Table of Contents

General Information

The Manual

Refer to this manual for proper installation and operation of your IQ Radar 300. The margin tabs denote the sections, and each section presents IQ 300 features. Please read all sections before operating the IQ 300.

Installation: Installing the IQ 300 and the interconnection instructions.

Start-up: Operating the keypad, programming the unit, and reading the display.

Operation: IQ 300 operating instructions.

Applications: Application examples and practical use.

Parameters: Available parameters and a description of function and use. Please read this section and familiarize yourself with the parameters available to you and get your IQ 300 working to its fullest.

Communications: Configure communication settings.

Troubleshooting: Responses to common installation and application problems.

Appendices: An alphabetical cross-reference of the parameters and their numbers, a record sheet for jotting down parameter values, a Temperature De-rating Chart, and a list of approvals and certificates.

IQ Radar 300

The IQ Radar 300 is to be used only in the manner outlined in this manual.

IQ 300 is a versatile process level monitoring instrument using advanced pulse radar techniques. The unit consists of an electronic component coupled to the antenna and process connection.

This device can handle virtually all of your pump control and level monitoring needs, often replacing expensive PLCs and integrating into a SCADA system for a fraction of the cost of competitive systems.

IQ Radar 300 Applications

- liquids, slurries
- process temperatures up to 200°C
- vacuum and pressurized vessels

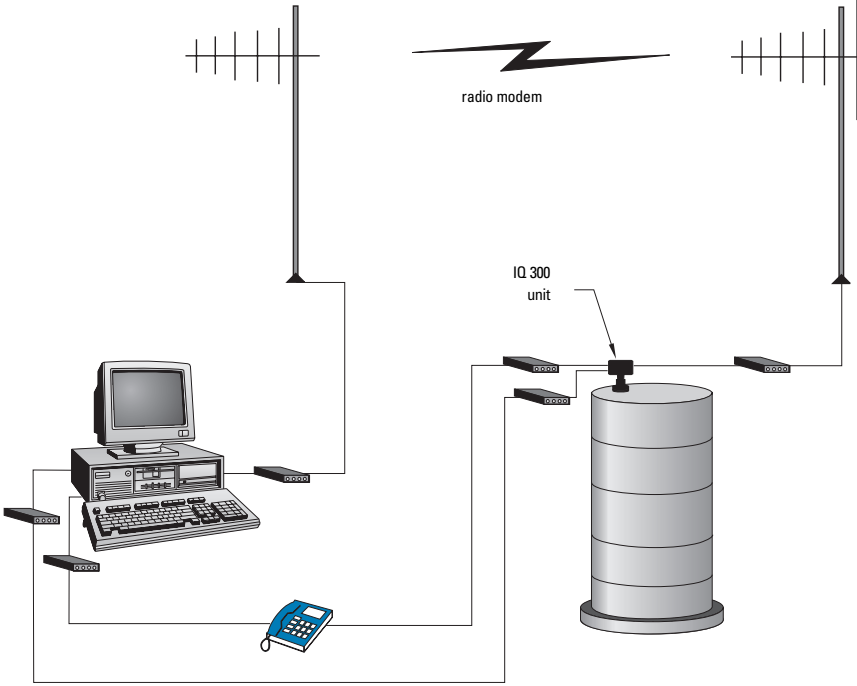
IQ Radar 300 Approvals and Certificates

- safety and radio
- hazardous area

Note: See Specifications on page 11 for an approvals listing and Appendix V on page 107 for approvals documentation.

IQ Radar 300 Communication Systems

The IQ Radar 300 is a level monitoring instrument using advanced pulse radar techniques that communicates component and system status to a Supervisory Control and Data Acquisition (SCADA) system.. [graphic will be revised]



The standard IQ 300 supports Modbus communications on board and Hear and Profibus PA via add-on cards.

Dolphin

Dolphin is a proprietary Milltronics protocol designed to be used with Dolphin Plus. For more information on Dolphin Plus, or to obtain a copy of the software, contact your Milltronics representative.

Modbus

Modbus is an industry standard protocol used by SCADA and HMI systems, and uses the IQ Radar 300's RS-232 ports to communicate. For a description of the Modbus protocol, contact your local Schneider representative.

Optional SmartLinx® Cards

The standard IQ Radar 300 unit may also be enhanced with Milltronics' SmartLinx® communication modules that interface with popular industrial communication systems.

This manual only describes the built-in communications. For more information on SmartLinx, please consult the appropriate SmartLinx manual.

Specifications

Milltronics makes every attempt to ensure the accuracy of these specifications but reserves the right to change them at any time. Contact your Milltronics representative for the most recent specifications.

IQ Radar 300

Power:

- 100/115/200/230 ±15% V ac[1], 50/60 Hz, 15 VA

Fuse:

- FU1, 2AG type, slow blow, .25 A, 250V

Interface:

- analog output: optically-isolated 0/4-20 mA into 750 Ω max, 0.02 mA resolution
- Dolphin/RS-485 link: refer to Dolphin Plus product specification
- programmer link: infrared receiver (refer to Programmer specification on page 13)
- display (local): backlit, alphanumeric, and multi-graphic liquid crystal for readout and entry

Performance:

- frequency: 5.8 GHz (U.S.A. 6.3 GHz)
- accuracy at 20° C: better than ±0.3% of range from 1 to 15m
- temperature drift: <±0.5% of range from –40 to 60° C (-40 to 392° F)
- measuring range: 0.4m to 15m
- repeatability: ± 10mm
- fail-safe: mA programmable high, low or hold upon LOE condition

Mechanical:

Process Connections (Please refer to Appendix IV) for pressure/temperature limitations.)

- flat faced flanges: 316 stainless steel, 2", 3", 4", 50mm, 80mm, 100mm. Bolt hole pattern to ANSI and DIN types.
- threaded connection: 316 stainless steel, 1-1/2" or 2", NPT, BSP
- sanitary connection: 316 stainless steel, 2", 3", or 4" tri-clamp

1 Factory set – see device nameplate.

Antennas:

- dielectric rod: Teflon® [2] (PTFE)
  Ultra-high molecular weight Polyethylene (UHMW-PE3)
  Length 41cm (16.3"), including integral gasket
- horn: 316 stainless steel
  diameters 100mm (4"), 150mm (6"), 200mm (8")
  emitter cone PTFE or UHMW-PE4
  waveguide extensions optional
- waveguide: 316 stainless steel
  emitter cone PTFE or UHMW-PE[4]

Sanitary Antennas (FDA approved materials):

- dielectric rod: one piece UHMW-PE4, optional PTFE
  2", 3", 4" tri-clamp connection
- horn: 304 stainless steel (316 special order)
  horn with integral 4" tri-clamp connection PTFE emitter

Enclosure (electronic):

- construction: aluminum, epoxy coated
- conduit: 2 x 1/2" NPT or PG 16 entry
- ingress protection: Type 6 / NEMA 6, IP-67

Weight:

- 6.5 kg (14.3 lb) with 2"/150 psi flange
- weight will vary with flange size and rating

Environmental:

- location: indoor/outdoor
- altitude: 2000m max
- ambient temperature: -40 to 60° C (-40 to 140° F)[4]
- relative humidity: suitable for outdoor (Type 6/NEMA 6/IP 67 enclosure)
- installation category: II
- pollution degree: 4

Process

- material dielectric: $\varepsilon_r > 1.8$
  For $\varepsilon_r < 3$, you should use a waveguide antenna or stillpipe. (See Mounting: Waveguide Antenna on page 29 or Mounting: Stillpipe or Sidepipe on page 30.)

2 Teflon is a registered trademark of Du Pont.

3 Not available for CENELEC EEx approval.

4 See Temperature De-rating on page 97 and Approvals on page 13.

- temperature: UHMW-PE -40 to 80°C (-40 to 176°F)
  PTFE -40 to 200°C (-40 to 392°F)[5]
- pressure (vessel): dependant on process connection type and temperature. Refer to Appendix IV on page 101 for charts.

Approvals (refer to device nameplate)

- safety: $CSA_{NBTL/C}$, CE, FM
- radio: BAPT, Industry Canada, FCC

Hazardous areas:

- IQ Radar 300: Cenelec/Sira[6], EEx de IIB+H_2T6 (Note: antenna may be used in Zone 0 environments).
  FM (USA) Class I, Div 1, Group A, B, C, D. Class II/III, Div. 1, Group E, F, G(Class I, Zone 1 IIC T6)
  CSA Class I/II, Div. 1, Group B, C, D, E,F, G.CE,
  $CSA_{NRTL/C}$ FM (non-hazardous)

Canadian Registration Number (CRN) for pressure fittings:[7]

- Ontario, British Columbia, Alberta: OF6494.512
- others pending
- 3A Sanitary

Note: Contact Milltronics for complete and up-to-date list of approvals.

Programmer (remote keypad)

- enclosure: general purpose
  67mm w x 100mm h x 25mm d
  (2.6" w x 4" h x 1" d)
- ambient temperature: -20 to 50° C (-5 to 122° F)
- interface: proprietary infrared pulse signal
- power: 9V battery (ANSI/NEDA 1604, PP3 or equivalent)
- weight: 150g (0.3 lb)

5 See Temperature De-rating on page 97 and Approvals on page 13.

6 Approved for PTFE material only

7 All process connections except for the sliding waveguide

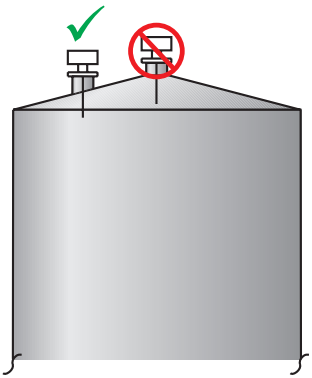
Installation

Location

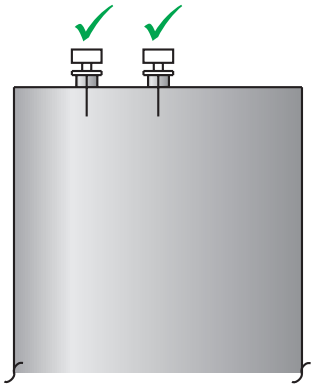
Note:
- Installation shall only be performed by qualified personnel and in accordance with local governing regulations.
- This product is susceptible to electrostatic shock. Follow proper grounding procedures.
- Do not mount in direct sunlight without the use of a sun shield.

Warning: For vessels with conical or parabolic tops, avoid mounting the unit at the centre. Otherwise, the concavity of the top can focus echoes into the centre, giving false readings.

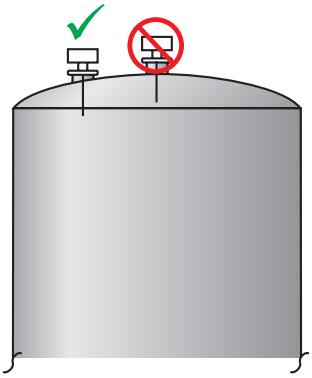
Conical



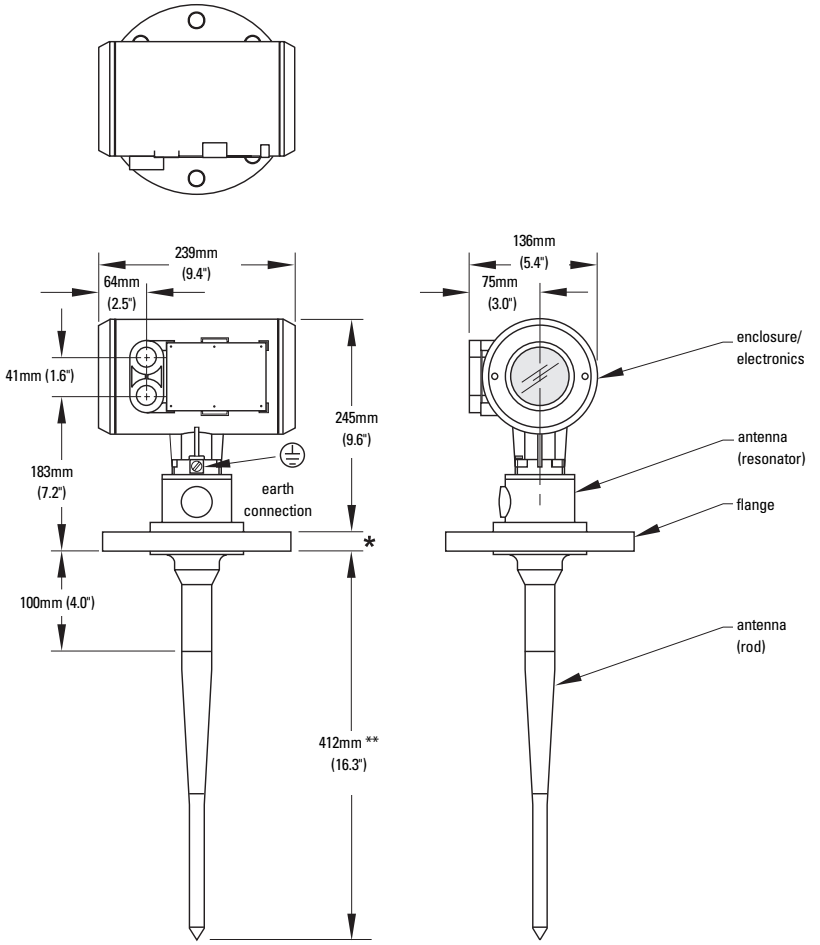
Flat



Parabolic



Dimensions: IQ Radar 300 with Rod Antenna

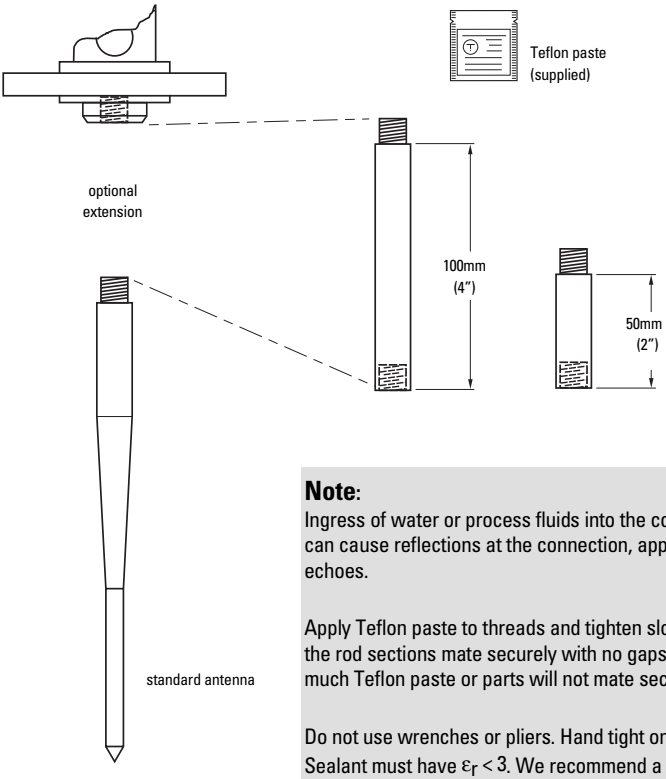


* Flange thickness 25mm (1") nominal.

** Standard length, 50 and 100mm (2" and 4") extensions available.

For information on temperature and pressure ratings, see Appendix IV on page 101.

Dimensions: Threaded Rod

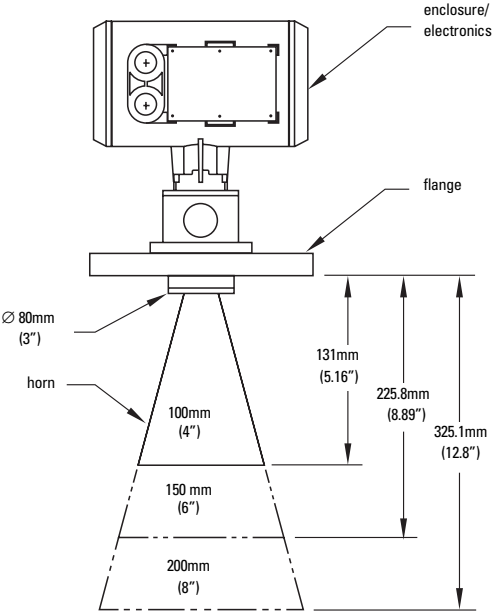


Note:
Ingress of water or process fluids into the connecting threads can cause reflections at the connection, appearing as false echoes.

Apply Teflon paste to threads and tighten slowly. Ensure that the rod sections mate securely with no gaps. Do not apply too much Teflon paste or parts will not mate securely.

Do not use wrenches or pliers. Hand tight only.
Sealant must have $\varepsilon_r < 3$. We recommend a sealant such as Teflon paste or silicone compound.

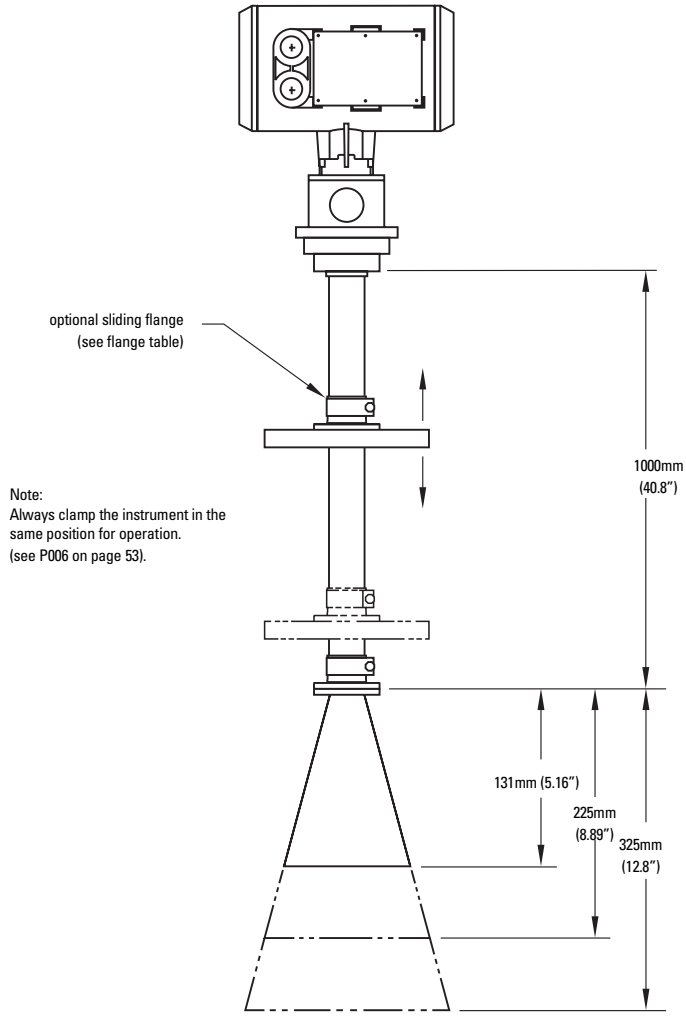
Dimensions: Horn



Nominal Horn Size	Horn O.D.	Horn Height
100mm (4″)	95.3mm (3.75″)	131.0mm (5.16″)
150mm (6″)	146.0mm (5.75″)	225.8mm (8.89″)
200mm (8″)	199.4mm (7.85″)	325.1mm (12.8″)

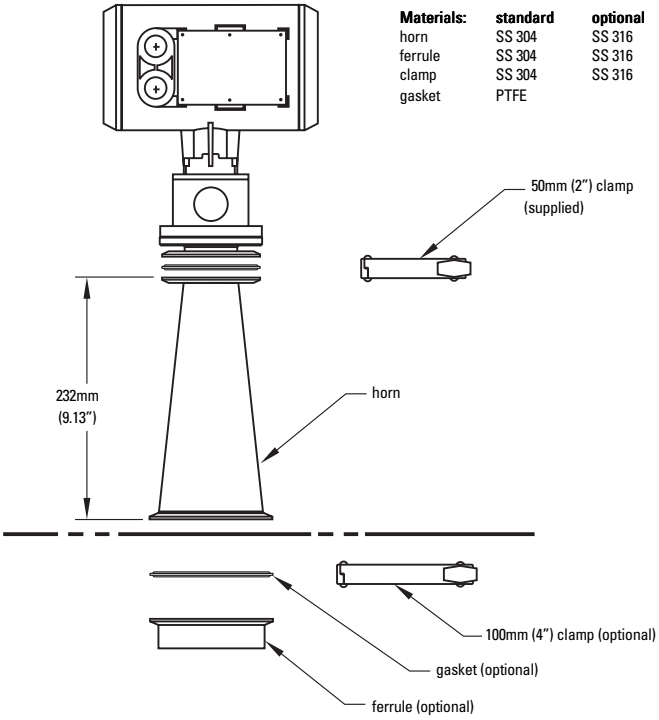
Note: Signal amplitude increases with horn diameter, so use the largest practical size.

Dimensions: Waveguide Extension

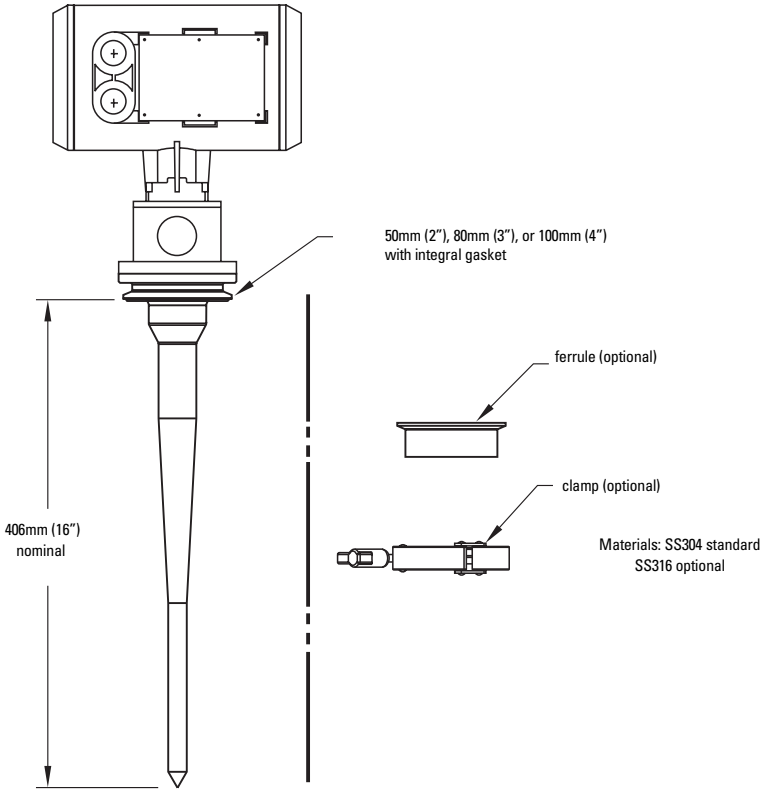


Note: Maximum pressure 0.5 bar at 60° C (140° F) for sliding flange option.

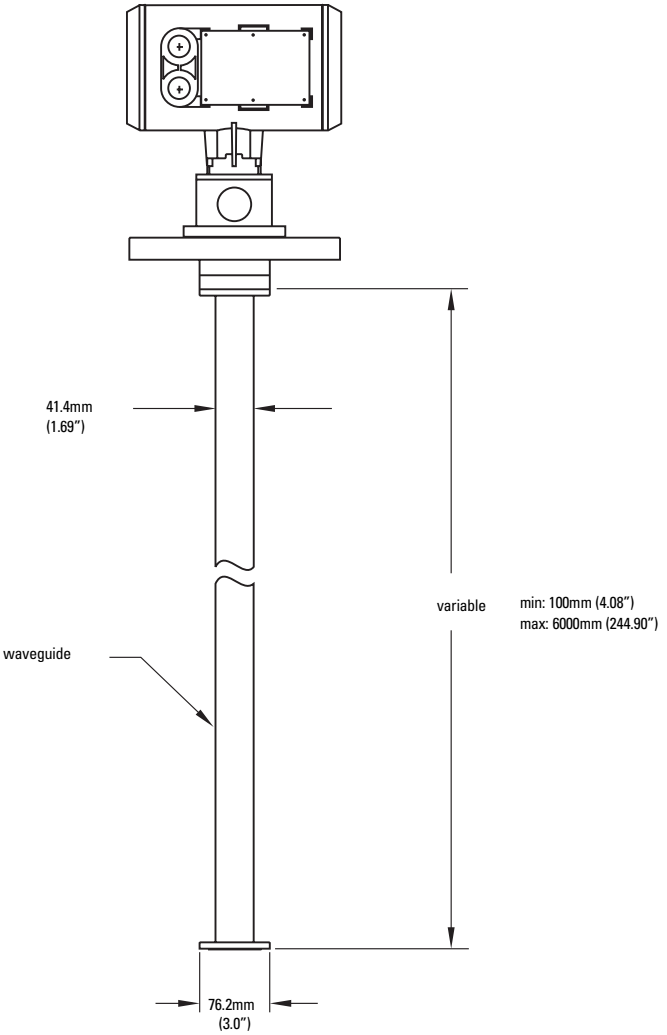
Dimensions: Sanitary Horn



Dimensions: Sanitary Rod

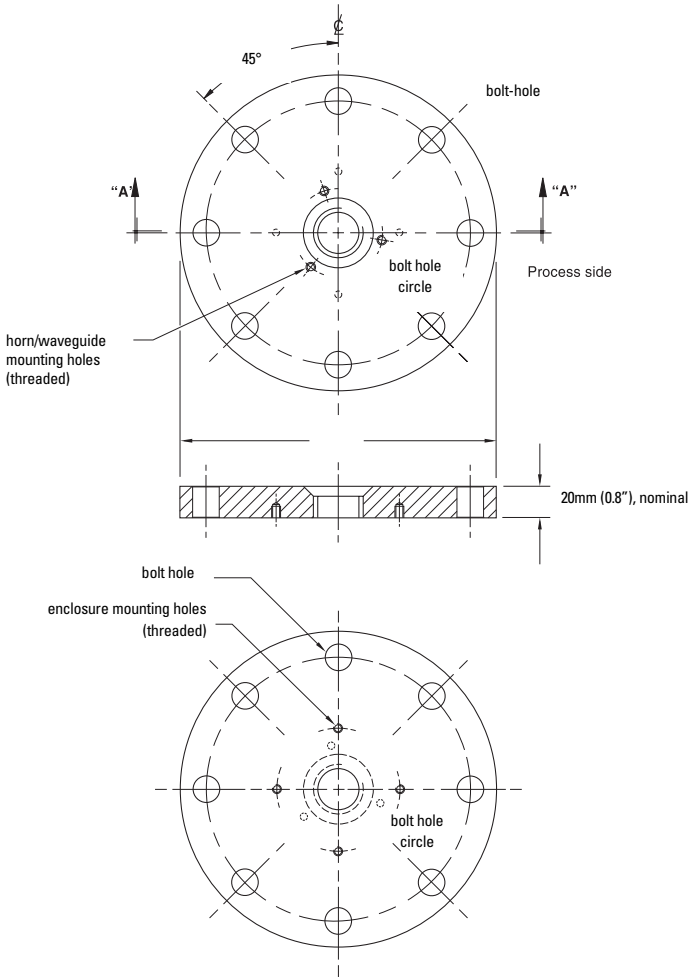


Dimensions: Waveguide



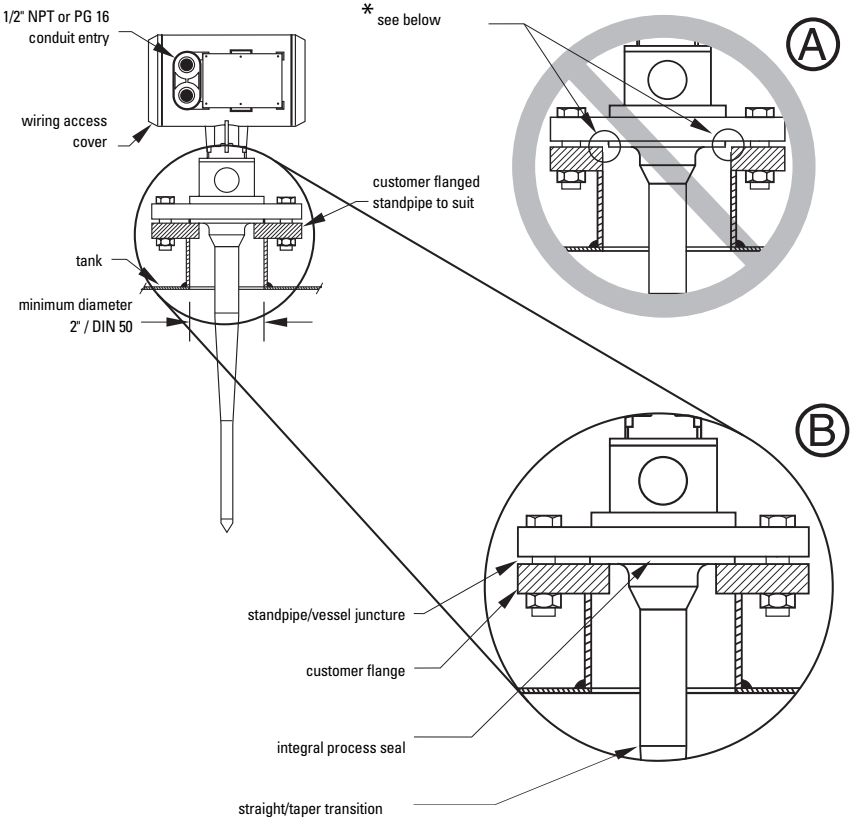
Note: you can connect a maximum of two waveguides together.

Dimensions: Flanges



Pipe Size	Flange Size	Flange O.D.	Bolt Hole Circle Ø	Bolt Hole Ø	Number of Bolts
2"	ANSI 150#	6.0"	4.75"	.7"	4
3"	ANSI 150#	7.5"	6.0"	.75"	4
4"	ANSI 150#	9.0"	7.50"	.75"	8
6"	ANSI 150#	11.0"	9.50"	.88"	8
8"	ANSI 150#	13.5"	11.75"	.88"	8
50mm	DN PN 16	165mm	125mm	18mm	4
80mm	DN PN 16	200mm	160mm	18mm	8
100mm	DN PN 16	220mm	180mm	18mm	8
150mm	DN PN 16	285mm	240mm	22mm	8
200mm	DN PN 16	340mm	295mm	22mm	12

Mounting



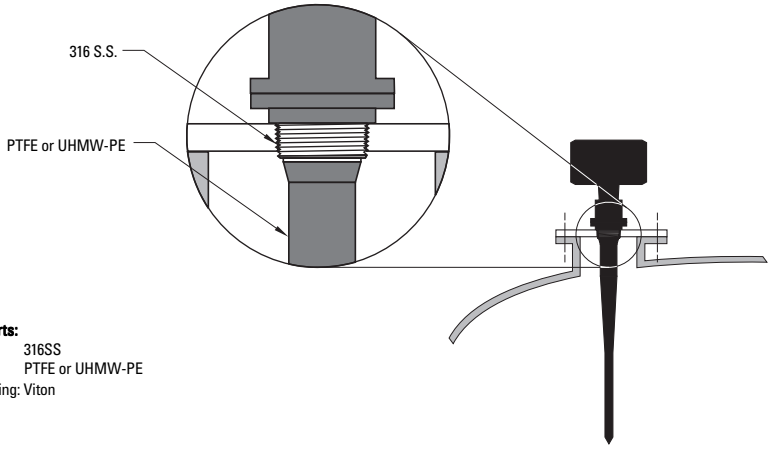
Note:

- The straight/taper transition of the rod should extend past the standpipe/vessel opening. Add extensions as required.
- Refer to the Rod Extension Requirements table.

* The unit in Ⓐ is improperly mounted. The Integral process seal MUST rest on customer flange as in Ⓑ.

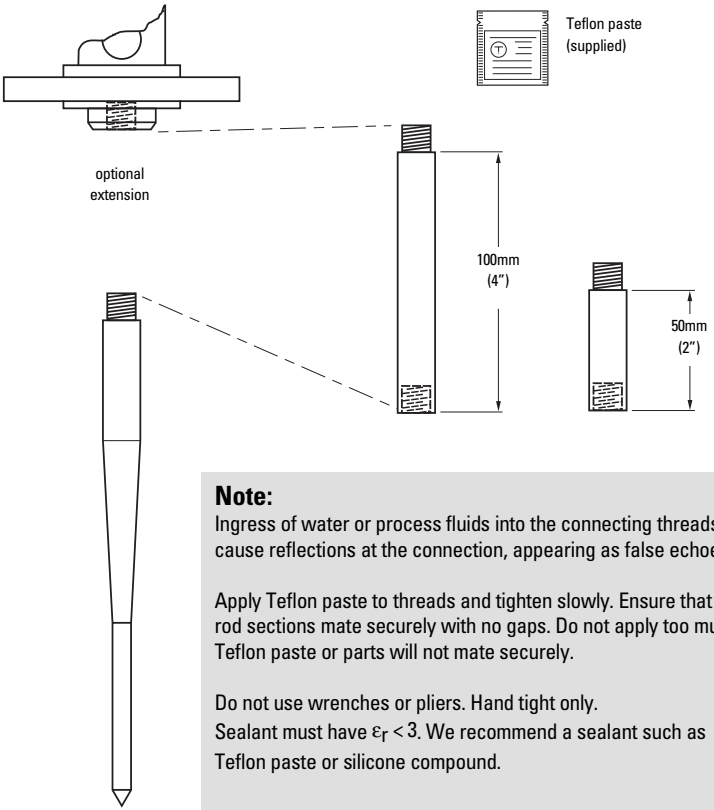
Threaded Rod Antenna

You can use 1.5" or 2" threaded process connections. There are three thread types: NPT, BSP, and G.



Wetted Parts:
Metal: 316SS
Polymeric: PTFE or UHMW-PE
Internal O-ring: Viton

Rod Assembly



Note:
Ingress of water or process fluids into the connecting threads can cause reflections at the connection, appearing as false echoes.

Apply Teflon paste to threads and tighten slowly. Ensure that the rod sections mate securely with no gaps. Do not apply too much Teflon paste or parts will not mate securely.

Do not use wrenches or pliers. Hand tight only.
Sealant must have $\varepsilon_r < 3$. We recommend a sealant such as Teflon paste or silicone compound.

Rod Extension Requirements

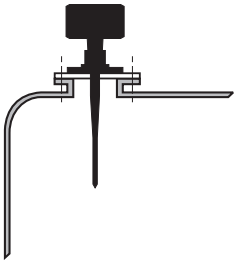
standpipe i.d.	standpipe height mm (inches)*		
	<100 (4)	100 to 150 (4 to 6)	150 to 200 (6 to 8)
50mm (2")	n/r	**	**
80mm (3")	n/r	50mm	100mm
100mm (4")	n/r	50mm	100mm
150mm (6")	n/r	50mm	100mm
>150mm (6")	n/r	n/r	n/r

n/r extension not required

* Consult Milltronics for assistance with standpipe sizes not listed.

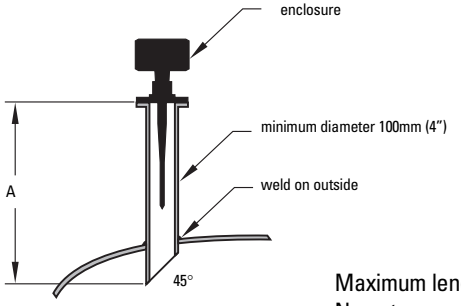
** application not recommended for 50mm (2") i.d. standpipes greater than 100mm (4") long.

Mounting: Rod Assembly



Ideally, the standpipe should be as short as possible. If your application requires a standpipe that exceeds our recommended maximum lengths, consider using a waveguide and horn combination. If you create a new standpipe for the radar unit, ensure the weld seams are on the outside of the standpipe, not the inside.
Ensure that there are no seams or lips on the inside of the standpipe or you may get erratic readings.

If the mounting illustrated above is not suitable due to the minimum blanking requirements, consider this option:



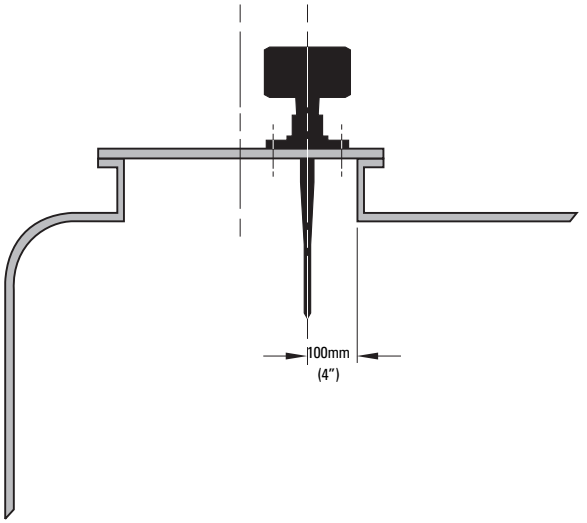
Maximum length 610mm (24")
No antenna extensions required

Standpipes that are 8" or larger in diameter provide excellent signal conditions. These conditions allow for standpipe lengths of up to 24" using the standard rod without any extensions.

Mounting: Manhole Covers

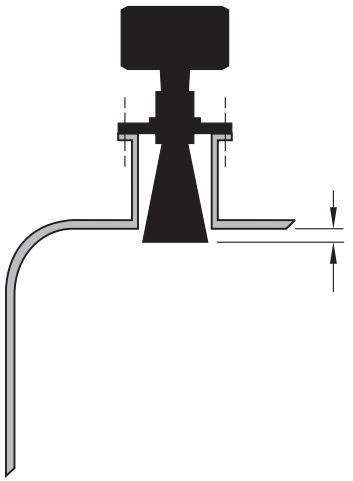
A manhole cover is typically a standpipe that is 24" in diameter or greater and has a cover.

To provide the optimum signal conditions, locate the antenna off-center with respect to the cover, typically 100mm (4") from the side of the manhole.



Mounting: Horn Antennas

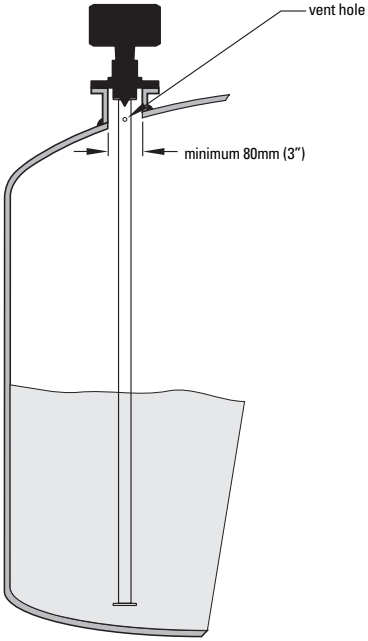
Usually, horns are mounted on short standpipes.



The end of the horn should protrude a minimum of 10mm (0.5") to avoid interference with the standpipe.

Mounting: Waveguide Antenna

This option is recommended for products with ε_r lower than 3. The maximum range of this application is reduced to 10m (33 feet). See P655 on page 67.



Mounting: Stillpipe or Sidepipe

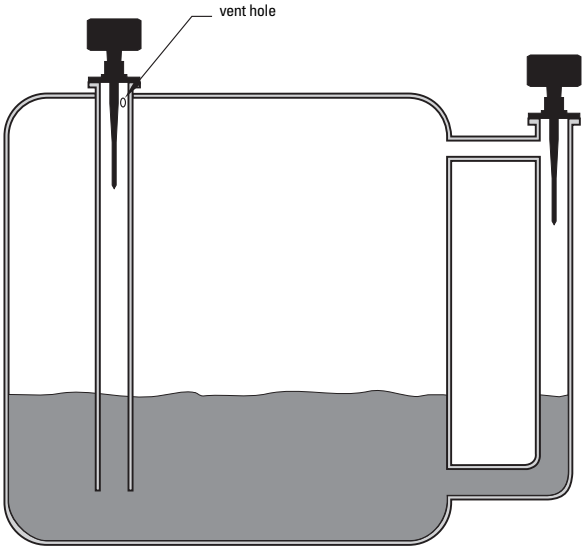
An alternate to the waveguide antenna, this option is also used for products with an ε_r less than 3 or for extremely turbulent or vortex conditions. This mounting arrangement can also be used to provide optimum signal conditions on foaming materials.

Suitable pipe diameters are 2" (50mm) to 10" (250mm). A rod antenna or a horn antenna may be used.

Note: The measurement range is reduced to 13m (43') for a 50mm (2") stillpipe or 14.5m (47') for an 80mm (3") stillpipe.

Smoothness

One continuous length of metallic pipe is preferred (no joints). If long length dictates the need for joints, then you must machine the joints to close tolerances (± 0.25mm [± 0.010"]) and weld a connecting sleeve on the outside.



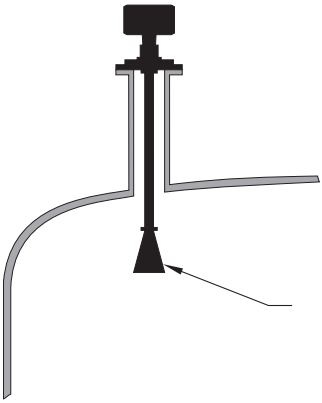
Suitable pipe diameters are 2" (50mm) to 10" (250mm).

You can use either a Rod or Horn antenna.

See P655 on page 67.

Ensure there is a vent at the upper end of the surge pipe to equalize pressure and keep the liquid level in the pipe constant with level in the vessel.

Mounting: Horn with Waveguide Extensions



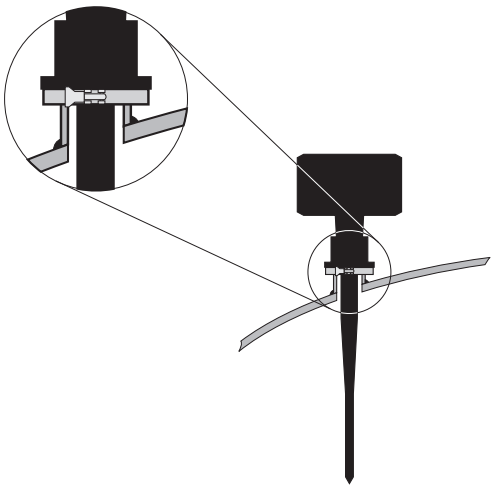
In applications where the standpipe is too long and the diameter is too small (such as a standpipe that is 100mm (4") in diameter and 460mm (18") in length), the rod antenna is not suitable due to standpipe interference. In this case, use the waveguide/horn combination. Waveguide extensions are available in custom lengths.

If the horn diameter is too large for the standpipe opening, you need to insert it from inside the vessel. The horn must be connected to the IQ 300 process flange.

Note: The IQ 300 maximum range of ??m is reduced by [0.64 x waveguide length]. Blanking and offset parameters are set by Milltronics. See the device tag for values.

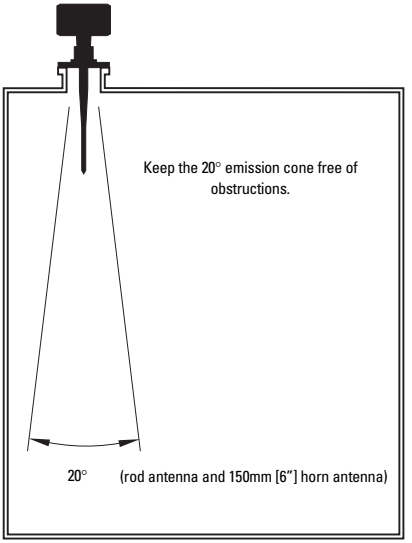
Mounting: Sanitary Mounting

There are two common sanitary mounting options; the 2", 3", and 4" tri-clamp with rod antenna and the sanitary 4" horn antenna.



Wetted Parts:
PTFE or UHMW-PE only.

Mounting: Location



Due to the polarization effect of the microwave signal related to the wall of the vessel, we recommend locating the IQ 300 a minimum of 30cm (1') away from the sidewall for every 3m (10') of vessel height.

Polarization Effect

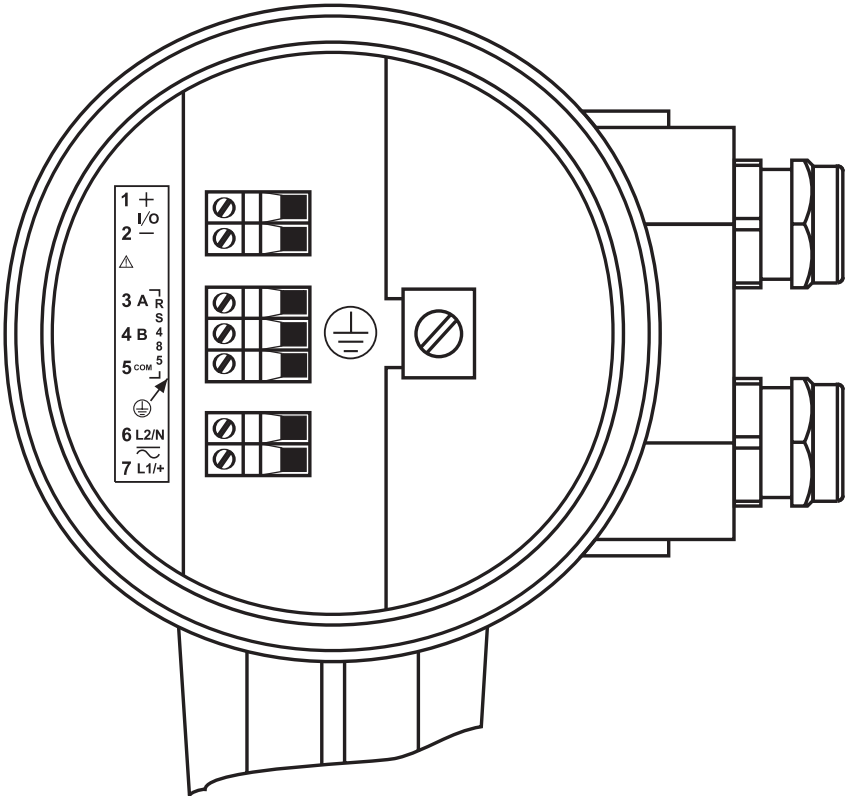
Mounting the unit too close to a wall may cause echoes to disappear at specific levels due to wave cancellation. A strong false reflection from an internal tank obstruction can be reduced or eliminated by rotating the unit to reduce this polarization effect.

False Reflections

Flat obstructions and struts perpendicular to the emission cone cause large false reflections. They reflect the radar signal with high amplitude. Round profile interfering surfaces diffuse reflections of the radar signals and cause false reflections with low amplitude.

Interconnection

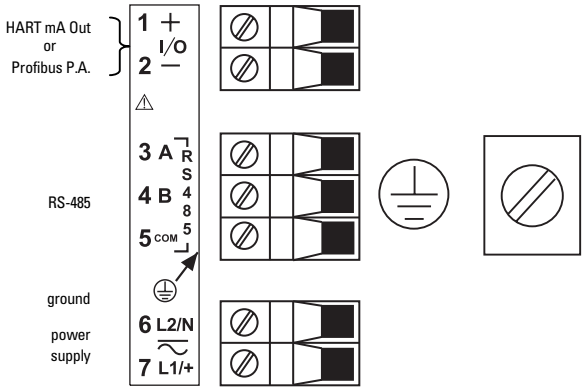
IQ Radar 300 Terminal Block



Notes

- mA, RS-485, wiring, 14 – 20 AWG, shielded copper wire
- Recommended torque on terminal clamping screws, 0.5 – 0.6 Nm
- Ground shields at one end only

IQ Radar 300 Wiring



Notes

- Line, 12 – 14 AWG, copper wire
- The equipment must be protected by a 15 A fuse or circuit breaker in the building installation.
- A circuit breaker or switch in the building installation, marked as the disconnect switch, shall be in close proximity to the equipment and within easy reach of the operator.

All field wiring must have insulation suitable for at least 250 V.

Communications Installation

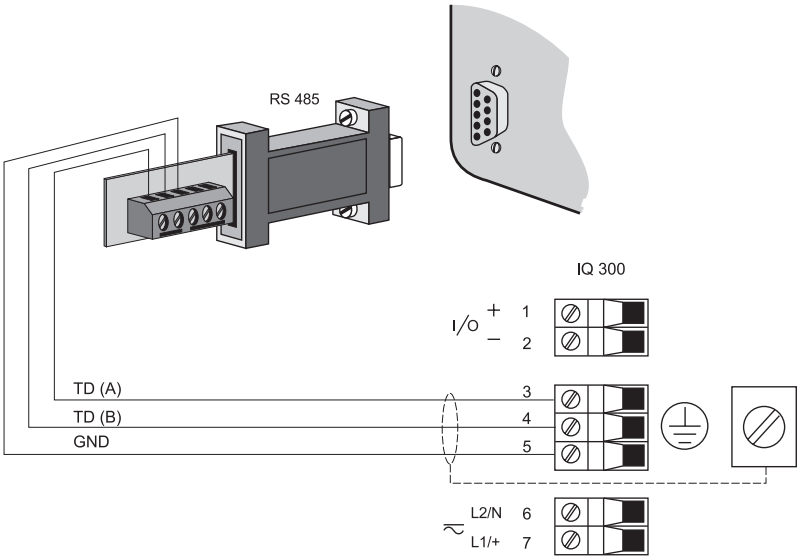
Wiring Guidelines

- RS-485 maximum length is 1,220 meters (4,000 feet)
- use 24 AWG (minimum)
- use good quality communication grade (shielded twisted pairs) cable for port 1that is recommended for RS-485.
- run the communication cable separately from power and control cables. (Do not tie wrap your RS-485 cable to the power cable or have them in the same conduit.)
- use shielded cable and connect to ground at one end only
- follow proper grounding guidelines for all devices on the bus

Improper wiring and incorrect cable choices are the two most common causes of communication problems.

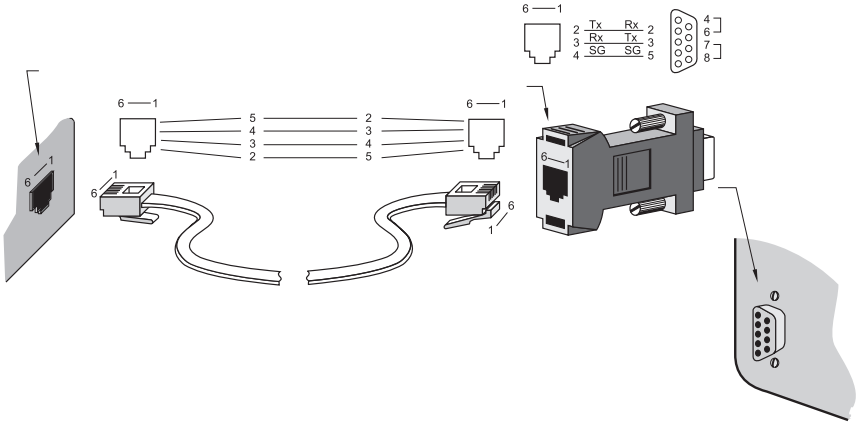
Port 1: RS-485

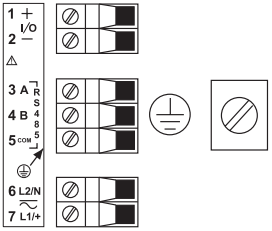
The terminal block uses terminal 3,4,5 and Ground for RS-485.



PC Connection

To connect the device to a computer requires the use of a RS-485 to RS-232 converter. Milltronics offers a converter that is powered by the RS-232 port on the computer (part number 20150159).





Port Configuration

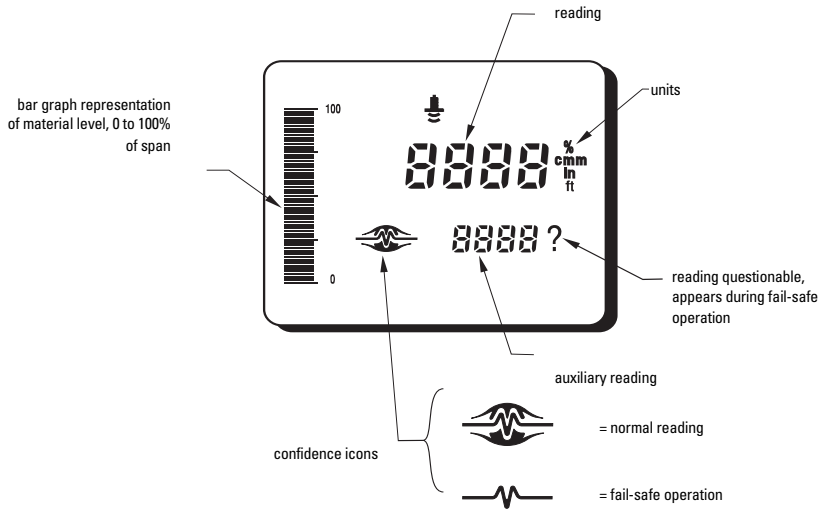
The IQ 300 uses Modbus to establish communication parameters. See Communication Parameters on page 72.

Start Up

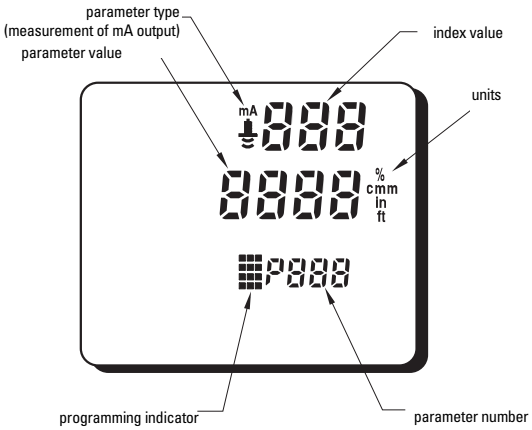
Overview

The IQ Radar 300 has two modes of operation: **RUN** and **PROGRAM**. After powering up and installation procedures are completed, the unit starts in the **RUN** mode and detects the distance from the antenna flange to the target in meters.

Run Mode Display



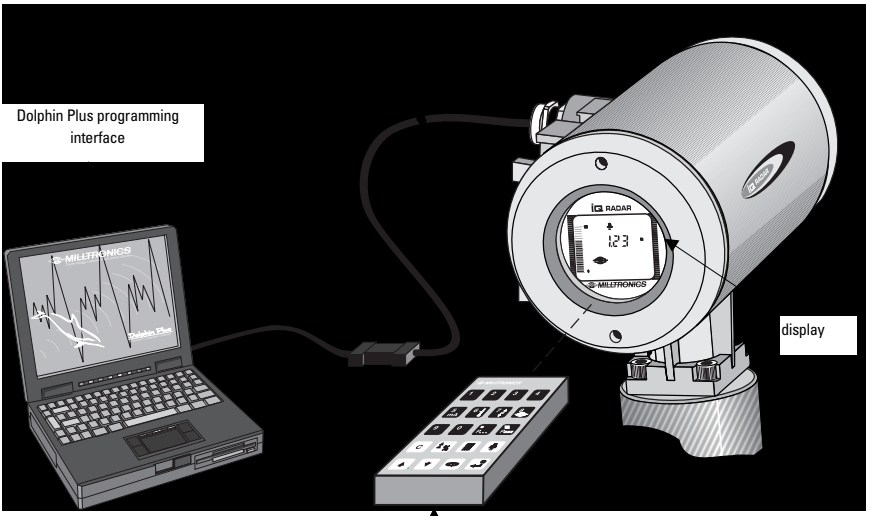
Program Mode Display



Programming

You can activate the **PROGRAM** mode at any time and set parameters to suit the application and/or user preferences. Programming can be carried out locally using the hand programmer or remotely through the optional Dolphin Plus/RS-485 interface. The system responds to both types of programming.

The instruction examples in this manual use icons from the hand programmer.



Dolphin Plus

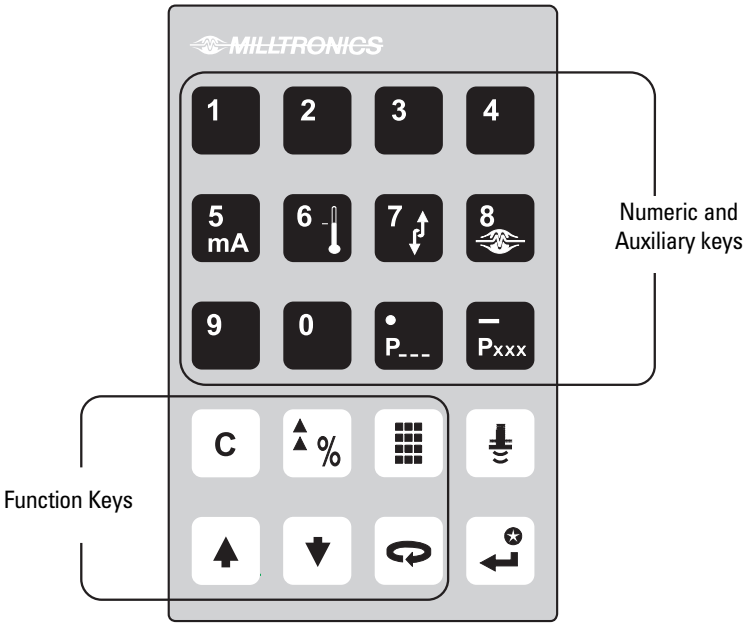
Dolphin Plus is a user interface program designed to configure the IQ Radar 300 from a laptop or a desktop PC. With Dolphin Plus you can modify parameter values in real time, view process values in graphic form on screen, save profiles, and generate instrument configuration reports. Dolphin Plus software is purchased separately. Please contact your Milltronics representative.

Hand Programmer

The programmer is a sturdy, hand-held, programming unit offering immediate access to the configuration parameters. Point programmer at the IQ Radar 300 display window (maximum distance 15cm [6"]) and press the buttons in the required sequence.

Local Programming

The hand programmer is used for local programming sequences. Please make sure you point the programmer directly at the unit to activate the programming options.



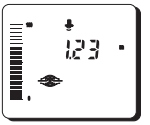
Key	Programming Mode	Run Mode
0 to 9	Values	
5 mA		mA output value
P___	Decimal point	parameter for auxiliary readings*
Pxxx	Negative value	
C	Clear value	
%		Toggle between Units and % on reading display
	End program session and enable **RUN** mode	Initiate and complete program mode access
		Distance
	Parameter scroll-up	
	Parameter scroll-down	
	Toggle fields	
	Enter the displayed value	

* Pressing P___ plus three-digit parameter number, sets parameter to show in the auxiliary display.

Accessing Program Mode

Note: Values shown are for demonstration purposes only.

1. The unit starts in **RUN** mode and readings correspond to existing settings.



2. Press the **PROGRAM** key [▤] to activate the **PROGRAM** mode. Initial program starts at P001.

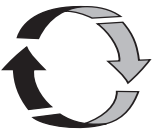
Accessing a Parameter

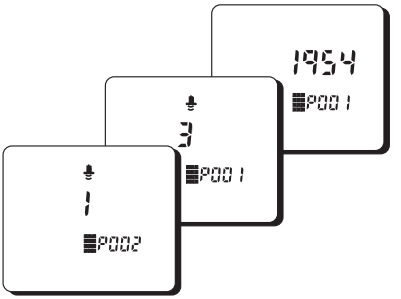
The parameter settings configure the units to a specific use. There are two ways to access parameter after you have pressed the **PROGRAM** key: Scroll Access and Direct Address.

Scroll Access

In **PROGRAM** mode, you can scroll through the parameters sequentially, and in either direction until you reach the required parameter. [scrolling range??]

1. Press **ARROW** keys [▲▼] to scroll up or down.





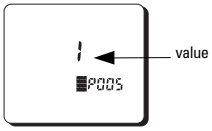
Direct Access

In **PROGRAM** mode, you can access a parameter directly by entering its number.

1. Press the **TOGGLE** key to open Parameter Number field.

2. The Parameter Number field goes blank.

3. Enter parameter number. Example: 0 0 1. The parameter value appears.



Note: Enter parameter numbers below 100 directly without leading zeros. Press the **ENTER** key to access the parameter. Example: To access P005, press 5 mA .

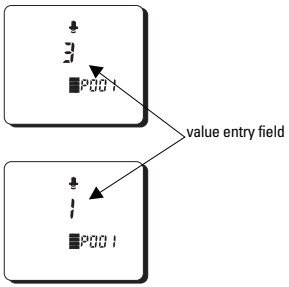
Modifying a Parameter Value

Once a parameter is accessed, you can set or modify its values.

Note:
- Security must be disabled. To disable security, set P000 to 1954.
- Values shown are for demonstration purposes only.
- Invalid entries will be rejected or limited.

Changing Parameter Values

1. Select parameter to modify.

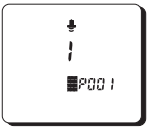


2. Enter new value. Example: press 1 and the **ENTER** key .

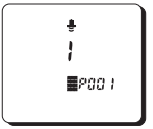
Clearing a Parameter Value

1. Scroll to, or select, the parameter.

2. Enter new value by pressing the number key, e.g. [1]. To erase value or incorrect entry, press the **CANCEL** key [c], to clear the value and then re-enter correct value.

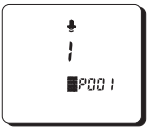


3. Press the **ENTER** key [↵] to set the value.

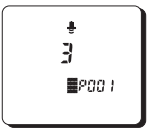


Resetting a Parameter Value

1. Scroll to or select the parameter.

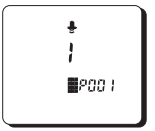


2. Press the **CANCEL** key [c] and then press the **ENTER** key [↵]. The value returns to factory default.



Accessing Run Mode

1. In **PROGRAM** mode, press the **PROGRAM** key [▤]. The screen may go blank for a moment



2. The IQ 300 returns to **RUN** mode.

Quick Start Programming

The first step in programming is to configure all parameters to their factory settings by performing a master reset through Parameter 999 (see page 80).

Then set these key parameters (P001 to P007) for a Quick Start:

- (P001) mode of measurement
- (P002) process material
- (P003) measurement response
- (P004) antenna configuration
- (P005) units
- (P006) empty distance
- (P007) span

Note: After these start-up parameters are configured, set Parameter P837.

Numerous other program parameters can be changed subsequently, or during another programming session. Refer to the Parameter Descriptions section that starts on page 55 for a list of available parameters.

When programming has been completed, the IQ Radar 300 can be put into **RUN** by pressing the programming button or by exiting Dolphin Plus.

Operation

Overview

The IQ Radar 300 is a level measuring device for liquids and slurries. Using advanced pulse radar technology, the device calculates material level by emitting a series of radar pulses and then analyzing their reflections.

The device consists of an enclosed electronic component mounted to a flanged antenna component. The electronic component generates a 5.8 GHz (U.S.A. 6.3 GHz) radar signal that is directed to the antenna, waveguide, or horn.

The radar signal is emitted axially from the antenna and propagates along this axis in a defined conical beam decreasing in strength at a rate proportional to the square of the change in distance.

The radar pulse detects the interface between the dielectric constant of the atmosphere and that of the material being measured. Electro-magnetic wave propagation is not sensitive to the temperature and atmospheric conditions or to variations in the vessel.

The series of echoes from the pulses transmitted are sensed by the antenna during the receive period of the electronics and are then stored as a profile of the activity in the vessel. The profile is analyzed and the distance of the material surface to the radar antenna is determined. This distance is used as a basis for display of material level and mA output.

Transceiver

The IQ Radar 300 transceiver operates under 1 of 5 sets of pre-set conditions (P003):

parameter value	measurement response P700/P701		rate update time P705	rate update distance P706	echo verification P711	fuzz filter P710	fail safe timer P070
1	0.1 m/min	slow	600	0.30	2	100	100
2	1 m/min		300	0.10	2	50	10
3	10 m/min		60	0.05	2	10	1
4	100 m/min		60	0.05	0	1	0.1
5	1000 m/min	fast	60	0.05	0	0	0

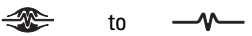
When the echoes are received, the relevant echo extraction technique (P820 and P830) is applied to determine the true material echo.

The measurement response limits the maximum rate at which the display and analog output respond to changes in measurement. Select this carefully, especially where liquid surfaces are in agitation or fall into the radar path during filling.

Loss of Echo (LOE)

A loss of echo occurs when the IQ 300 deems the calculated measurement unreliable, i.e. the confidence (P805) is less than the threshold (P804). Refer to Operation Troubleshooting on page 91

If the condition persists for a time beyond the limit as set by the fail-safe timer (P070), the Confidence icon changes from full to partial:



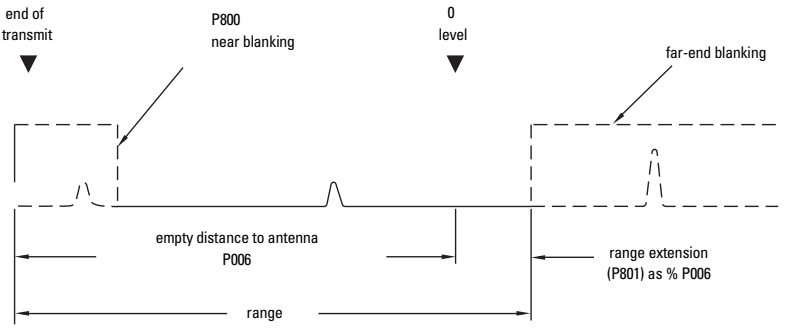
The response to LOE is set by P072. It determines whether the reading and mA output are immediately forced to the fail-safe default (P071). Upon receiving a reliable echo, the loss of echo condition is aborted (icon returns to full), and the reading and mA output return to the present level at the rate set by P072.

Blanking

Near blanking (P800) is set to ignore the zone in front of the antenna where false echoes can appear as an echo during the receive cycle (often created by internal impediments like a ladder rung). Usually indicated by an incorrect high level reading, false echoes can be overcome by increasing the near blanking value from its factory setting.

Far-end blanking is a feature that ignores the zone below the zero or empty level where false echoes can appear at levels that interfere with the processing of the true echo.

Typical Receiver Signal



In applications where the zero level is above the bottom of the vessel and you need to monitor the zone below the normal zero, range extension (P801) can extend the range into far-end blanking. Range extension is entered as a percentage of P006. As range extension reduces the protection afforded by the far-end blanking, it should be used judiciously because excessive range extension can reduce measurement reliability and accuracy. Range extension is factory set for 5% of P006. If false echoes appear after the blanking zone, P801 should be increased accordingly.

Analog Output

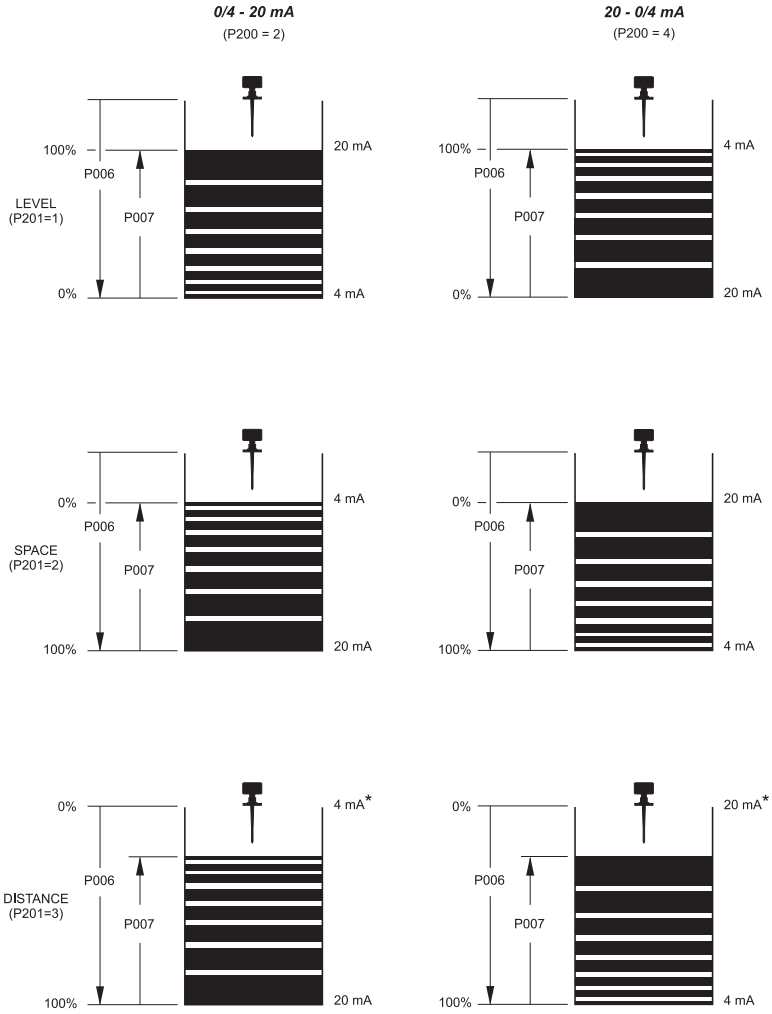
The IQ Radar 300 can be programmed to provide an analog output (P200) of 0 to 20, or 4 to 20, mA, and for proportional or inverse span.

Programming

When the unit is put into **PROGRAM** mode, the analog output level holds its prior value if the mA output function is not common output or if HART is not the communication protocol. [please verify]

Run

The analog output responds in the following manner:



*reference value only. mA level limited by near blanking.
0 and 100% are percentage of full scale reading (m, cm, mm, ft, in).

Volume

To program the unit for volume, set:

- operation (P001) to level **1** (see page 55)
- tank shape (P050) to a value other than **0** (see page 57)
- other volume parameters (P051 to P053) as required.

To program the unit for ullage, set:

- operation (P001) to space **2** (see page 55).

Fail-Safe

When the fail-safe timer (P070) expires, the mA output responds as follows:

Fail-safe Mode (071)	Status (0/4 - 20)	Status (20 - 0/4)
1 = high	22	0/2
2 = low	0/2	22
3 = hold	hold	hold

Run/Program

When the IQ Radar 300 changes from **RUN** to **PROGRAM**, the unit no longer responds to the process. The last measurement is stored and the associated readings and mA output are held.

The unit reverts to the parameter last addressed during the previous program session.

Upon return to **RUN**, the transceiver resumes operation. The reading and mA output default to the last measurement taken. The reading and associated outputs migrate to the current process level at a rate controlled by the measurement response (P003).

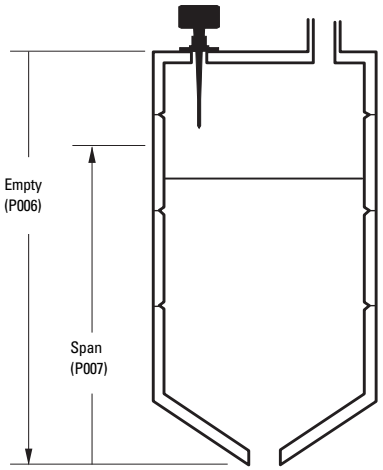
If the IQ 300 is left in **PROGRAM** mode for 10 minutes without input, it automatically reverts to **RUN** mode.

Application Examples

These IQ Radar 300 applications examples can be used as setup references. The parameter value tables relate the values to the functions.

Application Example: Asphalt in Storage Tank

Note: The minimum distance from the antenna face to the target is limited by the near blanking, P800.



The application is to obtain a level measurement and corresponding 4-20 mA output proportional to asphalt levels in a storage tank. The bottom of the antenna flange is 5m from the tank bottom. The empty level is 0m (bottom) and the full level (span) is 4.5m from the bottom. The maximum rate of filling or emptying is about 0.1m/min. In the event of a loss of echo, the IQ Radar 300 is to go into fail-safe Hi after 2 minutes.

Asphalt build-up on the rod antenna does not affect performance.

Parameter	Enter		
P999	----	master reset	
P001	**1**	mode of measurement	= level
P002	**1**	material	= liquid
P003	**2**	measurement response	= 1m/minute
P004	**240**	antenna	= dielectric rod, standard length
P005	**1**	units	= metres
P006	**5**	empty distance	= 5m
P007	**4.5**	span	= 4.5m
P070	**2**	fail-safe timer	= 2 minutes
P071	**1**	fail-safe	= Hi
P820	**1**	algorithm	= factory
P830	**4**	TVT type	= factory
P837 (Note below)	**2 & 1**	Auto Near TVT	= 0 (factory set)

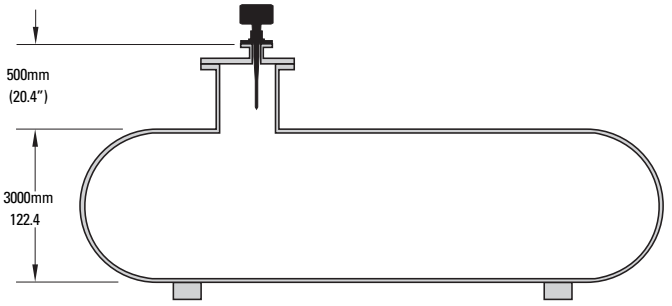
Note: Only set P837 if product is at least 2.5m (78") away. If closer, leave P837 at **0** until such time the level drops below 2.5m (78").

Run: To start normal operation, press the **PROGRAM** key [▦].

Application Example: Horizontal Tank with Volume

Note: The minimum distance from the antenna face to the target is limited by the near blanking, P800.

The application is to obtain a level measurement and corresponding 4-20 mA output proportional to material levels in a chemical tank. The bottom of the antenna flange is 3.5m from the tank bottom. The empty level is 0m (bottom) and the full level (span) is 3.0m from the bottom. The maximum rate of filling or emptying is about 0.1 m/min. In the event of a loss of echo, the IQ Radar 300 is to go into fail-safe Hi after 2 minutes.



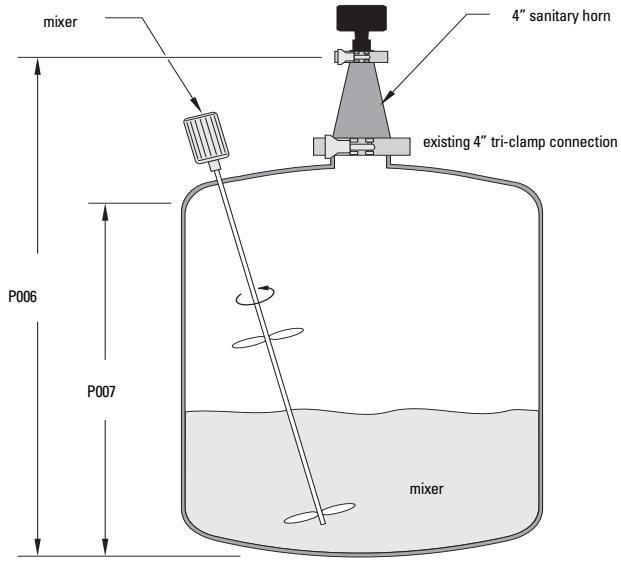
Parameter	Enter		
P999	**----**	master reset	
P001	**1**	mode of measurement	= level
P002	**1**	material	= liquid
P003	**2**	measurement response	= 1m/minute
P004	**240**	antenna	= dielectric rod, standard length
P005	**1**	units	= metres
P006	**5**	empty distance	= 5m
P007	**4.5**	span	= 4.5m
P050	**7**	tank shape	= parabolic ends
P051	**8000**	maximum volume	= litres
P052	**.8**	tank dimension A	= metres
P053	**6**	tank dimension L	= metres
P070	**2**	fail-safe timer	= 2 minutes
P071	**1**	fail-safe	= Hi
P820	**6**	algorithm	= first echo
P830	**4**	TVT type	= factory
P837 (Note below)	**2 & 1**	Auto Near TVT	= 0 (factory set)

Note: Only set P837 if product is at least 2.5m (78") away. If closer, leave P837 at **0** until such time the level drops below 2.5m (78").

Run: To start normal operation, press the **PROGRAM** key [▦].

Application Example: Juice Batch Tank with Sanitary Horn Antenna

Note: The minimum distance from the antenna face to the target is limited by the near blanking, P800.



Note: Sanitary Antenna Options: The one-piece antenna/process seal provides excellent mounting method, even on non-sanitary installations.

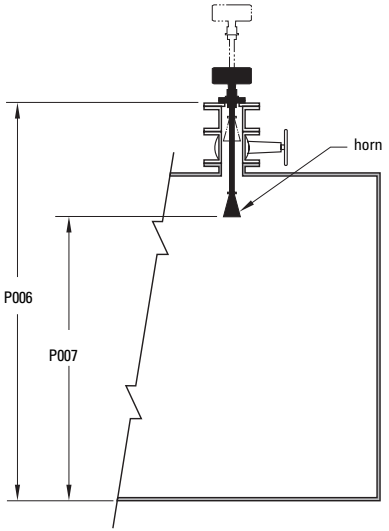
Parameter	Enter		
P999	**----**	master reset	
P001	**1**	mode of measurement	= level
P002	**1**	material	= liquid
P003	**2**	measurement response	= 1m/min.
P004	**240**	antenna	= dielectric rod, standard length
P005	**1**	units	= metres
P006	**5**	empty distance	= 5m
P007	**4.5**	span	= 4.5m
P070	**2**	fail-safe timer	= 2 minutes
P071	**1**	fail-safe	= Hi
P652	**tag value**	offset correction	= factory
P820	**1**	algorithm	= factory
P830	**4**	TVT type	= factory
P837 (Note below)	**2 & 1**	Auto Near TVT	= 0 (factory set)

Note: Only set P837 if product is at least 2.5m (78") away. If closer, leave P837 at **0** until such time the level drops below 2.5m (78").

Run: To start normal operation, press the **PROGRAM** key.

Application Example: Sliding Waveguide on Anaerobic Digesters

Blanking, P800, and offset P652 are set at the factory. Check the device tag for specific values.



Maximum level should be maintained at least .46m (18") from the end of the horn.

The raised position is for installation and maintenance. The lowered position is for operation. Program the unit for operation in the lowered position.

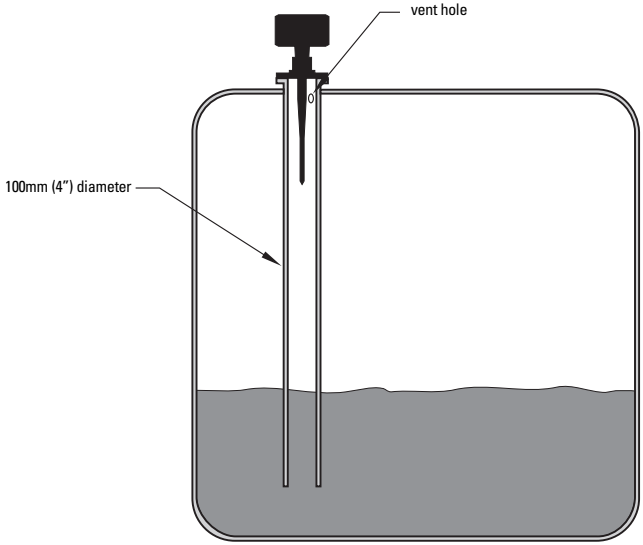
Parameter	Enter		
P999	**----**	master reset	
P001	**1**	mode of measurement	= level
P002	**1**	material	= liquid
P003	**2**	measurement response	= 1m/minute
P004	**240**	antenna	= dielectric rod, standard length
P005	**1**	units	= metres
P006	**5**	empty distance	= 5m
P007	**4.5**	span	= 4.5m
P652	**tag value**	offset correction	= factory
P800	**tag value**	blanking	= factory
P820	**1**	algorithm	= factory
P830	**4**	TVT type	= factory
P837 (Note below)	**2 & 1**	Auto Near TVT	= 0 (factory set)

Note: Only set P837 if product is at least 2.5m (78") away. If closer, leave P837 at **0** until such time the level drops below 2.5m (78").

Run: To start normal operation, press the **PROGRAM** key [▦].

Application Example: Stillpipe

An alternate to the waveguide antenna, this option is also used for products with an ε_r or less than 3 or if extremely turbulent or vortex conditions exist.



Note: For $\varepsilon_r < 3$, the lower 40cm of vessel level may not be measurable.

This mounting arrangement can also be used to provide optimum signal conditions on foaming materials.

Suitable pipe diameters are 50mm (2") to 250mm (10").

Note: The measurement range is reduced to 13m (43') for a 50mm (2") stillpipe or 14.5m (47') for an 80mm (3") stillpipe.

Parameter	Enter		
P999	**----**	master reset	
P001	**1**	mode of measurement	= level
P002	**1**	material	= liquid
P003	**2**	measurement response	= 1m/minute
P004	**240**	antenna	= dielectric rod, standard length
P005	**1**	units	= metres
P006	**5**	empty distance	= 5m
P007	**4.5**	span	= 4.5m
P655 (see chart below)	**0.955**	propagation factor	= 10mm (4") pipe
P820	**6**	algorithm	= factory
P830	**4**	TVT type	= factory
P837 (Note below)	**2 & 1**	Auto Near TVT	= 0 (factory set)

Note: Only set P837 if product is at least 2.5m (78") away. If closer, leave P837 at **0** until such time the level drops below 2.5m (78").

Pipe	P655 Value
50mm (2")	0.827
80mm (3")	0.915
100mm (4")	0.955
150mm (6")	0.980
200mm (8")	0.990

Note: See the P655 table on page 67 for other pipe diameters.

Run: To start normal operation, press the **PROGRAM** key  .

Parameter Descriptions

The parameters are the programmable features of the IQ Radar 300. Adjust the value settings on the parameters to configure the unit.

The parameter tables show the values you need to enter in **bold** type, followed by additional information when necessary. The pre-set values are the unit's factory settings that may need alteration for specific applications.

Press the **PROGRAM** key to access the parameter settings. [Tim: do you want to indicate the default values?]

P000 Lock

Secures the IQ Radar 300 from changes.

Value	**1954**	Lock off: programming permitted
	other	Lock activated: programming secured

To access this parameter directly, press **000** and enter any value other than **1954** to secure the programming lock. The **PROGRAM** mode is active for viewing only. To unlock, access this parameter and enter **1954**.

WARNING: Use this lock as backup security only. It uses a fixed value which can be discovered by unauthorized personnel.

Quick Start Parameters (P001 to P007)

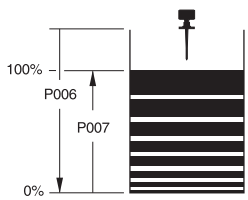
Parameters P001 to P007 are the main settings that apply to all applications and get the system operational.

P001 Operation

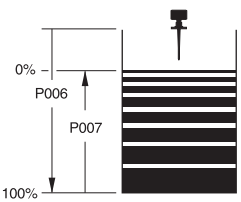
Determines the mode of measurement.

Values	**1**	Level: material level referenced to empty distance (P006)
	2	Space: space to material level referenced from span (P007)
	3	Distance: distance to target referenced from the flange face

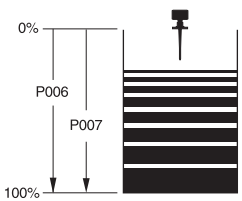
Level (a.k.a. volume)
(P001 = 1)



Space (a.k.a ullage)
(P001 = 2)



Distance
(P001 = 3)



P002 Material

Identifies the material being monitored.

Values	1	liquids or slurries

P003 Measurement Response

Sets the reaction speed of the unit to the measurement changes in the target range.

Values	measurement response P700/P701			rate update time P705	rate update distance P706	fuzz filter P710	echo verification P711	fail safe timer P070
	1	0.1m/minute	slow	600 secs	0.30 m	2	100	100
	2	1m/minute	▲	300 secs	0.10m	2	50	10
	3	10m/minute	⋮	60secs	0.05m	2	10	1
	4	102m/minute	▼	60secs	0.05m	0	1	0.1
	5	1020m/minute	fast	60secs	0.05m	0	0	0

Set P003 to a measurement response just faster than the greater measurement of the maximum filling or emptying rate.

If the IQ 300 cannot keep up with the rate of level change, select a faster rate. If the reading bounces around an average value, select a slower rate. In general, reliability is traded for speed. Noisy applications or those with agitators tend to be more manageable at slower response rates, as these make use of filtering, echo verification, and longer fail-safe delay.

- **filter**: averages successive measurements to filter out false echoes
- **echo verification**: discriminates between agitator blades in motion (spurious noise) and the target surface (true echo)
- **fail-safe timer**: establishes the period from the time a loss of echo (LOE) starts until the fail-safe default (P071) is triggered. The P003 pre-set timer value can be overridden by P070.

P004 Antenna

Identifies antenna configuration. [Tim: is this final?]

Values	240	factory
	241	rod + 50mm extension
	242	rod + 100mm extension
	243	rod + 150mm extension (50 + 100mm)

Setting this parameter automatically configures the offset correction, P652.

Horn antennas and waveguide/horn combinations will come from the factory with P652 pre-set and P004 set to 240. [still ok?]

P005 Units

Specifies units for programming and measurement.

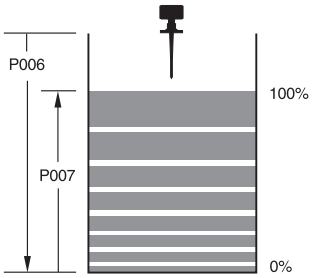
Values	**1**	metres
	2	centimetres
	3	millimetres
	4	feet
	5	inches

P006 Empty

Sets the distance in units (see P005) from flange face to empty level.

Values	-----	# units set in P005

Empty level can be set at any distance desired, not just actual empty.



P007 Span

Sets the distance from empty (P006) to full/100% level.

Values	-----	# units set in P005

Full level can be set at any measurement above the empty level.

Volume Parameters (P050 to P053)

Sets the IQ Radar 300 to calculate readings based on reservoir volume, rather than level

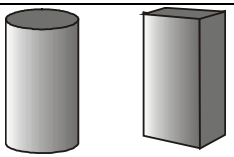
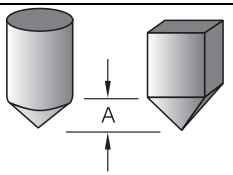
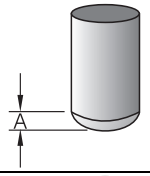
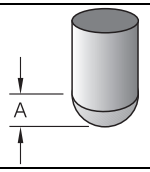
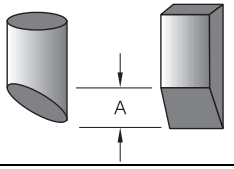
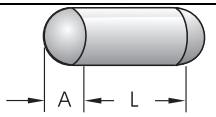
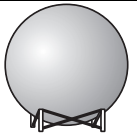
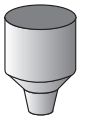
P050 Tank Shape

Enter the Tank Shape value that matches the monitored vessel or reservoir.

When Operation is **LEVEL** (P001 = 1), liquid (material) volume is calculated. When operation is **SPACE**, remaining vessel capacity is calculated.

In the **RUN** mode, Readings are displayed in volumetric units, see Maximum Volume (P051) on page 59. When percent is selected, the displayed volume Reading is a percentage of Maximum Volume.

Note: Parameters P052 and P053 set tank dimensions A and L.

Value #	Shape	Description
0	----	volume calculation not required (Factory disabled)
1		flat bottom
2		conical or pyramidal bottom
3		parabolic bottom
4		spherical bottom
5		angled bottom
6		flat ends
7		parabolic ends
8		sphere
9		universal linear

P051 Max Volume

For Readings in volumetric units (rather than percent), enter the vessel volume between Empty (P006) and Span (P007).

Values	Range: **0.000 to 9999**
Related Parameters	• P006 Empty • P007 Span

The units of measurement for this reading are non-dimensional. The volume is calculated from the empty position to the maximum position and is scaled according to the Tank Shape (P050) value. This allows the use of any volume units required.

Example

1. If maximum volume = 3650m^3, enter **3650**.
2. If maximum volume = 267500 gallons, enter **267.5** (1000s of gallons).

Enter the volume of the tank at full (Factory Setting = 100)

P052 Tank Dimension A

Dimension A is used in the tank shape parameter (P050) on page 57.

Values	Range: **0.000 to 9999** in units (P005)
Related Parameters	• P050 Tank Shape

If P050 = 2,3,4, or 5, enter the height of the tank bottom.
If P050 = 7, enter the length of one end section of the tank.

Note: Enter the dimension in units chosen in (P005).

P053 Tank Dimension L

Dimension L is used in the tank shape parameter (P050) on page 57.

Values	Range**: 0.000 to 9999** in units (P005)
Related Parameters	• P050 Tank Shape

If P050 = 7, enter the tank length (excluding both end sections).

Note: Enter the dimension in units chosen in (P005).

P054 Breakpoint Levels

When the tank shape is too complex for any of the pre-configured shapes, you can specify the volume based on segment.

Primary Index	global
Secondary Index	breakpoint
Values	Range: **0.000 to 9999** in units
Related Parameters	• P055 Volume Breakpoints (Universal Volume Calculation)

Enter up to 10 level breakpoints (where volume is known) if P050 = 9 [verify]

Entering a Level Breakpoint

1. Open parameter P054.
2. Enter a breakpoint in measurement units.
3. Match each breakpoint to the same index value for P055.

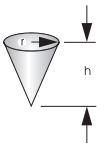
P055 Volume Breakpoints (Universal Volume Calculation)

Each segment defined by the level breakpoints (P055) requires a volume to allow the IQ 300 to make the level-to-volume calculations.

Primary Index	global
Secondary Index	breakpoint
Values	Range: **0.000 to 9999** in units
	Pre-set: **0.000**
Related Parameters	• P054 Volume Breakpoints (Universal Volume Calculation)

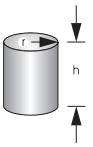
Typical volume calculations:

Cone



$V = (1/3)\pi r^2 h$

Cylinder



$V = \pi r^2 h$

Entering a Volume Breakpoint

1. Open parameter P055
2. For each index enter a volume
3. Match each volume to the same index value for P054

Display and Reading Parameters (P060 to P063)

P060 Decimal Position

Defines the maximum number of decimal places used on the LCD.

Values (Level measurement only)	**0**	no digits after the decimal point
	1	1 digit after the decimal point
	2	2 digits after the decimal point
	3	3 digits after the decimal point

In the **RUN** mode, the decimal position is adjusted to prevent the number of digits from exceeding the display capabilities. To keep the decimal place from shifting, reduce the number of decimal places to that shown at 100%.

For example, if 100% = 15m, use two decimal places for readings of 15.00 or parts thereof (e.g. 12.25).

P062 Offset Reading

Adds the specified value to the level reading, usually to reference the reading to sea level or to another datum level.

Values (Level measurement only)	Range: **-999 to 9999**
	Pre-set: 0.000

The operation of the device is not affected by the Offset Reading. This value is used for display only. All control measurements are still referenced to empty.

P063 Minimum Reading

Adjusts the minimum reading the product will show.

Values (Level measurement only)	Range: **-999 to 9999**
	Pre-set: 0.000

P063 is only applied after P062 Offset Reading and then only if reading displays level/volume (P001=1).

The milliAmp output is not affected.

Fail-Safe Parameters (P070 to P072)

P070 Fail-Safe Timer

Sets the time delay, in minutes, before going into fail-safe mode.

Values	Range**: 0.000 to 9999**
	Pre-set: 10.00 minutes

P071 Fail-Safe Material Level

Selects the default measurement in the event that the fail-safe timer expires.

Values	**1**	High: maximum span value
	2	Low: minimum span value
	3	Hold: hold current value

P072 Fail-Safe Level Advance

Sets the speed at which the IQ 300 advances and returns to the Failsafe Material Level.

Values	**1**	Restricted (pre-set): unit advances to/from the Failsafe Material leve as set by P003, P700, or P701.
	2	Immediate: Failsafe Material Level is assumed at once.
	3	Fast Back: Failsafe Level Advance is restricted. Returns to new measured material level at once.

mA Parameters (P200 to P219)

P200 mA Range

Selects the mA output range and relationship to span.

Values	**2**	4 to 20mA
	4	20 to 4mA

If 2 is selected, the mA output is directly proportional to the mA function. If 4 is selected, then the output is inversely proportional to the mA function.

P201 mA Function

Alters the mA output/measurement relationship. Set independently from P001.

Values	**0**	manual
	1	level
	2	space
	3	distance
	4	volume
	9	controlled by HART or Modbus

Independent mA Setpoints Parameters (P210 and P211)

Use these features as reference for calculating the minimum and/or maximum mA output to any point in the measurement range.

Note: Ensure the % symbol is displayed before entering a % value.

P201 (mA Function) Settings	Response
level, space, or distance	Enter the material level in Units (P005) or percent of Span (P007) as referenced to Empty (P006).
volume	Enter the volume in Maximum Volume (P051) units or as a percent of Maximum Volume.

P210 0/4mA Output Setpoint

Sets the process level that corresponds to the 0 or 4mA value.

Values	Range: **-999 to 9999**
Related Parameters	• P200 mA Range • P201 mA Function

Enter the value (in units or %) to correspond to 0 or 4mA.

P211 20mA Setpoint

Sets the process level that corresponds to the 20mA value.

Values	Range: **-999 to 9999**
Related Parameters	• P200 mA Range • P201 mA Function

Enter the value (in applicable units or %) to correspond to 20mA.

P214 mA Trim

Used to calibrate the mA output for 4mA.

Values	Range: **-1.00 to 1.000**
Related Parameters	• P215 mA Trim

Adjust this value so the input device indicates 4.000mA when P214 is accessed. Clearing this parameter returns unit to factory setting.

P215 mA Trim

Used to calibrate the output for 20 mA.

Values	Range: **-1.00 to 1.000**
Related Parameters	• P214 mA Trim

Adjust this value so the device indicates 20.00mA when P215 is accessed. Clearing this parameter returns unit to factory setting.

P219 mA Output Fail-Safe

Use for mA fail-safe operation, independent of the Fail-Safe Material Level (P071).

Values	0	Off (pre-set)	mA output responds to Failsafe Material Level
	1	HI	produce the Span mA output immediately
	2	LO	produce the Empty mA output immediately
	3	HOLd	last known value is held until normal operation resumes

Profile Record Parameters (P330 to P337)

WARNING: These parameters are for authorized service personnel or Technicians familiar with Milltronics echo processing techniques.

These features can record up to 10 Echo profiles, initiated manually (P330), or automatically (P331). See Scope displays (P810) for echo profile viewing hardware/software requirements. If 10 Profiles are already saved, addresses 1 through 10 are filled, and the oldest automatically initiated record is overwritten. Manually initiated records are not automatically overwritten. All records are automatically deleted in the event of a power interruption.

When a record is displayed, results are based on current programming (which may have been altered since the record was saved), so the effect on the echo profile can be observed when changing an echo parameter.

P330 Profile Record.

Records profiles for later viewing.

In addition to being a profile records library, this provides two functions:

- manually records and saves echo profiles
- displays an echo profile, recorded manually or automatically, (oscilloscope)

Selecting a record address

1. Enter **PROGRAM** mode and press **TOGGLE** key twice to highlight the index field. The field shows two underscores **_ _**.
2. Type the index number. The profile record information is shown.
3. Use **ARROW** keys and to scroll through the records.

Recording a profile manually

Press the **TRANSDUCER** key to fire the transducer and record the echo profile into the internal scope buffer for display.

Saving a manual record

Press the **ENTER** key to copy the echo profile record in the scope buffer and save it in the selected address in the record library. The parameter value field displays the new record information.

Displaying a record

Press the **AUXILIARY** key to enter display auxiliary mode and then:

1. Press 9 to display the time the profile was taken.
2. Press 0 to display the date the profile was taken.
3. Press the **TRANSDUCER** key to copy the current echo profile into the scope buffer for display on an oscilloscope or in Dolphin Plus.

To delete a record

Press the **CANCEL** key and then the **ENTER** key to delete the echo profile record in the selected address. The value returns to **- - - -**.

P331 Auto Record Enable

Enables or disables the Auto Profile Record function.

Values	**0**	Off
	1	On

P333 Auto Record Interval

Sets the allowable time lapse (in minutes) after an Auto Profile Record is saved before another Auto Profile Record can be saved (subject to all other restrictions).

Values	Range: **0.0 to 9999** (minutes)
	Pre-set: 120 minutes

Auto Record ON and OFF Setpoint Parameters (P334 to P337)

Use Auto Record **ON** Setpoint (P334) and Auto Record **OFF** Setpoint (P335) to define the level boundaries that trigger an Auto Profile Record of an Echo Profile.

If **----** is displayed for either P334 or P335, Auto Profile Records are saved, regardless of current level (subject to all other restrictions).

Enter the level value in Units (P005) or percent of Span (P007) relative to Empty (P006).

P334 Auto Record ON Setpoint

*Sets the critical level which, along with Auto Record **OFF** Setpoint, defines the boundaries for Auto Profile Records to be saved.*

Values	Range: **-999 to 9999**
Related Parameters	• P335 Auto Record OFF • P336 Auto Record Filling/Emptying • P337 Auto Record LOE Time

P335 Auto Record OFF Setpoint

*Sets the critical level which, along with Auto Record **ON** Setpoint, defines the boundaries for Auto Profile Records to be saved.*

Values	Range: **-999 to 9999**
Related Parameters	• P334 Auto Record ON • P336 Auto Record Filling/Emptying • P337 Auto Record LOE Time

P336 Auto Record Filling/Emptying

Restricts Auto Profile Records from being saved unless the level is rising, falling, or both.

Values	**0**	Auto Profile Record on filling or emptying
	1	Auto Profile Record on filling only
	2	Auto Profile Record on emptying only
Related Parameters	• P334 Auto Record ON • P335 Auto Record OFF • P337 Auto Record LOE Time • P702 Filling Indicator • P703 Emptying Indicator	

If the level changes at a greater rate than the corresponding Filling/Emptying Indicator (P702/P703) values, the Echo Profile is saved subject to this and other Auto Profile Record restrictions.

P337 Auto Record LOE Time

Limits Auto Profile Records from being saved unless extended LOE occurs.

Values	Range: **0.0 to 9999** (seconds)
	Pre-set: 0.0
Related Parameters	• P334 Auto Record ON • P335 Auto Record OFF • P336 Auto Record Filling/Emptying

If the LOE condition exceeds the period entered the Echo Profile is saved. When set for **0** (zero) LOE is not required for an Auto Profile Record to be saved.

Installation Records Parameter

P341 Run Time

Shows the accumulated number of days the IQ Radar 300 has been operating.

Values (view only)	Display: **0.0 to 9999** (days)

Range Calibration Parameters

P652 Offset Correction

Shows the offset value applied to the reading as a correction to the measurement.

Values	Range: **-999 to 9999**
	Pre-set: 0

Note: This parameter is automatically set when you enter parameter P004. This parameter may also have been factory set to a specific value to accommodate options such as horn and waveguide antenna systems. A tag on the instrument will specify the P652 value when these options have been supplied.

P655 Propagation Factor

Compensates for the change in the microwave velocity, as compared with propagation in free space, when propagation is within a stillpipe (metal).

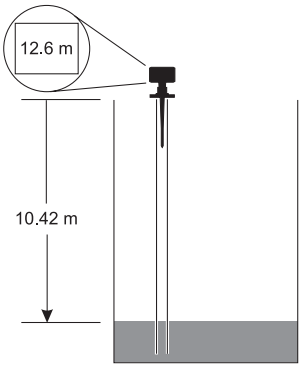
Values	Range: **0.000 to 1.000**
	Pre-set: 1

Pipe Size (i.d.)	Propagation Factor
50mm (2")	0.827
80mm (3")	0.915
100mm (4")	0.955
150mm (6")	0.980
20 mm (8")	0.990

Consult the factory for other sizes and propagation factor numbers.[Tim: who at the factory?]

Note: For waveguide antennas used as stillpipes, this value is on the product tag.

The propagation factor is constant for a given pipe diameter, or can be determined by comparing the radar distance reading to the actual process material distance (measured from the face of the IQ 300 flange).



$\frac{\text{actual distance}}{\text{IQ 300 distance}} = \text{p.f.}$

Using the readings shown:

$\frac{10.42\text{m}}{12.6\text{m}} = 0.827$

Enter the propagation factor: **0.827**

Rate Parameters

These parameters determine how material level changes are reported.

P700 Maximum Fill Rate

Adjusts the IQ 300 response to increases in the actual material level (or an advance to a higher Failsafe Material Level, P071).

Values	Range: **0.000 to 9999** (stored in meters)
Altered by	• P003 Measurement Response
Related Parameters	• P005 Units • P007 Span • P071 Fail-Safe Material Level

Enter a value slightly greater than the maximum vessel filling rate. This value, in Units (P005) or % of Span (P007) per minute, is automatically altered when Maximum Process Speed (P003) is altered.

P003 Value	Meters/Minute
1	0.1
2	1
3	10
4	100
5	1000

P701 Maximum Empty Rate

Adjusts the IQ 300 response to decreases in the actual material level (or an advance to a lower Failsafe Material Level, P071).

Values	Range: **0.000 to 9999** (stored in meters)
Altered by	• P003 Measurement Response
Related Parameters	• P005 Units • P007 Span • P071 Fail-Safe Material Level

Enter a value slightly greater than the vessel's maximum emptying rate. This value, in Units (P005) or % of Span (P007) per minute, is automatically altered when Measurement Response Speed (P003) is altered. Any emptying rate above this value will trigger any alarms set to **Rate**.

P003 Value	Meters/Minute
1	0.1
2	1
3	10
4	100
5	1000

P704 Rate Filter

Damps Rate Value (P707) fluctuations.

Values	**0**	rate display not required
	1	continuously filtered and updated
	2	update rate (use P705/P706)
Alters	• P707 Rate Value	
Related Parameters	• P705 Rate Update Time • P706 Rate Update Distance	

Enter the time or distance interval over which the Rate Value is to be calculated before the display updates.

This is automatically altered along with Measurement Response Speed (P003).

P705 Rate Update Time

Sets the time period (in seconds) over which the material level rate of change is averaged before Rate Value update.

Values	Range: **0.000 to 9999**
Related Parameter	• P707 Rate Value

P706 Rate Update Distance

The material level change (in metres) to initiate a Rate Value update.

Values	Range: **0.000 to 9999**
Related Parameter	• P707 Rate Value

P707 Rate Value

The rate of material level change (in Units (P005) or % of Span (P007) per minute).

Values (view only)	Display: **-999 to 9999**
Altered By	• P704 Rate Filler
Related Parameters	• P005 Units • P007 Span

A negative rate indicates the vessel is emptying.

Measurement Verification Parameters

P710 Fuzz Filter

Stabilizes the reported level due to level fluctuations (such as a rippling or splashing liquid surface) within the Echo Lock Window (P713).

Values	Range: **0 to 100** (0= off)
Altered by	• P003 Measurement Response
Related Parameters	• P007 Span • P713 Echo Lock Window

This value (in % of Span, P007) is automatically altered when Measurement Response Speed (P003) changes. The higher the value entered, the greater the range of stabilized fluctuation.

P711 Echo Lock

Selects the measurement verification process.

Values	**0**	off
	1	maximum verification
	2	material agitator
	3	total lock
Related Parameters	• P700 Maximum Fill Rate • P701 Maximum Empty Rate • P712 Echo Lock Sampling • P713 Echo Lock Window • P820 Algorithm	

If a material agitator (mixer) is used in the vessel monitored, set Echo Lock to **1** (maximum verification) or **2** (material agitator) to avoid agitator blade detection. To avoid stationary blade detection, ensure the agitator is always **ON** while the IQ 300 is monitoring the vessel.

When set for **1** (maximum verification) or **2** (material agitator), a new measurement outside of the Echo Lock Window (P713) must meet the sampling criterion (P712).

For **3** (total lock), Echo Lock Window (P713) is pre-set to **0** (zero). The IQ 300 continuously searches for the best echo according to the algorithm chosen (P820). If the selected echo is within the window, the window is then centered about the echo. If not, the window widens with each successive shot until the selected echo is within the window. The window then returns to its normal width.

When Echo Lock is **0** (off) the IQ 300 responds immediately to a new measurement, as restricted by the Max Fill/Empty Rate (P700/P701). However, measurement reliability is affected.

P712 Echo Lock Sampling

Sets the number of consecutive echoes appearing above or below the echo currently locked onto. Sampling ratio must occur before the measurements are validated as the new reading (for Echo Lock P711 values: 1 or 2).

Values	Range: **1:1 to 99:99** Format: x:y • x = the number of **above** echoes • y = the number of **below** echoes
Related Parameter	• P711 Echo Lock

P711 value	P712 pre-set value
1: max verification	5:5
2: material agitator	5:2

Example Settings:

- P711 = 2: material agitator
- P712 = 5:2

Results:

- A new reading will not be validated unless 5 consecutive measurements higher or 2 consecutive measurements lower than the current reading occurs.

Note: Resetting P711 returns P712 to the respective pre-set values.

P713 Echo Lock Window

Adjusts the new measurement changes permitted before the Echo Lock is applied.

Values	Range: **0.000 to 9999**
	Pre-set: 0.000
Altered by	• P003 Maximum Process Speed
Related Parameters	• P005 Units • P711 Echo Lock

The Echo Lock Window is a "distance window" (Units, P005) centered on the echo and used to derive the Reading. When a new measurement is in the window, it is re-centered and the new Reading calculated. Otherwise, the new measurement is verified by Echo Lock (P711) before the reading is updated.

When **0** is entered, the window is automatically calculated after each measurement. For slower values, the window is narrow; for faster P003 values, the window is wider.

Communication Parameters

The IQ 300 uses Modbus to establish communication parameters. To set the IQ 300 to either local programming or remote programming, go to P799. The Modbus Register Map is on.

P770 Serial Protocol

Sets the communications protocol used on the RS-485 port.

Values	**0**	Communications disabled
	1	Internal use only
	2	Modbus ASCII slave serial protocol
	3	Modbus RTU slave serial protocol

P771 Protocol Address

Allocates the unique identifier of the IQ 300 on the network for the RS-485 port.

Values	Range: **0 to 9999**
	Pre-set: 1

For devices connected with a serial Modbus slave protocol, this parameter is a number from 1-247. The network administrator must ensure that all devices on the network have unique addresses. Do not use the value **0** (zero) for Modbus communications because this is the broadcast address and is inappropriate for a slave device.

P772 Baud Rate

Sets the communication rate with the master device.

Values	**4.8**	4800 baud
	9.6	9600 baud
	19.2	19,200 baud
	38.4	38,400 baud

This specifies the rate of communication in Kbaud. Any value may be entered, but only the values shown are supported. The baud rate should reflect the speed of the connected hardware and protocol used.

P773 Parity

Sets the serial port parity for the RS-485 port.

Values	**0**	No Parity (default)
	1	Odd Parity
	2	Even Parity

Note: Ensure that the communications parameters are identical between the IQ Radar 300 and all connected devices.

Data Bits and Stop Bits

There are eight data bits and one stop bit.

P799 Communications Control

This parameter determines the read/write access to parameters via remote communications. If it has a value of **0**, then the user can only read parameters. If it has a value of **1**, then the user can read and write parameters. If it has a value of **2**, then the user can read/write P799, but can only read other parameters.

Values	**0**	Read only
	1	Read/write
	2	Restricted access – read only except for P799 which is read/write

Note: P000 and P799 are exclusive, but locks can be implemented in different ways.
- HART lock device command sets P000 to a locked value and sets P799 to 2
- The hand programmer retains control if P000 is set to **UNLOCK**.

Echo Processing Parameters

P800 Near Blanking

Sets the amount of blanking as measured from the flange face and extending into the measurement range. See Blanking on page 46.

Values	Range: **0 to 9999**
	Pre-set: 0.4m

Enter value in units of P005.

Note: This parameter may be set at the factory. If so, the appropriate values appear on the product tag.

P801 Range Extension

Sets the amount of range extension as measured from the empty distance (P006) and extending into the far-end blanking. See Blanking on page 46.

Values	Range: **0 to 99%**
	Pre-set: 5%

Enter value as a % of P006. The distance below empty is not blanked.

For tanks with conical or parabolic bottoms, increase this parameter to ensure that an empty tank reads empty.

P804 Confidence Threshold

Sets the minimum echo confidence in dB that the echo must meet in order to prevent a loss of echo condition and the expiration of the fail-safe timer (P070).

Values	Range: **0 to 99**
	Pre-set: 5
Related Parameters	• P070 Fail-Safe Timer

P805 Echo Confidence

Measures echo reliability.

Values (view only)	Display: **0 to 99**

Related Parameters	• P804 Confidence Threshold

P806 Echo Strength

Displays the strength of the selected echo, in dB above 1 µV rms.

Values (view only)	Display: **0 to 9**

P807 Noise

Displays the average and peak ambient noise (in dB above 1 µV RMS) being processed.

Values (view only)	x = average (-9 to 99)
	y = peak (-9 to 99)

The noise level is a combination of transient noise and electrical noise (receiving circuitry).

Algorithm Parameters

P820 Algorithm

Selects the algorithm to be applied to the echo profile in order to extract the true echo. [verify chart]

Values	**1**	ALF = flat **A**rea, **L**argest, and **F**irst average
	2	A = flat **A**rea only
	3	L = flat **L**argest only
	4	F = flat **F**irst only
	5	AL = flat **A**rea and **L**argest average
	6	AF = flat **A**rea and **F**irst average
	7	LF = flat **L**argest and **F**irst average
	8	bLF = smooth **L**argest or **F**irst
	9	bL = smooth **L**argest only
	10	bF = smooth **F**irst only

Select 1 for most applications and all mounting locations except the center of the vessel. Select 6 for the center of the vessel mounting location and for still pipes and waveguide antennas used as stillpipes.

TVT Adjustment Parameters

The following parameters are for authorized Milltronics Service personnel or Technicians familiar with Milltronics echo processing techniques.

P830 TVT Type

Selects the TVT Curve used.

Values	**1**	reserved
	2	reserved
	3	reserved
	4	Smooth 2 (Factory Set)
	5	reserved
	6	reserved
Related Parameters	•	P835 TVT Slope Min

Select the TVT type which gives the highest confidence (P805) under all level conditions. Use this parameter with caution, and do not use TVT Slopes with the **bF** or **bLF** Algorithm (P820).

P831 TVT Shaper

*Turns the TVT Shaper **ON** or **OFF**.*

Values	**0**	off
	1	on
Related Parameters	•	P832 TVT Shaper Adjust

Turn the TVT Shaper **ON** before using P832, and afterwards turn the TVT Shaper **ON** and **OFF** while monitoring the effect to pick up the true echo.

P832 TVT Shaper Adjust

Allows manual adjustment of the TVT curve.

Values	Range: **-50 to 50**
	Pre-set: 0
Related Parameters	• P831 TVT Shaper

Use this feature to bias the shape of the TVT curve to avoid crossing false echoes from fixed objects.

Adjustment to this parameter is best done while viewing the echo profile with Dolphin Plus. Refer to the Dolphin Plus online help for details. The TVT curve is divided into 40 breakpoints, accessible by enabling the point number as the breakpoint index field. Each breakpoint is normalized to a value of 0, as displayed in the parameter value field. By changing the breakpoint value, up or down, the intensity of the bias applied to that breakpoint of the curve is respectively changed. By changing the value of adjacent

breakpoints, the effective bias to the shaper can be broadened to suit the desired correction. In the case of multiple false echoes, shaping can be applied along different points of the curve. Shaping should be applied sparingly in order to avoid missing the true echo.

To change a breakpoint:

1. Confirm that P831, TVT shaper, is **ON**.
2. Go to P832
3. Press [↔] twice to highlight the index value
4. Press [▲] or [▼] to scroll through the 40 points (or type in the desired point)
5. Enter the value from –50 to 50
6. Press [↵]

P833 TVT Start Min

Use this feature to adjust the TVT Curve height to ignore false echoes (or pick up true echoes) near the start of the Echo Profile.

Values	Range: **30 to 225**
	Pre-set: 50
Related Parameters	• P834 TVT Start Duration

Enter the minimum TVT Curve start point (in dB above 1 uV RMS).

This feature should only be used if increased Near Blanking (P800) would extend farther than desired into the measurement range.

P834 TVT Start Duration

Use this feature in conjunction with TVT Start Min (P833) to ignore false echoes (or pick up true echoes) near the start of the Echo Profile.

Values	Range: **0 to 9999**
	Pre-set: 30
Related Parameters	• P833 TVT Start Min • P835 TVT Slope Min 77

Enter the time (in ms) for the TVT Curve to decrease from the TVT Start Min (P833) point to the TVT Curve baseline.

P835 TVT Slope Min

Enter the minimum slope (in dB/s) for the middle of the TVT Curve.

Values	Range: **0 to 9999**
	Pre-set: 200
Related	• P834 TVT Start Duration

Use this feature to adjust the slope declination, and use it in conjunction with TVT Start Duration (when a long flat TVT Type is selected) to ensure the TVT Curve remains above the false echoes in the middle of the Echo Profile. Alternatively, if TVT Type is set for **TVT Slopes** (P830 = 6), pre-set is 2000.

P837 Auto Near TVT

Use this feature to adjust the TVT Curve height to ignore false echoes near the start of the Echo Profile by placing the TVT above the current signal from 0m to 2m (78").

If the IQ 300 displays a full level, or if the reading fluctuates between a high level and a correct level, set this parameter to elevate the TVT in this region and to de-sensitize the receiver from any 'base noise' caused by internal antenna reflections and/or standpipe echoes.

Entry:

0 = Off (not used)
1 = Use Learned TVT
2 = Learn

Set Up:

1. Make sure material is at least 2.5m (78") away.
2. Press the **PROGRAM** key, press the **TOGGLE** key, and then select P833.
3. Press '2' and then press the **ENTER** key.
4. Press '1' and then press the **ENTER** key.

Press the **PROGRAM** key to return to **RUN** mode.

Test Parameters

P900 Software Revision

Displays the EPROM software revision level.

Values (view only)	Range: **00.00 to 99.99**

P901 Memory

Tests the memory. Test is initiated by scrolling to the parameter or repeated by pressing the **ENTER** key.

Values (view only)	**PASS**	normal
	FAIL	consult Milltronics

P904 Keypad

Press each keypad key in the following sequence:

As each key is pressed, the associated keypad number is displayed. On successful test completion, the display reads **PASS**. The display reads **FAIL** if a key is pressed out of sequence or the programmer keypad malfunctions.

P911 mA Output Value

Displays the current value of the mA output in MilliAmps.

Values	Range: **0.00 to 20.00**

When P201 is set to **0** (manual), a test value can be entered and the displayed value is transmitted to the output. Upon returning to the run mode, this value will remain. For all other mA output functions, this parameter is read only.

P920 Reading Measurement

*Displays the reading measurement that the unit is programmed for in **RUN** mode (P001, operation).*

Values (view only)	units showing Level/Space/Distance

P921 Material Measurement

Displays the reading measurement as though the unit were programmed to read Level (P001 = 1).

P922 Space Measurement

Displays the reading measurement as though the unit were programmed to read Space (P001 = 2).

P923 Distance Measurement

Displays the reading measurement as though the unit were programmed to read Distance (P001 = 3).

P924 Volume Measurement

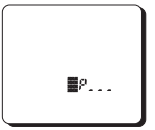
The calculated vessel capacity in Max Volume (P051) or % of Max Volume.

Values	Range: 0.000 to 9999
Related Parameters	• P051 Maximum volume

P999 Master Reset

Resets parameters to their factory setting.

1. Press the **PROGRAM** key [▤] to activate the **PROGRAM** mode.



2. Enter **999**.

3. Press the **CANCEL** key [c] and then the **ENTER** key [↵] to Clear All and initiate reset.

4. Reset complete. **Note**: reset takes several seconds to complete.

Communications: Modbus Register Map

The memory map of the IQ-300 occupies the Modbus holding registers (R40,001 and up). A description of the types of data is on the following pages. The table legend is at the bottom of the table. This map is used when protocol is Modbus RTU slave or Modbus ASCII slave. The table legend is located at the end of the table.

Register Map for Most Common Data

Legend	
Type	The type of data held in the group of registers.
Start	The first register to hold the referenced data.
Data Type	The possible values of the data in the register. See Data Types on page 85 for more information.
Description	The type of data held in the individual registers.
#R	The number of registers used for the referenced data.
Read/Write	Indicates whether the register is readable, writeable, or both.

Type	Description	Start	#R [8]	Data Type	Read/ Write
ID	Milltronics Product Code	40,064	1	3	R
Single Parameter Access (SPA)		R40,090	7	see appendix III	
Point Data	Reading (1)	41,010	1	-20,000 to 20,000	R
	Volume (1)	41,020	1	-20,000 to 20,000	R
I/O Data	mA Output	41,110	1	0000 to 20,000	R/W
Parameter Access		43,997 to 44,999			R/W

The IQ Radar 300 was designed to make it easy for master devices to get useful information via Modbus. This chart gives an overview of the different sections. A more detailed explanation of each section follows below.

Product ID (R40,064)

This value identifies the Milltronics device type. For the IQ Radar 300, the value is 3.

Point Data (R41,010 – R41,031)

Measurement point data contains the current reading on the instrument. This is the same as shown on the device's LCD for reading, and volume for the measurement point. The reading is based on the unit's operation, and could be level, distance, or volume. See the IQ 300 Parameter Descriptions on page 55 for details.

8 Maximum registers shown, fewer may be used depending on options installed.

The measurement registers is 41,010.

The available register

Data	Registers	Parameter
Reading	41,010	P920
Volume	41,020	P924
Temperature	41,030 and 41,031	P912

The reading is expressed as a percentage of full scale, multiplied by 100:

Reading	Value
0	0.00%
5000	50.00%
7564	75.64%
20,000	200.00%

Input/Output (R41,070 – R41,143)

The IQ 300 has one mA output.

mA Output (R41,110)

The mA output is scaled from 0 to 2,000 (0 to 20mA multiplied by 100). Displayed in P911.

Parameter Access (R43,997 – R46,999)

Parameter values are given as integers in the range of registers from R44,000 to R44,999. The last three numbers of the register correspond to the parameter number.

Parameter Register #	Format Register #	Parameter #
44,000	46,000	P000
44,001	46,001	P001
44,002	46002	P002
…	…	…
44,999	46,999	P999

The parameters are usually all read/write.

Note:

- Parameters P000 and P999 are read only. If P000 is set to **LOCK ON** then all of the parameters are read only.
- Parameter P999 (Master Reset) cannot be used via Modbus.
- See Data Types on page 85 for a description of the different types of data associated with different parameters.

However, before a parameter can be read or written to, the format (where decimal place is) and the indexes must be defined.

Format Word (R43,997)

Format word is an unsigned integer that contains a value that represents a certain decimal offset.

The decimal offset indicates how the remote system must interpret the integer value that is stored in the parameter access register. The following table shows how different parameter values can be shown based on a register value (integer) of **1234**.

Decimal	Offset	Example
0	0	1,234
1	-1	12,340
2	-2	123,400
3	-3	1,234,000
4	-4	12,340,000
5	-5	123,400,000
6	+1	123.4
7	+2	12.34
8	+3	1.234
9	Percent	12.34%

Examples of using the format word for both the index values and the decimal offset value are shown below:

Format	Decimal
0	0
3	3 right
8	3 left
9	percent

Primary Index (P43,999) and Secondary Index (P43,998)

Many parameters are indexed. There are two possible indexes, a primary index and a secondary index. If there is not an index, enter a value of **1**.

Reading Parameters

To read parameter values, follow the steps listed in either the Global or the Parameter Specific Index Method that follow. You must be able to program your HMI or SCADA system before completing these methods.

1. Write the primary index value into R43,999.

This is a value between 0 and 40 which specifies the input or output indexed by the parameter.

Examples (P920, primary index 1)

2. Write the secondary index value into R43,998.

This is a value between 0 and 40 that specifies the secondary index on the parameter. This value is usually 0.

3. Write the desired format value into R43,997 [such as??].

4. Read the value from the appropriate parameter register.

Types of values are:

- Numeric Values on page 85.
- Split Values on page 85.
- Text Messages on page 86.

A value of 22,222 indicates that an error has occurred. Specify a different format type and try again.

Writing Parameters

The method of writing parameters is similar to the method of reading them. Become familiar with Reading Parameters, page 83, before attempting to write any parameters.

Writing parameter values to the IQ 300:

1. Write the primary index value into R43,999.

2. Write the secondary index value into R43,998.

3. Write the desired format value into R43,997.

4. Write the value to the appropriate parameter register.

Communications: Data Types

The IQ Radar 300 parameters do not always use integers to hold values. For the convenience of the programmer, those values are converted to and from a 16-bit integer number. This section describes the conversion process.

Numeric Values

Numeric parameter values are the most common. For example, parameter P920 (Reading) returns a number that represents the current reading (either level or volume, depending on the IQ-300 configuration).

Numeric values are requested or set in units or percent of span, and may be specified using a number of decimal places.

Numeric values must be in the range -20,000 to +20,000 to be valid. If a parameter is requested and its value is more than +20,000, the number 32,767 is returned; if it is less than -20,000, the number -32,768 is returned. If this overflow happens, decrease the number of decimal places.

If a parameter cannot be expressed in terms of percent of span, or has no meaningful value, the number 22,222 is returned. Try requesting the parameter in units, or refer to the Parameter Description section on page 55 for an explanation of the format and use of the requested parameter.

Split Values

Certain parameters are actually a pair of numbers separated by a colon, using this format: **xx:yy**.

One example is P807 (Transducer Noise) where:

xx = the average noise value in dB.
yy = the peak noise in dB.

The number which corresponds to xx:yy, for either reading or setting a parameter, is determined by the following formula:

For storing to the device:

value = (xx + 128) x 256 + (yy + 128)

For reading from the device:

xx = (value / 256) – 128
yy = (value % 256) – 128

Where:

% is the modulus operator.

The modulus can be computed by following these steps:

$value_1$ = value / 256
$value_2$ = remainder of $value_1$
$value_3$ = $value_2$ x 256
yy = $value_3$ – 128

It may simplify Parameter to notice:
xx = (most significant byte of value) – 128
yy = (least significant byte of value) – 128

Text Messages

If a device parameter returns a text message, that message is converted to an integer and is then provided in the register. The numbers are shown in the following table:

Number	Text Message as displayed on LCD
22222	Invalid value
30000	Off
30001	On
30002	≡ ≡ ≡ ≡
30003	[ ]]] (parameter does not exist)
30004	Err
30005	Err1
30006	Open
30007	Short
30008	Pass
30009	Fail
30010	Hold
30011	Lo
30012	Hi
30013	De
30014	En
30015	- - - - (parameter has not been set)
-32768	Value is less than -20,000
32767	Value is greater than 20,000

Error Handling

Modbus Responses

When polled by a Modbus Master, a slave device will do one of the following:

1. Not reply. Which means that something went wrong with the transmission of the message.

2. Echo back the command with the correct response (see the Modbus specification for more details). This is the normal response.

3. Return an Exception Code. This reflects an error in the message.

IQ Radar 300 uses the following exception codes:

Code	Name	Meaning
01	Illegal Function	The function code received in the query is not an allowable action for the slave.
02	Illegal Data Address	The data address received in the query is not an allowable address for the slave.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the slave.

Error Handling

Errors can be traced to two general sources:

5. There is an error in transmission.

or

6. The host tries to do something that is not a valid action.

In the first case, the IQ 300 does not respond and the master waits for a **Response Time Out** error, which causes the master to re-send the message.

In the second case, it depends on what the host tries to do. In general, IQ 300 will not give an error to the host request. Various actions and the expected outcome are as follows:

- the host reads an invalid register, the host will get an undetermined value back.

- If the host writes an invalid register (a non-existing parameter or a read only parameter), the value will be ignored and no error response will be made. However, the current value will not reflect the desired new value.

- If the host writes a read only register, then the value will be ignored and no error response will be made. However, the current value will not reflect the desired new value.

- If P000 is activated, then the value will be ignored and no error response will be made. However, the current value will not reflect the desired new value.

- If the host attempts to write one or more registers that are out of range, an exception response code 2 or 3 is generated depending if the start address is valid.

- If the host attempts to read one or more registers that are out of range, an exception response code of 2 or 3 is generated.

- If the host used an unsupported function code, an exception response code of 01 should be generated. However, this is not guaranteed and there may be no response.

Troubleshooting

Communication Troubleshooting

Generally

1. Check the following:

    - There is power at the unit
    - The LCD shows the relevant data
    - The device can be programmed using the hand programmer

2. Check the wiring pin outs and verify that the connection is correct.

3. Verify that values in set-up parameters P770 to P773 match the settings in the computer communicating with the unit.

4. Check that the port you are using on the computer is correct. Sometimes trying a different Modbus driver will solve the problem. An easy stand-alone driver called ModScan32 is available from Win-Tech at www.win-tech.com. We have found that this driver is useful to test communications.

Specifically

1. You try to set an IQ 300 parameter via remote communications, but the parameter remains unchanged.

    - Some parameters can only be changed when the device is not scanning. Try putting the device in program mode using the operating mode function.
    - Try setting the parameter from the keypad. If it can not be set using the keypad, check the lock parameter and set it to **1954**.
    - The communications control parameter P799 must be set to **1** to be able to write parameter to the IQ 300.

Operation Troubleshooting

Operating symptoms, probable causes, and resolutions.

Symptom	Cause	Action
display reads 	level or target is out of range	• check specifications • check parameters
display reads 	material build-up on antenna	• clean • re-locate IQ 300
display reads 	location or aiming: • poor installation • flange not level • standpipe not vertical	• check to ensure standpipe is vertical
display reads 	antenna malfunction: • temperature too high • physical damage • excessive foam	• inspect • use foam deflector or stilling well • relocate • use a defoamer
Reading does not change, but the level does	IQ 300 processing wrong echo, i.e. vessel wall, or structural member	• re-locate IQ 300 • check standpipe for internal burrs or welds • increase blanking, P800
Measurement is consistently off by a constant amount	P006 not correct P652 not correct	• Check distance from Flange face to zero level (P006) • Check offset value (P652) or device tag
Screen blank	power error	• check nameplate rating against voltage supply • check power wiring or source
Reading erratic	echo confidence weak	• refer to P805 • use foam deflector or stilling well
	liquid surface vortexed	• decrease measurement response P003 • increase confidence threshold P804
	material filling	• re-locate IQ 300
Reading response slow	P003 setting	• increase response if possible

Symptom	Cause	Action
Reads correctly but occasionally reads high when vessel is not full	• detecting close range echo • build up near top of tank or nozzle • water or other high ε_r material in antenna threads • wrong antenna choice for application • stand pipe problem	• increase blanking • increase confidence threshold P804 • rod extensions may be required • See Application Example: Stillpipe on page 53
Level reading lower than material level	• material is within near blanking zone • tank near empty and low ε_r material • multiple echoes processed	• decrease blanking P800 (min. 0.4 m) • raise IQ 300 • decrease range extension • install still pipe deflector (contact Milltronics) • set P820 to '6'
	• Standpipe too narrow for length	• See Rod Extension Requirements on page 26
	• Internal seam in standpipe	• Inspect and remove seam

Maintenance

The IQ Radar 300 requires no maintenance or cleaning under normal operating conditions.

Note: Under severe operating conditions, the antenna may require periodic cleaning.

Appendix I

Alphabetical Parameter List

Parameter Name	Parameter Number	Page Number
Auto Near TVT	837	78
Auto Record Filling/Emptying	336	66
Auto Record Enable	331	65
Auto Record LOE Time	337	67
Auto Record Interval	333	65
Auto Record Off Setpont	335	66
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Algorithm	820	75
Antenna	004	56
Baud Rate	772	73
Breakpoint Levels	P054	60
Confidence Threshold	804	74
Decimal Position	060	61
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Echo Confidence	805	74
Echo Lock	711	71
Echo Lock Sampling	712	71
Echo Lock Window	713	72
Echo Strength	806	75
Empty	006	57
Fail-Safe Level Advance	072	62
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Fail-Safe Timer	070	60
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Keypad	904	79
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mA Function	201	63
mA Output Fail-Safe	219	64
04/ mA Output Setpoint	210	63
mA Output Value	911	79
mA Range	200	62
mA Setpoint	211	63
mA Trim	214/215	64/64
Master Reset	999	80

Appendix II

Programming Chart

Number	Parameter Name	Value
001	Operation	
002	Material	
003	Measurement Response	
004	Antenna	
005	Units	
006	Empty	
007	Span	
050	Tank Shape	
051	Max Volume	
052	Tank Dimension 'A'	
053	Tank Dimension 'L'	
054	Breakpoint Level	
055	Volume Breakpoints	
060	Decimal Position	
062	Offset Reading	
063	Minimum Reading	
070	Fail-Safe Timer	
071	Fail-Safe Material Level	
072	Fail-Safe Level Advance	
200	mA Range	
201	mA Range	
210	0/4mA Output Setpoint	
211	20mA Setpoint	
214	mA Trim	
215	mA Trim	
219	mA Output Fail-Safe	
330	Profile Record	
331	Auto Record Enable	
333	Auto Record Interval	
334	Auto Record ON Setpoint	
335	Auto record OFF Setpoint	
336	Auto Record Filling/Emptying	
337	Auto Record LOE Time	
341	Run Time	
652	Offset Correction	
655	Propagation Factor	
700	Maximum Fill Rate	
701	Maximum Empty Rate	
704	Rate Filter	
705	Rate Update Time	
706	Rate Update Distance	
707	Rate Value	
710	Fuzz Filter	
711	Echo Lock	
712	Echo Lock Sampling	

Number	Parameter Name	Value
713	Echo Lock Window	
770	Serial Protocol	
771	Protocol Address	
772	Baud Rate	
773	Parity	
799	Communications Control	
800	Near Blanking	
801	Range Extension	
804	Confidence Threshold	
805	Echo Confidence	
806	Echo Strength	
807	Noise	
820	Algorithm	
825	Echo Marker Trigger	
830	TVT Type	
835	TVT Slope Min	
837	Auto Near TVT	
900	Software Revision	
901	Memory	
904	Keypag	
911	mA Output Value	
920	Reading Measurement	
921	Material Measurement	
922	Space Measurement	
923	Distance Measurement	
924	Volume Measurement	

Appendix III

Single Parameter Access (SPA)

This appendix provides advanced communication information to qualified personnel, enabling access to any parameter value in any available format.

Built into the IQ Radar 300 is an advanced handshaking area used to read and write single registers to the unit. This section performs function similar to the Parameter Descriptions section on page 55, with two qualifiers:

1. Advanced section is more powerful and harder to program.

2. Advanced section only gives you access to one parameter at a time.

Mapping

Parameter Read and Write (40,090 – 40,097) is a series of eight registers used for reading and writing parameter values to and from the IQ 300. The first three registers are always unsigned integers representing parameters and index values. The second five registers are the format and value(s) of the parameter.

All parameters normally accessed through the hand-held programmer are available through these registers.

Address	Description
40,090	Parameter (integer)
40,091	Primary Index (integer)
40,092	Secondary Index (integer)
40,093	Format word (bit mapped)
40,094	Read value, word 1
40,095	Read value, word 2
40,096	Write value, word 1
40,097	Write value, word 2

Reading Parameters

Complete the following to read parameters through Modbus:

1. Send the parameter, its primary index, and its secondary index (usually 0), and format to registers 40,090 to 40,093.
2. Wait until you can read the written values from the registers (40,090 to 40,093) to confirm that the operation is complete.
3. Read the value from registers 40,094 and 40,095.

Writing Parameters

Complete the following to set parameters through Modbus:

1. Send the parameter, its primary index, and its secondary index (usually 0) to registers 40,090, 40,091, and 40,092.
2. Write the value to registers 40,096 and 40,097.
3. Write the desired format word to register 40,093 to enable the IQ-300 to interpret the value correctly.

Format Register

Bits	Values	Description
1-8	0-2	Error Code
9-11	0-7	3-bit number representing decimal offset
12	0/1	direction of offset (0 = right, 1 = left)
13	0/1	Numeric format: Fixed (0) or Float (1)
14	0/1	Read or Write of data, Read (0), Write (1)
15	0/1	Word order: Most Significant Word first (0), Least Significant Word first (1)
16		Reserved

For example, to format the level reading so that it is shown in percent with two decimal places shifted left, the format bits would look like this:

Bit Numbers	16	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01
Bit Values	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	reserved	most significant first	read	fixed format	offset direction to right	decimal offset of 2			no error code							

The value sent to the IQ 300 is 0000001000000000 binary or 4608 decimal. The value **4608** is sent as an integer to register 40,093 to format the output words 40,094 and 40,095 accordingly.

If the numeric data type is set for integer and the value contains decimal places, they are ignored. In this situation, use the decimal offset to ensure that you have an integer value and then write your code to recognise and handle the decimal offset.

Error Codes

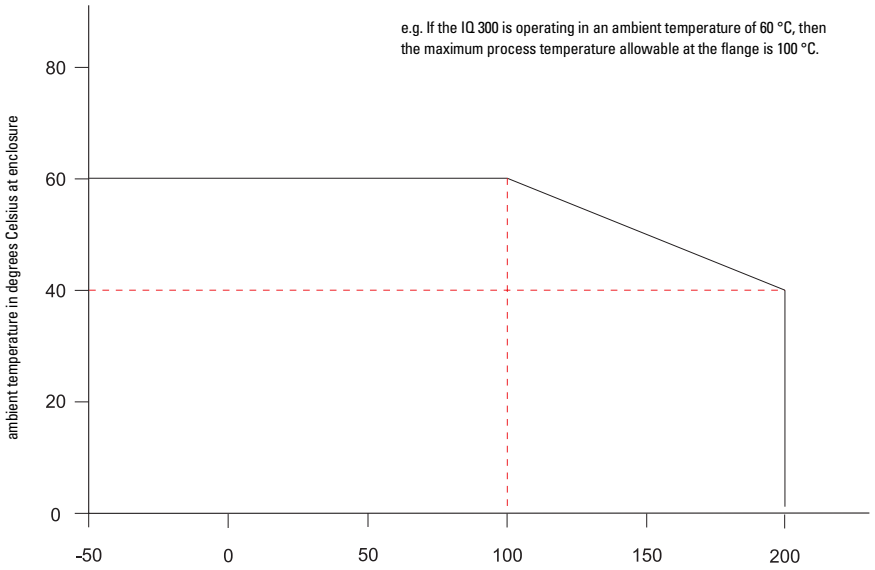
The error codes returned in the format area are 8-bit integers, found in the lowest 8 bits of the format word. This allows for 256 potential error codes.

There are currently two error codes available in the IQ 300.

Values	Description
0	No error
1	Data not available as percent (available as units)
2-255	Reserved

Appendix IV

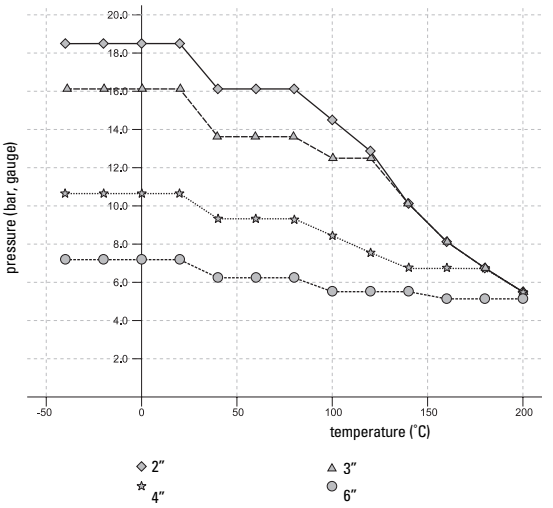
Temperature De-rating



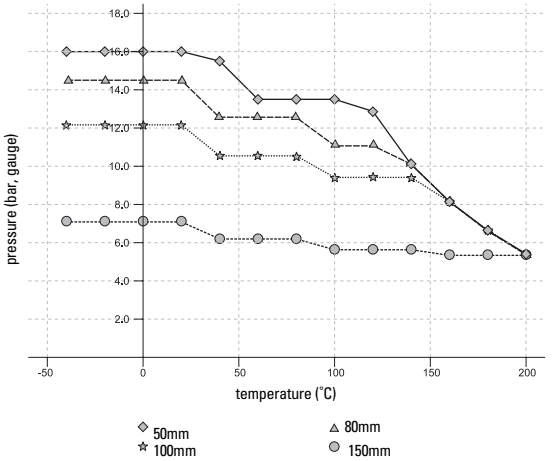
Process temperature in degrees Celsius at IQ 300 flange.

Note: UHMW-PE is limited to a maximum continuous service temperature of 80°C / 176°F.

Rod Antenna ANSI Hole Pattern, 150#[9, 10]



Rod Antenna DN Hole Pattern, PN16[9, 10]

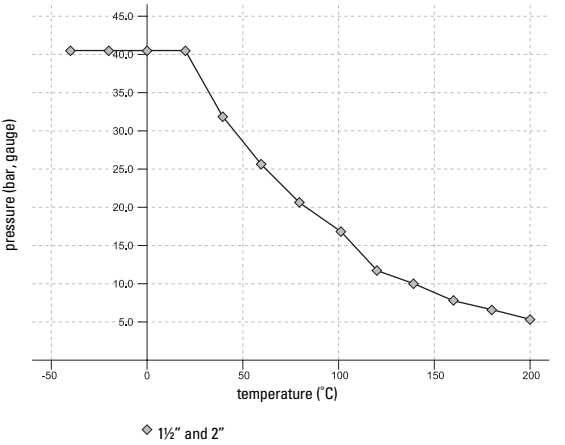


Appendix IV

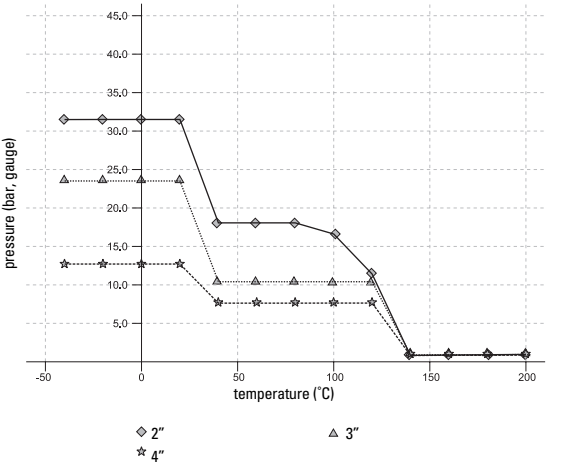
9 UHMW-PE antennas are rated to a maximum of 80°C (176°F) of continuous duty.

10 Customer to provide adequate bolting to retain vessel pressure and provide sufficient sealing.

Rod Antenna Threaded Connection



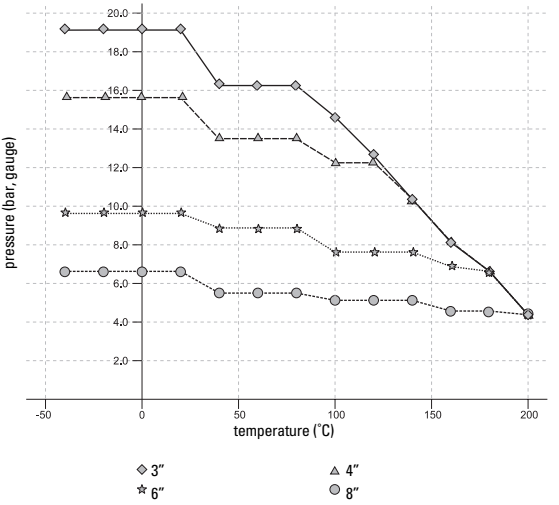
Rod Antenna Sanitary Connection[11]



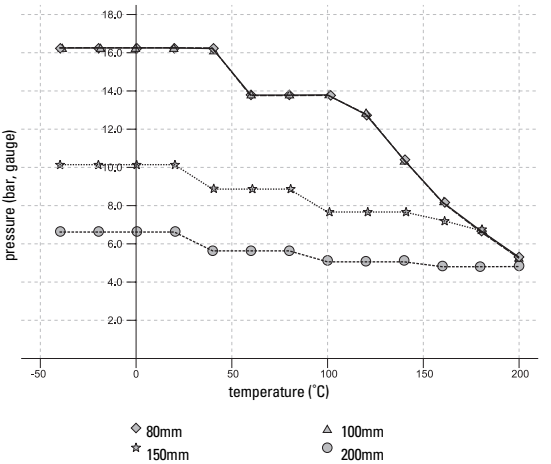
Appendix IV

11 UHMW-PE antennas are rated to a maximum of 80°C (176°F) of continuous duty; however, they can be used for periods of up to 3 hours at temperatures up to 120°C (248°F) at 1 bar pressure.

Horn Antenna or Wave Guide – ANSI Hole Pattern, 150#[12]



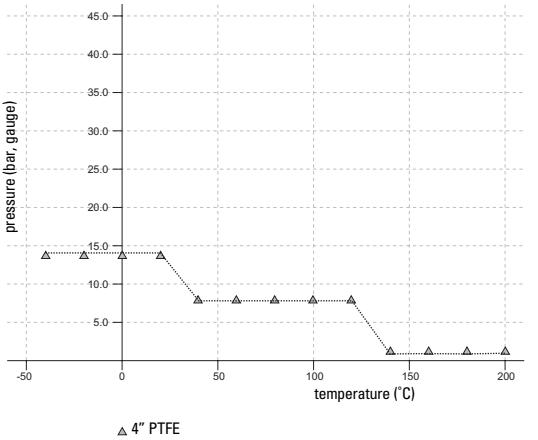
Horn Antenna or Wave Guide DN Hole Pattern, PN16[12]



Appendix IV

12 Customer to provide adequate bolting and flat-faced gasket to retain vessel pressure and provide sufficient sealing.

Horn Antenna Sanitary Connection



Appendix IV

Appendix V

BZT Approval – English

Regulierungsbehörde für Telekommunikation und Post

Telecommunications

Decree 39/1998
General Licence No. 826 Intended for common use when employing transmission and reception plants of MILLTRONICS LIMITED company, Worcester, England.

1. Based on § 47 par. 1 and 5 of the Telecommunications Law (TKG) from July 25th, 1996 (BGBl. I.S. 1120, the frequency 5.8 GHz is assigned as General Assignment for common use when employing transmission and reception radio plants distributed by MILLTRONICS LIMITED company, Worcester, England, and characterized by the designation "IQ Radar". These radio plants are used for level measurement in chemical Industry plants with maximum radiating capacity of 30uW and a bandwidth of up to 1.3GHz. This General Assignment does not exclude further assignments of the same frequency for similar or equal purposes when using other devices.
2. The radio plants must be identified as follows: "Bundesadler"(Federal Eagle Symbol), assignment number "BZT G750826K", company name "MILLTRONICS LIMITED, Worcester, England" and identification "IQ Radar".
3. The use of this frequency must not Interfere with other telecommunication or radio plants.
4. This General Assignment does not provide any protection for users of such radio plants against frequency interferences by users operating in the same frequency range.

Additional Information for the distributor and users of radio plants sold under this General Assignment

1. There is no need for particular frequency assignment or for conformity rating as ruled by §61 of the Telecomunications Law. If the radio plants sold for this frequency use and for this purpose comply electrically and mechanically with a design technically proofed by an accredited testing lab and if they are identified as described under #2 of the above mentioned regulations.
2. The identification label must be applied to the radio devices' enclosure, either on a nameplate or in an appropriate location on the enclosure. When stamped or engraved, it must be visible. The identification must be time and wear resistant and must be fixed in such a way to the enclosure, in order that any attempted removal of the latter will cause it to tear. It must always be visible from the outside.
3. The distributing company has to add a complete reprint of this General Assignment to each device for sale under the above mentioned approval.
4. The General Assignment allows for interconnection of the radio plants with other telecommunication plants, provided there is a need to do so. In this case, the corresponding technical requirements and legal requirements for telecommunication must be respected. If the telecommunication plants to be interconnected with the radio plants are linked to public telecommunication networks, the interconnection is subject to a preceding written authorization by the Telecommunications and Mail Regulation Service. For further information, please contact the responsible offices of this Service.
5. The above mentioned transmission and reception radio plants must comply with the EMVG directives, and consequently include CE identification.
6. The General Assignment does not deal with the security of persons in electromagnetic fields, nor with the electrical or mechanical security of radio plants, including antenna plants. Those are subject to special regulations and directives.
7. The General Assignment only applies to frequency use in its legal aspect for telecommunication. It does not involve any other directives, even if they concern legal aspects for telecommunication, and third-party rights, particularly additional permissions and approvals, if required, with regards to construction and private jurisdiction, for example.

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BZT Approval – German Original Text

Regulierungsbehörde für Telekommunikation und Post

Fernmeldewesen

Vfg 39/1998
Allgemeinzuteilung Nr. 826 für die Benutzung durch die Allgemeinheit unter Verwendung von Sende- und Empfangsfunkanlange der Firma MILLTRONICS LIMITED, Worcester, England.

1. Hiermit wird auf Grund § 47 Abs. 1 und 5 des Telekommunikationsgesetzes (TKG) vom 25. Juli 1996 (BGBl. I S. 1120) die **Frequenz 5,8 GHz** als Allgemeinzuteilung für die Benutzung durch die Allgemeinheit unter Verwendung von Sende- und Empfangsfunkanlagen der **Vertriebsfirma MILLTRONICS LIMITED, Worcester, England**, mit der Typenbezeichnung "**IQ Radar**" zugeteilt, Diese Funkanlagen dienen der **Füllstandsmessung in Anlagen der chemischen Industrie** mit einer Strahlungsleistung von maximal 30 uW und einer belegten Bandbreite von bis zu 1,3 GHz. Diese Allgemeinzuteilung schließt weitere Zuteilungen der gleichen Frequenz zu ähnlichen oder gleichen Zwecken unter Verwendung anderer Geräte nicht aus.
2. Die Funkanlagen sind wie folgt zu kennzeichnen: **Bundesadler**, Zulassungsnummer "**BZT G750826K**", sowie der Name der Vertriebsfirma MILLTRONICS LIMITED, Worcester, England und der Typenbezeichnung "*IQ Radar*".
3. Im Rahmen dieser Frequenznutzung dürfen andere Telekommunikationsanlagen sowie andere Funkanlagen nicht gestört werden.
4. Im Rahmen dieser Allgemeinzuteilung besteht für die Benutzer solcher Funkanlagen keinerlei Schutz vor frequenzmäßigen Beeinträchtigungen durch andere Frequenznutzer im gleichen Frequenzbereich.

Zusatzhinweise für die Vertriebsfirma und die Benutzer einer unter dieser Allgemeinzeteilung in den Verkehr gebrachten Funkanlage

1. Es bedarf keiner weiteren Frequenzzuteilung und keiner Konformitätsbewertung im Sinne des § 61 TKG im einzelnen, wenn die für diese Frequenznutzung und diesen Verwendungszweck in Verkehr gebrachten Funkanlagen mit dem bei einem akkreditierten Prüflabor technisch geprüften Baumuster elektrisch und mechanisch übereinstimmen und wie unter Ziffer 2 der o. a. Bestimmungen beschrieben, gekennzeichnet sind.
2. Die Kennzeichnung ist am Gehäuse der Funkanlagen, entweder auf einem Typenschild oder an örtllich zusammenhängender Stelle, wenn die Form einer Prägung oder Gravur gewählt wird, an gut sichtbarer Stelle anzubringen. **Die Kennzeichnung muß dauerhaft und abnutzungssicher ausgeführt und so mit dem Gehäuse verbunden sein, daß sie beim Entfernen zerstört wird. Sie muß von außen jederzeit sichtbar sein.**
3. Die Vertriebsfirma dieser Funkanlagen ist verpflichtet, jedem unter dem o. g. Zulassungszeichen in den Verkehr zu bringenden Funkgerät einen vollständigen Nachdruck dieser Allgemeinzuteilung beizufügen.
4. Auf Grund dieser allgemeinen Frequenzzuteilung düfen diese Funkanlagen mit anderen Telekommunikationsanlagen zusammengeschaltet werden, soweit dafür ein Bedarf besteht und die jeweiligen technischen und telekommunikationsrechtlichen Anforderungen erfüllt werden.

   Sofern die Telekommunikationsanlangen, mit denen diese Funkanlagen zusammenschaltet werden sollen, mit öffentlichen Telekommunikationszetzen verbunden sind, bedarf diese Zusammenschaltung der vorherigen schriftlichen Genehmigung der Regulierungsbehörde für Telekommunikation und Post (Reg TP). Entspreschende Auskünfte erteilen die zuständigen Außenstellen der Reg TP.
5. Die obengenannten Sende- und Empfangsfunkanlagen müssen die Vorschriften des EMVG erfüllen, also auch eine CE-Kennzeichnung tragen.
6. Diese allgemeine Frequenzzuteilung hat weder die Sicherheit von Personen in elektromagnetischen Feldern noch die elektrische und mechanische Sicherheit der Funkanlagen einschließlich der Antennenanlagen zum Gegenstand. Hierfür gelten die einschlägigen Bestimmungen und Vorschriften.
7. Diese allgemeine Frequenzzuteilung betrifft nur telekommunikationsrechtliche Aspekte der Frequenznutzung. Sonstige Vorschriften, auch telekommunikationsrechtlicher Art, und Rechte Dritter, insbesondere ggf. zusätzliche erforderliche Zulassungen und Genehmigungen, z. B. baurechtlicher oder privatrechtlicher Art bleiben unberührt.

Amtsblatt 7/98