Quick Reaction Perimeter Intrusion Detection Sensor
(QUPID – Form C)

Installation and Users Manual

14 JUNE 2002
REVISION 2

QUPID INSTALATION AND USERS MANUAL

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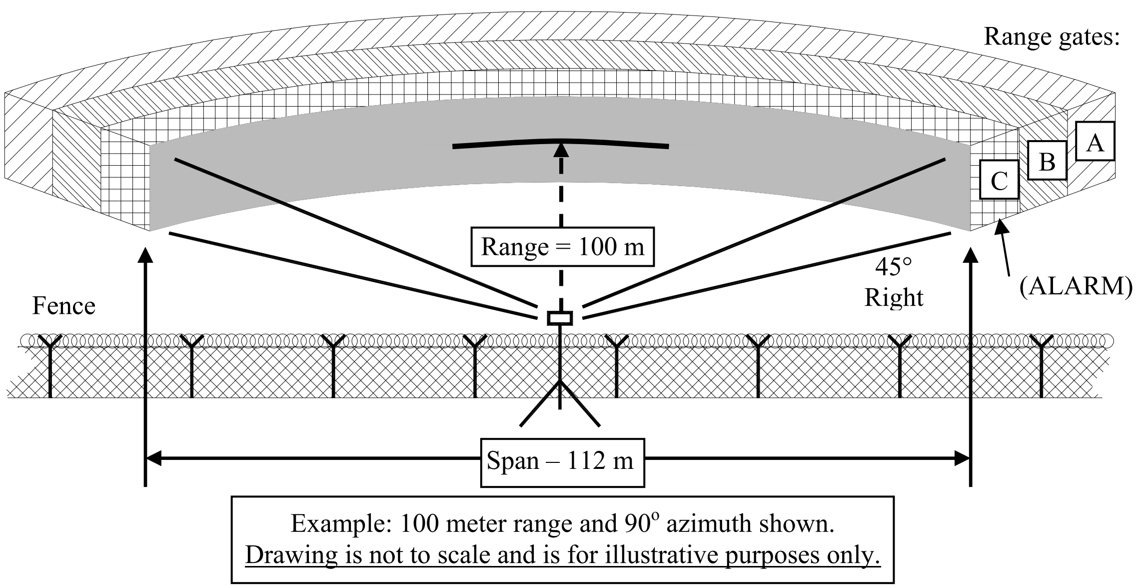
1.0 OVERVIEW

1.1 The QUPID sensor is a rapidly deployable, easily transportable and quickly relocatable security sensor for a variety of applications. This sensor utilizes Ultra Wide Band radar technology operating in the "S" band (2.0 to 2.4 GHz), with a very low average transmit power output of less than 5 milliwatts. The sensor is used to detect intrusion towards a protected area or asset, prior to the intruder reaching the perimeter. In this application, the sensor performs as a "beyond the fence" perimeter intrusion detection device.

1.2 The general detection zones for a nominal range of 100 meters is illustrated below in Figure 1-1. As shown in this figure, the basic detection pattern is a 90^{o} semi-circular arc with an alarm radius of 100 meters. Note that in addition to 100 meters, ranges of either 70 or 30 meters can also be selected. QUPID will indicate an intrusion by detection of an intruder sequentially passing through range gates A, B and then C (the alarm range setting).

Figure 1-1 QUPID Range Gate Detection Pattern (100 Meter Example)



1.3 The span of coverage of the sensor is defined here as the linear distance (chord) to the +/- 45° points. This is also the maximum distance between a line of sensors to ensure overlapping coverage. The sensor range and the fixed sensor angle of coverage of +/- 45° about the centerline determines this distance. For the 100 meter case illustrated, the span of coverage is 112 meters.

NOTE: Details for detection zone as a function of range setting is given in Section 5.0, under Constraints and Limitations.

2.0 COMPONENTS

The following components are required to establish one (1) detection zone with QUPID.

1. Universal Mounting Bracket (UMB).

2. QUPID sensor with attached UMB mounting plate and auxiliary antenna reflectors.

3. Other miscellaneous items required for installation and setup:

- #2 Phillips screwdriver
- Flat blade screwdriver
- Compass

3.0 INSTALLATION PROCEDURES

Unpack sensor with attached antenna reflector and place on clean surface as shown in Figure 3-1.

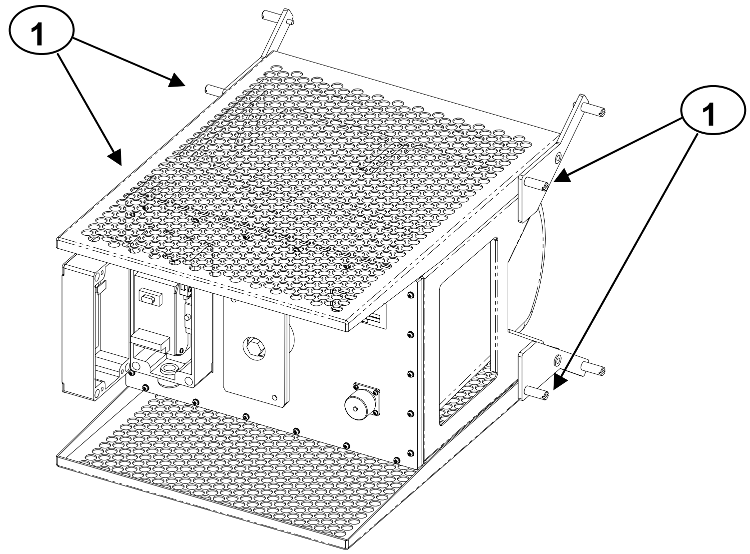


Figure 3-1 QUPID Sensor and Folded Antenna Reflector

3.1 Unscrew the captive thumb screws (Figure 3-1, Item 1), one on each side of each antenna reflector, until the spring on the screw pushes the screw clear of the threaded hole.

3.2 Carefully unfold antenna reflectors as shown in Figure 3-2, Item 1. At approximately a 30° angle, the mating threaded holes and the thumb screws on the side angle support will align. Push in on the spring loaded thumb screws, Figure 3-2, Item 2, located on both sides of each antenna reflector, and tighten.

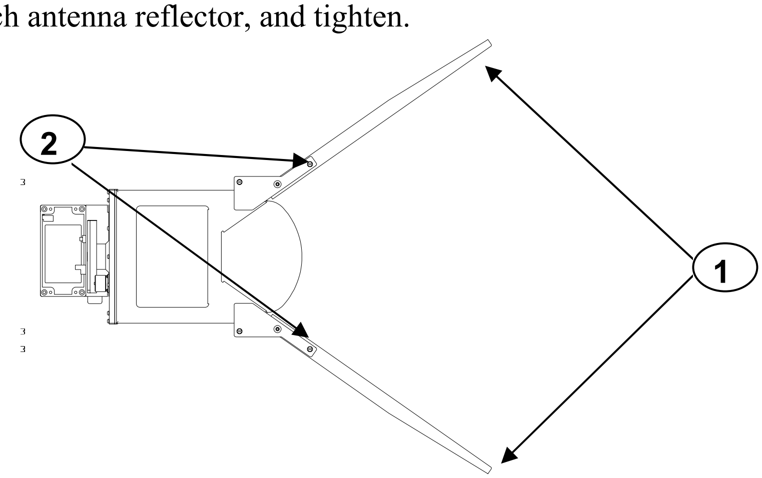


Figure 3-2 Deploy Antenna Reflectors

3.3 Range Adjustment: Unscrew the protective cap (Figure 3-3, Item 1). Using a flat blade screwdriver, adjust the range setting to the desired value (30, 70, 100 meters)

NOTE: The range setting has three "click" positions; clockwise (CW or turning to the right) rotation increases the range (fully CW = 100M). Fully left (counter-clockwise) will set the sensor to its minimum range of 30 meters.

NOTE: The range switch protective cap **must be securely reinstalled** after adjustment to ensure proper weather sealing of the QUPID sensor.

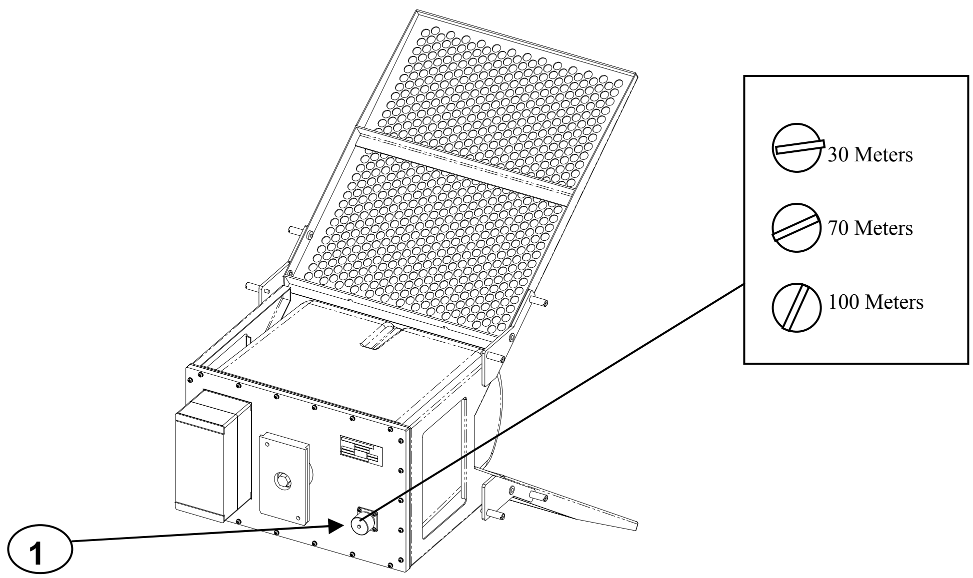


Figure 3-3 Adjust Range Setting

3.4 Using a flat blade screwdriver, remove the two tabs covering the interface box door screws (Figure 3-4, Item 1). Using a Phillips screwdriver, remove the 4 screws (Figure 3-4, Item 2) and open the interface box door.

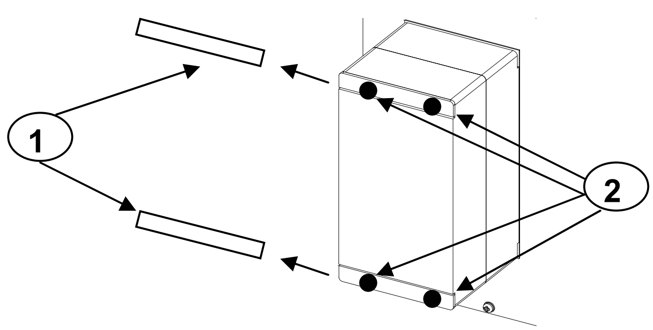


Figure 3-4 Interface Box

3.5 Route power and alarm cable through the cable clamp located on the bottom of the box (Figure 3-5, Item 1) and connect wires as shown in Figure 3-6.

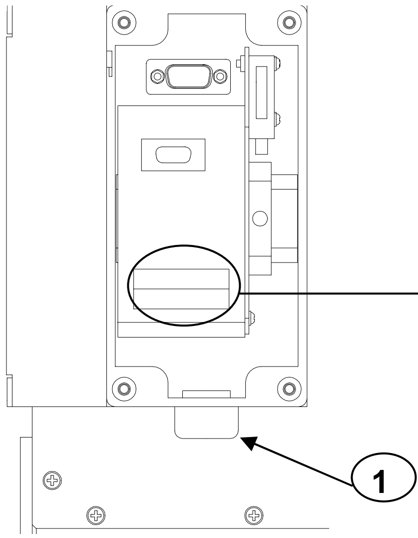
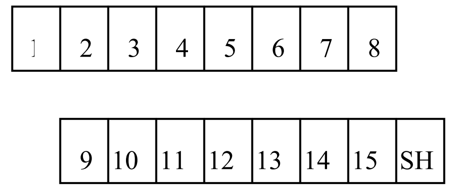


Figure 3-5 Interface Box Wiring



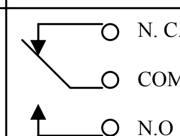
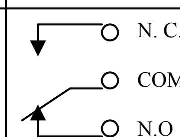
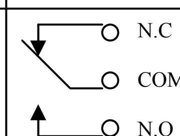
TERMINAL	SIGNAL NAME
1	ALARM N.O.
2	ALARM COM
3	ALARM N.C.
4	FAULT N.O.
5	FAULT COM
6	FAULT N.C.
7	TAMPER N.O.
8	TAMPER COM
9	TAMPER N.C.
10	SELF TEST (1)
11	SELF TEST (2)
12	
13	+12V POWER
14	12V RTN
15	CHASSIS GROUND
SH	

Figure 3-6 Wiring Schematic

The Form-C relay contacts are brought out to the Interface connection block as individual, independent dry contacts.

Absolute maximum rating for these contacts are:
16 Volts and 100 milliamperes maximum
Operation beyond these ratings may cause permanent damage to the sensor.

The contacts are protected with a self resetting PTC fuse in the COM line, which may have an initial resistance of up to 2 ohms (at 22° C).

RELAY STATES IN A NORMAL (NON-INTRUSION) MODE		
SENSOR STATE	**CONTACT STATE**	**DIAGRAM**
INTRUSION (ALARM)	Relay contacts close when in ALARM state	
TAMPER	Relay contacts are closed when in non-tamper state	
FAULT	Relay contacts close When in fault state	

3.6 After wires have been connected, tighten cable clamp (Figure 3-5, Item 1) securely to hold cable in place

3.7 Close interface box cover and install screws and screw cover tabs.

4.0 MOUNTING AND SETUP

4.1 The sensor can be mounted on a various selection of surfaces such as walls, buildings, metal poles, etc. However, regardless of the mounting fixture you choose, the diameter must be two and one half (2 ½") inches and must be placed approximately six (6 m) meters (optimum height) from the ground. The mounting fixture must be extremely rigid and must be plumb both vertically and horizontally.

4.2 Position the universal mounting bracket (Figure 4-1, Item 1) above the mounting fixture, ensuring the stop pin (Figure 4-1, Item 9) is oriented to be at the bottom of the universal mounting bracket. Slide the clamps down the mount allowing two and one half (2.5 cm) centimeters of clearance above the top mounting clamp and the top of the mounting fixture (Figure 4-1, Item 3). Tighten the star nuts on the top and bottom clamps (Figure 4-1, Item 4).

4.3 Loosen the star nuts, one on each side of the universal mounting bracket (Figure 4-1, Item 5). Rotate the clamp bracket (Figure 4-1, Item 6) until the top of the bracket is perfectly vertical to the sensor mounting bracket (Figure 4-1, Item 7) as indicated by the red dotted line. Tighten star nuts (Figure 4-1, Item 5). After the star nuts are tightened, use a flat blade screwdriver to tighten the universal mounting bracket screws, one on each side (Figure 4-1, Item 8).

4.4 Slide the QUPID mounting bracket onto the universal mounting bracket until the QUPID bracket is resting on the universal mounting bracket stop pin (Figure 4-1, Item 9). Push in on the spring loaded thumb screws and hand tighten (Figure 4-1, Item 2). After the screws are hand tight, use a flat blade screwdriver to securely tighten the two screws. Use compass to bore sight desired angle.

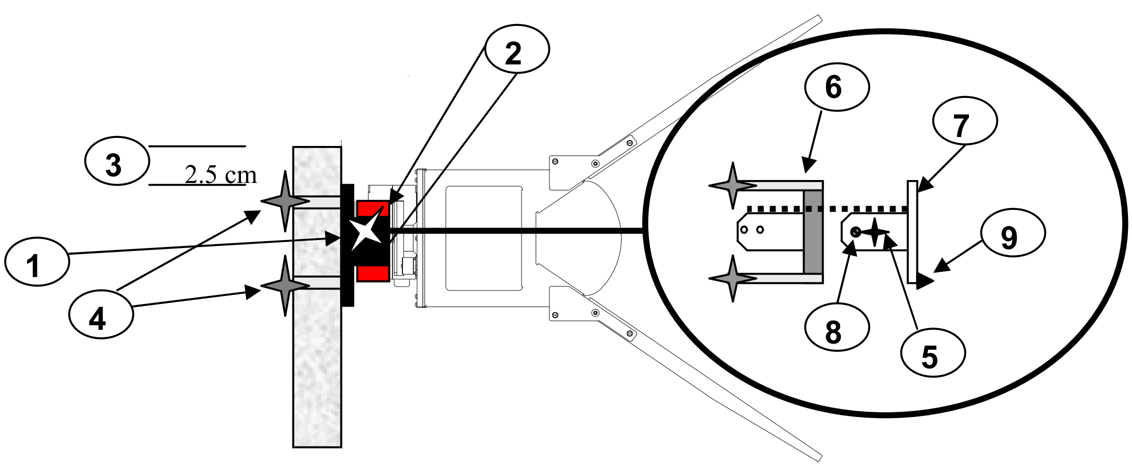
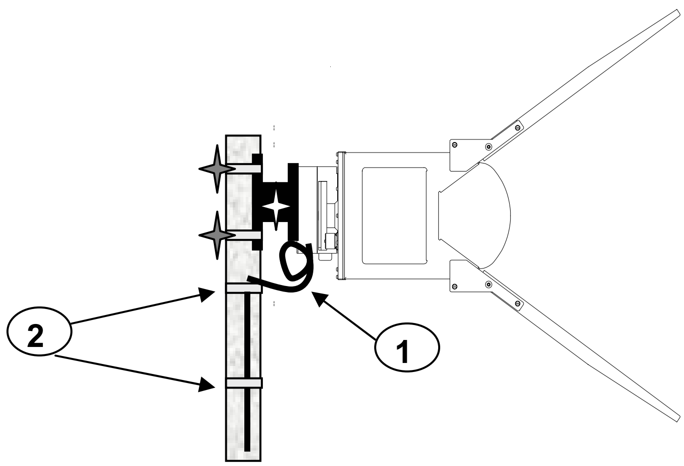


Figure 4-1 Sensor Mounting

<u>CAUTION:</u> Care should be taken during set-up and take down of the sensor. Allowing the sensor to fall could injure personnel and damage equipment.

4.5 Attach the power/sensor alarm cable to the mounting fixture using wire ties, leaving an approximately fifteen (15 cm) centimeter loop before the first wire tie is installed (Figure 4-2) Item 1). This will prevent any stress being placed on the cable and the cable clamp. Place wire ties at approximately thirty (30 cm) centimeter intervals for the entire length of the mounting fixture (Figure 4-1, Item 2)



<u>Figure 4-2 Power/Alarm Cable Routing</u>

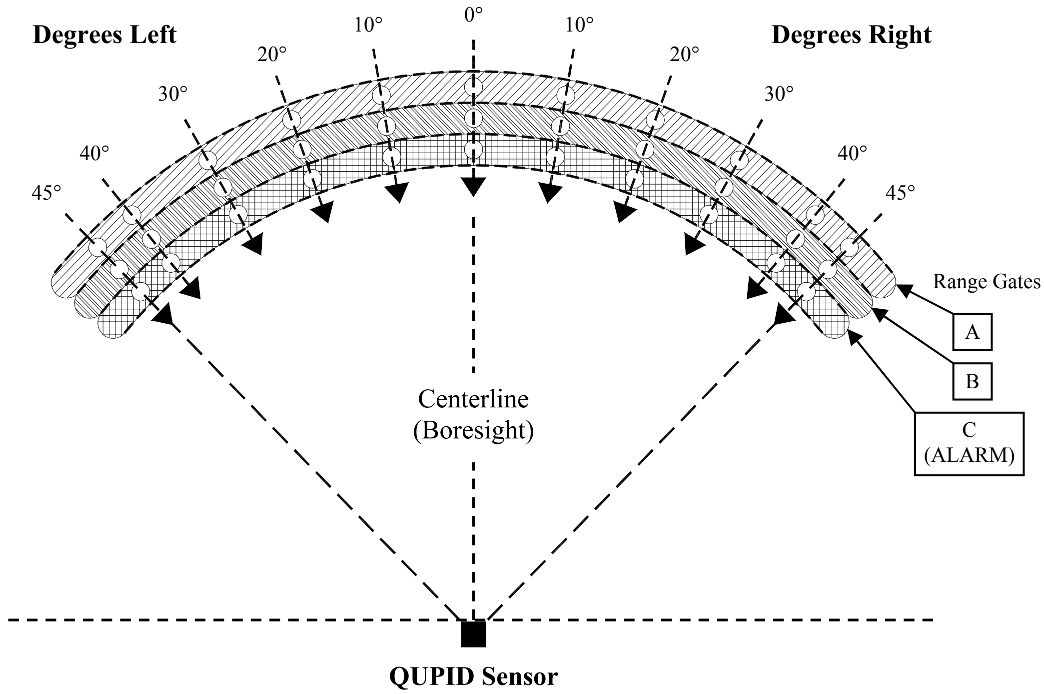


Figure 4-3 QUPID Sensor Detection Test

4.6 Conduct sensor walk test to verify detection zone as illustrated in Figure 4-3.

NOTE: To properly test range gate detection, the tester must begin the test 15 meters beyond the range gate setting. For example, to test for detection at 100 meters, the intruder must begin approaching QUPID at a distance of 115 meters. To detect an intruder presence at the 70 meter range setting, begin the test at 85 meters. To test at a 30 meter setting, begin at 45 meters.

In all cases the intruder must continue moving through all three range gates in their entirety. That is, the tester must continue walking or belly crawling through the gates until the QUPID alarms. This may require the tester to continue movement until reaching the innermost boundary of the last ("C") gate which is the gate boundary closest to the QUPID.

See details in Section 5.0 about range setting and clearance distances.

5.0 CONSTRAINTS AND LIMITATIONS

The following constraints and limitations must be considered for installation of QUPID sensors.

5.1 Line of sight constraint: The QUPID sensor must have direct, unobstructed line of sight of the area encompassed by all three of the range gates. The surface cannot be obscured by uneven ground which could possibly provide a "shadowed" area that an intruder might take advantage of. The sensor cannot see targets that are hidden in a ravine or depression that is not in view of the sensor.

Any shadowed areas can be reduced by locating the sensor such that it has direct view of that area. Mounting the sensor as high as possible (6 meters is the optimum height) and taking advantage of the local terrain will help.

5.2 Blockage: QUPID, being a radar sensor, cannot penetrate solid objects such as large tree trunks or vehicles. This includes any large objects that may be present between the sensor location and the range gates. Therefore, the field of view *to and including* the areas encompassing range gates A, B and C must be clear of solid obstacles that may block the field of view.

NOTE: Additional sensors may be required to provide coverage of potentially shadowed or blocked areas.

5.3 Vegetation and clearance: Vegetation, particularly wet vegetation moving in the wind, can be detected by the QUPID sensor. Moving vegetation located in only one range gate should not cause a nuisance alarm; however, *it will increase the probability of a nuisance alarm occurring*. The primary purpose of having three (3) separate range gates is so that an alarm will be initiated only if motion is detected in range gate A, then B, and then C (alarm setting), within the time correlating to rate of motion of valid targets.

Each of the three range gates is approximately 3.75 meters wide from front to back, and are adjacent to each other. The total width (front to back) of the sensor area is therefore approximately 11.3 meters wide. Thus, the area actively covered by the three range gates of the QUPID sensor is an arc almost 12 meters wide stretching more than +/- 45° from the centerline of the sensor.

The combined positions of the range gates' area (an arc almost 12 meters wide) is a function of the selected alarm range setting (100, 70 or 30 meters). The first two range gates (A and B) are positioned ***beyond*** the selected alarm range. An intruder approaching a protected area will cross through range gates A and B, then the alarm will sound when the intruder enters range gate C at or near the selected range (e.g., 70 meters). Therefore, an area at least 12 meters (40 feet) beyond the selected range, as well as range gate C, must be clear of obstacles to ensure detection of intruders and reduction of nuisance alarms. See the **Figure 5-1** and **Table 5-1** below as an illustration:

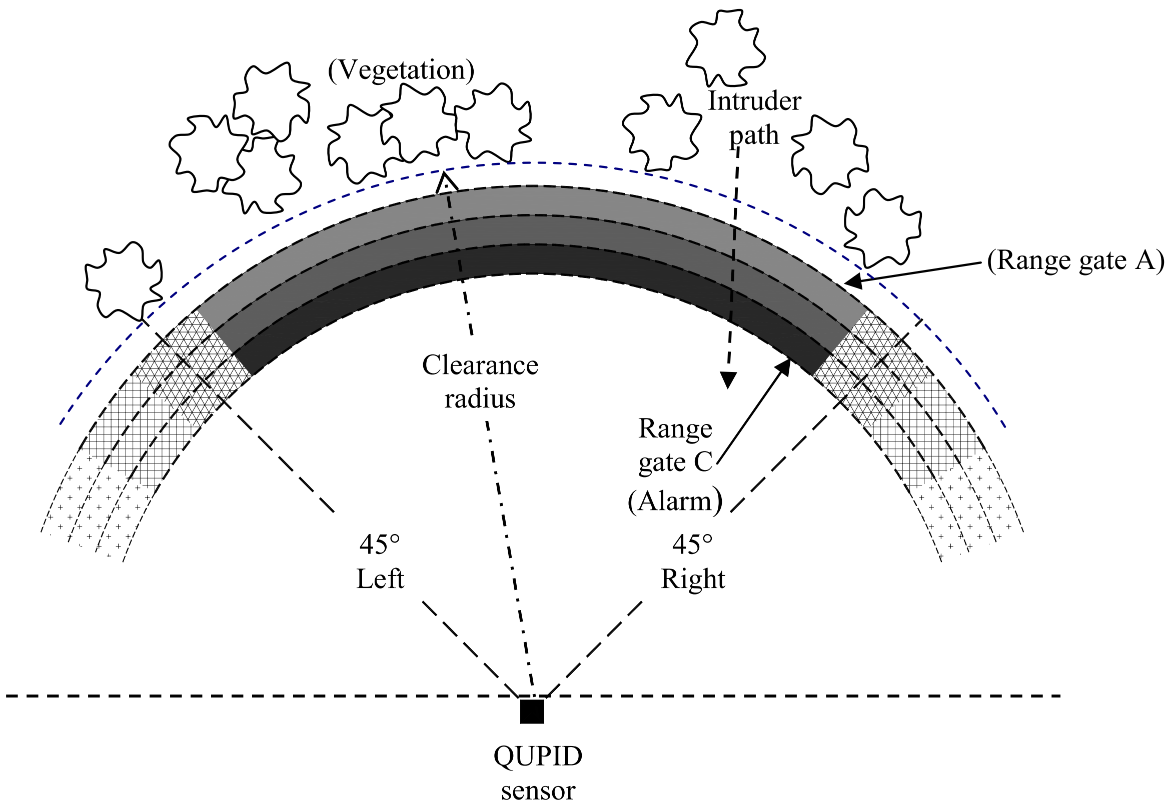


Figure 5-1
Range Gate and Clearance Positions

Range Setting	Minimum Clearance Radius
100 meters	112 meters
70 meters	82 meters
30 meters	42 meters

Table 5-1
Range Setting and Clearance Radius

NOTE: The edges of the nominal +/- 45° azimuth coverage are not sharply defined and large targets, including vegetation and vehicles beyond this angle may be detected if they cross through the gates. To minimize nuisance alarms, QUPID sensor locations and range selections should be carefully chosen to minimize the presence of vegetation or other large (non-intruder) targets in the range gate areas, even beyond the nominal +/- 45° coverage. Additionally, to minimize nuisance alarms vegetation height throughout the three range gates should be maintained lower than 20 to 25 centimeters (8 to 10 inches).

NOTE: Large stationary objects that pass through any range gates (such as fences and buildings) – **even beyond the 45° points**, may act as a radar "mirror", causing multiple reflections or "echoes" of a target. This can produce multiple alarms for a single intruder, especially once the target is inside of the alarm range (gate C) and close to the reflector. Large and/or elongated targets (e.g. trucks and large vehicles) may also trigger multiple alarms.

To reduce nuisance alarms, QUPID sensor locations and range selections should be carefully chosen to minimize the presence of vegetation or other large (non-intruder) targets in the range gate areas, even beyond the nominal +/- 45° coverage. Additionally, vegetation height through the three range gates should be maintained lower than 20 to 25 centimeters.

5.4 Sensor alignment: The azimuth coverage of the QUPID sensor is nominally +/- 45° from the centerline of the sensor. Care must be exercised in aligning multiple sensors so that the edges of the coverage patterns overlap between adjacent sensors and are at no more than +/- 45°.

5.5 Spacing between multiple sensors: The sensor pattern is approximately a 90° semi-circular arc. The maximum spacing between sensors is a function of the range selected at the sensor. The maximum recommended spacing for each of the three range settings is shown below in **Table 5-2**. It may be necessary to reduce the spacing from the maximum due to uneven terrain, or blockage.

NOTE: Spacing must be adjusted to ensure overlapping coverage between adjacent sensors, especially in shadowed or blocked areas. Coverage may require verification by performing intrusion tests.

Range setting	Maximum Spacing (Span between sensors)	Minimum Spacing (Span between sensors)‡
100 meters	112 meters	20 meters
70 meters	80 meters	20 meters
30 meters	40 meters	10 meters

‡ For coplanar units pointing in the same direction (In-Line Configuration)

Table 5-2
Spacing Between Sensors

The sensor's range gates are a constant distance (radius) from the sensor. When used along a line, the linear distance from the line to the range gates will vary as a function of the cosine of the angle off of boresight (the centerline). This should be taken into account when deploying sensors to ensure clearance of large clutter, coverage of shadowed areas, and determining detection distance. Sensors may have to be deployed at less than the maximum spacing and/or more sensors used. See following **Figure 5-2** and **Table 5-3** as an example of linear distances from a line:

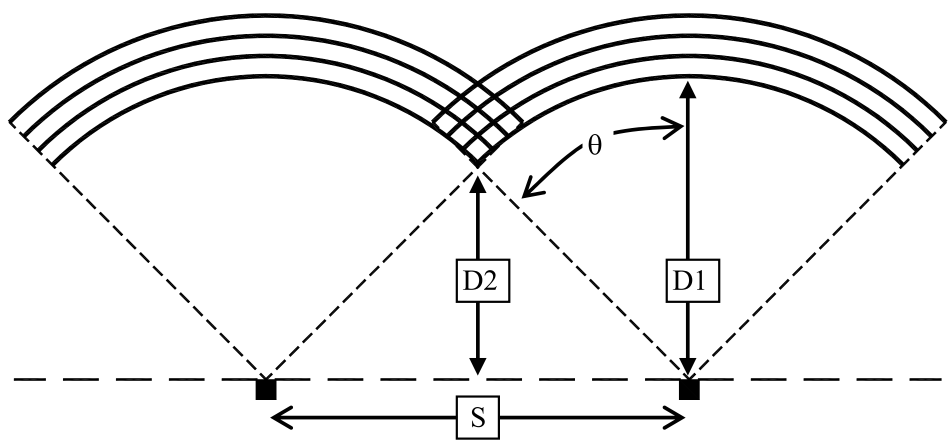


Figure 5-2
Spacing Between Sensors

D2 = D1*cos(θ),   where θ = angle from boresight.

Range Setting (D1)	Distance (D2) at 20°	Distance (D2) at 30°	Distance (D2) at 45°
100 meters	93.9 meters	86.6 meters	70.7 meters
70 meters	65.7 meters	60.6 meters	49.5 meters
30 meters	28.2 meters	26.0 meters	21.2 meters

Table 5-3
Linear Dimension to a Fence Line

Figure 5-3 can be used if the angle of overlapping coverage or the distance (S) between sensors is known:

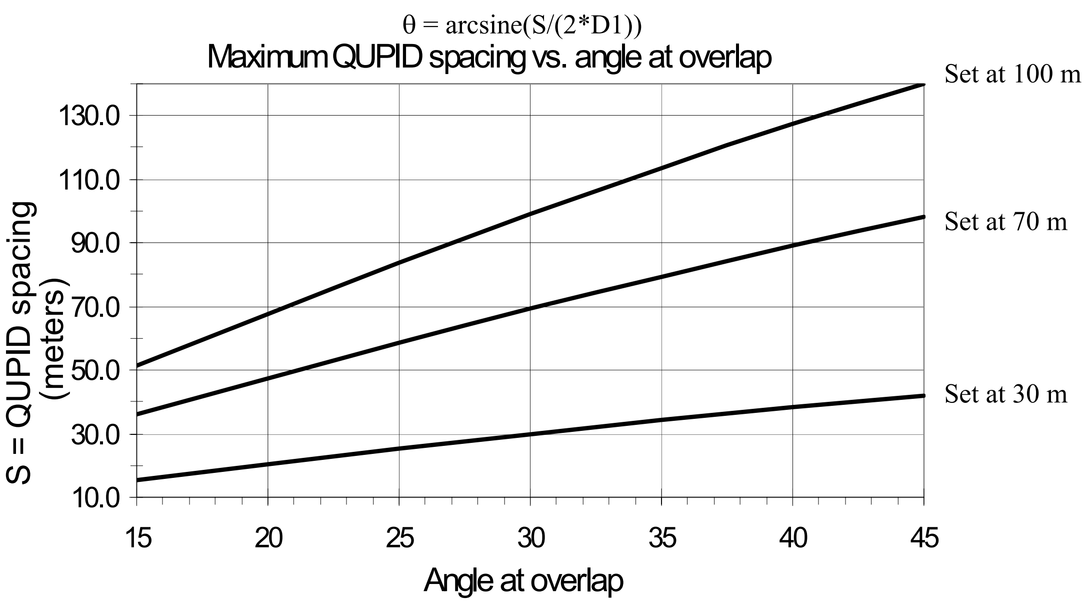


Figure 5-3
Sensor Spacing vs. Angle Overlap

Spacing for other angles: For units that are not coplanar (in a line)

If the sensors are not pointing the same direction in a line, it will be necessary to reduce the spacing between sensors to ensure that there is no gap in coverage. This is necessary when the sensors are required to go around the corner of a perimeter, or are placed along an irregularly shaped perimeter. The reduction in maximum spacing is necessary to ensure proper coverage without significant gaps.

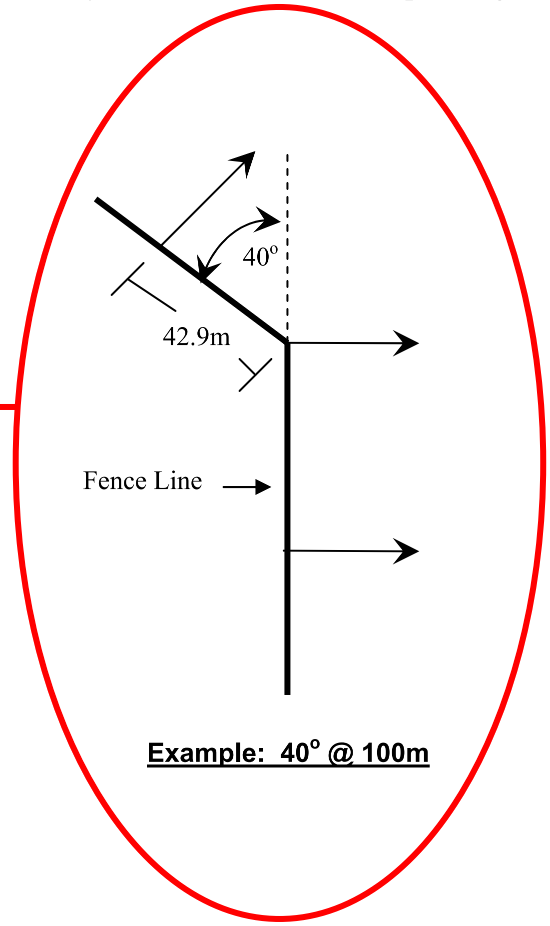
Sensors that need to be placed at angles with respect to each other for additional coverage **will have to be deployed at reduced spacing**:

- going around perimeter corners
- coverage of blocked areas
- coverage of shadowed areas

See Table 5-4 and the provided sketch as an example of sensor coverage at various angles. Following the figures, gives the maximum recommended sensor to sensor spacing for various difference angles and alarm range settings. These distances may have to be reduced, depending on the terrain.

DIFFERENCE ANGLE (DEGREES)	30 m RANGE (S)	70 m RANGE (S)	100 m RANGE (S)
IN-A LINE 0	33.9 m	79.2 m	113.1 m
10	28.7 m	66.1 m	94.1 m
20	23.6 m	53.4 m	75.8 m
30	18.9 m	41.6 m	58.5 m
40	14.7 m	30.8 m	42.9 m
50	11.0 m	21.6 m	29.5 m
60	8.0 m	14.0 m	18.6 m
70	5.8 m	8.5 m	10.5 m
80	4.4 m	5.1m	5.6 m
90	4.0 m	4.0 m	4.0 m

Table 5-4
Maximum QUPID sensor to sensor spacing for various difference angles between sensors
Use compass to boresight desired angle



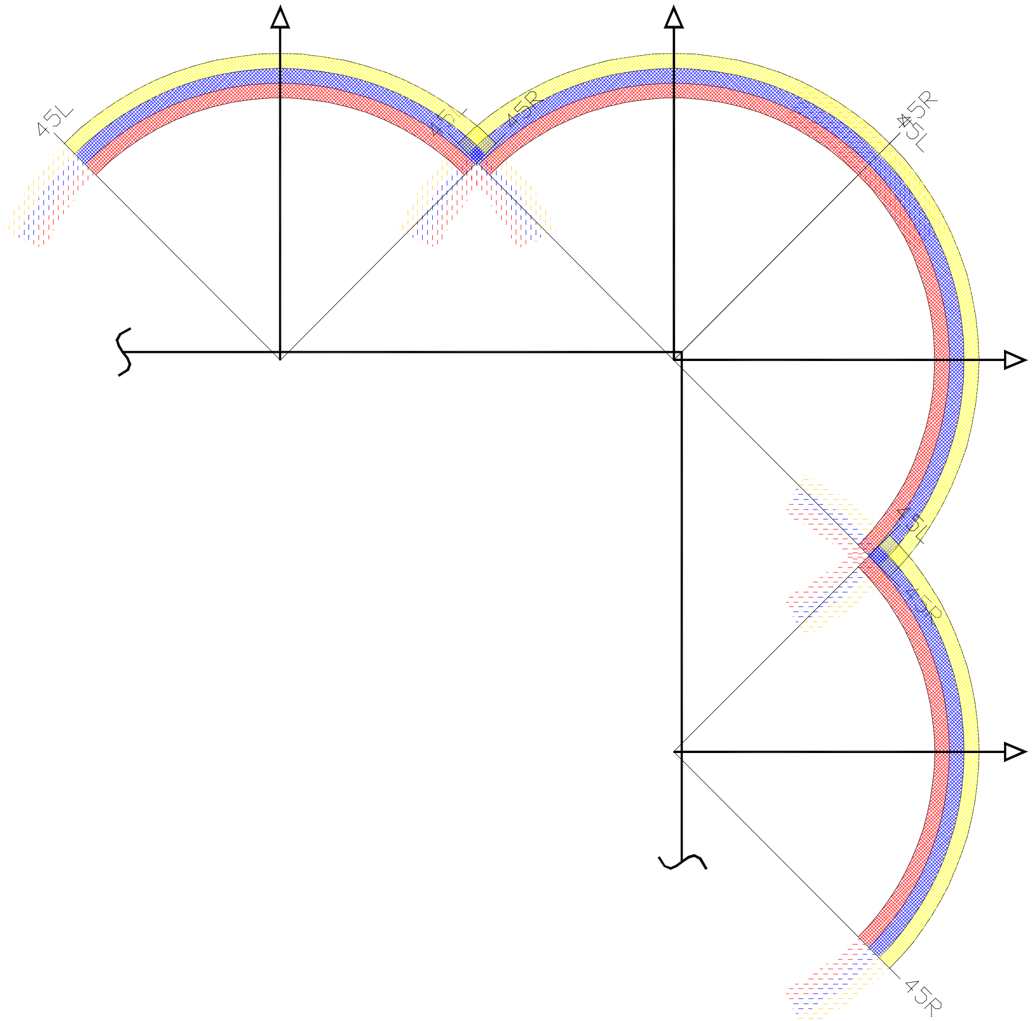


Figure 5-4
Example of deployment of 4 sensors to cover a 90° corner along a fence line

5.6 **Power:** The QUPID sensor requires a conditioned 12 volt DC power source (11.5 to 14.8 VDC). Operating primary power consumption is approximately 3 watts (about 250 mA at 12 VDC). The following wiring table is the minimum recommended AWG wire size for the DC power wiring for a single sensor, if the sensor is to be placed a significant distance from the power source. This table takes into account the two way run (power and return), with a 1.5 ohm total wire run resistance.

A junction box may be required to adapt the power run wire size to the QUPID connection block (maximum #12 AWG).

DISTANCE (meters)	DISTANCE (feet)	AWG
0 to 35	0 to 115	18
35.1 to 56.4	116 to 185	16
56.5 to 90	186 to 295	14
90.1 to 143.3	296 to 470	12
143.4 to 228.6	471 to 750	10
228.7 to 359.7	751 to 1180	8
359.8 to 576	1181 to 1890	6

Table 5-5
Wire table for single sensor power run

NOTE: For long sensor runs, it may be easier to supply AC mains to power a supply local to the sensor (the conditioned power source).

5.7 Intruder detection**:** The QUPID sensor was designed to detect intruders down to a low crawler profile over a flat surface out to the 70 meter setting. Higher profile intruders can be detected at the 100 meter setting. Refer to **Table 5-6** below.

Range setting	**Vehicle**	**Runner**	**Walker**	**High Crawler**	**Low Crawler**
100 meters	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✗ No
70 meters	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✓ Yes
30 meters	✓ Yes	✓ Yes	✓ Yes	✓ Yes	✓ Yes

Table 5-6
Range Setting and Target Detection

5.8 Interference susceptibility: The receiver in the QUPID sensor may be affected by strong "in band" signals in the microwave S band. This could include high level harmonics transmitted from L band transponders or transmitters.

6.0 MAINTENANCE AND TROUBLESHOOTING

6.1 MAINTENANCE

The QUPID sensor is a sealed unit and should not be opened. There are no user replaceable parts, connections or adjustments inside the sensor. Maintenance should be confined to checking for proper operation and if a fault is found, the QUPID sensor should be replaced with a known working unit.

The sensor should be replaced if:

- The sensor does not properly function on walk-in tests
- There are any cracks or openings in the radome
- The radome is not properly seated and sealed to the base plate
- The radome is missing hardware
- The protective cap for the range gate switch is missing

The auxiliary reflectors ("ears") should be checked regularly for loose hardware or damage:

- Loose hardware should be properly tightened
- Damaged "ears" should be replaced

6.2 TROUBLESHOOTING

Perform the sensor detection walk-in test as discussed in **Section 4.0**.

There are no user replaceable parts, connections or adjustments inside the sensor. Troubleshooting should be confined to checking for proper operation and if a fault is found, the QUPID sensor should be replaced with a known working unit.

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