Ranger® R Series Radars

Installation and Maintenance Manual

R1, R2, R3, R3D, R5, R5D

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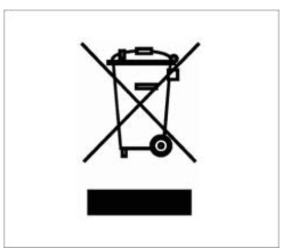
When sending an e-mail (✉), please include:

- Contact info (e-mail, phone, fax, other as required)
- Product model and software version number
- If possible, the serial number of the product
- A description of the problem/issue
- Data recordings and/or log files, if available
- Any other pertinent information



DISPOSAL

Dispose in accordance with the laws and regulations applicable in your jurisdiction.

REVISION RECORD TABLE

Manual Revision	ECO #	Pages	Description of Modification
1.0	13-008	All	Initial Release
2.0		All	Insertion of ITAR statement
3.0	14-001	All	Add "FLIR Proprietary Information" to footer
4.0	16-025	All	Safety distances added
5.0	18-016	12	Safety distances corrected

The following symbols are used throughout this document:

Caution!
The CAUTION symbol is used to alert the reader to situations where a hazard to personnel safety may arise.

WARNING!

The WARNING symbol is used to alert the reader to situations where equipment damage is imminent if a recommended process is not followed or alert the reader of a process that will alter or reset current configuration of a specific setup.

DANGER!

The DANGER symbol is used to alert the reader to situations where a hazard to personnel may result in serious injury possibly leading to death.

Disclaimer!
Disclaimers provide a means of specifying limitations or other requirements on equipment.

Note
Notes comprise additional information to assist the reader in the use or understanding of the equipment or subject.

DEFINITIONS AND ACRONYMS

AXML	Amphitech eXtensible Markup Language
BIT	Built-in Test
CE	Refers to CE marking, a conformity mark in Europe
Doppler	Doppler effect. Also refers to Doppler radar operation mode, where target speed is used to reject fixed clutter.
FastScan	Scanning mode featuring a fast update rate
FCC	Federal Communications Commission (usually refers to the US agency)
FMCW	Frequency Modulated Continuous Wave
GPS	Global Positioning System
GUI	Graphical User Interface
IP	Internet Protocol
KBPS	KiloBits Per Second
LAN	Local Area Network
MBPS	MegaBits Per Second
PPI	Plan Position Indicator
PPS	Pulse Per Second
PSR	Perimeter Surveillance Radar
RCS	Radar Cross Section
RF	Radio Frequency
TCP	Transmission Control Protocol
VDC	Volts of Direct Current
XML	EXtensible Markup Language

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1 INTRODUCTION

This manual describes the R1, R2, R3, R3D, R5 and R5D Perimeter Surveillance Radars (PSR) installation and scheduled maintenance actions. Complete electrical, mechanical and physical interfaces of the system are also provided. The Installation manual is intended for an audience of technically qualified personnel.

> **Note**
> For detailed instructions on how to use the different modes of the R1, R2, R3, R3D, R5 and R5D, please refer to the Operator Manual for Mid-Range Perimeter Surveillance Radars.

1.1 EQUIPMENT FEATURES AND SPECIFICATIONS

1.1.1 R1, R2, R3, R3D, R5 and R5D Radar Assembly

The R1, R2, R3, R3D, R5 and R5D provide detection capability for moving objects on the ground over an area of up to 360° and presents detection data to the operator through a Graphical User Interface (GUI). The data may also be transmitted via a third-party software application using an Extensible Markup Language (XML) Client responsible for implementing security policies.

	R1, R2, R3 and R3D Specifications	R5 and R5D Specifications
Weight	R1, R2, R3: 12.5 Kg R3D: 13.2 Kg	17 Kg
Cooling	No forced cooling required	
Operating Temperature Range	-30ºC to +60ºC	
Operating Altitude Range	Up to 15,000 ft. / 4,572 m.	
Power Input	20 - 32 VDC (Nominal 24 VDC), less than 45 W	
Frequency Band	Ka	
Instrumented Range	R1: 5- 700 m R2: 5-1400 m R3: 5-2800 m R3D: 5-6500 m	R5: 10-5000 m R5D: 5-10000 m
Warm-up time	Ready to operate approximately 1 minute after power-up	
Scan rate	Up to 55 scans/minute	
Environmental	NEMA 4, IP65	
Wind	140 Km/hr	
Radiated Power	Safe for human exposure	

Table 1 – R1, R2, R3, R3D, R5 and R5D Radar Assembly Specifications

Disclaimer!
The R1, R2, R3, R3D, R5 and R5D are designed for operation while in a fixed location and not intended for use on moving platforms. Failing to adhere to this recommendation could compromise detection capability of the unit.

Disclaimer!
Due to the inherent nature of radar detection, the R1, R2, R3, R3D, R5 and R5D may present "nuisance" alarms triggered by animals, moving vegetation, ocean surf or waves moving within the radar field of detection.

Disclaimer!
Due to the inherent nature of radar detection, small and/or very slow moving objects may not be detected by the R1, R2, R3, R3D, R5 and R5D.

Disclaimer!
Under heavy rainfall conditions (> 10 mm/hr), the R1, R2, R3, R3D, R5 and R5D performance can be reduced, typically for targets furthest away. Under such conditions, the unit may not detect some moving objects and may result in increased nuisance alarms.

WARNING!

This equipment has been designed to comply with the limits for a Class A digital device, pursuant to part 15 of the Federal Communications Commission (FCC) Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate Radio Frequency energy and, if not installed and used in accordance with this instruction manual, may cause harmful interference to radio communications. Contact local authorities for frequency authorization prior to installing and operating this equipment.

WARNING!

This equipment must be installed by qualified personnel to insure conformity with all local codes.

1.2 SAFETY ISSUES

This equipment generates Radio Frequency energy and is intended for outdoor installation only. Based on limits specified by the Federal Communication Commission (FCC) on Radio Frequency (RF) Emissions, the safety distances listed in the table below must be respected to ensure personnel safety.

Caution!
The installation must provide a separation distance from all persons and must not be co-located or operating in conjunction with any other antennas or transmitters. This safety distance complies with the FCC Limits for Maximum Permissible Exposure (MPE) for general population / uncontrolled exposure.

Safety Distances				
	Nominal Output Power	Frequency Band	FCC MPE distance (cm)	
			Controlled Exposure	General Population
R1,R2,R3	0.8 Watt	Ka	22	22
R3D (FastScan)	0.8 Watt	Ka	22	22
R3D (Doppler)	0.8 Watt	Ka	22	22
R5,R5D	0.56 Watt	Ka	13	28
R5D (Doppler)	0.56 Watt	Ka	25	55

Note: theses distances are for guidance only

1.3 UNPACKING THE R1, R2, R3, R3D, R5 and R5D RADAR ASSEMBLY

Following verification of the shipping documents, move case to a clean area. Open case and follow these steps:

Step 1 Inspect packing for any damage. If damage is noted, take photos and contact shipper.
Step 2 Remove packing material and retain for future use.
Step 3 Remove unit carefully.
Step 4 Place it on a flat clean surface, being careful not to damage the connector on the underside of the unit.
Step 5 Compare the part and serial numbers appearing on the shipping invoice with the part and serial numbers appearing on each unit.
Step 6 If they do not match, contact your distributor/retailer with details.
Step 7 Make a list of items received versus items ordered and note each item’s condition upon receipt.
Step 8 If they do not match, contact your distributor/retailer with details.
Step 9 Make a visual inspection of each unit to ensure it was not damaged during shipment.
Step 10 Keep this report. If there is damage, it is best to make digital photographs to aid with the claims process with the carrier.

Note
The R5 or R5D Radar is shipped with foam material to secure the antenna during transportation. Follow the special unpacking procedures provided inside the shipping case. If you can’t find the unpacking procedures, contact customer support to request a copy.

2 HARDWARE SYSTEM DESCRIPTION

2.1 HARDWARE COMPONENT DESCRIPTION

The R1, R2, R3, R3D, R5 and R5D Radar Systems comprise the following components. Some of these components may not be needed, depending on the specific installation.

1. R1, R2, R3, R3D, R5 and R5D Radar Assembly
2. Radar Server computer
3. Client computer
4. Breakout box
5. Radar power supply
6. Network infrastructure
7. Cabling

2.2 PHYSICAL SYSTEM OVERVIEW

Figure 1 shows a typical hardware configuration of a R1, R2, R3, R3D, R5 and R5D Radar Systems.

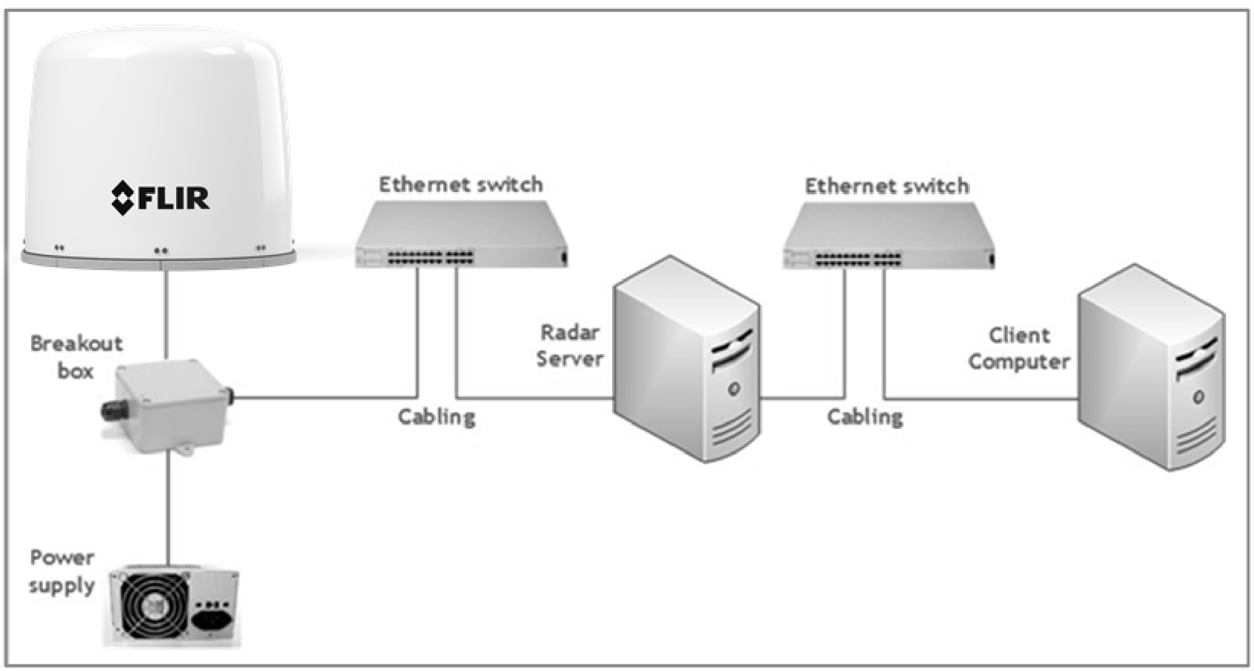


Figure 1 - R1, R2, R3, R3D, R5 and R5D Radar Systems Physical Overview

2.2.1 R1, R2, R3, R3D, R5 and R5D Radar Assembly

The R1, R2, R3, R3D, R5 and R5D Radar Assemblies consist of the radar antenna and RF components, a mechanical scanning sub-assembly, and a processor sub-assembly.

Figure 2 – Left: R1, R2, R3 Center: R3D Right: R5, R5D

2.2.2 Radar Server Computer

The Radar Server computer hosts the following applications:

- Radar Application Manager
- Radar Server Application
- Radar Terminal Application
- Radar Console Application (configuration and diagnostics only)
- Control Station Interface

Depending on the installation, the Radar Server computer may also host the client applications and function as the Client Computer.

2.2.3 Client Computer

The Client computer hosts the client applications (Cameleon Tactical, Control Station, XML third-party application). You can also use the Radar Console for remote diagnostics.

2.2.4 Breakout Box

In some installations a breakout box may be installed in close proximity of the radar to incorporate the radar power supply and/or an Ethernet fiber-optic media converter.

2.2.5 Radar Power Supply

The radar power supply provides 28 VDC to the R1, R2, R3, R3D, R5 and R5D Radar Assemblies. Refer to Section 3.2 for determining the appropriate power supply capacity required.

2.2.6 Network Infrastructure

The network infrastructure consists of Ethernet switches, Ethernet media converters, wireless Ethernet transceivers, etc. The network infrastructure provides the physical support for the Device and the Client networks. Refer to the Configuration Manual for a description of these networks.

2.2.7 Cabling

FLIR Radar Systems provide connectorized cables for sale in standard lengths. Pre-cut cable lengths vary. You can order cables with connectors at both ends. Please contact your FLIR Sales Representative for assistance.

3 PLANNING SYSTEM INSTALLATION

Before installing the R1, R2, R3, R3D, R5 and R5D Radar Systems, the following installation parameters of the R1, R2, R3, R3D, R5 and R5D radar assemblies must be determined:

- Final location
- Height above ground and tilt angle
- Power requirements
- System network topology, and network components needed to support this topology

3.1 RADAR ASSEMBLY INSTALLATION

3.1.1 Determining an Optimal Location

The optimal R1, R2, R3, R3D, R5 and R5D Radar Assembly location is determined based on the following factors:

- Unobstructed line of sight to the area under surveillance
- Radar height above ground
- Proximity to large radar reflectors such as buildings, trucks, aircraft and other large metallic objects
- Operating mode (FastScan or Doppler)
- Power and connectivity availability
- Line of sight to other R1, R2, R3, R3D, R5 and R5D units

The radar assembly should be installed in a location where it has an unobstructed view of the area to be monitored. Since it is not always possible to get an unobstructed line of sight out to the instrumented range, the installation point should be selected so as to maximize the area the radar can monitor. One must consider terrain contour, seasonal vegetation changes, and potential obstruction from ground vehicles such as cars, trucks and trains, as well as aircraft and ships, since it may change over time.

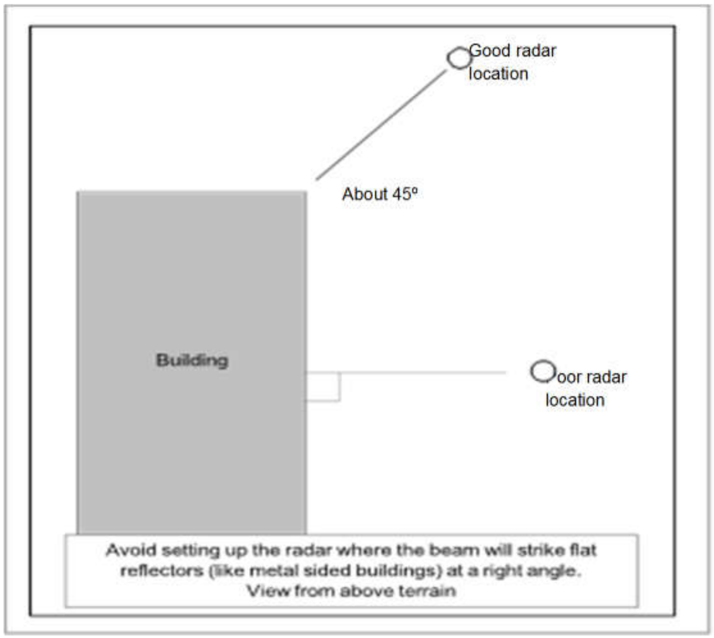


Figure 3 - Optimizing Radar Location (aerial view)

3.1.2 Installation Considerations

The height must be carefully determined based on the line of sight and on the type of targets to be detected. Typical minimum detection ranges are given in Table 3.

Before installation, carefully analyze the requirements specific to the site to select each radar installation height above ground. Mounting the radar too high may result in reduced radar sensitivity due to increased radar returns from the ground (refer to Figure 6).

Radar model	Typical height above ground	Considerations
ALL	< 2 m	Typical, for best detection of a crawling person. However, to get a line of sight out to the maximum range, a higher installation point may be desirable.
R1, R2, R3	1 - 3 m	If higher, detection capability may be reduced at close range and clutter levels increased.
R3D, R5, R5D	2 – 10 m	Installing higher: • may reduce detection capability at close range • increases clutter levels • may degrade performance when the radar is operating in Fast Scan mode

Table 2 - Installation Considerations

The radar installation should maximize the radar beam on the terrain surface. In certain conditions (such as rising terrain, hilly terrain, etc.), it might be desirable to tilt the whole radar assembly and/or tilt the radar antenna. Instructions for setting the tilt angle of the antenna can be found in Section 4.2.

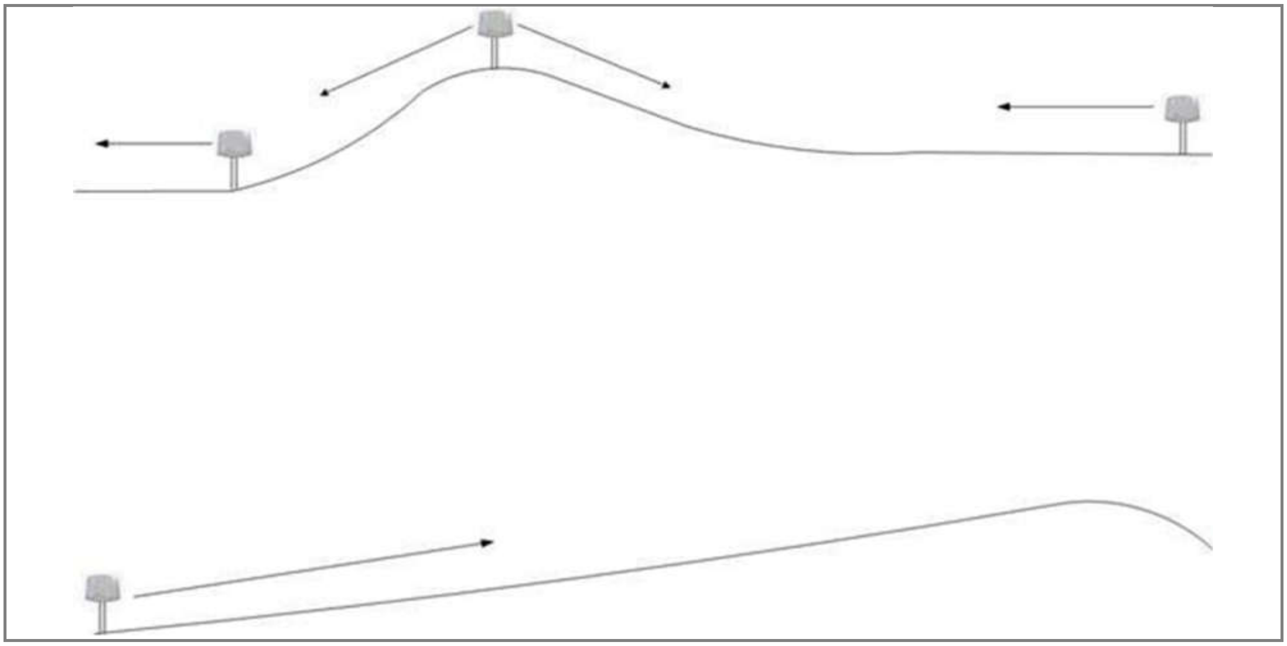


Figure 4 - Optimizing Grazing Angle

> **Note**
> In an uneven terrain environment, the radar should be installed so as to follow (or "graze"), to the extent possible, terrain contour as shown in Figure 4. Optimizing the grazing angle may require adjusting the tilt angle of the antenna, as described in Section 4.2.1.

> **Note**
> FLIR Radars recommends asking your Sales Representative about site surveys prior to all first installations, to ensure proper site selection and ideal system installation recommendations for optimal functioning of the radar to your specific requirements.

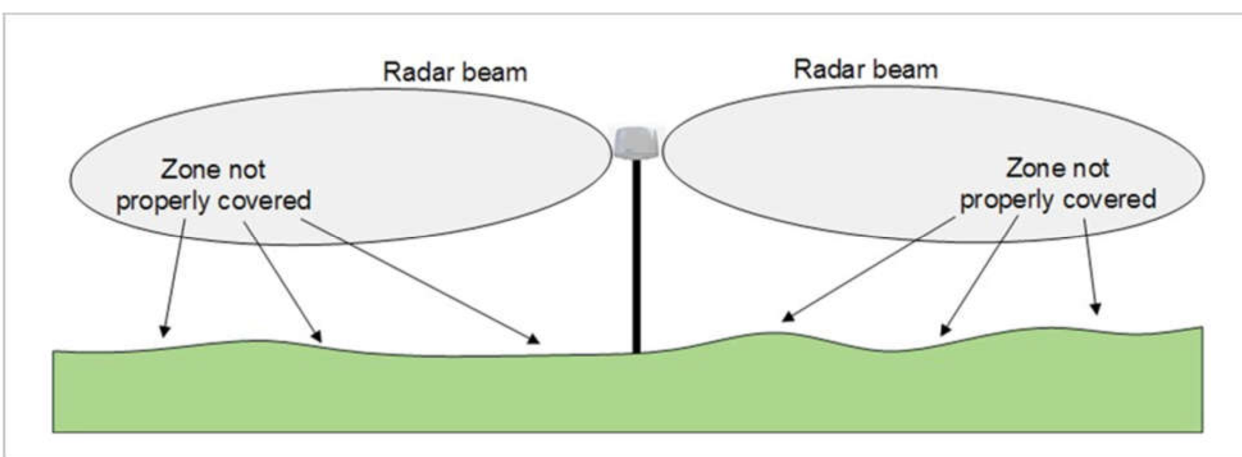


Figure 5 - Radar Installation on Even Terrain - Incorrect Height and Incorrect Tilt Angle

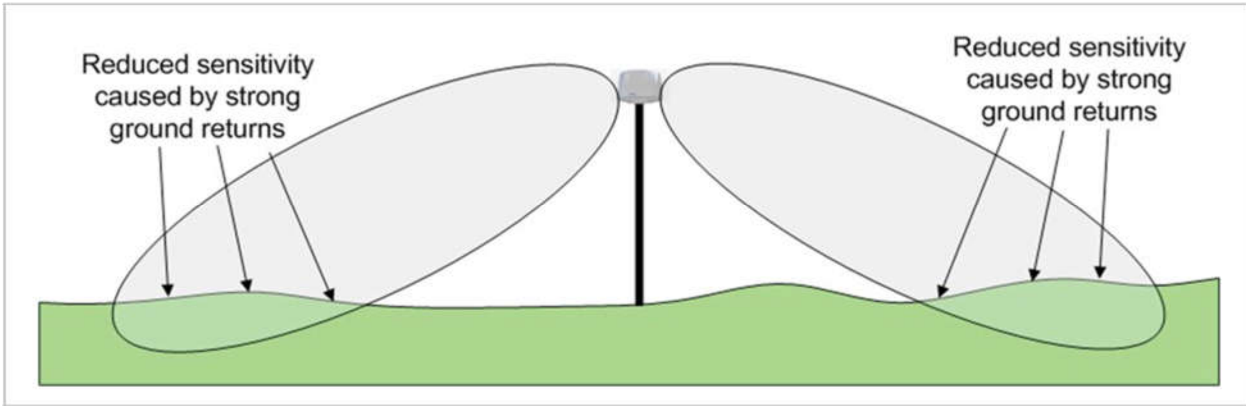


Figure 6 - Radar Installation on Even Terrain - Incorrect Height and Correct Tilt Angle (only applicable to FastScan mode)

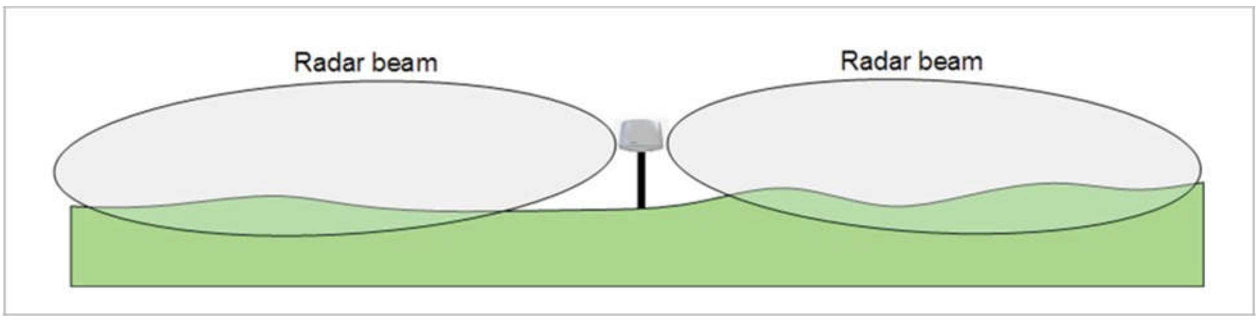


Figure 7 - Radar Installation on Even Terrain - Correct Height and Tilt Angle

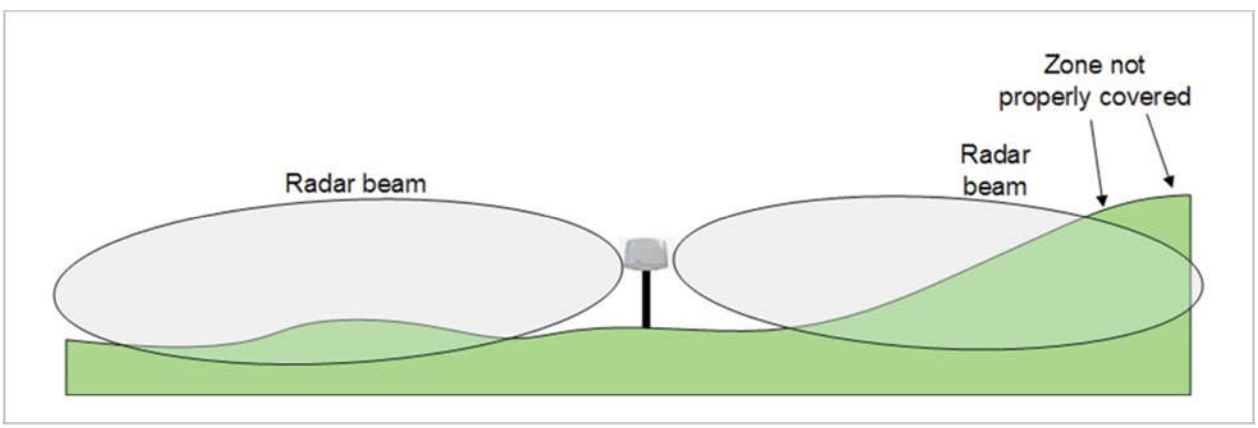


Figure 8 - Radar Installation Near Rising Terrain - Sub-Optimal Radar Position and Tilt Angle

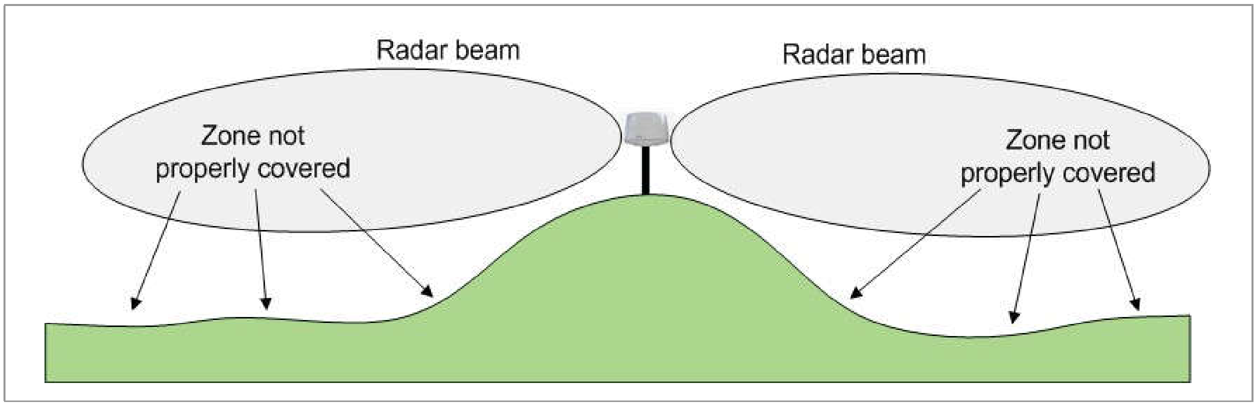


Figure 9 - Radar Installation on Even Terrain - Incorrect Height

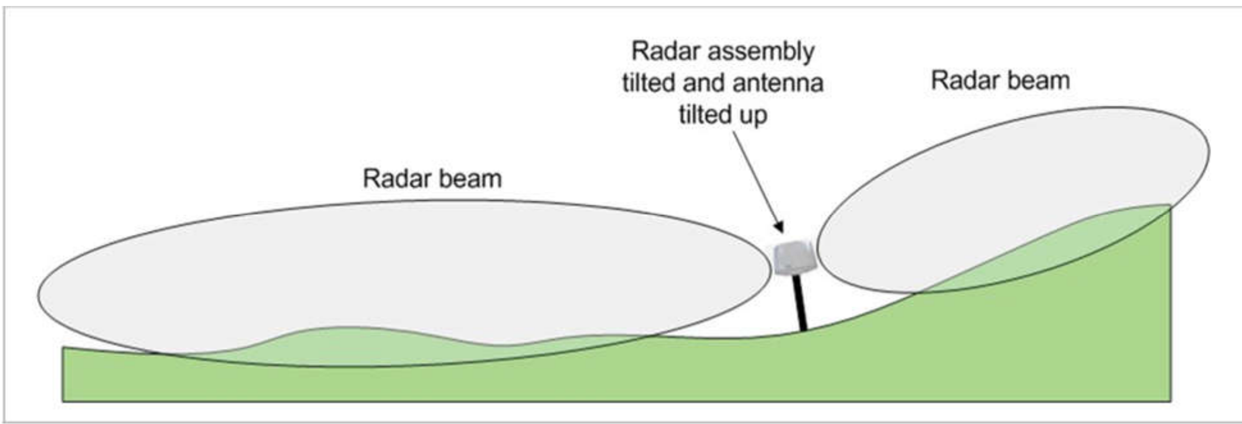


Figure 10 - Radar Installation Near Rising Terrain - Correct Radar Position and Tilt Angle

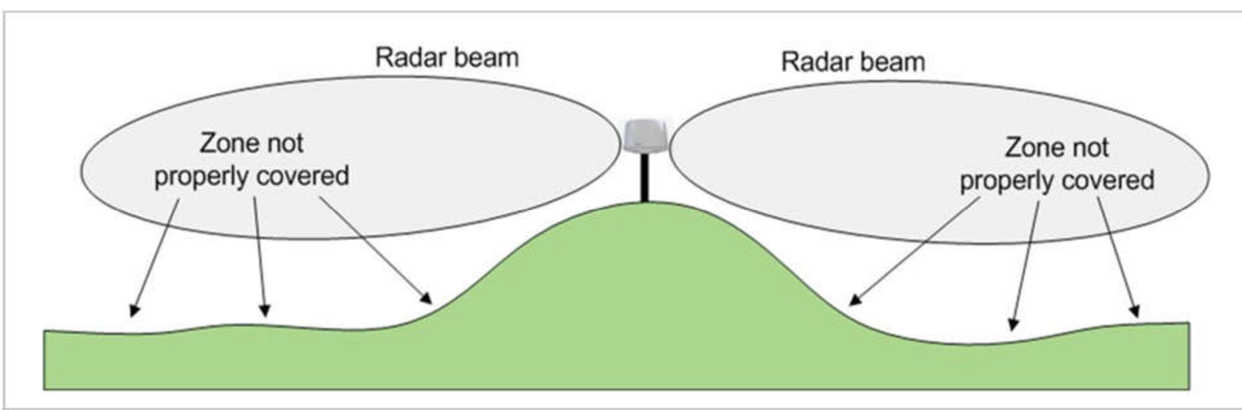


Figure 11 - Radar Installation on Hill Top - Incorrect Tilt Angle

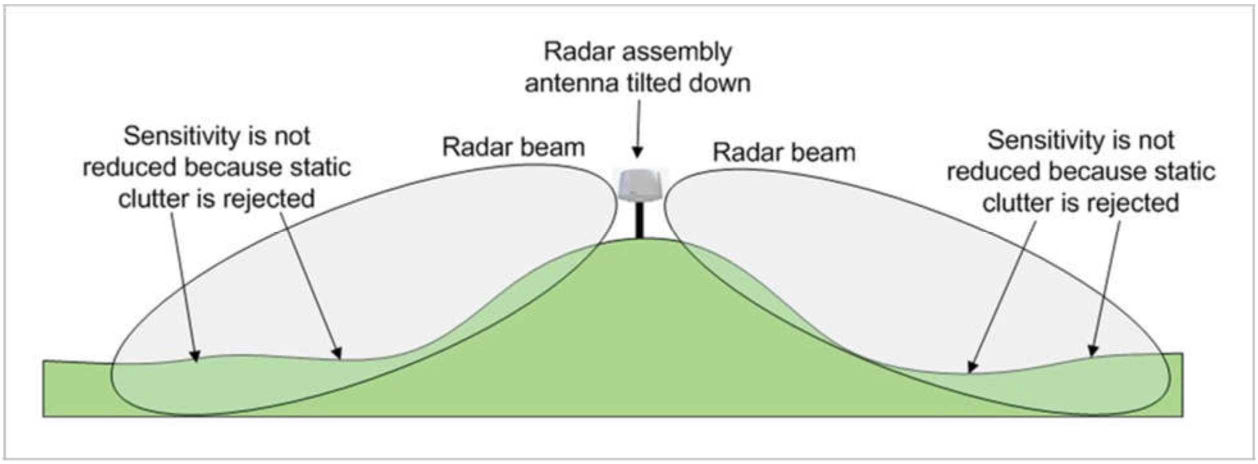


Figure 12 - Radar Installation on Hill Top - Correct Tilt Angle (only applicable to Doppler mode)

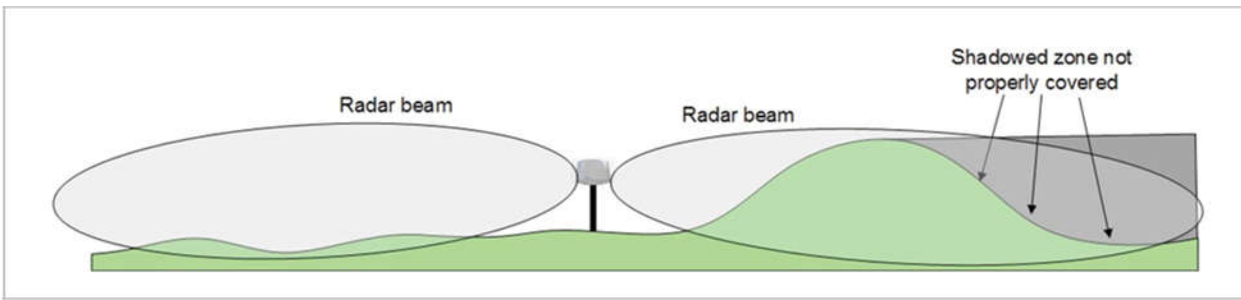


Figure 13 - Radar Installation Near Hill - Shadowed Zone

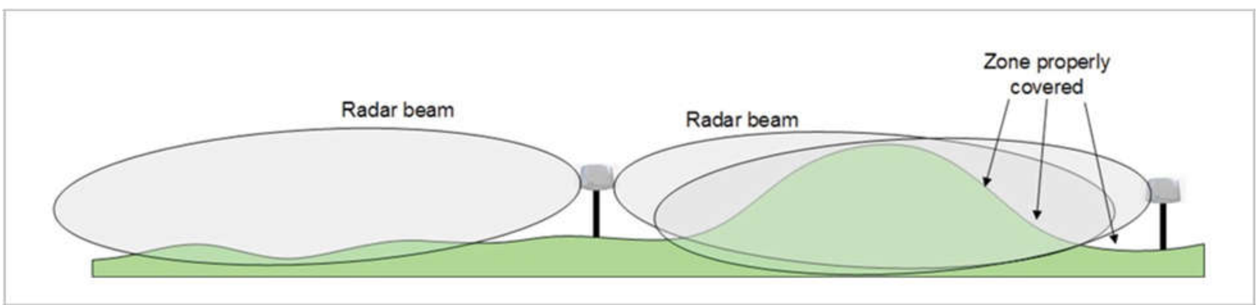


Figure 14 - Radar Installation Near Hill - No Shadowed Zone

> **Note**
> Typical detection ranges according to installation height and tilt angle are given in Table 3 through Table 6.

3.1.3 Doppler Operating Mode Considerations

The R3D and R5D offer the following advantages:

- In high-clutter environments, it can operate in either FastScan mode or in Doppler Mode.
- It can be switched to Doppler Mode if, in FastScan mode, it cannot reliably detect small targets in rough vegetation, uphill terrain, or any other high-clutter environment.
- In Doppler Mode, the scan rate is reduced to increase time-on-target, allowing for separation of moving targets from clutter.

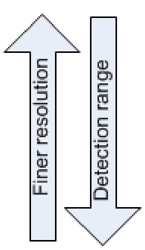
Generally, the FastScan mode is recommended for low clutter environments. If high clutter levels prevent proper detection of targets, it is recommended to switch to a Doppler mode.

The three following conditions dictate switching from FastScan to Doppler mode:

- Detection range of line-of-sight targets is below expected or required values.
- Radar is mounted high and/or environment contains tall vegetation and/or uphill terrain.
- Detection of targets past the FastScan detection range is required.

Three Doppler modes are available: Short, Medium and Long time-on-target. When switching to Doppler mode, it is recommended to first use the short time-on-target, and verify radar operation and detection in the environment considered. If target detection still doesn't meet expectations, then the radar should be switched to medium or long time-on-target. It is important to note that each time the time-on-target is increased, the track reporting delay increases.

For each Doppler mode, two selected ranges can be configured (R3D: 3400m or 6500m, R5D: 5500m or 10500m). The short range provides the best resolution, but the maximum detected range is restricted to approximately 3 km for the R3D and 5 km for the R5D. Beyond these ranges it is recommended to use the long-range setting. For the short time-on-target, it is not recommended to use the long-range setting, as the effective detection performance does not fully take advantage of the available range. For the long time-on-target, the short- range setting is not recommended because the long time-on-target is not used to its full potential and at this range, medium and short time-on-target provide faster update rates.



R3D Range	R5D Range	FastScan	Doppler		
			Short time-on-target	Medium time-on-target	Long time-on-target
700/1400/2800 m	5000 m	OK	N/A	N/A	N/A
3400 m	5500 m	N/A	OK	OK	Not recommended
6500 m	10500 m	N/A	Not recommended	OK	OK

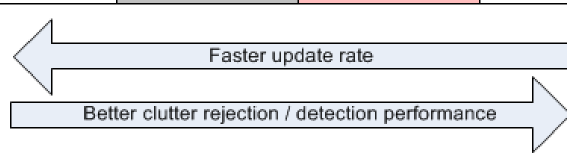


Figure 23 - R3D and R5D Mode Selection Table

3.2 POWER DISTRIBUTION NETWORK

The R1, R2, R3, R3D, R5 and R5D radars require a nominal 28 VDC (accepting from 20 to 32 VDC) at their input and consume less than 45W in operation. You should select a power supply capable of delivering 28 VDC consistently through a range of expected temperatures.

The supply must deliver a sustained 45W of power. Allowance for a power-on surge should be provided. Therefore, a minimum 75W of power is recommended for trouble-free operation in all conditions.

A single power supply may supply multiple radar assemblies; the minimum capacity recommended is 75W per unit. Additional equipment powered by the power supply must be taken into account when determining the power supply capacity (i.e. Ethernet media converters, wireless transceivers, etc.).

When long supply wires are required, a proper wire gauge must be used to ensure that the resulting voltage drop along the supply wires meets the radar minimum operating voltage. In some cases, the power supply may be incorporated into a breakout box located next to the radar assembly, to ensure low voltage drop.

> **Note**
> The system is reverse-polarity protected up to a maximum of 44 V_{DC}

4 HARDWARE INSTALLATION

4.1 RADAR ASSEMBLY INSTALLATION

4.1.1 Unit and Mounting Plate Outline

Figure 15, Figure 16 and Figure 17 show the R1, R2, R3, R3D, R5 and R5D radar outlines, mounting and connector locations, and regular mounting plate outline.

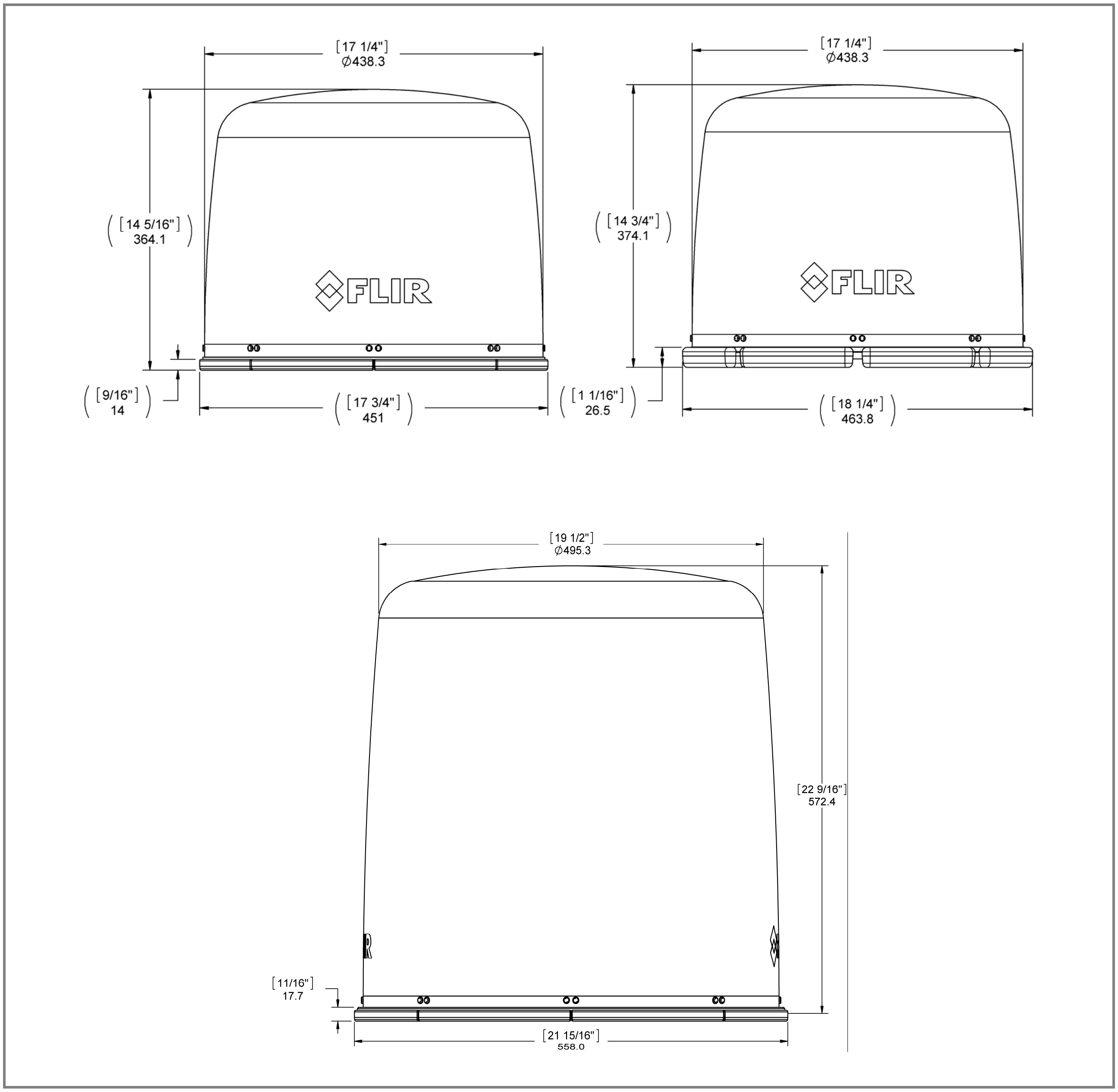


Figure 15 – Top Left - R1, R2 and R3; Top Right - R3D; Bottom - R5 and R5D: Outline

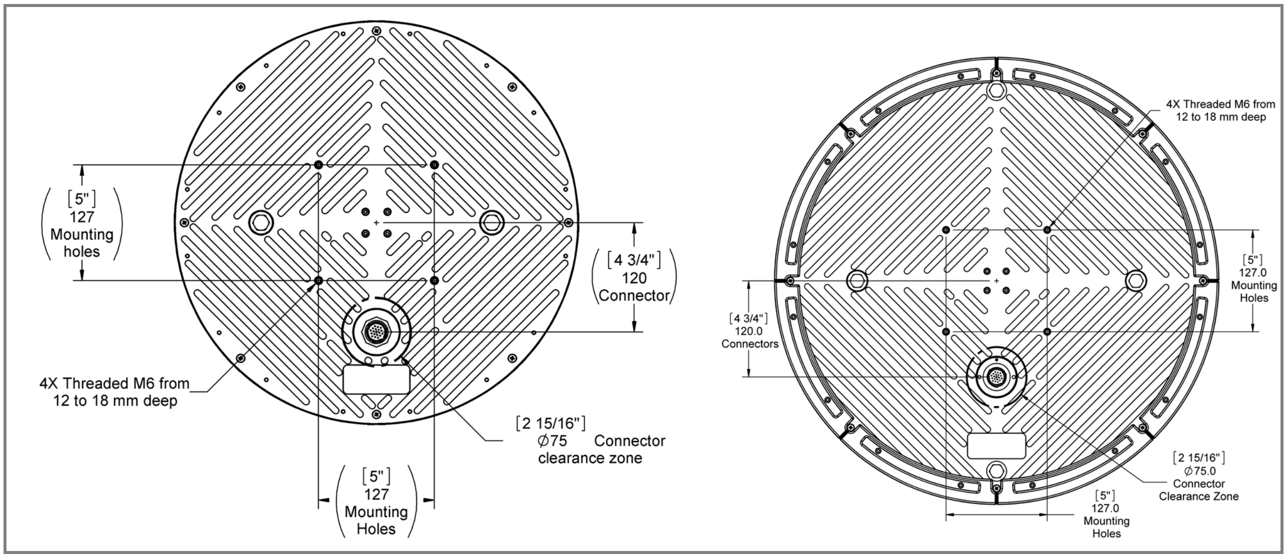


Figure 16 – Left - R1, R2, R3 and R3D; Right - R5 and R5D: Mounting and Connector Location

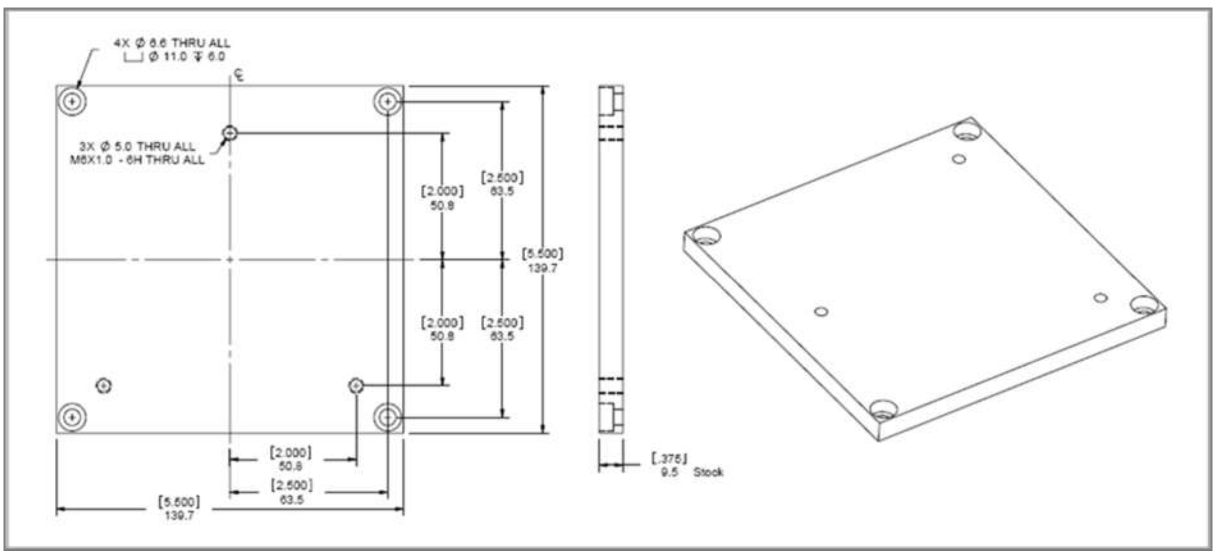


Figure 17 - Regular Mounting Plate Outline

4.1.2 Radar Mounting

The radar mount must provide stability and rigidity in order to support the weight of the R1, R2, R3, R3D, R5 and R5D radars. This way, the unit maintains consistent stable radar images and readings, which are critical to the performance of the system. Securing the radar requires four M6 screws. In selecting or designing the mount, high wind speed conditions must be considered.

WARNING!

All four screws should be used to ensure that the radar is properly secured.

To ensure maximum performance, the radar must turn at a steady speed. Therefore, the mounting surface should follow the following criteria:

- Flat and level to within 1/2° on level terrain, to properly direct the radar energy. If needed, it is possible to tilt the radar assembly up to 22.5° to follow the terrain contour.
- The mount area should be designed such that rain water does not accumulate.
- The mount area must provide enough clearance for the power/data connector and for the installer to have room to manually mate the power/data cable to the connector.
- The screws need to be long enough to go through the mounting surface plus 12.7 mm (1/2”) plus the washer thickness. If the mounting surface is a 6.3 mm (1/4”) plate, then the screws (threads) should be 19 mm (3/4”) in length.
- The maximum screw penetration into the radar should not exceed 15.7 mm (~5/8”).
- Torque should not be excessive but should result in no rocking movement whatsoever.
- The use of a compound such as Loctite® is recommended to maintain the screws in the desired position. A lock washer is not required.
- The two aerating vents on the bottom of the radar units should not be obstructed.

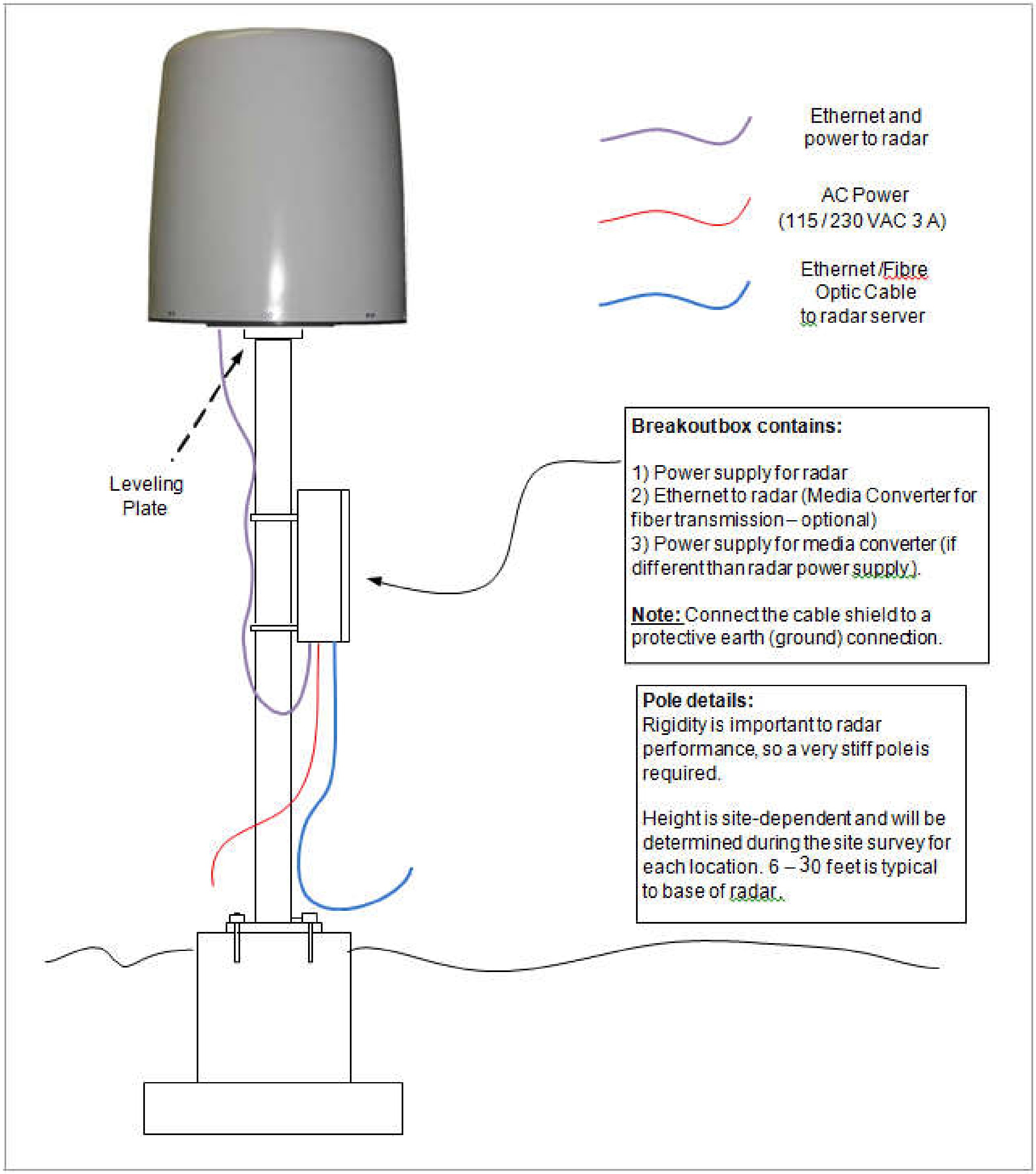


Figure 18 - Radar Mounting

4.1.3 Water Accumulation

The R1, R2, R3, R3D, R5 and R5D Radar Assemblies are designed to prevent water ingress in the radar unit, however it is preferable to use a mounting plate that will prevent water accumulation at the base. The mounting plate should clear the aerating vents at the bottom of the radar. Figure 19 shows the preferred type of mounting plate. If the mounting plate is larger in diameter than the base of the radar, it is recommended that the spacer included with the radar be used, as shown in Figure 20. This spacer should be inserted between the radar and the mounting plate.

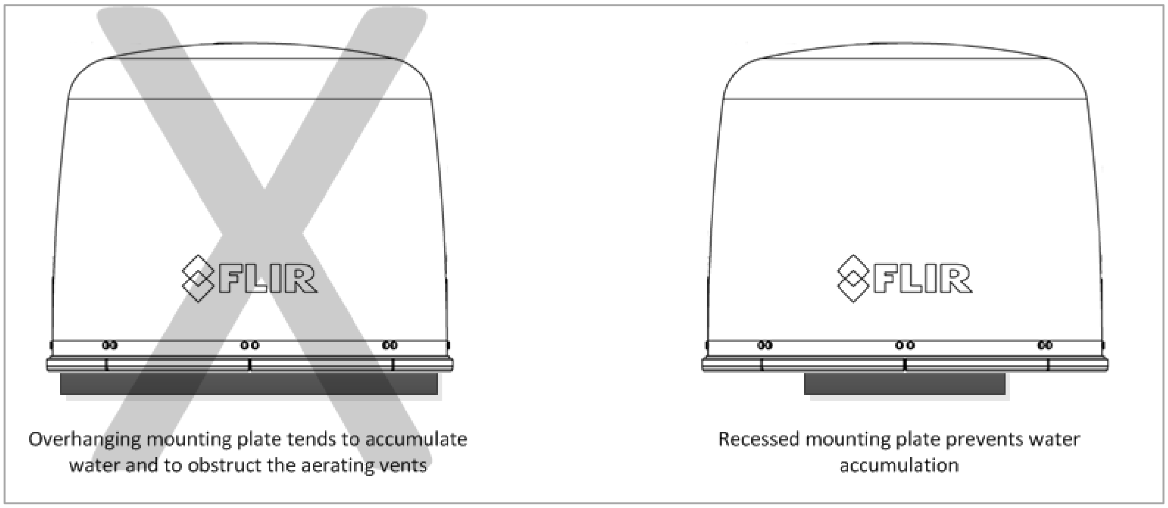


Figure 19 - Preventing Water Accumulation at Radar Base

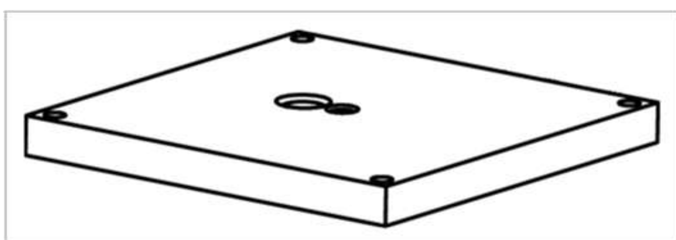


Figure 20 - Radar Spacer

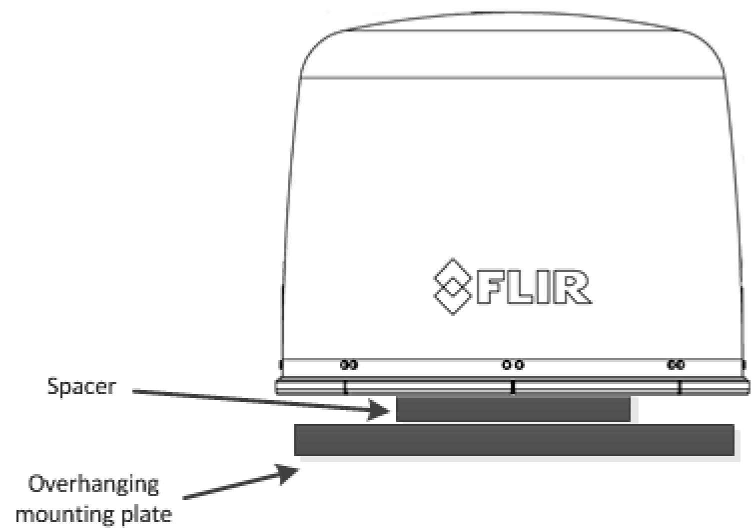


Figure 21 - Overhanging Mounting Plate

4.2 ANTENNA TILT ADJUSTMENT

Note
The R1, R2, R3, R3D, R5 and R5D radars are factory-adjusted so that the antenna points to the horizon.

Note
Radar performance is optimal at 0 degree of tilt angle under most circumstances. Only modify the antenna tilt angle if required by the terrain profile (refer to Section 3.1).

Changing the antenna tilt angle has an impact on the minimum and maximum detection ranges. Typical detection distances are given in Table 3, Table 4, Table 5 and Table 6.

4.2.1 Typical detection distances — R1, R2 and R3

Detection Range R1, R2, R3 and R3D FastScan (meters) Minimum / maximum (Low Crawler) Minimum / maximum (Walker) Minimum / maximum (Car) Note: The R1 is limited to 700m and the R2 to 1400m					
Radar Height	**-5° tilt**	**-3° tilt**	**-1° tilt**	**0° tilt**	**1° tilt**
0.5 m	5 / 300 5 / 1100 5 / 2550	5 / 400 5 / 1500 5 / 2600	5 / 480 5 / 1900 5 / 2600	6 / 500 5 / 1900 5 / 2600	9 / 500 5 / 1900 5 / 2600
1.0 m	6 / 300 5 / 1100 5 / 2550	8 / 400 5 / 1500 5 / 2600	12 / 480 5 / 1900 5 / 2600	16 / 500 5 / 1900 5 / 2600	23 / 500 5 / 1900 5 / 2600
1.5 m	9 / 300 5 / 1100 5 / 2550	13 / 400 5 / 1500 5 / 2600	19 / 480 5 / 1900 5 / 2600	25 / 500 5 / 1900 5 / 2600	38 / 500 5 / 1900 5 / 2600
2.0 m	13 / 300 5 / 1100 5 / 2550	17 / 400 5 / 1500 5 / 2600	26 / 480 7 / 1900 7 / 2600	35 / 500 10 / 1900 10 / 2600	52 / 500 14 / 1900 14 / 2600
2.5 m	17 / 300 7 / 1100 7 / 2550	22 / 400 10 / 1500 10 / 2600	33 / 480 14 / 1900 14 / 2600	44 / 500 19 / 1900 19 / 2600	66 / 500 29 / 1900 29 / 2600
3.0 m	20 / 300 11 / 1100 11 / 2550	27 / 400 14 / 1500 14 / 2600	40 / 480 21 / 1900 21 / 2600	54 / 500 29 / 1900 29 / 2600	81 / 500 43 / 1900 43 / 2600
4.0 m	27 / 300 18 / 1100 18 / 2550	36 / 400 24 / 1500 24 / 2600	55 / 480 36 / 1900 36 / 2600	73 / 500 48 / 1900 48 / 2600	109 / 500 72 / 1900 72 / 2600
5.0 m	34 / 300 25 / 1100 25 / 2550	46 / 400 33 / 1500 33 / 2600	69 / 480 50 / 1900 50 / 2600	92 / 500 67 / 1900 67 / 2600	138 / 500 100 / 1900 100 / 2600

Table 3 - R1, R2 and R3 Minimum/Maximum Detection Range for Low Crawler, Walker and Car

4.2.2 Typical detection distances — R5

Detection Range R5 and R5D FastScan (meters) Minimum / maximum (Low Crawler) Minimum / maximum (Walker) Minimum / maximum (Car)					
Radar Height	**-5° tilt**	**-3° tilt**	**-1° tilt**	**0° tilt**	**1° tilt**
2 m	15 / 1050 10 / 1300 10 / 2350	22 / 1850 10 / 2350 10 / 4100	37 / 2300 10 / 2900 10 / 4850	58 / 2400 16 / 3000 16 / 5000	130 / 2300 36 / 2900 36 / 4850
3 m	24 / 1050 13 / 1300 13 / 2350	34 / 1850 18 / 2350 18 / 4100	58 / 2300 31 / 2900 31 / 4850	90 / 2400 48 / 3000 48 / 5000	202 / 2300 107 / 2900 107 / 4850
4 m	32 / 1050 21 / 1300 21 / 2350	45 / 1850 30 / 2350 30 / 4100	78 / 2300 51 / 2900 51 / 4850	122 / 2400 80 / 3000 80 / 5000	274 / 2300 179 / 2900 179 / 4850
5 m	40 / 1050 25 / 1300 25 / 2350	57 / 1850 42 / 2350 42 / 4100	99 / 2300 72 / 2900 72 / 4850	153 / 2400 111 / 3000 111 / 5000	345 / 2300 251 / 2900 251 / 4850
6 m	49 / 1050 38 / 1300 38 / 2350	69 / 1850 54 / 2350 54 / 4100	119 / 2300 92 / 2900 92 / 4850	185 / 2400 143 / 3000 143 / 5000	417 / 2300 322 / 2900 322 / 4850
7 m	57 / 1050 46 / 1300 46 / 2350	81 / 1850 65 / 2350 65 / 4100	139 / 2300 112 / 2900 112 / 4850	217 / 2400 175 / 3000 175 / 5000	488 / 2300 394 / 2900 394 / 4850
8 m	66 / 1050 55 / 1300 55 / 2350	93 / 1850 77 / 2350 77 / 4100	160 / 2300 133 / 2900 133 / 4850	249 / 2400 207 / 3000 207 / 5000	560 / 2300 465 / 2900 465 / 4850
9 m	74 / 1050 63 / 1300 63 / 2350	105 / 1850 89 / 2350 89 / 4100	180 / 2300 153 / 2900 153 / 4850	281 / 2400 239 / 3000 239 / 5000	632 / 2300 537 / 2900 537 / 4850

Table 4 – R5 Minimum/Maximum Detection Range for Low Crawler, Walker and Car

4.2.3 Typical detection distances — R3D

Detection Range R3D (meters) Minimum / Maximum (Low Crawler) Minimum / Maximum (Walker) Minimum / Maximum (Car) Note 1: The detection is limited to 3000m when the selected range is 3400m Note 2: The table represents detection for the LONG Time-On-Target selection. When operating in SHORT Time-on-Target, the Maximum range is 72% of the table value. When operating in MEDIUM Time-On-Target, the Maximum range is 85% of the table value.				
Radar Height	**-6° tilt**	**-4° tilt**	**-2° tilt**	**0° tilt**
0.5 m	5 / 210 5 / 1200 5 / 1800	5 / 450 5 / 2600 5 / 3900	5 / 630 5 / 3600 5 / 5400	6 / 700 5 / 4000 5 / 6000
1 m	5 / 210 5 / 1200 5 / 1800	6 / 450 5 / 2600 5 / 3900	8 / 630 5 / 3600 5 / 5400	16 / 700 5 / 4000 5 / 6000
2 m	11 / 210 5 / 1200 5 / 1800	14 / 450 5 / 2600 5 / 3900	19 / 630 6 / 3600 6 / 5400	35 / 700 10 / 4000 10 / 6000
3 m	17 / 210 9 / 1200 9 / 1800	22 / 450 12 / 2600 12 / 3900	31 / 630 17 / 3600 17 / 5400	54 / 700 29 / 4000 29 / 6000
4 m	23 / 210 16 / 1200 16 / 1800	30 / 450 20 / 2600 20 / 3900	42 / 630 29 / 3600 29 / 5400	73 / 700 48 / 4000 48 / 6000
6 m	36 / 210 28 / 1200 28 / 1800	46 / 450 37 / 2600 37 / 3900	65 / 630 51 / 3600 51 / 5400	110 / 700 86 / 4000 86 / 6000
8 m	55 / 210 41 / 1200 41 / 1800	63 / 450 53 / 2600 53 / 3900	88 / 630 74 / 3600 74 / 5400	148 / 700 124 / 4000 124 / 6000
10 m	61 / 210 54 / 1200 54 / 1800	79 / 450 69 / 2600 69 / 3900	111 / 630 97 / 3600 97 / 5400	186 / 700 162 / 4000 162 / 6000

Table 5 – R3D Minimum/Maximum Detection Range for Low Crawler, Walker and Car; LONG Time-On-Target

SHORT Time-On-Target detection range calculation example:

- Walker, radar height = 8 meters and antennas tilt = -2°
  - Minimum detection range = 74 meters
  - According to Note 2, The Maximum detection range = 0.72 x 3600 = 2592 meters

MEDIUM Time-On-Target detection range calculation example:

- Walker, radar height = 8 meters and antennas tilt = -2°
  - Minimum detection range = 74 meters
  - According to Note 2, The Maximum detection range = 0.85 x 3600 = 3060 meters

4.2.4 Typical detection distances — R5D

Detection Range R5D (meters) Minimum / Maximum (Low Crawler) Minimum / Maximum (Walker) Minimum / Maximum (Car) Note 1: The detection is limited to 5000m when the selected range is 5500m Note 2: The table represents detection for the LONG Time-On-Target selection. When operating in SHORT Time-on-Target, the Maximum range is 72% of the table value. When operating in MEDIUM Time-On-Target, the Maximum range is 85% of the table value.				
Radar Height	**-6° tilt**	**-4° tilt**	**-2° tilt**	**0° tilt**
0.5 m	5 / 300 5 / 1600 5 / 2700	5 / 660 5 / 3300 5 / 5600	5 / 980 5 / 4900 5 / 8400	6 / 1100 5 / 5500 5 / 9400
1 m	5 / 300 5 / 1600 5 / 2700	6 / 660 5 / 3300 5 / 5600	8 / 980 5 / 4900 5 / 8400	16 / 1100 5 / 5500 5 / 9400
2 m	11 / 300 5 / 1600 5 / 2700	14 / 660 5 / 3300 5 / 5600	19 / 980 6 / 4900 6 / 8400	35 / 1100 10 / 5500 10 / 9400
3 m	17 / 300 9 / 1600 9 / 2700	22 / 660 12 / 3300 12 / 5600	31 / 980 17 / 4900 17 / 8400	54 / 1100 29 / 5500 29 / 9400
4 m	23 / 300 16 / 1600 16 / 2700	30 / 660 20 / 3300 20 / 5600	42 / 980 29 / 4900 29 / 8400	73 / 1100 48 / 5500 48 / 9400
6 m	36 / 300 28 / 1600 28 / 2700	46 / 660 37 / 3300 37 / 5600	65 / 980 51 / 4900 51 / 8400	110 / 1100 86 / 5500 86 / 9400
8 m	55 / 300 41 / 1600 41 / 2700	63 / 660 53 / 3300 53 / 5600	88 / 980 74 / 4900 74 / 8400	148 / 1100 124 / 5500 124 / 9400
10 m	61 / 300 54 / 1600 54 / 2700	79 / 660 69 / 3300 69 / 5600	111 / 980 97 / 4900 97 / 8400	186 / 1100 162 / 5500 162 / 9400

Table 6 – R5D Minimum/Maximum Detection Range for Low Crawler, Walker and Car; LONG Time-On-Target

SHORT Time-On-Target detection range calculation example:

- Walker, radar height = 8 meters and antennas tilt = -2°
  - Minimum detection range = 74 meters
  - According to Note 2, The Maximum detection range = 0.72 x 4900 = 3528 meters

MEDIUM Time-On-Target detection range calculation example:

- Walker, radar height = 8 meters and antennas tilt = -2°
  - Minimum detection range = 74 meters
  - According to Note 2, The Maximum detection range = 0.85 x 4900 = 4165 meters

4.2.5 Antenna Tilt Adjustment Procedure — R1, R2, R3 and R3D

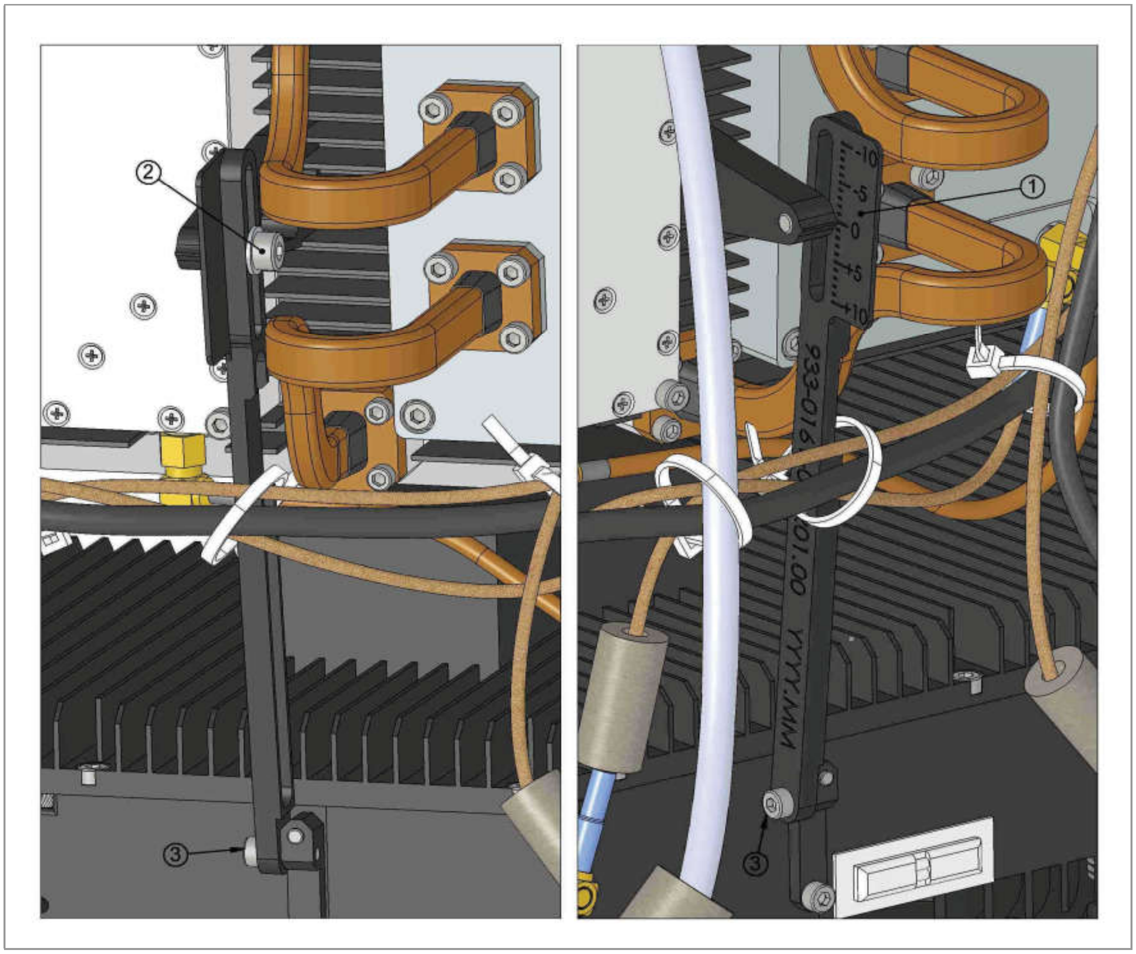


Figure 33 - Radar Antenna Tilt Adjustment – R1, R2, R3 and R3D

Step 1 Unfasten the 8 screws from under the base of the unit, then remove the radome

Step 2 Gently loosen screws (2) and (3), in Figure 4, until the antenna can be tilted

Step 3 Tilt the antenna to the desired angle, that is read on the Tilt angle indicator (1), then re-tighten screw (3) to 10 in-lb and screw (2) to 22 in-lb, to maintain the antenna position

Step 4 Replace the radome and re-install the 8 screws at the bottom of the unit and tighten to 10 in-lb, being careful not to overtighten. Hand-tighten only until resistance increases — base seal should be compressed by approximately 2 mm.

4.2.6 Antenna Tilt Adjustment Procedure — R5 and R5D

Step 1 The R5 and R5D tilt angle can be adjusted using the three screws on each side of the antenna assembly. The central screw on each side is the adjustment screw that allows you to change the tilt angle in increments of 1 degree. The two slot screws on each side of the adjustment screw allow you to loosen the antenna assembly in order to change the tilt angle. Remove the radome by first unscrewing the 8 screws under the base of the unit

Step 2 Loosen the two slot screws on each side of the antenna

Step 3 Unscrew the alignment screw on each side of the antenna

Step 4 Position the alignment screw on each side of the antenna to the desired tilt angle

Step 5 Screw back the alignment screw on each side of the antenna

Step 6 Tighten the two slot screws on each side of the antenna

Step 7 Replace the radome and re-insert the 8 screws under the base of the unit, being careful not to over-tighten. Hand-tighten only until resistance increases - base seal should be compressed by approximately 2mm

4.3 RADAR POWER DISTRIBUTION NETWORK INSTALLATION

Electrical power is delivered to the radar through the power/data connector. A single weatherproof connector is used to provide all external connections to the radar assembly. The connector is a “bayonet”- type connector. The pin assignments are indicated in the figure and table below:

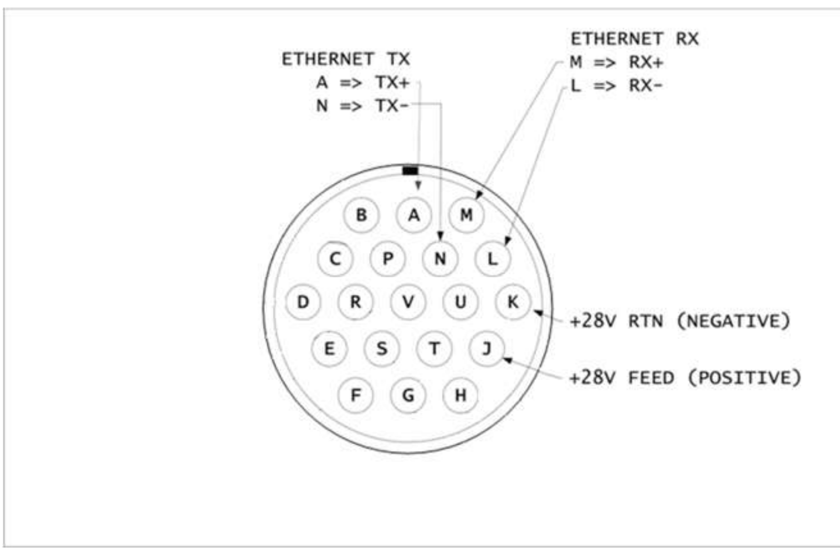


Figure 22 - Power/Data Connector Pin Out

Pin	Function	Pin	Function
A	ETHERNET TX +	L	ETHERNET RX -
B	Unused	M	ETHERNET RX +
C	Unused	N	ETHERNET TX -
D	Unused	P	Unused
E	Unused	R	Unused
F	Unused	S	Unused
G	Unused	T	Unused
H	Unused	U	Unused
J	FEED +28 V	V	Unused
K	RETURN +28 V *		

Table 7 - Power / Data Connector Pin Assignment – R1, R2, R3, R3D, R5 and R5D

Note
RETURN +28V has the same meaning as the – (minus) terminal on a battery. The cable connecting to the radar should use the appropriate mating connector (FLIR Radars Part # 401-1015).

4.4 NETWORK INFRASTRUCTURE INSTALLATION

Ensure installing the network components per the manufacturer's recommendations.

The recommended Ethernet cabling for connecting network components is Cat 5e or Cat 6. The IEEE 802.3 standard specifies that the maximum cable length is to be 100 meters (328 feet) between two Ethernet devices for 10 and 100 Mbps links.

5 RADAR TRANSMISSION CONFIGURATION

5.1 CONFIGURING THE RADAR TARGET AZIMUTH UPDATE

The target azimuth update is the azimuth angle at which each radar scan starts. Around this region, the tracking of targets and intruders may be sub-optimal. It is recommended to set this parameter to an azimuth outside the radar transmit sector. Figure 23 shows good and bad choices for a given radar. In this installation, the radar transmit sector is [300º - 60 º], so a good choice for the target azimuth update is at the opposite end, or 180º.

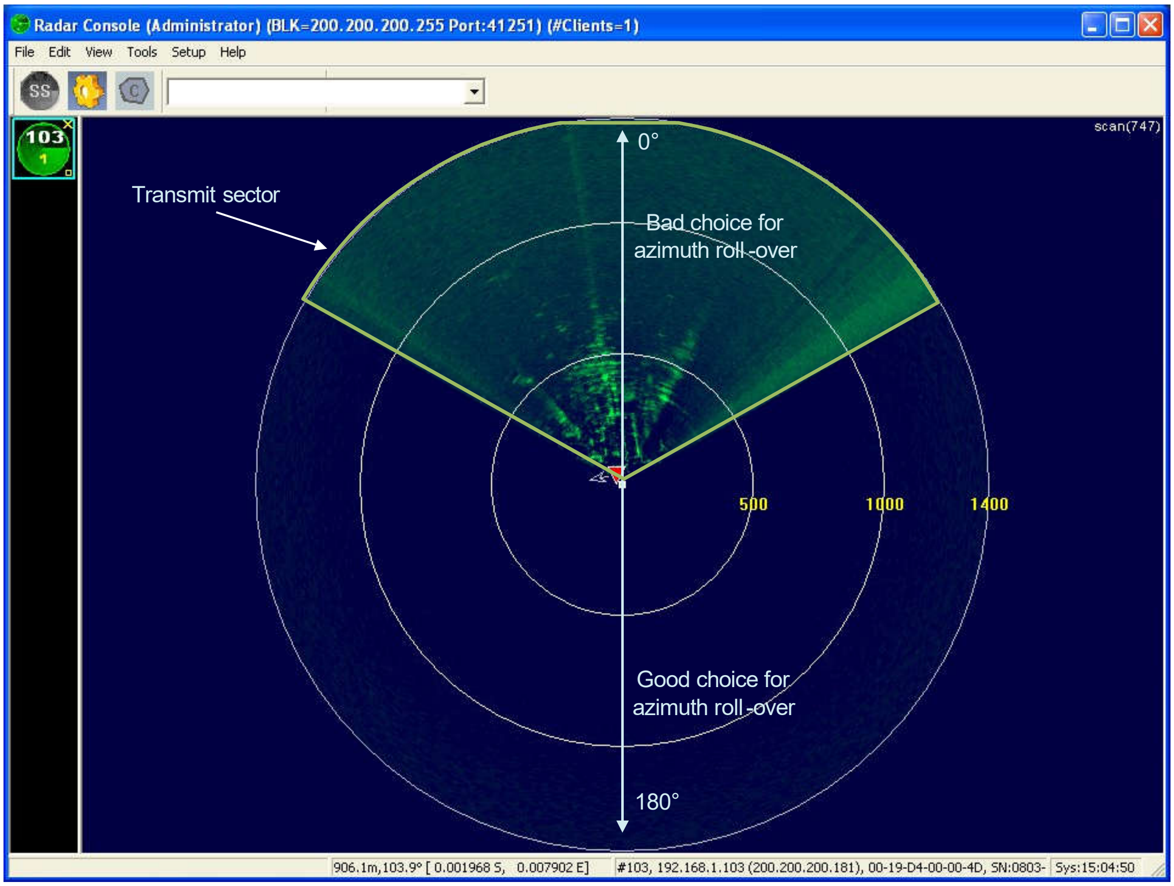


Figure 23 - Good and Bad Choices for Radar Target Azimuth Update

If the transmit sector covers the entire PPI area [0º - 360º], a good choice for the target azimuth update is an azimuth angle at which few targets / intruders are expected. Generally, it is best to avoid setting the target azimuth update at an azimuth aligned with a road.

Once the target update azimuth angle is established, it must be set in the radar unit.

Step 1 In **Radar Console** application, program the `RD_target_up_az` parameter with the value established, as shown in Figure 66

Step 2 Press the  button

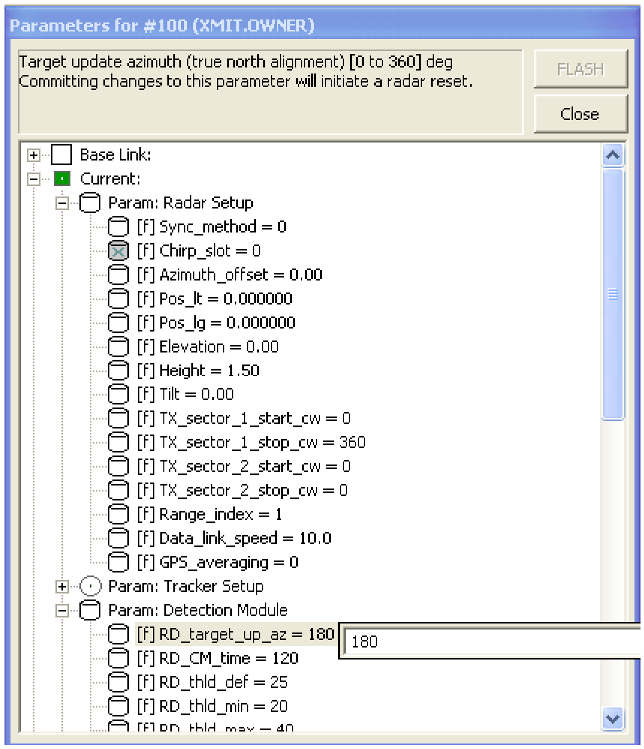


Figure 24 - Configuring the Target Azimuth Update

5.2 CONFIGURING THE CHIRP SLOTS

When two or more R1, R2, R3, R3D, R5 and R5D Radar Assemblies are used at the same site, each unit must be given a different frequency slot or a different time slot (or chirp slot) if they use the same frequency slot. This prevents the units from interfering with one another. If only a single unit is involved, any frequency or chirp slot can be used. It is recommended to always use synchronization method 2 unless the GPS reception is obstructed.

Radar Assembly	Synchronization method	Frequency Band	Available chirp slots
R1, R2, R3, R3D, R5 and R5D, FastScan Mode	1 or 2	---	0 - 3 (method 1) 0 - 7 (method 2)
R3D, Doppler Mode	2	---	0 - 3 (3400 m) 0 - 1 (6500 m)
R5D, Doppler Mode	2	2	0 – 2 (5500 m) 0 – 1 (10500 m)
R1, R2, R3, R3D, R5 and R5D, units in FastScan Mode & units in Doppler Mode	2	Refer to Table 9 and Table 10	Refer to Table 9 and Table 10

Table 8 - R1, R2, R3, R3D, R5 and R5D Radar Assemblies Synchronization Method

The R1, R2, R3 and R3D radars operate in the same frequency band. Similarly, the R5 and R5D also operate in the same frequency band, however they use a different band than the R1, R2, R3 and R3D. Therefore any R1, R2, R3 or R3D does not interfere with a R5 or R5D. The chirp slots of these two frequency groups can be setup separately.

A unique chirp slot must be assigned to each radar assembly at a given site and within the same frequency group. Chirp slots correspond to transmission resources. When many radars transmit on the same site, they will not interfere with one another if they use different chirp slots, as described in Table 9 and Table 10.

If the number of radars exceeds the quantity of available chirp slots, chirp slot values may be reused if the following conditions are met:

1. Their transmission sectors are defined so that they do not transmit towards each other.
2. They are separated by a distance at least greater than the radar range.

Figure 25 shows an example of a system where 2 radars are both using chirp slot 0.

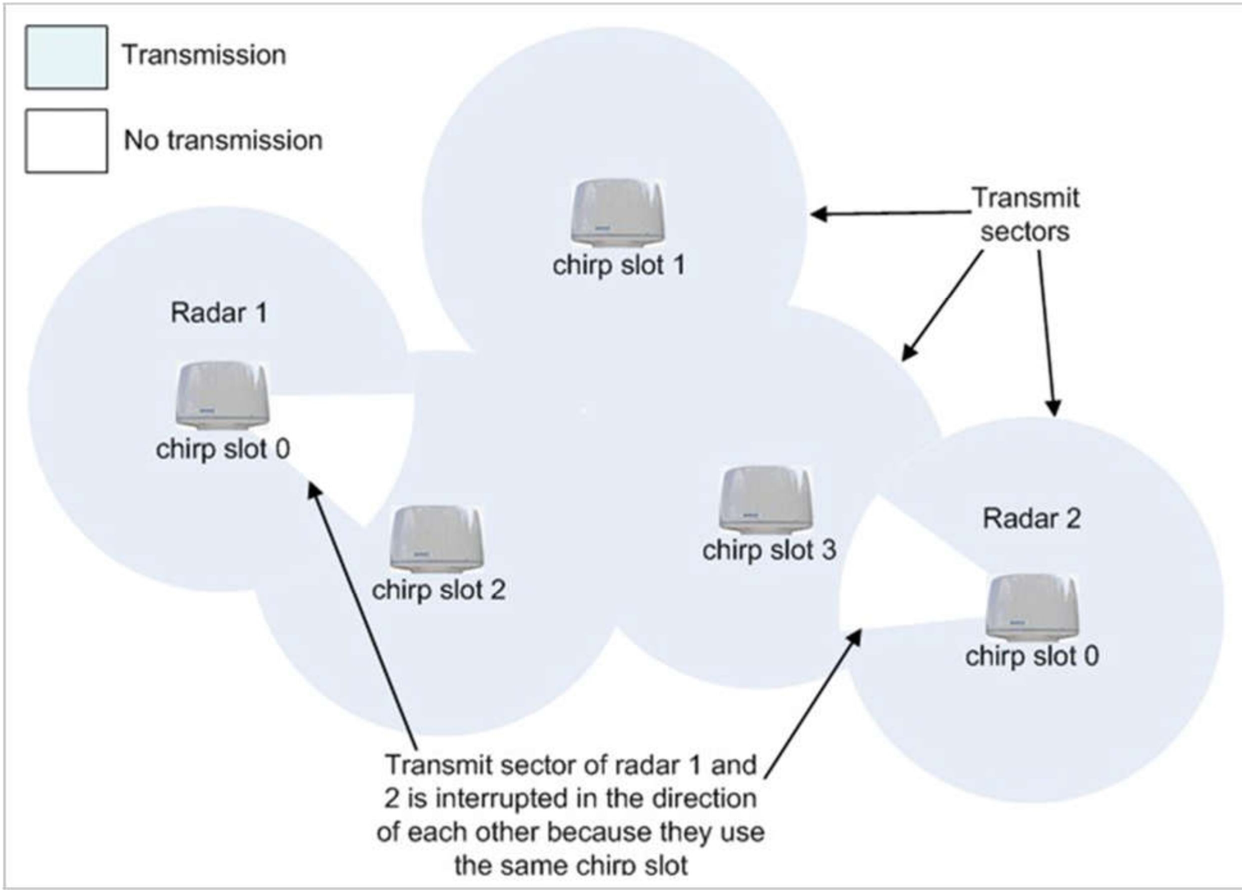


Figure 25 - Reusing Chirp Slots

The R1, R2, R3, R3D, R5 and R5D possess 8 chirp slots in FastScan mode. The R3D has 4 chirp slots in 3400m Doppler mode and 2 chirp slots in 6500m Doppler mode. The R5D has 6 chirp slots over 2 frequency bands in 5500m Doppler mode and 4 chirp slots over 2 frequency bands in 10500m Doppler mode.

Frequency Group : R1, R2, R3 and R3D			
# of Radars FastScan	# of Radars Doppler 3400 m	# of Radars Doppler 6500 m	Total # of Radars
Up to 8 (chirp slots 0-7)	0	0	Up to 8
Up to 4 (chirp slots 0, 2, 4, 6)	Up to 3 (chirp slots 1, 2, 3)	0	Up to 7
Up to 1 (chirp slot 0)	0	Up to 1 (chirp slot 0)	Up to 3
0	Up to 4 (chirp slots 0, 1, 2, 3)	Up to 2 (chirp slots 0, 1)	Up to 6
0	Up to 4 (chirp slots 0, 1, 2, 3)	0	Up to 4
0	0	Up to 2 (chirp slots 0, 1)	Up to 2

Table 9 - Number of Radars for Multiple Radar Modes R1, R2, R3 and R3D

Frequency Group: R5 and R5D					
# of Radars FastScan	# of Radars Doppler 5500m Freq Band 0	# of Radars Doppler 5500m Freq Band 1	# of Radars Doppler 10500m Freq Band 0	# of Radars Doppler 10500m Freq Band 1	Total # Radars
Up to 8 (chirp slots 0-7)	0	0	0	0	Up to 8
Up to 4 (chirp slots 0, 2, 4, 6)	Up to 2 (slots 0, 1)	Up to 2 (slots 0, 2)	Up to 1 (slot 1)	Up to 1 (slot 0)	Up to 10
0	Up to 3 (slots 0, 1, 2)	Up to 3 (slots 0, 1, 2)	Up to 2 (slots 0, 1)	Up to 2 (slots 0, 1)	Up to 10

Table 10 - Number of Radars for Multiple Radar Modes R5 and R5D

To configure a radar synchronization method and chirp slot, use the following steps:

Note
The synchronization method must be programmed before being able to change the chirp slot.

Step 1 Start the Radar Console application in direct mode

Step 2 Logon as Administrator on the Radar Console. Select the desired radar assembly to configure, and click on the  button.

Step 3 In the Parameters window, Radar Setup group of parameters, and Current, set Sync_method and Chirp_slot to the desired values. For the R5D also set the frequency Band to the desired value. Then press the FLASH button. The radar assembly will reset.

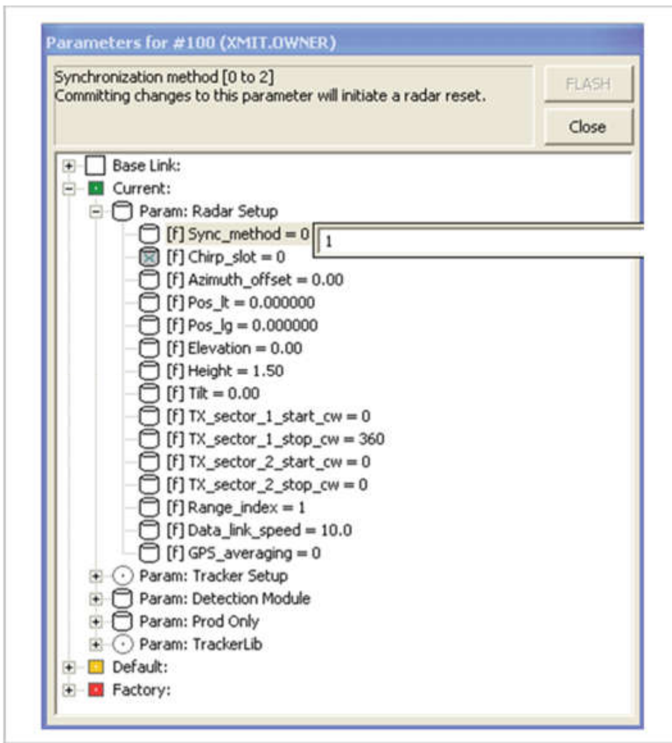


Figure 26 - Configuring Chirp Slots

5.3 CONFIGURING TRANSMISSION SECTORS

A transmission sector is an angular zone where the radar transmits radar energy and detects targets. The R1, R2, R3, R3D, R5 and R5D support up to 2 transmission sectors in FastScan mode. The R3D and the R5D support 1 transmission sector in Doppler mode. Additionally, a maximum transmit sector of 180° is supported in long time-on-target Doppler mode. Table 11 summarizes the available transmit sectors for each mode.

Mode	Transmit sector(s)
FastScan (All radars)	2 sectors of [0° - 360°]
Doppler Short	1 sector of [0° - 360°]
Doppler Medium	1 sector of [0° - 360°]
Doppler Long	1 sector of [0° - 180°]

Table 11 - Transmit Sectors

By default, one transmission sector from 300° to 60° is configured. For most deployments is it recommended to use complete coverage by setting the sector to 0° to 360°. If an assembly causes some interference with other equipment or, if there are other reasons for changing the transmission sector(s), use the following steps:

Step 1 Start the Radar Console application in direct mode

Step 2 Logon to the Radar Console. Select the desired radar assembly to configure, and click on the  button.

Step 3 In the Parameters window, Radar Setup group of parameters, and Current, select the start and stop angles of the desired transmit sector and press enter, as shown in Figure 27. After entering the start and stop angles, press the FLASH button. The radar assembly will reset.

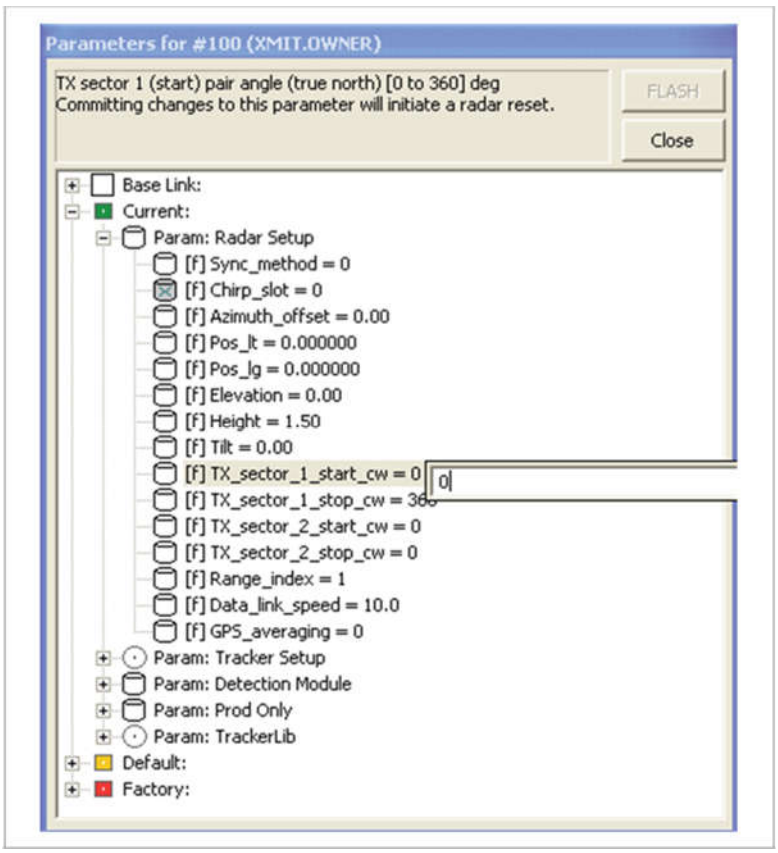


Figure 27 - Configuring the Radar Assembly Transmission Sectors

6 TROUBLESHOOTING

The following tables cover the Built-In Test (BIT) error codes and their description and solutions for resolving problems.

> **Note**
> In the event that any of these error codes are reported, follow the procedure below.

Step 1 Try re-initializing the system.

Step 2 If the error persists, gather the following information:

- Physical installation
- Network topology
- Software version
- Radar serial number
- Conditions under which the error occurred
- Any relevant application/system logs

Step 3 Contact Customer Support.

Error Code format: <Failure Category> . <Sub-Assembly code> <number>

Failure Category	Description
0	Host-Equipment Continuity
1	Radar Temperature
2	Radar Transmitter/Receiver Current
3	Radar Transmitter/Receiver Voltage
4	Radar Scan Monitoring
5	Radar RF Signal Monitoring
6	Embedded GPS Communication
7	Radar RF Signal Synchronization
8	Radar Time Synchronization
9	Configuration and Parameters
10	Memory Check (RAM, Flash, etc.)

Table 12 - Radar Failure Category Definition

Sub-Assembly	Description
0	System
1	Interface (Connector, IO board, cable, etc.)
2	Power Supply
3	RF (HW2)
4	Motor, drivers and encoders
5	CPU
6	RF (HW3)
7	Embedded GPS Controller
8	Not Used
9	Reserved for compatibility check

Table 13 - Radar Sub-Assembly Definition

7 MAINTENANCE

7.1 VISUAL INSPECTION

Due to the critical nature of perimeter surveillance applications, it is of paramount importance to keep the radar units trouble-free by routinely conducting visual verifications. The visual verification must check the following:

- Verify that the radome is clear from any obstruction such as trees or branches or any natural formation of dirt, grime or bird deposits. Such formations may attenuate radar signals. In order to clean the radome, see directions below (Section 7.3).

7.2 RECOMMENDED MAINTENANCE SCHEDULE

Maintenance Item/Action	Frequency	Comments
CLEANING	Dependent on the environment	
MECHANICAL INSPECTION	Every year	To be done only by a trained technician or return to FLIR for inspection
MOTOR	Change every 4 years	Return to FLIR for maintenance
GASKET	Immediately if damaged. Otherwise change every 3 years	
SLIP RINGS	Change every 4 years	Return to FLIR for maintenance
SUPER CAPS	Change every 4 years	Return to FLIR for maintenance
GORE™ MEMBRANE VENTS	Recommended every 2 years or less depending on the environment	

Table 14 – Recommended Maintenance Schedule

7.3 CLEANING THE UNIT

Follow the instructions below to clean the Assembly:

Step 1 Use a moist clean cloth if the radome is lightly soiled.
Step 2 Use a mild cleaner and moist cloth if the radome is heavily soiled.

7.4 EXTERNAL MECHANICAL INSPECTION

Follow the instructions below to perform an external mechanical inspection:

Step 1 Inspect for cracks, damage or deterioration.

Note
For any damaged part, contact FLIR Radars Customer Support for repair instructions.

7.5 REMOVING THE RADOME

Follow the instructions below to remove the Radar Radome:
Step 1 Set the radome on a clean surface and with a moist clean cloth wipe the surface of any dirt.
Step 2 Remove the radome by first unscrewing the 8 screws under the base of the unit. Refer to Figure 28 to see the location of the screws.
Step 3 Carefully remove any dirt on the radome and gasket. Pay particular attention to locations where these parts are in contact with each other. Replace gasket if damaged. Contact FLIR Radars Customer Support for to help in ordering a new one.

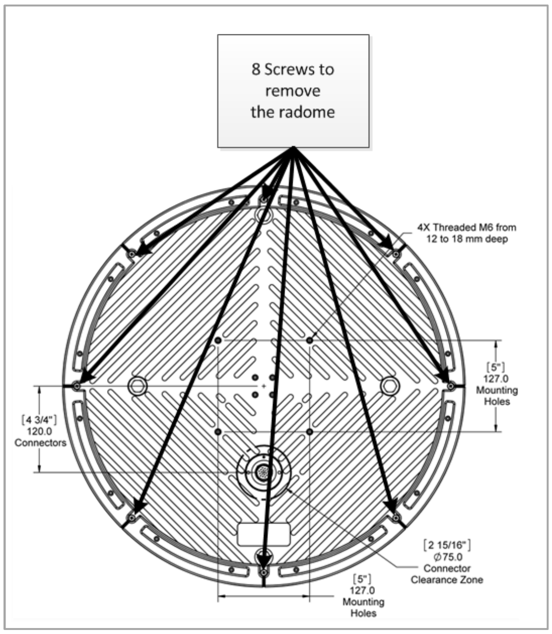


Figure 28 – Radome screws location

7.6 REPLACING THE RADOME

Follow the instructions below to replace the Radar Radome:

Step 1 Make sure the gasket is clean and set in place.

Step 2 Replace radome and re-insert the 8 screws under the base of the unit. Be careful not to over-tighten. Using a Torque screwdriver set to 10 lb-in, hand-tighten until resistance increases. The base seal should be compressed by approximately 2mm when the mechanical stop is reached.

7.7 INTERNAL MECHANICAL INSPECTION

Follow the instructions below to verify the gears:

Step 1 Place the radar in a clean, dry location.

Step 2 Remove the radome. See Section 7.5.

Step 3 Verify that there are no plastic fragments on the base of the radar.

Step 4 Verify both spur gears for wear. The gears are located between the base and the rotating payload (Figure 29). In the event of noticeable wear, please contact FLIR Radars Customer Support for repair instructions.

Step 5 Verify for loose screws or components. Any loose screws should be torqued as follows:

- SMA connectors to 9 lb-in
- M3 screws to 10 lb-in
- M4 screws to 22 lb-in
- M6 screws to 80 lb-in

Step 6 Verify for corrosion on accessible PCBs and on the external connector pins. In the event of corrosion, please contact FLIR Radars Customer Support for repair instructions.

Step 7 Verify for a loose payload. Hold the payload as shown in Figure 31 and gently try to move it up and down. The maximum up and down movement should be less than 1mm. In the event of a loose payload, please contact FLIR Radars Customer Support for repair instructions.

Step 8 Verify that the Gore Vents are not obstructed or broken (Figure 30).

Step 9 Inspect the radome for any defect.

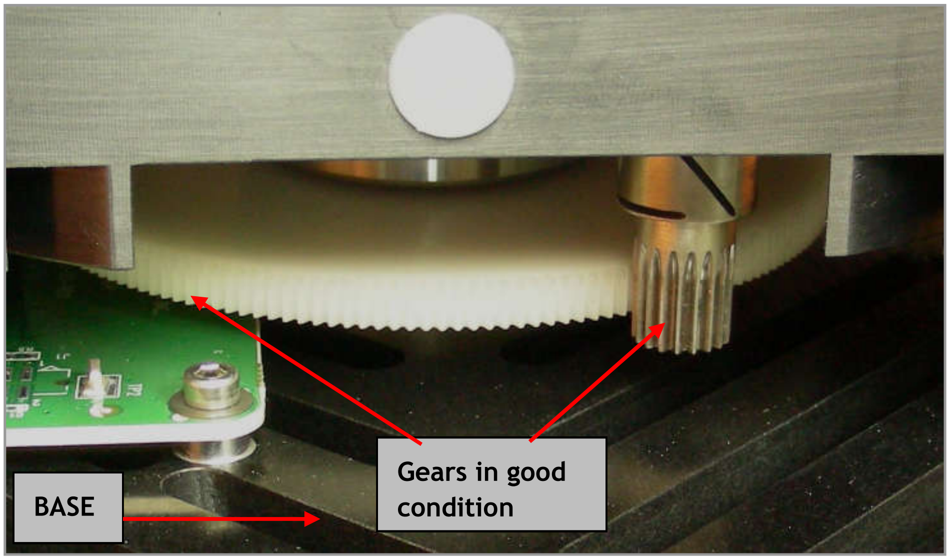


Figure 29 - Steps 3 & 4: Check Spur Gears

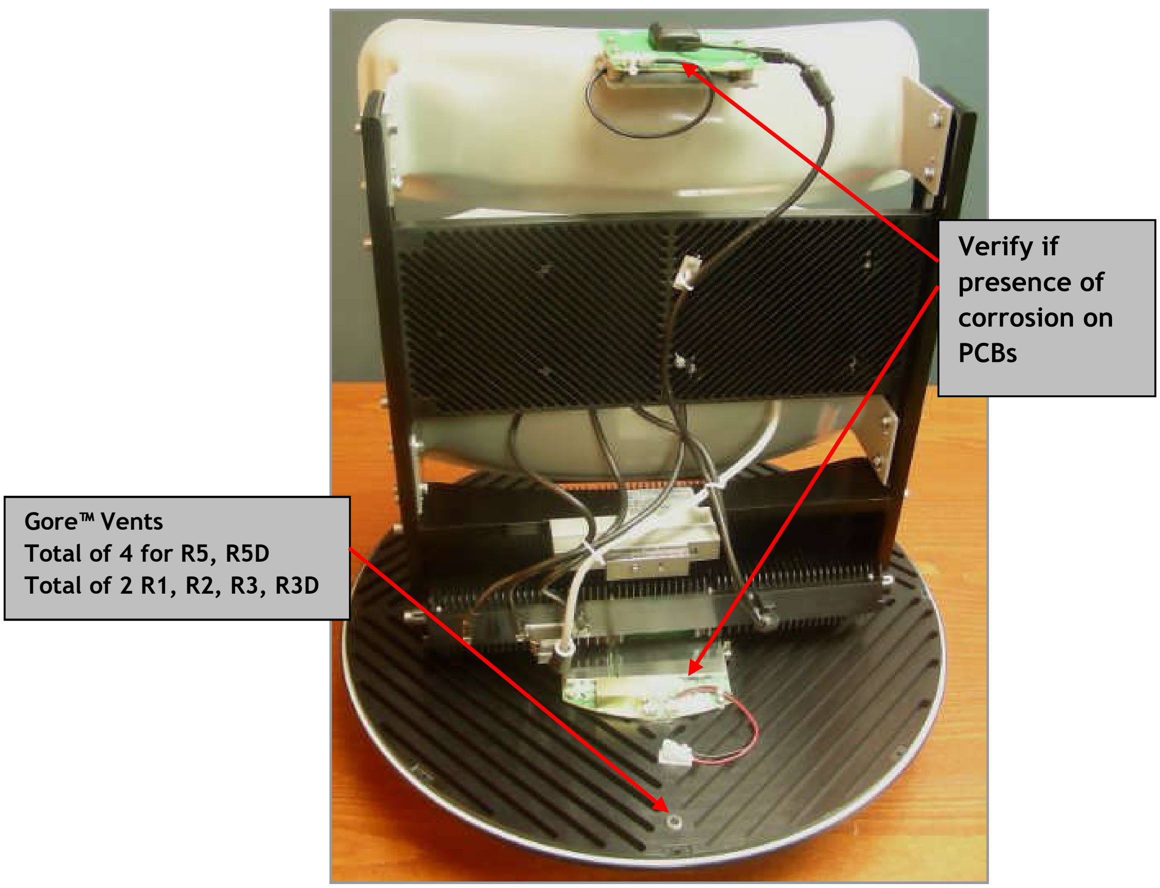


Figure 30 - Check mechanical components (R5, R5D shown)

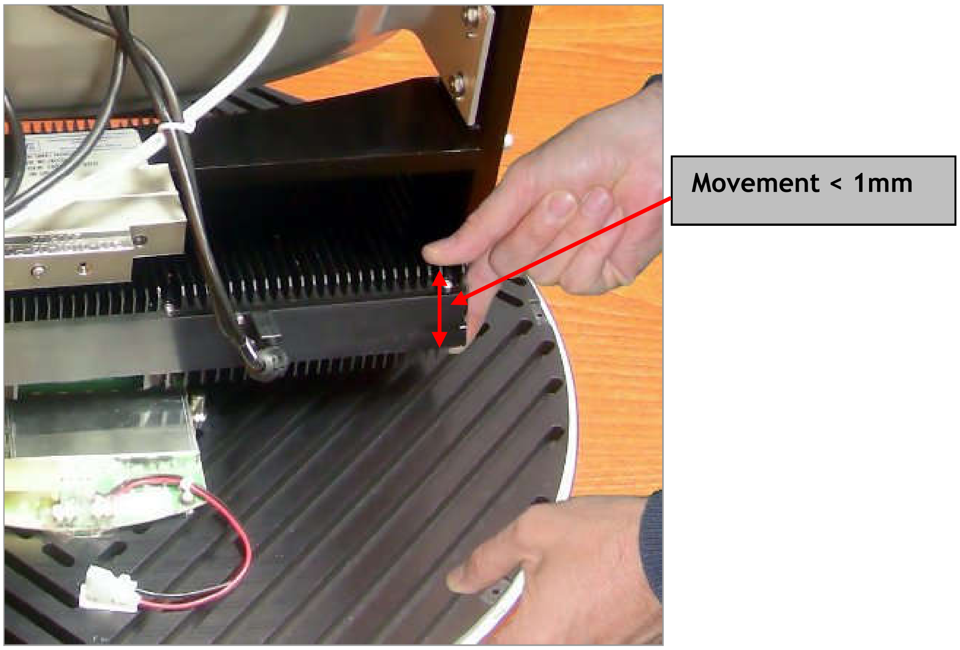


Figure 31 - Verify for loose payload (R5, R5D shown)

7.8 REPLACING THE MEMBRANE GORE VENT

The Gore Membrane Vents are screwed in under the base plate assembly.

The R1, R2, R3, R3D, R5 and R5D have Gore Membrane Vents to even the pressure as well as to prevent insects and water from entering the radar. The instructions below are given for the replacement of the Gore Membrane Vents. Contact FLIR Radars Customer Support for help in ordering new ones.

NOTE: The estimated time to complete this procedure is from 2 minutes to 15 minutes. There is no need to remove the radome.

Figure 32 - Gore Membrane Vents

Step 1 Remove the Gore Vents (4 for R5 and R5D; 2 for R1, R2, R3 and R3D) from the radar base plate using a 16mm hex socket.

Step 2 Clean and dry the plate surface in contact with the Gore Membrane Vents.

Step 3 Screw the new Gore Membrane Vents back in place and torque the parts to 8 lbs-in using a 16mm socket.

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