# IGA-5001
# Product Specification

| | | |
|---|---|---|
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## NOTICE



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## DOCUMENT CHANGE HISTORY

| ISSUE | DATE | ECP | DESCRIPTION OF CHANGE |
|---|---|---|---|
| 1.0 | 25 Aug 2008 | 08/103 | Initial Release |
| 1.1 | 15 May 2009 | 08/103 | Update for Phase 5, Qualification review and TSO doc |
| 1.2 | 06 Aug 09 | 09/293<br>09/297 | Phase 5 review update<br>Remove 'Icing Cat B' from table 2 and Alpha string |
| 1.3 | 06 Aug 09 | 09/293 | Document errors updated post Ph5 review assessment. |
| 1.4 | 18 Dec 2009 | 09/364 | General update to include gain plots, ground screw and outline drawing |
| 1.5 | 26 April 10 | 09/354 | 9th order add to SBB dual channel reference; paragraph 7, 1, 9. |
| | | 10/177 | Correct the Alpha string |
| 1.6 | 8 Aug 2011 | 11/259 | Section 8.1: Vibration category U2 added to string<br>Table 1: TSO-C132 received, removed "in process". |
| 1.7 | 24 Aug 2011 | 11/259 | Table 6; Helicopter Vibration category added and levels (FF1) removed from Random category. |

## DOCUMENT APPROVAL AND VALIDATION

| | NAME | SIGN | DATE |
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# 1. SCOPE

This document outlines the technical details of the IGA-5001 Intermediate Gain Antenna, part number 677-A0181. The aim of this document is to describe the product, its architecture, functional design and other specifications.

Figure 1: IGA 5001 Intermediate Gain Antenna

# 2. ABBREVIATIONS

| | |
|---|---|
| C/M | Carrier to Multipath (ratio) |
| DC | Direct Current |
| DLNA | Diplexer and Low Noise Amplifier |
| EIRP | Effective Isotropic Radiated Power |
| GPS | Global Positioning System |
| G/T | Gain over Temperature (ratio) |
| HPA | High Power Amplifier |
| IGA | Intermediate Gain Antenna |
| LNA | Low Noise Amplifier |
| PIM | Passive Inter-modulation |
| RF | Radio frequency |
| Rx | Receive signal |
| RHCP | Right Hand Circular Polarization |
| RTCA | Radio Technical Commission for Aeronautics |
| SBB | SwiftBroadband |
| SDM | System Definition Manual (Inmarsat Specification) |
| SDU | Satellite Data Unit |
| Tx | Transmit signal |
| VSWR | Voltage Standing Wave Ratio |

# 3. APPLICABLE DOCUMENTS

[1] 677-A0181_OD: IGA-5001 Outline Drawing

# 4. REFERENCE DOCUMENTS

[1] Inmarsat System Definition Manual (SDM)

[2] RTCA/DO-160F Environmental Conditions and Test Procedures for Airborne Equipment

[3] Minimum Operational Performance Standards for Geosynchronous Orbit Aeronautical Mobile Satellite Services (AMSS) Avionics, RTCA/DO-210D.

[4] Software Considerations In Airborne Systems And Equipment Certification; 1-Dec-92, RTCA/DO-178B

# 5. ANTENNA DESCRIPTION

The IGA-5001 is an Intermediate Gain Antenna (IGA) that is designed for direct interfacing with the COBHAM series of Satellite Data Units (SDU's) which contain the beam steering function.
The IGA communicates with the SDU using the COBHAM proprietary modem interface via the control port along with the 28 VDC. and the GPS RF signal.
The antenna is ideally suited for use in dual Channel Class 7 SBB systems

# 6. OUTLINE DIMENSIONS

For reference only
[Refer to [1] 677-A0181_OD: IGA-5001 Outline Drawing for absolute values]

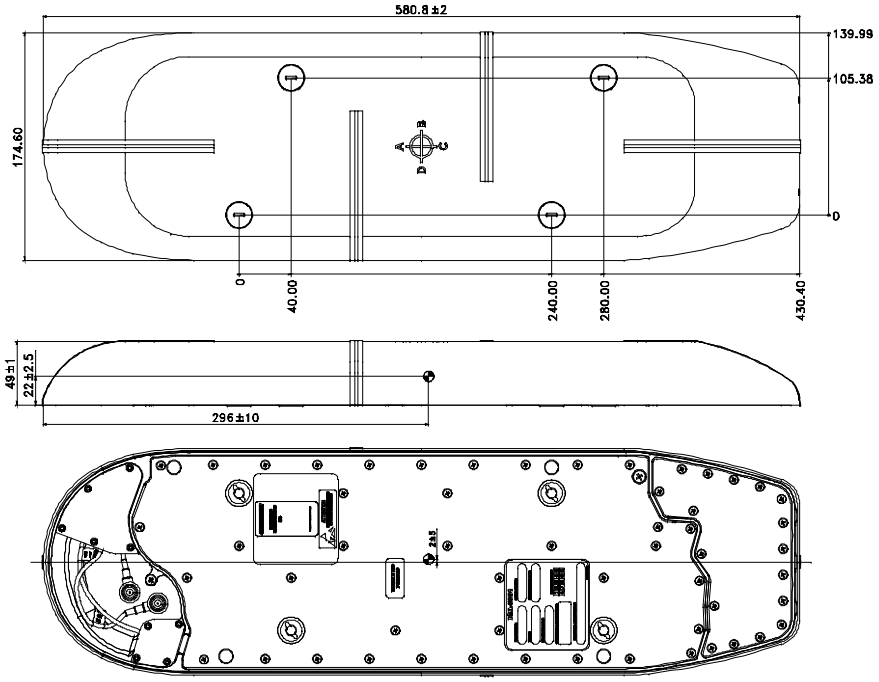


Figure 2 : Outline dimensions for reference only

# 7. NOMINAL PRODUCT SPECIFICATIONS

Table 1: The main parameters of the IGA-5001 antenna

| Specification | IGA-5001 Antenna |
|---|---|
| **Length** | 581mm [22.9”] |
| **Width** | 175mm [6.9”] |
| **Height** | 49mm [1.9”] |
| **Weight kg [lb]** | 3.5kg [7.7 lbs] |
| **Operating Temperature range** | -65°C to +70°C [-85°F to +158°F] |
| **Altitude** | Up to 21000 m [70000 ft] |
| **Frequency** | 1525 MHz to 1660.5 MHz (L-band) |
| **Power supply** | Nominal 28 VDC supplied by SDU |
| **Coverage** | Seamless coverage over >85% of the Inmarsat Hemisphere (typically >90%) |
| **Polarization** | Right hand circular |
| **Gain** | > 6 dBic over 90% of the Inmarsat service hemisphere<br>> 2 dBic over 99% of the same hemisphere |
| **Qualification (Software)** | DO-178B Level D |
| **Qualification (Environmental)** | DO-160F |
| **Certification** | TSO-C132 |

## 7.1 RF Performance

### 7.1.1 Polarisation

The antenna polarisation is RHCP.

### 7.1.2 Axial Ratio

The axial ratio is typically less than 6 dB over the declared coverage volume of the antenna. Polarization losses caused by an axial ratio greater the 6dB are compensated for by excess gain of the antenna.

### 7.1.3 Operating Frequency Range

1) Rx: 1.525-1.559 GHz
2) Tx: 1.6265-1.6605 GHz

### 7.1.4 Service Coverage Definition

The minimum coverage performance are that simultaneous G/T, EIRP and Axial Ratio coverage is achieved over at least 85% of the upper hemisphere (excluding the lowest 5° above the horizon) and with the aircraft in horizontal flight.

### 7.1.5 Service Coverage

The service coverage was computed for the following system parameters:

Table 2: System parameters

| **Rx Band system parameters at ambient** | |
|---|---|
| Antenna to DLNA Cable Loss [dB] | 0.7 |
| DLNA Noise Factor [dB] | 1.2 |
| DLNA Gain [dB] | 56 |
| Tx HPA [dBW] | 14.0 |
| Temp Tx Noise (degrees Kelvin) | 2.8 |
| Degradation Pointing (dB) | 0.12 |

Table 3: Service Coverage

| **Freq (MHz)** | **G/T % coverage (> 19dB/K)** | **EIRP % coverage** | **Service Coverage % Pass** |
|---|---|---|---|
| 1525 | 99.0 | - | 93.7 |
| 1542 | 98.7 | - | |
| 1559 | 97.9 | - | |
| 1626 | - | 94.1 | |
| 1644 | - | 94.8 | |
| 1661 | - | 95.1 | |

Excess coverage margin will allow the use of a higher RF loss antenna-to-DLNA cable. It is recommended that in such cases the service coverage be assessed with the particular system parameters.

### 7.1.6 Antenna Gain

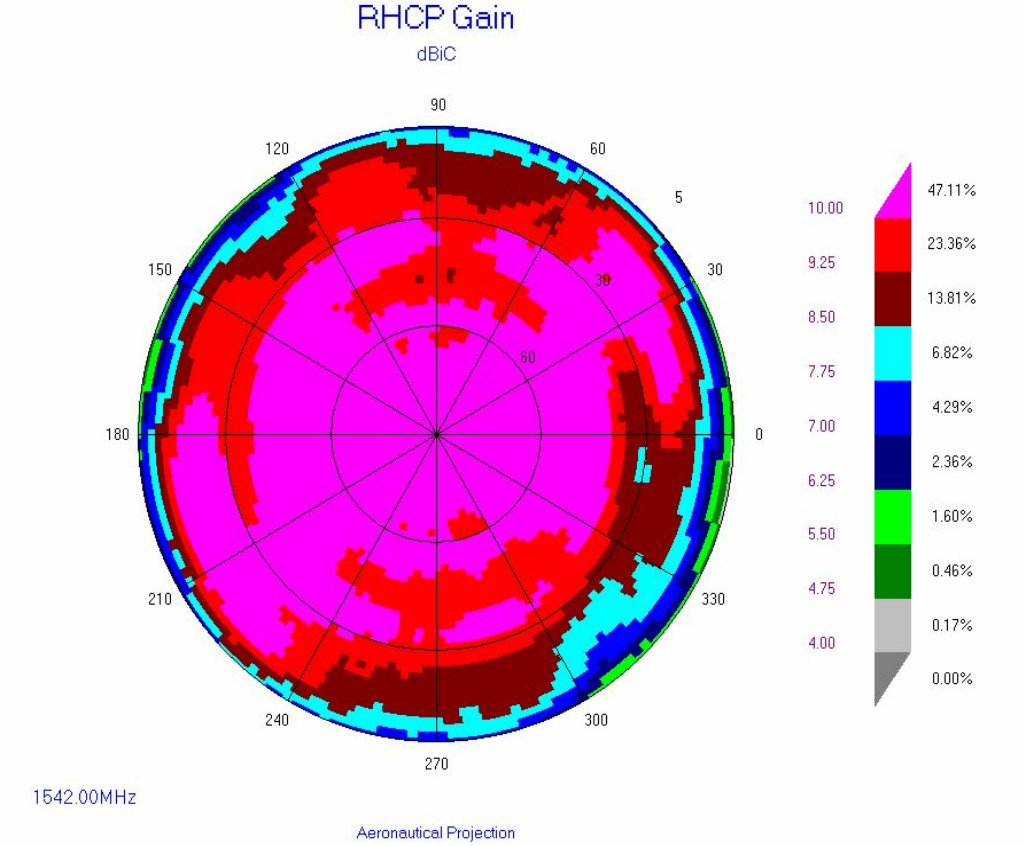


Figure 3: IGA-5001 Gain map

A gain map for the IGA-5001 antenna is shown above. Note that the minimum required gain is nominally 6 dBic (dark blue).

The antenna gain is 6-12 dBic over significantly more than the required 85% of the Inmarsat hemisphere, and typically >2 dBic over 99% of the same hemisphere.

### 7.1.7 Gain at low elevations

Table 4: Gain at Low Elevation

| IGA-5001 RHCP Gain (dBiC) at 1542MHz | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elevation (degrees) | | | | | | | | |
| | | **90** | **75** | **60** | **45** | **30** | **15** | **10** | **5** | **0** |
| **Azimuth (degrees)** | **0** | 11.1 | 11.2 | 10.7 | 9.8 | 8.2 | 7.2 | 6.0 | 4.7 | 3.1 |
| | **45** | 11.1 | 10.9 | 10.8 | 10.1 | 8.7 | 7.4 | 6.2 | 4.5 | 2.7 |
| | **90** | 11.1 | 10.8 | 10.2 | 10.1 | 9.4 | 9.0 | 8.4 | 7.4 | 6.1 |
| | **135** | 11.1 | 11.3 | 10.9 | 10.6 | 10.1 | 10.2 | 9.5 | 7.9 | 6.2 |
| | **180** | 11.1 | 11.5 | 11.2 | 10.7 | 9.4 | 9.5 | 8.5 | 7.3 | 5.9 |
| | **225** | 11.1 | 11.2 | 10.9 | 10.6 | 10.1 | 8.5 | 7.4 | 5.8 | 4.1 |
| | **270** | 11.1 | 10.9 | 10.3 | 10.0 | 9.6 | 9.3 | 8.9 | 8.0 | 6.8 |
| | **315** | 11.1 | 10.9 | 10.5 | 10.0 | 9.7 | 9.9 | 9.1 | 7.6 | 6.0 |

| IGA-5001 RHCP Gain (dBiC) at 1644MHz | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Elevation (degrees) | | | | | | | | |
| | | 90 | 75 | 60 | 45 | 30 | 15 | 10 | 5 | 0 |
| Azimuth (degrees) | 0 | 10.7 | 10.7 | 10.3 | 9.6 | 8.2 | 6.4 | 5.1 | 3.8 | 2.4 |
| | 45 | 10.7 | 10.7 | 10.3 | 9.3 | 8.3 | 6.0 | 4.7 | 2.9 | 0.5 |
| | 90 | 10.7 | 10.8 | 10.9 | 10.5 | 9.7 | 8.6 | 8.0 | 6.9 | 5.9 |
| | 135 | 10.7 | 10.9 | 11.1 | 10.3 | 10.1 | 10.1 | 9.9 | 8.8 | 7.6 |
| | 180 | 10.7 | 10.7 | 10.8 | 10.4 | 9.3 | 8.1 | 7.0 | 5.6 | 4.1 |
| | 225 | 10.7 | 10.7 | 10.3 | 9.3 | 9.0 | 7.8 | 6.5 | 4.7 | 2.5 |
| | 270 | 10.7 | 10.8 | 10.9 | 10.3 | 9.7 | 8.7 | 8.2 | 7.1 | 6.0 |
| | 315 | 10.7 | 10.8 | 10.6 | 9.9 | 9.3 | 9.5 | 9.0 | 7.8 | 6.3 |

#### 7.1.7.1 Measured Carrier to Multipath (C/M) Discrimination

The carrier to multipath results for various frequencies and azimuth angles have been measured for the antenna pointing 5° and 20° above the horizon, as required by the Inmarsat SDM. The worst-case results at each frequency are presented below in Table 5:

Table 5: Carrier to Multipath Discrimination

| Frequency (MHz) | Azimuth (°) | $C/M_{med}$ (dB) at elevation 5° | Azimuth (°) | $C/M_{med}$ (dB) at elevation 20° |
|---|---|---|---|---|
| 1525 | 45 | 17.62 | 90 | 19.23 |
| 1542 | 45 | 17.69 | 90 | 19.22 |
| 1559 | 45 | 17.97 | 90 | 19.26 |
| 1626 | 45 | 18.9 | 67.5 | 19.53 |
| 1644 | 45 | 19.07 | 90 | 19.87 |
| 1661 | 90 | 18.52 | 90 | 19.96 |

***Note Inmarsat spec is 10 dB at 5°* and 12 dB t 20° elevation**.
Worst case Median C/M.
It is clear that the antenna C/M is a minimum of 7.5 dB better than specification in any azimuth direction.

### 7.1.8 SWR

The antenna VSWR at the RF port does not exceed 1.5:1 for any selected beam.

### 7.1.9 Passive Intermodulation (PIM) in the Receive Band

PIM products in the antenna meet 9th order requirements for dual channel SwiftBroadband systems.

## 7.2 Antenna Interfaces

### 7.2.1 RF Port

The RF interface to the IGA-5001 is a 50 Ohm TNC male connector color coded “BLUE” at the end of a ~200mm pig-tail co-axial cable. This port contains direct lightning protection which results in a low impedance point to ground, connection of the power/control co-axial cable to this port may result in damage to the SDU.

### 7.2.2 DC Power / GPS / Control Port

This interface, for conditioned DC power, control between the IGA and the SDU and for GPS RF from the IGA is a 50 Ohm TNC male connector colour coded “RED” at the end of a ~200mm pig-tail cable.

Power dissipation: < 7 W

## 7.3 Built In GPS Front-end

The antenna houses a GPS antenna and LNA with the following specifications:

1) Frequency: 1575.42 MHz ± 2.0 MHz
2) Impedance: 50 Ohm nominal
3) LNA Gain: 28 dB ± 3 dB
4) Noise Figure: <4.0 dB @ ambient temperature.
5) The GPS RF signal is transferred to the SDU via the control cable

## 7.4 Paint specification– p-Static protection

The antenna is painted with an aircraft grade polyurethane outer coating (white) or equivalent (CA40000) and with an antistatic sub layer (DeSoto® Antistatic Coating 528x306). The standard antenna color is white, but other options are available on request. The anti-static paint layer is connected to the antenna chassis via two screws in the side of the radome.

## 7.5 Grounding

Antenna grounding is achieved through the four (4) mounting bolts and their surrounding contact areas (shown below). These areas are protected from the environment by silicon “O” rings and are raised by 0.5mm from the surrounding surfaces to ensure ground contact. The resistance between the contact area and the surrounding chassis is less than 5 milli Ohms.
The antenna also has a single grounding point provided inside the connector compartment.

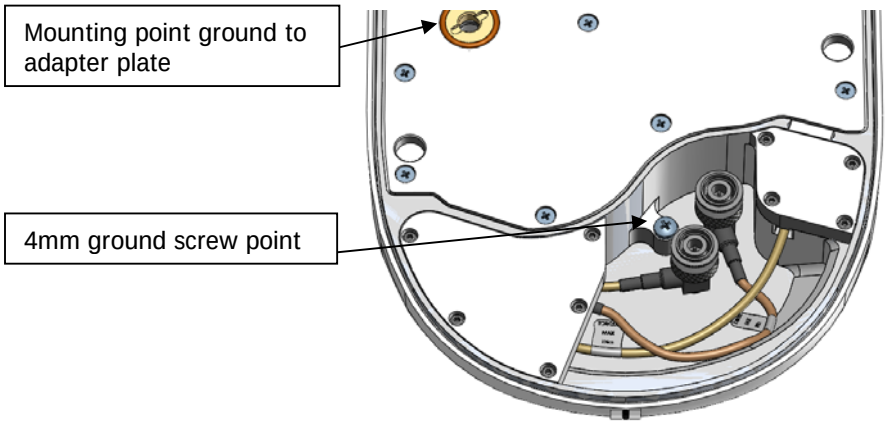


Figure 4: Antenna grounding details

## 7.6 Lightning Protection

In addition to the protection provided by the composite radome, the antenna is protected against lightning by segmented lightning diverter strips. The antenna is qualified to RTCA-DO-160F cat 1A2A lightning strike and is designed to be fully operational after such a lightning strike. Refer to the antenna installation manual for grounding requirements.

## 7.7 Antenna Sealing

The antenna is of a breathing design which allows for pressure equalization during ascent and descent, the breathing mechanism is via a “Gortex”™ membrane which inhibits the ingress of fluids.

## 7.8 Connector Sealing

No special precautions are required for connector sealing. The TNC connectors are environmentally sealed once mated and with correct torque applied.

## 7.9 Maintainability

The antenna does not contain any user adjustable or maintainable parts. Routine inspection for radome damage and general corrosion preventative measures is recommended during routine aircraft maintenance.

# 8. QUALIFICATION

## 8.1 Environmental Specification to DO-160 F

Table 6: DO-160F Categories

| Conditions | Categories |
|---|---|
| TEMPERATURE & ALTITUDE<br>1. Operational Conditions<br>2. Start-up After Ground Soak at Low/High Temperature<br>3. Ground Survival Temperature<br>4. Steady State – Altitude<br>5. Decompression<br>6. Overpressure<br>In-Flight Loss of Cooling Test | E1<br>With the extension of Operating Low Temperature to -65 °C<br><br><br><br><br><br><br>X |
| TEMPERATURE VARIATION | A |
| HUMIDITY | B |
| OPERATIONAL SHOCKS AND CRASH SAFETY | B and E |
| VIBRATION | 1) Highest level combination of:<br>a) S(MLY)<br>2) Highest level combination of:<br>a) R(CC1EE1) extended to 5 hours endurance vibration on each axis<br>b) U2(FF1) extended to 5 hours endurance vibration on each axis<br>3) H (R) |

| Conditions | Categories |
|---|---|
| EXPLOSION PROOFNESS | E II |
| WATERPROOFNESS | S |
| FLUIDS SUSCEPTIBILITY | F |
| SAND & DUST | S |
| FUNGUS RESISTANCE | F |
| SALT FOG | T |
| MAGNETIC EFFECT | Z |
| POWER INPUT | X |
| VOLTAGE SPIKE | X |
| AUDIO FREQUENCY CONDUCTED SUSCEPTIBILITY | X |
| INDUCED SIGNAL SUSCEPTIBILITY | CC |
| RADIO FREQUENCY SUSCEPTIBILITY | CS: R and Y<br>RS: R and Y |
| EMISSION OF RF ENERGY | H |
| LIGHTNING INDUCED TRANSIENT SUSCEPTIBILITY | A3J44 |
| LIGHTNING DIRECT | 1A & 1A |
| ICING | A |
| ELECTROSTATIC DISCHARGE | A |
| FIRE, FLAMMABILITY | X |

[E1X]AB[BE][S(MLY)R(CC1EE1)U2(FF1)H(R)]ESFSFTZXXX[CC][RY]H[A3J44][1A1A]AAX

## 8.2 MOPS

The antenna complies with DO-210D [3].

## 8.3 Software Level

The antenna complies with DO-178B Level D [4].