AccuRange AR3000™ Distance Measurement Sensor

User's Manual

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For use with AR3000™
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Acuity
A product line of Schmitt Industries, Inc.
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This device has been tested for electromagnetic emissions and immunity and has been found to be in compliance with the following directives for class B equipment:

EN 61326/A3:2003

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
AR3000™ Series Distance Measurement Sensors
Rev. **1.9**
For use with AR3000

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1. Introduction

This section is a guide to getting started with the AR3000 and this manual. The AR3000 has a number of configurable parameters, a minimum of which must be set before the sensor can be used the first time. However, once the parameters are set, the sensor will default to that configuration until changed by the user.

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 and formats
  Analog Output Operation – current loop scaling
  Alarm Output Operation – alarm switch settings
  Trigger Input Operation – external trigger
  Performance Optimization – Sample Rate, Background Elimination, Exposure control
  AR3000 Command Set – explains all commands for customizing the application

1.1. General Overview

The AR3000 is a pulsed time-of-flight rangefinder that measures distance using a laser beam, a photodiode, and a microprocessor. The rangefinder works based on time of flight measurement by emitting high-frequency pulsed laser light which is diffusely reflected back from the target. This return signal is compared with a reference clock. From the amount of time, a resulting distance is determined with great accuracy. The maximum range measurement for the device is ~10,000 feet (3000 m) using special reflective targets such as 3M 3000X reflective sheeting. On normal diffuse surfaces, the maximum range is 980 feet (300 m). The Class 2 visible pilot laser makes it simple to aim the rangefinder which uses a Class 1 infrared (invisible) diode. Speed and accuracy performance vary depending on target surface reflectance. The AR3000 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 AR3000 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 2000 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 is in the form of serial data (RS232 or RS422 models) and 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 pilot laser at any person, particularly a person's eyes or face.

Do not attempt to disassemble the sensor. 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 60°C (140°F) or less than -40°C (-40°F).

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

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 AR3000 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 light (infrared measurement laser or visible pilot laser) 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 after selecting a measurement mode. For full instructions use the individual sections of this manual for mounting, power connections, data connections and configuration.

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

1.3.1. Mounting and Power connection

Mount the sensor in such a way that the case is not twisted or warped. Use three screws through M4 X 6 threaded mounting holes on the sides or bottom of the AR3000 sensor. The laser should be aimed at a target such that the distance from the sensor face to the target can be measured.

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

Connect the Supply + (Blue) and Ground (Gray/Pink or alternate Tan in some cables) wires of the sensor cable to a 10 to 30 volt DC power supply (or use the sensor's power supply if it came with one).

1.3.2. Serial Data Wires

Quick suggestion: Connect the wires to a 9 pin D-SUB male connector that can be plugged into a COM port of a PC (RS232): Black (Ground) to pin 5, White (Transmit) to pin 2, and Brown (Receive) to pin 3. Start a HyperTerminal program on the PC and set it for that COM port at 115200 baud, 8 bit, 1 start, parity: none, 1 stop, no flow control.

To view distance measurements and verify functionality, type DT<Enter>. The sensor will report its present measurements 100 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. Note: This command mode can only be stopped by sending an escape (<Esc>) character.

1.3.3. Analog Output Signals

Quick suggestion: connect a DVM (digital volt meter) to the wires: Gray/Pink or alternate Tan to Common, Yellow to mA input.

The default mode is 4-20mA current loop. The meter should read near 4 mA when a target is placed in the laser beam near 1 m range and 20 mA near 300 m range.

1.3.4. Alarm Signals

Use the Status display on the rear of the AR3000 sensor to view the activity of the Q1 and Q2 alarms.

2. General Description

The AR3000 is a laser diode based distance measurement sensor for ranges up to 980 feet (300m) on regular surfaces and up to 9800 feet (3000 m) using a reflective target. The accuracy is generally specified with a linearity of +/- 0.8 inches (20mm) at 100 Hz. Linearity will vary depending on pulse frequency, distance averaging, temperature and surface reflectivity of the target surface.

Two versions of the AR3000 are available. The standard model (with a 2 mrad laser divergence) and a 10 mrad model. See the data sheet for performance details.

2.1. Principles of Operation

The AR3000 uses the time of flight of light to measure distance. The laser beam is projected from the housing's smaller lens (top) and shines on a target surface, where it creates a spot. From the target, the laser light is scattered in all directions. The sensor's larger lens collects a portion of the reflected light, which is focused on a photo detector and converted to an electrical signal which is used to determine a distance.

2.2. Mechanical Dimensions

The following diagram shows the mechanical dimensions for the AR3000. The sensor has three M4 X 6 threaded holes on each side and on the bottom surface for mounting to a fixture. The cable is for power and all communication (serial, analog, trigger, power, etc.). It has a 12-pin M16 flange-mount plug (Binder series 723). The outer case of the sensor is extruded aluminum with powder-coated paint for corrosion resistance.

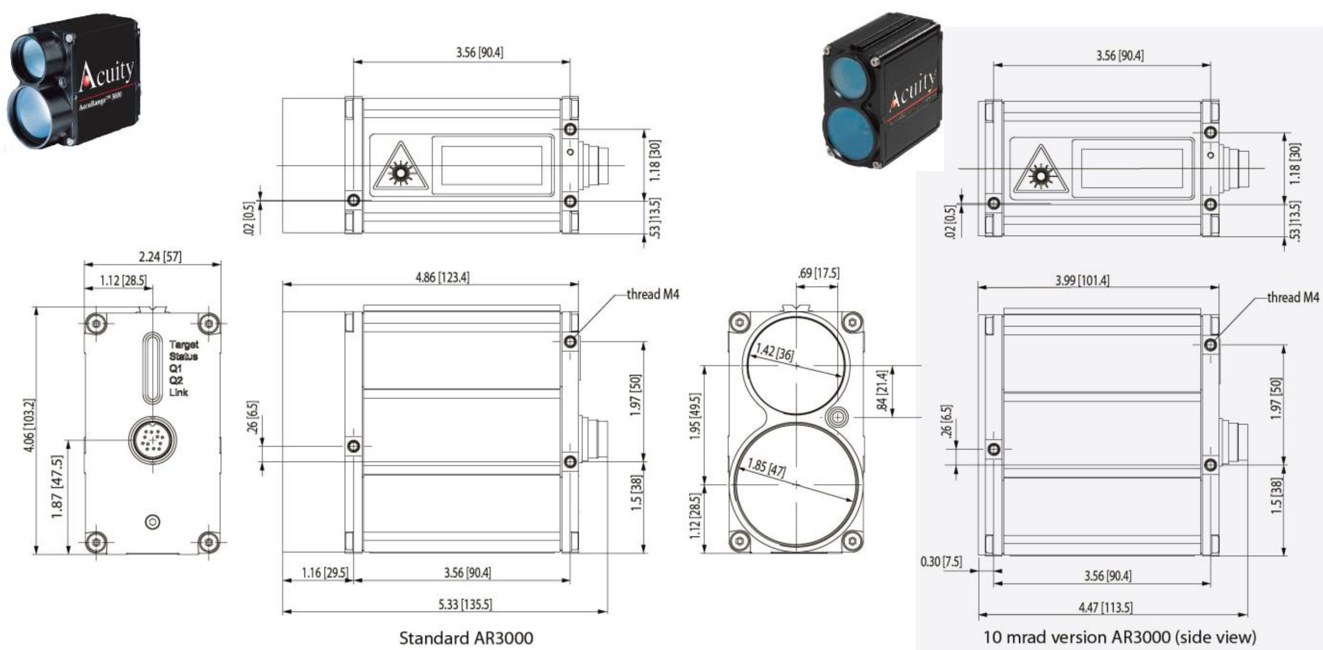

Figure 1 Mechanical layout of AR3000 sensor

2.3. Installation

The AR3000 sensor is typically installed by affixing the sensor to a machined bracket with threaded bolts through the three mounting holes on either of the sensor's sides or the bottom. Their location is shown in the mechanical drawing of Figure 1. The laser should be aimed at a target such that the distance from the sensor face to the target can be meausured.

2.4. Laser Safety

The AR3000 has two lasers, a measurement laser and an aiming Pilot laser. The laser used for measurements is a Class 1 laser device in accordance with EN60825-1:2001. Laser radiation emitted by Class 1 lasers is entirely harmless to the human eye and no precautions are necessary.

The laser used for the aiming Pilot laser is Class 2. 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. 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.

2 mrad

10 mrad

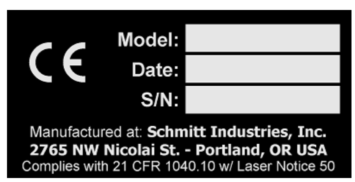

Figure 2 Laser safety labels for AR3000

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. Pilot Laser

The Class 2 visible pilot laser is emitted from a small window between the two large lenses on the front of the AR3000 distance measurement sensor. Its purpose is to help users aim and align the sensor to a distant target. In the factory default startup mode, the pilot laser is enabled and flashes at a frequency of 2 Hz.

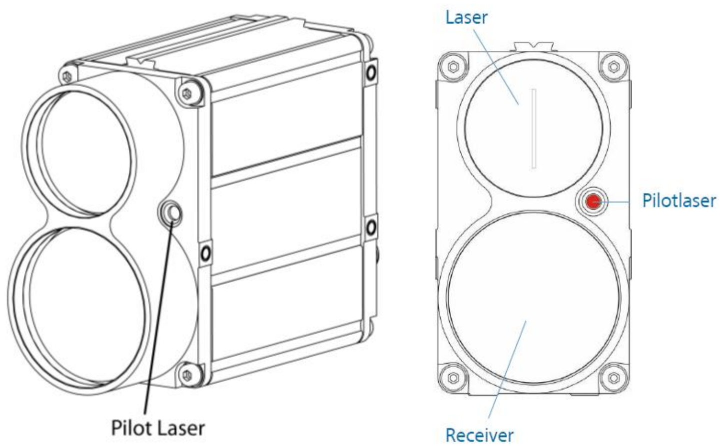

Figure 3 - Location of Pilot Laser on front face of AR3000

The pilot laser is not aligned to emit in a direction parallel with the measurement laser. Instead, its beam intersects with that of the measurement laser at a distance of 246 feet (75 m). The pilot laser axis makes a 0.002° angle with the horizon. The figure below shows the tolerance on pilot laser positioning in relation to the invisible measurement laser as a function of the distance to an object being measured. The rectangular shape is the relative size of the infrared measurement laser. The red-dashed circle is the perimeter inside which the pilot laser could appear. The pilot laser is much smaller than the tolerance circle

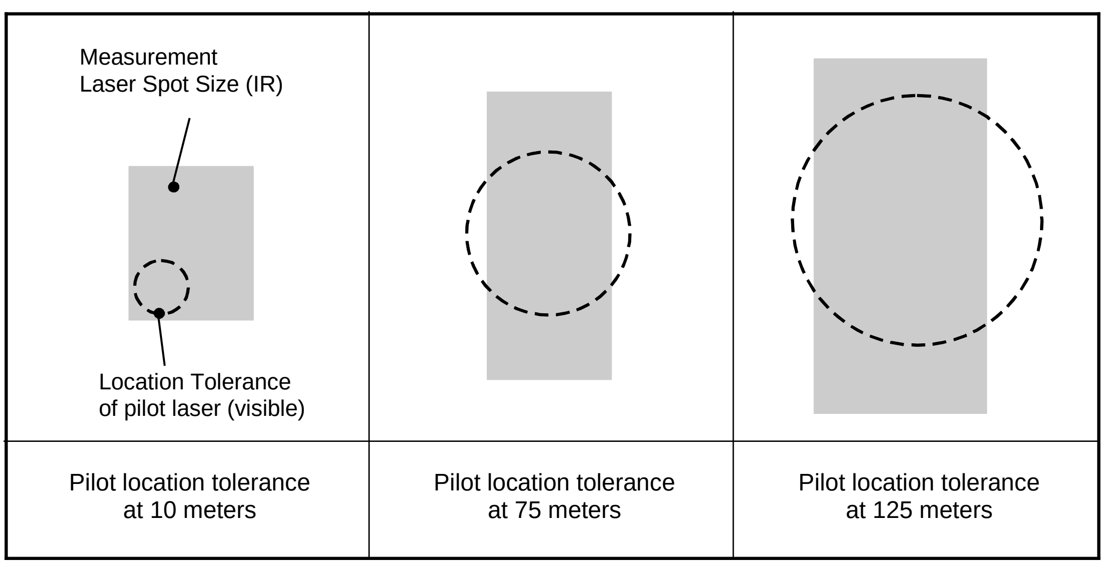

Figure 4 Tolerance of 2 mrad Pilot Laser location relative to the infrared measurement laser

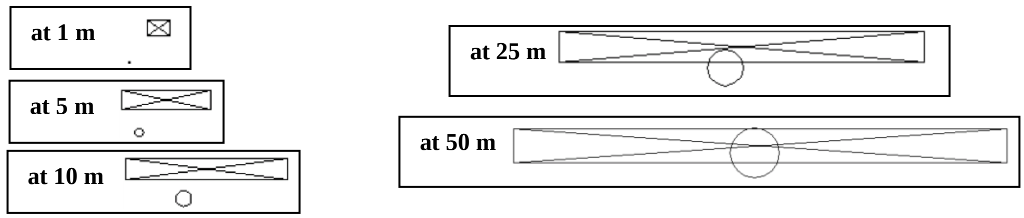

Figure 5 Tolerance of 10 mrad Pilot Laser location relative to the infrared measurement laser

2.6. Laser Beam Profile

The invisible measurement laser beam emitted from AR3000 sensor has a rectangular profile that expands (diverges) as its distance from the sensor increases. This table indicates the approximate beam dimensions at different distances from the sensor.

Distance from sensor (meters[feet])	Laser spot height x width (mm[in])	
	Standard 2 mrad Sensor	10 mrad sensor
1[3]	25x53[1.0x2.1]	9x14[0.35x0.55]
10[33]	40x54[1.6x2.1]	14x104[0.55x4.1]
50[160]	106x57[4.2x2.2]	34x504[1.3x20]
100[330]	190x61[7.5x2.4]	59x1004[2.3x40]
500[1600]	856x95[34x3.7]	259x5004[10x200]
1000[3300]	1690x137[67x5.4]	509x10000[20x390]

Note that the specified divergence (2 mrad or 10 mrad) is for the faster expanding laser axis and that the height expands faster on the 2 mrad model while the width expands faster on the 10 mrad model.

2.7. Sensor Maintenance

The AR3000 sensor requires little maintenance from the user. The sensor lenses 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 a sensor does not function according to specifications, contact Schmitt Industries, Inc. Do not attempt to loosen any screws or open the sensor housing.

2.8. Sensor Service

The AR3000 sensor has no user-serviceable parts. Refer all service questions to Schmitt Industries, Inc. Do not attempt to loosen any screws or open the sensor housing.

2.9. Sensor Specifications

Go to http://www.acuitylaser.com/pdf/ar3000-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. Note that the sensor's Zero Point is the same as the plane created by the front-most cover plate around the lenses.

3.2. Cabling

The AR3000 has a multipurpose cable with solder tail wires. The standard cable, Schmitt p/n CBA300201, is 6.6 feet (2 m). Longer cable lengths are available. Connection and termination according to the instructions is essential for correct sensor operation. Read the wire descriptions in Section 4.1 for connection information.

Connect the cable's 12-pin connector (Binder series 425) to the sensor's plug (Binder series 723, M16 size) on the back cover of the AR3000 sensor. Be sure to tightly secure the connection.

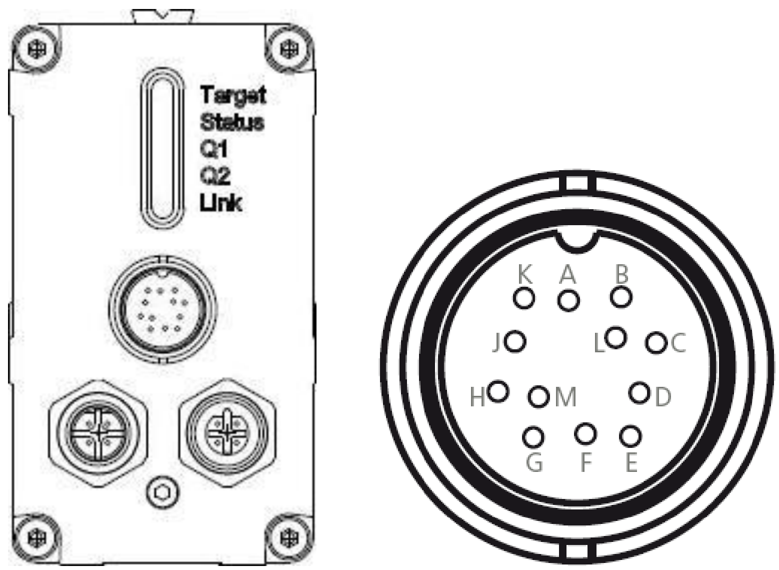

Figure 6 Back cover with 12-pin plug and pin arrangement

Figure 7 Interface cable

3.2.1. Standalone Cabling

To use the AR3000 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 wires connecting to data display, recording, or control equipment. See Signal and Power Interface (section 4) for wire connections. This method assumes that the sensor has been previously configured using the serial interface to designate startup parameters and settings.

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. The alarm outputs can be used to indicate the analog output validity.

The two alarm output wires can be used to connect to control equipment. These signals can also indicate the sensor's measurement validity.

3.2.2. Serial Connection to a Host Computer

Connect a 15 or 24 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. 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 AR3000 is connected to. In the next configuration screen, set to 115200 baud, 8 bits, no parity, 1 stop bit and no flow control to communicate with a sensor in the default configuration. Free demonstration software is also available through the Acuity website.

RS232 model: A 9-pin serial D-sub serial female connector can be attached to the serial output wires to connect the AR3000 directly to an IBM-PC compatible 9-pin serial port.

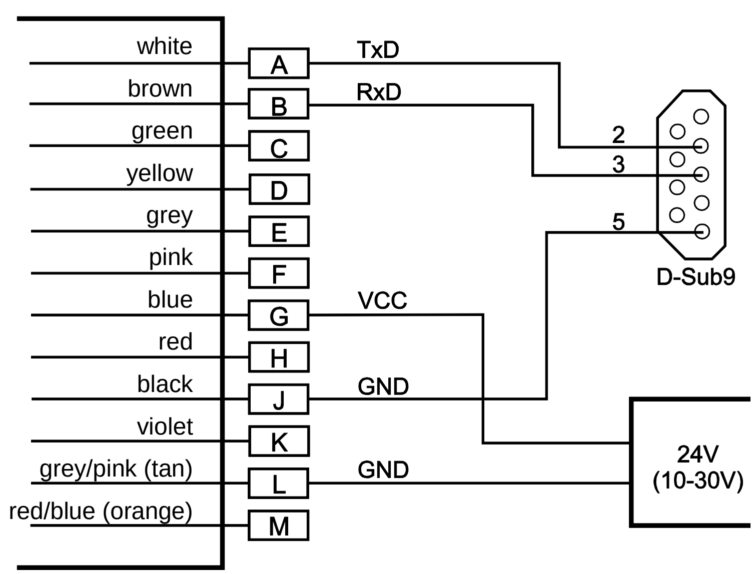

Figure 8- Wiring configuration for 9-pin connector for RS232 serial communications

RS422 model: An RS422 adapter must be used to connect the AR3000 to an IBM-PC compatible computer. The RS422 wires are as follows:

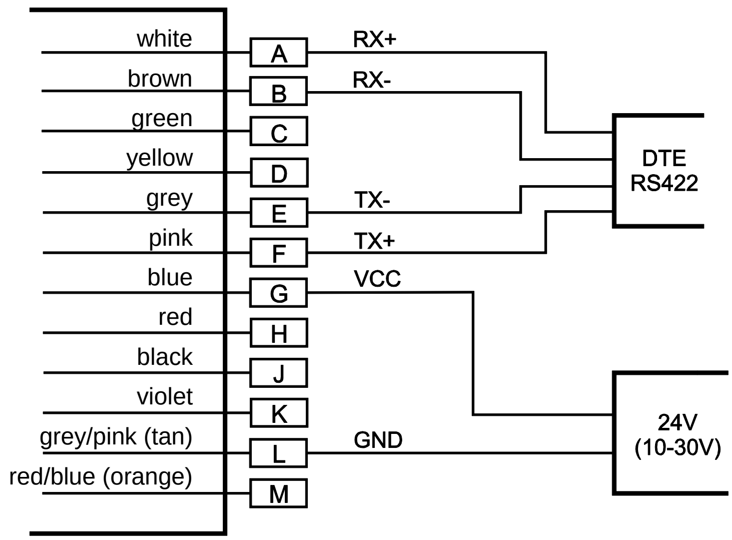

Figure 9- Wiring configuration for RS422 serial communications

3.3. Power On

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

When power is applied the red pilot laser beam will be emitted from the front of the AR3000 and blink with a frequency of 2 Hz (default mode). The terminal emulator will show the sensor's firmware revision and serial number. The sensor will not transmit measurement readings until a measurement mode is selected (see section 7.1 for more details). To begin measuring in *Distance Tracking* mode, type DT<Enter>. Distance readings will scroll up the HyperTerminal window and the units will be in meters. Note: This command mode can only be stopped by sending an escape (<Esc>) character.

3.3.1. 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 (excluding the baud rate). If the sensor's baud rate is unknown, then the BR115200<Enter> command must be issued from the HyperTerminal program while set at each of the AR3000's possible baud rates until the AR3000 accepts the command and sets the baud rate to 115200. 115200 is the standard baud rate for the AR3000. The possible baud rates are 9600, 19200, 38400, 57600, 115200, 230400, and 460800.

3.3.2. 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 20 inches (0.5 m) from the sensor's zero point, and that the laser beam is hitting the target. If ERROR codes are transmitted, perform the correction for that ERROR code (see section 5.3).

Verify that the target is of sufficient reflectance by verifying that the “TARGET” LED on the rear of the sensor is Yellow or Green. Do not use retro reflective targets if the “TARGET” LED becomes RED in color when the sensor is aimed at the target.

Distance offset settings may alter the values output by the sensor. Reset the sensor to the factory default to remove their effect (PR command).

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 AR3000 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 10 AR3000 multipurpose cable with 12 conductors plus shield and corresponding pin arrangements

4.1. Sensor Cable Wire Colors and Functions

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

Wire Color (alternate)	Pin	Function in All Modes
Green	C	External Trigger Input (3V to 30 V)
Yellow	D	Analog output (4-20 mA current loop)
Blue	G	Supply Voltage +24V (10- 30 VDC)
Red/Blue (Orange)	M	Alarm Output 1 (Q1)
Violet	K	Alarm Output 2 (Q2)
Black	J	Ground (serial)
Gray/Pink (Tan)	L	Ground (Power supply common return)
Clear		Shield
Red	H	Not connected

Table 1 Non-Serial Wire Connections

The serial communications wires can be used for either the RS232 or RS422 model. The RS422 model has a 120 ohm terminating resistor between the receiving pair's wires (RX+ and RX-).

Function in Selected Serial Mode			
Wire	**Pin**	**RS232 models**	**RS422 models**
Brown	B	RxD – Receive Data	RX– : Receive Data –
White	A	TxD – Transmit Data	RX+ : Receive Data +
Gray	E	Not connected	TX- : Transmit Data -
Pink	F	Not connected	TX+ : Transmit Data +

Table 2 Serial Wire Connections

4.1.1. Power Supply (Blue, Gray/Pink or Tan)

The Gray/Pink wire (or alternate Tan in some cables) is the Power Supply Common return, also named Ground. It carries the return current for the power supply and the analog signals.

The Blue wire is the Power Supply Input to the sensor. The sensor requires +24 VDC power and consumes <5 W without the heater and 11.5 W when the automatic heater is on.

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. 24 VDC should be used when the heater may be needed. Voltages less than 10 VDC may result in inaccurate measurement readings or the AR3000 not even turning on.

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 RS232 or RS422 (Brown, White, Gray, Pink)

Both the RS232 and RS422 models are compatible with the associated ANSI communication standards. The desired model (RS232 or RS422) must be selected when ordering the AR3000.

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

RS232 model: 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	
White	2	Transmit data from sensor
Brown	3	Receive data to sensor
Black	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.

Table 3 RS232 Model Serial Connections

RS422 model: 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 to an RS422 model.

Color	
White	Receive data to sensor (+)
Brown	Receive data to sensor (-)
Pink	Transmit data from sensor (+)
Gray	Transmit data from sensor (-)
Black	Signal ground reference

Table 4 RS422 Model Serial Connections

4.1.4. Analog Output (Yellow, Gray/Pink or Tan)

The Gray/Pink wire (or alternate Tan in some cables) is the return signal for the Analog Output. It is also the power supply ground. 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 Yellow wire delivers a current proportional to the measured distance.

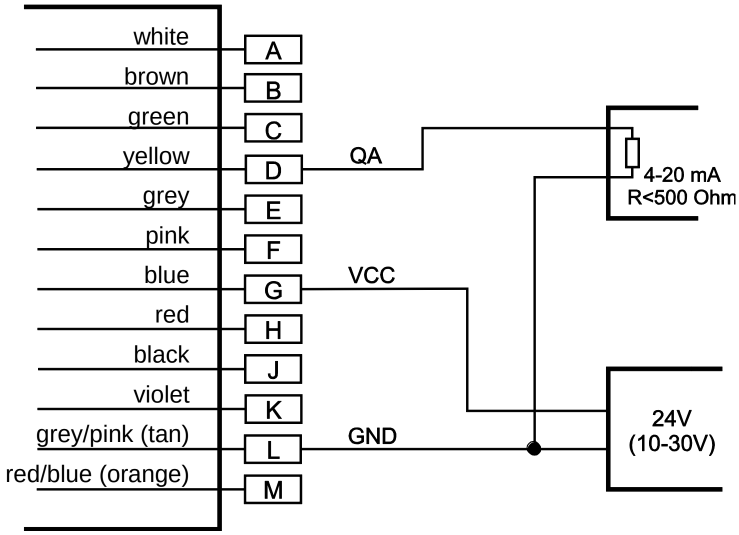

Figure 11 Wiring Diagram for Analog output

The best conversion to voltage is obtained by connecting a 500-ohm load resistor (1/4 Watt minimum) between the Yellow and Gray/Pink (alternate Tan) wires at the measurement point. This gives a 2 volt to 10 volt output range.

See Analog Output Operation (section 5.6) for mode selection and scaling options. This will pass the signal at full speed (2000 samples per second). To filter better at slower speeds, use a 0.047 uF capacitor (200 samples per second) or a 0.47 uF capacitor (20 samples per second).

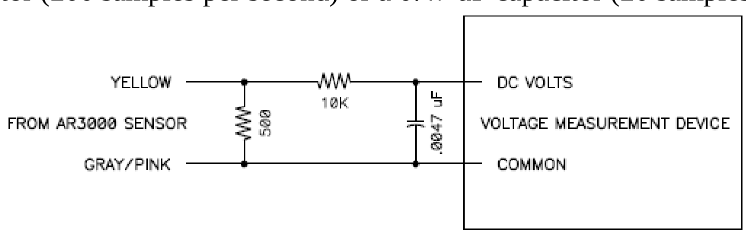

Figure 12 Wiring Diagram for Analog output with filter

4.1.5. Alarm Outputs (Red/Blue or alternate Orange, Violet)

The Red/Blue or alternate Orange (Q1) and Violet (Q2) wires are the Alarm Outputs.

See Alarm Output Operation (section 6) for operation options and details.

The Alarm Outputs are open collector PNP transistor switches to the positive power supply (VCC). When a Alarm Output is not active, its output will be high impedance and no current will flow through it. When a Alarm Output is active (On) it can source up to 200mA of current. A current limiting circuit will protect the output in the case of a short circuit.

The load for the output should be connected to ground (Gray/Pink or alternate Tan wire). The voltage on the Alarm wire must not exceed the limits of the Power Supply connection voltages (Blue and Gray/Pink or Tan wires), or excessive current may flow into the sensor and cause damage.

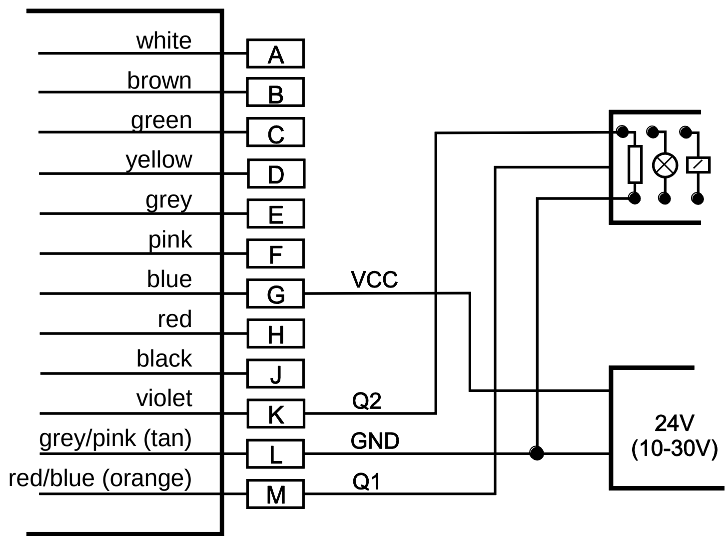

Figure 13 Wiring diagram for Alarm Outputs

4.1.6. Laser Trigger (Green)

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

The trigger input is intended for triggering a distance measurement with an external signal that is applied as a voltage on the green wire. A voltage between 3.0 V and 30 V is a HIGH input and a voltage between 0 V and 1.5 V is a LOW input. It is for the user to specify a desired delay time and a pulse flank to be selected for synchronization. The user must select the DF measurement mode setting in the AR3000. An <Esc> character must be sent to exit the trigger mode.

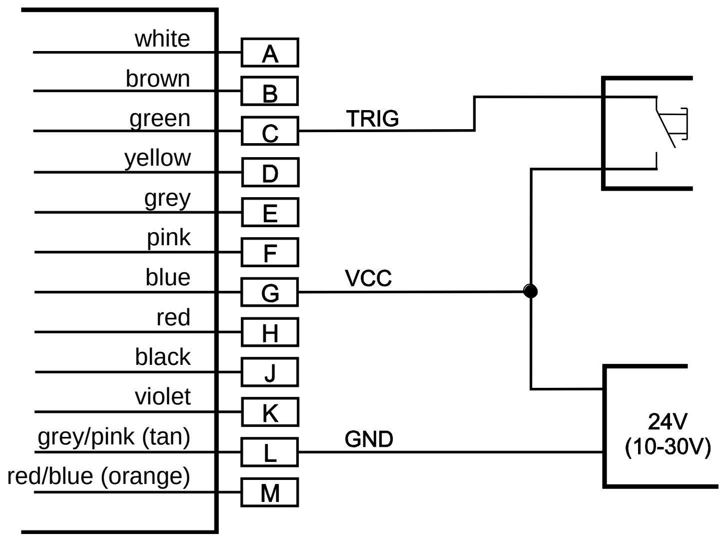

Figure 14 Wiring diagram for Trigger Input

If a switch is used, the input may need a debouncing circuit to prevent multiple triggers or triggers on the wrong edge.

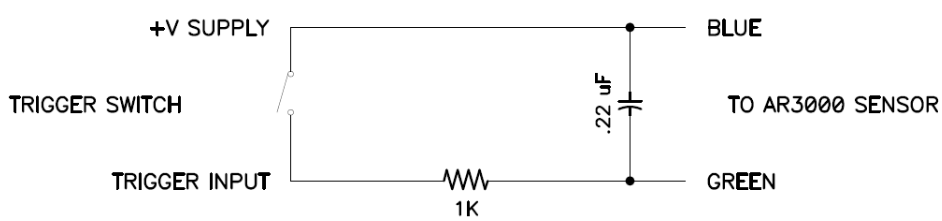

Figure 15 Debounce circuit for Trigger Input switch

5. Serial Interface Operation

5.1. Serial Hardware Interface

The serial port is available as either an RS232 or RS422 model, which must be selected when placing an order for the AR3000 sensor.

5.1.1. Communications Protocol

The easiest way to configure the AR3000 is by using a PC with a serial (RS232 or RS422) communication port and a terminal emulation program. The communications protocol uses the ASCII format. Commands that set a parameter value can be used to query the parameter by typing the command without any numbers.

{command}<Enter> Executes command or displays parameter

{command}{parameter[parameter[..]]}<Enter> Sets the command parameter. The command is followed by an optional space and then the parameter. More parameters may be required. A space is required to separate the parameters. Parameters not entered are taken as zero.

For example:

Type **AS<Enter>** to display the current Autostart setting.
Type **ASID<Enter>** to set the current Autostart setting to the ID mode.

Before an operating session begins, users should configure the AR3000 sensor with parameters that meet the particular measuring site conditions and requirements. All valid parameter settings will be preserved on turning the AR3000 sensor off and restored when it is turned back on. They can only be replaced with new value entries or changed back to their default values by running an initialization routine. Below is a short view of the commands accepted through the AR3000 (RS232 or RS422) communications protocol:

Command	Description
ID	Displays the sensor's manufacturing data and serial numbers
ID?	Displays the Online Help menu
Measurement Modes	
DT	Starts continuous repetitions of distance results - DM (<Esc> to stop)
VM	Single velocity measurement of 25 results
VT	Starts continuous repetitions of velocity measurements - VM (<Esc> to stop)
DF	Starts external hardware trigger measurement mode (<Esc> to stop)
DM	Single distance result of SA measurements
Status	
TP	Queries inner temperature
HW	Hardware status
PA	Displays all parameter values
Setup Parameters	
AS	Queries / sets Autostart command
PL	Queries / sets pilot laser mode for aiming
PR	Resets all parameters to standard values
DR	Resets the device to simulate "cold start"

SF	Queries / sets scale factor
OF	Queries / sets user-specified offset
SO	Sets current distance as negative offset
MW	Queries / sets measurement window
MF	Queries / sets sampling frequency
SA	Queries / sets number of samples to be averaged before outputting a result
TD	Queries / sets trigger delay
SE	Queries / sets error mode (0, 1, 2)
Q1	Queries / sets Alarm 1 output
Q2	Queries / sets Alarm 2 output
QA	Queries / sets endpoints for Analog output
BR	Queries / sets baud rate
SD	Queries / sets output format (decimal/hex)
TE	Queries / sets terminator for ASCII serial mode (RS232/RS422)

Table 5 Online Help Menu for AR3000

5.1.2. Show Model Identifications (ID)

Type **ID<Enter>** to display the AR3000 manufacturing data in this order: product code, firmware version, firmware data, firmware time, serial number, date of manufacture and time of manufacture.

5.1.3. Show Online Help (ID?)

Type **ID?<Enter>** to display the AR3000 online menu of available parameters and settings similar to the table in section 5.1.1

5.1.4. Baud Rate (BRx)

This parameter specifies the serial baud rate. The Baud Rate can only be specified via the serial interface and it requires the host device to change its own Baud Rate after commanding the sensor to change. The standard setting for baud rate is 115200 baud and it is not affected by the PR (parameter reset) command.

Type **BR<Enter>** to display the current baud rate.

Type **BR x<Enter>** to specify the baud rate.

The serial port will respond by displaying the new value.

x: baud rate value. Allowed values are 9600, 19200, 38400, 57600, 115200 (standard), 230400, and 460800 baud.

Examples

BR9600<Enter> Set the baud rate to 9600
BR115200<Enter> Set the baud rate to 115200

5.2. Serial Data Output (SD, SF, TE)

The Serial Data Format units, and errors are selectable using the Serial Output Control command. Serial data is transmitted from the AR3000 as characters (bytes) of 8 data bits with no parity and 1 stop bit. The sample data sent represents calibrated distance readings.

Available formats are decimal, hexadecimal, and binary (SD).

Signal strength and/or internal temperature may also be transmitted (SD).

Distance output, normally in meters (velocity in m/s), may be scaled by the scale factor (SF).

A distance offset value (OF) is applied to the output value.

The ASCII termination character may be selected from several options (TE).

5.2.1. Serial Data Format (SD*x y*)

These parameters specify the serial output format (decimal, hexadecimal, or binary) and whether the signal strength and/or the internal temperature are sent. The factory default setting is SD0 0 for distance-only output in decimal format.

Type **SD<Enter>** to display the current output format settings.

Type **SD x y<Enter>** to specify the new format and data. The parameters must be separated by a space. Non-entered parameters are taken as 0.

The serial port will respond by displaying the new values.

x: strength and temperature data selector according to the following chart

y: format selector according to the following chart

Formats for both distance (DM) and velocity (VM) measurements are shown.

SDx y	Command	**SD0 y** (Decimal)	**SD1 y** (Hexadecimal)	**SD2 y** (Binary)
SDx 0 Distance	DM VM	`D 001.234` `D-000.002  001.234`	`H0004D2` `HFFFFFE 0004D2`	3 bytes 3+3 bytes
SDx 1 Distance+Strength	DM VM	`D 001.234 00556` `D 000.002  001.234 00556`	`H0004D2 022C` `H000002 0004D2 022C`	3+1 bytes 3+3+1 bytes
SDx 2 Distance+Temperature	DM VM	`D-001.234 +29.2` `D-000.002 -001.234 +29.2`	`HFFF62E 124` `HFFFFFE FFF62E 124`	3+2 bytes 3+3+2 bytes
SDx 3 Distance+Strength+ Temperature	DM VM	`D 001.234 00556 +29.2` `D-000.002  001.234 00556 +29.2`	`H0004D2 022C 124` `HFFFFFE 0004D2 022C 124`	3+1+2 bytes 3+3+1+2 bytes

Table 6 Serial Output format selection chart

Each format has certain characteristics. The first character indicates the data format.

Decimal	**D**	The most significant bit of the character is a ‘0’.
Hexadecimal	**H**	The most significant bit of the character is a ‘0’. The value is equivalent to the corresponding decimal value with the decimal point removed.
Binary	**1xxxxxxx**	The most significant bit of the character is a ‘1’. Only 3-byte values (Velocity or Distance) start with a ‘1’. The most significant byte is first.

Velocity command reports the velocity as the first number (if velocity commanded).

Decimal	`-0123.456`	sign (space or '-'), 4+3 decimal digits plus space
Hexadecimal	**FFFFFE**	24 bit 2's complement number plus space
Binary	**1BBBBBBB 0BBBBBBB 0BBBBBBB**	21 bit 2's complement number

The Distance is reported in units determined by the scale factor (see section 5.2.2).

Decimal	`-0123.456`	sign (space or '-'), 4+3 decimal digits
Hexadecimal	**FFFFFE**	24 bit 2's complement number
Binary	**1BBBBBBB 0BBBBBBB 0BBBBBBB**	21 bit 2's complement number

The signal strength value follows distance and does not have units, but typically ranges from <600 to >3400. The AR3000's performance is optimized when 1500 < Signal Strength < 3400.

Decimal	**01956**	space plus 5 digits
Hexadecimal	**07A4**	space plus 16 bit number
Binary	**0BBBBBBB** [0BBBBBBB]	The 7 most significant bits of the 14 bit number (only the first, most significant byte is transmitted)

Temperature is reported in °C and follows distance and/or signal strength. The internal temperature is typically about 8°C warmer than the external temperature.

Decimal	**+23.4**	space, sign ('+'or '-'), 2+1 decimal digit
Hexadecimal	**00EA**	space plus 16 bit 2's complement number
Binary	**1BBBBBBB 0BBBBBBB**	14 bit 2's complement number

5.2.2. Data Units Scale Factor (SFx.xxxxxx)

This parameter specifies the distance scale factor (multiplier). The default setting is 1.0 (SF1), which generates the sample result in meters. The units are not labeled.

Type **SF<Enter>** to display the current scale factor.

Type **SF x<Enter>** to specify the scale factor.

The serial port will respond by displaying the new value.

x: scaling factor multiplier (from meters). The resolution is approximately 0.000001. The allowed range of the scale factor is from -10.000 to -0.001 and from 0.001 to 10.000. Direct conversion to inches (39.3701) or millimeters (1000.0) is not possible.

Examples

SF1<Enter>	Scale factor = 1.0	Output in units of meters
SF3.24084<Enter>	Scale factor = 3.24084	Output in units of feet.

5.2.3. Serial Output Termination Character (TEx)

This parameter specifies the output termination for the serial transmission. The factory default setting is Carriage Return Line Feed (TE0).

Type **TE<Enter>** to display the current termination character code.

Type **TE x<Enter>** to specify the serial output termination setting.

The serial port will respond by displaying the new value.

x: Code representing the termination according to the following chart. Binary mode has no termination characters.

x	0	1	2	3	4	5	6	7	8	9
Hexadecimal	0x0D0A	0x0D	0x0A	0x02	0x03	0x09	0x20	0x2C	0x3A	0x3B
Description	CR LF	CR	LF	STX	ETX	Tab	Space	Comma	Colon	Semicolon

Table 7 Parameters for serial output line termination

5.3. Error Messages

The AR3000 will automatically generate error code messages 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 Switches for error handling in those output modes.

Red Status LED: Contact Schmitt Industries, Inc. for technical support.

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

Code	Description	Remediation
E02	No target	Check for measuring distance to local target Change measurement window limits (MW)
E04	Defective laser	Contact Schmitt Industries, Inc. for technical support

Table 8 Error Code descriptions

5.4. Pilot Laser Control (PLx)

This parameter specifies one of four operating modes for the pilot laser. The factory default is PL2 (blinking at 2 Hz).

Type **PL<Enter>** to display the current pilot laser setting.

Type **PL x<Enter>** to specify the pilot laser setting.

The serial port will respond by displaying the new value.

x: specifies the pilot laser behavior:

- **0** Off – no pilot laser
- **1** On – pilot laser is on continuously
- **2** Flash – Pilot laser is blinking on and off at 2 Hz
- **3** Flash – Pilot laser is blinking on and off at 5 Hz

5.5. Displaying, Configuring and Resetting Parameters

As the AR3000 sensor is configured for specific requirements, it may be helpful to view the settings that are saved in the sensors EEPROM. Below are list of commands that allow users to view or reset parameters.

5.5.1. Displaying current settings (PA)

Type **PA<Enter>** to display the current AR3000 settings as shown below:

```
measure frequency[MF]............2000(max2000)hz
trigger delay/level[TD]..........0.00msec 0
average value[SA]................20
scale factor[SF].................1.000000
measure window[MW]...............-5000.000 5000.000
distance offset[OF]..............1.000
error mode[SE]...................1
digital out[Q1]..................20.000 10.000 1.000 1
digital out[Q2]..................1.000 30.000 0.500 1
analog out[QA]...................1.000 300.000
RS232/422 baud rate[BR]..........115200
RS232/422 output format[SD]......dec (0), value (0)
RS232/422 output terminator[TE]..0Dh 0Ah (0)
SSI output format[SC]............bin (0)
pilot laser [PL].................2
autostart command[AS]............ID
```

5.5.2. Show Hardware Status (HW)

Type **HW<Enter>** to display a specific list of diagnostic information for the AR3000 sensor. The information can be interpreted by a technician at Acuity.

5.5.3. Show Internal Temperature (TP)

Type **TP<Enter>** to display the sensor's internal temperature.

This will output the sensor's internal temperature in the format [–]000.0 (°C). This may be helpful information if the sensor will be installed in environments which exceed the temperature specification for the unit -40 to 140°F (-40 to 60°C).

5.5.4. Reset all Parameters (PR)

Type **PR<Enter>** to restore the AR3000 to factory default settings. This command does not affect the baud rate.

The serial port will respond by displaying all of the new settings (like the PA command).

5.5.5. Perform Diagnostic Reset (DR)

Type **DR<Enter>** to perform a diagnostic reset of the AR3000, simulating an actual voltage break situation. This command may prove useful for testing the behavior of the AR3000 when power is applied.

5.5.6. Auto Start (ASx)

Autostart defines the command that will be activated when the AR3000 is powered on. The factory default command for Autostart is ID.

Type **AS<Enter>** to display the Autostart command.

Type **ASx<Enter>** to set a new Autostart command.

The serial port will respond by displaying the new command.

x Represents any of the following commands (without parameters).

ID, ID?	Display the requested information
DM, VM, TP, HW	Measure and display the requested values.
DT, DF, VT	Enter the continuous mode (requires <Esc> to stop)
PA, MF, TD, SA SF, MW, OF, SE Q1, Q2, QA, BR SD, TE, PL, AS	Display the requested settings
BB, AB, SC	Display the requested settings (SCSI and fieldbus models)

Example

ASDT<Enter> The AR3000 sensor will begin in the distance tracking mode after power-up. Note that only an <Esc> character can stop distance tracking.

Analog Output Operation (QA, SE)

The analog output uses two wires in the basic configuration see section 4.1.4.

The analog output is updated with each sample result according to combination effected by the measurement frequency and the sample averaging. The analog output will deliver a current which increases linearly from 4 mA at the Zero-point to 20 mA at the Span-point.

5.6. Analog Output Zero-point and Span-point (QAx y)

These parameters specify the Zero-point (4 mA value) and Span-point (20 mA value) for the analog output signal. The factory default setting is QA1.000 300.000 for a Zero-point (x) of 1 meter and a Span-point (y) of 300 meters.

Type **QA<Enter>** to display the current analog output Zero-point and Span-point.

Type **QA x y<Enter>** to set the parameters, which must be separated by a space. The space before parameter x is optional. Values not entered are taken as zero. The combinations of parameters x and y are compared to sample results, which are affected by the scale factor and distance offset values (SF and OF - See section 7.2).

The serial port will respond by displaying the new values.

x specifies the analog output Zero-point (4 mA value) with a resolution of approximately 0.001.

y specifies the analog output Span-point (20 mA value) with a resolution of approximately 0.001.

It may be desirable to assign the Zero-point and Span-point to anywhere within the sensor's measurement range. The Zero-point may be a value larger than the Span-point. In this case, the range will increase as the sample result decreases.

5.7. Error Mode (SE0, SE1 or SE2)

This parameter specifies the behavior of the AR3000 analog output signals during error conditions E02 (common) and E04 (See Error Messages section 5.3 for more information). The default setting is SE1. This parameter also affects the alarm output error mode. See section 6.2.

Type **SE<Enter>** to display the current error mode.

Type **SE x<Enter>** to specify the error mode.

The serial port will respond by displaying the new values.

x: specifies the analog output behavior during an error condition:

- **0** will cause the AR3000 to output and hold the last valid analog output
- **1** will cause the sensor to output 3 mA to report an error
- **2** will cause the sensor to output 21 mA to report an error

6. Alarm Output Operation (Q1, Q2, SE)

The AR3000 comes standard with two, dedicated digital alarm switches. See the wiring in section 1.3.4 Alarm outputs operation may also be referred to as *digital* or *limit* outputs. Users of the AR3000 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 described below. The alarm output is updated with each sample averaged.

6.1. Alarm Output (Q1w x y z / Q2w x y z)

The default settings for both Q1 and Q2 are: 0.000 0.000 0.000 1 . The parameters for Q1 and Q2 specify the behavior of the output signals alarm 1 and alarm 2, correspondingly. Note that alarm 1 (Q1) and alarm 2 (Q2) act independently of each other.

Type **Q2<Enter>** to display the current settings for alarm switch output 2 (Q2).

Type **Q1 w x y z<Enter>** to set the parameters, where w, x, y, and z represent the parameter values, which must be separated by spaces. The space before parameter w is optional. The values have a resolution of approximately 0.001. Values not entered are taken as zero. The combinations of parameters w, x, and y are compared to sample results, which are affected by the scale factor and distance offset values (SF and OF - See section 7.2).

The serial port will respond by displaying the new values.

w is the parameter for the start of the measurement range where the alarm becomes active. The resolution of this parameter is three decimal places (0.001).

x is the parameter for the length of the measurement range over which the alarm is active. The resolution of this parameter is three decimal places (0.001, $x \geq y \geq 0$).

y is the parameter for the hysteresis over which the alarm output will remain stable between active and inactive. The hysteresis parameter eliminates the alarm output from toggling wildly when crossing a single location **w** by providing a dead band (y) where the output won't change. The resolution of this parameter is three decimal places (0.001, $x \geq y \geq 0$).

z is the parameter for setting the behavior of the alarm output signal during the active range, high (on) or low (off). **z** can be 0 (bottom figure: LOW or OFF) or 1 (top figure: HIGH or ON).

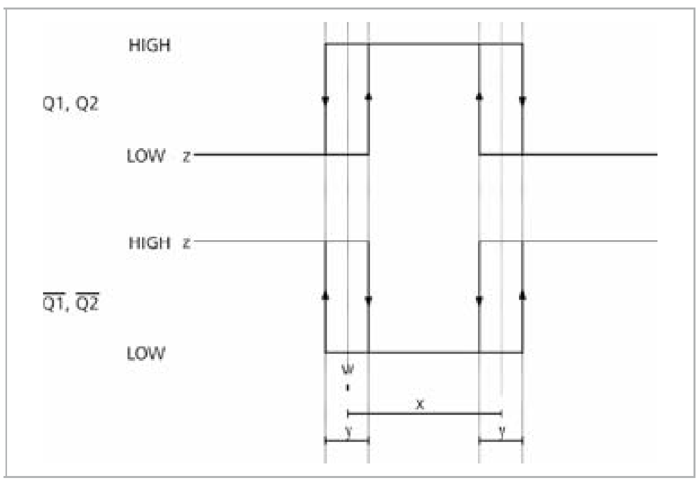

Figure 16 Alarm Output parameter characteristics

6.2. Error Mode behavior for the alarm switches (SE0, SE1 or SE2)

This parameter specifies the behavior of the AR3000 alarm output signals during error conditions E02 (common) and E04 (See Error Messages section 5.3 for more information). The default setting is SE1. This parameter also affects the analog output error mode. See section 5.7.

Type **SE<Enter>** to display the current alarm and analog output mode setting.

Type **SE x<Enter>** to set the new value, where x represents the value.

The serial port will respond by displaying the new value.

x: specifies the alarm output behaviors during an error condition:

0 cause the AR3000 to output and hold the last valid alarm state

1 force the following behavior for both alarm 1 and alarm 2 based on the z parameter of the corresponding Q1 or Q2 command.

z = 0 error forces the alarm output HIGH

z = 1 error forces the alarm output LOW

2 force the following behavior for both alarm 1 and alarm 2 based on the z parameter of the corresponding Q1 or Q2 command.

z = 0 error forces the alarm output LOW

z = 1 error forces the alarm output HIGH

7. Performance and Optimization

7.1. Measurement Modes

The AR3000 will not begin measuring and reporting until the user selects a measurement mode. Once initiated, the distance will be measured, and when a sample result is computed, it will be sent on both the serial, analog, and alarm signals. See section 5.2 to specify the serial format, section 5.6 to specify the analog behavior, and section 6 to specify the alarm behavior.

The sample result values are affected by the scale factor and distance offset values (SF and OF - See section 7.2).

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

The overall data output speed will depend on the ratio between the sensor's measurement frequency (MF) and the averaging function (SA).

7.1.1. Perform Distance Measurement (DM)

This command causes the AR3000 to performs one set of measurements and generates the output(analog, alarm, and serial) based on the resulting average.

Type **DM<Enter>** to initiate a single distance measurement. This command does not change any configuration settings.

The time required for each measurement depends on the number of averaged samples (SA) and the preset measuring frequency (MF). With the factory default settings the DM command takes 10 ms to complete.

The time for the output depends on the measurement frequency.

7.1.2. Start Distance Tracking Mode (DT) (<Esc> to stop)

In the Distance Tracking mode, the AR3000 performs continuous distance measurements (like repeating the DM command) until stopped with the Escape character (0x1B) via the serial port (<Esc> key in HyperTerminal).

Type **DT<Enter>** to start the distance tracking mode. This command does not change any configuration settings.

Type **<Esc>** to stop tracking the distance. Note: This is the only way to stop.

The output rate of measured values depends on the number of averaged samples (SA) and the preset measuring frequency (MF). With the factory default settings, DT mode will generate sample results at 100Hz.

7.1.3. Perform Velocity Measurement (VM)

This command causes the AR3000 to takes 25 averaged samples, after which it will use those 25 samples to calculate a resulting velocity. The alarm and analog outputs are updated for each sample (at the DT mode rate), but only one serial output is generated after the 25 samples are complete. The maximum measurable velocity is 100 m/s. With the factory default scaling factor (SF1) the velocity units will be m/s.

Type **VM<Enter>** to initiate a single velocity measurement. This command does not change any configuration settings.

The time required for each measurement depends on the number of averaged samples (SA) and the preset measuring frequency (MF). With the factory default settings the VM command takes 250 ms to complete.

7.1.4. Start Velocity Tracking Mode (VT) (<Esc> to stop)

In the Velocity Tracking mode, the AR3000 performs continuous velocity measurements (like repeating the VM command) until stopped with the Escape character (0x1B) via the serial port (<Esc> key in HyperTerminal). The alarm and analog outputs are updated for each sample (at the DT mode rate), but only one serial output is generated for each 25-sample result. The maximum measurable velocity is 100 m/s. With the factory default scaling factor (SF1) the velocity units will be m/s.

Type **VT<Enter>** to start the velocity tracking mode. This command does not change any configuration settings.

Type **<Esc>** to stop tracking the velocity. Note: This is the only way to stop.

The output rate of measured values depends on the number of averaged samples (SA) and the preset measuring frequency (MF). With the factory default settings, the VT mode will generate alarm and analog output results at 100Hz and velocity results (serial port) at 4Hz.

7.2. Samples Averaged (SAx)

This sets the number of distance measurements to be acquired and averaged for each distance result. The factory default for this setting is 20.

Type **SA<Enter>** to display the current number of measurements to average per sample.

Type **SA x<Enter>** to change the value, where x is the new value. The allowed range of x is from 1 to 30000.

The serial port will respond by displaying the new values.

The calculation is: $\text{SampleResult} = \text{OF} + \left(\text{SF} \cdot \left(\frac{D_1 + D_2 + D_3 + \ldots + D_{SA}}{SA} \right) \right)$ where D_n is a single distance result from a laser pulse, SA is the number of measurements to average per sample, SF is the current scaling factor (section 5.2.2), and OF is the current offset value (section 7.5).

7.3. Measurement Frequency (MFx)

The sets the rate at which distance measurements are acquired each second. Each measurement consists of a single laser pulse, so this also sets the rate of emitted laser pulses. The factory default for this setting is 2000 Hz.

Type **MF<Enter>** to display the current number of measurements to be acquired per second.

Type **MF x<Enter>** to change the value, where x is the new value. The allowed range of x is from 1 to 2000 (Hz).

The serial port will respond by displaying the new values.

The time to measure a distance sample is SA/MF (the sample rate is MF/SA).

Examples:

MF1000, SA1000	sample time = 1 second	rate = 1 sample/second
MF2000, SA1000	sample time = 0.5 second	rate = 2 samples/second
MF2000, SA20000	sample time = 10 second	rate = 0.1 sample/second

7.4. Measurement Window (MWx y)

This sets a window of allowed sample results for the AR3000. Targets detected outside the limits x and y will return an error (E02 - no target). Factory default setting is MW-5000.000 5000.000. The resolution of these values is three decimal places.

Type **MW<Enter>** to display the current measurement window values.

Type **MW x y<Enter>** to set the new measurement window values, where x and y are the window limit values separated by a space. The values have a resolution of approximately 0.001 and x must be less than y. The values are not checked for plausibility. The parameters x and y are compared to sample results, which are affected by the scale factor and distance offset values (SF and OF - See section 7.2).

The serial port will respond by displaying the new values.

This command may be useful to set to mask sources of interferences in front of or behind the targeted measurement locations.

7.5. Distance Offset (OFx.xxx)

This sets an offset that is added to the scaled average before generating a result. The factory default offset is 0.000.

Type **OF<Enter>** to display the current offset.

Type **OF x<Enter>** to change the offset, where x is the new value, which may have a sign and has an approximate resolution of 0.001. The value is not checked for plausibility.

The serial port will respond by displaying the new values.

See section 7.2 for more information.

7.6. Set Origin (SO)

This command takes a single distance result and sets its negative value as the new offset. This adjusts the sample result to be zero at the current location. Note that this command changes the value of the OF (distance offset) parameter. The sensor will then generate distance values relative to the newly-assigned zero location.

Type **SO<Enter>** to adjust the offset value such that the current location is zero.

8. External Trigger Operation

The AR3000 can operate with a hardware trigger that has been connected according to the diagram in Section 4.1.5. To operate with an external hardware trigger, the AR3000 must operate in the Trigger Measurement Mode, started by the Start Trigger command (DF).

The Trigger Delay (TD) settings affect the External Trigger operation.

8.1. Start External Trigger Mode (DF) (<Esc> to stop)

This command causes the AR3000 to enter the External Trigger mode. The AR3000 will then remain in the External Trigger mode until stopped with the Escape character (0x1B) via the serial port (<Esc> key in HyperTerminal). While in the External Trigger mode the AR3000 continuously waits for external trigger events. On receipt of each trigger event, the AR3000 emits a single laser pulse and acquires a single distance measurement. These measurements are counted and stored until the count matches the Samples Averaged parameter value (SA), and then the Sample Result is computed and the outputs are generated (serial, analog, and alarms). For example, if SA is set to 20, then 20 triggers are required to get a single result (see section 7.2).

The 'trigger event' response to the external trigger input signal is specified with the Trigger Delay parameters (TD – See section 8.2).

Type **DF<Enter>** to start the External Trigger mode. This command does not change any configuration settings.

The serial port will respond with **external trigger on ...**

Type **<Esc>** to stop waiting for an external trigger. Note: This is the only way to stop.

The serial port will respond with **external trigger off**.

The time to get a result depends on the number of samples averaged (SA) and the setting for trigger delay (TD). The measurement frequency parameter (MF) is ignored in the External Trigger mode. The time between the last bit of a trigger impulse and the first bit of output value is approx. 200 µs. The trigger delay, measurement frequency and the average will influence the time delay

8.2. Trigger Delay (TDx y)

The Trigger Delay parameters specify the delay and transition edge used in the External Trigger mode. The factory default setting is TD0.00 0

Type **TD<Enter>** to display the current trigger delay values.

Type **TD x y<Enter>** to set the new trigger delay values. A space must separate the values.

The serial port will respond by displaying the new values.

x: The delay time has units of milliseconds (ms) with a resolution of approximately 0.01ms. The allowed range for the delay is 0 to 300 ms.

y: The transition edge has a value of 0 or 1.

- 0 falling edge – trigger input transition from HIGH to LOW
- 1 rising edge – trigger input transition from LOW to HIGH

Example:

TD8.5 0<Enter> Sets the trigger event to happen 8.5ms after the trigger input signal falls (external input goes from HIGH to LOW).

9. Hardware Status Display

The rear panel of the AR3000 distance measurement sensor includes a display of several, colored LED's with labels. These indicators represent the status of the unit's ability to function without using queries through the serial interface.

LED	Term	Color	Description
Target	Signal Strength of return signal	OFF	No return signal
		Red, pulsed	Signal too low (<600)
		Red, steady	Low signal (600 – 1000)
		Yellow	Signal (1000-1500)
		Green, steady	Ideal signal (1500 – 3400)
		Green, pulsed	Strong signal (>3400)
Status	Operational readiness state	OFF	Not ready
		Red	Sensor defect, contact Acuity
		Green	Ready
Q1	Alarm 1	Off	Off
		Yellow	Active
Q2	Alarm 2	Off	Off
		Yellow	Active
Link	Bus State	Used only with optional SSI or Profibus	

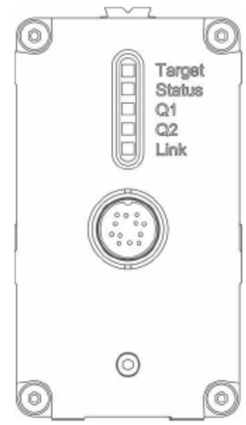

Figure 17- Rear panel of AR3000

Table 9 Status Display Indications

10. Serial Command Quick Reference

AR3000 Configuration Data Settings (Serial)			
Command Name	Serial Command	Serial Code / Function / Setting	Factory Default
Model identification	ID	Displays the sensor's manufacturing data and serial numbers	
Online Help Menu	ID?	Show's menu of possible configurations	
Distance tracking mode	DT	Start continuous Measurement Tracking (<Esc> to stop)	
Velocity measurement	VM	Single velocity measurement after 25 distance samples	
Velocity tracking	VT	Start continuous Velocity Tracking with 25 sample intervals (<Esc> to stop)	
Trigger mode	DF	External hardware trigger mode (<Esc> to stop)	
Take single sample	DM	This serial command causes a single distance reading	
Temperature display	TP	Displays AR3000 internal temperature (usually 8°C above ambient)	
Hardware status	HW	Reports internal diagnostics information (temperatures and voltages)	
Pilot Laser Control	PL	Queries / set pilot aiming laser ON, OFF, or blinking characteristics	`PL2` (blink 2 Hz)
ASCII output format	SDx y	Queries / sets output format including distance, signal strength and temperature	`SD0 0`
Scale factor	SFx.xxxxxx	Used to obtain output in units other than meters.	`SF1.0`
Program Offset	OFx.xxx	Queries / sets offset to measured values	`OF0.000`
Serial command terminator	TE	Queries / sets termination character	`TE0` (CR LF)
Set current distance to zero	SO	Takes a single sample and assigns it the zero point	
Measurement window	MWx y	Masks interference outside the limits x and y	`MW-5000.000 5000.000`
Measurement Frequency	MF	Queries / sets pulse rate of AR3000	`MF2000`
Averaging Function	SA	Queries / sets number of samples to be averaged before outputting a value	`SA20`
Error mode for Alarm Switch	SE0	Hold last valid measurement for analog and alarm switches	`SE1`
	SE1	Analog: 3mA; Alarm High to Low	
	SE2	Analog: 21mA; Alarm Low to High	
Alarm 1 (Q1) output	Q1w x y z	Queries / sets the range, length, hysteresis and behavior of alarm switch Q1	`Q1 0 0 0 1`
Alarm 2 (Q2) output	Q2w x y z	Queries / sets the range, length, hysteresis and behavior of alarm switch Q2	`Q2 0 0 0 1`
Analog output	QAx y	Queries / sets the zero and span point for the 4-20mA signal	`QA1.000 300.000`
Setting a Trigger delay	TDx y	Queries / set Delay for x with y flank	`TD0 0`
Baud rate	BRx	9600 **BR9600** 19200 **BR19200** 38400 **BR38400** 57600 **BR57600** 115200 **BR115200 (standard)** 230400 **BR230400** 460800 **BR460800**	`BR115200`
Autostart configuration	ASx	Queries / set which modes and parameters will become active after power up of AR3000	`ASID`
Cold-start simulation	DR	Simulates a cold start with power reset	
Reset to factory default	PR	Returns all sensor settings to factory default	

Table 10 Serial Command Quick Reference