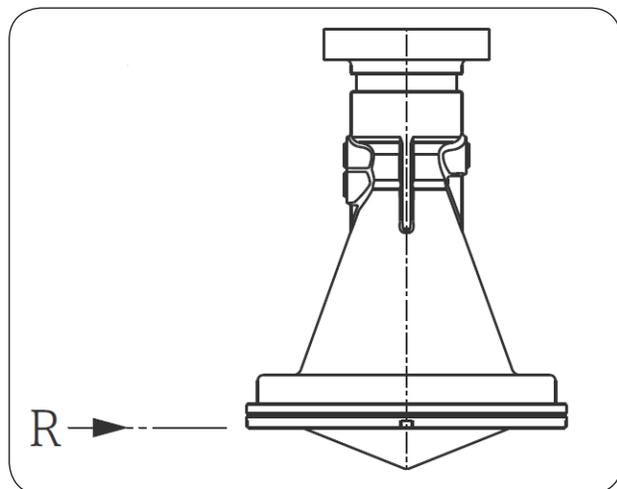

*Reference Point for Nile 502 / 504*

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# CONNECTIONS

command, then collect the data with a "aD0" command, as explained in Chapter 5. The Nile places four parameters in its data buffer:

**a+AA.AAA+BB.BBB+CC+DD.D<cr><lf>**

where:

| | |
|---|---|
| a = | SDI-12 address 0-9, A-Z |
| AA .AAA = | Stage (feet, inches, meters etc.) |
| BB.BBB = | Distance to water (feet, i.e. raw radar measurement) |
| CC = | Measurement Status (0 = success, 1-9 fail) |
| DD.D = | Power Supply Voltage (Volts) |

Make several measurements ("aM!" and "aD0!") and verify that the Distance measurement is correct.

[NOTE: Do not be concerned if the Distance measurement is several inches in error, the radar sensor may have a small distance offset, and it is often difficult to directly measure between the antenna and the water surface. ]
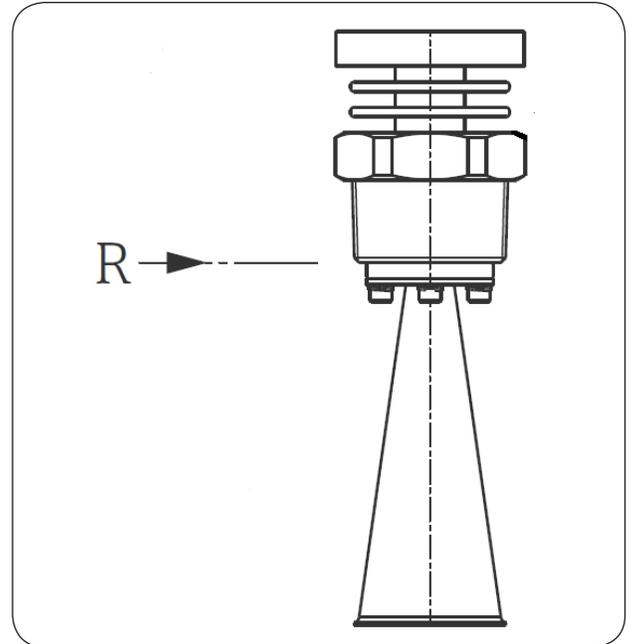


*Reference Point for Nile 517*

If your Nile includes the optional LCD display, the Distance to water value will be continually displayed. With the default SDI-12 address at '0' the communication should look similar to the following:

| | |
|---|---|
| **Data logger Command:** | **0M!** |
| **Nile Sensor Response:** | **00044** |
| **Data logger Command:** | **0D0!** |
| **Nile Sensor Response:** | **0-1.234+1.234+00+12.5** |

In the final response: the Nile SDI-12 address = 0; Current Water Level = -1.234; Distance to the reflected surface = 1.234; Measurement status = 0; Battery voltage = 12.5.

Step 4. Set Current Water Level– The radar unit measures the distance from the antenna of the horn to the water surface. The SDI-12 interface (internal or external) processes the raw Distance measurement with the following equation:

**Level = m \* Distance + b**

The Slope (m) and Offset (b) terms are programmable, allowing the user to scale the reading into other engineering units. The Nile comes from the factory with the following settings:

**SDI Address: 0**
**Slope: -1.0**
**Offset 0.0**

With these values the Level measurement data will be in units of feet. The slope is negative because the Nile measures Distance; as the water rises Distance decreases. These setups are stored in FLASH memory within the Nile and will remain there even if the power is disconnected. The extended commands for changing the address, slope and offset are described in detail in Chapter 5.

If connecting more than one sensor to the SDI-12 bus, make certain each sensor has a unique address.

When the Nile is first installed, you will want to adjust the Offset such that the SDI-12 measurement data corresponds to the current water elevation or stage as determined with a staff gauge or other datum. To set the Nile level reading to match the current water level, use the extended command "aXSCSdd.d!" (where a = SDI-12 address and d.dd = the current stage level), which causes the Nile to make a fresh measurement and automatically update the Offset as needed to produce the desired Stage. (See Chapter 5 for details). The SDI-12 communication between the SDI-12 data logger and the Nile radar sensor will look similar to the following:

**Data logger Command:**    **0XSCS10.0!**
**Nile Sensor Response:**    **00041**
**Data logger Command:**    **0D0!**
**Nile Sensor Response:**    **0+12.34**

In the final response: Nile SDI-12 address = 0; New calculated level offset = 12.34.

Step 5. Log and Output the Nile Radar Data—Set up the data logger to automatically measure and record the stage data from the Nile radar. The default source or input will most likely be SDI-12 address 0 and parameter/value 1 (SDI01).

Step 6. Install the Nile radar sensor—See Chapter 3

When in fast measure mode the radar makes continuous measurements which allow a different type of NOAA mode measurement to take place. When in fast measure mode the "aM1!" command takes the data from the previous six minutes and performs the same procedure as the NOAA mode measurements, namely:

1.  Collect a set of 1-Hz samples centered in the previous six minute time block, the length of which is selected by the user the SDI-12 command "aXWNMddd!", see details in Chapter 5: SDI-12 Command & Response Protocol.
2.  Computes the standard deviation for the data set.
3.  Multiplies the standard deviation by 3 to obtain a High and Low outlier threshold.
4.  Sifts through the data set and discards data points above and below the outlier thresholds.
5.  Computes the mean and standard deviation again for the data set with the outliers removed.

In addition to the "aM1!" command, the "aM2!" and "aM3!" commands have been added which take simple averages and standard deviation of the previous 1 minute(aM2!) and 15 second(aM3!) data sets respectively. All of these commands also have concurrent types.

# CONNECTIONS

| Nile SDI-12 Command Summary Table | | |
|---|---|---|
| **Command** | **Power Mode** | **Description** |
| aM! | 0 | *Typical Measurement (default)* |
| aC! | 0 | *Typical Concurrent Measurement* |
| aM1! | 0 | *181 Second Standard Deviation Measurement* |
| aC1! | 0 | *361 Second Standard Deviation Measurement* |
| aM! | 1 | *Fast Mode Typical Measurement* |
| aC! | 1 | *Fast Mode Typical Concurrent Measurement* |
| aM1! | 1 | *Previous 361 *Sample Standard Deviation Measurement* |
| aC1! | 1 | *Previous 361 *Sample Standard Deviation Concurrent Measurement* |
| aM2! | 1 | *Previous 60 *Sample Standard Deviation Measurement* |
| aC2! | 1 | *Previous 60 *Sample Standard Deviation Concurrent Measurement* |
| aM3! | 1 | *Previous 15 *Sample Standard Deviation Measurement* |
| aC3! | 1 | *Previous 15 *Sample Standard Deviation Concurrent Measurement* |

*One sample per second.

## RS-232 Data Output

The Nile radar has the ability to output serial data to a computer or other serial device, independent of a data logger. For continuous operation in RS-232, the Nile must be in power mode 1. An RS-232 communication cable must be used to connect the Nile to the computer serial port. The serial port settings are; baud rate = 9600, data = 8 bit, parity = none, stop = 1, and flow control = none. The communication to the computer requires a terminal emulator software, like Hyperterminal or Tera Term. Use a 1/8 inch screw driver to attach the appropriate wires at the Nile Radar.

| RS-232 Connections | | |
|---|---|---|
| **Nile** | **Description** | **RS-232 Cable** |
| RS232_TXD | Transmit output – This is the RS232 data output from the Nile to computer or other serial device | RS232_RXD (Pin 2) |
| RS232_RXD | Receive input – This is the RS232 data input for the Nile from computer or other serial device. | RS232_TXD (Pin 3) |
| GND | Connect to RS232 ground/common connection with computer or serial device. Communication ground not power ground. | GND (Pin 5) |

NOTE: Must still connect power connections +12V and GND

## RS-232 Interface Setup

To optimize power requirement when the operating the Nile, two Power modes are available.
- Mode 0. Low Power. SDI-12 Operation Only. This is the most effective power mode for the Nile and is used when using the SDI-12 output for communication. In this mode the RS-232 port is disabled.
- Mode 1. High Power. SDI-12 and RS-232. The RS-232 port is enabled, allowing continuous data sent on the com port.

**Power Mode 0**
Power mode 0 only supports SDI-12 and puts the Nile into the lowest power mode possible. This mode is default for the Nile. Since this in the default mode, it implies the RS-232 communication is locked out. To safeguard the Nile from being locked out of the RS-232 enable modes, the RS-232 port can be activated by power cycling the Nile. When power is first applied to the Nile, regardless of the power mode set, the RS-232 port will stay active for 1 minute. During this active period the user will have access to the command mode before the Nile returns to the low power 0 mode. If the "#" character is received with this first minute the Nile will automatically go into the Command Mode 2 and Power Mode 1 allowing the command mode to continue working past the 1 minute mark.

**Power Mode 1**
In Mode 1 any character except the '#' character will cause the unit to send one line of data out the RS-232 port. This non-# character flags the Nile that a command is being entered. Entering the '#' character suspends any normal activity on the port and waits for the command to be received.

## LCD Display (Optional)

The Nile radar unit features many setup options and configurations, including measurement units, max/min distance, averaging, and media conditions. For most users the Nile comes from the factory pre-configured for most hydrological applications and can be used "out of the box." For special applications and when performing maintenance and diagnostics, the radar unit configuration can be monitored and changed by using the optional LCD display

**NOTE**: Remember that the LCD display shows current distance to water (not stage).

The display features the following:

- 4-line display
- 3-button menu access
- Configurable display format

*Optional LCD Display shown on Nile 502 / 504*

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# CONNECTIONS

- Data backup function
- Data comparison function
- Data transfer function

NOTE: The permitted ambient temperature for the display is between –20 to +70 °C (–4 to +158 °F). Temperatures outside this range may impair the readability of the display.

## HistoROM

HistoROM data management system is comprised of three components of the Nile sensor; the Display, Electronic, and Memory Element (HistoROM). The system configuration is stored in the HistoROM which is directly integrated into the housing of the Nile. This is where all firmware parameters are managed. The Display also contains memory functionality and is a field tool that allows configuration of the Nile onsite. The Electronic uses the data stored in the HistoROM to perform the functions of the sensor. This data management system is used for three purposes:

1. **Duplication** - The configuration settings for the Nile are stored in the HistoROM. These settings can be copied and saved on the Display. The Display serves as a data carrier and stores these settings like a USB Flash Storage Device. This allows the configuration settings to be copied to other Nile sensors. The Display is carried from one Nile sensors to the next and used to down load the same configuration settings to all Nile sensors.

2. **Backup/Restore** - Once the Nile settings have been set, they can be copied to the display. This serves as a backup for later use. The settings that are changed on the Nile intentionally or by mistake are saved in the HistoROM. The original settings can be retrieved from the display and loaded back on the HistoROM.

3. **Electronic Exchange** – In the event the electronic of the Nile are damaged or faulty, the electronic is easily removed. When the new electronic is put into place, the HisoROM automatically loads the configuration settings onto the new electronic and measurement resumes.

## Display Set-up

To access the display, unscrew the housing cover (the round casing with the glass window), taking care not to contaminate or dislodge the o-ring seal inside.
The LCD display has a short cord and can be detached from the unit for convenience.

The three buttons on the LCD display can be used to access and modify the Nile's settings. The unit supports other configurations such as tank volume gauging that are not used for stream gauging applications. When using the LCD setup menus, be careful to not indiscriminately alter the setup parameters. For special applications or problematic installations such as having false echoes from a bridge pier see Chapter 5: Optimization

- The E key is the "Enter" button. Press this key to enter a menu or confirm a change.
- Use the + and – buttons to scroll through the menu.
- Press the + and – buttons at the same time to back out of a menu.

To begin the basic setup, press E to enter the main menu. Use the + or – key to select the setup, then press E to enter that menu.

The chart below shows the available key combinations.



*Optional LCD Display*

| Key | Meaning |
|---|---|
| E | **Enter key**<br>For measured value display<br>• Press briefly to open the operating menu<br>• Press for 2 seconds to open the context menu<br><br>For menu/submenu<br>• Press briefly to open a selected menu, submenu, or parameter<br>• Press for 2 sec to display parameter function help text (if available)<br><br>For text/numeric editor<br>• Press briefly to open a selected group or carry out the selected action<br>• Press for 2 sec to confirm the edited parameter value |
| + | **Plus key**<br>For menu/submenu<br>• Press to move the selection bar downward in the menu options list<br><br>For text/numeric editor<br>• Press to move the selection bar to the right (forwards) in the input mask |
| – | **Minus key**<br>For menu/submenu<br>• Press to move the selection bar upwards in the menu options list<br><br>For text/numeric editor<br>• Press to move the selection bar to the left (backwards) in the input mask |

# CONNECTIONS

| Key | Meaning |
|---|---|
| ⊖ + ⊕ | **Escape key combination (press keys simultaneously)**<br>For menu/submenu<br>• Press briefly to<br>  - exit the current menu level and move to the next higher level<br>  - close the parameter help text<br>• Press for 2 sec to return to the measured value display (home)<br><br>For text/numeric editor<br>• Press to close the text or numeric editor without applying changes |
| ⊖ + E | **Minus/Enter key combination (press and hold down the keys simultaneously)**<br>• Press to reduces the contrast (brighter setting) |
| ⊕ + E | **Plus/Enter key combination (press and hold down the keys simultaneously)**<br>• Press to increases the contrast (darker setting) |
| ⊖ + ⊕ + E | **Minus/Plus/Enter key combination (press and hold down the keys simultaneously)**<br>For measured value display<br>• Press to enable or disable the keypad lock |
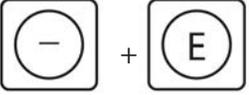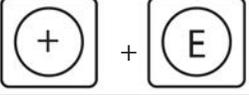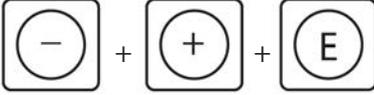
Once you have accessed the setup menu, select the parameters you want to set. Most factory settings will be appropriate for open water applications, but the following menu items may be useful.

## Common Display Tasks

Deleting Echo Tracking History

It is recommended to clear the echo tracking history when installing the Nile radar in the field. This is the history of measurements that create a site profile that are saved to optimize the measurement. However, if you have performed testing in the office/lab and then install in the field it will have echo history saved from the office/lab testing and this can cause accuracy issues. See Chapter 4 for instructions.

Disable Echo Tracking History

There is an option to disable the echo tracking history feature, this will make the Nile similar to how the H-361x series were, which is with no site profile history. See Chapter 4 for instructions.

Saving/Restoring Configurations

When replacing the Nile radar with another Nile radar it may advantageous to copy the existing Nile configuration from the existing to the new Nile radar. Doing this will save all the Nile settings and echo tracking history. The configuration is saved and restored with the display. See Chapter 4 for instructions.

Performing Mapping
The display also provides the ability to accomplish mapping in the field.  Mapping allows the user to profile the path to the water surface to eliminate false echoes from interfering objects such as bridge piers or riverbanks. See Chapter 4 for mapping instructions.

Adjusting Integration/Averaging Time
In some cases, it may be necessary to adjust the integration/averaging time due to wave action on the surface of the water or when the structure the Nile is mounted fluctuates/bounces. See Chapter 4 for adjusting the intergration/averaging time.

Editing Tank Mode
There are two main modes used in the Nile for water surface application; "Vessel" and "Open Channel". When verifying the radar in the office/lab versus the field, it may be necessary to change this mode for both of these drastic environment changes. See Chapter 4 for how to change the tank modes.

# 03 /INSTALLATION
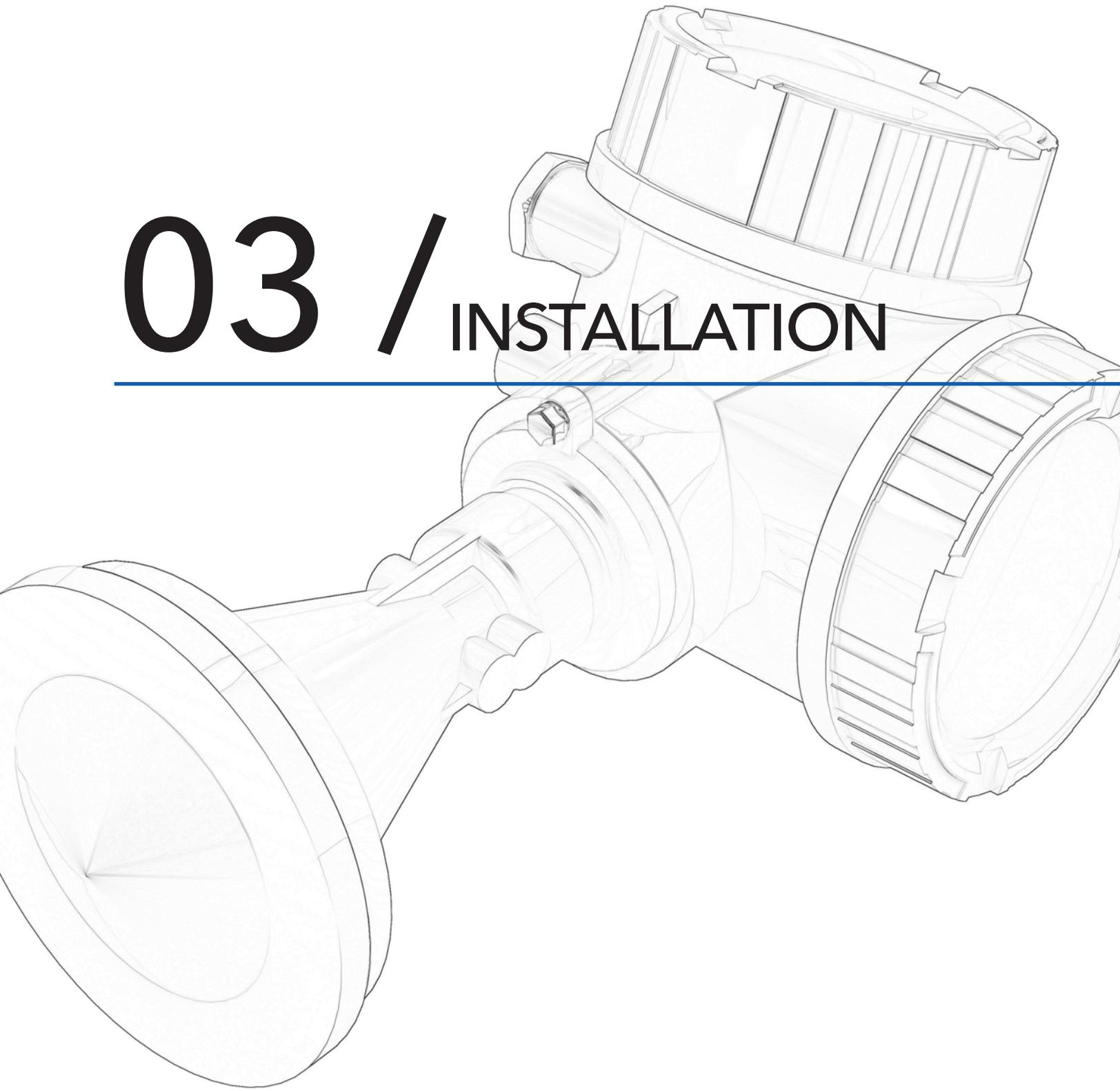
The Nile is a time-of-flight microwave radar level sensor that excels in applications where ice, logs, floating debris and boat traffic can damage stilling wells and other infrastructure. When installed on a bridge over shallow streams having sandy bottoms, the Nile radar can be moved from location to location as the river shifts channel position after storm events.

**Caution: Remove all power from the unit before making any connections.]**

**[Warning: All wiring must be performed by qualified individuals in accordance with applicable codes such as the ANSI/NFPA 70 specifications or the Canadian Electrical Code Part 1.]**

## Installing The Nile Radar Sensor

For best results, install the Nile radar unit:
- On a solid structure. Select a structure that does not vary in either axis after installation. Typical movement caused by wind, temperature, and traffic will affect the accuracy of the data. Concrete and metal bridges are usually the best choice.
- Physically close to the structure. The mounting hardware and frames that keep the radar out away from the structure are more susceptible to vibration from traffic or wind movement.
- In an enclosure. The Nile can be mounted out in the open, but the enclosure will help to deter vandals and thieves.

## Other Considerations

- A clear path to the water surface.  As the radar signal leaves the horn and makes its way to the surface of the water, the footprint size increases. This can result in unwanted reflections from objects within that larger footprint. Although data from unwanted reflection can be eliminated with "echo tracking", it is recommended to mount the Nile above bridge piers to avoid data echo and also draw down effect.

| | 502 | 504 | 517 |
|---|---|---|---|
| **Beam Angle** | 10° | 8° | 8° |
| **Beam Width:** | | | |
| 3m (9.84ft) | .53m (1.74ft) | .42m (1.38ft) | .42m (1.38ft) |
| 6m (19.69ft) | 1.05m (3.45ft) | .84m (2.76ft) | .84m (2.76ft) |
| 9m (29.53ft) | 1.58m (5.18ft) | 1.26m (4.13ft) | 1.26m (4.13ft) |
| 12m (39.37ft) | 2.10m (6.89ft) | 1.68m (5.51ft) | 1.68m (5.51ft) |
| 15m (49.22ft) | 2.63m (8.63ft) | 2.10m (6.89ft) | 2.10m (6.89ft) |
| 20m (65.62ft) | 3.50m (11.48ft) | 2.80m (9.19ft) | 2.80m (9.19ft) |
| 25m (82.03ft) | | 3.50m (11.48ft) | 3.50m (11.48ft) |
| 30m (98.43ft) | | 4.20m (13.78ft) | 4.20m (13.78ft) |
| 35m (114.84ft) | | 4.89m (16.04ft) | 4.89m (16.04ft) |
| 40m (131.24ft) | | 5.59m (18.34ft) | 5.59m (18.34ft) |
| 45m (147.65ft) | | | 6.29m (20.64ft) |
| 60m (196.86ft) | | | 8.39m (27.53ft) |
| 70m (229.67ft) | | | 9.79m (32.12ft) |

$$W = 2 \cdot D \cdot \tan\frac{\alpha}{2}$$

*Relationship between beam angle α, distance D, and beam width diameter*

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# INSTALLATION

- Vertical Alignment. Use the provided leveling bubble to mount the Nile perpendicular to the surface of the water within +/– 1 degree. Vertical alignment is critical to getting quality data. Because the radar depends on the microwave signal bouncing off the surface of the water and back to the unit, failing to properly align the instrument can cause loss of up to 50% of your data points or more.

- Beam Mounting Alignment. The Nile radar beam has an elliptical/parabolic shape type of footprint. For best data, align the unit such that the footprint of the beam encounters NO obstructions on the way to the water surface. Mount your Nile Radar using the follow steps to optimize the data returned.

Step1. Locate the two vertical tick marks on the collar at the base of the cone, circled in orange in the image.

Step2. Align the Nile radar such that the tick marks face away from the mount structure or in some cases toward the greater view of the water surface.

Step3. Once in place, mount such that the Nile will not rotate or move in this axis.

Step4. If needed, loosen the bolt circled in red, rotate the tick marks around the axis, and then tighten back down. Be careful not to over tighten.  Over-tightening can create cracks in the case.
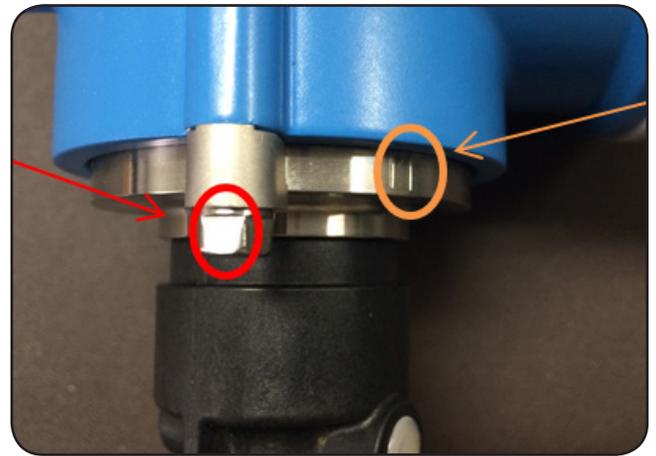


*Beam Mounting Alignment*

## Optional Mounting Hardware

The Nile has two optional mounting hardware options:
- Collar Mount (PN: NILE FL), typically used for a box mount
- Bracket Mount (PN: NILE MB), typically used for open bridge side mount.
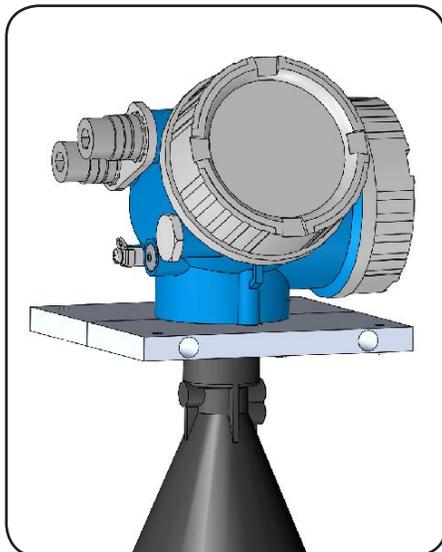


*Collar Mount*
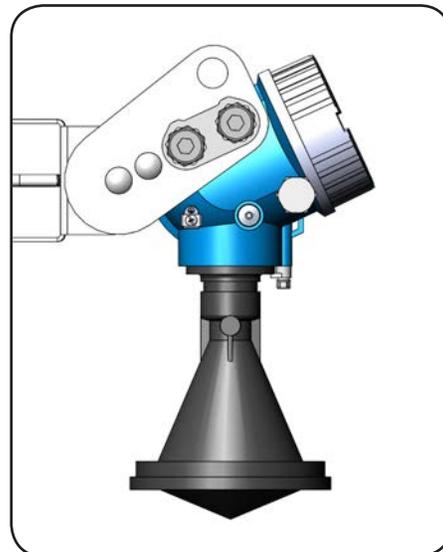


*Bracket Mount*

## Installation Techniques

As noted previously, for installations where vandalism is of concern or additional protection is needed, many users prefer to install the radar unit in a protective housing. The housing provides a convenient location for installing other gauge station equipment such as a battery or data logger. Several housings are available from WaterLOG, please contact your local service representative for further information. WaterLOG also offers optional installation packages that have a solar panel, battery and short-range telemetry radio for communicating with a nearby gauge station.

## General Installation Recommendations

Before proceeding with the installation, please consider several site preparation and maintenance issues. The Nile Series has been designed to operate safely in accordance with current technical, safety, and EU standards. The manual must have been read and understood, and the instructions followed.

*[Warning: Working over water or on tall structures can be dangerous. Use a safety harness, fall arrest device, life-saver, and/or other safety equipment when conditions warrant.]*

## Sensor Precautions

Although the Nile is designed for use in extreme environmental conditions, it is a precision instrument, and care should be taken during installation:
- Do not jar or drop the Nile Radar.
- Mount rigidly to prevent movement from wind and vibration.
- Align the antenna horn within 1° of vertical to prevent trigonometric measurement errors and reduction in maximum range due to off-axis return signal.
- Operate the sensor only within the recommended temperature range of –40°C to 80°C.

## Selecting a Mounting Location

- Mount high enough that the instrument will not be submerged during high water or flood conditions.
- Mount above the smoothest portion of the water surface, generally between piers of a bridge structure. Bridges with long spans between the piers experience more vibration. In these situations, mount the radar 1/4 to 1/3 the span distance from the pier to minimize the vibration.
- Ensure a clear path between the sensor and the water to avoid false reflections. Mount the sensor where the beam path is clear of excessive turbulence, splashing, waves, pipes, wires, and other obstructions. Refer to beam path chart at beginning of this chapter.
- Avoid installing over submerged obstructions such as rocks or bridge piers that disturb or distort the water level.
- Avoid horizontal structural surfaces such as beams, brackets, and sidewall joints because these surfaces tend to reflect a strong false signal. If these are unavoidable, use the display to map the radar beam profile, which will optimize the profile by electronically suppressing interference echoes. Mapping functions are covered in Section 4 - Optimization.

# INSTALLATION

- Be aware that bridges and other large structures expand and contract with temperature. Bridge height can change by a few inches with diurnal temperature changes. Trucks and other traffic loads can cause transient changes to bridge height.

## Making Connections

Because the Nile can be exposed to the sun and weather, a cable rated for water immersion (rain) and sunlight resistance is required.

- A polyurethane or similar sunlight and waterproof rated cable is recommended.
- Do not use utility PVC or other wiring materials, which can become brittle or crack when exposed to ultraviolet radiation from the sun.
- If conduit is used to connect to the Nile radar sensor, remove and discard the liquid-tight cord retainer. If metal conduit is used, the conduit must be grounded.
- When using conduit, the entry must be sealed with silicone or other sealant to prevent moisture from entering the Nile enclosure via the conduit piping.
- The thermal mass of the casing will cause water vapor to internally condense and accumulate with changes in the weather.



*Liquid-tight cord retainer*

*[Caution: Remove all power from the unit before making any connections.]*

*[Warning: All wiring must be performed by qualified individuals in accordance with applicable codes such as the ANSI/NFPA 70 specifications or the Canadian Electrical Code Part 1.]*

## Grounding Your Nile

Proper grounding is important and should be kept simple. Proper grounding removes ground loops which can be the cause of equipment failure. Grounding the Nile is a simple yet subtle thing to do. No grounding methods will protect your site if it suffers a direct lightning strike; however, these general techniques, if strictly followed, can help protect the equipment from normal occurrences.

The two typical methods for grounding the Nile are:

1. Grounding the Nile using cable.
2. Grounding the Nile when using a wireless radio.

This information will serve as a reference guide to grounding your Nile radar:

## Grounding The Nile Radar Using Cable

Follow the same rules for both installations for grounding over cable. These techniques will help solve many of your grounding related problems:

- Use metal conduit, junction boxes, and/or pull boxes.  The metal conduit will act as a shield that will conduct away electrical noise.
- Use an electrical cable with a shield and at least 3 conductors. The wire conductor gauge of 20-22 awg is recommended for most applications, but 18 or 16 gauge conductors will work as well.
- Use a metal conducting conduit the entire distance from the enclosure to the gauge house.
- Make all earth ground connections at the gauge house—not at the radar.

## Grounding the Nile Radar when Using a Wireless Radio

This type of equipment installation is ideal because a radio transmitter/receiver pair replaces the cabling that causes many of the grounding problems. There is no common powering or grounding required between these two systems. The equipment at the remote end or radar installation is connected to a local battery. The remote radar is electrically isolated from the data logger equipment. Thus, lightning and other electrical events will have little effect on this type of installation.

# 04 / OPTIMIZATION
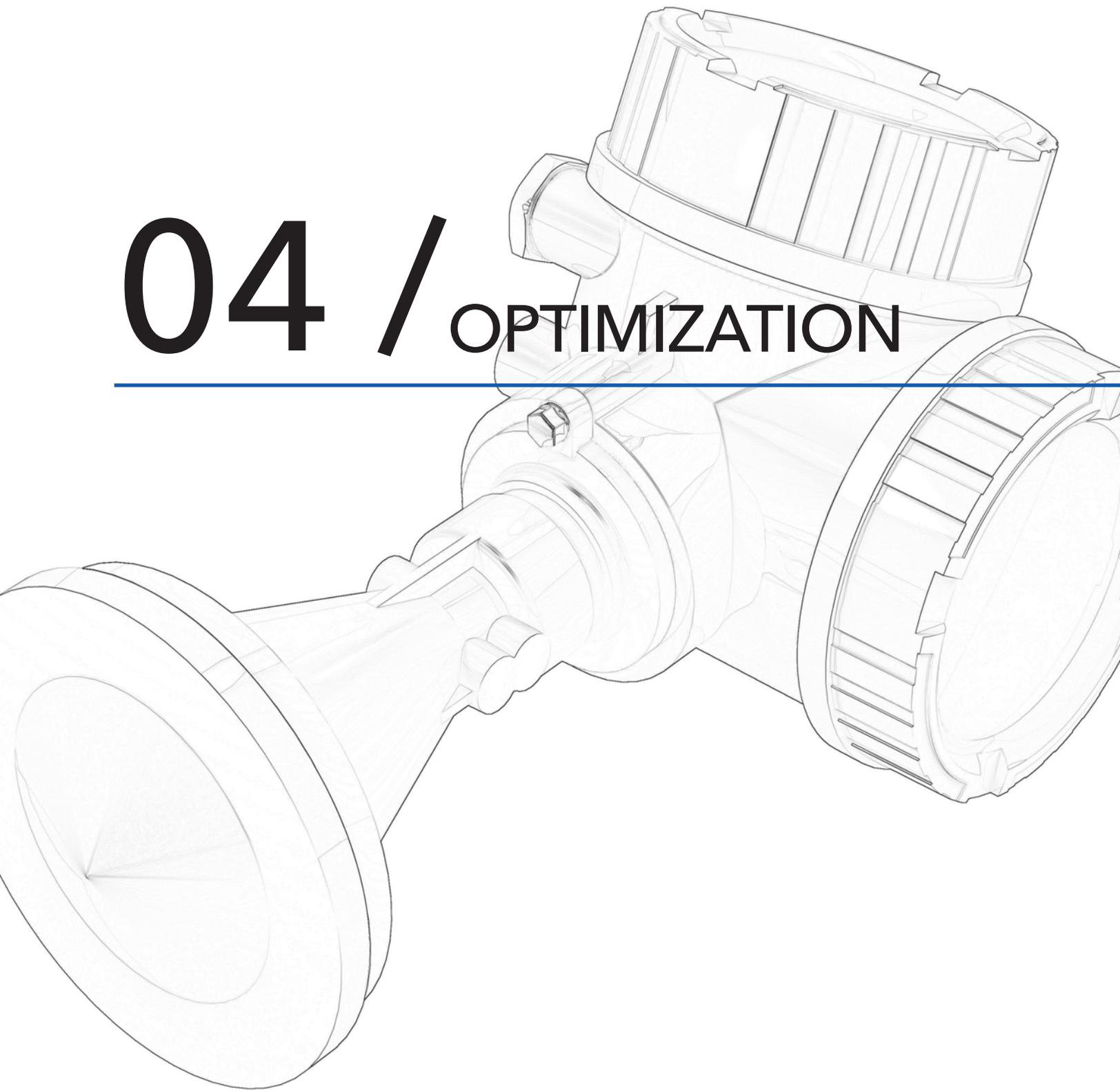
## Deleting Echo Tracking History

It is recommended to clear the echo tracking history when installing the Nile radar in the field. This is the history of measurements that create a site profile, which is saved to optimize the measurements.

However, when there has been testing/verification performed in the office/lab the history will be based on that environment and not the actual field installation. This invalid echo history may cause inaccuracies in the measurement data. Therefore, we recommend clearing the echo history if any of the following is true or possible.

- First installation use
- After office/lab testing/verification
- Moving/replacing the Nile radar

### Steps for Deleting Echo Tracking History

1. Remove the cap covering the display and detach the display if desired by rotating the display until it clicks then lift the display out to use.
2. Power up the Nile radar and press the 'E' key to enter the "Main Menu".
3. Using the '-' and '+' keys highlight the "Expert" option and press the 'E' key.
4. Enter access code "0000", highlight the checkmark box and press the 'E' key.



5. Go down in the "Expert" menu and highlight the "Sensor" option and press the 'E' key.
6. Then go down and highlight the "Echo tracking" option and press the 'E' key.
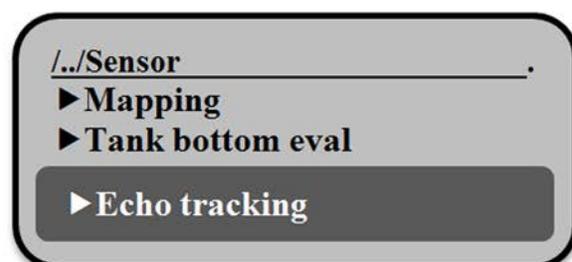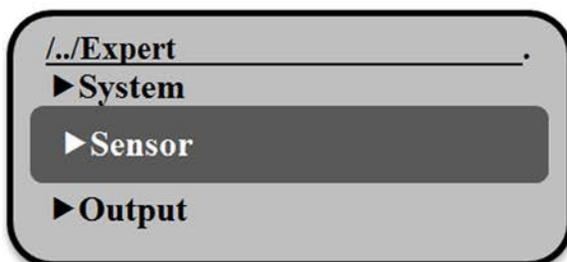


7. In the Echo tracking menu highlight "History reset" option and press the 'E' key.
8. Then go down and highlight the "Delete history" and press the 'E' key.

# OPTIMIZATION
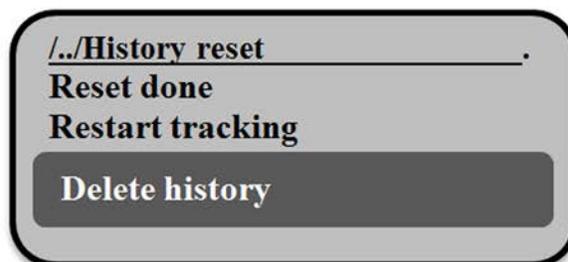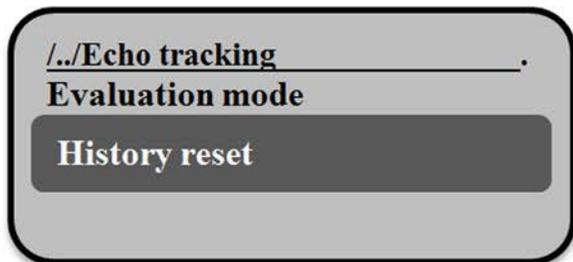


9.  When the deleting is done the screen will return to the "Echo tracking" menu.
10. Deleting echo tracking history is complete.

SDI-12 Command for Deleting Echo Tracking History

**Command:**    **aXCLRH!**
**Reponse:**    **aWork**

Sending the above SDI-12 command will delete the echo tracking history. The 'a' is to be the current SDI-12 address of the Nile radar, the default is '0'. See Chapter 5 for more details.

## Disable Echo Tracking History

It may be desired to turn off the echo tracking history which means the Nile will no longer use the history to profile the site and dynamically correct for false echoes. Follow the instructions below to disable the echo tracking history feature.

Steps for Deleting Echo Tracking History

1.  Remove the cap covering the display and detach the display if desired by rotating the display until it clicks then lift the display out to use.
2.  Power up the Nile radar and press the 'E' key to enter the "Main Menu".
3.  Using the '-' and '+' keys highlight the "Expert" option and press the 'E' key.
4.  Enter access code "0000", highlight the checkmark box and press the 'E' key.



5.  Go down in the "Expert" menu and highlight the "Sensor" option and press the 'E' key.
6.  Then go down and highlight the "Echo tracking" option and press the 'E' key.
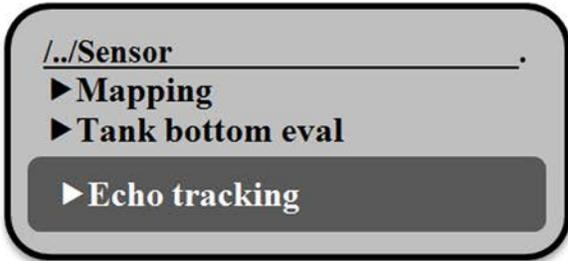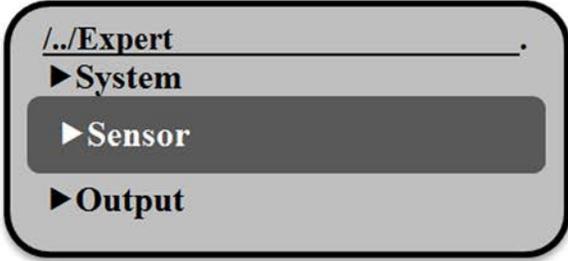
7.  In the Echo tracking menu highlight "Evaluation mode" option and press the 'E' key.
8.  Then go down and highlight the "History off" and press the 'E' key.
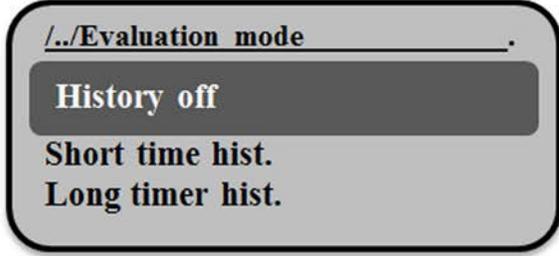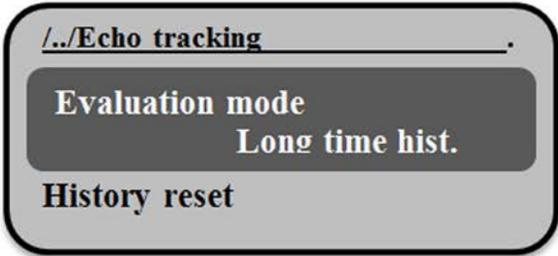


9.  When the history is off the screen will return to the "Echo tracking" menu displaying the "Evaluation mode – History off"
10. Disabling the echo tracking history is complete.

## Saving / Restoring Configurations

When replacing the Nile radar with another Nile radar it is recommended to copy the existing Nile configuration from the existing to the new Nile radar. Doing this will save all the Nile settings and echo tracking history. The configuration is saved and restored using the display. Follow the below steps for saving and restoring (to the HistoROM in-bedded in the Nile housing) the Nile configuration and history.

### Steps for Saving Configuration

1.  Remove the cap covering the display and detach the display if desired by rotating the display until it clicks then lift the display out to use.
2.  Power up the Nile radar and press the 'E' key to enter the "Main Menu".
3.  Using the '-' and '+' keys highlight the "Expert" option and press the 'E' key.
4.  Enter access code "0000", highlight the checkmark box and press the 'E' key.
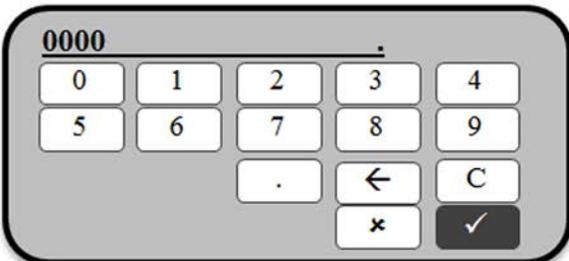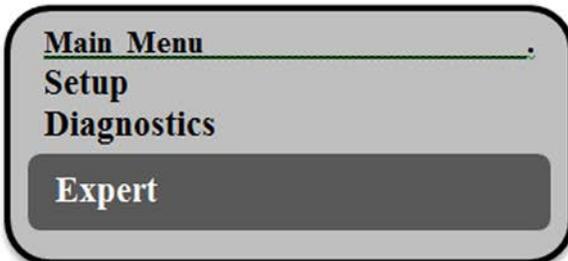
# OPTIMIZATION

5.  Go down in the "Expert" menu and highlight the "System" option and press the 'E' key.
6.  Then go down and highlight the "Conf. backup disp" option and press the 'E' key.
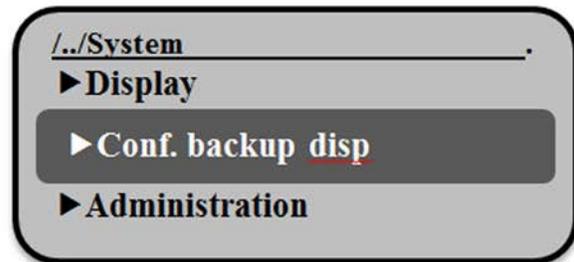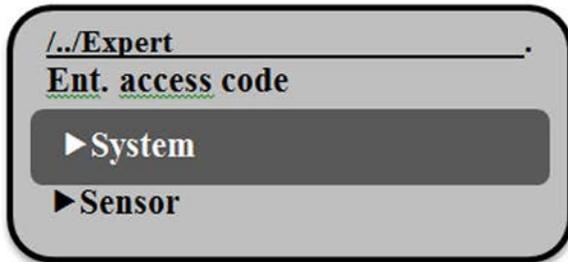


7.  In "Conf. backup disp" menu highlight "Config. managem." option and press the 'E' key.
8.  Then go down and highlight the "Execute backup" and press the 'E' key.
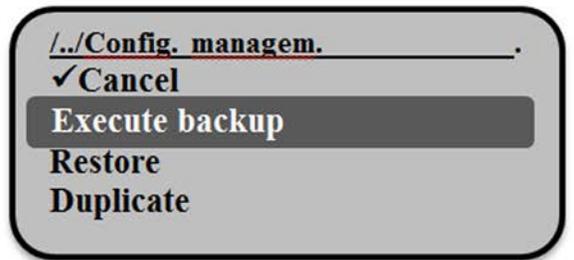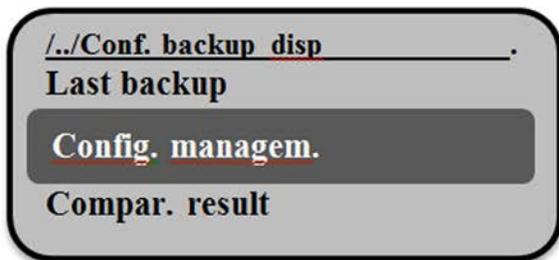


9.  The display will show the backup progress bar until finished and then will return back to the "Conf. backup disp" menu screen.
10. Saving the Nile configuration complete.
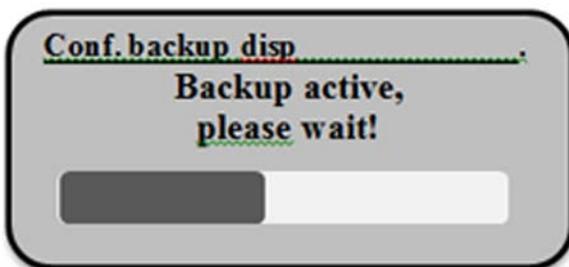


Steps for Restoring Configuration
1.  Follow the "Steps for Saving Configuration" through Step 6 and then continue below to restore a saved Nile configuration.
2.  Go down and highlight the "Restore" and press the 'E' key.
3.  The display will show the restore progress bar until finished and then the Nile radar will restart and return to the home screen showing the distance to water value.
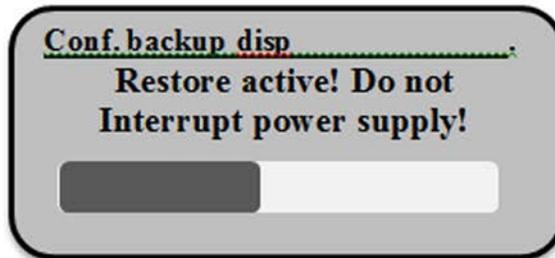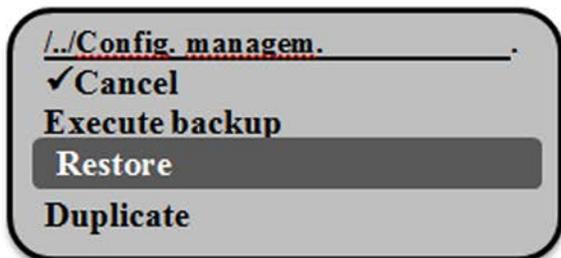
4.   Restoring the Nile configuration is complete.

## Performing Mapping

The Nile Radar has the ability to map or profile its path to the surface of the water by suppressing interference echoes from obstructions that may cause false echoes. When adding a map to the instrument, you are creating a threshold that will tell the unit to ignore all false signals before this threshold. The mapping feature is accessed through the Nile's optional LCD display.

The signal from the Nile reflects off everything within its footprint, which may include the water surface, the riverbank, and part of a bridge pier. Mapping will eliminate the data points from the bank and bridge pier so only the reflections from the water surface are recorded in the data.

Example:
In this example, the Nile is mounted on a bridge. The beam reflects off the bridge pier at 30 ft, the left riverbank at 40 ft, the right riverbank at 45 ft, and the water surface at 50 ft.  In this case, mapping helps the sensor learn the path to the water and then ignore all of the data points from the false echoes above 48 feet. The strongest signals would be from the water surface, but mapping allows us to ignore the data points that are not related to the water surface level.



Note that mapping does not just blank out the data above 48 ft; it maps the path of the signal and then subtracts out those signals above the initial water surface point.  Thus, even if the water rises above the 48 ft point and overtops the banks, the Nile will still return an accurate water level.
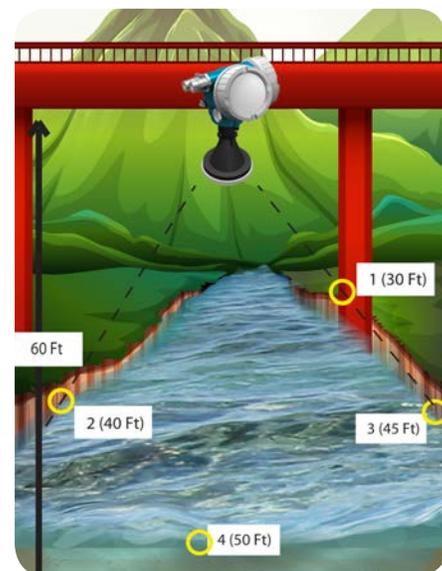
# OPTIMIZATION

In our example, let's say the riverbank returns signal strength of 5 db. When the water rises above the bank, the Nile will record the 5 db from the bank and perhaps 30db from the water surface. The graph will add the 5 db to the 30 db for a total of 35 db where the water is overtopping the bank. The mapping then subtracts out the 5db from the bank so it still shows only the water surface level.

NOTE: Adding a map will not cause your device to read incorrectly unless you initially map out the water surface. Additionally, if a second map is needed after the initial mapping is performed the initial map must be deleted first. For instructions on deleting a map see "Steps to Delete a Mapping" below (page 30).
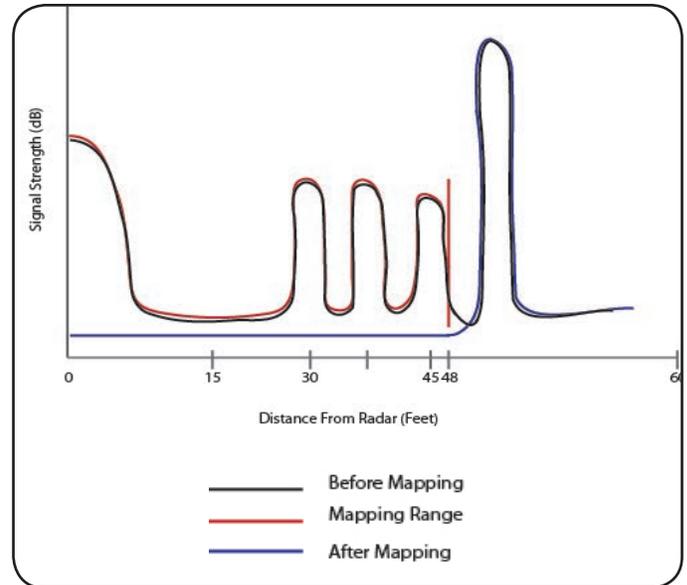


Steps To Perform Mapping

1. Remove the cap covering the display and detach by rotating it slightly until it clicks out. It is attached to the Nile by an 18" cable.
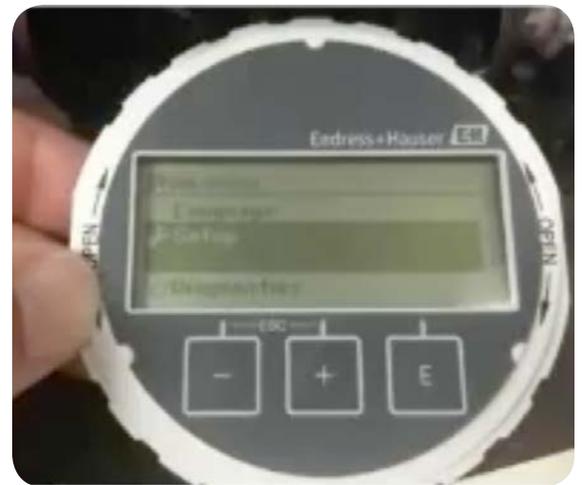


2. Press (E) key to enter in the Main menu.
3. Go down and highlight "Setup" and press the 'E' key
4. Then go down and highlight "Mapping" and press the 'E' key.
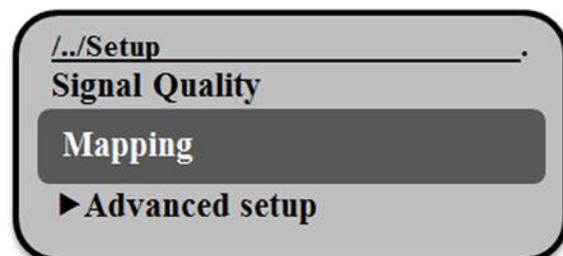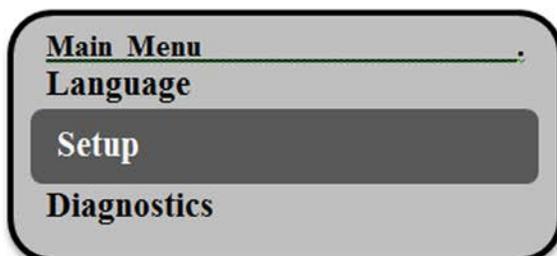
5. In the mapping menu, press the 'E' key on "Confirm distance".
6. Then highlight "Manual map" and press the 'E' key.
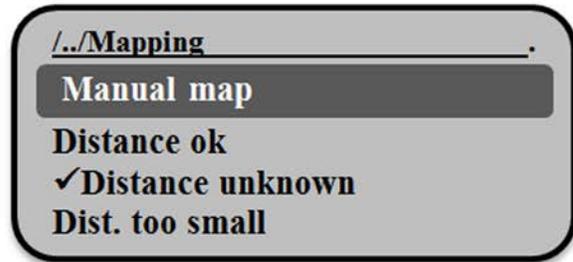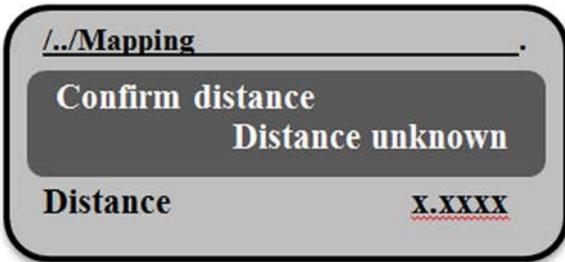


7. Press the 'E' key on the "Map. End point" option.
8. Enter in the mapping end point which in the above example would be around 48 feet and highlight the checkmark box and press the 'E' key.
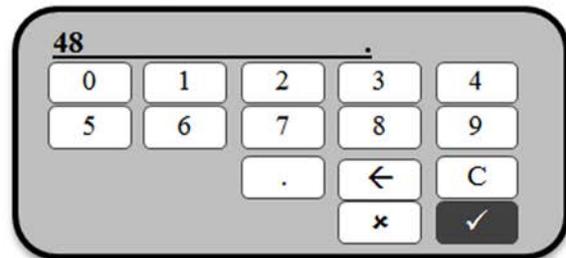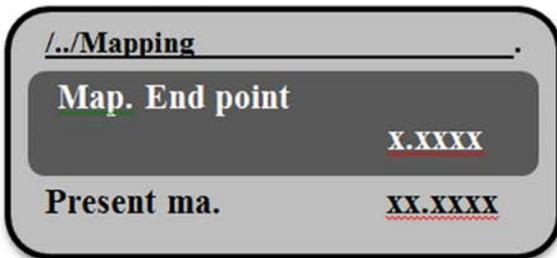


9. Press the 'E' key on the "Record map" option.
10. Then go down and highlight the "Record map" option and press the 'E' key.
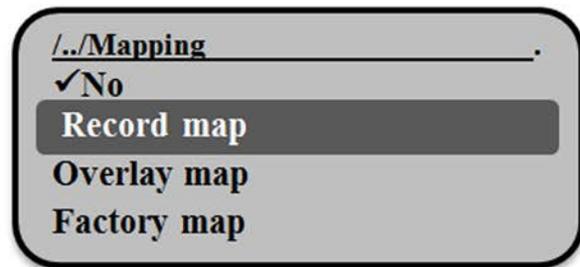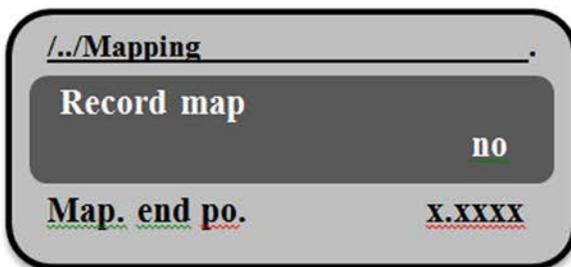


11. When it is complete it return to a "Distance" screen, press the key corresponding with the checkmark to continue.
12. Mapping is complete.

# OPTIMIZATION

## Steps to Delete a Mapping

When a Radar is installed we recommend performing a mapping.  As time passes new obstructions may be exposed and the site may need to be remapped, but multiple mappings can result in bad data.  When a mapping is performed it gets saved in the radar.  If a second map gets performed it also gets saved and the radar tries to honor both mappings resulting in some radar confusion.  To avoid this confusion simply delete the first mapping before performing the second.

To delete a mapping, follow steps 1-5 in the 'Steps to Perform Mapping' section, then follow steps 2-6 below.

1.  Follow steps 1-5 in the 'Steps to Perform Mapping' section (see page 28)
2.  In the mapping menu, press the 'E' key on "Confirm distance".
3.  Then scroll down and highlight "Factory map" and press the 'E' key. (*Figure 15*)
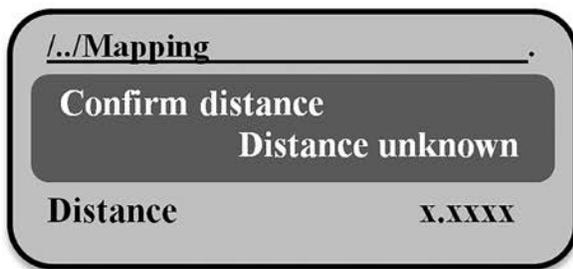


*Figure 14*
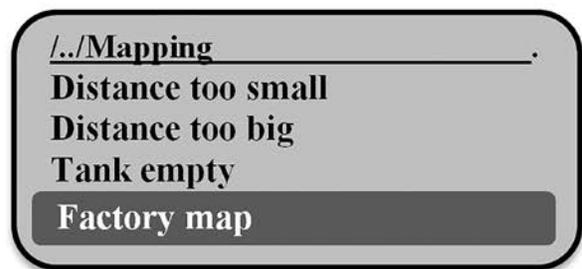


*Figure 15*

4.  Press the key corresponding with the checkmark to continue.
5.  The screen will show an "End of sequence" then press the key corresponding with the checkmark to continue.
6.  The screen will be back on the mapping option inside the setup menu.   All maps have been erased, and you can now perform a second mapping.

## Adjust Integration / Averaging Time

It may be necessary in some installations to edit the integration time used for averaging the measured distance to water value. Below is a list of possible reasons to adjust the integration time of the Nile radar. By adjusting the averaging time (generally increasing averaging) you can smooth out noisy data.

*   High wave action on surface of water
*   Wind gusts on shallow water
*   Reservoir applications
*   Unstable bridge or structure for radar mounting
*   High traffic bridges

Steps for Adjusting Integration/Averaging Time

1.  Remove the cap covering the display and detach the display if desired by rotating the display until it

30

2. Power up the Nile radar and press the 'E' key to enter the "Main Menu".
3. Using the '-' and '+' keys highlight the "Expert" option and press the 'E' key.
4. Enter access code "0000", highlight the checkmark box and press the 'E' key.
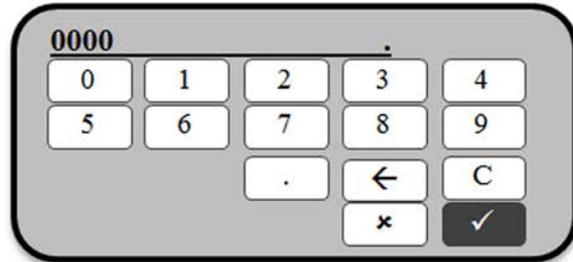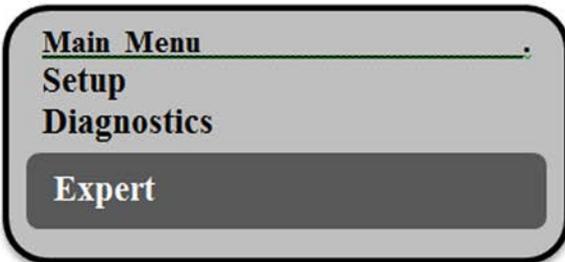
5. Go down in the "Expert" menu and highlight the "Sensor" option and press the 'E' key.
6. Then go down and highlight the "Distance" option and press the 'E' key.
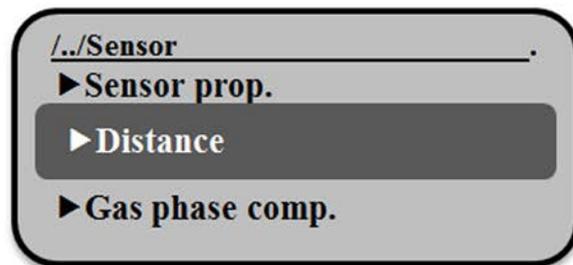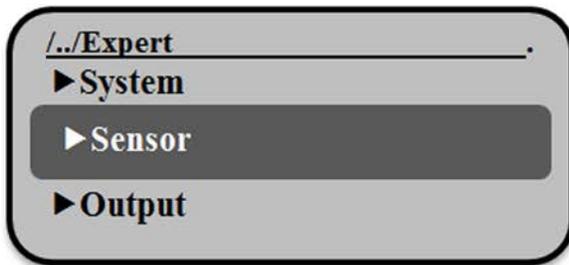
7. Go down and highlight the "Integration time" option and press the 'E' key.
8. Enter the desired integration time, the default is 5.00 seconds. Then highlight the checkmark box and press the 'E' key. Recommended range 1-30 seconds.
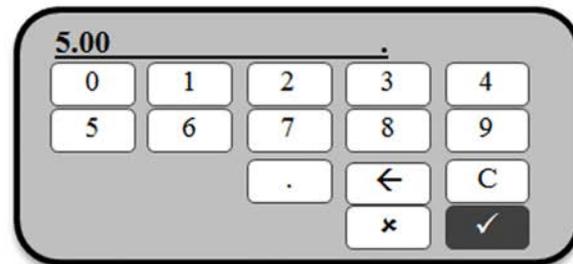
9. The screen will return to the "Distance" menu displaying the new integration time.
10. Adjusting integration time is complete.

## Edit Tank Type

Simple tests to validate the accuracy of the Nile are often used in indoor testing chambers. When testing the Nile in these types of settings, it will be necessary to change the tank type to "vessel" mode instead of the default "open channel" mode. The "open channel" mode is recommended for field use. Changing these mode types is done using the Nile display.

# OPTIMIZATION

Simple tests to validate the accuracy of the Nile are often used in indoor testing chambers. When testing the Nile in these types of settings, it will be necessary to change the tank type to "vessel" mode instead of the default "open channel" mode. The "open channel" mode is recommended for field use. Changing these mode types is done using the Nile display.

Steps for Editing Tank Type
1. Remove the cap covering the display and detach the display if desired by rotating the display until it clicks then lift the display out to use.
2. Power up the Nile radar and press the 'E' key to enter the "Main Menu".
3. Using the '-' and '+' keys highlight the "Setup" option and press the 'E' key.
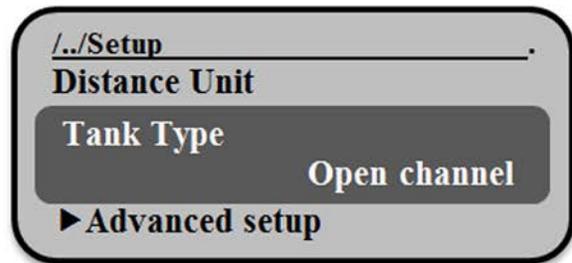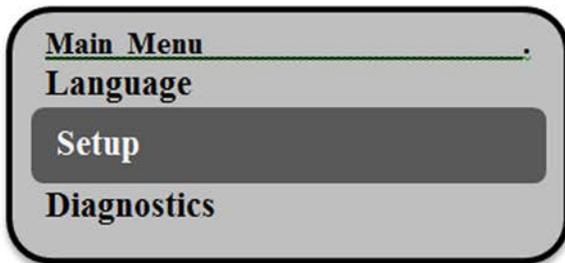


4. Go up and highlight "Vessel standard" type and press the 'E' key.
5. After editing the screen will return to the "Setup" menu showing "Vessel standard".
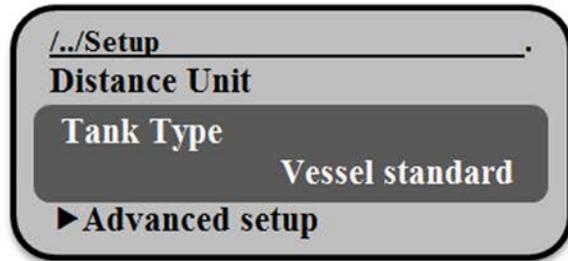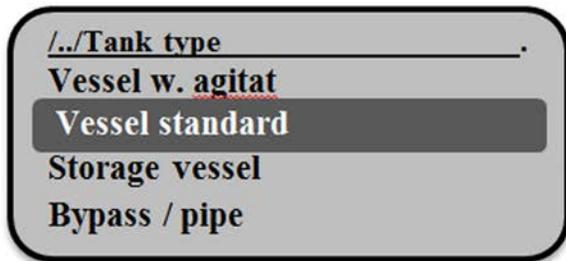


6. Editing the tank type is complete.

SDI-12 Command for Editing the Tank Type

Description:   Set tank type to "Open channel"
Command:   aXSTTO!
Reponse:          aWork

Description:   Set tank type to "Vessel standard"
Command:   aXSTTV!
Reponse:          aWork

Sending the above SDI-12 command will set the tank type accordingly. The 'a' character is to be the current SDI-12 address of the Nile radar, the default is '0'. See Chapter 5 for more details.

# 05 / SDI-12 COMMAND & RESPONSE PROTOCOL

# SDI-12 COMMAND & RESPONSE

This chapter includes the Serial Digital Interface (SDI-12) Command and Response Protocol used by the WaterLOG Nile Series and a description of the commands and data format supported by the Nile.

*[Refer to the document "A SERIAL DIGITAL INTERFACE STANDARD FOR HYDROLOGIC AND ENVIRONMENTAL SENSORS". Version 1.3 January 12, 2009 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 Nile SDI-12 sensor, and the Nile then replies with a "response."

## SDI-12 Measurement Commands

For data loggers that cannot sustain a 1-second logging interval, three options are available. Configuring the Nile to operate in a selected mode is done using the SDI-12 instructions.

### The "NOAA" 3-minute Mode Measurement (aM1!)

The Nile internally performs the following measurement sequence.
1.      Makes 181 measurements at a precise 1 second interval.
2.      Computes the standard deviation for the data set.
3.      Multiplies the standard deviation by 3 to obtain a High and Low outlier threshold.
4.      Sifts through the data set and discards data points above and below the outlier thresholds.
5.      Computes the standard deviation again for the data set with the outliers removed.

The standard deviation is computed as follows:

1.      Compute the mean for the data set
2.      Compute the deviation by subtracting the mean from each value
3.      Square each individual deviation
4.      Divide by one less than the sample size
5.      Take the square root

The "aM1" command response is "0185" (184 seconds, 5-parameters). The sensor buffer will contain 4 parameters; mean stage, standard deviation, number of outliers discarded, number of good values, and battery voltage.

### The "NOAA" 6-Minute Mode Measurement (aC1!)

The Nile internally performs the following measurement sequence.
1. Makes 360 measurements at a precise 1 second interval.
2. Computes the standard deviation for the data set.
3. Multiplies the standard deviation by 3 to obtain a High and Low outlier threshold.
4. Sifts through the data set and discards data points above and below the outlier thresholds.
5. Computes the standard deviation again for the data set with the outliers removed.

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The standard deviation is computed as follows:

1. Compute the mean for the data set
2. Compute the deviation by subtracting the mean from each value
3. Square each individual deviation
4. Divide by one less than the sample size
5. Take the square root

The "aC1" command response is "036005" (360 seconds, 5- parameters). The sensor buffer will contain 5 parameters; mean stage, standard deviation, number of outliers discarded, number of good values, battery voltage.

The Fast Measure Mode

The fast measure mode is used by changing the Nile power mode to mode 1. In this mode, the Nile is always awake and automatically collecting data from the radar unit at a 1-second interval , this is done using the "XWPM" SDI-12 Extended Command (see Chapter 5). The Nile stores the previous six minutes of data in the stack. In this mode, the sensor uses additional power. When an "aM!" measurement is received, the sensor response is "0014" (1-seconds, 4-parameters). The service request is sent within 55mS of receipt of the command (170mS of receipt of the break). This leaves plenty of time for a data logger to collect the data while sustaining a 1-second logging interval. The data placed in the sensor buffer is the results of the previous internal measurement (1-second old). The data logger must implement its own internal NOAA or other filtering and averaging computations.

When in fast measure mode the radar makes continuous measurements which allow a different type of NOAA mode measurement to take place. When in fast measure mode the "aM1!" command takes the data from the previous six minutes and performs the same procedure as the NOAA mode measurements, namely:

1. Collect a set of 1-Hz samples centered in the previous six minute time block, the length of which is selected by the user the SDI-12 command "aXWNMddd!", see details in Chapter 5: SDI-12 Command & Response Protocol.
2. Computes the standard deviation for the data set.
3. Multiplies the standard deviation by 3 to obtain a High and Low outlier threshold.
4. Sifts through the data set and discards data points above and below the outlier thresholds.
5. Computes the mean and standard deviation again for the data set with the outliers removed.

In addition to the "aM1!" command, the "aM2!" and "aM3!" commands have been added which take simple averages and standard deviation of the previous 1 minute(aM2!) and 15 second(aM3!) data sets respectively. All of these commands also have concurrent types.

# SDI-12 COMMAND & RESPONSE

| Nile SDI-12 Command Summary Table | | |
|---|---|---|
| **Command** | **Power Mode** | **Description** |
| aM! | 0 | *Typical Measurement (default)* |
| aC! | 0 | *Typical Concurrent Measurement* |
| aM1! | 0 | *181 Second Standard Deviation Measurement* |
| aC1! | 0 | *361 Second Standard Deviation Measurement* |
| aM! | 1 | *Fast Mode Typical Measurement* |
| aC! | 1 | *Fast Mode Typical Concurrent Measurement* |
| aM1! | 1 | *Previous 361 *Sample Standard Deviation Measurement* |
| aC1! | 1 | *Previous 361 *Sample Standard Deviation Concurrent Measurement* |
| aM2! | 1 | *Previous 60 *Sample Standard Deviation Measurement* |
| aC2! | 1 | *Previous 60 *Sample Standard Deviation Concurrent Measurement* |
| aM3! | 1 | *Previous 15 *Sample Standard Deviation Measurement* |
| aC3! | 1 | *Previous 15 *Sample Standard Deviation Concurrent Measurement* |

*One sample per second.

## Command Summary

Step1. Change the Nile power mode to 1, always on mode using the below commands.

| Change Power Mode SDI-12 Commands | |
|---|---|
| **aXRPM!** | Read current power mode, 0 = Sleep(default), 1 = Always on |
| **aXWPMd!** | Write power mode, 0 = Sleep, 1 = Always on(RS232 output enabled) |

Step2. Set the desired com port mode using SDI-12 commands. Using the below commands.

| Change Power Mode SDI-12 Commands | |
|---|---|
| **aXRCM!** | Read Current Com Port Mode, 0 = SDI-12, 1 = Auto Print, 2 = Wake and Print |
| **aXWCMd!** | Write Com Port Mode, 0 = SDI-12, 1 = Auto Print, 2 = Wake and Print |

| RS232 Data Output Modes | |
|---|---|
| **Mode 0** | (Default) Typical SDI-12 operation |
| **Mode 1** | Auto Print mode, the Nile will print the stage data to the RS232 port following the measurement sequence. Approximately every second. |
| **Mode 2** | Wake and Print, the Nile will print the stage data to the RS232 port only if a character has been received on the Nile RS232 port which will cause it to wake up and make a measurement. |

Step3. Connect the serial device to the Nile using the RS-232 connections table.

Step4. Nile stage data will start printing according to the mode set.

The Nile supports the following SDI-12 commands:

| Standard Commands | | Extended Commands | |
|---|---|---|---|
| aM! | Typical Measurement | aXSCS! | Set Current Stage |
| aM1! | Standard deviation measurement, 181 seconds (power mode = 0) | aXRS! | Read Slope |
| aM1! | Previously measured 361 sample standard deviation measurement (power mode = 1) | aXWSnn! | Write Slope |
| aM2! | Previously measured 60 sample standard deviation measurement (power mode =1) | aXRO! | Read Offset |
| aM3! | Previously measured 15 sample standard deviation measurement (power mode = 1) | aXWOnn! | Write Offset |
| aC! | Typical concurrent measure command | aXRPM! | Read Power Mode 0 = Sleep, 1 = Always On |
| aC1! | 361 Second standard deviation measurement (power mode = 0) | aXWPMn! | Write Power Mode 0 = Sleep, 1 = Always On |
| aC1! | Previously measured 361 sample standard deviation measurement (power mode = 1) | aXRCM! | Read Com Port Mode, 0 = SDI-12, 1 = Auto Print, 2 = Wake and Print |
| aC2! | Previously measured 60 sample standard deviation measurement (power mode =1) | aXWCM! | Write Com Port Mode, 0 = SDI-12, 1 = Auto Print, 2 = Wake and Print |
| aC3! | Previously measured 15 sample standard deviation measurement (power mode = 1) | aXRNM! | Read number of measurements stored for the "aM1!" command in (power mode = 1) |
| aD0! | Send Data | aXWNMd! | Write number of measurements stored for the "aM1!" command in (power mode = 1) |
| aR! | Continuous Measurement | aXCLRH! | Delete/Clear the echo tracking history |
| aV! | Verify | aXSTTO! | Set the tank type to "Open channel" |
| aI! | Send Identification | aXSTTV! | Set the tank type to "Vessel standard" |

# SDI-12 COMMAND & RESPONSE

| a! | Send Acknowledge | **aXTEST!** | Displays the current settings, then displays data at a fast rate |
|---|---|---|---|
| **aAn!** | Change Address | **aXHELP!** | Displays the supported commands |

NOTES:
- "a" is the sensor address
- All commands/responses are upper-case printable ASCII characters.
- Commands terminate with a "!" character.
- Responses terminate with <cr><lf> characters, which are the carriage return (0D) hex and line feed (0A) hex characters
- The command string must be transmitted in a contiguous block with no gaps of more than 1.66 milliseconds between characters.
- Sensors are initially programmed at the factory with the address of "0" for use in single sensor systems, but "1-9", "A-Z", and "a-z" can be used as addresses for additional sensors connected to the same SDI-12 bus. The "*" and "?" characters are "wild card" addresses that select any sensor, regardless of its actual address.
- The Nile does not support the "aR0!" continuous measurement commands because the measurement and math operations require more than 10 mS to complete

## Standard Commands

**The Measure Commands ("M" Commands)**

The "M" commands initiate measurements.

| MEASURE COMMANDS – These commands initiate measurements | | | |
|---|---|---|---|
| **Command** | **Nile Response** | **Description** | |
| **aM!** | **atttn<cr><lf>** | Measure Command | Initiates Measurement |
| **aM1!** | **atttn<cr><lf>** | (NOAA) Measure Command | Nile supports two different "aM1" measurement commands: Power Mode = 0 and Power Mode = 1 |
| **aM2!** | **atttn<cr><lf>** | 1-Minute Average Measure Command | Nile only supports the "aM2" measurement when the Power Mode = 1 |
| **aM3!** | **atttn<cr><lf>** | 15-Second Average Measure Command | Nile only supports the "aM3" measurement when the Power Mode = 1 |

where
- a      is the sensor address ("0–9", "A–Z", "a–z", "*", "?").
- M      is an upper-case ASCII character indicating the command.
- 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 | 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. |
| a<cr><lf> | is the service request sent to the data recorder upon completion of the measurement, indicating the sensor is ready. |

NOTES:
- 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.
- No service request is sent following "C" commands. Communicating with other sensors will NOT abort a concurrent measurement.

EXAMPLE 1: "aM!" (Measure Command)

**Command** = **aM!** ["make measurement" command]
**Response** = **a0044<cr><lf>** [indicating **time (4 sec)** and **n values (4)**]
NOTE: the service request is normally sent within 530 mS of receipt of the break.

**Subsequent Command=** **aD0!** ["send data" command]
**Response** = **a+AA.AAA+BB.BBB+CC+DD.D<cr><lf>**
where:
AA.AAA = Stage (feet, inches, meters, etc.)
BB.BBB = Distance (feet)
CC = Measurement Status:

| | |
|---|---|
| 0 = No errors | 6 = Wrong command byte |
| 1 = 500 ms response timeout | 7 = Response code not zero |
| 2 = Response overflowed the buffer | 8 = Field device malfunction (device status = $80) |
| 3 = No preamble FFs | 9 = Wrong byte count byte |
| 4 = Missing start byte (delimiter) | 10 = Not enough bytes received |
| 5 = Wrong delimiter | 11 = Frame parity error |

DD.D = Power Supply Voltage (volts)

Each SDI-12 data point or "measurement is input from the radar subsystem. The "aM!" command does not filter or average the measurement data. The radar unit internally processes raw distance measurements with a damping factor and other filtering algorithms

# SDI-12 COMMAND & RESPONSE

EXAMPLE 2:  "aM1!" (NOAA Measure Command: Power Mode = 0)

Measurement sequences for **Power Mode = 0:**

1.      Makes 181 measurements at precise 1.0 second intervals
2.      Computes the standard deviation for the data set as follows:
a.      Compute the mean for the data set
b.      Compute the deviation by subtracting the mean from each value
c.      Square each individual deviation
d.      Divide by one less than the sample size
e.      Take the square root
3.      Multiplies the standard deviation by 3 to obtain a High and Low outlier threshold.
4.      Sifts through the data set and discards data points above and below the outlier threshold.
5.      Computes the mean and standard deviation again for the data set with the outliers removed.

|  |  |  |  |
|---|---|---|---|
| **Command** | = | **aM1!** | [(NOAA) "make measurement" command] |
| **Response** | = | **a1845<cr><lf>** | [showing **time (184 sec)** and **n values (5)**] |

NOTE: The service request is normally sent within 182 seconds of receipt of the command. The 184-second value reported allows time for a few retries when communicating with the radar subsystem.

|  |  |  |
|---|---|---|
| **Subsequent Command=** |  | **aD0!**   ["send data" command] |
| **Response** | = | **a+AA.AAA+BB.BBB+CCC+DDD+EE.E<cr><lf>** |

where:

| | | |
|---|---|---|
| AA.AAA | = | Stage (feet, inches, meters, etc.) |
| BB.BBB | = | Standard Deviation (feet, inches, meters, etc.) |
| CCC | = | Number of outlier data points discarded |
| DDD | = | Number of good values |
| EE.E | = | Power supply Voltage (volts) |

EXAMPLE 3:  "aM1!" (NOAA Measure Command: Power Mode = 1)

Measurement sequences for **Power Mode = 1**:

1.   Make Collect a set of 1-Hz samples centered in the previous six-minute time block, the length of which is selected by the user (ranging from 1–360 data points)
2.   Compute the standard deviation for the data set as follows:
        a. Compute the mean for the data set
        b. Compute the deviation by subtracting the mean from each value
        c. Square each individual deviation
        d. Divide by one less than the sample size
        e. Take the square root
3.   Multiply the standard deviation by 3 to obtain a High and Low outlier threshold.

4. Sift through the data set and discards data points above and below the outlier threshold
5. Compute the mean and standard deviation again for the data set with the outliers removed

| | | | |
|---|---|---|---|
| **Command** | = | **aM1!** | [(NOAA) "make measurement" command] |
| **Response** | = | **a0015<cr><lf>** | [showing **time (1 sec)** and **n values (5)**] |
| **Subsequent Command=** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+AA.AAA+BB.BBB+CCC+DDD+EE.E<cr><lf>** | |

where:

| | | |
|---|---|---|
| AA.AAA | = | Stage (feet, inches, meters, etc.) |
| BB.BBB | = | Standard Deviation (feet, inches, meters, etc.) |
| CCC | = | Number of outlier data points discarded |
| DDD | = | Number of good values |
| EE.E | = | Power supply Voltage (volts) |

EXAMPLE 4: "aM2!" (1-Minute Average Measure Command)

| | | | |
|---|---|---|---|
| **Command** | = | **aM2!** | ["1-minute average measurement" command] |
| **Response** | = | **a0013<cr><lf>** | [showing time (1 sec) and n values (3)] |
| **Subsequent Command=** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+AA.AAA+BB.BBB+CC<cr><lf>** | |

where:

| | | |
|---|---|---|
| AA.AAA | = | Stage (feet, inches, meters, etc.) |
| BB.BBB | = | Standard Deviation (feet, inches, meters, etc.) |
| CC | = | Number of outlier data points discarded |

NOTE: The Nile only supports the"aM2" measurement command when Power Mode = 1.
• When Power Mode = 0, the Nile returns "a0000" signifying the command is not supported in this mode.
• When Power Mode = 1, the Nile averages the data collected from the previous minute and returns the mean and standard deviation, computed as follows:
    a. Compute the mean for the data set
    b. Compute the deviation by subtracting the mean from each value
    c. Square each individual deviation
    d. Divide by one less than the sample size
    e. Take the square root

EXAMPLE 5: "aM3!" (15-Second Average Measure Command)

| | | | |
|---|---|---|---|
| **Command** | = | **aM3!** | ["15-second average measurement" command] |
| **Response** | = | **a0013<cr><lf>** | [showing time (1 sec) and n values (3)] |
| **Subsequent Command=** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+AA.AAA+BB.BBB+CC<cr><lf>** | |

where:

| | | |
|---|---|---|
| AA.AAA | = | Stage (feet, inches, meters, etc.) |
| BB.BBB | = | Standard Deviation (feet, inches, meters, etc.) |
| CC | = | Power Supply Voltage (volts)] |

# SDI-12 COMMAND & RESPONSE

NOTE: The Nile only supports the"aM3" measurement command when Power Mode = 1.
- When Power Mode = 0, the Nile returns "a0000" signifying the command is not supported in this mode.
- When Power Mode = 1, the Nile averages the data collected from the previous minute and returns the mean and standard deviation, computed as follows:
  - a. Compute the mean for the data set
  - b. Compute the deviation by subtracting the mean from each value
  - c. Square each individual deviation
  - d. Divide by one less than the sample size
  - e. Take the square root

## The Concurrent Measurement Commands ("C" Commands)

The "C" commands are similar to the "M" commands except that they can occur while other SDI-12 sensors on the bus are also taking measurements. The "nn" field has an extra digit and the sensor does NOT issue a service request when it has completed the measurement.

| Command | Nile Response | Description | |
|---------|---------------|-------------|---|
| aC! | atttnn\<cr>\<lf> | Concurrent Measurement Command | The concurrent equivalent to the typical aM! command. If power mode = 1 then this is the fast response measurement. |
| aC1! | atttnn\<cr>\<lf> | Concurrent NOAA Measurement Command | 361 sample/second standard deviation measurement command. If power mode = 1 then it is a previous 361 sample standard deviation measurement. |
| aC2! | atttnn\<cr>\<lf> | Concurrent 1-Minute Average Measurement Command | With power mode = 1, this is a previously measured 60 samples standard deviation measurement. |

where
| | |
|---|---|
| **a** | is the sensor address ("0-9", "A-Z", "a-z", "*", "?"). |
| **C** | is an upper-case ASCII character indicating the command. |
| **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 zero (00), no data will be available using subsequent "D" commands. |

EXAMPLE 6: "aC!" (Concurrent Measurement Command)

This command is similar to the "aM!" command (See EXAMPLE 1), but note that the "nn" field has an extra digit.

EXAMPLE 7: "aC1!" (Concurrent (NOAA) Measurement Command)

While in power mode = 0 this command returns a 360 second standard deviation measurement.  While in power mode = 1 this command returns the previous 360 second standard deviation measurement.  (See EXAMPLE 3), but note that the "nn" field has an extra digit.

The data logger must wait 1 second before collecting data, so this command may not work for applications requiring a faster response.

EXAMPLE 8: "aC2!" (1-minute Average Concurrent Measurement Command)

This command is similar to the "aM2!" command (See EXAMPLE 4), however, the nn field has an extra digit.

## The Send Data Command ("D" Command)

The Send Data command returns sensor data generated as the result of previous "aM!", "aM1!", "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 | Nile Response | Description | |
|---------|---------------|-------------|---|
| aD0! through aD9! | apd.d ... pd,-.d<cr><lf> | Send Data Command | Initiates sending data |
| where<br>    **a**       is the sensor address ("0-9", "A-Z", "a-z", "*", "?").<br>**D0...D9**    are upper-case ASCII characters indicating data parameters received. .<br>    **p**      is a polarity sign (+ or -).<br>  **d.d**     represents numeric digits before and/or after the decimal. A decimal may be used in any position in the valuew after the polarity sign. If a decimal is not used, it will be assumed to be after the last digits.<br><br>          For example: +3.29 +23.5 -25.45 +300 | | | |
| NOTES:<br>• If one or more values were specified and a "aD0!" returns no data (<cr><lf> only), the measurement was aborted and a new "M" command must be sent. | | | |

# SDI-12 COMMAND & RESPONSE

EXAMPLE 9: "aD0!" (Send Data Command)

| | | | |
|---|---|---|---|
| **Previous Command** | = | **aM!** | ["make measurement" command] |
| **Response** | = | **a0044<cr><lf>** | [showing **time (4 sec)** and **n values (4)**] |

NOTE: The service request is normally sent within 530 mS of receipt of the break. The 4-second value reported allows time for a few retries when communicating with the radar subsystem.

| | | | |
|---|---|---|---|
| **Subsequent Command =** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+AA.AAA+BB.BBB+CC.C<cr><lf>** | |
| where: | | | |
| AA.AAA | = | Stage (feet, inches, meters, etc.) | |
| BB.BBB | = | Distance (feet) | |
| CC | = | Measurement Status | |
| DD.D | = | Power Supply Voltage (volts) | |

## The Continuous Measurement Commands ("R" Commands)

The Nile does not support the "aR0!" continuous measurement commands because the measurement and math operations require more than 10 mS to complete.

## Variation: Measurements with CRC

All Measure and Concurrent Measure Commands support the CRC functionality to enhance the error detection capability in SDI-12 data collecting systems. A letter "C" appended to the Start Measurement Commands (MC!, MC1! … MC9!), Start Concurrent Measurement Commands (CC!, CC1! ...CC9!), and will cause the request that the data be returned with a 16 bit Cyclic Redundancy Check (CRC). When these commands are used, the data returned in response to the D command have a CRC code appended to it. For example: Changing the "aM!" command to "aMC!" will append a CRC to the "aM1!"data; Changing the "aC1!" command to "aCC1!" will append a CRC to the "aC1!" data.

## The Send Acknowledge Command

| Command | Nile Response | Description | |
|---|---|---|---|
| a! | a<cr><lf> | Send Acknowledge Command | Returns a simple status response that includes the address of the sensor. |
| where      **a**      is the sensor address ("0-9", "A-Z", "a-z", "*", "?"). | | | |
| NOTES:<br>• Any measurement data in the sensor's buffer is not disturbed. | | | |

## The Verify Command ("V" Command)

The result of this command is similar to the "aM!" command except that the values generated are fixed test data and diagnostic data for testing purposes.

| Command | Nile Response | Description | |
|---------|---------------|-------------|---|
| aV! | atttn<cr><lf> | Verify Command | Initiates verify sequence |
| where | | | |
| **a** | is the sensor address ("0–9", "A–Z", "a-z", "*", "?"). | | |
| **V** | is an upper-case ASCII character indicating the command. | | |
| **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. | | |
| NOTES:<br>• 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. | | | |

EXAMPLE 10: "aV!" (Verify Command)

> **Command** = aV! ["verify" command]
> **Response** = a0013<cr><lf> [showing **time (1 sec)** and **n values (3)**]

NOTE: the service request is normally sent within 530 mS of receipt of the break.

> **Subsequent Command =** aD0! ["send data" command]
> **Response** = a+123.456+78.9+CC+y<cr><lf>
> Key:
> +123.456 = Fixed test data
> +78.9 = Fixed test data
> y = ROM checksum test (0 = Failed, 1 = Passed)

## The Send Identification Command ("I" Command)

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

# SDI-12 COMMAND & RESPONSE

| Command | Nile Response | Description |
|---|---|---|
| aI! | allcccccccccmmmmmmvvvxx…xx<cr><lf> | Send Identification Command |
| where | | |

where
| | | |
|---|---|---|
| **a** | is the sensor address ("0–9", "A–Z", "a–z", "*", "?"). | |
| **ll** | is the SDI-12 version compatibility level, e.g., version 1.2 is represented as "12". | |
| **cccccccc** | is an eight character vendor identification to be specified by the vendor and usually in the form of a company name or its abbreviation. | |
| **mmmmmm** | is a six character field specifying the sensor model number. | |
| **vvv** | is a three 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 11: "aI!" (Send Identification Command)

| | | | |
|---|---|---|---|
| **Command** | = | **aI!** | ["send identification" command] |
| **Response** | = | **a013  DAA NILE 00AS#000000V031<cr><lf>** | |

## The Change Sensor Address Command ("A" Command)

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

| Command | Nile Response | Description | |
|---|---|---|---|
| aAn! | n<cr><lf> | Change Sensor Address Command | Changes 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 indicating the command. | |
| **n** | is a the new sensor address to be programmed ("0–9", "A–Z"). | |

NOTES:
• To verify the new address, use the Send Identification "I" Command.

EXAMPLE 12: "aAn!" (Send Identification Command)

| | | | |
|---|---|---|---|
| **Command** | = | **aA2!** | ["change sensor address" command] |
| **Response** | = | **2<cr><lf>** | [indicates sensor address was changed to 2] |

## Extended Commands ("X" Commands)

The Nile processes Distance data and computes Stage = Slope (m) * Distance + Offset (b). During installation it is convenient to quickly set the Nile'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 Nile to make a fresh measurement and automatically update the Offset (b) term as needed to produce the desired Stage.

EXAMPLE 13: Set Current Stage Command

| | | | |
|---|---|---|---|
| **Command** | = | **aXSCS2.3!** | [command to set stage to 2.3] |
| **Response** | = | **a0041\<cr>\<lf>** | [showing time (4 sec), n values (1) to set stage] |
| **Subsequent Command** | = | **aD0!** | ["send data" command] |
| **Response** | = | **a+12.80\<cr>\<lf>** | [indicates new offset term to produce desired stage] |

### The Extended Read/Write Stage_Offset and Stage_Slope Commands

The Nile processes the Distance data and computes Stage = m * Distance + b. 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 Slope and Offset terms. The Slope is set to -1.0 and the Offset to 0.00 at the factory. With the factory default (-1.0), the Stage will be in units of water depth (in feet). The reason for a negative slope is that the radar measures Distance; as the water rises Distance decreases.

| Command | Nile Response | Description | |
|---|---|---|---|
| **aXRS!** | **a0011\<cr>\<lf>** | Extended Read Slope Command | Reads current Slope |
| **aXWSddd!** | **a0011\<cr>\<lf>** | Extended Write Slope Command | Writes a new Slope term |
| **aXRO!** | **a0011\<cr>\<lf>** | Extended Read Offset Command | Reads current Offset |
| **aXWOddd!** | **a0011\<cr>\<lf>** | Extended Write Offset Command | Writes a new Offset term |
| **where** | | | |
| **a** | is the sensor address ("0–9", "A–Z", "a–z", "*", "?"). | | |
| **XRS** | are an upper-case ASCII characters indicating the command "Read Slope". | | |
| **XRO** | are an upper-case ASCII characters indicating the command "Read Offset". | | |
| **XWS** | are an upper-case ASCII characters indicating the command "Write Slope". | | |
| **XWO** | are an upper-case ASCII characters indicating the command "Write Offset". | | |
| **ddd** | is the new slope or offset value to be written (e.g., 20.0, 195). | | |

**NOTES:**
- This command takes 001 seconds to complete and places 1 value in the data buffer.
- These values are stored in non-volatile FLASH memory within the sensor. Once the new Slope or Offset value is written to the FLASH memory, a copy is sent to the sensor data buffer for verification.
- Use the "aD0" command to collect and view the new slope or offset. To verify these settings any other time, use the "XRS!" or "XRO!" commands.

EXAMPLE 14: Extended Read Slope Command

| | | | |
|---|---|---|---|
| **Command** | = | **aXRS!** | ["read slope" command] |
| **Response** | = | **a0011<cr><lf>** | [showing **time (1 sec)** and **n values (1)**] |

| | | | |
|---|---|---|---|
| **Subsequent Command =** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+1.00<cr><lf>** | [Slope is read as 1.00] |

[Read Offset is completed in the same way using the "aXRO!" command]

EXAMPLE 15: Extended Write Slope Command

| | | | |
|---|---|---|---|
| **Command** | = | **aXWS!** | ["write slope" command**]** |
| **Response** | = | **a0011<cr><lf>** | [showing **time (1 sec)** and **n values (1)**] |

| | | | |
|---|---|---|---|
| **Subsequent Command =** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+1.234<cr><lf>** | [New Slope is written as 1.234] |

[Write Offset is completed in the same way using the "aXWO!" command]

**The Extended Read/Write Power_Mode Commands**

This command is used to view or change the power mode. These values are stored in non-volatile FLASH memory within the sensor. The Nile comes from the factory with the power mode set to the Sleep mode (power mode = 0). Normally, the Nile transmits the service request within 530 mS of receipt of the break. As with some data loggers, this leaves insufficient time to sustain continuous measurements once per second.

The Power_Mode (power mode = 1) is an internal setting that puts the Nile in a fast measure mode. In this mode the Nile is always awake and automatically collecting data from the radar unit and storing it at 1-second intervals. In this mode the sensor uses additional power. Changing this mode will allow and disallow the use of some measurement types.

| Command | Nile Response | Description | |
|---|---|---|---|
| **aXRPM!** | **a0011<cr><lf>** | Extented Read Power_Mode Command | Reads current Power_Mode |
| **aXWPMn!** | **a0011<cr><lf>** | Extended Write Power_Mode Command | Writes a new Power_Mode |
| **where** | | | |
| | **a** | is the sensor address ("0–9", "A–Z", "a–z", "*", "?"). | |
| | **XRPM** | are upper-case ASCII characters indicating the command "Read Power_Mode". | |
| | **XWPM** | are upper-case ASCII characters indicating the command "Write Power_Mode". | |
| | **n** | is the new setting (0 or 1) | |
| | | 0 = Sleep between measurements (Normal) | |
| | | 1 = Make continuous measurements | |
| **NOTES:** | | | |
| • This command takes 001 seconds to complete and places 1 value in the data buffer. <br> • Use the "aD0" command to view the current value. To verify the power mode setting any other time, use the "XRPM!" command. | | | |

EXAMPLE 16: Extended Write Power_Mode Command

| | | | |
|---|---|---|---|
| **Command** | = | **aXWPM1!** | ["write power mode" command] |
| **Response** | = | **a0011\<cr>\<lf>** | [showing **time (1 sec)** and **n values (1)**] |
| | | | |
| **Subsequent Command =** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+1\<cr>\<lf>** | [indicates active power mode] |

[The Power Mode setting can be either 0 or 1]

## The Extended Read/Write Com Port Mode

The Com Port Mode command is used to put the Nile radar in a mode to send data out the RS232 Com port pins to a computer or other serial device. This is used for applications where SDI-12 is not how the data needs to be received. The modes are as follows.

| | |
|---|---|
| Mode 0 | (Default) Typical SDI-12 operation |
| Mode 1 | Auto Print mode, the Nile will print the stage data to the RS232 port following the measurement sequence. Approximately every second. |
| Mode 2 | Wake and Print, the Nile will print the stage data to the RS232 port only if a character has been received on the Nile RS232 port which will cause it to wake up and make a measurement. |

| Command | Nile Response | Description | |
|---|---|---|---|
| **aXRCM!** | **a0011\<cr>\<lf>** | Extented Read Serial Port Mode Command | Reads current Serial Port Mode |
| **aXWCMn!** | **a0011\<cr>\<lf>** | Extended Write Serial Port Mode Command | Writes a new Serial Port Mode |

**where**

      **a**      is the sensor address ("0–9", "A–Z", "a–z", "*", "?").
    **XRCM**    are upper-case ASCII characters indicating the command "Read Serial Port Mode"
    **XWCM**   are upper-case ASCII characters indicating the command "Write Serial Port Mode".
      **n**     is the new setting (0, 1 or 2)
         0 = SDI operation
         1 = Send data auto
         2 = Send data when interrupt received.

**NOTES:**
- This command takes 001 seconds to complete and places 1 value in the data buffer.
- Use the "aD0!" command to view the current value. To verify the serial port mode setting any other time, use the "XRCM!" command.

# SDI-12 COMMAND & RESPONSE

EXAMPLE 17: Extended Write Serial Port Mode Command

| | | | |
|---|---|---|---|
| **Command** | = | **aXWCM2!** | ["write serial port mode" command] |
| **Response** | = | **a0011<cr><lf>** | [showing **time (1 sec)** and **n values (1)**] |
| | | | |
| **Subsequent Command =** | | **aD0!** | ["send data" command] |
| **Response** | = | **a+2<cr><lf>** | [indicates active power mode] |

[The Serial Port Mode setting can be either 0, 1, or 2]

## The Extended Read/Write Number_of_Measurements

This command is used to change the number of measurements used in the "aM1!" command when the Power Mode is set to 1. The Radar comes from the factory with the number of measurements set to 360. This setting is stored in non-volatile FLASH memory within the sensor. The minimum and maximum values that can be written are 1 and 360, respectively; anything beyond these values will be set to one of the endpoints.

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 "XRNM" command.

| Command | Nile Response | Description | |
|---|---|---|---|
| **aXRNM!** | **a0011<cr><lf>** | Extented Read Number_of_ Measurements Command | Reads current number of measurements when sensor is in Power Mode = 1 |
| **aXWNMnnn!** | **a0011<cr><lf>** | Extended Write Power_Mode Command | Writes current number of measurements when sensor is in Power Mode = 1 |
| **where** | | | |
|       **a** is the sensor address ("0-9", "A-Z", "a-z", "*", "?").<br>  **XRNM** are upper-case ASCII characters indicating the command.<br>  **XWPM** are upper-case ASCII characters indicating the command.<br>    **nnn** is the new setting (1-360) | | | |
| **NOTES:**<br>• This command takes 001 seconds to complete and places 1 value in the data buffer.<br>• Once a new value is written, a copy is sent to the sensor data buffer for verification.<br>• Use the "aD0" command to view the current value. To verify the power mode setting any other time, use the "XRNM!" command. | | | |

## The Extended Clear Echo Tracking History Command

This command is used to delete the existing echo tracking history previously stored. This is the history of measurements that create a site profile that are saved to optimize the measurement. However, if you have performed testing in the office/lab and then install in the field it will have echo history saved from the office/lab testing and this can cause accuracy issues.

| Command | Nile Response | Description | |
|---|---|---|---|
| aXCLRH! | aWork<cr><lf> | Extented Read Power_Mode Command | Reads current Power_Mode |
| **where** | | | |
| | a | is the sensor address ("0–9", "A–Z", "a–z", "*", "?"). | |
| | XCLRH | are upper-case ASCII characters indicating the command "Clear History". | |
| **NOTES:** | | | |
| • This command takes 001 seconds to complete and places 1 value in the data buffer. . | | | |

EXAMPLE 18: Extended Clear History Command

| | | | | |
|---|---|---|---|---|
| **Command** | = | **aXCLRH!** | ["clear history" command] |
| **Response** | = | **aWork<cr><lf>** | [showing **time (1 sec)** and **n values (1)**] |

## The Extended Set Tank Type Command

There are two main tank modes used in the Nile for water surface application and they are "Vessel" and "Open Channel". When verifying the radar in the office/lab versus the field, it may be necessary to change this mode for both of these drastic environment changes.

| Open Channel | (Default) To be used in the field over open water. |
|---|---|
| Vessel Standard | To be used when verifying in a close environment like office or lab testing. |

| Command | Nile Response | Description |
|---|---|---|
| aXSTTx! | aWork<cr><lf> | Extended Set Tank Type mode command |
| **where** | | |
| a | is the sensor address ("0–9", "A–Z", "a–z", "*", "?"). | |
| XSTT | are upper-case ASCII characters indicating the commandcommand "Read Serial Port Mode". | |
| x | is the new setting<br>O = Open channel mode<br>V = Vessel standard mode | |
| **NOTES:** | | |
| • This command takes 001 seconds to complete and places 1 value in the data buffer. | | |

EXAMPLE 19: Extended Write Set Tank Type Command

|  |  |  |  |
|---|---|---|---|
| **Command** | **=** | **aXSTTO!** | ["Set tank type to open channel" command] |
| **Response** | **=** | **aWork\<cr>\<lf>** | [showing "Work" means it was successful] |

**The Extended "XTEST" (Test Mode)**

This command is used for installation or production testing and requires the use of a H-4191 interface, and a PC or Data Logger such as the Storm 3 or XL-Series. This command causes the Nile 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 measurement data. This is not compliant with the SDI-12 specification and cannot used with most data loggers. This command returns different data based on the Power Mode setting. To activate the test mode, send the command "aXTEST!".

In Power Mode = 0, The Nile will enter the test mode and make continuous measurements.
In Power Mode = 1, the Nile will enter the test mode and take the raw data that would otherwise be used for an "aM1!" command and outputs it to the SDI-12 bus one value at a time in order from newest to oldest. After the data is sent, the Nile waits for 2 seconds and then starts over as if a new "aXTEST!" command were sent.

Exit the test mode 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 Nile. Removing power from the Nile also causes it to exit this mode.

| Command | Nile Response | Description |
|---|---|---|
| **aXTEST!** | **a: +AA.AAA +BB.BBB +CC\<cr>\<lf>** | Enters test mode |
| **where**<br>       **a**       is the sensor address ("0–9", "A–Z", "a–z", "*", "?").<br>   **AA.AAA**    is the Stage<br>   **BB.BBB**    is the Distance<br>        **CC**    is the measurement status | | |
| **NOTES:**<br>• Exit the test mode 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 Nile. Removing power from the Nile also causes it to exit this mode. | | |

Example 20: Extended "XTEST" Mode (Test Mode)

|  |  |  |  |
|---|---|---|---|
| **Command** | **=** | **aXTEST!** | ["test mode"] |
| **Response** | **=** | **0: +1.202 +3.222 +0** | |
|  |  | **0: +1.212 +3.232 +0** | |
|  |  | **0: +1.222 +3.342 +0** | |
|  |  | **0: +1.232 +3.352 +0** | |
|  |  | **0: +1.232 +3.352 +0** | |
|  |  | **etc.** | |

# 06 / RS-232 COMMANDS
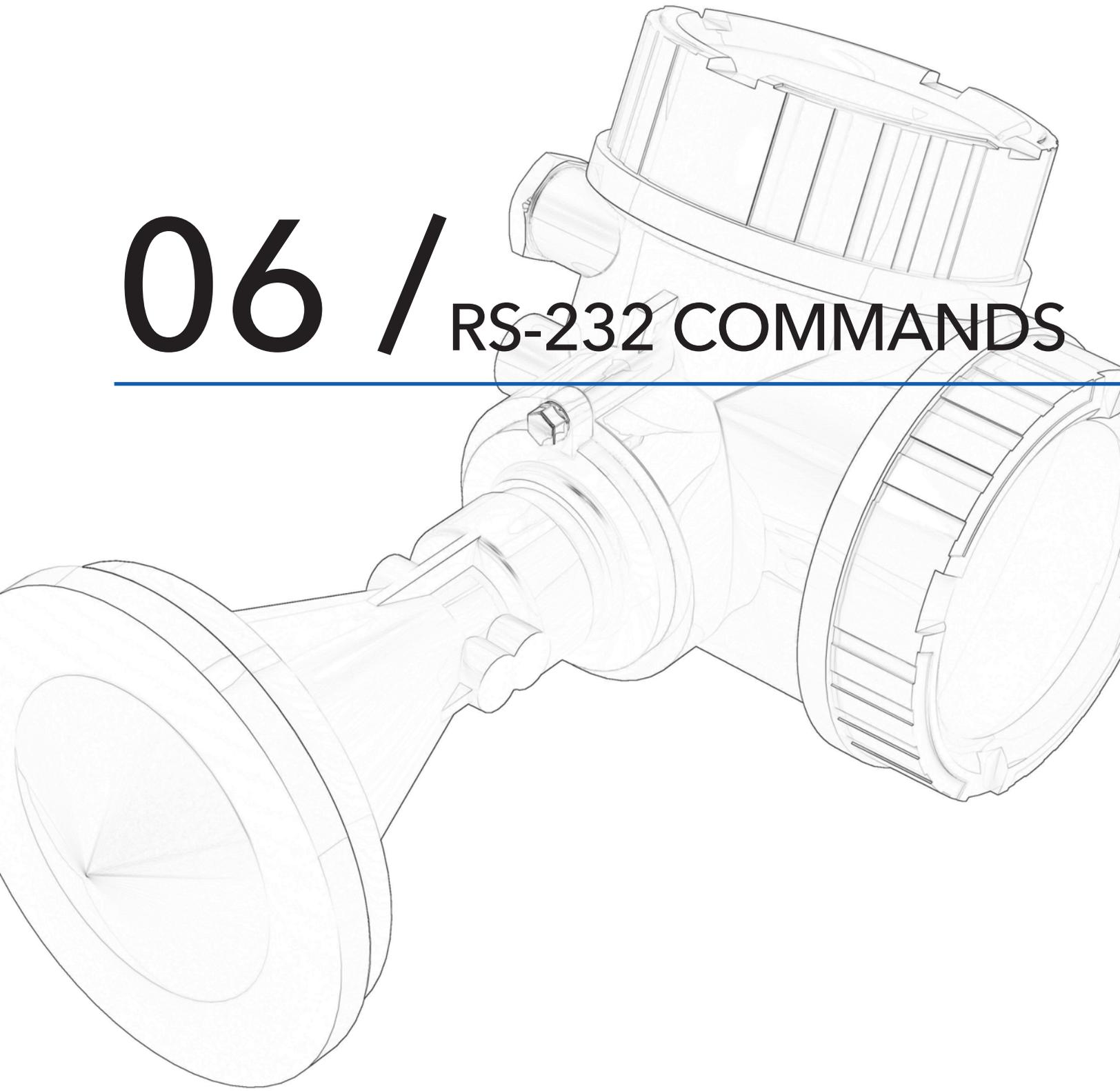
# RS-232 COMMANDS

## RS-232 Interface

To optimize power requirement when the operating the Nile, two Power modes are available.

- Mode 0. Low Power. SDI-12 Operation Only. This is the most effective power mode for the Nile and is used when using the SDI-12 output for communication. In this mode the RS-232 port is disabled.
- Mode 1. High Power. SDI-12 and RS-232. The RS-232 port is enabled, allowing continuous data sent on the com port.

### Power Mode 0

Power mode 0 only supports SDI-12 and puts the Nile into the lowest power mode possible. This mode is default for the Nile. Since this in the default mode, it implies the RS-232 communication is locked out. To safeguard the Nile from being locked out of the RS-232 enable modes, the RS-232 port can be activated by power cycling the Nile. When power is first applied to the Nile, regardless of the power mode set, the RS-232 port will stay active for 1 minute. During this active period the user will have access to the command mode before the Nile returns to the low power 0 mode. If the "#" character is received with this first minute the Nile will automatically go into the Command Mode 2 and Power Mode 1 allowing the command mode to continue working past the 1 minute mark.

### Power Mode 1

In Mode 1 any character except the '#' character will cause the unit to send one line of data out the RS-232 port. This non-# character flags the Nile that a command is being entered. Entering the '#' character suspends any normal activity on the port and waits for the command to be received.

## RS-232 Commands

All RS-232 commands start with the '#' character and are terminated with a carriage return (CR) or line feed (LF). If the '#' character has been received and a CR or LF has not been received within 10 seconds the command entry times out and returns to the normal current operating mode.

| RS-232 Commands | Description |
|---|---|
| #SLOPE? | Returns the current slope for the water level reading |
| #SLOPE=xxxx | Sets the current slope for the water level reading to xxx, where xxx = a floating point value |
| #OFFSET? | Returns the current offset for the water level reading |
| #OFFSET=xxxx | Sets the current offset for the water level reading to xxxx, where xxxx = a floating point value |
| #STAGE? | Returns the current water level reading |
| #STAGE=xxxx | Causes the unit to make a water level measurement and calculate a new offset value so the current water level measurement will be xxxx, where xxxx = floating point value |
| #POWER? | Returns the current power mode setting |

| #POWER=x | Sets the current power mode<br>0 = Low power mode, SDI-12 operation only<br>1 = High power mode, SDI-12 and RS-232 operation |
|---|---|
| #COM? | Returns the current communication mode setting |
| #COM=x | Sets the current communication mode<br>0=SDI-12 operation only<br>1 = Continuous send data on com port<br>2 = Only send data when a key has been pressed |
| #HELP | Returns a list of all commands |
| #ID? | Returns the sensor ID equivalent to the SDI-12 command |
| #DVID | Returns the sensor E+H ID information |

# 07 / APPENDIX
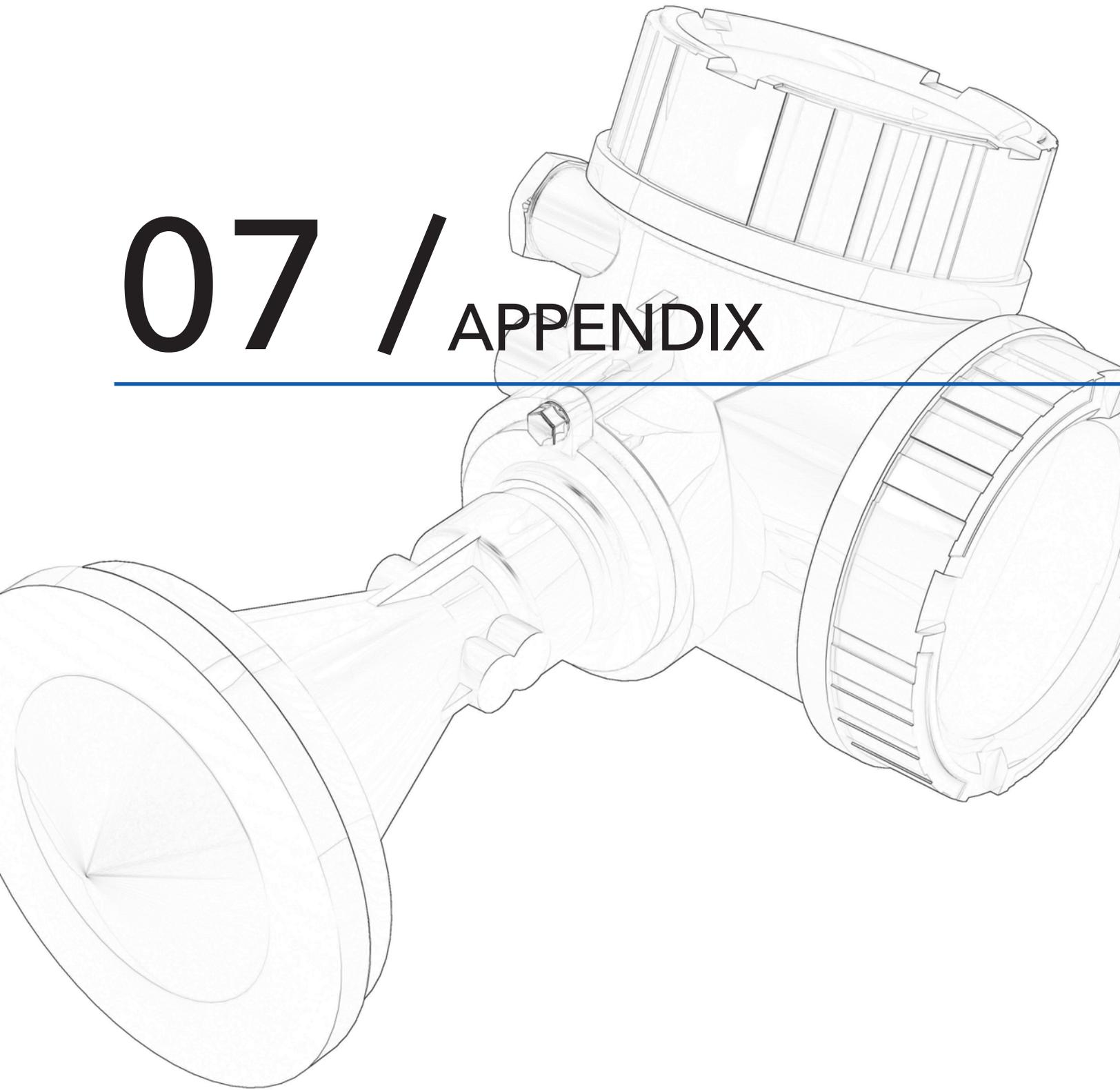
## Appendix A: FCC Approval

FCC/Industry Canada
This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Canada CNR-Gen Section 7.1.3

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) This device may not interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

[Any] changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

In addition, the devices are compliant with the LPR (Level probe radar) regulation for free space applications according to the FCC Code of Federal Regulations, CFR 47, Part 15, Sections 15.205, 15.207, 15.209, 15.256 for antenna sizes bigger than 50 mm (2.0 in) 12). For these applications the devices must be professionally installed in a downward operating position. In addition, the devices are not allowed to be mounted in a zone of 4 km around RAS stations and within a radius of 40 km around RAS stations the maximum operation height of devices is 15 m (49 ft) above ground.

# APPENDIX

## Appendix B: Specifications

| MEASUREMENTS | | | |
| --- | --- | --- | --- |
| | Nile 502 | Nile 504 | Nile 517 |
| Range | 1 to 20 m (3 to 66 ft) | 2 to 40 m (7 to 131 ft) | 2 to 70 m (7 to 230 ft) |
| Standard Accuracy* | ±2 mm (0.08 in) over range of 1.06 to 20 m (3.5 to 66 ft) | ±3 mm (±0.1 in) over range of 2.1m to 40 m (7.0 to 131 ft) | ±3 mm (±0.1 in) over range of 2.1m to 70 m (7.0 to 2309 ft) |
| Near Target Accuracy | ±5 mm (±0.2 in) over range of 0 to 1.06 m (0 to 3.5 ft) | ±21 mm (±0.8 in) over range of 0 to 2.1 m (0 to 7.0 ft) | ±21 mm (±0.8 in) over range of 0 to 2.1 m (0 to 7.0 ft) |
| Temperature Error (Limited Temperature Change) | ±2 mm (±0.08 in) max error per 10°C change | ±5 mm (±0.2 in) max error per 10°C change | ±5 mm (±0.2 in) max error per 10°C change |
| Temperature Error Max | ±5 mm (±0.2 in) max error from -40° C to 60° C | ±15 mm (±0.6 in) max error from -40° C to 60° C | ±15 mm (±0.6 in) max error from -40° C to 60° C |
| Frequency | ~26 GHz | ~26 GHz | ~26 GHz |
| Transmitting Power | <0.4 nW/cm$^2$ | <2.5 nW/cm$^2$ | <2.5 nW/cm$^2$ |
| Beam Angle | 10° | 8° | 8° |
| Measurement Distance | Nile 502 | Nile 502 | Nile 502 |
| | Beam Width | Beam Width | Beam Width |
| 3 m (9.84 ft) | .53 m (1.74 ft) | .42 m (1.38 ft) | .42 m (1.38 ft) |
| 6 m (19.69 ft) | 1.05 m (3.45 ft) | .84 m (2.76 ft) | .84 m (2.76 ft) |
| 9 m (29.53 ft) | 1.58 m (5.18 ft) | 1.26 m (4.13 ft) | 1.26 m (4.13 ft) |
| 12 m (39.37 ft) | 2.10 m (6.89 ft) | 1.68 m (5.51 ft) | 1.68 m (5.51ft) |
| 15 m (49.22 ft) | 2.63 m (8.63 ft) | 2.10 m (6.89 ft) | 2.10 m (6.89 ft) |
| 20 m (65.62 ft) | 3.50 m (11.48 ft) | 2.80 m (9.19 ft) | 2.80 m (9.19 ft) |
| 25 m (82.03 ft) | | 3.50 m (11.48 ft) | 3.50 m (11.48 ft) |
| 30 m (98.43 ft) | | 4.20 m (13.78 ft) | 4.20 m (13.78 ft) |
| 35 m (114.84 ft) | | 4.89 m (16.04 ft) | 4.89 m (16.04 ft) |
| 40 m (131.24 ft) | | 5.59 m (18.34 ft) | 5.59 m (18.34 ft) |
| 45 m(147.65 ft) | | | 6.29 m (20.64 ft) |
| 60 m (196.86 ft) | | | 8.39 m (27.53 ft) |
| 70 m (229.67 ft) | | | 9.79 m (32.12 ft) |

| COMMUNICATION | |
| --- | --- |
| Output | SDI-12, RS-232 |

| POWER | |
| --- | --- |
| Voltage Input | 10 to 16 VDC |
| Supply Current | Active: <13.5 mA |

| ENVIRONMENTAL | |
| --- | --- |
| Operating Temperature | -40° C to + 60° C |
| Storage Temperature | -40° C to + 60° C |
| KPD-LED Display | -20° C to + 70° C |

| PHYSICAL | | | |
| --- | --- | --- | --- |
| Size (Housing) | 168 mm (6.61 in) x 144 mm (5.67 in) | | |
| Size (Horn) | 80 mm (3.15 in), 115 mm (4.53 in) x 137.9 mm (5.43 in) | 100 mm (3.94 in), 135 mm (5.31 in) x 150.5 mm (5.93 in) | 100 mm (3.94 in), 95 mm (3.74 in) x 282 mm (11.10 in) |
| Weight | 2.7 kg | 2.7 kg | 4.2 kg |
| Material (Housing) | PBT Plastic | PBT Plastic | PBT Plastic |
| Material (Horn) | PP Cladded | PP Cladded | 316L |

| WARRANTY |
| --- |
| The Nile series radars are warranted against defects in materials and workmanship for two years from date of shipment. For complete terms and conditions, visit http://www.ysi.com/terms-and-conditions.php |

| Note | For detailed specifications, see user manual. Specifications subject to change without prior notice due to ongoing commitment to product testing and improvement. LR October, 2016 (D51-05 1016)<br><br>* Accuracy was determined under the following reference conditions:  +24°C±5°C, 960 mbar abs., 60% ± 15% RH, using a metal plate reflector with a minimum diameter of 1 m, in accordance with EN 61298-3. |
| --- | --- |

NILE 502 / 504
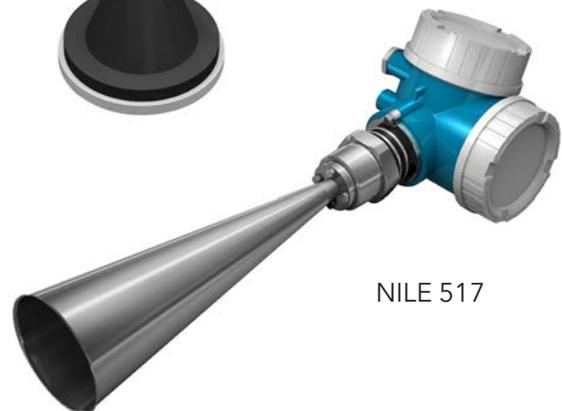
NILE 517

## Dimensions

Dimensions of the Nile 502/504 electronics housing
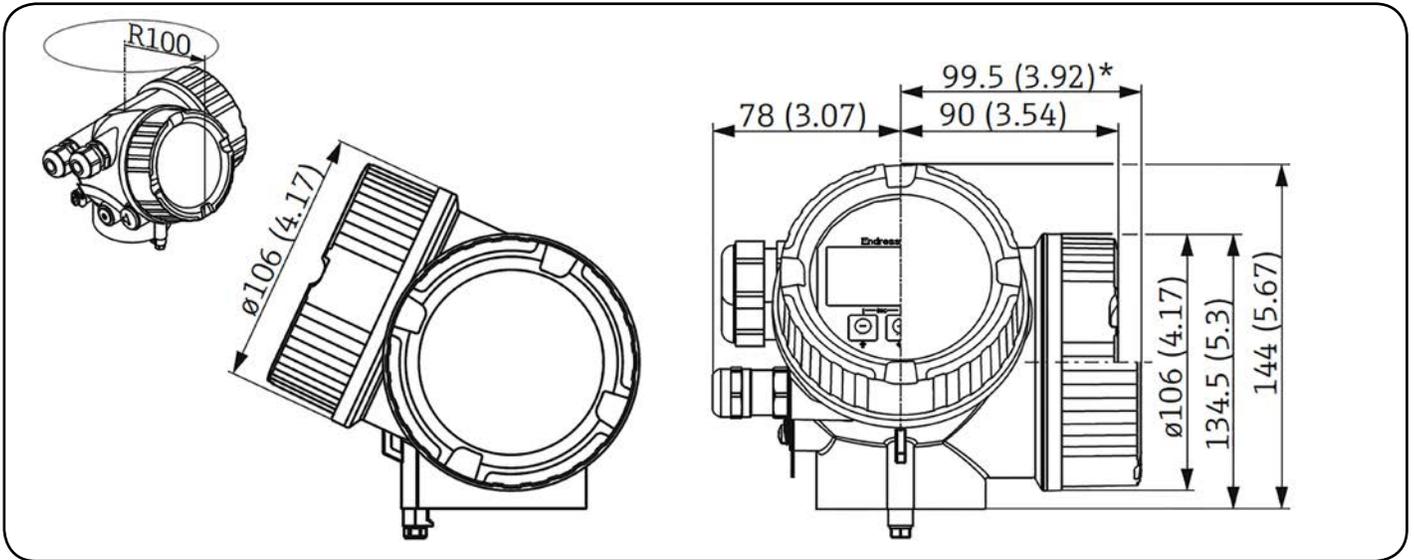


*Dimensions in mm (in)*

Dimensions of Nile 502 / 504
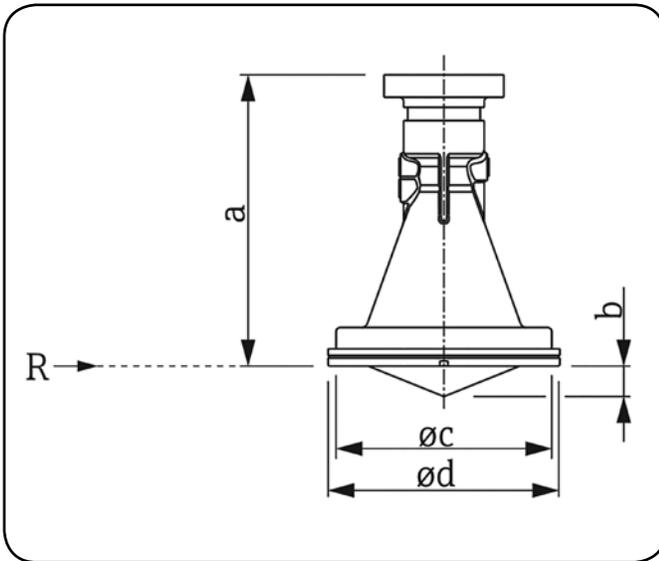


R      Reference point of the measurement

| | Feature 100 "Process connection" <br> •    UAE Mounting bracket <br> •    XRO: Customer side connection | |
|---|---|---|
| | *Nile 502 Antenna Horn 80mm/3"* | *Nile 504 Antenna Horn 100 mm/4"* |
| *a* | *137.9 mm (5.43 in)* | *150.5 mm (5.93 in)* |
| *b* | *15 mm (0.59 in)* | *20 mm (0.79 in)* |
| *Φc* | *107 mm (4.21 in)* | *127 mm (5 in)* |
| *Φd* | *115 mm (4.53 in)* | *135 mm (5.31 in)* |

# APPENDIX

Dimensions of the Nile 517 electronics housing
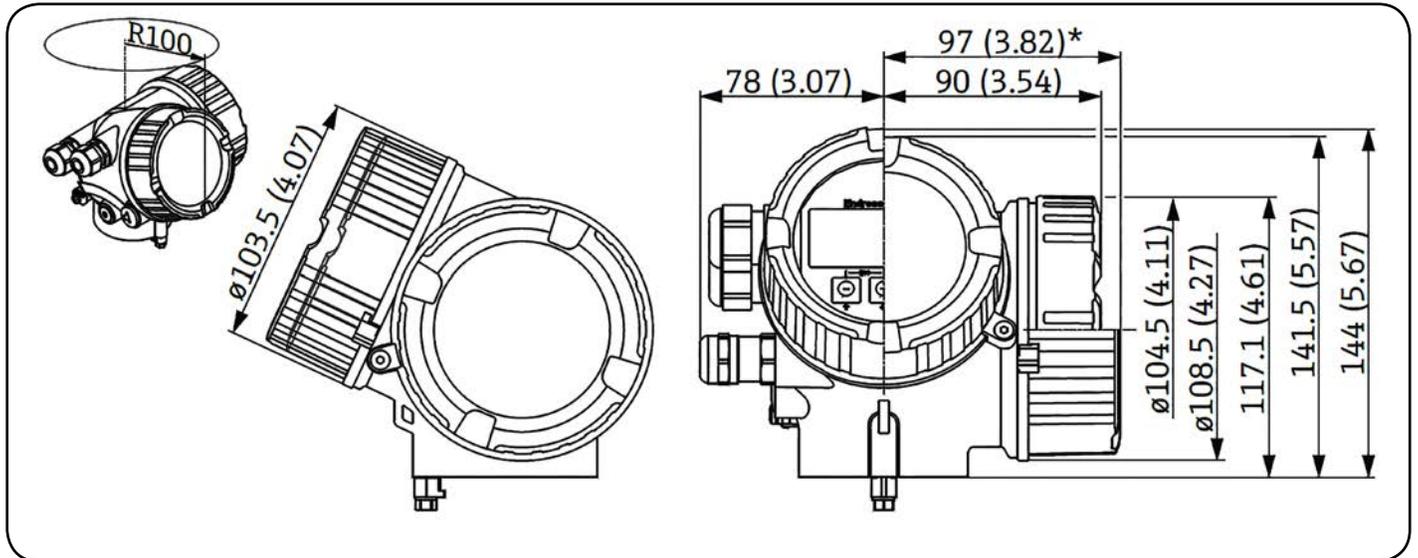


Dimensions of Nile 517
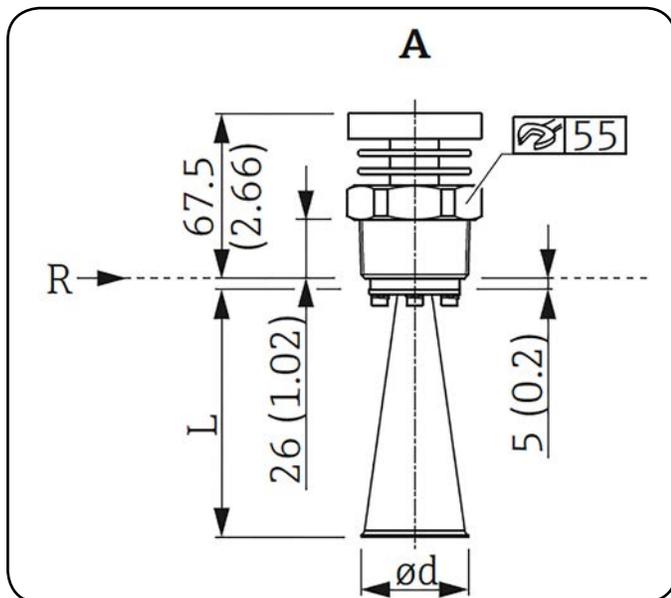
## Appendix C: Mounting Instructions Nile Radar Flange

### 1 What's In The Box

Please contact YSI customer service immediately if any expected items listed are not in the box.

| Standard Items | Quantity |
|---|---|
| Nile Flange Plate A | 1 |
| Nile Flange Plate B | 1 |
| ¼-20 Socket Head Cap Screw | 6 |
| ¼ Locking Washer | 4 |
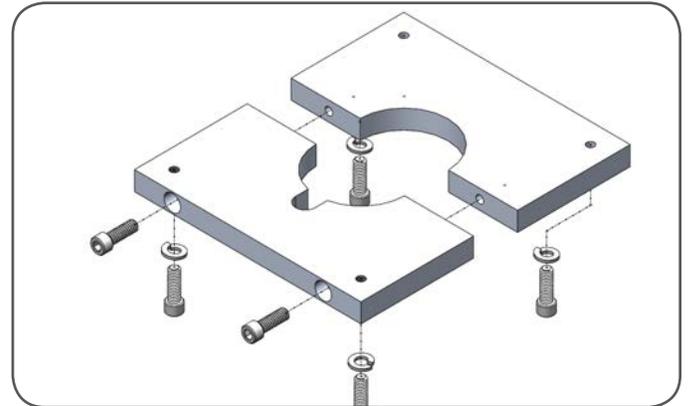


Nile Radar Sensor Mounting Flange Kit

### 2 Align Flange

Align the Flange Plates A and B around the narrow neck of the radar horn. Loosely secure using 2 of the ¼-20 Socket Head fasteners.
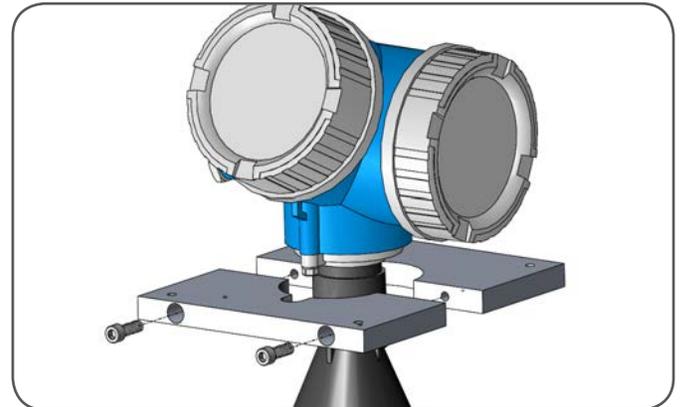


Align Flange Pieces Around the Radar Horn

### 3 Secure Flange

Slide the loose bracket over base of radar collar.
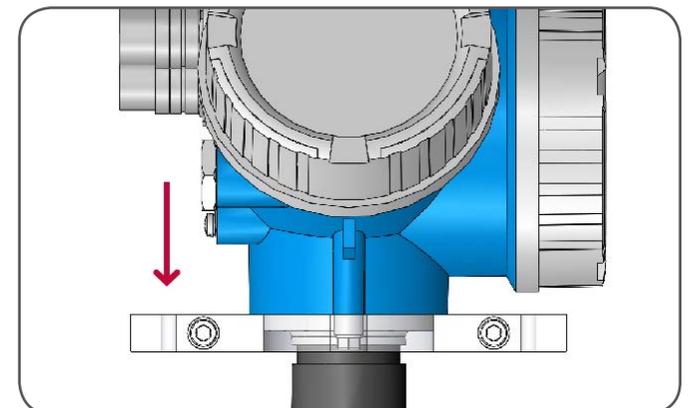


Slide Bracket Over Base

# APPENDIX

Be sure to align flange radar cone retaining clip "cut out" with the radar cone retaining clip. Tighten the 2 ¼-20 Socket Head screws to firmly secure Flange to the radar collar.
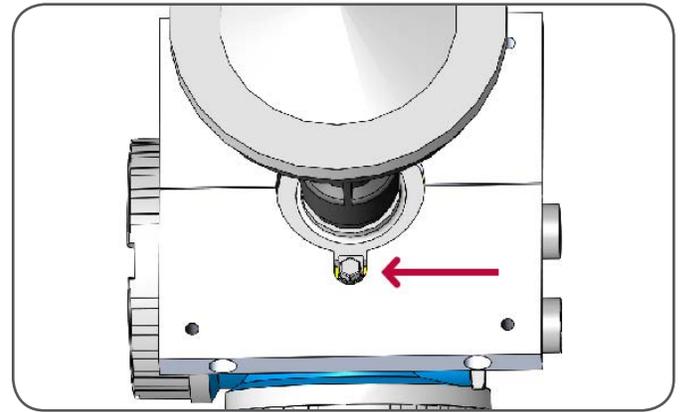
Align Cut-out in Flange to Radar Retaining Clip

## 4 Mount Flange

Using the remaining 4 ¼-20 fasteners and Lock Washers, mount the Flange to the radar housing or other mount or enclosure.
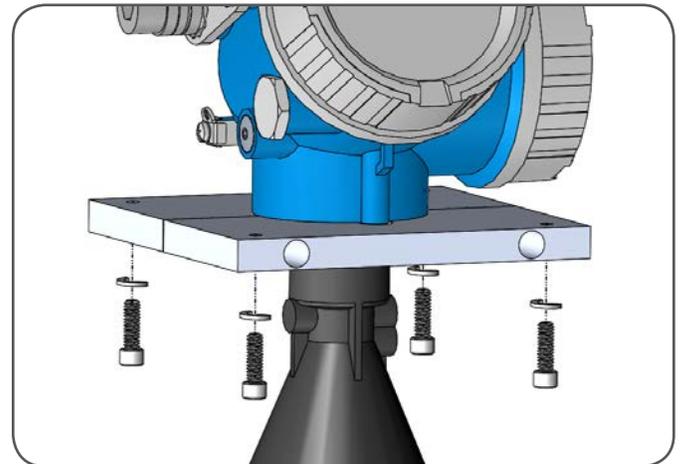
Secure Flange to Housing or Base Other Mount

## Appendix D: Mounting Instructions Nile Radar Bracket

# 1 What's In The Box

Please contact YSI customer service immediately if any expected items listed are not in the box.

| Standard Items | Quantity |
|---|---|
| Pole Bracket | 1 |
| Radar Bracket | 1 |
| 2 in. U-bolt | 1 |
| 2.5 in. U-bolt | 1 |
| Silicone O-Rings | 2 |
| 5/16-18 x 3/4 in. Carriage Bolts | 2 |
| 5/16 in. Washers | 2 |
| 5/16-18 Locking Nuts | 2 |
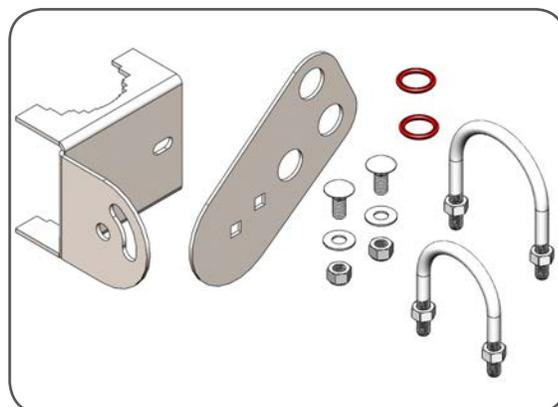


Nile Radar Sensor Mounting Bracket Kit

**Note:** This bracket has been designed for use with either horizontal or vertical mounting poles of either 2 or 2.5 inches in diameter. Instructions for assembly in either configuration are the same, with the orientation of the brackets being the only difference as shown in the images below.
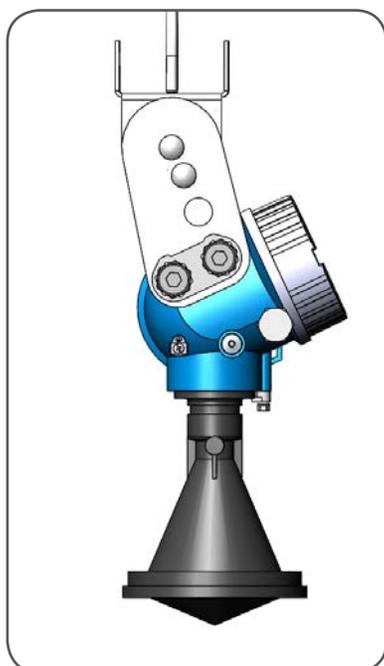


Nile Mounting Bracket Horizontal
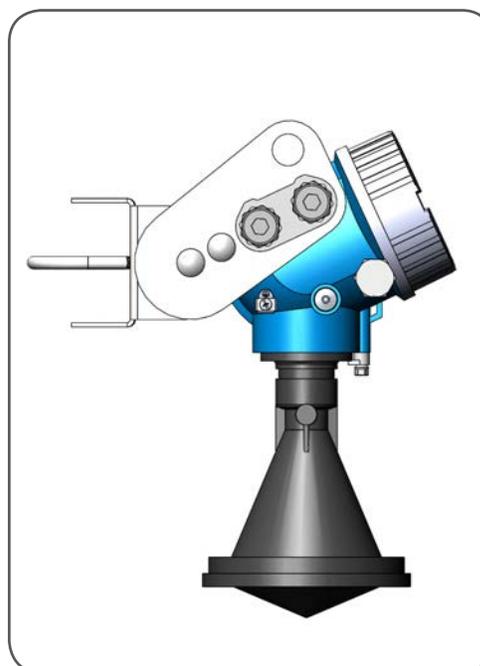


Nile Mounting Bracket Vertical

# APPENDIX

**2**   Remove Retaining Bracket

Begin by removing the  Wire nut retaining bracket and the 2 Wire Routing Nuts from the radar body. (Be sure that the Attached o-rings stay in place on the Wire Routing Notes as shown).

*Note*: Any wires that have been routed through the wire nuts and connected to electronics within the radar body will have to be disconnected and removed until installation of the bracket is completed.
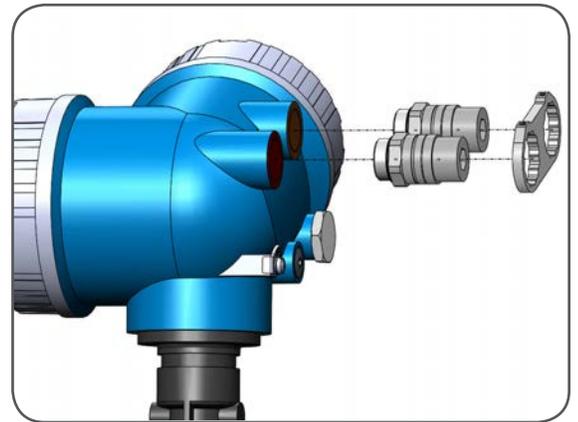


Remove Wire Nut Retaining Bracket and the two Wire Routing Nuts

**3**

Decide On Mounting Pole

Determine whether you will be mounting the radar on a vertical pole or an horizontal pole.  Align the Radar bracket accordingly as shown below.
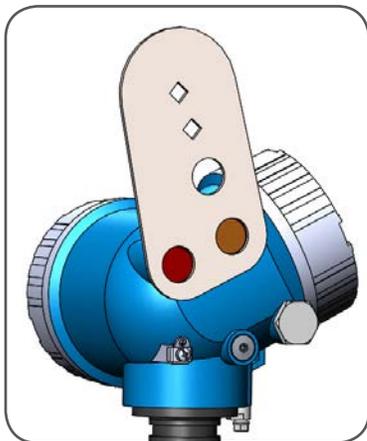


Nile Mounting Bracket Horizontal Alignment
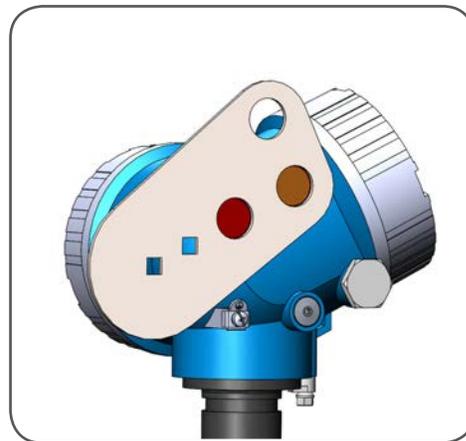


Nile Mounting Bracket Vertical Alignment

**4**   Insert Wire Routing Nuts

Insert both Wire Routing Nuts through the appropriate holes in the mounting flange and install 1 supplied o-ring on each of the Wire Routing Nuts as shown.
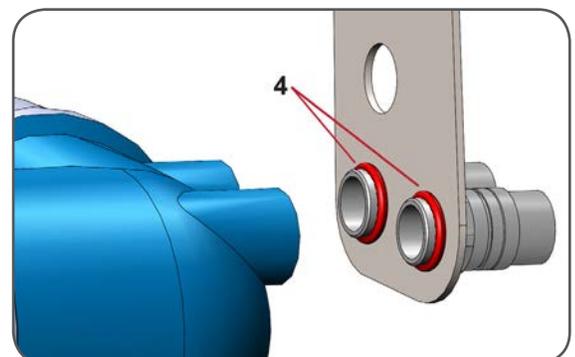


Insert Wire Routing Nuts

## 5 Reinstall Wire Routing Nuts

Reinstall the Wire Routing Nuts into the Radar Body and tighten until the flange plate is secure. (Pay special attention to not deform the silicone O-rings through over tightening so as to retain the water resistant qualities of the radar.)
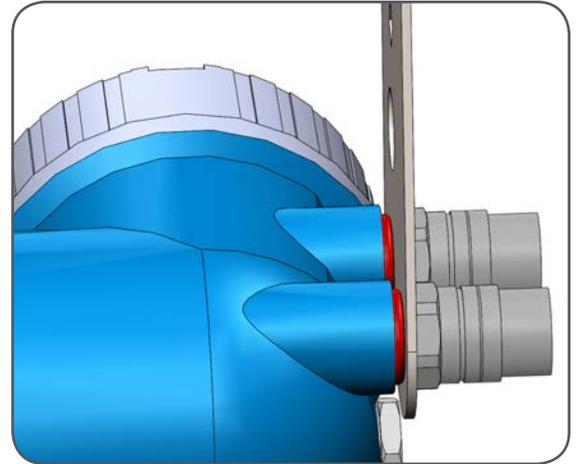


Reinstall Wire Routing Nuts

## 6 Mount Pole Bracket To Flange Plate

Mount the Pole Bracket to the Flange Plate using the supplied Carriage Bolts, Washers, and Lock Nuts as shown. (Leave locking nuts slightly loose so as to allow for final radar alignment)
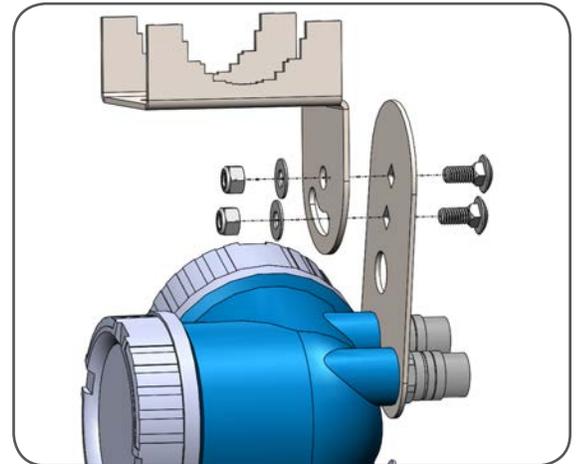


Mount Pole Bracket to Flange Plate

## 7 Mount On Pole

Choose appropriate u-bolt based on diameter of mounting pole. Mount radar and bracket on pole and align radar unit for optimal radar function. Tighten lock nuts to secure Mounting bracket.
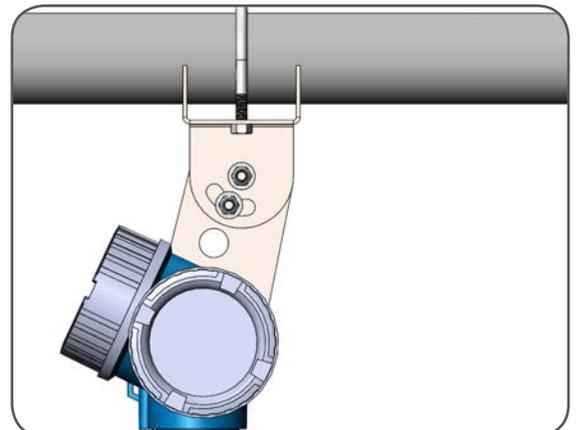


Mount Radar and Bracket on Pole, and Align the Radar Unit for Optimal Radar Function

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