AUTOMATION P R O D U C T S GROUP, INC.

Operator's Manual

IRU-2000
IRU-3000
IRU-5000
IRU-6400
IRU-9400

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• **Warranty and Warranty Restrictions**

APG warrants its products to be free from defects of material and workmanship and will, without charge, replace or repair any equipment found defective upon inspection at its factory, provided the equipment has been returned, transportation prepaid, within 24 months from date of shipment from factory.

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Warranty is specifically at the factory. Any on site service will be provided at the sole expense of the Purchaser at standard field service rates.

All associated equipment must be protected by properly rated electronic/ electrical protection devices. APG shall not be liable for any damage due to improper engineering or installation by the purchaser or third parties. Proper installation, operation and maintenance of the product becomes the responsibility of the user upon receipt of the product.

Returns and allowances must be authorized by APG in advance. APG will assign a Return Material Authorization (RMA) number which must appear on all related papers and the outside of the shipping carton. All returns are subject to the final review by APG. Returns are subject to restocking charges as determined by APG's "Credit Return Policy".

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• The IRU Series Ultrasonic Sensors

Model	Range	Available Outputs
IRU-5000's	4 to 79 in.	4-20 mA 4-20 mA + (2) NPN Trip Points 0-2.5 V / 0-5 V (software selectable)
IRU-2000's	1 to 25 ft.	Solid State Relay (IRU-2002 only), Isolated 4-20 mA (IRU-2003 only) 4-20 mA 4-20 mA + (2) NPN Trip Points
IRU-6400's	1 to 30 ft.	0-2.5 V / 0-5 V
IRU-3100's	1.50 to 35 ft.	4-20 mA 4-20 mA + (2) NPN Trip Points
IRU-9400's	0.5 to 35 ft.	4-20 mA 4-20 mA + (2) NPN Trip Points 0-2.5 V / 0-5 V
IRU-3400's	1.50 to 50 ft.	4-20 mA 4-20 mA + (2) NPN Trip Points

The IRU series represents APG's line of general purpose ultrasonic sensors. With a choice of operating ranges from just a few inches to as far as 50 feet, the IRU product line is designed to fit a wide range of industrial automation applications. Sensor adjustments, such as sensitivity and filtering options, are made by interfacing the sensor to a PC using an RST module and APG's free Windows based programming software. The IRU sensors incorporate internal temperature compensation for increased accuracy under varying environmental conditions. The sensors are housed in PC/PET, PVC, or UV resistant ABS to seal out moisture and resist a wide range of chemicals.

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• Understanding Ultrasonics

Ultrasonic sensors use a transducer to transmit bursts of ultrasonic sound waves. Each burst contains a series of pulsed sound waves that emit in the shape of a cone, reflect off the target, and are detected by the sensor. The time required for the sound waves to travel to and from the target is converted into a distance measurement by the sensor. Ultrasonic sensing is affected by several factors including the target surface, distance, size, and angle. The following considerations will help ensure the best possible target conditions.

Surface

The ideal target surface is hard and smooth. This type of surface will reflect a greater amount of signal than a soft or uneven surface. Sound wave absorbent materials, such as granules and powders, will reduce the operating range of the sensor and decrease measurement accuracy.

Distance

Sound wave attenuation increases as the distance traveled increases. Therefore, targets at longer ranges require better reflective characteristics than targets that are closer to the sensor.
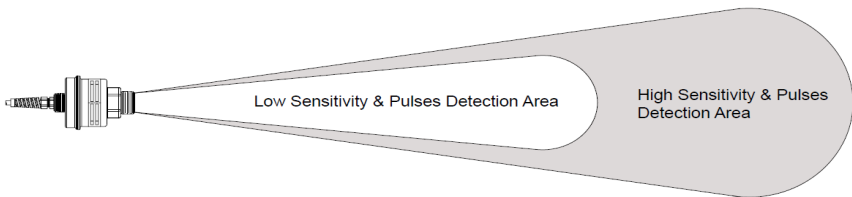
Size

A large object will have a greater surface area to reflect the signal than a smaller one. Therefore, a large target will be detected at a greater distance than a small target. The surface area recognized as the target will generally be the portion closest to the sensor.

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Angle

The inclination of the object's surface in relation to the sensor face will affect the strength of the reflected sound waves. Surfaces perpendicular to the sensor will reflect more signal directly back to the sensor. If a surface is more than a few degrees off perpendicular, enough of the signal will be reflected away from the sensor that the target will not be detected. Generally speaking, a target angle greater than 5 degrees off perpendicular will not be detected. The target angle becomes increasingly critical as the distance to the target increases**.**

Environmental Conditions

Temperature, humidity, vapors, dust, and pressure can affect the sensor's performance. APG ultrasonic sensors are designed to compensate for many of these conditions. However, if the conditions are extreme, sensor performance can be degraded enough to require the use of a longer-range sensor than normal conditions would require. Ultrasonic sensors may not be suitable for applications with heavy chemical vapors (such as solvents or gasoline), heavy dust or when significant surface foam is present.

Low Sensitivity & Pulses Detection Area

High Sensitivity & Pulses Detection Area

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• Sensor Mounting

Proper sensor mounting is critical for successful operation of an ultrasonic sensor. Using the following guidelines can help ensure trouble free installation and operation:

1. Ensure that the sensor face is perpendicular to the target surface. If the target is more than a few degrees off perpendicular, it may not be detected. Targets at greater distances will require more precise sensor alignment.

2. Mount the sensor in a location that provides an unobstructed column of air from the sensor to the target. The required width of the air column depends on several factors, including the angle and reflective characteristics of any potential targets on the edge of the column, the sensitivity setting of the sensor, the maximum distance to the target, and the reflective characteristics of the target itself. Generally speaking a 3 to 4 foot diameter unobstructed column is sufficient even at longer ranges.
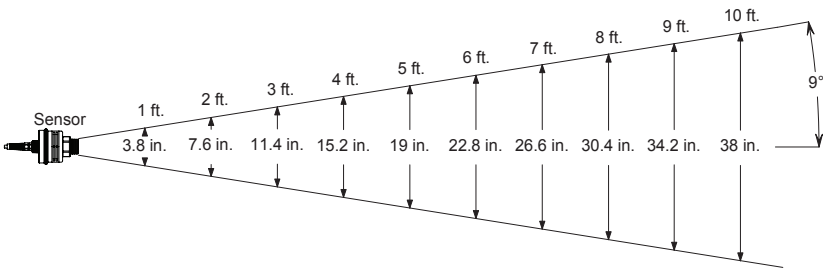
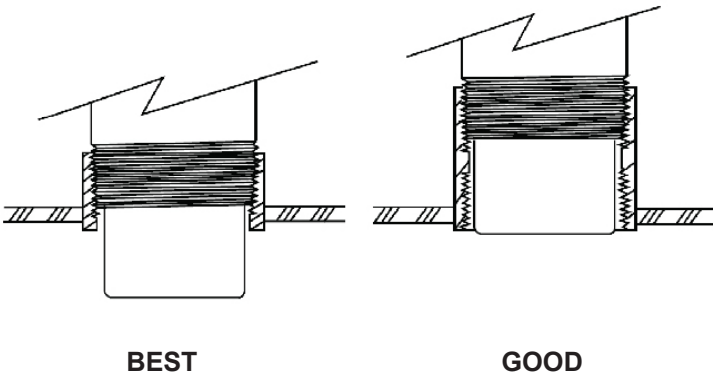Typical beam spread of an ultrasonic sensor operating at maximum sensitivity setting.

NOTE: Stilling pipes are an excellent solution for liquid level applications where an unobstructed path to the target is not feasible (see stilling pipe mounting on page 9 for details).

3. When mounting outdoors, it's best to shade the sensor from direct sunlight. Direct sunlight can warm the sensor housing above the ambient temperature causing false temperature readings and overcompensation by the sensor.

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4. Always mount above the highest anticipated target level by at least the published minimum blanking distance. If a target enters into the blanking area, error in the detection will occur. It is always advisable to allow for sufficient headroom to ensure that the target does not enter the blanking area.

5. Generally it is advisable to mount the sensor away from any vessel fill spouts. However, if heavy foam is expected, it is often helpful to mount the sensor near a fill spout where the foam is being dispersed.

6. Avoid mounting the sensor in the direct center of a tank with a significantly domed top. A domed top can act as parabolic dish, amplifying small undesired signals that may be present inside the tank.

7. Avoid mounting the sensor in close proximity to tank walls, especially on tanks with corrugated walls or in applications where product buildup on the tank walls may occur.
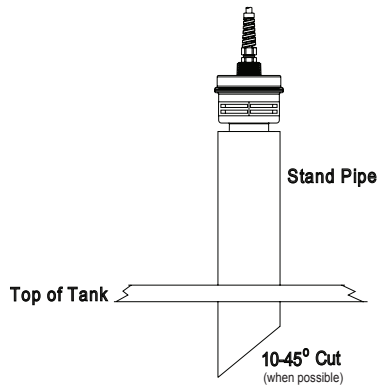
NPT Mounting

A half-coupler is preferable to a full-coupler to help ensure that the sensor face extends below the mounting fixture. The coupler must be aligned so that the sensor face is perpendicular to the target surface. <u>Thread the sensor into the coupler only hand tight</u>.

BEST   **GOOD**

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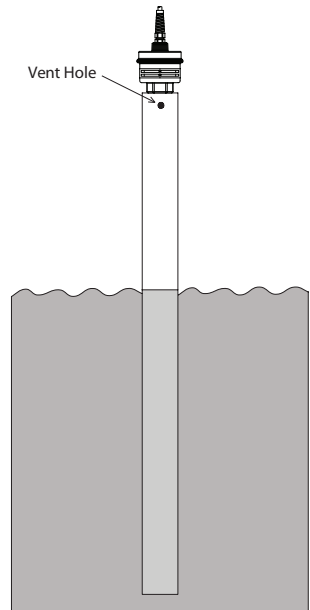Tel: 1/888/525-7300 • Fax: 1/435/753-7490 • www.apgsensors.com • sales@apgsensors.com

Stand Pipe Mounting

Stand pipes are used to provide headroom at the top of a tank when the target is expected to come closer to the sensor than the minimum blanking distance. It's very critical that the stand pipe be installed perpendicular to the target. This is especially important on longer range applications. The pipe must have smooth walls (no joints) and no burs or obstructions. If possible, cut the end of the pipe at a 10°-45° angle (see drawing). Use the largest diameter pipe and shortest length possible. As a general rule, the diameter of the pipe should be 1/2 the length. The pipe ID must remain the same through it's entire length.

Stilling Pipe Mounting

Stilling pipes provide access to difficult areas and help eliminate problems with foam. The pipe must have smooth walls (no burs or joints). Because the sound waves will concentrate and propagate down the inside walls of the tube, any irregularities on the tube walls may produce echo returns and cause false readings. Stilling pipes are limited to liquid targets that will not leave heavy deposits on the tube walls. Because the sound waves are confined inside the pipe, it is usually necessary to greatly reduce the sensors sensitivity and pulses settings. A vent hole must be provided at the top of the pipe. Be sure to keep the vent hole inside of the blanking area.

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• Hazardous Location Installation

The models listed below are CSA C/US certified for use in Class I, Division 2, Groups C and D, T6; Ex nA IIB T6, IP65; Class I, Zone 2; AEx nA IBB, T6, IP65 hazardous locations:

IRU-2125, IRU-2423, IRU-2425, IRU-3135, IRU-3433, IRU-3435, IRU-5413, IRU-5415, IRU-5423, and IRU-5425

Parameters for hazardous location installations:

1. Ambient temperature between -30^{0}C to 60^{0}C (-22^{0}F to +140^{0}F).
2. Humidity up to 100%
3. Pollution degree 2
4. Installation category II
5. Altitude up to 2000 meters
6. Indoor and/or outdoor use
7. 24 Vdc supply voltage
8. Supply voltage fluctuations must not exceed 10% of nominal supply voltage.

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• Hazardous Location Installation

Installation In Class I Division 2 Groups C and D
Class I Zone 2 A Ex nA IIB

Hazardous Area

Non-Hazardous Area

- Install in accordance with Section 18 of the CEC or Article 500 of the NEC.
- CSA listed or NRTL/UL listed conduit seal at location A & B.
- The cable is potted into the sensor and runs continuously from the sensor through the Hazardous area and into the Non-Hazardous area.
- Electrical equipment connected to associated apparatus should not generate more than 250 V rms.
- Tampering or replacement with non-factory components may adversely affect the safe use of the system.
- DO NOT DISCONNECT WHILE CIRCUIT IS ALIVE UNLESS AREA IS KNOWN TO BE NON-HAZARDOUS

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Hazardous Location Installation Drawing
IRU Series and DST Series Sensors

SCALE NONE   DO NOT SCALE DRAWING   SHEET 1 OF 1

PART NO: 0Z430   DRAWING NO: 9003066   REV B

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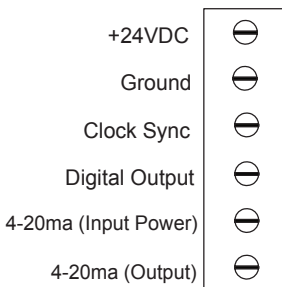
• **Wiring**

The IRU series sensors are configured with either a terminal wiring strip (IRU-2002 & IRU-2003 only), a multiconductor cable or a micro-connector. For optimal performance, the sensors should be supplied 24 Vdc. A high quality power supply is recommended.

NOTE: Clock synchronization (available on many models): is used to help prevent cross-talk between sensors located in close proximity. When the clock synchronization lines of two or more sensors are connected, the sensors will synchronize the transmit signals of each sensor. The sensors must share a common ground in order for the clock synchronization feature to function.

Solid State Relay Output (IRU-2002 only)

+24VDC	⊖
Ground	⊖
Clock Sync	⊖
Digital Output	⊖
Relay	⊖
Relay	⊖
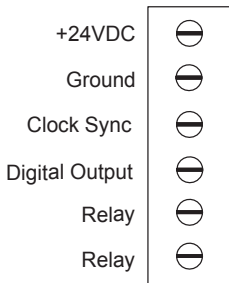
Isolated 4-20 mA Output (IRU-2003 only)

+24VDC	⊖
Ground	⊖
Clock Sync	⊖
Digital Output	⊖
4-20ma (Input Power)	⊖
4-20ma (Output)	⊖

*****Digital Output (IRU-2002 and IRU-2003 only) is used to interface with APG digital displays--part no. ACC-1007 or ACC-1008.

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Isolated 4-20 mA Wiring (IRU-2003 only)

The IRU-2003 is equipped with an isolated 4-20 mA output. This means that the 4-20 mA circuit can be powered by the receiver (such as a datalogger) or the source that is powering the receiver. Isolated wiring is used to prevent potential ground loops that can exist in instances where the IRU and receiver are not sharing the same power source. The 4-20 mA circuit can also be wired as a standard current sourcing 4-20 mA signal simply by powering the circuit from the same power source used by the main IRU sensor circuit
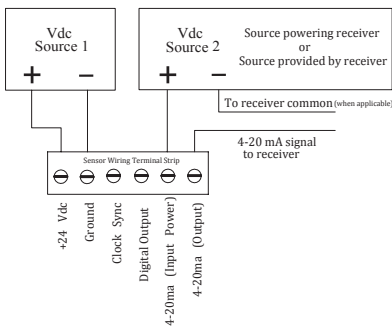
Isolated Wiring   Signal Sourcing Wiring
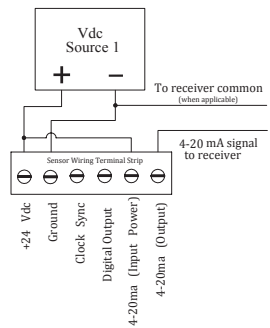
4-20 mA Output (IRU-xxx3, excluding IRU-2003)

3-Conductor Cable
Red...................... +24 Vdc
Black .... Ground
White .... 4-20 mA Output

4-20 mA with 2 NPN Trip Outputs (IRU-xxx5)

5-Conductor Cable
Red...................... +24 Vdc
Black .... Ground
Orange .... 4-20 mA Output
White .... NPN 1
Green .... NPN 2

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4-20 mA with 2 NPN Trip Outputs
(continued)

6-Conductor Cable
Red......................+24 Vdc
Black ....Vdc Ground
Orange ....4-20 mA Output
Blue ....NPN Output 1
White ....NPN Output 2
Green..................Clock Sync.

Mirco-Connector (IRU-xxx5-M)
1 Brown ....+24 Vdc
2 White ....NPN Output 1
3 Blue ....Vdc Ground
4 Black ....4-20 mA Output
5 Grey ....NPN Output 2
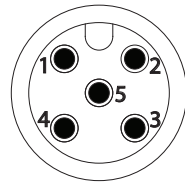
0-2.5/5Vdc Output (IRU-xxx9)

5-Conductor Cable
Red......................+24 Vdc
Black ....Ground
White ....0-2.5/5 Vdc Output
Green ....Analog Ground
Orange ....Excitation

Mirco-Connector (IRU-xxx9-M)
1 Brown ....+24 Vdc
2 White ....Vdc Output
3 Blue ....Ground
4 Black ....Analog Ground
5 Grey ....Excitation

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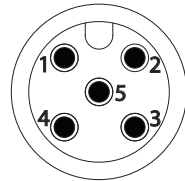
0-2.5/5Vdc Output **with Serial Communication** (IRU-xxx9S)

8-Conductor Cable
Red......................+24 Vdc
Black ....Ground
Orange ....Excitation
White ....0-2.5/5 Vdc Output
Green ....Analog Ground
Brown ....RS-232 Ground
Yellow ....RS-232 TX
Blue ....RS-232 RX

Mirco-Connector (IRU-xxx9S-M)
1 White ....0-2.5/5 Vdc Output
2 Brown ....+24 Vdc
3 Green ....Analog Ground
4 Yellow ....RS-232 TX
5 Grey ....RS-232 Ground
3 Pink ....RS-232 RX
4 Blue ....Ground
5 Red...................Excitation

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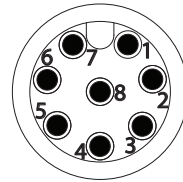
• RST Module Communication and Wiring

The IRU series sensors are fully programmable using an RST programming module (excluding the IRU-6429S and IRU-9429S), which acts as an interface between the sensor and a personal computer.

APG offers two version of the RST module:

RST-3001 (USB interface) & RST-2001A (9-pin serial interface)

The RST module is connected in series between the sensor and it's power source using the two 2-pin Phoenix connectors on the module. 15-28 Vdc from the power source is connected to one 2-pin connector, while the Vdc + and Vdc - of the sensor is connected to the module through the second 2-pin connector (as shown below). When power is applied, the red LED between the Phoenix connectors on the RST should illuminate and the sensor should start audibly "ticking". The operating parameters of the sensor can then be adjusted using the included Windows based utility software.

NOTE: The utility software can be downloaded at: www.apgsensors.com/accessories/rst-3001.html

Sensor -24 Vdc

Sensor +24 Vdc

RST-3001

To Computer USB Port

24 Vdc Power Supply

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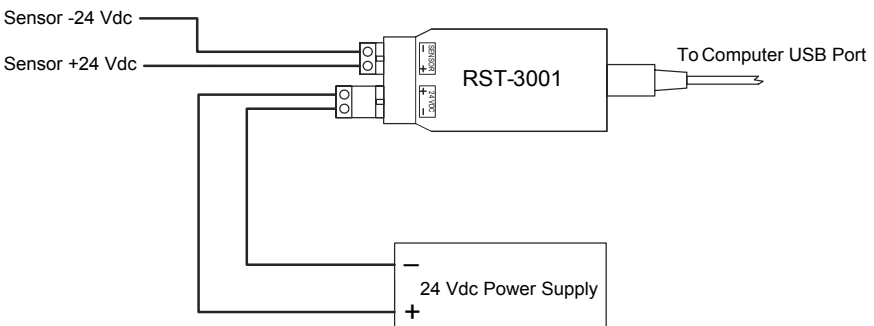
• Serial Communication (IRU-6429S and IRU-9429S only)

Sensors with the built-in RS-232 communications will communicate at 9600 baud, 8 bit with 1 stop bit and no parity. The sensor will accept an ASCII command, and return distance and temperature values in ASCII. When the sensor receives the SEND command (all capital letters), the sensor will transmit the distance in feet followed by a comma and then the temperature in degrees Celsius, followed by a carriage return and line feed. The distance will be five characters (e.g. 05.25) and the temperature will have a + or - followed by one or two characters (e.g. +22).

NOTE: In applications where the sensor is powered down between readings, each time the sensor is powered, the sensor must be given enough time to initialize and process the readings through the filtering parameters (averaging, out of range samples, window, and sample rate) before the sensor can be polled with a SEND command. This can take anywhere from 3 to 30+ seconds, depending on the settings in the filtering parameters.

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• Utility Software Installation

The Windows based utility software, used for adjusting sensor settings, is supplied on a mini CD. The installation program should auto-run when the mini CD is inserted into a CD or DVD ROM drive. The installation process will prompt you as needed to complete the installation. If the installation program does not auto-run when the CD in inserted, the "Setup.exe" program can be executed from the Windows "Start" menu "Run" option by entering the file location and file name, or by locating and double clicking on the file using Windows Explorer.

Troubleshooting Sensor Communications

- The communications status is displayed in the lower right hand side of the screen, indicated as either "ERROR No Communication", or "Communication OK". If an error is indicated, click on the "Communications" button to change the communication port to match the RST's connection to the computer (Com Port 1, Com Port 2 or USB).
- If communication is not established, check the RST wiring and the cable connection to the computer. **A minimum of 15 volts must be supplied in order to establish communications.**
- If you are using the RST-2001A serial interface module, and communication cannot be established, then you may have a computer communications port conflict. If device drivers have been loaded on your computer for another device that uses the serial com port, then the drivers must be removed or disabled before another device (such as the RST unit) will be able to communicate through the port.

The parameter windows in the utility software should automatically be populated with the current sensor settings once communications is established. The "Receive" will also load the sensor setting into the utility program. Sensor settings are changed by clicking on the appropriate window(s), entering the desired value(s), and then click the "Send" button. The "Reset" button will load the factory settings into the sensor. The "File" button is used to save or recall the full list of sensor settings to or from the computer. The program is closed by clicking on the "Exit" button.

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• Using the Utility Software

There are five windows that indicate real time sensor status:

- •Distance
- •Analog Output (when applicable)
- •Temperature
- •Communication Status
- •Signal Strength (Gain Control setting 1 only)

The "distance" reading indicates the distance from the sensor face to the target being detected. "Analog Output" status indicates the calculated value of the analog output signal based on the target distance and the analog settings. The "Signal Strength" window indicates how well the sensor is detecting the target when operating in AutoSense mode (Gain Control setting 1). The signal strength scales from 0 to 7. A value of 0 indicates a strong target signal, while a value of 7 indicates the sensor is not able to detect a target. "AutoSense Disabled" indicates the sensor is in manual mode (Gain Control settings of 0, 2, or 3).

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• Programming Sensor Parameters

The IRU series have the flexibility to be programmed for use in a wide range of applications. Each of the programmable parameters is describe below.

Units: Determines the unit of measure to be used in the utility software. Options: 1 = Feet,   2 = Inches, 3 = Millimeters

Blanking: Sets the distance, beginning at the sensor face, to the point where the sensor will begin looking for target signals. All targets closer than the blanking distance will be ignored. <u>The blanking should never be set to less than the minimum range specification of the sensor</u>. Doing so may cause the sensor to detect the transducer vibrations created during the transmit process, which will cause the sensor to "lock up" at the blanking distance.

Setting the blanking to less than the minimum range specification is not recommended, although it is sometimes helpful to set the blanking to a greater value. For example, when mounting in a stand-pipe it is recommended that the blanking be set to a distance so that it extends beyond the bottom of the pipe. This helps prevent unwanted signals, which may be generated in the confined space of a pipe, from being detected. <u>Be aware that if the desired target moves into the blanking distance, errors in measurement will occur</u>.

Sensitivity: Controls the level of amplification, or gain, that is applied to a returning signal from the target. The sensitivity setting is expressed as a percentage; 0 to 100%. When possible, it is good practice to keep the sensitivity as low as possible while still allowing the target to be reliably tracked. Keeping the sensitivity low reduces the chances of picking up undesired target echoes and can also help reduce any interference caused by electrical or acoustical noise. Lowering the sensitivity also has the effect of narrowing the detection area, or beam spread, of the sensor. Because sound waves travel better through cooler air than through warmer air, if the sensor is setup when the temperature is cool, and the temperature is expected to increase, the sensitivity setting should be increased an additional 10 to 20% to accommodate future warmer temperatures.

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Sensitivity/Trip Point Control (IRU-2002 and 2003 only): Used to select between potentiometer and software control of the sensitivity setting and *relay trip point distance (*IRU-2002 only).
Options: 0 = Potentiometer Control, 1 = Software Control

Pulses: Controls the number of sound wave pulses being sent in each ultrasonic burst. The greater the number of pulses, the stronger the transmitted signal. The pulses should be set to between 15 and 20 for most open air applications. In small enclosed areas, such as in a stilling pipe, the number of pulses may need to be reduced in order to eliminate multiple echoes caused by too much sound energy being introduced into a confined space. Shorter range targets and targets with good reflective characteristics require fewer pulses than longer range or poorly reflective targets.
If the pulses parameter is set to 0, the sensor will not transmit. This can be a useful tool for troubleshooting. If the sensor is not transmitting (pulses = 0), the distance reading should display the value set in the Max Distance parameter (see page 24). An unstable distance reading that jumps around and does not hold at maximum distance is a good indication the sensor is being affected by electrical noise.

Gain Control: Determines the method in which gain is applied to target signals. The options are as follows:

0 = Manual: Uses a standard set gain scheme for general purpose use.
1 = Autosense: Uses a self-adjusting gain scheme. The sensor will continually adjust the gain based on the strength of echo from the target. When AutoSense is activated, the maximum attainable gain will be limited by the Sensitivity and Pulses parameter settings. AutoSense requires more time for signal processing and is therefore not recommended for fast moving targets.
 2 = Hard-Target: Uses a slowly ramping gain scheme to provide better optimization throughout the range on targets with good reflective characteristics.
 3 = Soft-Target: Uses a fast ramping gain scheme for better tracking of targets with poor reflective characteristics.

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Average: Defines the number of target samples (readings) that will be averaged together to become the distance reading. Each qualified sample (see Window and Out of Range Samples below) is placed into a first-in, first-out (FIFO) buffer and averaged with previous samples to generate a steady output. The higher the number of samples averaged, the greater the smoothing effect of the readings. A higher Average setting will result in slower response to rapid changes in the target distance.

Window: Sets the radius of the target acceptance window. The target acceptance window is a zone extending along the sensing plane in both directions starting from the target distance. The Window parameter determines the length that the window extends in each direction. For example, if the sensor is detecting a target at 5 ft. and the Window is set at 1 ft., then any target detected between 4 ft. and 6 ft. will be accepted. Any target detected within the Window will be considered legitimate and figured into the averaging buffer. Any target detected outside of the Window will considered "out of range" and will be ignored based on the setting in the Out of Range Samples parameter (see below).

Out of Range Samples: Determines the number of consecutive target samples that occur outside of the acceptance window before the "out of range" target is recognized as a legitimate target. Suppose the Out Of Range Samples is set to 10. If a target is suddenly detected outside of the acceptance window, it will be ignored until it has been detected for 10 consecutive samples, at which point it will be qualified as a legitimate target. If the "out of range" target was detected for only 9 consecutive samples before moving out of the sensing area, it would never be acknowledged as a target and the reading would stay with the last qualified target sample. The combination of the Window and Out of Range Samples parameters allow the sensors to be used in applications where undesired targets, such as agitator blades, intermittently enter the sensing area. These filter parameters are also helpful for qualifying legitimate targets while ignoring errant echoes that might occur in the application.

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Sample Rate: Sets how many times per second the sensor takes a reading. The Sample Rate is expressed in Hertz. Options allow rates from 1 to 50 Hz. The maximum Sample Rate setting is determined by the Max Distance setting. The greater the Maximum Distance setting, the slower the maximum allowable Sample Rate setting. A higher Sample Rate will achieve a more rapid response to target movements but can also decrease the stability of the measurement. Lowering the Sample Rate will help increase sensor life and decrease the chance of detecting errant echoes. It is highly recommended that the Sample Rate be set only as high as is necessary for the application. A sample rate of 1-2 Hz is usually appropriate for slow moving level sensing applications.

Multiplier: Used to true the sensor's distance reading with the actual physical measurement to the target. Since the speed of sound is not constant through all environments and temperatures, the multiplier parameter allows the user to adjust for these variations in atmosphere. To determine the appropriate multiplier setting, measure from the face of the sensor to the intended target. Then divide the measured distance by the distance reading of the sensor, and enter the resulting value in the Multiplier setting. For example, if the target is measured at 2.5 ft. from the sensors face, and the software distance reading is 2.61 ft. The multiplier setting would be 2.5 / 2.61, which = 0.9579

Offset: Used to adjust the zero reference point of the sensor. When the Offset is set to 0, the zero reference of the sensor is at the face of the transducer. Setting the Offset to a negative number will move the zero reference backward (behind the sensor face), while a positive setting will move the reference forward (in front of the sensor face).

Temp_Comp: Used to enable or disable the internal temperature compensation of the sensor. The speed of sound through air changes about 0.18% for every 1 ^{0}C of temperature change. Enabling the internal temperature compensation can reduce the effects of temperature changes by 50% or more, depending on the temperature gradient through the sensing range.

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NOTE: If the internal temperature compensation is enabled and the sensor is exposed to direct sun light, the radiant heat can warm the sensor housing above the ambient temperature, which can affect the internal temperature sensor and cause overcompensation.

Maximum Distance: Sets the maximum distance, beginning from the sensor face, to the point where the sensor will stop looking for target signals. Target signals detected beyond the Maximum Distance value will be ignored by the sensor. The software distance reading will display the Maximum Distance value under loss of echo conditions (no targets detected).

View Noise Level (view only): Displays the number of echoes being detected by the sensor. Noise levels in excess of 30 are usually an indication of the presence of a noise source, which may interfere with the sensor operation. Reducing the sensitivity may help reduce the detected noise level.

Set Noise Threshold: Sets the threshold level for the noise filter. If the noise level exceeds this threshold, the sensor will maintain the last reading before the noise threshold was reached. The reading will be maintained until the noise level drops below the threshold. Sources of noise are most often from electric sources but can also be from acoustical sources, such as the release of high pressure air near the sensor face.

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• Using External Temperature Compensation

A correction factor for changes in temperature can be applied to the sensor readings using an external temperature probe in conjunction with a PLC. Applying a correction formula to the sensor output may achieve better results than using the internal temperature compensation in some applications.

The formula for the change in the speed of sound is:

$$((T1 - T2 + 273)/273)^{0.5}$$

T1 = present temperature in °C
T2 = temperature when sensor was calibrated.

There are two approaches for using the correction formula. One uses the factory calibration with the sensor's multiplier set to 1.00. The factory calibration is based on a temperature of 25°C. Therefore, T2 will equal 25. The second approach is to calibrate the sensor as outlined in the multiplier section then apply the temperature correction. In this case, T2 becomes the temperature at the time of calibration.

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• Analog Scaling

To scale the analog output, simply enter the desired distance, beginning at the sensor face, to each of the two end points of the analog signal using the 4 mA/0 V Set Point and 20 mA/2.5/5 V Set Point parameters. The analog output will be scaled between the two distance values entered in these settings. The output can be scaled in either direction; signal rising or falling as the distance increases (see diagram below). If the detected target is outside the scaled range, the sensor will output either full scale or minimum scale depending on which end of the analog scale the target resides.
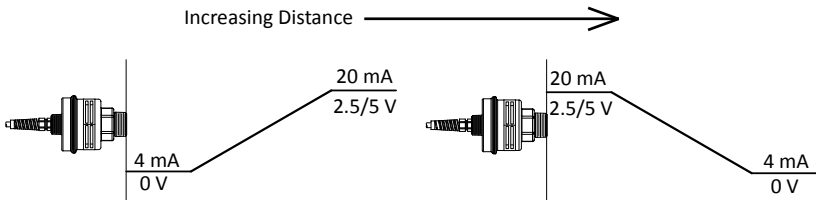
• Analog Calibration (No adjustments required in most applications)

Calibration of the analog signal is accomplished using the 4 mA Calibration and 20 mA Calibration or the 2.5/5 Volt Calibration parameters. To calibrate the output, the sensor must be outputting the analog endpoint value that you wish to calibrate (i.e, full scale or minimum scale). Increasing or decreasing the value in the calibration parameter will increase or decrease the corresponding output signal value. For example, decreasing the 20 mA Calibration value will decrease the 20 mA signal output value. These parameters are factory set and normally should not require adjustment. The default values (shown below) will bring the output to within a few mirco-amps or micro-volts of an exact analog signal value.

4 mA Calibrate = 8200
20 mA Calibrate = 41000
2.5 Volt or 5 Volt Calibrate = 4095

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• Programming Relay and NPN Trip Outputs

Relay or NPN trip outputs can be programmed to operate using one of six control logic functions, providing a high degree of flexibility for process monitoring and control. Each control logic function, or "trip type", is described in the Trip Type section below.

Trip Distance: Sets the distance to the trip position nearest the sensor face.

Trip Window: Sets the distance, beginning from the trip distance, to the farthest trip position.

Trip Type: Determines the control logic of the relay or NPN output (see chart on next page for more information).

Type 0 or "Near" activates the output whenever the target is closer than the trip distance (trip window is not used with type 0).

Type 1 or "Exclusive" activates the output whenever the target is closer than the trip distance OR farther than the trip distance + trip window.

Type 2 or "Hysteresis Near" activates the output whenever the target moves closer than the trip distance. Once active, the output will remain active until the target moves beyond the trip distance + trip window, at which point the output deactivates. Once deactivated, the output will remain deactivated until the target once again moves closer than the trip distance.

Type 3 or "Far" activates the output whenever the target moves beyond the trip distance (trip window is not used with type 3).

Type 4 or "Inclusive" activates the output whenever the target is further than the trip distance and closer than the trip distance + trip window.

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Type 5 or "Hysteresis Far" activates the output whenever the target moves beyond the trip distance + trip window. Once active, the output will remain active until the target moves closer than the trip distance, at which point the output deactivates. Once deactivated, the output will remain deactivated until the target once again moves beyond the trip distance + trip window.
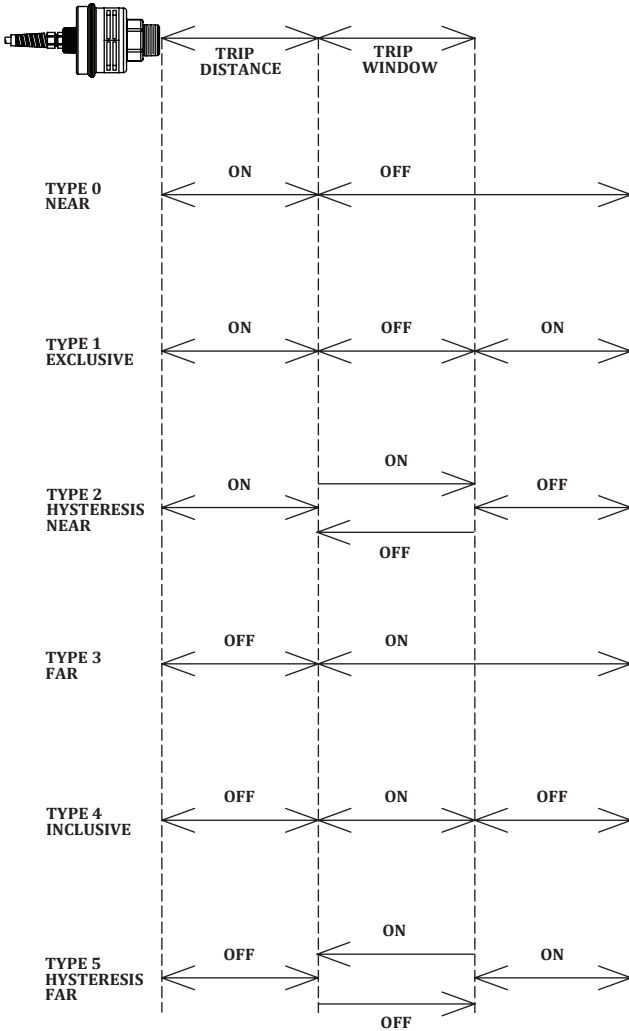
- **IRU 2000 Series Specifications**

Detection Range: 1 to 25 ft. (0.3 to 7.62 m)
Available Outputs:
   4-20 mA
   4-20 mA + (2) NPN Trip Points (300 mA max.)
   RS-485 + (1) NPN Trip Point (300 mA max.)
   Solid State Relay (130 mA max., 120 V AC or DC)
Operating Voltage: 12-28 Vdc
Programming Voltage: 15-28 Vdc
Operational Current Draw (without communications): 70 mA @ 24 Vdc
Maximum Power Rating: 2.5 W
Housing:
   IRU-2000 Series: ABS
   IRU-2100 Series: PVC
   IRU-2400 Series: Polycarbonate/PET blend
Mounting:
   IRU-2000 Series: Surface Mount (4 bolt)
   IRU-2100 Series: 2 in. or 3 in. NPT (front), 1 in. NPT (rear)
   IRU-2400 Series: 2 in. NPT (front)**,** 3/4 in. NPT (rear)
Transducer Type: ABS (2000 series), PVC (2100 series) or PVDF (2400 series)
faced ceramic
Ingress Rating: IP65
Hazardous Location Approvals (CSA C/US):
   General Purpose (all models)
   Class I, Div. 2, Groups C & D, T6; Ex nA IIB T6, IP65; Class I Zone 2;
   AEx nA IIB, T6 (models IRU-2125, IRU-2423, IRU-2425 only)
Sample Rate: 1 to 22 Hz (programmable)
Response Time: Programmable (45 ms minimum)
Resolution: 0.1 in. (2.5 mm)
Accuracy: +/- 0.25% of detected range (with no temperature gradient)
Sensor Adjustments: USB (requires RST-3001)
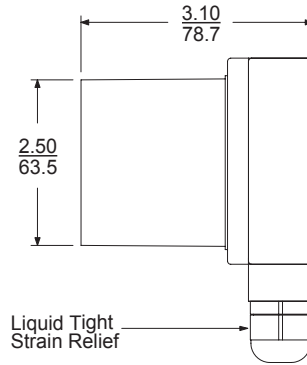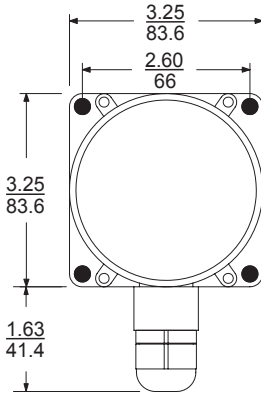**Operating Temperature:** -40 to 140 ^{0}F (-40 to 60 ^{0}C)
Beam Pattern: 9^{0} off-axis (at maximum pulses and sensitivity settings)
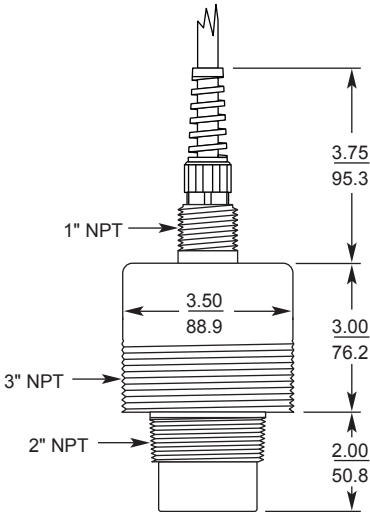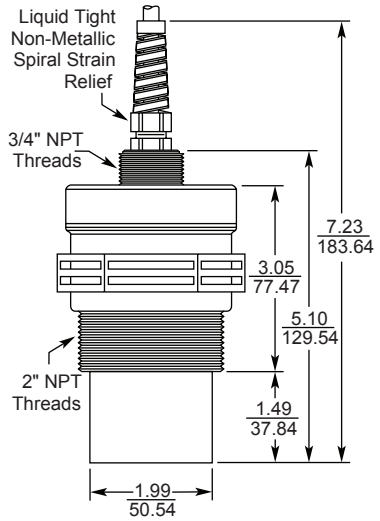**Electrical Connection:** Pigtail or micro-connector
Frequency: 69 kHz

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IRU-2000 Series Dimensions -- in./mm

IRU-200x

3.25 / 83.6
2.60 / 66
3.25 / 83.6
1.63 / 41.4

3.10 / 78.7
2.50 / 63.5

Liquid Tight
Strain Relief

IRU-21xx

3.75 / 95.3
1" NPT
3.50 / 88.9
3" NPT
3.00 / 76.2
2" NPT
2.00 / 50.8

IRU-24xx

Liquid Tight
Non-Metallic
Spiral Strain
Relief

3/4" NPT
Threads

7.23 / 183.64
3.05 / 77.47
5.10 / 129.54
2" NPT
Threads
1.49 / 37.84
1.99 / 50.54

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• IRU 3000 Series Specifications

Detection Range: 1.50 to 50 ft. (0.46 to 15.24 m)
Available Outputs:
    4-20 mA
    4-20 mA + (2) NPN Trip Points (300 mA max.)
Operating Voltage: 12-28 Vdc
Programming Voltage: 15-28 Vdc
Operational Current Draw (without communications): 70 mA @ 24 Vdc
Maximum Power Rating: 2.5 W
Housing:
    IRU-3100 Series: PVC
    IRU-3400 Series: Polycarbonate/PET blend
Mounting:
    IRU-3100 Series: 3 in. NPT (front), 1 in. NPT (rear)
    IRU-3400 Series: 3 in. NPT (front)**,** 3/4 in. NPT (rear)
Transducer Type: PVDF (3400 series) or PVC (3100 series) faced ceramic
Ingress Rating: IP65
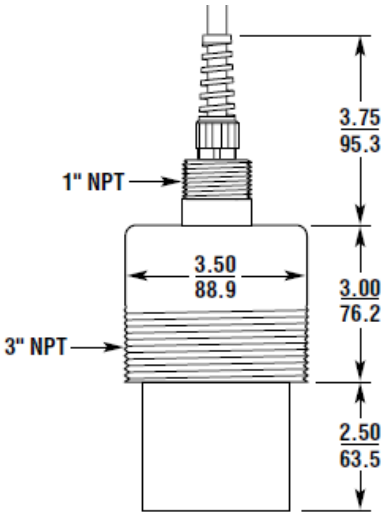**Hazardous Location Approvals (CSA C/US):**
    General Purpose (all models)
    Class I, Div. 2, Groups C & D, T6; Ex nA IIB T6, IP65; Class I Zone 2;
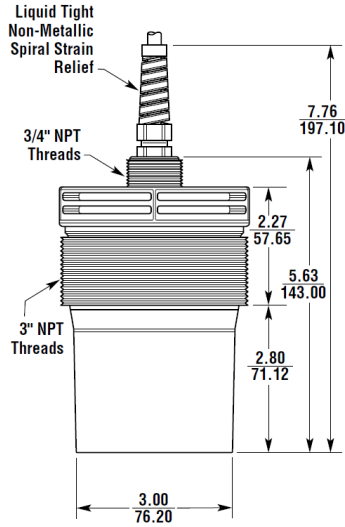   AEx nA IIB, T6 (models IRU-3135, IRU-3433, IRU-3435 only)
Sample Rate: 1 to 22 Hz (programmable)
Response Time: Programmable (45 ms minimum)
Resolution: 0.1 in. (2.5 mm)
Accuracy: +/- 0.25% of detected range (with no temperature gradient)
Sensor Adjustments: USB (requires RST-3001)
Operating Temperature: -40 to 140 ^{0}F (-40 to 60 ^{0}C)
Beam Pattern: 9^0 off-axis (at maximum pulses and sensitivity settings)
Electrical Connection: Pigtail or micro-connector
Frequency: 43 kHz

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IRU-3000 Series Dimensions -- in./mm

IRU-31xx

1" NPT

3.75
95.3

3.50
88.9

3.00
76.2

3" NPT

2.50
63.5

IRU-34xx

Liquid Tight
Non-Metallic
Spiral Strain
Relief

3/4" NPT
Threads

7.76
197.10

2.27
57.65

5.63
143.00

3" NPT
Threads

2.80
71.12

3.00
76.20

• IRU-5000 Series Specifications

Detection Range: 4 to 79 in. (102 to 2700 mm)
Available Outputs:
   4-20 mA
   4-20 mA + (2) NPN Trip Points (300 mA max.)
   0-2.5 Vdc or 0-5 Vdc (software selectable)
Operating Voltage: 12-28 Vdc
Programming Voltage: 15-28 Vdc
Operational Current Draw (without communications): 60 mA @ 24 Vdc
Maximum Power Rating: 2.5 W
Housing: Polycarbonate/PET blend
Mounting:
   IRU-5410 Series: 1 in. NPT (front), 3/4 in. NPT (rear)
   IRU-5420 Series: 2 in. NPT (front), 3/4 in. NPT (rear)
   IRU-5320 Series: 2 in. Tri-Clamp
Transducer Type: PVDF faced ceramic
Ingress Rating: IP65
Hazardous Location Approvals (CSA C/US):
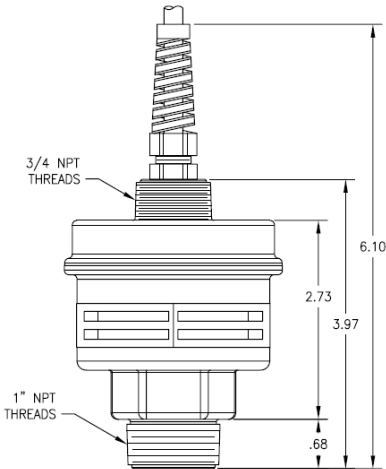   General Purpose (all models)
   Class I, Div. 2, Groups C & D, T6; Ex nA IIB T6, IP65; Class I Zone 2;
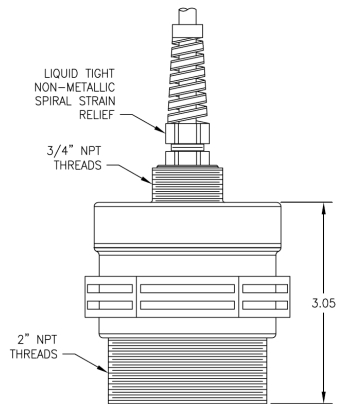   AEx nA IIB, T6 (models IRU-5413, IRU-5415, IRU-5423, IRU-5425 only)
Sample Rate: 1 to 50 Hz (programmable)
Response Time: Programmable (20 ms minimum)
Resolution: 0.1 in. (2.5 mm)
Accuracy: +/- 0.25% of detected range (with no temperature gradient)
Sensor Adjustments: USB (requires RST-3001)
Operating Temperature: -40 to 140 ^{0}F (-40 to 60 ^{0}C)
Beam Pattern: 9^0 off-axis (at maximum pulses and sensitivity settings)
Electrical Connection: Pigtail or micro-connector
Frequency: 143 kHz

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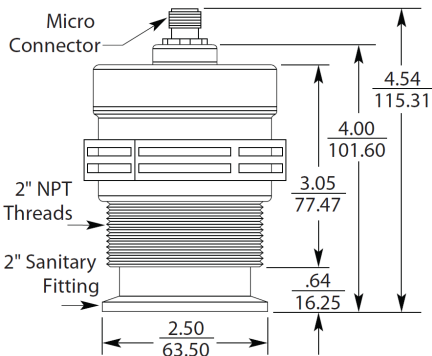*APG...Providing tailored solutions for measurement applications*
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IRU-5000 Series Dimensions -- in./mm

IRU-541x

3/4 NPT
THREADS

6.10

2.73

3.97

1" NPT
THREADS

.68

IRU-542x

LIQUID TIGHT
NON−METALLIC
SPIRAL STRAIN
RELIEF

3/4" NPT
THREADS

3.05

2" NPT
THREADS

IRU-532x

Micro
Connector

$\dfrac{4.54}{115.31}$

$\dfrac{4.00}{101.60}$

$\dfrac{3.05}{77.47}$

2" NPT
Threads

2" Sanitary
Fitting

$\dfrac{.64}{16.25}$

$\dfrac{2.50}{63.50}$

• IRU-6429 Specifications

Detection Range: 1 to 30 ft. (0.3 to 9.1 m)

Outputs: 0-2.5 Vdc or 0-5 Vdc (software selectable)

Operating Voltage: 12-28 Vdc

Programming Voltage: 15-28 Vdc (RST), 12-28 Vdc (RS-232)

Operational Current Draw (without communications): 70 mA @ 24 Vdc

Maximum Power Rating: 2.5 W

Housing: Polycarbonate/PET blend

Mounting: 2 in. NPT (front)**,** 3/4 in. NPT (rear)

Transducer Type: PVDF faced ceramic

Ingress Rating: IP65

Approvals: CSA C/US General Purpose

Sample Rate: 1 to 15 Hz (programmable)

Response Time: Programmable (67 ms minimum)

Resolution: 0.1 in. (2.5 mm)

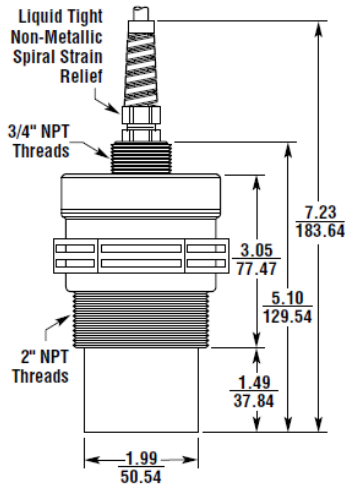**Accuracy:** +/- 0.25% of detected range (with no temperature gradient)

Sensor Adjustments: USB (requires RST-3001) or RS-232 (IRU-6429S only)

Operating Temperature: -40 to 140 ^{0}F (-40 to 60 ^{0}C)

Beam Pattern: 9^0 off-axis (at maximum pulses and sensitivity settings)

Electrical Connection: Pigtail or micro-connector

Frequency: 69 kHz

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• **IRU-9400 Series Specifications**

Detection Range: 0.5 to 35 ft. (0.15 to 10.67 m)
Outputs:
   4-20 mA
   4-20 mA + (2) NPN Trip Points (300 mA max.)
   0-2.5 Vdc or 0-5 Vdc (software selectable)
Operating Voltage: 12-28 Vdc
Programming Voltage: 15-28 Vdc (RST), 12-28 Vdc (RS-232)
Operational Current Draw (without communications): 60 mA @ 24 Vdc
Maximum Power Rating: 2.5 W
Housing: Polycarbonate/PET blend
Mounting: 2 in. NPT (front)**,** 3/4 in. NPT (rear)
Transducer Type: Electrostatic
Ingress Rating: NEMA 12
Approvals: CSA C/US General Purpose
Sample Rate: 1 to 22 Hz (programmable)
Response Time: Programmable (45 ms minimum)
Resolution: 0.1 in. (2.5 mm)
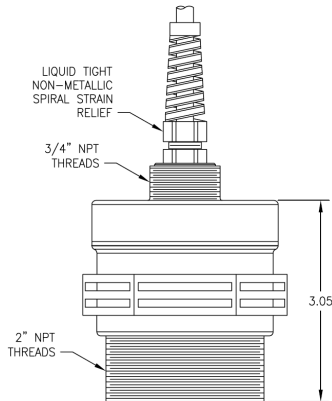**Accuracy:** +/- 0.25% of detected range (with no temperature gradient)
Sensor Adjustments: USB (requires RST-3001) or RS-232 (IRU-9429S only)
Operating Temperature: -40 to 140 ^{0}F (-40 to 60 ^{0}C)
Beam Pattern: 9^0 off-axis (at maximum pulses and sensitivity settings)
Electrical Connection: Pigtail or micro-connector
Frequency: 50 kHz

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Certificate of Compliance

Certificate:	1384697	**Master Contract:**	237484
Project:	2166699	**Date Issued:**	2010/02/19
Issued to:	**Automation Products Group Inc**		

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Authorized   Gary Boswell, P.Eng., Product
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PRODUCTS
CLASS 2252 03   - PROCESS CONTROL EQUIPMENT
CLASS 2252 83   - PROCESS CONTROL EQUIPMENT - Certified to US Standards
CLASS 2258 02   - PROCESS CONTROL EQUIPMENT - For Hazardous Locations
CLASS 2258 82   - PROCESS CONTROL EQUIPMENT - For Hazardous Locations -
                          Certified to US Standards

CLASS 2252 03 – PROCESS CONTROL EQUIPMENT

DQD 507 Rev. 2009-09-01

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Certificate:	1384697	**Master Contract:**	237484
Project:	2166699	**Date Issued:**	2010/02/19

CLASS 2252 83 – PROCESS CONTROL EQUIPMENT – To U.S. Requirements

IRU Series Ultrasonic Sensors, Models IRU-2002**, IRU-2003**, IRU-2005**, IRU-2122, IRU-2123, IRU-2125, IRU-2423, IRU-2425, IRU-3133, IRU-3135, IRU-3433, IRU-3435, IRU-5113, IRU-5115, IRU-5119, IRU-5413, IRU-5415, IRU-5423, IRU-5425, IRU-5429, IRU-6429, IRU-9423, IRU-9425 and IRU-9429 input Rated 12 to 28Vdc, 80mA max; Outputs 4-20mA, solid state relay, NPN; Ambient temperature range -30°C to +60°C.

** designates the color of the housings BK = black, RD = red, default = blue

DST Series Ultrasonic Sensor Models DST-2421, DST-3431, DST-5111 and DST-9421 input Rated 12 to 28Vdc, 60mA max; Ambient temperature range -30°C to +60°C.

NOTE: The above models are Pollution Degree 2, Installation Category II.

CLASS 2258 02 – PROCESS CONTROL EQUIPMENT – For Hazardous Locations

CLASS 2258 82 – PROCESS CONTROL EQUIPMENT – For Hazardous Locations – To U.S. Requirements

Class I, Division 2, Groups C and D, T6; Ex nA IIB T6 (Canada), IP65; Class I, Zone 2; AEx nA IIB, T6 (USA), IP65:

IRU Series Ultrasonic Sensors, Models IRU-2125, IRU-3135, IRU-2423, IRU-2425, IRU-3433, IRU-3435, IRU-5413, IRU-5415, IRU-5423 and IRU-5425; input Rated 12 to 28Vdc, 80mA max; Outputs 4-20mA, NPN; Ambient temperature range −30°C to +60°C.

NOTE: The above models are Pollution Degree 2, Installation Category II.

APPLICABLE REQUIREMENTS

C22.2 No 0 - M1991 - General Requirements - Canadian Electrical Code Part II.

C22.2 No 0.4 - M1982 - Bonding and Grounding of Electrical Equipment (Protective Grounding).

C22.2 No 213 - M1987 - Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations.

CAN/CSA-C22.2 No. 1010.1-92 - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements (Includes Amendment 1)

CAN/CSA-C22.2 No. 1010.1B 97 - Amendment 2 to CAN/CSA C22.2 No. 1010.1 92, "Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements"

T.I.L. No I -29 - Additional Requirements For Process Control Equipment Certified to CSA Standard CAN/CSA C22.2 No 1010.1-92

DQD 507 Rev. 2009-09-01

CSA INTERNATIONAL

Certificate:	1384697	Master Contract:	237484
Project:	2166699	Date Issued:	2010/02/19

ISA S82.01-1994 - Safety Standards for Electrical and Electronic Test, Measuring, Controlling, and Related Equipment - General Requirements

CAN/CSA E60079-0:07 - Electrical apparatus for explosive gas atmospheres - Part 0 - General requirements.

CAN-CSA E60079-15:02 - Electrical Apparatus for Explosive Gas Atmospheres - Part 15-Type of Protection n.

UL 1604, Third Edition - Electrical Equipment for Use in Class I and II, Division 2, And Class III Hazardous (Classified) Locations.

UL 60079-0, 4th Ed. - Electrical Apparatus for Explosive Gas Atmospheres - Part 0 - General Requirements.

UL 60079-15, 1st Ed. - Electrical Apparatus for Explosive Gas Atmospheres - Part 15 - Electrical Apparatus with Type of Protection n.

DQD 507 Rev: 2009-09-01

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CE DECLARATION OF CONFORMANCE
IRU SERIES ULTRASONIC SENSOR

November 4, 2009

Prepared By:

Elden Tolman
Product Development Engineer
Automation Product Group, Inc.
1025 West 1700 North
Logan, UT 84321

Test Specification: EN 61326:2002
Test Method: ICE 61000

Manufacturer:

Automation Products Group, Inc.
1025 West 1700 North
Logan, UT 84321

Test Location:

815 West 1800 North
Logan, UT 84321

22975 NW Evergreen Parkway Suite 400
Hillsboro, Oregon, 97124

1. CERTIFICATION

I HEREBY CERTIFY THAT:

The measurements shown in this test report were made in accordance with the procedures given in European Council Directive 89/336/EEC. The equipment was passed and the test performed according to European Standard EN 61326:2002 using method ICE 61000.

_____   11/12/09

Product Line Manager   Date

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2. SUMMARY OF RESULTS

The IRU Series Ultrasonic sensor has been found to be fully compliant with the following standards and specifications:

Test	Specification	Method	Resulting Performance Criterion
Radiated Emissions	EN 61326 Class A:2002	EN 61326:2002	Pass
ESD Immunity	EN 61326 Annex A	ICE 61000-6-2	Performance Criteria A
Radiated Immunity	EN 61326 Annex A	ICE 61000-4-3	Performance Criteria B
EFT Burst	EN 61326	ICE 61000-4-4	Performance Criteria B
Surge	EN 61326	ICE 61000-4-5	Pass
Conducted Immunity	EN 61326 Annex A	ICE 61000-4-6	Performance Criteria A

3. PERFORMANCE CRITERIA

3.1 Pass:
In the case of Radiated Emissions, no significant readings were observed.

3.2 Performance Criteria A:
The device will continue to operate as intended. No degradation of performance or loss of function is allowed below the performance level specified by the manufacturer, when the device is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation and what the user may reasonably expect from the device if used as intended.

3.3 Performance Criteria B:
The device will continue to operate as intended after the test. No degradation of performance or loss of function is allowed below the performance level specified by the manufacturer, when the device is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation and what the user may reasonably expect from the device if used as intended.

3.4 Performance Criteria C:
Temporary loss of function is allowed, provided the function is self recoverable or can be restored by the operation of controls.

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