PLS® Communications & Technology

PDA-150-MIL Product Sheet

Complaint with

STANDARD MIL-STD 461F

STANDARD MIL-STD 810G

STANDARD MIL-STD 188-164A

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1. PROPOSED ANTENNA SYSTEM

PALS spent many years in the sector gaining know-how and employing spectacular engineers becoming a professional family. All of our PALS employees are ready to answer any questions you might have or will have. The proposed antenna system in this document is PALS Drive Away 150 Military known as PDA-150-MIL which PALS believes will fulfill customers' needs. PDA-150-MIL antenna is one of the most popular models PALS offers and many units are already deployed in the field for many years. PDA-150-MIL is a satellite antenna that can be mounted on the vehicle, can be automatically pointed to the satellite, and can be deployed in the stow position, which allows receiving/transmitting in Ku-Band. This document also purposed to present technologies used and why this system should be chosen over any competitor.

Figure 1 General View of PDA-150-MIL Antenna System

Please note PALS offers many color options depending on customer requests. Although the antenna presented in this document is a military type and comes in mil type 383 Green and Desert yellow. PDA-150-MIL antenna characteristics table is given below:

KU-BAND ANTENNA KEY CHARACTERISTICS		
#	**Technical specification**	**Value**
1	Reflector Diameter (Elliptical)	1500 x 1417mm
2	Reflector Material	Carbon Fiber
3	Elevation/Azimuth Angle of Motion	Elevation: 10-90 degrees, Azimuth: ±220 degrees
4	Send Frequency	13.75-14.50GHz
5	Receive Frequency	10.75-12.75 GHz.
6	Send/Receive Polarization	Linear Orthogonal
7	Send Band Gain	44.50dBi
8	Receiving Band Gain	43.00dBi
9	Operating Temperature Outdoor Unit	-30/+60 degrees
10	Operating Temperature Indoor Unit	-10/+55 degrees
11	Storage Temperature Outdoor Unit	-40/+70 degrees
12	Storage Temperature Outdoor Unit	-20/+60 degrees
15	AKB Indoor Unit Weight	14 ± 3 kg
16	Outdoor Unit Weight	155 ± 3 kg

Table 1 Ku-band ANTENNA KEY CHARACTERISTICS

2. KEY FEATURES

PDA-150-MIL antenna system is specifically designed for ease of use. Whether if it's operator is a professional who has experience in satellite communication or an operator who had his first encounter with a satellite communication antenna with some training.

Key features of the PDA-150-MIL antenna system that stands out against competitors are presented below **:**

- Ku, Ka, X, DBS Band options are available
- Strong yet lightweight Carbon-Fiber design which rigorously tested to operate in the toughest environments (wind, rain, sun...)
- High capacity of gain, low loss, and state-of-art antenna signal acquisition
- 0,01° pointing accuracy with resolvers at 3 axes
- Fully motorized driving mechanism with zero backlash gear system
- Dual offset (dual optic) elliptical antenna and feed system
- Low power consumption De-Ice system (Optional)
- Supports SNMP ver. 2.0c for M&C
- Beacon and/or DVB-S/S2 Tracking Receiver (Optional)
- Manual drive tool kit for emergencies
- Hand-held control unit (Optional)

Compatibility:

- MIL-STD-810G (Environmental Conditions)
- MIL-STD-461F (EMI-EMC)
- MIL-STD-1472 (Acoustic)
- MIL-STD-188-164A (RF)
- ITU-RS-580 (RF)
- ITU-RS-465-6 (RF)
- EUTELSAT ESOG120

3. MECHANICAL FEATURES

PALS knows the importance of mechanical design as well as other aspects of manufacturing a satellite antenna system. All features come from experience in the field or well-designed working scenarios. Every design, manufacturing process, product, the feature is tested in both factories and fields.

3.1. DIMENSIONAL ADVANTAGES

PDA-150-MIL antenna is designed by our experienced engineer who expert in their field. PDA-150-MIL antenna is designed to be mounted on top of any motorized vehicle. Many laws and regulations require to be a vehicle at a certain height level. Therefore PDA-150-MIL antenna's slim design causes minimal height difference. PDA-150-MIL dimensions are as given below:

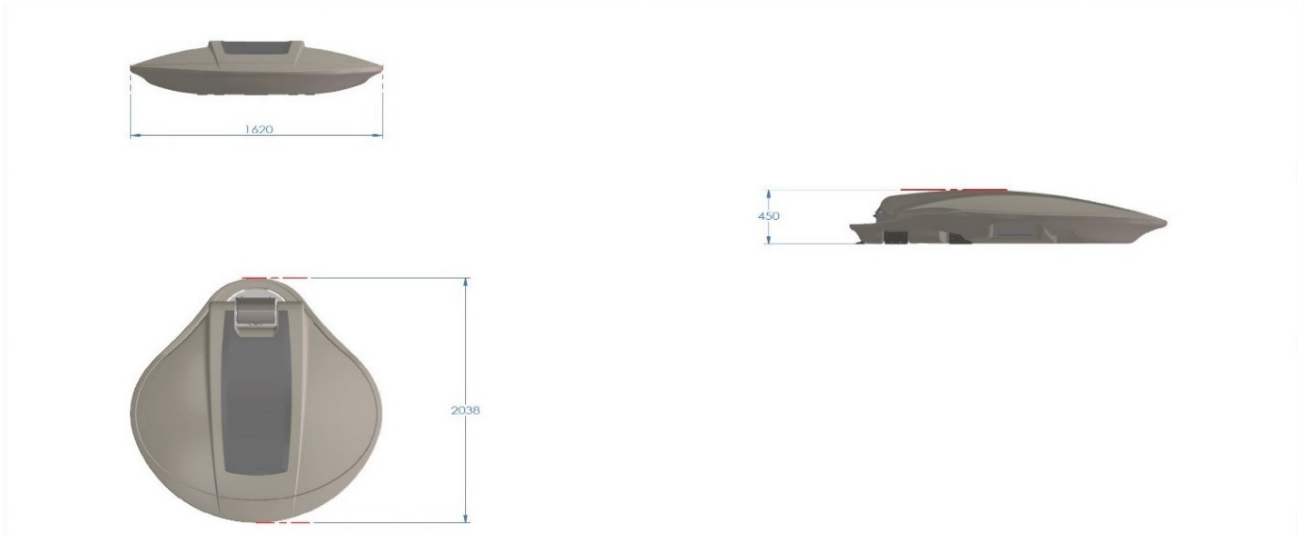


Figure 2 PDA-150-MIL Antenna System Dimensions in mm

The sweeping area when the antenna is deployed and in movement is presented as below.

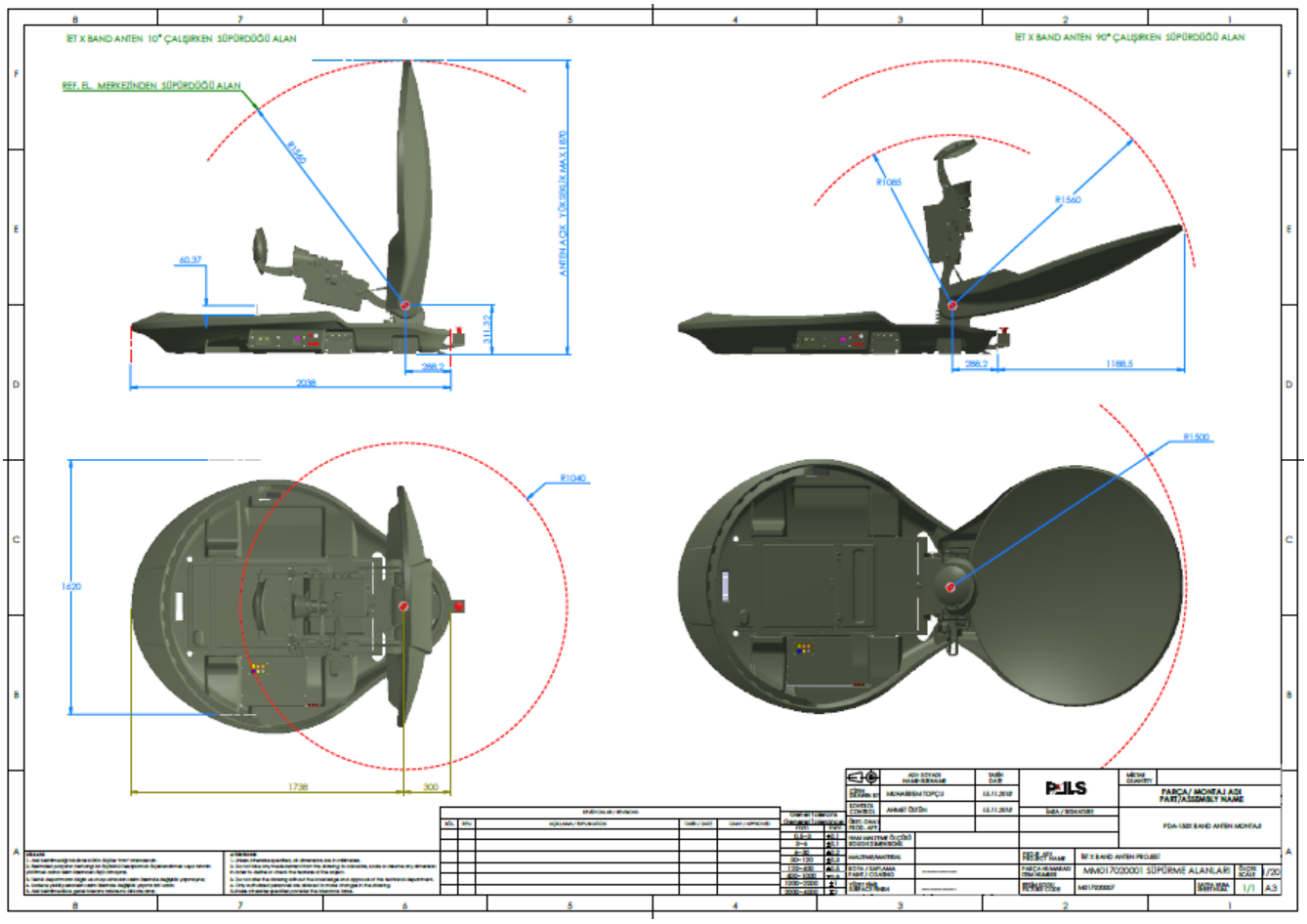


Figure 3 PDA-150-MIL Sweeping Area

3.2. CARBONFIBER DESIGN

The antenna system itself is designed to be light in weight yet durable for many years thanks to the latest fiber technology used to manufacture the PDA-150-MIL antenna to be precise and durable. Flexibility and resiliegiveives its strength to antenna housing (POD). The POD design of the antenna system is presented below.

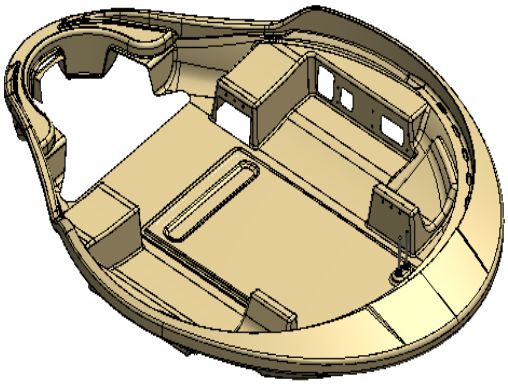


Figure 4 PDA-150-MIL Antenna POD Design

The main and sub-reflector of the antenna are also made out of carbon fiber. Although carbon fiber's key feature is its flexibility any changes in reflector causes changes in RF performance. PDA-150-MIL antenna designed to be guaranteed RF performance under any weather condition causing expansion or shrinking without compromising its durability. The main factor achieving this other than design experience is the choosing right material for manufacture. The carbon fiber used has a much lower thermal expansion coefficient (<2x10-6 for carbon fiber compared with / 23x10-6 for aluminum) ensuring that system accuracy is preserved in· all temperatures, preventing the reflector from warping due to changes in heat - by careful use of differing fiber weaves a virtually zero thermal expansion coefficient can be achieved.

Figure 5 PDA-150-MIL Antenna Main Reflector Design

Due to PALS' firm quality assurance policies, every antenna unit needs to be pass verification tests after its manufacture. PALS performs optical laser technology to verify its products are manufactured according to design standards and the right material is used ensuring its accuracy is better than 0.5 mm RMS.

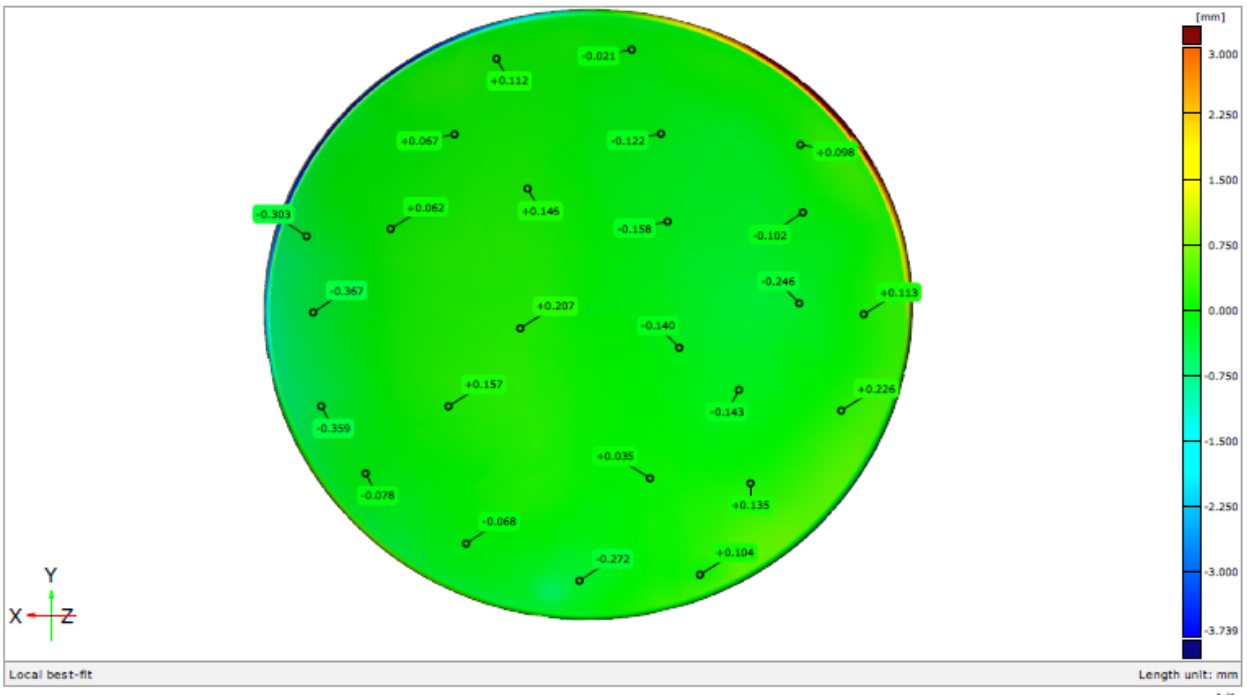
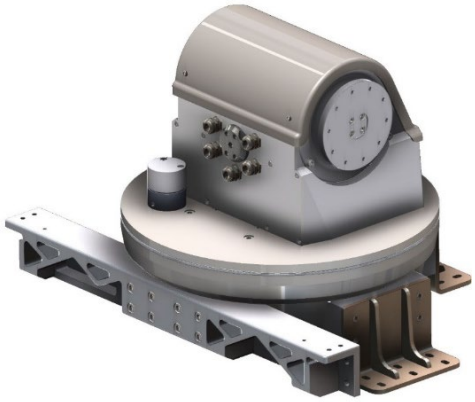


Figure 6 PDA-150-MIL Antenna Reflector Sample Verification Result Using Optical Laser Technology

3.3. ZERO BACKLASH DURABLE STRUCTURE

PDA-150-MIL antenna designed to be durable first. Make sure it won't be affected by metal fatique over years. The right material and right metallurgic techniques are chosen and applied to be making sure customer satisfaction. AL6061 is used in all metal parts used in this system unless otherwise stated.



PDA-150-MIL ensures have zero backlash in the main reflector. This means there is no gap between gears moving antenna reflectors, especially when changing direction. This feature ensures there will be no moving or swinging on the reflector when deployed.
This was achieved by using centrifugal casted bronze alloy planetary azimuth gears. Heat treatment ensures the gear itself is rigid but is not going to be worn down and cause any gap between gears in the future. This technology has proven itself by many units deployed in the field for many years.

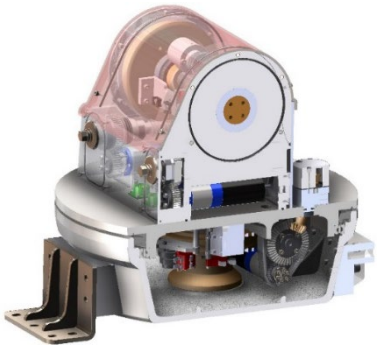


Figure 7 PDA-150-MIL Antenna Chasis Side Cut View (Bronze parts can be seen)

Zero backlash is also ensured in the elevation axis as well by using an infinite eccentric type worm shaft. The elevation structure is presented below.

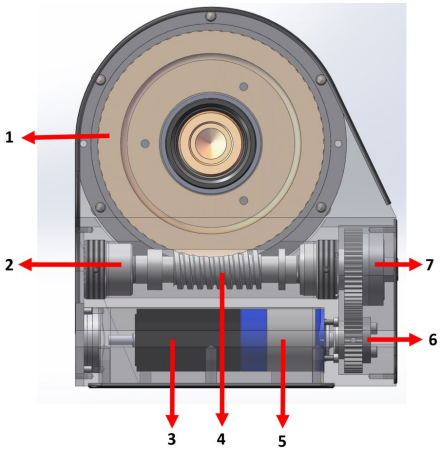


Figure 8 PDA-150-MIL Antenna Elevation Structure Side View

#	Part name
1	Elevation Eccentric Gear
2	Worm Shaft Gear
3	DC Motor
4	Infinite Turn Shaft
5	DC Motor Reducer
6	DC Motor Gear
7	Worm / Manual Gear

Table 2 PDA-150-MIL Antenna Elevation Parts

3.4. WIND PERFORMANCE

PDA-150-MIL antenna designed to be show excess performance under wind-load. Which is an environmental factor that partakes most and common factor of RF performance losses. PALS presents the following wind load performances:

	Value
Operational	72 km/h
Survival	180 km/h

Table 3 PDA-150-MIL Antenna Verified Wind Performance

Please note survival values are in force as the antenna is deployed or stowed in any direction. Operational wind speed means when stated wind speed is present there won't be any RF performance loss worse than 0.4 dB as stated on Eutelsat's ESOG120.

PALS began to develop its components in the design phase to achieve this performance. After design values are simulated in verification tests. As presented below:

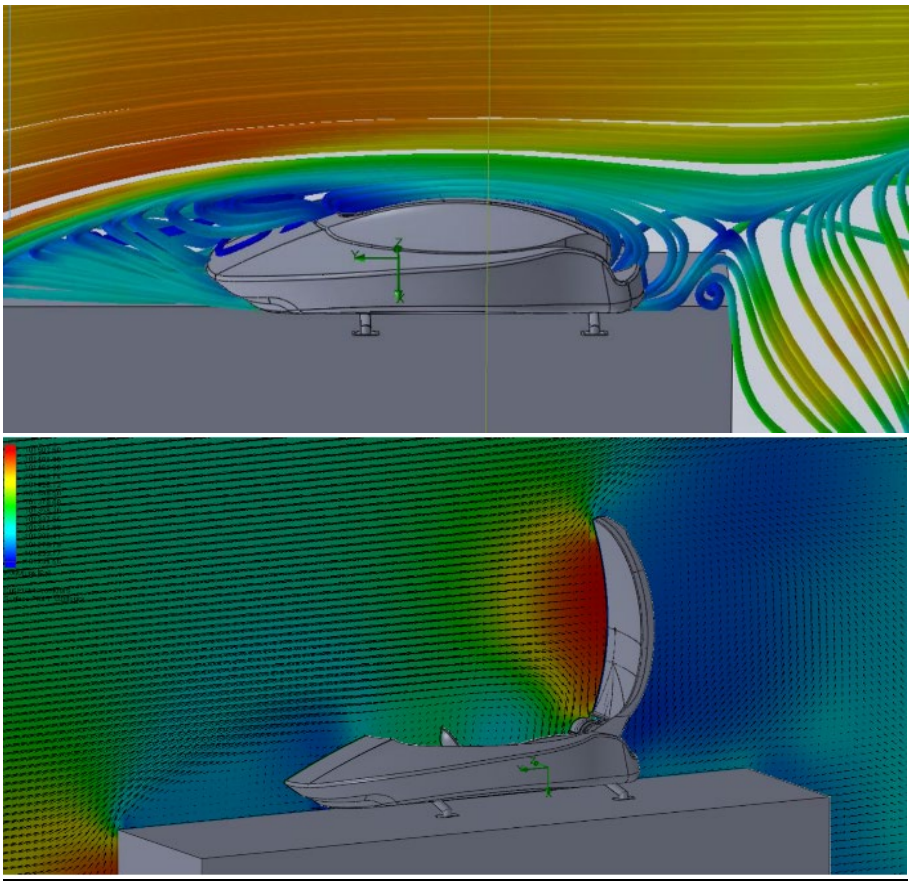


Figure 9 PDA-150-MIL Antenna Simulation Results (Left is survival, Right is operational)

After the design and manufacturing phase, wind performance values are verified using a wind turbine tunnel. PDA-150-MIL successfully passed stated values in tests as well.

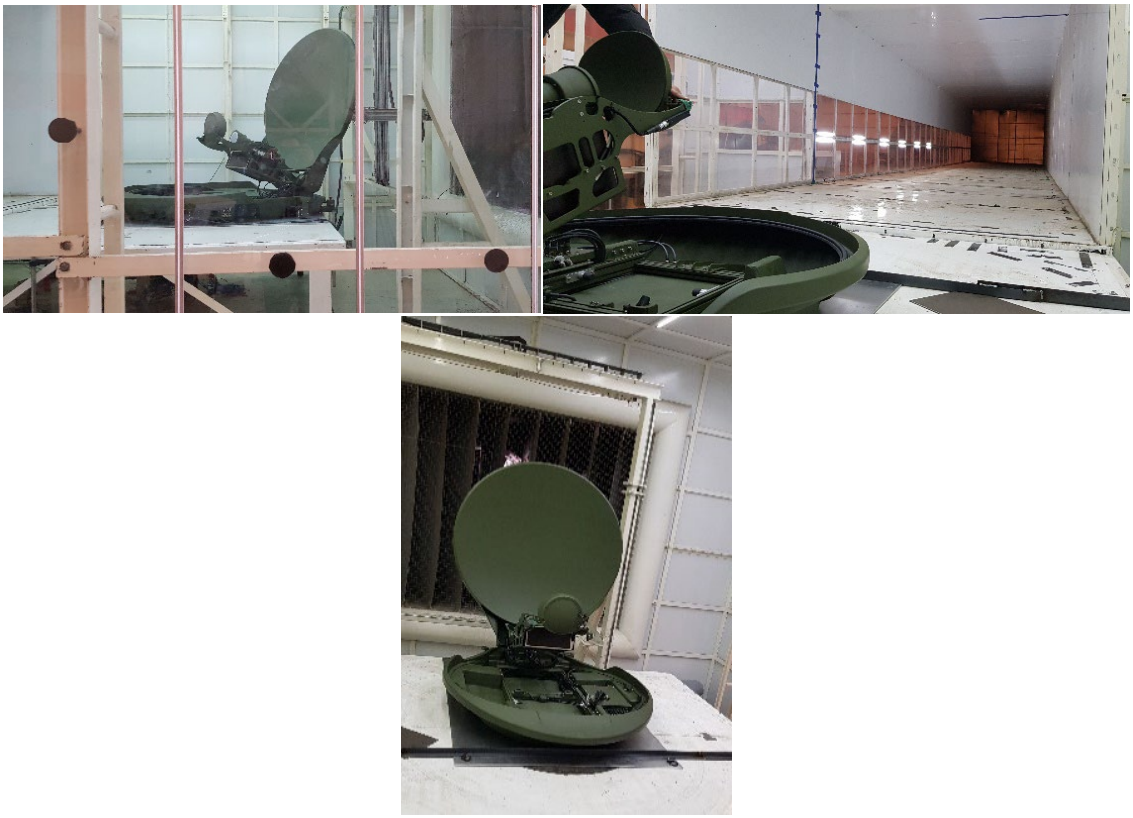


Figure 10 PDA-150-MIL Antenna While Under Wind Turbine Test (Actual Footage)

3.5. DE-ICING (OPTIONAL)

Heater elements can be embedded in the surfaces of the system to prevent icing. Due to the very low thermal expansivity of Carbon Fibre their · is no shape change with temperature. PALS uses electrical de-icing via an embedded Carbon fiber element in the surface behind the reflective layer. This operates at about 30-40W per sq. ft and heat can only be conducted forward to the reflector surface due to the core of the antenna structure having a low conductivity.

The rear face of the reflector is a slower-acting heat source but is economical in terms of energy consumption. The system is controlled via the ambient temperature and can be set by the user. De-icing is recommended for extremely cold environments that are subject to frequent heavy snowfall. Ambient temperature and current ice status are monitored by the system at all times thanks to its de-ice sensor and snow accumulation sensor.

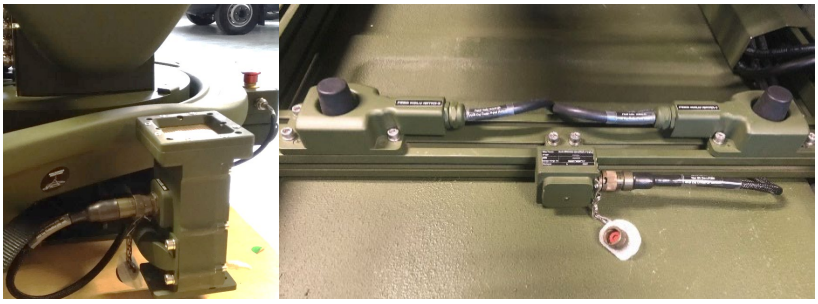


Figure 11 PDA-150-MIL Antenna De-ice System Parts (Left: De-ice Sensor, Right: Snow Accumulation Sensor)

Optional de-icing (frost prevention system) can be embedded into the PDA-150-MIL antenna system to perform the following functions.

- To thaw frozen connections under snow and ice load before operating the Antenna.
- To prevent snow and ice from accumulating on the reflector and feed horn so that the RF performance is not affected during operation.
- To ensure that units such as motors, sensors, etc. work up to -30 degrees
- To prevent the accumulation of snow and ice in the pod during operation.

PDA-150-MIL de-icing system contains total max. **1800 Watts** RMS heating elements make sure its operation won't be interrupted under any condition. Although it only spends max. **600 Watts** RMS at any given time without any loss of performance, thanks to its sophisticated de-icing algorithm. Even if de-ice is on automatic or manual mode. This feature ensures PDA-150-MIL antenna won't cause any additional electrical load on the transportable vehicle's electrical systems (i.e. generator). The layout of the de-ice heating elements is presented in the drawing below.

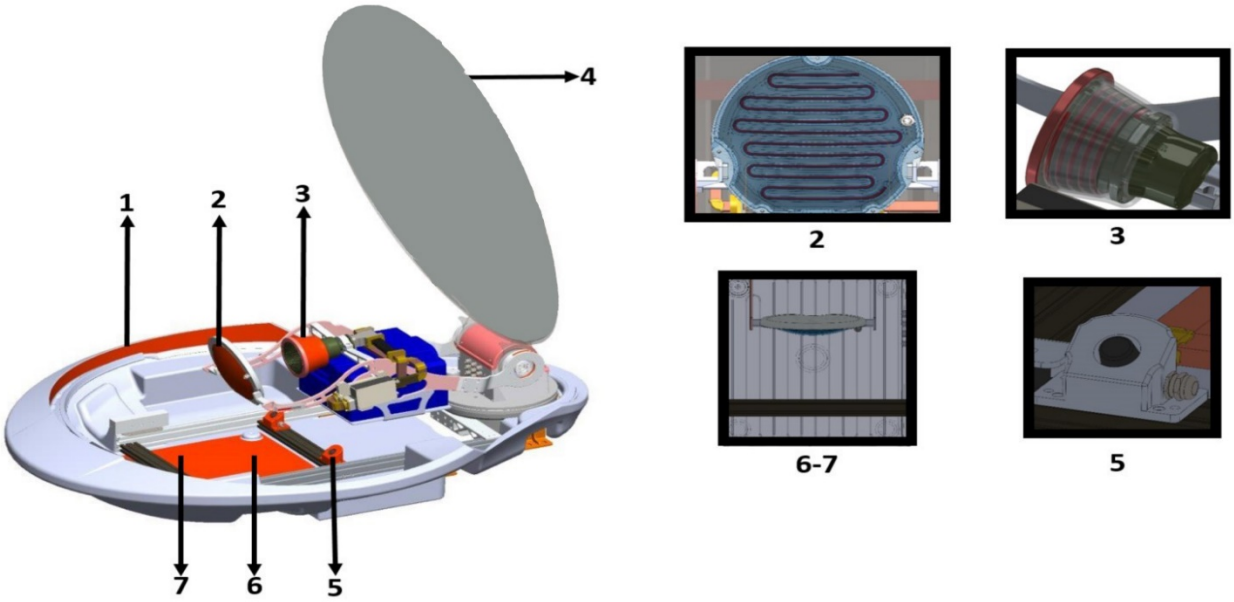


Figure 12 PDA-150-MIL Antenna System De-Ice Heating Element Placements

#	Part Name
1	Pod Rim and Azimuth Heater
2	Sub Reflector Heater
3	Horn Heater
4	Main Reflector Heater
5	Feed Arm Floor Heater
6	Pod Base Heater 1
7	Pod Base Heater 2

Table 4 PDA-150-MIL Antenna System De-Ice Corresponding Heating Elements

The de-icing sysis ais also undergo military tests according to MIL-STD-810G. Make sure systhe tem can be operated under 8mm of glazing ice (hard ice) and the system can be operated after 42 mm of accumulated glazing ice which is enough thickness to carry an adult male. PDA-150-810G under theprocess of ice accumulation test images are presented below.

Figure 13 PDA-150-MIL Antenne While Under Icing Test (Left: Working in 8mm ice, Right: Surving on min 42mm ice)

4. RF FEATURES

PDA-150-MIL antenna system, thanks to its mechanical design, ensures the best RF performance given on its similar models in the market. RF features presented in this section are real-time test results during its verification tests. Every unit is manufactured tested and fine-tuned to verify its datasheet values according to PALS' Quality Assurance policies. Every unit sold also delivered with Factory Test Results specifically presenting unit manufactured.

4.1. RADIATION PATTERN PERFORMANCE

PDA-150-MIL antenna gain radiation pattern (Radiation Pattern) complies with **MIL-STD-188-164A / ITU-RS-580 / ITU-R S.465-6** criteria. The radiation pattern of the PDA-150-MIL antenna is given below.

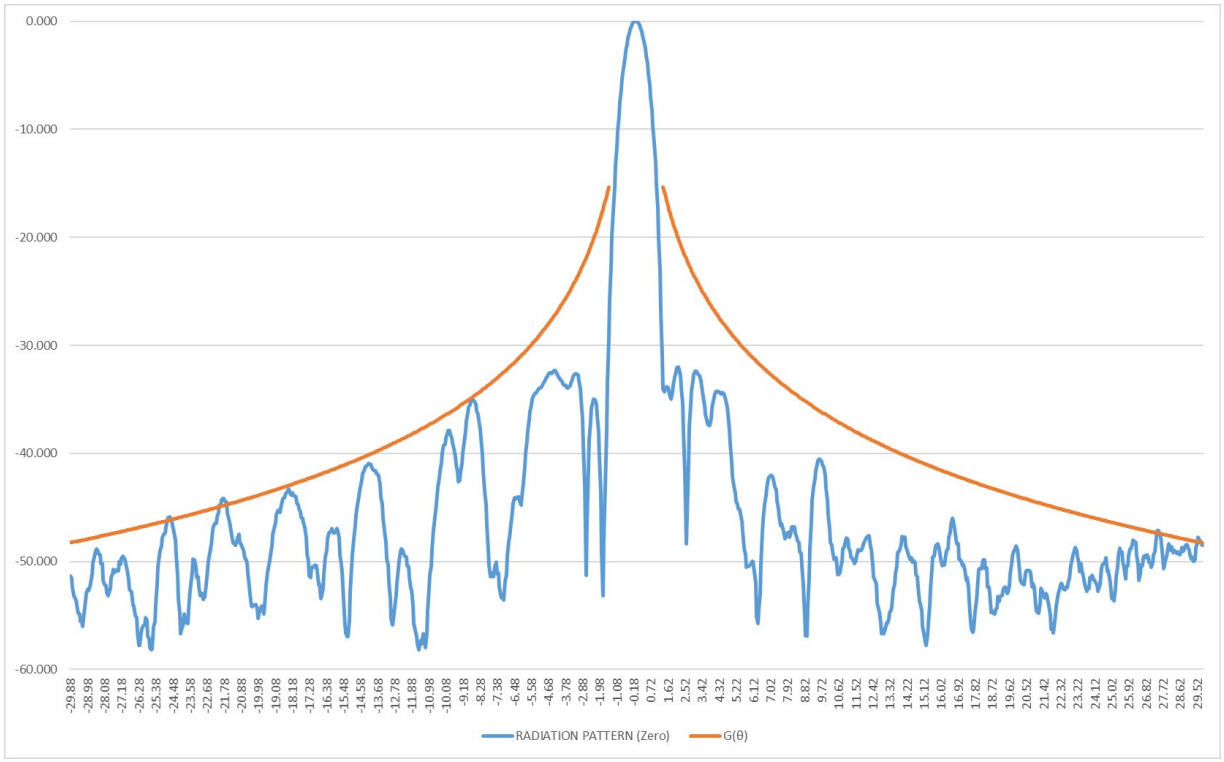


Figure 14 PDA-150-MIL Antenna Ku-Band Pattern Cut with Envelope in Azimuth Axis

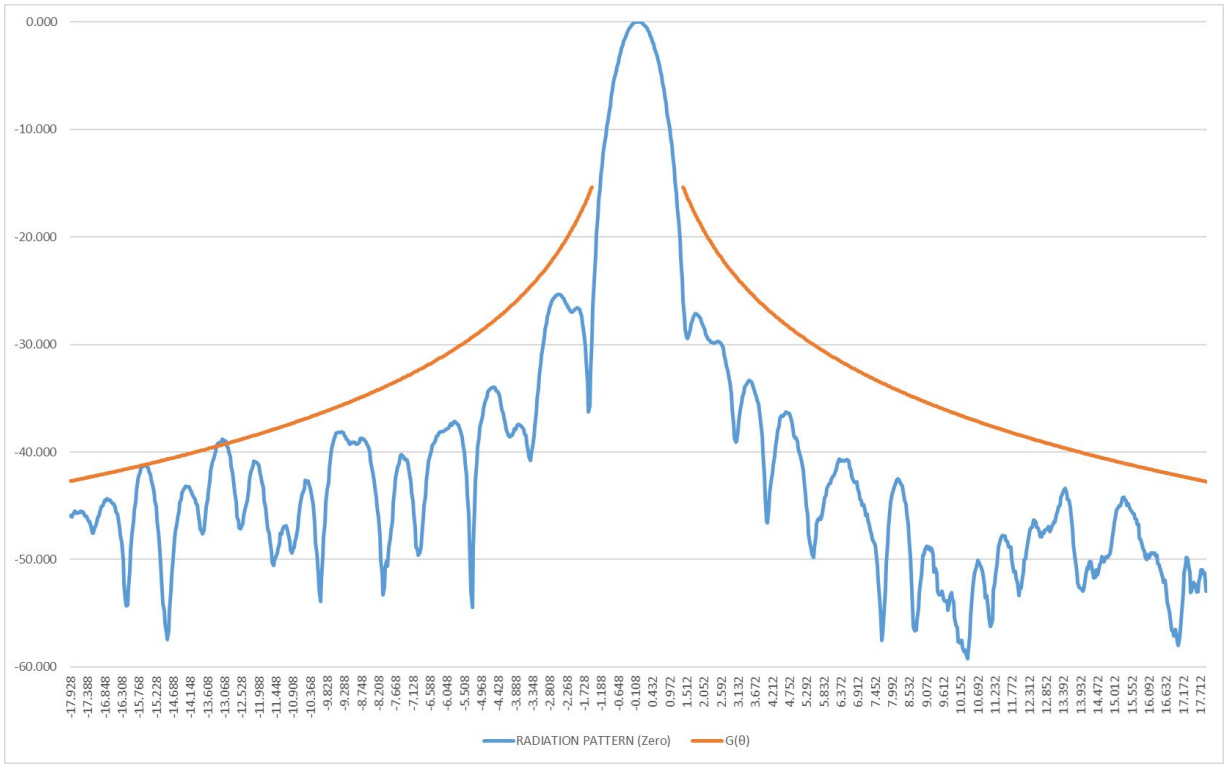


Figure 15 PDA-150-MIL Antenna Ku-Band Pattern Cut with Envelope in Elevation Axis

4.2. CROSSPOL PERFORMANCE

PDA-150-MIL antenna comes with a standard transmit reject filter. The antenna also has an embedded receive reject filter which makes it different from its counterparts. It also has an OMT for Ku which has 1 kW total RF power for Ku Band and 0.5 kW total RF power for X Band. All parts mentioned are designed, manufactured and fine-tune in the house making sure making out of its best performance.

Ku Band Cross Pol (Boresight)			
Frequency	**AntennaCooll**	**Crosspol**	**Isolation**
(GHz)	**(dBm)**	**(dBm)**	**(dB)**
10.70	-64.60	-105.00	40.40
10.95	-65.10	-111.50	46.40
11.70	-69.90	-114.00	44.10
12.50	-69.90	-113.00	43.10
12.75	-66.30	-109.00	42.70
13.75	-67.60	-114.70	47.10
14.00	-67.00	-109.00	42.00
14.25	-68.20	-114.00	45.80
14.50	-68.65	-119.00	50.35

Table 5 PDA-150-MIL Antenna CrossPol Performance

4.3. AUTOPOINTING FEATURE

PDA-150-MIL antenna system has state of art auto pointing algorithm. Combined with its RF performance given in this section, auto pointing performance is approved by EUTELSAT according to the ESOG120 standard. The algorithm is also makes sure of antenna is not pointed to side-lobes of satellite signal but pointed to boresight of satellite beam. The auto pointing test is conducted with three different satellites using two different DVB and a beacon signal four times. Every auto pointing error should be within <0.4 dB margin to pass tests. The error mentioned above means autopointing should be within this margin compared to an operator manually pointing antenna. This test procedure is also applied to every unit manufactured, as part of PALS' Quality Assurance policy. As a result PALS gained rightfully use of following logo:

Figure 16 EUTELSAT Characterized Logo

Please note test results mentioned are open to public on Eutelsat's web page and can be found any time.

4.4. BEACON AND/OR DVB-S/S2 RECEIVER FEATURE (OPTIONAL)

A Beacon **and/or** DVB-S/S2 receiver can be embedded PDA-150-MIL antenna and it's PAC-550-MIL antenna controller. Meaning a beacon receiver can be used for antenna processes such as autopointing, tracking etc. as well as a DVB-S/S2 receiver as well in same box without making physical changes. This feature makes the system superior compared to it's competitors because there are only beacon or DVB options offered in market when it comes to receiver. simultaneously

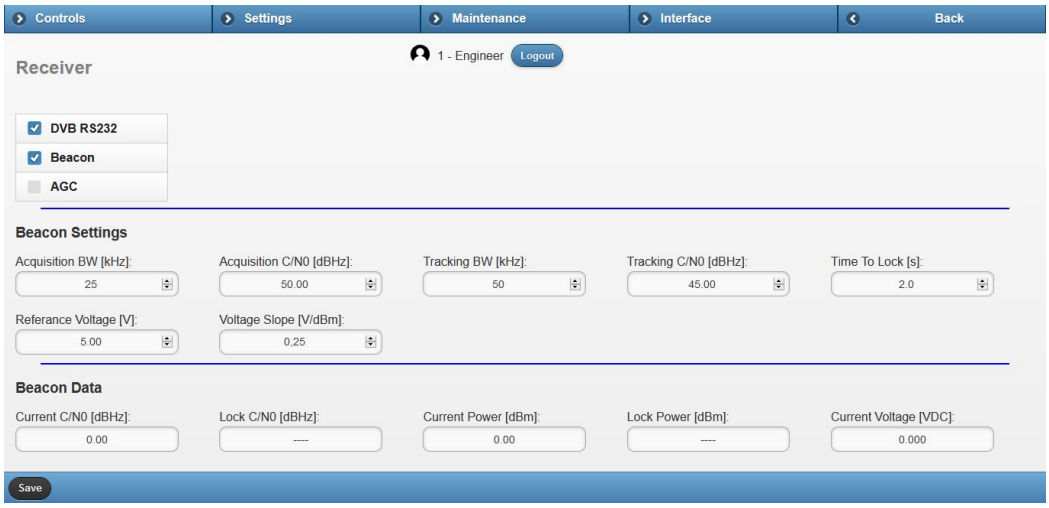


Figure 17 PDA-150-MIL Receiver Settings Web Interface

If customer desires to use their own beacon receiver which already owned or would be bought in future it also can be used by system for it's processes using AGC input. Controller provides an analogue voltage input in order to satellite signal acquisition in order to be used by Beacon receiver or Modem.

4.5. TRACKING PERFORMANCE

PDA-150-MIL antenna system is equipped with two different tracking algorithm. When satellite signal acquired and tracking is enabled step trackalgorithm is deployed. Algorithm start to register satellite position by user definable interval.

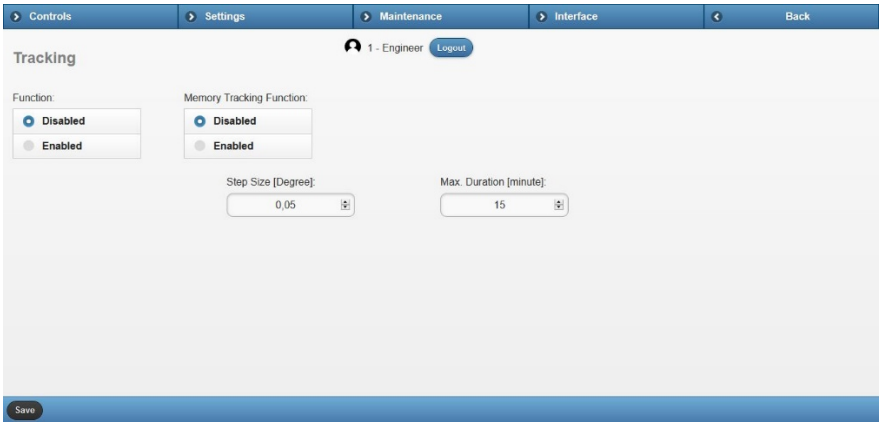


Figure 18 PDA-150-MIL Tracking Settings Web Interface

After 24 hours of position saving memory track function can be used to track satellite. Memory tracking function allows user to track satellite even if there is no signal to be tracked exists. Memory tracking uses satellite position saved beforehand in 24 hours using step tracking in order to achieve this.

Tracking algorithm also allows user to successfully track inclined orbit satellites. An inclined orbit satellite tracking graphic is presented below as an example.

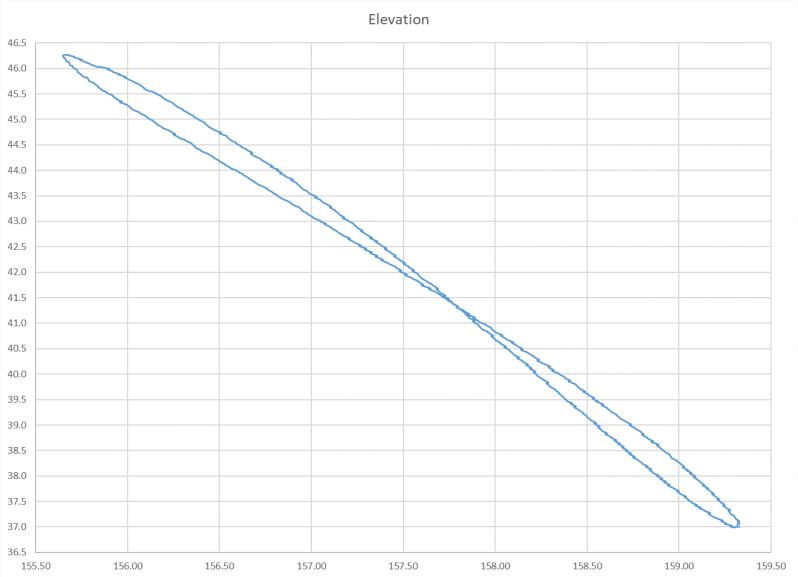


Figure 19 Inclined Orbit Satellite Tracking Plot

5. ENVIRONMENTAL CONDITION TESTS

PALS employs certified military standard experts on their fields. PALS conducts sector defining American Department of Defence (DoD) standard MIL-STD-810G and it's method applied to PDA-150-MIL antenna system and its sub components. Environmental condition tests conducted to PDA-150-MIL system are presented in table below.

ENVIRONMENTAL SPECIFICATIONS			
Temperature	Compliant with MIL-STD-810g Method 501.5 and 502.5	Operational Survival	-30°C to 55°C -40°C to 70°C
Wind Speed	Compliant with ESOG-120	Operational Survival	72 km/h 180 km/h
Rain	Compliant with MIL-STD-810g Method 506.5	Survival in heavy rainstorm	
Humidity	Compliant with MIL-STD-810g Method 507.5	%95 Aggravated	
Solar Radiation	Compliant with MIL-STD-810g Method 505.5	1120 W/m2 (A1 Cycle)	
Low Pressure	Compliant with MIL-STD-810g Method 500.5	4500 mt	
Shock	Compliant with MIL-STD-810g Method 516.5		
Sand and Dust	Compliant with MIL-STD-810g Method 510.5		
Tempreture Shock	Compliant with MIL-STD-810g Method 503.5	-40/70 Cyclic	
Icing	Compliant with MIL-STD-810g Method 521.3	Min 37 mm Survival	

Table 6 Environmental Condition Characteristics

Some of the photographs taken before or after environmental condition tests which belongs to PDA-150-MIL are presented below.

- **Temperature:** Compliant with MIL-STD-810g Method 501.5 and 502.5 — Operational: -30°C to 55°C, Survival: -40°C to 70°C

Figure 20 PDA-150-MIL Antenna System After Temperature Tests

- **Rain:** Compliant with MIL-STD-810g Method 506.5 — Survival in heavy rainstorm

Figure 21 PDA-150-MIL Antenna System During Rain Test (Actual Footage)

- **Humidity**: Compliant with MIL-STD-810g Method 507.5 — %95 Aggravated

Figure 22 PDA-150-MIL Antenna System During Humidity Test (Actual Footage)

- **Solar Radiation:** Compliant with MIL-STD-810g Method 505.5 — 1120 W/m2 (A1 Cycle)

Figure 23 PDA-150-MIL Antenna System After Solar Radiation Test

- **Shock:** Compliant with MIL-STD-810g Method 516.5

Figure 24 PDA-150-MIL Antenna System During Shock Test (Actual Footage)

- **Vibration:** Compliant with MIL-STD-810g Method 514.6

Figure 25 PDA-150-MIL Antenna System During Vibration Test (Actual Footage)

- **Sand and Dust:** Compliant with MIL-STD-810g Method 510.5

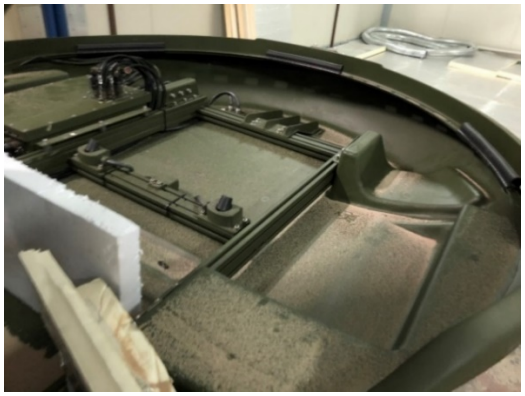


Figure 26 PDA-150-MIL Antenna System During Sand/Dust Test (Actual Footage)

- **Tempreture Shock:** Compliant with MIL-STD-810g Method 503.5 — -40/70 Cyclic

Figure 27PDA-150-MIL Antenna System Before Temperature Shock

- **Icing:** Compliant with MIL-STD-810g Method 521.3 — Min 37 mm Survival

Figure 28 PDA-150-MIL Antenna System After Icing Test

6. ELECTROMAGNETIC INTERFERENCE (EMI) AND ELECTROMEGNETIC COMPATIBILITY (EMC) TESTS

PDA-150-MIL also proven its worth at electromagnetic field as well. MIL-STD-461F tests are applied to antenna system and successfully passed from them. Meaning antenna system is not going to be effected from electromagnetic interference caused by surrounding environment and devices. Also PDA-150-MIL system is not going to emit any electromagnetic enterference causing disruption systems working around it. Whether from or to, cable or air. PDA-150-MIL passed following military type EMI/EMC tests.

Standard	Test Name	Explanation
MIL-STD-461F	CE102	Conducted Emissions – Power Leads, 10 kHz to 10 MHz
	CS101	Conducted Susceptibility – Power Leads, 30 Hz to 150 kHz
	CS114	Conducted Susceptibility – Bulk Cable Injection, 10 kHz to 200 MHz
	CS115	Conducted Susceptibility – Bulk Cable Injection, Impulse Excitation
	CS116	Conducted Susceptibility – Damped Sinusoidal Transients, Cables and Power Leads, 10 kHz to 100 MHz
	RE102	Radiated Emissions – Electric Field, 10 kHz to 18 GHz
	RS103	Radiated Susceptibility – Electric Field, 2 MHz to 40 GHz

Table 7 EMI/EMC Test Table of PDA-150-MIL Antenna System Passed

7. CONTACT INFORMATION

Please do not hesitate to contact with us for any inquiries, questions and information. We would be happy to help.

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