Acuity
Laser Measurement

AccuRange AR1000™ Laser Distance Sensor
AccuRange AR1000H™ Laser Distance Sensor w/ Heater

User's Manual

Rev. 1.6
For use with AR1000™ and AR1000H™
September 23, 2009

Acuity
A product line of Schmitt Industries, Inc.
2765 NW Nicolai St.
Portland, OR 97210
www.acuitylaser.com

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1. Contact your Acuity distributor or call Schmitt Industries, Inc. to obtain a return merchandise authorization (RMA) number within the applicable warranty period. Schmitt Industries will not accept any returned product without an RMA number.

2. Ship the product to Schmitt Industries, postage prepaid, together with your bill of sale or other proof of purchase. your name, address, description of the problem(s). Print the RMA number you have obtained on the outside of the package.

This device has been tested for electromagnetic emissions and immunity and has been found to be in compliance with the following directives for class A equipment:

> **EN 61000-6-2:2002**
> **EN 55011:2000**

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.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this device in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his or her own expense.

User's Manual for the
AR1000™ Series Laser Distance Sensor
Rev. 1.6
For use with AR1000 and AR1000H

Table of Contents

1.   Introduction

This section is a guide to getting started with the AR1000 and this manual. The AR1000 has a number of configurable parameters, but many applications can use the sensor in its default factory configuration.

The recommended order for reading the manual is:

- General Overview – Gives a brief understanding of the sensor operation.

- Operating Guidelines – Provides a few important safety tips.

- Definition of Terms – An aid for proper communication.

- Quick Start Instructions – This should provide the information necessary to connect the sensor and verify its operation, either with a serial terminal program at 9600 baud, or by connecting the current loop or Alarm Output interface.

- General Description – Gives important laser, operation, mechanical, and mounting information.

- Installation and Checkout – Tailor the application. Use the other chapters for reference:
      Signal and Power Interface – how to hook everything up
      Serial Interface Operation – modes, formats, bias
      Analog Output Operation – current loop, voltage, scaling
      Alarm Output Operation – alarm settings
      Performance Optimization – Sample Rate, Background Elimination, Exposure control
      AR1000 Command Set – explains all commands for customizing the application

1.1.   General Overview

The AR1000 is a time-of-flight rangefinder that measures distance using a laser beam, a photodiode, and a microprocessor. The rangefinder works based on comparative phase measurement by emitting modulated high-frequency light which is diffusely reflected back from the target with a certain shift in phase. This return signal is compared with a reference signal. From the amount of phase shift, a resulting distance is determined with great accuracy. The maximum range measurement for the device is 500 feet (150 m) using special reflective targets. On normal surfaces, the maximum range is 120 feet (30 m). The Class 2 visible laser diode makes it simple to aim the rangefinder. Speed and accuracy performance vary depending on target surface reflectance. The AR1000 technical data sheet specifies sensor performance standards.

A variety of configuration settings can be selected via the serial port. The complete list of settings is found in the AR1000 Command Set chapter and each setting is discussed in detail in a specific operation chapter.

The Sample Rate can be specified and the sensor has maximum capability of 50 samples per second. Sampling may be turned on and off. It can even be triggered using an input signal wire or a serial command.

Measurement output can be in the form of serial data (RS232 or optional RS422), Analog Output (4-20mA current loop). Special order sensors include Profibus®, or SSI interfaces. Those interface configurations are not discussed in this manual. Contact Acuity for details.

Do not point the sensor at any person, particularly a person's eyes or face.

Do not attempt to disassemble the sensor or loosen any screws. Improper disassembly will destroy the optical alignment of the sensor and necessitate factory repairs.

Do not operate the sensor in areas where the sensor case is exposed to direct sunlight for extended periods or where the air temperature is more than 50°C (122°F) or less than -10°C (14°F).

Don't allow fast temperature variations during sensor operation.

Avoid excessive vibration and shocks. The sensor contains securely mounted but precisely aligned optical components.

Do not operate the sensor if the lens is fogged or dirty.

Do not scratch the lenses on the front face of the sensor. Keep the lenses clean with expert optical procedures. The lenses are glass with an anti-reflection coating. Avoid the use of organic cleaning solvents.

Do not touch the lenses with bare fingers. The oils are very difficult to remove.

Operate only with DC supply voltages up to 30 volts.

1.2. Definition of Terms

Sensor – The complete AR1000 measurement device.

Target – The object of measurement. The relative distance from the sensor to the target is measured by the sensor.

Laser, Laser beam – This bright light is emitted from the sensor, reflected from the target, and collected by the camera lens.

<Range> – The maximum relative distance measurable by the sensor.

Range – 1. <Range>, 2. The region over which the target can be measured. At the near end of the range the sensor measures zero. At the far end of the range the sensor measures its maximum value (its Range value).

1.3. Quick Start Instructions

This will get the sensor running in its factory default configuration.

Only one output type (Serial or Analog) is needed to indicate sensor operation.

1.3.1. Mounting

Caution: be sure that the laser will not cause an eye hazard.

Quick suggestion: Lay the sensor on the floor or a table. It may need to be held in place with a clamp or a weight. Orient the laser so that the laser is not obstructed. Use a piece of paper such as a business card to insert into the beam to use as a measurement target. The laser should be aimed at a target such that the distance from the reference point to the target can be meausured.

Mount the sensor in such a way that the case is not twisted or warped. Use four screws through the ¼" (6.6 mm) mounting holes on the sides of the mounting flanges.

Attach the cable's 12-pin connector to the plug on the rear of the sensor.

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Connect the orange (Supply +) and blue (Ground) wires of the sensor cable to a 10 to 30 volt DC power supply (or use the power supply if the sensor came with one).

1.3.2. Serial Data Wires

The serial connection is required to set up a unit for operation.

1.3.2.1. RS232 Model

Connect the RS232 wires to a 9 pin D-SUB male connector that can be plugged into a COM port of a PC (RS232): Grey (Ground) to pin 5, Green (Transmit) to pin 2, and Yellow (Receive) to pin 3. See section 3.2.2.

1.3.2.2. RS422 Model

Connect the RS422 wires to a RS422 adapter connected to a PC COM port. See section 3.2.2.

Start a HyperTerminal program on the PC and set it for that COM port at 9600 baud, 8 bit, 1 start, parity: none, 1 stop, no flow control.

To view distance measurements type SF1000<Enter>DT<Enter>. The sensor will report its present measurements six times per second in millimeters. If a target surface is placed in the measurement range of the sensor, the screen should display distance information. The distance is measured from the start of the measurement range. If there is no target in the measurement range, the sensor will output an error code. If there is no output, the sensor may be set to a different baud rate.

1.3.3. Analog Output Signals

Quick suggestion: connect a DVM (digital volt meter) to the wires: Blue to Common, Red to mA input. Assign the *Range Beginning (RB)* and *Range Ending (RE)* parameters to the desired lengths (in meters). Type *DT* to begin the Distance Tracking mode. The output is a 4-20mA current loop. The meter should read near 4 mA when a target is placed in the laser beam near RB and 20 mA near RE.

1.3.4. Alarm Signal

Quick suggestion: connect the alarm signal wire (white) to a 1K resistor in series with an LED, anode to the resistor, cathode to ground (gray).

The default action is: Alarm will go active (LED lights) if a target is measured at a distance greater than 1000mm (but less than 100m).

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2. General Description

The AR1000H is a laser diode based distance measurement sensor for ranges up to 118 feet (30m) on regular surfaces and up to 500 feet (150 m) using a reflective target. The accuracy is generally specified with a linearity of +/- 0.08 inches (2mm). Linearity will vary depending on temperature and surface reflectivity of the target surface. The AR1000H unit version has an on-board heater for cold use in cold environments.

± 2 mm for white surfaces, (+15 °C ... +30 °C)

± 3 mm for natural surfaces, (+15 °C ... +30 °C)

± 4 mm at 0.1 ... 0.5 m range in DS mode, (+15 °C ... +30 °C)

± 5 mm over full temperature range (-40 °C ... +50 °C)

2.1. Principles of Operation

The AR1000H uses the time of flight of light to measure distance. The laser beam is projected from the housing's aperture and shines on a target surface, where it creates a small spot. From there the laser light is scattered in all directions. A collection lens is located in the sensor to the side of the laser aperture. It collects a portion of the reflected light, which is focused on a photodetector and converted to an electrical signal. The signal is amplified and symbolizes a shift in phase. This phase is compared to a reference signal to determine the amount of shift and hence a change in distance..

2.2. Mechanical Dimensions

The following diagram shows the mechanical dimensions for the small AR1000. The sensor has four 6.6 mm holes on the side flanges for mounting to a fixture. The cable is for power and all communication (serial, analog, trigger, power, etc.). It is a 12-pin M18 flange-mount connector (Binder series 723). The outer case of the sensor is extruded aluminum with powder-coated paint for corrosion resistance.
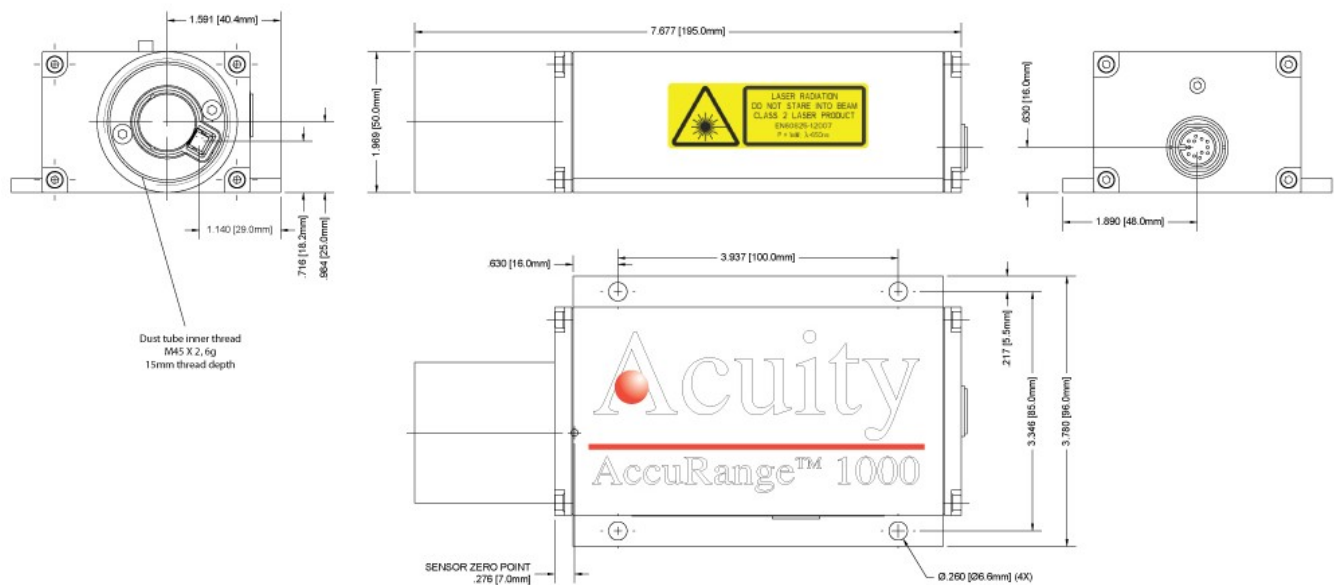
2.3.   Installation

The AR1000 sensor is typically installed by affixing the sensor to a machined bracket with bolts through the four mounting holes in the sensor. Their location is shown in the mechanical drawing above. The laser should be aimed at a target such that the distance from the reference point to the target can be meausured.

Laser strikes distant target and measures the distance based on the laser reflection returned to the collection lens.

LENS

7   137
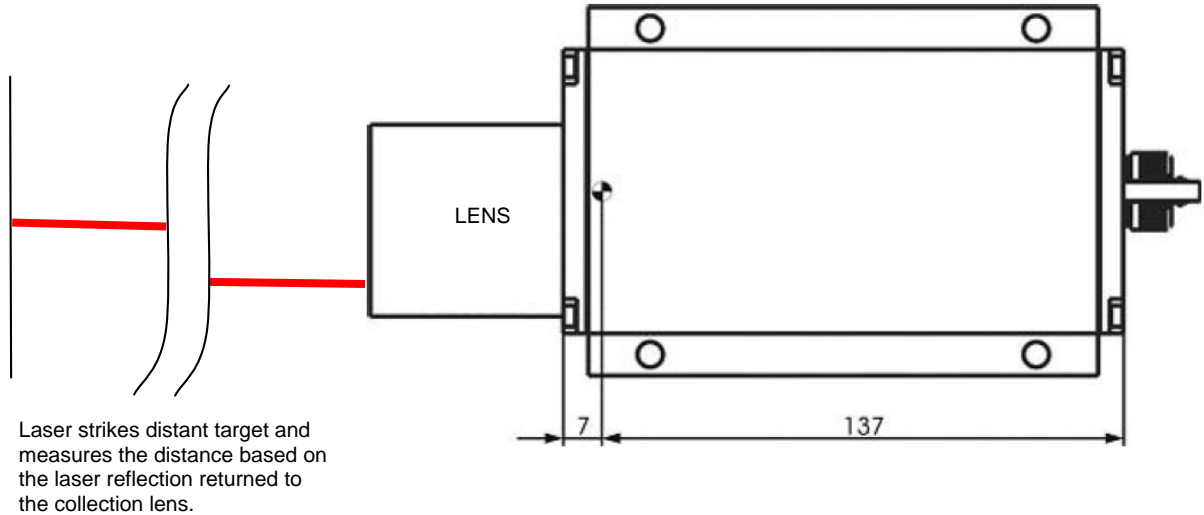
Figure 1 Zero distance reference point

2.4.   Laser Safety

Caution: This laser device should not be aimed at the human eye. Installers of laser sensors should follow precautions set forth by ANSI Z136.1 Standard for the Safe Use of Lasers or by their local safety oversight organization. The AR1000 is a class 2 laser product as stipulated in IEC 60825-1/DIN EN 60825-1:2001-11 and a class II product under FDA 21CFR. In the event of accidental, short time laser exposure, the human eye is sufficiently protected by its own aversion response (blinking). This natural reflex may be impaired by medication, alcohol and drugs. Although the product can be operated without taking special safety precautions, refrain from directly looking into the laser beam. Do not direct the laser beam at other people to avoid potential eye hazards.

CE
Model:
Date:
S/N:
Manufactured at: **Schmitt Industries, Inc.**
2765 NW Nicolai St. - Portland, OR USA
Complies with 21 CFR 1040.10 w/ Laser Notice 50

LASER RADIATION
DO NOT STARE INTO BEAM
CLASS 2 LASER PRODUCT
EN60825-1:2007
P ≤ 1mW; λ=650nm

Figure 2 AR1000 laser safety labels

The laser safety classification reflects worst case situations. User settings or maintenance cannot increase the level of laser radiation. Do not attempt to loosen any screws or open the sensor housing.

2.5. Sensor Maintenance

The AR1000 sensor requires little maintenance from the user. The sensor lens should be kept clean of dust buildup as a part of regular preventative maintenance. Use compressed air to blow dirt off the window or use delicate tissue wipes. Do not use any organic cleaning solvents on the sensor. If your sensor does not function according to specifications, contact Schmitt Industries, Inc. Do not attmept to loosen any screws or open the sensor housing.

2.6. Sensor Service

The AR1000 sensor is not user-serviceable. Refer all service questions to Schmitt Industries, Inc. Do not attempt to loosen any screws or open the sensor housing.

2.7. Sensor Specifications

Go to http://www.acuitylaser.com/pdf/ar1000-data-sheet.pdf

3. Installation and Checkout

3.1. Mounting

Mount the sensor in such a way that the case is not twisted or warped. Using three hard points along the front and back edges or a slightly compliant mounting system are the best methods. Do not clamp or squeeze the sensor case excessively. If the case is distorted, the sensitivity and accuracy of the sensor may be affected.

3.2. Cabling

The AR1000 has a multipurpose cable with solder tail wires. The standard cable length is 6.6 feet (2 m) and longer cable lengths are available. Connection and termination according to the instructions is essential for correct sensor operation. Read the wire descriptions in Section 4.1for connection information.

Connect the cable's 12-pin connector (Binder series 423) to the plug (Binder series 723) on the back cover of the AR1000 sensor. Be sure to tightly secure the connection.
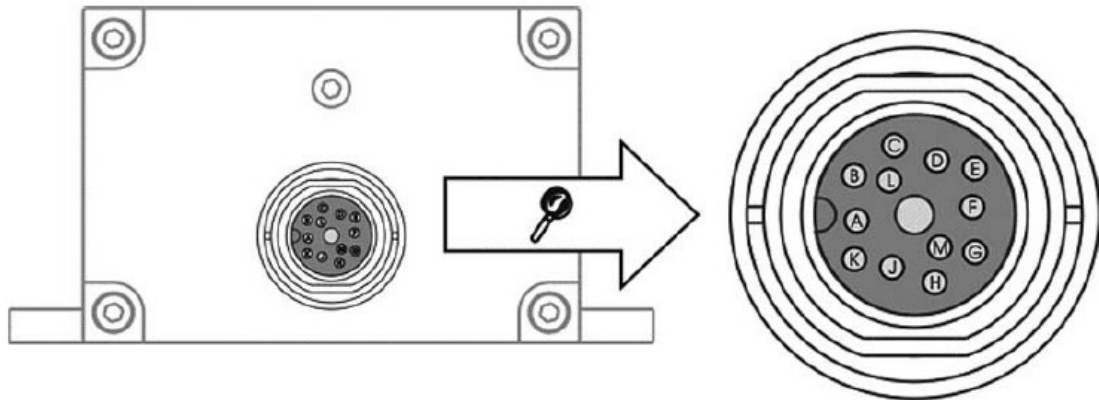
Figure 3 Back cover with 12-pin plug and pin arrangement

Figure 4 Interface cable

3.2.1. Standalone Cabling

To use the AR1000 without a serial connection to a host computer, the only connections necessary are the power and ground wires, the analog output wires, and optionally the alarm output wire connecting to your data display, recording, or control equipment. See Signal and Power Interface (section 4) for wire connections. In its default configuration, the AR1000 does <u>not</u> measure data on power-up.

In 4-20mA analog output mode, the best accuracy and linearity for the current loop is obtained with a 500-ohm load to current loop return at the measurement point. An out-of-range current indicates a sensor measurment error.

The alarm output wire can be used to connect to control equipment.

3.2.2. Serial Connection to a Host Computer

RS232: A 9-pin serial D-sub serial connector can be attached to the serial output wires to connect the AR1000 directly to an IBM-PC compatible 9-pin serial port.
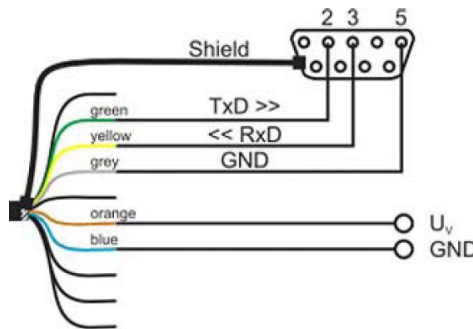
Figure 5 Wiring configuration for 9-pin connector for RS232 serial communications

RS422: An RS422 adapter must be used to connect the AR1000 to an IBM-PC compatible computer. The RS422 wires are as follows:
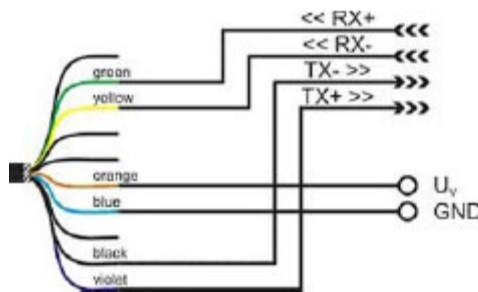
Figure 6 Wiring configuration for RS422 serial communications

For testing use a terminal emulation program such as the Windows® HyperTerminal. HyperTerminal is included in most versions of Microsoft Windows. To access HyperTerminal, follow these links:

START > PROGRAMS > ACCESSORIES > COMMUNICATIONS > HYPERTERMINAL

After naming the connection and choosing an icon, choose the COM port that the AR1000 is connected to. In the next configuration screen, set to 9600 baud, 8 bits, no parity, 1 stop bit and no flow control to communicate with a sensor in the default configuration.

3.3. Power On

Connect a 15 volt power supply to the power and ground lines of the sensor cable. See Signal and Power Interface (section 4) for wire connections. Only the power and ground need be connected for operation in addition to the serial interface.

Caution: be sure that the laser will not cause an eye hazard.

When power is applied the laser beam will be emitted from the laser aperture near the large lens of the AR1000. The laser beam will be bright red when viewed against a white surface. The sensor will not transmit measurement readings until a measurement mode is selected. To begin measuring in *Distance Tracking* mode, type DT<Enter>. Distance readings will scroll down the Hpyerterminal window and the default units are be in meters. See section 5.1 for command information.

3.4. Verifying Operation

In DT (distance tracking) mode, the AR1000 transmits approximately 6 samples per second at 9600 baud over the serial signals, and transmits measured distance over the current loop output at the same update rate. The actual measurement speed will depend upon the selected measurement mode and the reflectance of the target surface. The current loop should put out 4 mA at the near end of the measurement range, and 20 mA at the far end. Check either, or both, signals to verify basic sensor operation.

3.5. Troubleshooting

The sensor displays simple error indications using its function display LEDs. Trouble shooting steps are shown below:

Symptom	Possible Cause	Correction
No laser light and no sample data	Sampling is turned off Power supply voltage is too low	Turn Sampling on Check power supply input voltage
Serial port not responding	Power supply voltage is too low Baud rate incorrect or unknown	Check power supply input voltage See section 3.5.1
Error code (Exx) is transmitted on serial port	See Error codes section 5.3.	

3.5.1. Serial Communications Check

If no information is received over the serial port, check the power supply and serial wire connections. The sensor may be in a configuration that prevents serial communication, such as being set at the wrong baud rate.

Type PR<Enter> to reset the sensor to the factory defaults (including 9600 baud rate). If the sensor's baud rate is unknown, then the PR<Enter> command must be issued from the hyperterminal program while set at each of the AR1000's possible baud rates until the

AR1000 accepts the command and sets the baud rate to 9600. The possible baud rates are 2400, 4800, 9600, 19200, and 38400.

3.5.2. Sensor Output Check

If the sensor output value is in error, check that the sensor and target are stationary and stable, that the target is at least 4 inches (0.1 m) from the sensor's lens, and that the laser beam is hitting the target.

The distance offset setting may alter the values output by the sensor. Reset the sensor to the factory default to remove its effect.

The sensor may need to warm up for 5-10 minutes before reaching full accuracy. Leave it on for a few minutes and re-check the sensor accuracy.

4.   Signal and Power Interface

The AR1000 has a multipurpose cable (sensor cable) with solder tail wires. Connection and termination according to the instructions is essential for correct sensor operation. Read the wire descriptions for connection information.
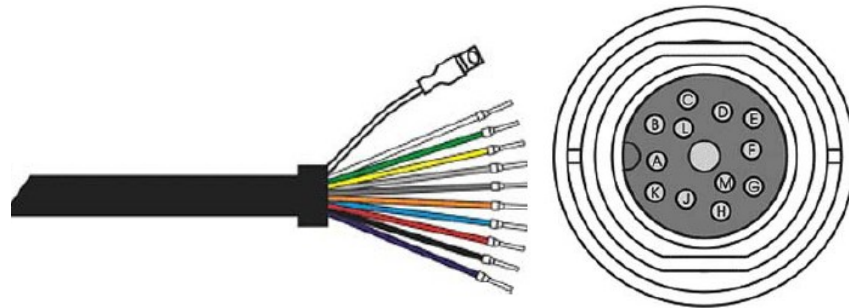
Figure 7 AR1000 multipurpose cable with 10 conductors plus shield and corresponding pin arrangments

4.1.   Sensor Cable Wire Colors and Functions

The tables below shows the wiring on systems ordered without power supplies.

Wire	Pin	Function in All Modes
Brown	C	External Trigger Input (3V to 24 V)
Red	D	Analog output (4-20 mA current loop)
Orange	G	Supply Voltage +15V (10- 30 VDC)
White	H	Alarm Output
Grey	J	Ground (serial)
Blue	L	Ground (Power supply common return)
Clear		Shield

The serial communications wires can be used for RS232 or RS422.

Function in Selected Serial Mode			
Wire	Pin	RS232 models	RS422 models
Yellow	B	RxD – Receive Data	RX– : Receive Data –
Green	A	TxD – Transmit Data	RX+ : Receive Data +
Black	E		TX- : Transmit Data -
Violet	F		TX+ : Transmit Data +
Grey	J	Ground (serial)	

4.1.1. Power Supply (Orange, Blue)

The Blue wire is the Power Supply Common return, also named Ground. It carries the return current for the power supply and the analog signals.

The Orange wire is the Power Supply Input to the sensor. The sensor requires +10 VDC power at 125 mA. The Analog Output uses an additional current up to 25 mA.

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Power supplies from 10 VDC to 30 VDC may be used. Higher voltages will result in excessive current drawn by the over-voltage protection circuitry and may cause permanent damage. Voltages less than 10 VDC may result in inaccurate measurement readings. With the use of the on-board heater, the AR1000 sensor uses 24 W of power at 24 VDC.

4.1.2. Shield (Clear)

The un-insulated wire is the cable and case shield and is connected to ground inside the sensor. It should also be connected to ground at the power supply end of the cable.

4.1.3. Serial Communications (Green, Yellow, Black, Violet)

RS232 and RS422 modes are compatible with the associated ANSI standards.

See Serial Interface Operation (section 5) for information on commands and data.

RS232: RS232 is normally used for slower speeds and shorter distances of communications. A standard 9-pin D-SUB RS232 serial female connector can be built to interface with an IBM or compatible computer using connection the pins below.

Color	Pin	
Green	2	Trasmit data from sensor
Yellow	3	Receive data to sensor
Gray	5	Signal ground reference
n/c	1, 4, 6	DCD, DTE, DCE – These three signals can be tied together to satisfy some PC signal requirements for hardware handshake.
n/c	7, 8	CTS, RTS – These two signals can be tied together to satisfy some PC signal requirements for hardware handshake.

RS422: RS422 is normally used for faster speeds and longer distances of communications. Two wires, usually twisted together, carry each differential (noise-immune) signal. There are no standard PC connections. A special adapter is required to connect to a PC using RS422.

Color	
Green	Receive data to sensor (+)
Yellow	Receive data to sensor (-)
Voilet	Trasmit data from sensor (+)
Black	Trasmit data from sensor (-)
Gray	Signal ground reference

4.1.4. Analog Output (Blue, Red)

The Blue wire is the return signal for the Analog Output. It is connected to ground inside the sensor and should not be connected to ground outside the sensor. Inadvertently connecting it to ground may cause a reduction in accuracy of the analog output. The analog signal for distance is a 4-20 mA current loop. Sensor error signaling can be configured to output either 3 mA or 21 mA.

In Current Loop mode the Red wire delivers a current proportional to the measured distance.
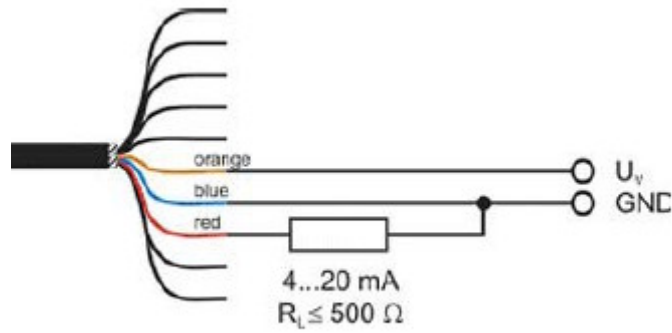
Figure 8 Wiring Diagram for Analog output

The best conversion to voltage is obtained by connecting a 500-ohm load resistor (1/4 Watt minimum) between the red and blue wires at the measurement point. This gives a 2 volt to 10 volt output range. See Analog Output Operation (section 6) for mode selection and scaling options.

The sensor may be connected directly to a meter or a filter may be inserted to reduce noise.
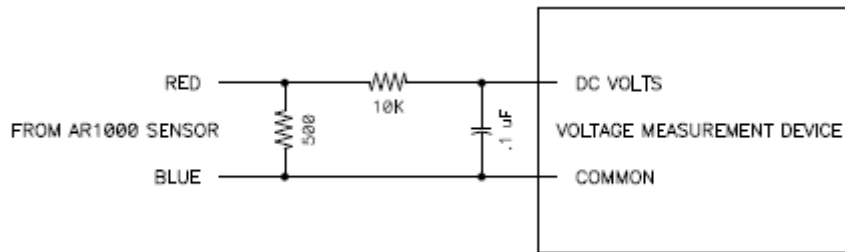
Figure 9 Wiring Diagram for filtering the Analog output

4.1.5. Alarm Output (White)

The White wire is the Alarm Output.

See Alarm Output Operation (section 7) for operation options and details.

The Alarm Output is an open collector PNP transistor switch to the positive power supply. When the Alarm Output is not active, its output will be high impedance and no current will flow through it. When the Alarm Output is active (On) it can source up to 500mA of current.

The load for the output should be connected to ground (Blue wire). The voltage on the Alarm wire must not exceed the limits of the Power Supply connection voltages (orange and blue wires), or excessive current may flow into the sensor and cause damage.
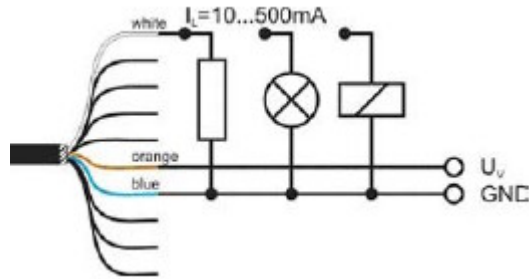
Figure 10 Wiring diagram for Alarm Output

4.1.6. Laser Trigger (Brown)

The Brown wire is the Trigger input. It is normally left unconnected to enable the laser.

The trigger input is used with the DF measurement mode or TM trigger mode setting in the AR1000.

The trigger input is intended for triggering a distance measurement with an external signal that is applied as a voltage between 3 V and 24 V. The user specifies a delay time and trigger edge for measurement initiation.

Trigger level is defined:
    HIGH: Switch is closed.
    LOW: Switch is open.

Trigger edge is defined:
    Rising edge: Switch closes, input voltage transitions from LOW to HIGH.
    Falling edge: Switch opens, input voltage transitions from HIGH to LOW.
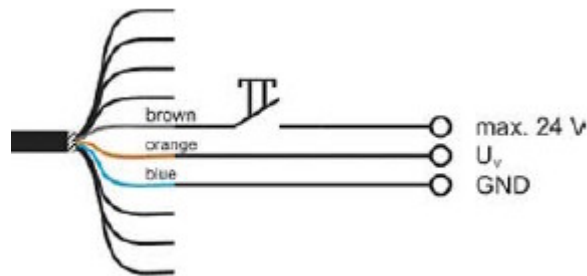
Figure 11 Wiring diagram for Trigger Input

If a switch is used, the input may need a debouncing circuit to prevent multiple triggers or triggers on the wrong edge. This input circuit can be used with a supply from 10V to 30V (The 1K resistor limits the voltage at the sensor input).
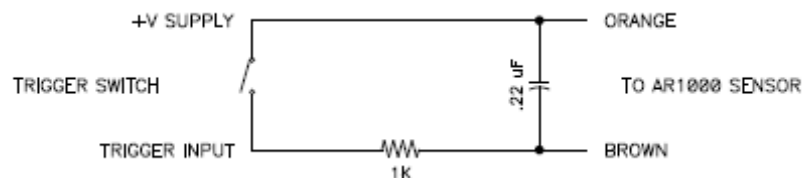
5. Serial Interface Operation

5.1. Serial Hardware Interface

The serial port hardware is installed either as RS232 (order sensor p/n AP1000232) or RS422 (order sensor p/n AP1000422). The installed serial port hardware can only be selected at the time of purchasing the AR1000 sensor. The serial port allows full-duplex operation.

5.1.1. Communications Protocol

Serial port communication is required to configure the AR1000 for operation. The easiest way to commnicate is by using a PC with an RS232 communication port and a terminal emulation program. The communications protocol is in ASCII format.

Before an operating session begins, users should configure the AR1000 sensor with parameters that meet the particular measuring site conditions and requirements. All valid settings will be preserved when the AR1000 sensor is turned off and restored when turned back on. They can only be replaced with new value entries or changed back to their default values by communication through the serial port. Below is a short view of the commands accepted through the AR1000 serial protocol:

| Command	Description
ID	Online Help menu
DT	Starts distance tracking
DS	Starts distance tracking 7 m
DW	Starts distance tracking on white target at 10 Hz
DX	Starts distance tracking on white target at 50 Hz
DF	Starts remote-triggered single distance measurement (single shot)
DM	Starts single distance measurement (single shot)
TP	Queries inner temperature
SA	Queries / sets floating average value (1 ...20)
SD	Queries / sets output format (decimel/hex)
ST	Queries / sets time to measure (0...25)
SF	Queries / sets scale factor
SE	Queries / sets error mode (0, 1, 2)
AC	Queries / sets alarm start point
AH	Queries / sets alarm hysteresis
AW	Queries / sets alarm width
HO	Queries / sets heater temperature ON value
HF	Queries / sets heater temperature OFF value
RB	Queries / sets beginning of range (4 mA)
RE	Queries / sets end of range (20 mA)
RM	Queries / sets removal of measured value
TD	Queries / sets trigger delay
TM	Queries / sets trigger mode
BR	Queries / sets baud rate
AS	Queries / sets autostart
OF	Queries / sets offset

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Command	Description
SO	Sets current distance as offset
LO	Turns laser on
LF	Turns laser off
PA	Displays all parameter values
PR	Resets all parameters to standard values

5.1.2. { XE "(button) Serial Communication Mode" }Baud Rate{ XE "Bn Baud Rate" } (BR)

The Baud Rate is selectable via the serial interface and it requires the host device to change its own Baud Rate after commanding the sensor to change.

The following Baud Rates are provided (with corresponding serial command):
    2400   BR2400<Enter>
    4800   BR4800<Enter>
    9600   BR9600<Enter>   (default)
   19200   BR19200<Enter>
   38400   BR38400<Enter>

5.2.   Serial Data Output (SD, SF)

The Serial Data Format units, and errors are selectable using the Serial Output Control{ XE "An, Nn   Serial Output Control" } command. Serial data is transmitted from the AR1000 as 8 data bits with no parity and 1 stop bit. The sample data sent represents calibrated distance readings.

Available formats are decimal and hexadecimal

Output units are determined by the scaling factor. The nominal units (scaling factor = 1) is meters.

Adjustable offset modes are Unbiased, Zero-Based, and Offset-Based.

5.2.1. ASCII Output Format (SD*d* , SD*h* or *SDs*)

The factory default setting for output format is decimal (*d*)

SD selects between ASCII decimal (*d*) with distance only, hexadecimal (*h*) output or ASCII decimal (s) with both distance and signal strength formats of measured value data. SD affects all commands that output a distance value.

Decimal Notes:

Decimal (d) output values are based on units of meters (m) multiplied the scale factor SF.

Decimal output has an optional (-) sign, at least one digit before the decimal point, three digits after the decimal point, and is followed by <CR><LF> (carriage return and line feed characters).

Decimal (s) output values are xxx.xxx yyyyyy where x is the distance and y is the signal strength. The range for the signal strength is between 0 ... 999999 and the values depend on the measurement mode (DT, DS, etc.).

Due to the different calculation algorithms used in the different measurement modes, the signal strength for a given distance and target surface may be different.

The minimum value of 000001 can be reached before the sensor reports an E15 error (see Error Codes Section 5.3). A maximum signal strength value of 99999 may be reached before the sensor becomes overloaded with ambient light and reports an E17 error.

Hexadecimal Notes:

Hexadecimal output values are calculated on units of millimeters (mm) multiplied by the scale factor SF.

Hexadecimal output has a leading space, six hexadecimal digits, and is followed by <CR><LF> (carriage return and line feed characters).

Negative distance values are output in two's complement notation.

Hexadecimal output values are limited to six hex digits. A number requiring more than six digits will be clipped and output only the lower six digits. The clipped number could therefore exibit an incorrect sign as well as incorrect values. Use the SF command to keep the output values between hex 800000 (decimal -8388608) and hex 7FFFFF (decimal 8388607).

Examples:

Distance = 4.996 m, SF1   dec: 4.996
                            hex: 001384 (hex code for 4996 (mm))

Distance = 4.996 m, SF10   dec: 49.960
                            hex: 00C328 (hex code for 49960 (4996 mm x scale factor 10))

5.2.2. Serial Data Units or Scale Factor (SFx.x)

The default setting for units is meters (SF1). The output is not labeled.
The AR1000 is capable of reporting data in any units because the user can set a scale factor. To convert the units to feet, the scale factor would be 3.28084 feet / meter.

Scale factor	Significant digit	Output	Unit of Measure
SF1	0.001 m	12.345	meter
SF3.24084	0.01 feet	4.860	feet
SF1000	1 mm	12345	millimeter
SF3937	0.01 inch	39.37	inch

5.3. Error Codes

The AR1000 will automatically generate error codes in the ASCII output stream. Some of these errors may also be represented through the analog and alarm output functions. See the sections for Current Loop Output and Alarm Output for error handling in those output modes.

Below is a list of the error codes that may be transmitted over the serial output.

Code	Description	Remediation
E15	Sensor slow to respond due to low reflectivity or min. range <3.9 in. (0.1m)	Use brighter targets or reflective sheeting.. Ensure min. range >3.9 in. (0.1m)
E16	Too much target reflectance	Use darker targets or reflective sheeting

Code	Description	Remediation
E17	Too much ambient light (sun)	Reduce ambient light at target and minimize shiny surfaces
E18	DX mode: measured distance greater than specified target range	Check measurement path for obstacles
E19	DX mode: target speed > 10 m/s	Reduce relative motion speed of target
E23	Temperature below 14°F (-10 °C)	Increase ambient temperature to 14°F (-10°C)
E24	Temperature below 140°F (60 °C)	Reduce ambient temperature to 140°F (60°C)
E31	Faulty memory hardware, EEPROM error	Reset parameters. If it persists, contact technical support
E51	High ambient light or hardware error	Reduce ambient light. If it persists, contact technical support
E52	Faulty laser diode	Contact technical support
E53	EEPROM parameter not set (ex: division by zero)	Verify the Scale Factor (SF) is not zero. Contact technical support
E54	Hardware error (PLL)	Contact technical support
E55	Hardware error	Contact technical support
E61	Invalid serial command	Verify command set
E62	Hardware error or Parity error in serial communication settings	Verify Parity = NONE in serial interface
E63	SIO Overflow	Check time of emitted signals in application software. Integrate delay on transmission if necessary
E64	Framing - error SIO	Check format of serial interface: 8 data bits, 1 stop bit, NO Parity (8N1)

5.4. Laser ON and Laser OFF (LO, LF)

5.4.1. Laser ON (LO)

This command turns the laser beam on. This function can be useful for aiming the laser at a target. The sensor does not measure in this mode.

5.4.2. Laser OFF (LF)

This command turns the laser beam off. The sensor does not measure in this mode.

5.5. Displaying, Configuring and Resetting Parameters (PA, PR, AS, TP)

As the AR1000 sensor is configured for your needs, it may be helpful to view the settings that are saved in the sensors EEPROM. The PA allows users to view those settings in an online report through the serial communications interface. The PR command resets all settings to factory defaults.

5.5.1. Displaying current settings (PA)

The PA command PA<Enter> will display the current settings. An example is shown below:

```
average value[SA].................1
display format[SD]................d
measure time[ST]..................0
scale factor[SF]..................1
error mode[SE]....................1
```

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```
ALARM center[AC]..................20
ALARM hysterese[AH].............. 0.1
ALARM width[AW]..................10
heating on[HO]...................3
heating off[HF]..................12
distance of Iout=4mA [RB]........15
distance of Iout=20mA [RE].......25
remove measurement [RM]..........0 0 0
trigger delay, trigger level[TD]..0 0
trigger mode, trigger level[TM]...0 1
baud rate[BR]....................9600
autostart command[AS]............ID
distance offset[OF]..............0
```

5.5.2. Resetting sensor settings (PR)

Typing PR<Enter> will restore the AR1000 to factory default settings.

5.5.3. Autostart configuration (ASxx)

Factory default setting is ID

Autostart defines which function will be carried out when the AR1000 is powered on. Possible entries are those delivering a measured value on the output side, an ID command or the command for turning the laser on (LO).

For example, if ASDT<Enter> has been commanded, the AR1000 sensor will begin with distance tracking after power-up.

Note that the Autostart setting will not operate at power-up if Trigger Mode is ON (TM1 x) and the trigger condition is not met.

5.5.4. Temperature Display (TP)

The TP<Enter> command displays the AR1000's internal temperature in Celcius. This may be helpful information if the sensor will be installed in environments which exceed the temperature specification for the unit (-10 to 60°C)

5.5.5. Command Display (ID)

The ID<Enter> command displays the AR1000's command set in the following format.

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```
ID[Enter].....................show this list
DT[Enter].....................distance tracking
DS[Enter].....................distance tracking 7m
DW[Enter].....................distance tracking with cooperetive target (10Hz)
DX[Enter].....................distance tracking with cooperetive target (50Hz)
DF[Enter].....................distance measurement with external trigger
DM[Enter].....................distance measurement
TP[Enter].....................internal temperature [C]
SA[Enter] / SAx[Enter]........display/set average value [1..20]
SD[Enter] / SDd[Enter].......display/set display format [d/h]
ST[Enter] / STx[Enter]........display/set measure time [0..25]
SF[Enter] / SFx.x[Enter]......display/set scale factor
SE[Enter] / SEx[Enter].......display/set error mode [0/1/2]
                             0..Iout=const., ALARM=const.
                             1..Iout: 3mA @RE>RB, 21mA @RE<RB, ALARM: OFF@AH>0,  ON@AH<0
                             2..Iout: 21mA @RE>RB, 3mA @RE<RB, ALARM:  ON@AH>0, OFF@AH<0
AC[Enter] / ACx.x[Enter]......display/set ALARM center
AH[Enter] / AHx.x[Enter]......display/set ALARM hysterese
AW[Enter] / AWx.x[Enter]......display/set ALARM width
HO[Enter] / HOx[Enter]........display/set temperature of heating on [ -40*C ... +70*C]
HF(Enter] / HFx[Enter]........display/set temperature of heating off[ -40*C ... +70*C
RB[Enter] / RBx.x[Enter]......display/set distance of Iout=4mA
RE[Enter] / REx.x[Enter]......display/set distance of Iout=20mA
RM[Enter] / RMx y.y z[Enter]..remove measurement
TD[Enter] / TDx y[Enter]......display/set trigger delay [0..9999ms] trigger level [0/1]
TM[Enter] / TMx y[Enter]......display/set trigger mode [0/1] trigger level [0/1]
BR[Enter] / BRx[Enter]........display/set baud rate [2400..38400]
AS[Enter] / ASd[Enter]........display/set autostart command [DT/DS/DW/DX/DF/DM/TP/LO/ID]
OF[Enter] / OFx.x[Enter]......display/set distance offset
SO[Enter].....................set current distance to offset (offset = - distance)
LO[Enter].....................laser on
LF[Enter].....................laser off
PA[Enter].....................display settings
PR[Enter].....................reset settings
```

6. Analog Output Operation (RB, RE, SE)

The analog output uses two wires. The output is Red and the return is Blue. The return wire is the power supply ground. The current loop output is always on.

The analog output is updated with each sample measured. The analog output will deliver a current which increases linearly from 4 mA at the range beginning point to 20 mA at the range end point.

Best accuracy and noise immunity is obtained by connecting a 500 Ohm resistor to the current return wire at the measurement point. For connection details, see section 0

6.1. Setting the analog range beginning point (RB)

The default setting for RB is 1000 (1000 meters is beyond the allowable range of the AR1000)

The parameter units for RB are dictated by the scale factor (SF). See section 5.2.2

The RB, *range beginning* command, sets the location of the point that is assigned 4 milliamps in the current loop output. The range beginning point can be set to any distance within the sensor's natural measurement range. RB may be greater or less than RE.

6.2. Setting the analog range end point (RE)

The default setting for RE is 2000 (2000 meters is beyond the allowable range of the AR1000)

The parameter units for RE are dictated by the scale factor (SF). See section 5.2.2 for information about scale factors (SF).

The RE, *range end*, command sets the location of the range ending point sometimes referred to as the end of the measurement range. The range ending point is assigned 20 milliamps in the current loop output. The range ending point can be set to any distance within the sensor's natural measurement range. RE may be greater or less than RB.

6.3. Setting the Error Mode (SE0, SE1 or SE2)

The default setting is SE1

The AR1000 can be configured to output analog signals for special error conditions that correspond to Error Messages E15, E16, E17 and E18 (See Error Messages section 5.3 for more information).

SE0<Enter> will cause the AR1000 to output and hold the last valid measurement

SE1<Enter> will cause the sensor to output 3 mA if RE>RB and 21 mA if RE<RB

SE2<Enter> will cause the sensor to output 21 mA if RE>RB and 3 mA if RE<RB

The SE command also affects the Alarm output. See section 7.5

7. Alarm Output Operation (AC, AH, AW, SE)

The alarm output uses the white wire in the basic configuration.

Alarm output is also referred to as *digital switching output*. Users of the AR1000 laser sensor may wish to monitor the position of an object and receive an alarm if it moves beyond set distance limits. To do this, users establish parameters of a measurement window using commands AC *alarm commence*, AH *alarm hysterisis* and AW *alarm width*. The range subject to monitoring begins at AC and ends at AC+AW. The alarm output transition hysteresis can be set via parameter AH.

The alarm output is updated with each sample measured.

7.1. Set the alarm start (commence) point (ACx)

The default setting for AC is 1000 (1000 meters is beyond the allowable range of the AR1000)

The units for AC are dictated by the scale factor (SF). See section 5.2.2 for information about scale factors (SF).

AC sets the beginning of the distance range, for which the alarm output will be turned active. The length of this active range can be set using the AW parameter.

7.2. Set the alarm hysteresis (AHx)

The default setting for AH is +0.1

Hysteresis is used to keep the Alarm output state from toggling rapidly near an alarm boundary becasue the sensor's measurement 'noise' is causes the value to bounce across the boundary. Hysteresis sets a boundary deadband to keep the Alarm output more stable. The Alarm output is not allowed to change state as long as the measurement stays within the deadband.

The units for AH are dictated by the scale factor (SF). See section 5.2.2 for information about scale factors (SF).

AH allows you to make parameter settings for the output transition hysteresis at the beginning and the end point of the active range of the alarm output.

The mathematical sign of AH is used to set the logic level (HIGH or LOW) of the Alarm state.

Positive sign ("+"): active range is HIGH-active. No sign setting means positively-signed
Negative sign ("-"): active range is LOW-active.

7.2.1. Positive alarm hysteresis

In the case of a positive AH, the output switches
with increasing distance:
   from LOW to HIGH if the distance is found to be greater than (AC+AH/2).
   from HIGH to LOW if the distance is found to be greater than (AC+AW+AH/2)
with decreasing distance:
   from LOW to HIGH if the distance is found to be smaller than (AC+AW-AH/2).
   from LOW to HIGH the distance is found to be smaller than (AC-AH/2).

7.2.2. Negative alarm hysteresis

In the case of a negative AH, the output switching pattern will be the opposite of positive.
with increasing distance:

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from HIGH to LOW if the distance is found to be greater than (AC+AH/2).
from LOW to HIGH if the distance is found to be greater than (AC+AW+AH/2)
with decreasing distance:
from HIGH to LOW if the distance is found to be smaller than (AC+AW-AH/2).
from HIGH to LOW the distance is found to be smaller than (AC-AH/2).

7.3. Set the alarm window (AW)

The default setting for AW is 100000

The units for AW are dictated by the scale factor (SF). See section 5.2.2 for information about scale factors (SF).

AW sets the length of the active range, beginning at AC.

AW is always equal or greater than "0" (zero).

AW is always equal or greater than |AH| (absolute value of AH)

7.4. Example of alarm output configuration
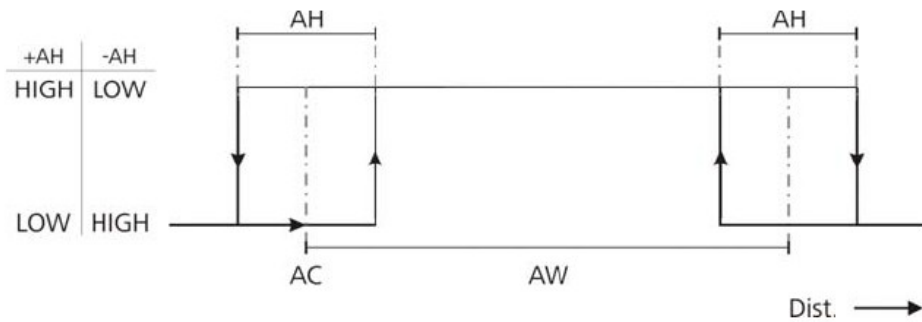
Figure 12 Alarm output behavior with AH+ and AH-

Example: A moving object is monitored within a window of 10 m to 11 m with a hysteresis of 0.2 m. The commands would be: **AC10 AH0.2 AW1**

Increasing distance (meters)									
	9.8	9.9	10.0	10.1	10.2	…	11.0	11.1	11.2	11.3
+AH	L	L	L	H	H	H	H	L	L	H
-AH	H	H	H	L	L	L	L	H	H	H
Decreasing distance (meters)									
	11.3	11.2	11.1	11.0	…	10.2	10.1	10.0	9.9	9.8
+AH	L	L	L	L	H	H	H	H	H	L
-AH	H	H	H	H	L	L	L	L	L	H

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7.5. Error Mode behavior for the alarm output (SE0, SE1 or SE2)

The factory default setting is SE1

The AR1000 alarm output can be configured to output different alarm outputs for special error conditions that correspond to Error Messages E15, E16, E17 and E18 (See Error Messages section 5.3 for more information).

SE0<Enter> will cause the AR1000 to alarm and hold the output state from the last valid measurement.

SE1<Enter> will force the following behavior
　　AH: ALARM=LOW
　　-AH: ALARM=HIGH

SE2<Enter> will force the following behavior
　　AH: ALARM=HIGH
　　-AH: ALARM=LOW

The SE command also affects the Analog output. See section 6.3

8. Performance Optimization

8.1. Measurement Modes

The AR1000 will not begin measuring and outputting distances until the user selects a measurement mode. Once initiated, the distance reading will be output on both the serial and analog lines.

Users may select among several modes that will optimize the sensors' speed or accuracy performances for the specific measuring application.

8.1.1. Distance Tracking Mode (DT)

The Distance Tracking mode is a versatile measuring mode that gives priority to the quality (accuracy) of the measurement rather than a specific measuring rate. In this mode, the actual sampling time will vary depending on the reflectivity (amplitude of the returning light signal) of the target. Darker targets may cause longer measuring times.

The minimum time to measure is 160 ms (6Hz), the maximum time is 6 s. If the measuring signal fails to reach a specified quality within six seconds, an error message is output (see Error codes 5.3).   The time to measure may also be limited by setting the ST parameter to a desired value.

8.1.2. Close-range Distance Tracking (DS)

The Close-range Distance Tracking mode should be used when measuring varied target surfaces between 20 to 275 inches (0.5 to 7 m) because it gives better speed performance. The time to measure may also be limited by setting the ST parameter to a desired value.

8.1.3. 10 Hz Distance Tracking (DW)

The 10 Hz Distance Tracking mode can be selected when working with a cooperative target. A cooperative target is a target surface with high diffuse reflectivity.   Examples of cooperative targets include white surfaces (paper, paint, etc.) or special reflective targets (contact technical service). Cooperative targets return strong signals to the AR1000 sensor and minimize the time required to perform internal algorithms.

In addition to requiring a cooperative target, there may not be jumps in measured distance greater than 6.3 in. (160 mm) per sample period. The target should not move faster than 5.2 ft/sec (1.6 m/sec).

8.1.4. 50 Hz Distance Tracking (DX)

The 50 Hz Distance Tracking mode can be selected when working with a cooperative target. A cooperative target is a target surface with high diffuse reflectivity.   Examples of cooperative targets include white surfaces (paper, paint, etc.) or special reflective targets (contact technical service). Cooperative targets return strong signals to the AR1000 sensor and minimize the time required to perform internal algorithms.

In addition to requiring a cooperative target, there may not be jumps in measured distance greater than 6.3 in. (160 mm) per sample period. The target should not move faster than 13

ft/sec (4 m/sec).   For higher rates of measurement, preceding measured values will be included in the process to calculate a currently measured value.

8.1.5. Hardware Trigger Mode (DF)

This serial command enables the Trigger input to cause single sample to be measured and outputs to be generated. The time to measure may also be limited by setting the ST parameter to a desired value. The maximum suggested trigger is 3.5 Hz (with ST1).

See section 9.2 for Trigger Delay and Edge command (TD) parameters.

Turn the Trigger Mode off when using DF (TM0 x – see section 9.3).

8.1.6. Take Single Sample (DM)

On receipt of this command, a single sample to be measured and outputs is generated. The time to measure may also be limited by setting the ST parameter to a desired value.

This command does not change any configuration settings.

8.2. Averaging Function (SAx)

Factory default setting is 1.

The SA function commands the sensor to output the average value of the previous 1 to 20 measured values (parameter x has allowed values of 1..20).

Calculation is based on this formula.

$$\text{Average value } x = \frac{X_1 + X_2 + X_3 + ... + X_{n\,(20)}}{n} \quad \text{with } n = SA$$

8.3. Set Measurement Time (STx)

Factory default setting is 0. This setting affects DT, DS, DF and DM measurement modes.

The ST command allows users to manually set the sample period for the AR1000.

The time required for the AR1000 to take a measurement depends on the selected measurement mode. Generally, the poorer the surface reflectance of a target, the longer the AR1000 will take to determine its distance. For example, if error message E15 is output because of poor reflectance and insufficient time to measure, the ST setting should be increased.

Available ST value range: 0 to 25

x = 0	Measurement time is automatic depending on returned signal. The smallest time possible for attaining a quality measurement is used. The minimum sample period with ST0 is 240 ms and the maximum sample period is 6 seconds..
x = 1..25	Measurement time is set <u>approximately</u> to:
	x * 240ms for DT mode
	x * 150ms for DS mode

One use for the ST command is to reduce the data volume or rate by increasing the time per measurement.

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8.4. Set Zero Point (OFx)

Factory default setting is 0 (the sensor's natural zero point)

The OF command allows users to manually set a zero point anywhere relative to the sensor's natural zero point. The commanded zero point can be a negative number. The parameter units for OF are dictated by the scale factor (SF). See section 5.2.2 for information about scale factors (SF).

8.4.1. Set current distance to Zero (SO)

The SO command performs a distance measurement and saves the measured reading as an offset value with inverted mathematical sign (OF).

8.5. Filter Measurements (RMx y.y z)

Factory default setting is 0 0 0

Do not use this command when the AR1000 is used to control equipment as it may cause hazards!

RM is intended to facilitate settings for a range of expected distance values. Values which are found to be outside of this expected range will be corrected until matching the most recently valid measured values.

RM is only used in DT mode.

The command's format consists of three parameters which are separated by space (20h).

x designates the number of preceding measured values that will be evaluated in the case of non-conforming measurement. A maximum of ten preceding measured values can be evaluated.

y defines the range of permissible values. If this range is exceeded in negative or positive direction, the respective measured value will be corrected accordingly.

z stands for the number of values that are out of the permissible value range (out of tolerance values). In the event of out-of-tolerance values arriving in succession, the most recently corrected value will be included in the correction process for the next out-of-tolerance value.

The maximum allowed number of out-of-tolerance values is100.
Example: RM3 0.5 1 (x=3, 2y=1, z=1).

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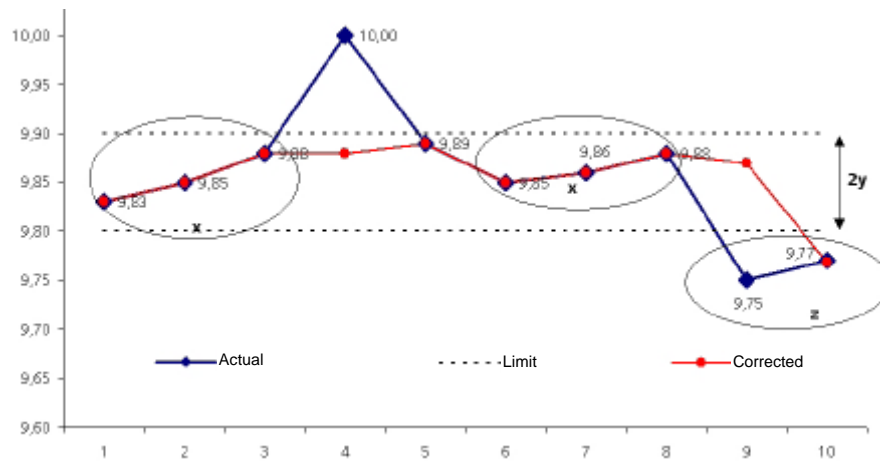
8.6. Set Heater ON Temperature (HOx)

This parameter is only available in the AR1000H laser sensor.

Factory default setting is 3 (corresponding to 3°C)

The HO command determines the low temperature below which the AR1000H sensor's internal heater will automatically turn on. A temperature sensor inside the AR1000H monitors the internal temperature of the device and compares it to the HOx value. If the measured internal temperature is less than HOx, the heater will be activated. The range of permissible values for the Heater ON setting is -40 to 70°C

To query the Heater ON temperature without making changes, type **HO [enter]**

8.7. Set Heater OFF Temperature (HFx)

This parameter is only available in the AR1000H laser sensor.

Factory default setting is 12 (corresponding to 12°C)

The HF command determines the High temperature above which the AR1000H sensor's internal heater will automatically turn off. A temperature sensor inside the AR1000H monitors the internal temperature of the device and compares it to the HOx value. If the measured internal temperature is greater than HFx, the heater will be de-activated. The range of permissible values for the Heater ON setting is -40 to 70°C

To query the Heater OFF temperature without making changes, type **HF [enter]**

9. Trigger Mode Optimization

Trigger mode is only available in the standard AR1000 and NOT available in the AR1000H (heater) sensor version.

The AR1000 can operate with a hardware trigger that has been connected according to the diagram in Section 4.1.6. To operate with an external trigger, the AR1000 must be configured in the Trigger Measurement Mode (DF). See Section 8.1.5 for details about this measurement mode. The Trigger Delay (TD) and Trigger Mode (TM) functions should only be used in the Hardware Trigger Mode (DF).

9.1. Designating Trigger Mode (DF)

DF mode allows a measurement that is triggered by an external trigger pulse. Initially, after selecting this mode, the operator does not receive any response. As soon as the trigger pulse has been detected, the AR1000 will send data and update the digital and/or analog output. See TD (section 9.3) to select the trigger delay and edge.

Note that if TM is on (TM1 x) then the trigger does not always produce the measurement output in the DF mode. Set TM0 x prior to using DF mode.

9.2. Setting a Trigger Delay and edge (TDx y)

The factory default setting is 0 0

The Trigger Delay (TDx y) consists of two parameters which are separated by space (20h).
   x   (0..9999)   delay time in milliseconds from trigger edge until measurement is performed.
   y   (0:falling, 1:rising)   trigger level.

Example:

TD1000 0<Enter>

In the given example, the delay time is set to 1000 ms and the trigger is set to the falling edge (HIGH to LOW transition).

9.3. Triggering Autostart (TMx y)

The factory default setting is 0 1.

The Triggering Autostart function allows users to set the hardware trigger to initiate the auto-start command (set via parameter AS. See Section 5.5.3).

TMx y uses two parameters which are separated by a space (20h).
   x   (0:no autostart trigger, 1:autostart trigger ON)
   y   (0: trigger on LOW, 1: trigger on HIGH)

Triggering occurs via the external trigger input. All starting modes which are selectable via AS can be launched and stopped by external triggering. These are:
   DS, DT, DW, DX, DF, DM, TP, LO, and ID.

Normally for triggering, the trigger input must be held in the active state until completion of the function. If the trigger is in the active state when the TM1 x command is issued, then the function will activate.

Note that ASDF is not reliable in TM mode, use ASDM instead.

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9.3.1. Example 1: Triggering Autostart

The Autostart function has the parameters **ASDT**

The Trigger Autostart has the parameters **TM1 1**
    Trigger signal = High; DT is performed.
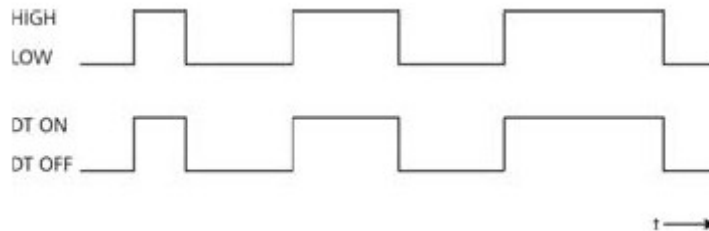   Trigger signal = Low; DT is stopped.

Figure 13 Triggering Autostart Low to High

9.3.2. Example 2: Triggering Autostart)

The Autostart function has the parameters **ASDM**

The Trigger Autostart has the parameter **TM1 0**
    Trigger signal=High; no change in state.
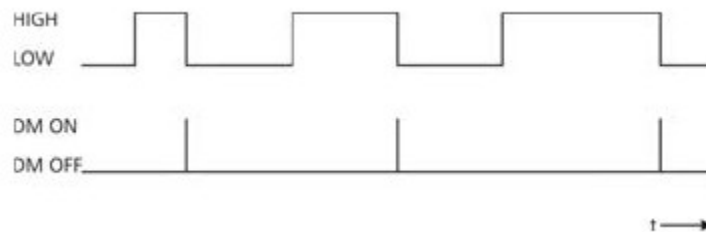   Trigger signal=Low; DM active, i.e. one measurement is triggered.

Figure 14 Triggering Autostart High to Low

10.   Serial Command Quick Reference

Type <Enter> after each command.

AR-1000 Configuration Data Settings (Serial)			Factory Default
Command Name	Serial Command	Serial Code / Function	
Online help menu	ID	Displays serial command menu	
Distance tracking mode	DT	Self-adjusting sample period. 6 Hz max	
Close-range distance tracking	DS	Self-adjusting sample period for ranges < 7 m	
10 Hz distance tracking	DW	10 Hz sampling rate to cooperative target with short movements	
50 Hz distance tracking	DX	50 Hz sampling rate to cooperative target with short movements	
Trigger mode	DF	External hardware trigger causes a sample to be executed	
Take single sample	DM	Serial command to take a single distance reading	
Temperature display	TP	Displays AR1000 internal temperature °C	
Averaging function	SAx	X is an integer 1 to 20. Calculates a floating average	SA1
ASCII output format	SDd	Decimal output	SDd
	SDh	Hexadecimal output	
Set measurement time	STx	Manually set the sample period 1 to 9999 ms; 0 = self-adjust	ST0
Scale factor	SFx.x	Used to obtain output in units other than meters.	SF1
Error mode for Alarm Output	SE0	Hold last valid measurement	SE1
	SE1	Alarm Low to High	
	SE2	Alarm High to Low	
Alarm start point	ACx	The location where the alarm output activates	AC1000
Alarm hysteresis	AHx.x	Behavior of alarm	AH0.1
Alarm window	AWx.x	Sets the active range for the alarm output	AW100000
Heater ON temperature	HOx	Sets the temperature below which the heater activates (AR1000H only)	HO3
Heater OFF temperature	HFx	Sets the temperature above which the heater de-activates (AR1000H only)	
Zero point for Analog output	RBx	Sets the distance for 4 mA	RB1000
Span point for Analog output	REx	Sets the distance for 20 mA	RE2000
Filter measurements	RM x y.y z	Filters z readings outside the window of y.y after evaluating x readings	RM0 0 0
Trigger delay for DF mode	TDx y	x = trigger delay (0..9999 ms). y = trigger edge (1:rising, 0:falling)	TD0 0
Setting a Trigger mode	TMx y	Delay for x with y edge	TM0 1
Baud rate	BRx	2400 BR2400 4800 BR4800 9600 BR9600 19200 BR19200 38400 BR38400	BR9600
Autostart configuration	ASx	Configures which modes and parameters will become active after power up of AR1000	ASID (online menu)
Set zero point	OFx	Sets zero point for serial output with a user-entered number	OF0
Set current distance to zero	SO	Takes a single sample and assigns it the zero point	
Turn laser on	LO	Turns on laser	
Turn laser off	LF	Turns off laser	
Display current settings	PA	Shows the current parameter settings	
Reset to factory default	PR	Returns all sensor settings to factory default	

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