



HGA-6000 High Gain Antenna Installation Manual

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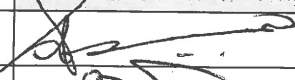
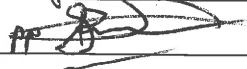
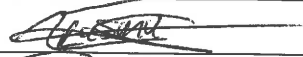
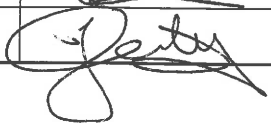
CONTROLLED DOCUMENTATION

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DOCUMENT CHANGE HISTORY

ISSUE	DATE	DCP	DESCRIPTION OF CHANGE
1.0	01 Sep 2004	03/400	Initial release
1.1	02 Nov 2004	04/397	Cable Options. Included installation software guidelines.
1.2	02 Jan 2005	05/029	Added reference to document: Cable Selection Guide, OP-050
1.3	13 Dec 2007	07/264	General layout updates Removal of connector PIM Specification Block diagram modifications Update of RTCA Qualification Details Removal of Interconnect Wiring Diagram (Appendix A)
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1.6	25 June 2015	14/119	Updated Figure 8 to include units of measure. Updated Table 5 to add software part number. Updated Section 5.3 to comply with Section 5.1. Added Section 6 – Discontinued Products. Updated Appendix B Steps 5 & 9.
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DOCUMENT APPROVAL

	NAME	SIGN	DATE
AUTHOR	Andrew de Pomeroy Legg		
EDITED	Peter Meaker		9 Oct 2015
APPROVED	Willem Kasselman		14 Oct 2015
APPROVED	Adrian Erasmus		13 Oct 2015
APPROVED QA	Willy Merten		14 Oct 2015

SAFETY WARNING

The following general safety precautions must be observed during all phases of operation, service and repair of this equipment. Failure to comply with these precautions or with specific warnings in this manual may violate the safety standards of design, manufacture and intended use of the equipment.

RADIATION WARNING

During transmission this system can radiate microwave power from the antenna unit in any direction. High levels of radio frequency radiation are considered harmful to health. Although all countries have not agreed upon a single value, the American National Standards Institute (ANSI/IEEE C95.1-1999) recommends that any person in a controlled environment should not be exposed to radiation stronger than $5\text{mW}/\text{cm}^2$ at the frequencies used in this system. Accordingly, the operator of the system should ensure that no person should approach within 6.6 feet (2 metres) of the antenna when the system is transmitting, unless adequate screening is provided.

Despite this warning, specific system configurations may have a much shorter safe distance. This is dependent on factors like the number of channels used, the use of cooperative channels etc. Should shorter safe distances be a requirement in a specific application, please contact Cobham or the manufacturer of the SDU equipment.

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ACRONYMS

AMO	Aircraft Maintenance Organization
ARINC	Aeronautical Radio Inc.
AWG	American Wire Gauge
BITE	Built-in Test Equipment
BSU	Beam Steering Unit
dB	Decibel
DLNA	Duplexer / Low Noise Amplifier
FAA	Federal Aviation Administration
GHz	Gigahertz
GPS	Global Positioning System
HGA	High Gain Antenna
HLD	High Power Amplifier / Low Noise Amplifier / Duplexer
HPA	High Power Amplifier
HSD	High Speed Data
IRS	Inertial Reference System
kHz	Kilohertz
LNA	Low Noise Amplifier
MHz	Megahertz
PC	Personal computer
PIM	Passive Intermodulation
RF	Radio Frequency
Rx	Received signal
SDM	System Definition Manual
SDU	Satellite Data Unit
Tx	Transmitted signal
VSWR	Voltage Standing Wave Ratio

1. SCOPE

- 1) This Installation Manual provides the installation instruction for the HGA-6000 High Gain Aero SATCOM Antenna System. The HGA-6000 Antenna System conforms to the Inmarsat SDM for an Aero-H antenna, and is approved for use with Aero-H/H+, Swift64 and SwiftBroadband SATCOM Systems.
- 2) The Slimline HGA-6000 antenna is the same basic antenna with a different dust-cover shape. Throughout this manual, the two antennas can be considered to be the same other than when specifically detailed.
- 3) This document does not cover the installation of a complete SATCOM System, which includes installation of an ARINC 741 compliant Satellite Data Unit (SDU) and its associated peripherals. This document must be used in conjunction with the appropriate SATCOM equipment manufacturer's installation manual.
- 4) Aircraft specific installation details will have to be derived by the installer, using this manual as a guideline, while adhering to standard aircraft practices.

2. APPLICABLE DOCUMENTS

- [1] ARINC Characteristics 741P1-9 Aviation Satellite Communications System
- [2] RTCA DO-160D (including changes 1, 2 and 3), Environmental Conditions and Test Procedures for Airborne Equipment
- [3] ARINC 429 Parts 1, 2 & 3, 'Mark 33 Digital Information Transfer System'
- [4] Inmarsat Aeronautical System Definition Manual Module 2: Technical Requirements for Inmarsat Aircraft Earth stations. Version 1.20.02.

3. EQUIPMENT DESCRIPTION

3.1 SYSTEM OVERVIEW

- 1) The purpose of the HGA-6000 Antenna System is to provide an L-band RF link between Inmarsat Aero-H/H+, Swift64 and SwiftBroadband SATCOM systems and an Inmarsat satellite.
- 2) The HGA-6000 High Gain Antenna is used together with the following subsystems interconnected as shown in Figure 1:
 - a) HGA-6000 High Gain Antenna, Cobham Part Number 677-A0161. Please contact Cobham for the specific part number variants as these may change based on the product labeling and customer specific details.
 - b) Diplexer/LNA (DLNA). Please contact Cobham for part numbers as these may vary based on the product application.
 - c) High Power Amplifier (HPA). Please contact Cobham for part numbers as these may vary based on the product application.
 - d) Satellite Data Unit (SDU). Please contact Cobham for part numbers as these may vary based on the product application.
 - e) HPA/LNA/Diplexer (HLD). This replaces the HPA and DLNA where weight and space is an issue. Please contact Cobham for part numbers as these may vary based on the product application.

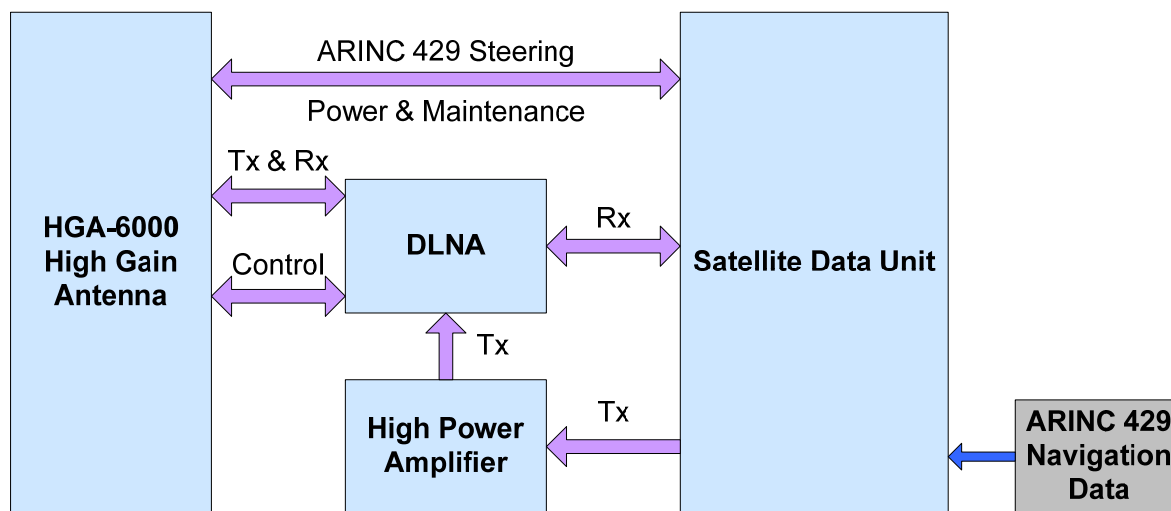


Figure 1 : Block diagram of HGA-6000 in a SATCOM system

3.2 HGA-6000 High Gain Antennas

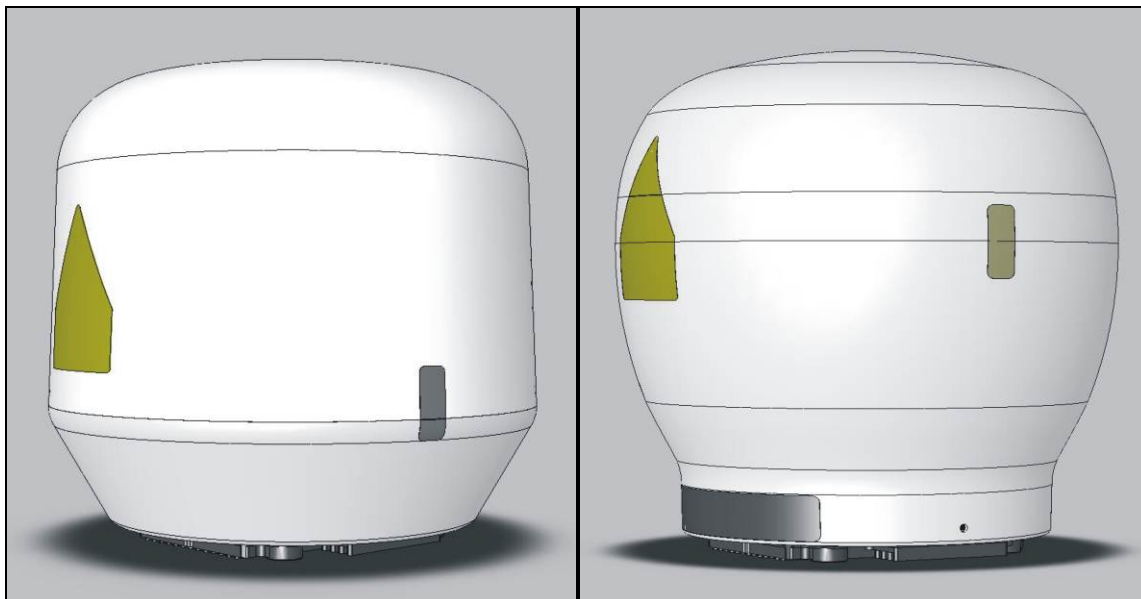


Figure 2 : HGA-6000 & Slimline HGA-6000 High Gain Antennas

The HGA-6000 antenna is intended for use in an airborne satellite communication system, providing access to the Inmarsat Aero H, H+, Swift64 or SwiftBroadband systems. The antenna complies with the requirements for an Inmarsat Aero High Gain Antenna as defined in [4].

The only difference between the HGA-6000 and the Slimline HGA-6000 is a reshaped dust-cover designed to cater for different mounting/space requirements.

The HGA-6000 interfaces to suitable avionics that will provide the required modulation/demodulation, RF amplification and the correct beam steering commands.

Two interfaces are provided for controlling the antenna: An ARINC 429 Interface and a Coaxial Modem Interface:

- The HGA-6000 is capable of interfacing directly to the ARINC 429 interface of an SDU (as defined in ARINC 741 [1]). In this configuration the antenna will accept the commands normally intended for a Beam Steering Unit (BSU). This will also allow the antenna to control the DLNA. This configuration is depicted in Figure 1.
- Alternatively, the co-axial modem interface allows the HGA-6000 to be used in conjunction with an Cobham Beam Steering Unit or Satellite Data Unit. The drawings in the manual do not show this method, although block diagrams of the installation option utilizing this interface are given in Appendix A.

3.2.1 HGA-6000 Outline Drawings

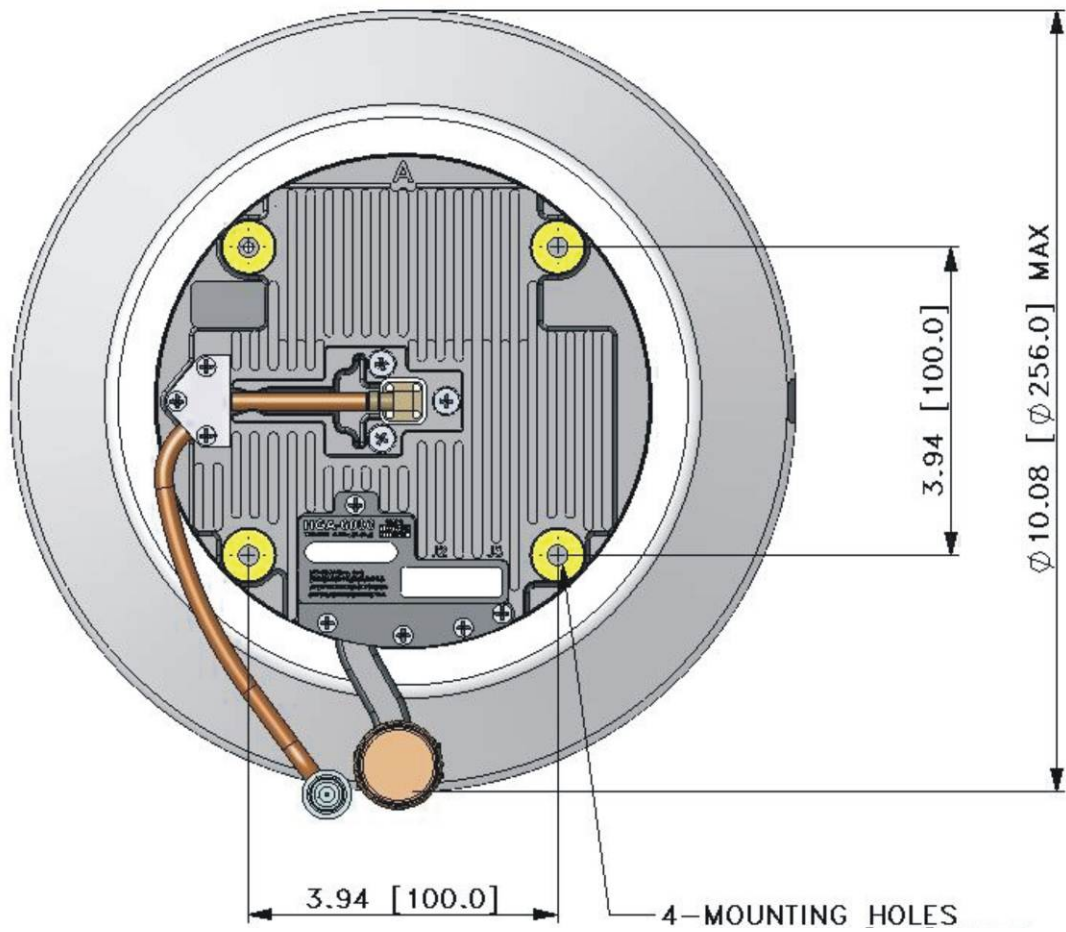


Figure 3 : HGA-6000 bottom view

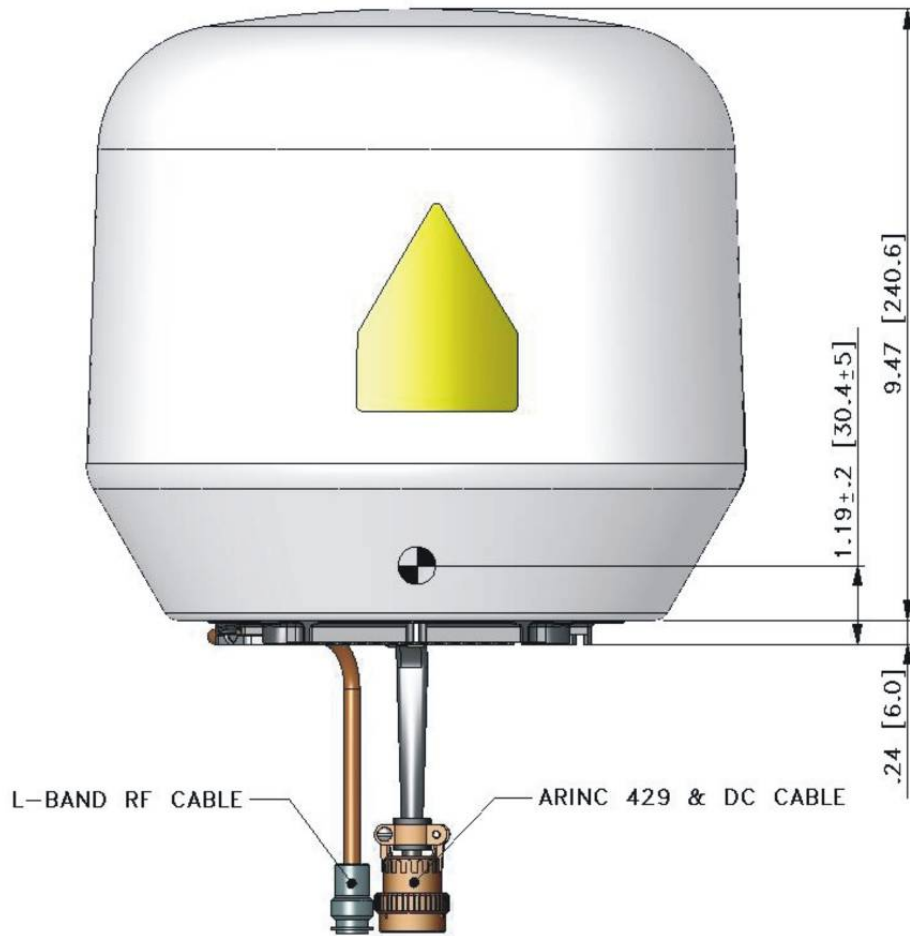


Figure 4 : HGA-6000 side view

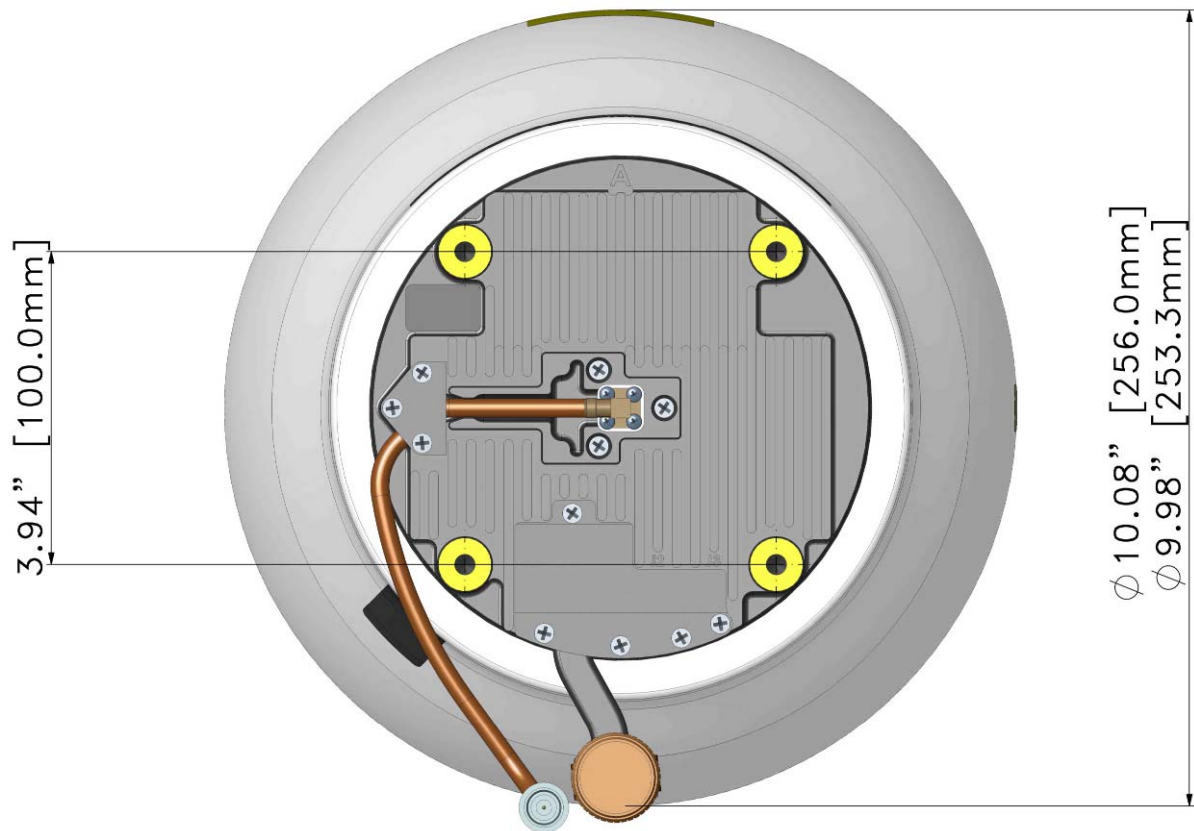


Figure 5 : Slimline HGA-6000 bottom view

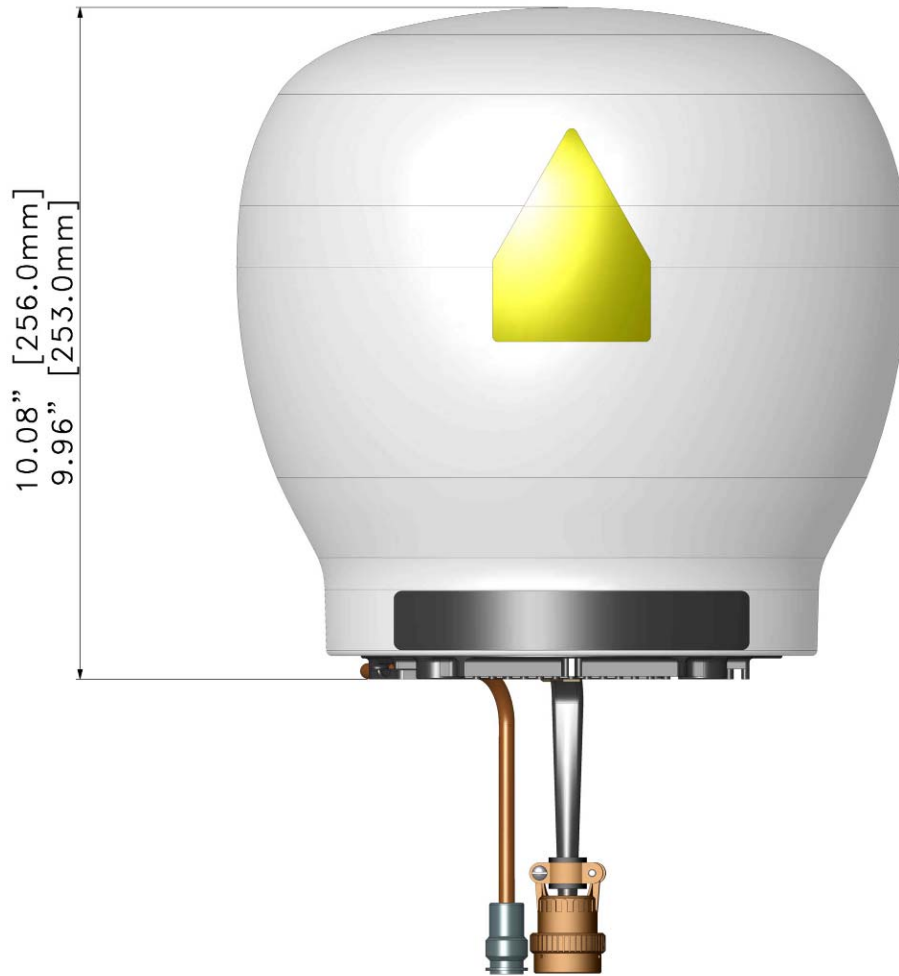


Figure 6 : Slimline HGA-6000 side view

3.2.2 HGA-6000 Technical Specifications

Dimensions:	10.08" (256 mm) diameter 9.71" (247 mm) height
Weight:	4.2 lb (1.9 kg) max
Weight with cables:	4.8 lb (2.2 kg) max
Slimline Dimensions:	10.08" (256 mm) diameter 10.08" (256 mm) height
Slimline Weight (with cables):	4.63±0.44lbs (2.10 ± 0.20 kg)
Temperature Range:	-85 °F to 158 °F (-65 °C to +70 °C) (operating) -85 °F to 185 °F (-65 °C to +85 °C) (storage)
Altitude:	Up to 70,000 feet
Frequency:	1525 MHz to 1660.5 MHz
Polarization:	Right Hand Circular Polarized (RHCP)
Coverage:	Seamless hemispherical coverage, compliant to Inmarsat SDM
Gain:	12.7 dBiC (typical, measured with a 15" [380 mm] RG400 pigtail)
Software Qualification:	RTCA/DO-178B, Level D
Environmental Qualification:	RTCA/DO-160D:

[E1]XAB[BCE][R(E,E1)S(L,M)]EWXXFXZ[A(WF)B]A[A(WF)B]C[WW]H[A3E3]XBA

3.2.3 HGA-6000 Electrical Interfaces

1) The HGA-6000 interfaces to the aircraft are typically done via 2 cables that exit from the base of the unit.

J1: L-Band Feed

- L-Band Rx: 1525 to 1559 MHz
- L-Band Tx: 1626.5 to 1660.5 MHz

J2: Data and Power

- +28VDC Power
- ARINC 429
- DLNA Control
- RS232 Maintenance Port

2) Power: 28 VDC @ 800 mA

3) Operating voltage: 22 – 30.3 VDC

3.2.3.1 HGA-6000 to DLNA RF Interconnection

Table 1 : HGA-6000 L-Band RF connector

NAME	CONNECTOR	DESCRIPTION
J1	11TNC-50-3-117	L-Band Tx and Rx

- 1) Connector J1 may be changed to be customer specific.
- 2) It is recommended that the coaxial interconnection between J1 and DLNA have a maximum loss of 0.3dB. The performance of the HGA-6000 is such that slightly higher cable loss (up to 0.5dB) can be accommodated depending on the system configuration. Consult Cobham for further information.

3.2.3.2 HGA-6000 to SDU Interconnection

Connecting the antenna to the SDU using the Modem Interface is done via a single coaxial cable. Details are not given in this manual for this option, please contact Cobham for further details in this regard.

3.2.3.2.1 Wiring Table

A 9-pin D-Type Female Connector may be installed at an accessible location for antenna maintenance, if required.

Table 2 : HGA-6000 Electrical Interface

SIGNAL	J2	DESCRIPTION
+28V_DC IN	Y	Aircraft power
28V_RET	S	Grounded to case internally
A429_Tx_A Out	G	ARINC 429 from antenna
GND	M	Screen for ARINC 429
A429_Tx_B Out	H	ARINC 429 from antenna
A429_Rx_A IN	A	ARINC 429 to antenna
GND	M	Screen for ARINC 429
A429_Rx_B IN	B	ARINC 429 to antenna
GND	R	Screen for DLNA signals
DLNA_BITE	L	DLNA BITE
DLNA_CTL	K	DLNA on/off control from antenna
GND	F	Serial data ground (to D-type pin 5)
RS232_RxD	D	Serial data to antenna (to D-type pin 3)
RS232_TxD	E	Serial data from antenna (to D-type pin 2)

3.2.3.2.2 Connector Types

Table 3 : Standard HGA-6000 Data and power cable connectors

NAME	CONNECTOR	DESCRIPTION
J2	MS3476W16-26P	Pigtail Connector
	MS3471W16-26S	Mating connector to Pigtail

Connector J2 may be changed to be customer specific.

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4. HGA-6000 HIGH GAIN ANTENNA INSTALLATION

4.1 Installation Overview

4.1.1 Equipment required

Connecting the antenna to the SDU via the modem is done via a single coaxial cable. Details are not given in this manual for this option.

Table 4 : HGA-6000 Equipment Required

ITEM	PART NAME	PART NUMBER
1	HGA-6000 Antenna	677-A0161-XXX*
2	HGA-6000 Power and Data Pigtail	supplied as part of the antenna
3	HGA-6000 L-band coaxial cable	supplied as part of the antenna

* **NOTE:** Contact Cobham for Variation part number details

The following items are not permanently installed on the aircraft as part of the SATCOM system but are required during the installation and/or maintenance process.

Table 5 : Test Equipment Required for HGA-6000 system installation

EQUIPMENT	PURPOSE
Antenna Support PC program: 800-A0124, Aero Antenna Systems Support	Software program required for antenna installation if antenna misalignment compensation must be performed by the antenna. If antenna misalignment compensation is performed by the SDU, this software is not required. Refer to the relevant SDU installation manual for further information.
Laptop computer with Microsoft Windows 98, 2000, XP or higher and a RS232 COM port.	To run the Antenna Support PC program and interface with the antenna maintenance port.
Alignment protractor and electronic spirit level with accuracy to within 0.25 degrees	To determine difference in aircraft and antenna alignment. The antenna attitude angles may be measured by placing the spirit level on the mounting area before the antenna is mounted.

4.1.2 General Electrical Requirements

- 1) The minimum wire size for power lines is #22AWG. Where workmanship standards allow, #24AWG may be used for all other lines. The installer is however responsible for determining the appropriate wire size required for the length of cable run, to ensure that the specified maximum cable losses do not exceed those indicated in this manual.
- 2) Keep the interconnect cables away from circuits carrying heavy current, pulse transmitting equipment and any other potential source of interference.
- 3) Use shielded twisted-pair wiring for all balanced connections. Shields should be grounded.
- 4) The characteristic impedance of each coaxial cable (connectors included) should be 50 Ohms with a VSWR of less than 1.2:1

4.1.3 Summarized Installation Tasks in Sequence

HGA-6000 installation tasks

- Step 1) The HGA-6000 will typically be mounted in the aircraft's tail radome. A suitable mounting plate or structure will be required to interface with the four mounting holes in the HGA-6000 base and must be supplied by the installer.
- Step 2) Determine or measure the HGA-6000 alignment angles prior to mounting the HGA-6000. See section 4.2.2.2.
- Step 3) Mount the HGA-6000.

Final testing

- Step 4) If using a non-Cobham SDU, run the Antenna Systems Support software (see Appendix B). Installation angles are now entered. If using a Cobham SDU, then the install angles may be stored in the SDU. Refer to the Swift64 or SwiftBroadband SDU installation manuals.
- Step 5) Complete the connection of the HGA-6000 to the Swift64 or SwiftBroadband system.

4.2 HGA-6000 Installation Guidelines

4.2.1 Mechanical Fixing

- 1) The installation mounting plate or structure must provide a flat platform for the HGA-6000.
- 2) The HGA-6000 is fixed to the mounting plate/structure by means of four ¼ inch 28UNF screws which screw into the base of the antenna from below. A locking wire thread insert in each of the four mounting holes will ensure that the screws remain secure. The mounting hole specifications are provided in Section 3.2.1, as well as in Figure 7.

Choose correct screw length to ensure engagement with the locking coil of the insert, that is minimum engagement = 1/4"

- 3) Provision may be required to accommodate the four screw heads on the aircraft's mounting structure.

4.2.2 Antenna Alignment

4.2.2.1 Antenna Markings

The base of the antenna is marked with a letter "A", as indicated by the arrow below. There are two notches on the side of the baseplate that corresponds with the "A". These notches can be used to determine where the "A" is if the antennas has already been installed. Take note of the B, C and D sides of the antenna, as these will be used to set the installation angles of the antenna as described in 4.2.2.2.

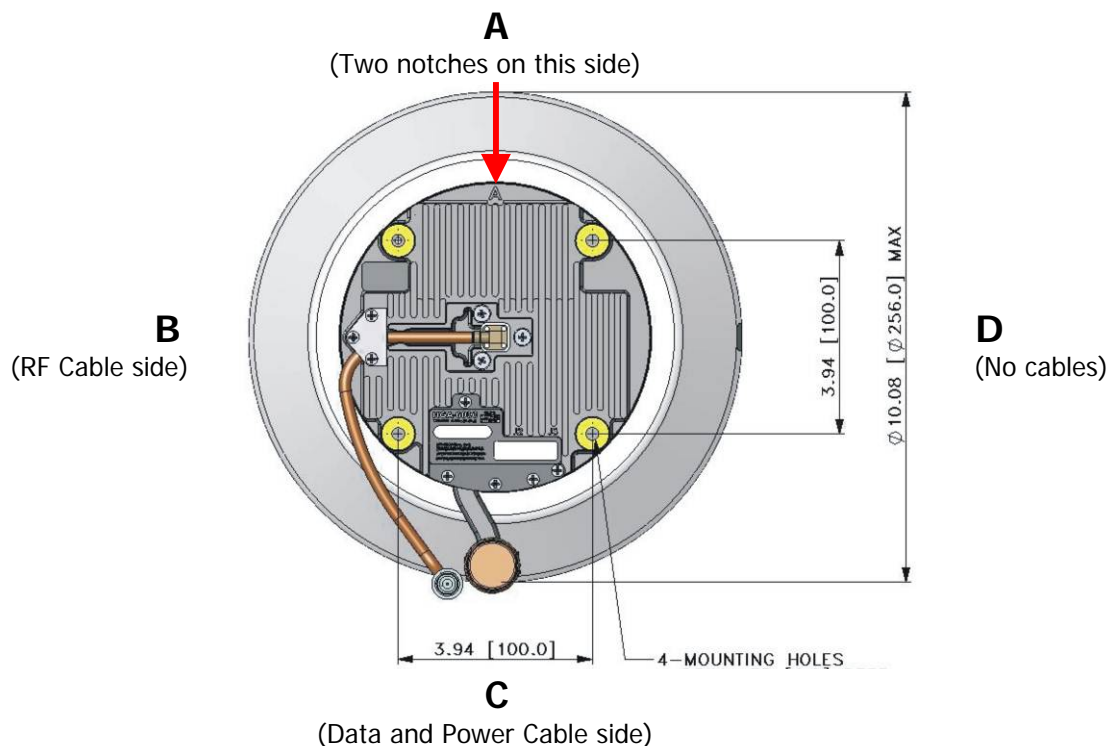


Figure 7 : HGA-6000 Alignment marking from the base of antenna

4.2.2.2 Data required during installation process

Once the antenna is installed the installation angles of the antenna must be entered manually. **It is recommended that these angles be measured before the antenna is mounted** as it may be difficult to measure these angles once the antenna is in place.

All angles to be entered are positive values only. The required accuracy for all angles is 0.25 deg.

After the antenna has been mounted, the installation software will prompt the installer to provide input to the following:

- 1) What is the azimuth angle of a line drawn between sides A and C, relative to the longitudinal axis of the aircraft? The screw holes in the aircraft that will be used for mounting the antenna can be used as a reference. Range: 0 to 90 deg
- 2) Which of sides A or C is closer to the aircraft nose? (Any side can be selected if they are equally close).
- 3) Is side A on the port or starboard side of C? (Any side may be selected if line AC is parallel to the longitudinal axis of the aircraft).
- 4) What the elevation angle is as measured with an electronic spirit level of a line drawn between sides A and C? Range: 0 to 45 deg.
- 5) Is side A higher or lower than side C? (If both A and C are at the same level, then either may be selected)
- 6) What the elevation angle is as measured with an electronic spirit level of a line drawn between sides B and D? Range: 0 to 45 deg.
- 7) Is side B higher or lower than side D?
- 8) What is the roll attitude of the aircraft when parked on the runway, as measured by the aircraft attitude reference system (AHRS, IRS or the SRU)? The angle is positive when wing tip is down on starboard side; negative if the starboard wing tip is higher than port wing tip.
- 9) What is the pitch attitude of the aircraft when parked on the runway, as measured by the aircraft attitude reference system (AHRS, IRS or the SRU)? Positive when nose points up, negative if nose points down.

4.2.3 Co-location with other Antennas

The systems most likely to be affected by the HGA-6000 system are GPS, Iridium, and other SATCOM systems, such as Ku-Band equipment. The installer needs to take this into account when planning an installation. For each new combination of equipment, empirical verification may be required.

4.2.4 Grounding

- 1) Although not required for correct operation of the antenna, grounding resistance between the HGA-6000 and the aircraft is often specified by the airframe manufacturer. Typical values fall in a range between 2.5 m Ω and 20 m Ω . This can be calculated by the difference in resistance between the RF cable connector screen and one of the mounting points, and the same point on the cable and the airframe close to the mounting point.
- 2) Grounding between the HGA and the mounting plate will be by means of the 4 mounting screws at the base of the antenna. Electrical contact may be required by the airframe manufacturer (e.g. no paint or other insulating substances should be present at these contact points).
- 3) Grounding between the mounting plate and the aircraft can be by means of the 4 mounting bolts and grounded aircraft anchor nuts. If a separate mounting plate is used, a ground strap screwed to one of the grounding holes on the plate can provide alternative grounding.

4.3 Mounting Procedure

- 1) If a separate mounting plate is utilized, mount the HGA-6000 to the mounting plate prior to aircraft installation. Otherwise, mount directly onto aircraft mounting structure. Four ¼ inch 28UNF screws need to be used for this purpose. Torque the screws to 5.2 ft-lb (7 Nm).
- 2) Align the HGA-6000 mounting plate holes with the mounting holes on the aircraft. Insert the mounting bolts and torque down evenly. (Refer to hole tolerances given in Figure 7 in case Cobham mounting plate is not used)
- 3) Verify the ground resistance to the antenna is within a suitable range.
- 4) Install a cable loom as applicable to your installation into the Aircraft. Ensure that the connector of the loom is within the required length from the HGA-6000.
- 5) Install the coaxial feed from the DLNA to within 12 inches of the HGA-6000 and connect the antenna's TNC connector. Tighten to a maximum of 0.7 ft-lb (1 Nm).

NOTE: Correct installation can only be verified when final system checkout is conducted. Retain access to antenna installation for this purpose

- 6) Connect a PC to the HGA-6000 maintenance port. This step is not required if you are using the SDU-73XX or the BSU-7100. The offset angles may be programmed in the Antenna or the BSU/SDU, which is preferable.
- 7) Power up the system.
- 8) Enter the mounting angles (into the SDU, BSU or Antenna) that have been recorded previously as described in Section 4.2.2.2.

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5. HGA-6000 MAINTENANCE, INSPECTION, REPAIR AND SERVICING

5.1 Scheduled Maintenance

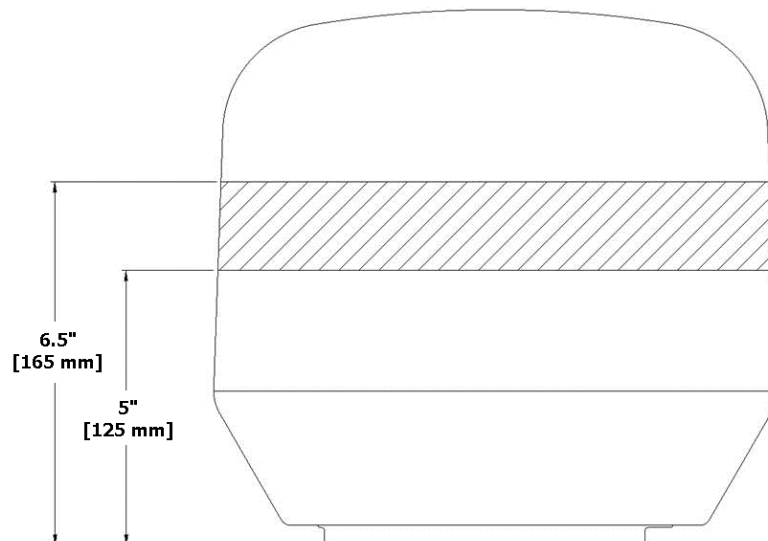
The HGA-6000 does not require scheduled maintenance or adjustment.

5.2 Inspection

The recommended inspection interval is equal to the Mandatory Periodic Inspection interval for the aircraft type on which it is fitted or 600 hours, whichever is shorter. This may be modified depending on the accessibility of the antenna.

Table 6 : HGA-6000 Inspections and Actions

INSPECTION	ACTION
1. Check antenna dust-cover for damage (e.g., dents, cracks, tears etc). See Figure 8 for damage criteria.	If damage exceeds the limits of Figure 8, remove and replace the damaged antenna. The damaged antenna can be returned to the manufacturer for inspection and repair.
2. Check that the HGA-6000 is securely fastened.	Re-tighten the screws as necessary to obtain proper torque figure. See Mounting Procedure to obtain correct torque procedure.
3. Measure resistance from the base plate of the HGA-6000 to the fuselage. Resistance should be within the tolerances specified by the airframe manufacturer or installation designer.	If resistance exceeds specification, remove the antenna from the aircraft, and refurbish all grounding points. Remount antenna.



NON-ALLOWABLE DAMAGE	ALLOWABLE DAMAGE
Dents in shaded area	Max 3 mm indentation in non-shaded area
Cracks and tears	Scratches

Figure 8 : HGA-6000 Inspection Criteria and Damage Limits

5.3 Built-In Test Log Analysis

- 1) This inspection should be performed whenever antenna malfunction is suspected.
- 2) Connect a PC to the RS-232 maintenance interface of the HGA-6000 and using the installation software, select HGA-6000 maintenance option and follow the on-screen instructions.
- 3) Faulty units must be returned to Cobham for repair.

5.4 HGA-6000 Repair and Servicing

No repair actions will be able to be performed in the field. Faulty units must be returned to Cobham for repair.

5.5 Removal Procedure

The removal procedure is the reverse of the installation procedure.

5.6 Warranty Seal

Warranty will be void if the "Warranty Seal" on any unit is removed or damaged.

5.7 Storage and Transportation

The units must be placed inside a padded box. The box must be stored in a dry area (<50%RH) where the temperature remains within the range of -85°F to +185°F (-65°C and 85°C).

6. DISCONTINUED PRODUCTS

Cobham has ceased production of the Satcom Reference Unit (SRU) and Magnetic Sensor Unit (MSU) in October 2009. The following part numbers are affected:

Table 6-1: Discontinued Products

Product	Part number
MSU-7250	677-A0144
SRU-7200	677-A0132

The references to the SRU and MSU in this document are retained as these components are present in a number of operational systems.

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**APPENDIX A: EXAMPLES OF INSTALLATION
CONFIGURATIONS**

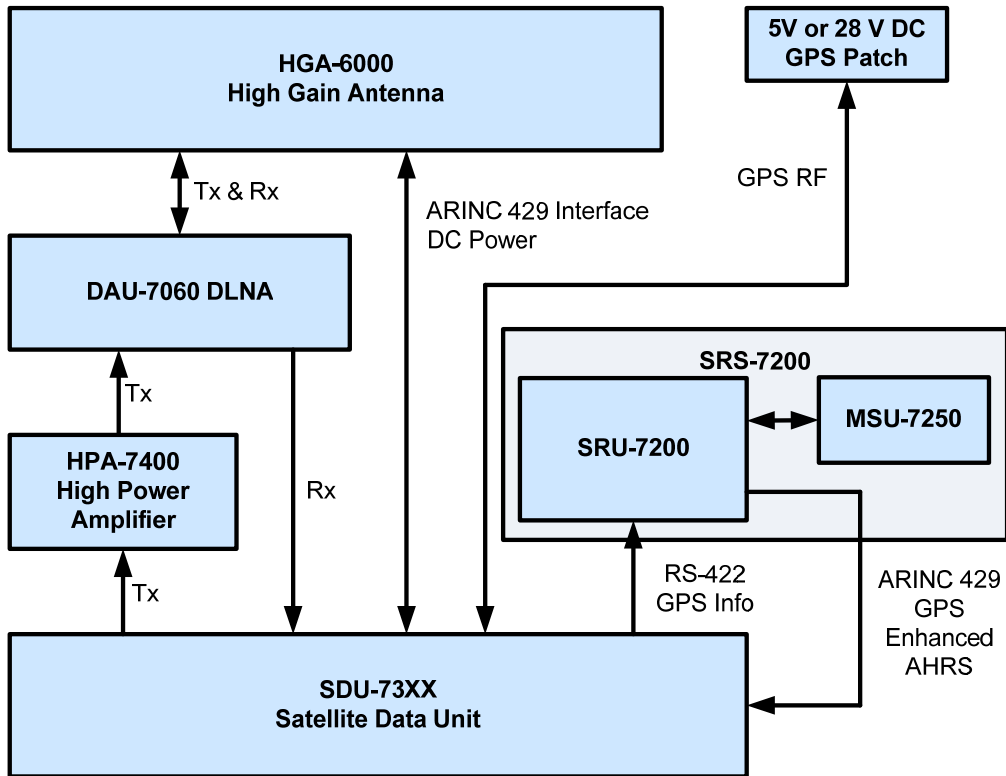


Figure 9 : Cobham SwiftBroadband System using SRS-7200 AHRS System

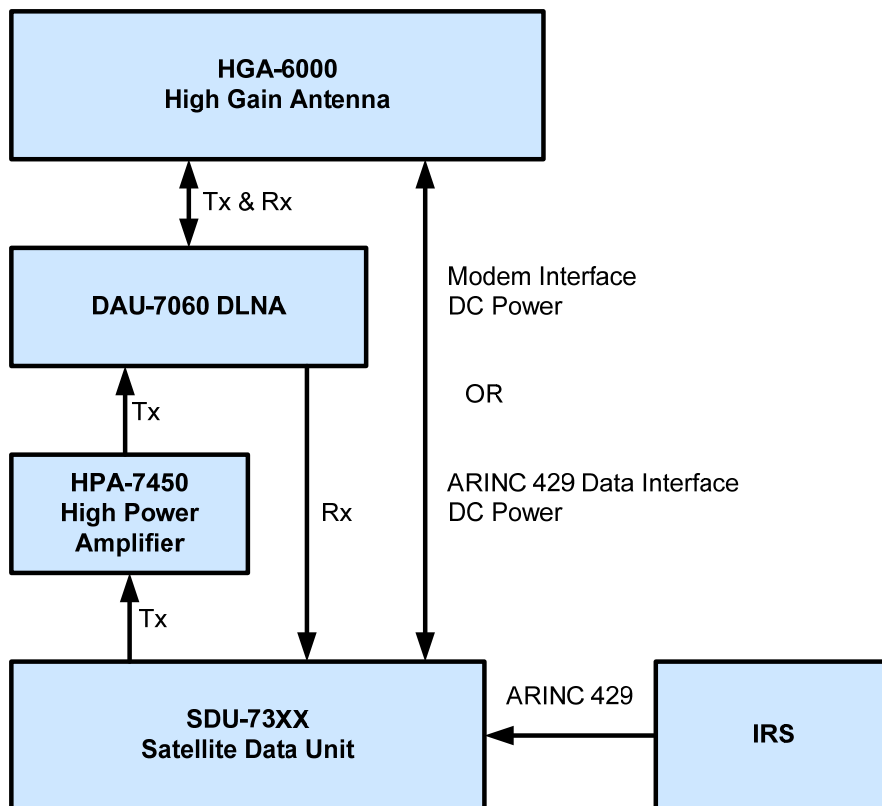


Figure 10 : Cobham SwiftBroadband System using IRS System

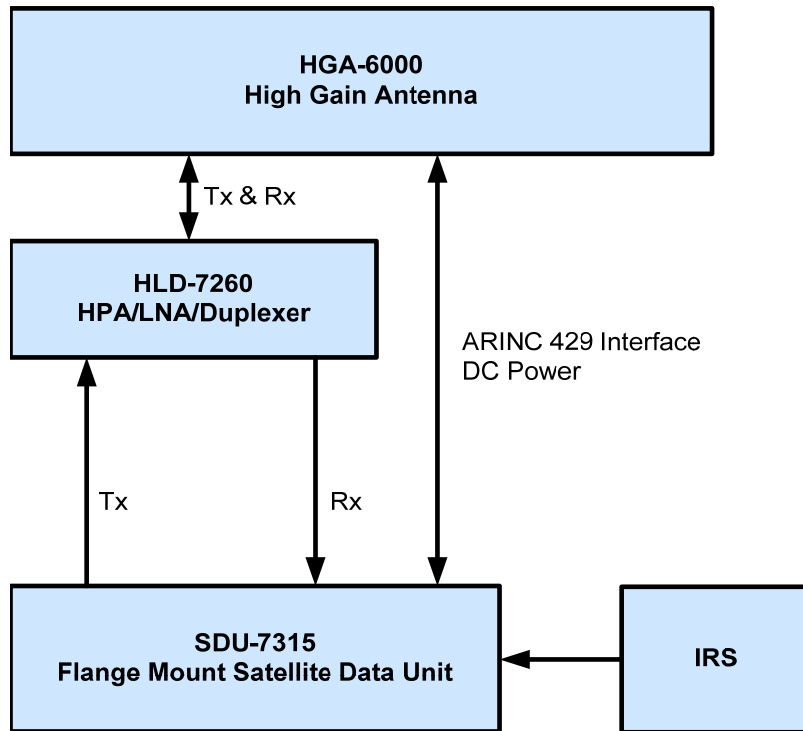


Figure 11 : SwiftBroadband SATCOM System using HLD and IRS Navigation System

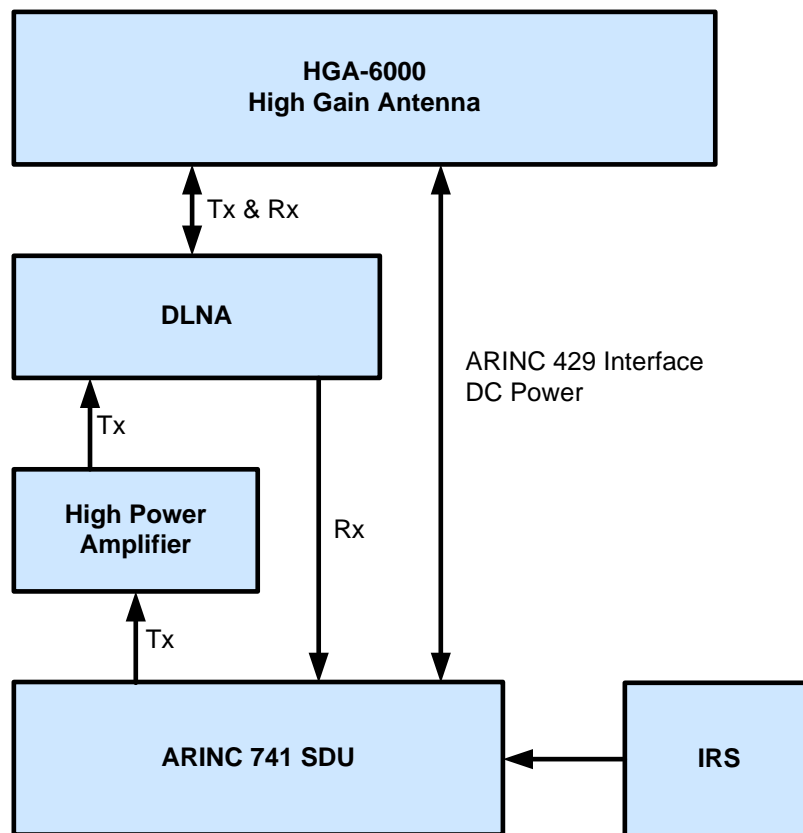


Figure 12 : ARINC 741 SATCOM System using IRS Navigation System

APPENDIX B: ANTENNA SUPPORT SOFTWARE GUIDE

Antenna Support Software

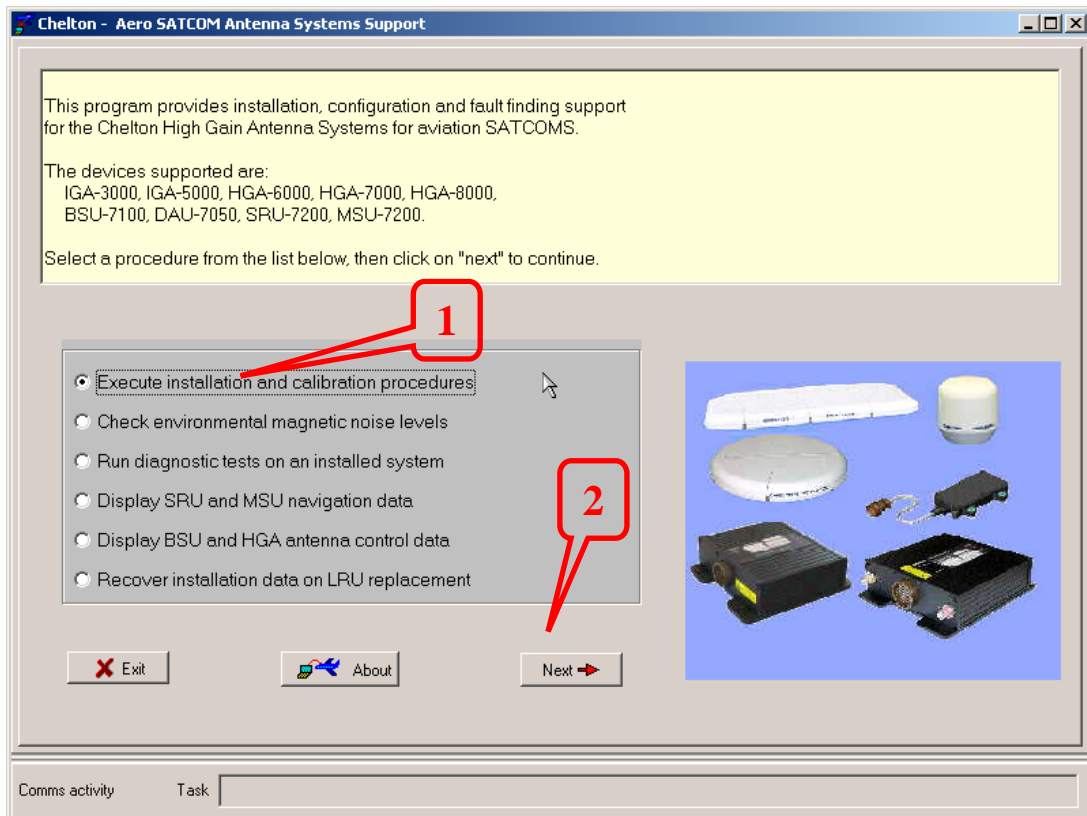
The Antenna Support Software will guide the installer during the antenna installation process. This is not required when the antenna is installed with the SwiftBroadband SDU.

The following figures depict the initial antenna installation step-by-step.

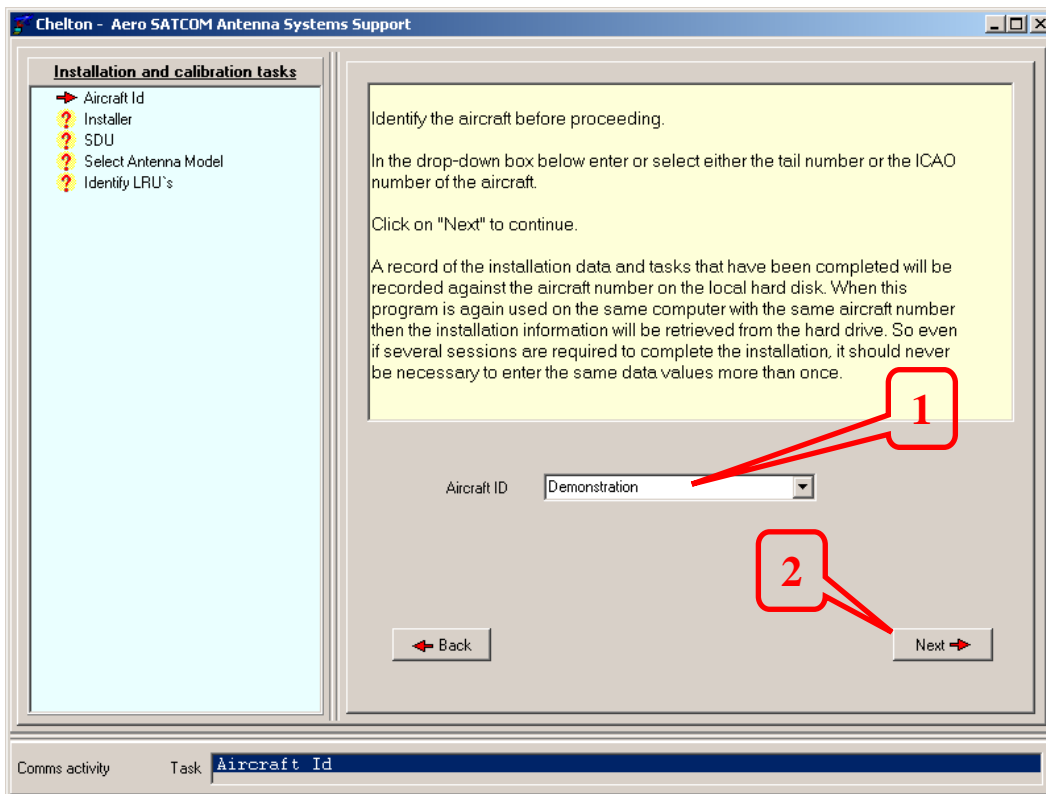
Step 1: Run the Antenna Systems Support software

Name	Size	Type
Logs		File Folder
Chelton_Antenna_Support.exe	1,518 KB	Application
HGA6000#1.ICD	2 KB	ICD File
Settings.ini	1 KB	Configurati

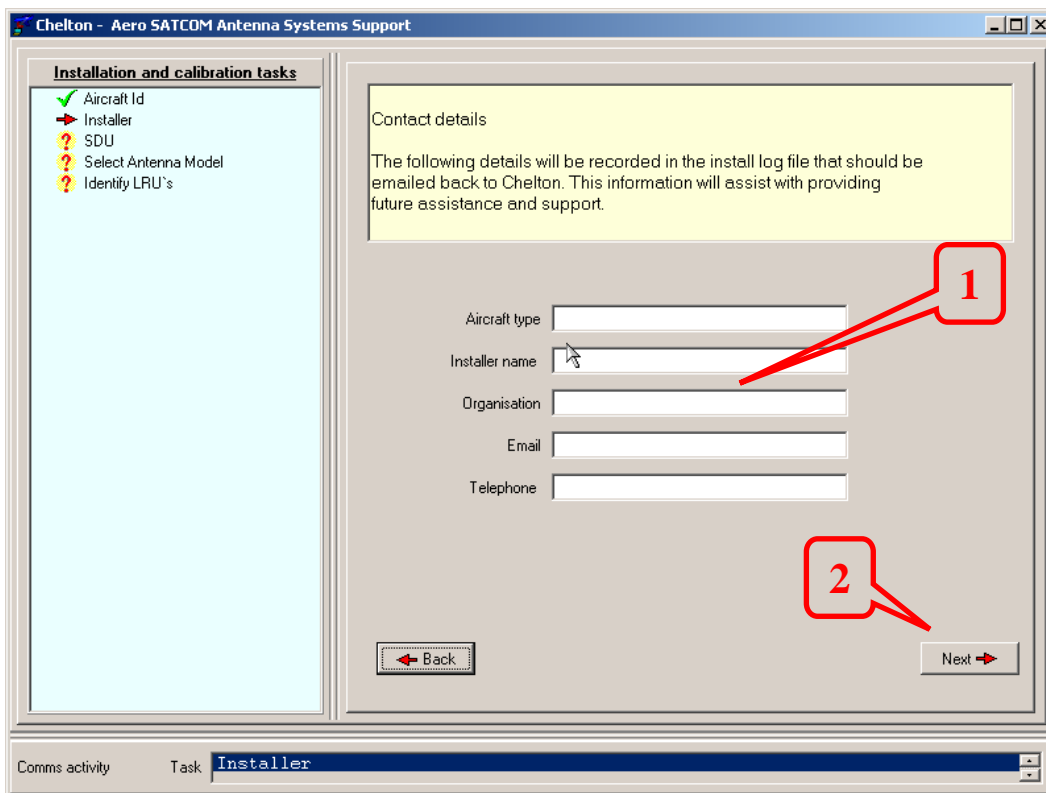
Step 2: For initial HGA-6000 installation, click (1), then (2)



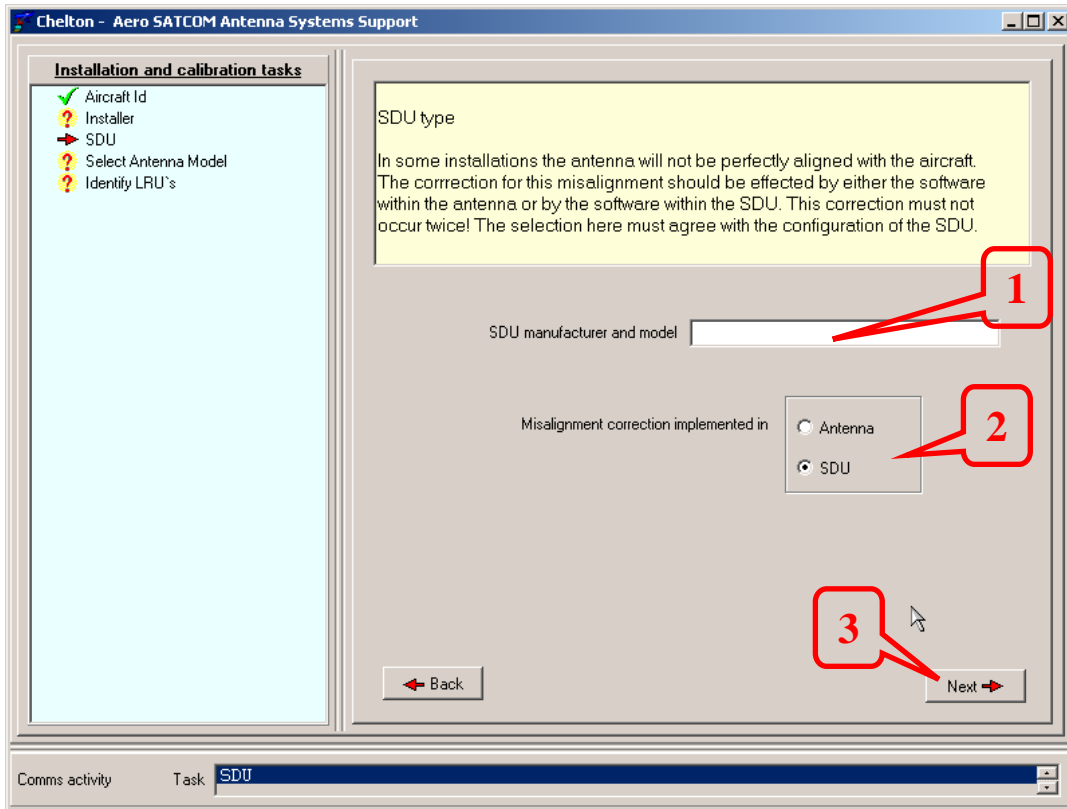
Step 3: Fill in at (1), click on (2)



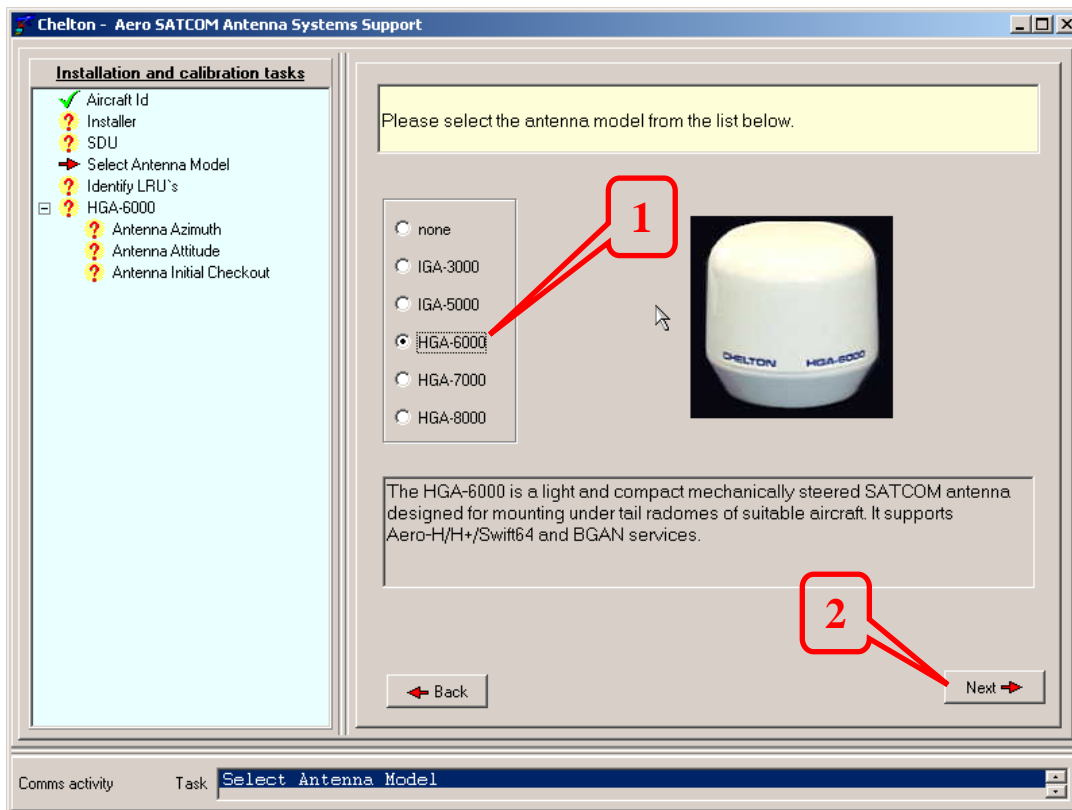
Step 4: Fill in at (1), click on (2)



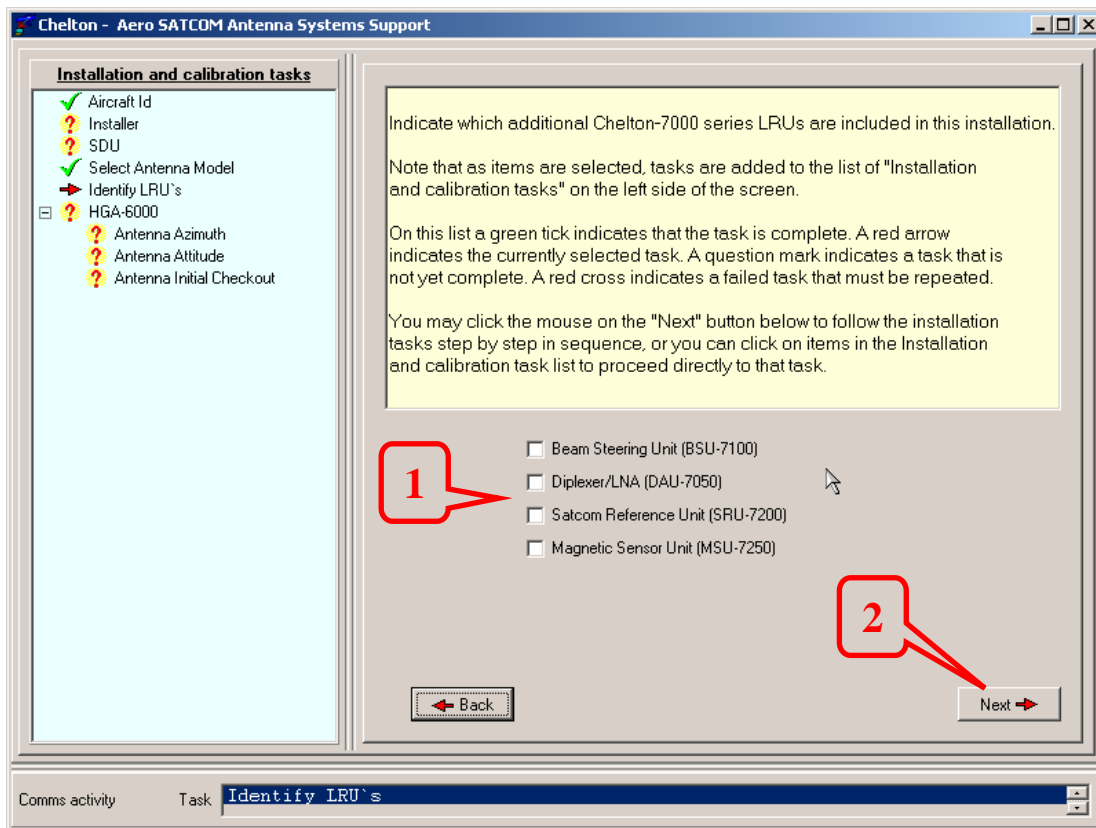
Step 5: Fill in at (1), select misalignment angle correction at (2) and click on (3)



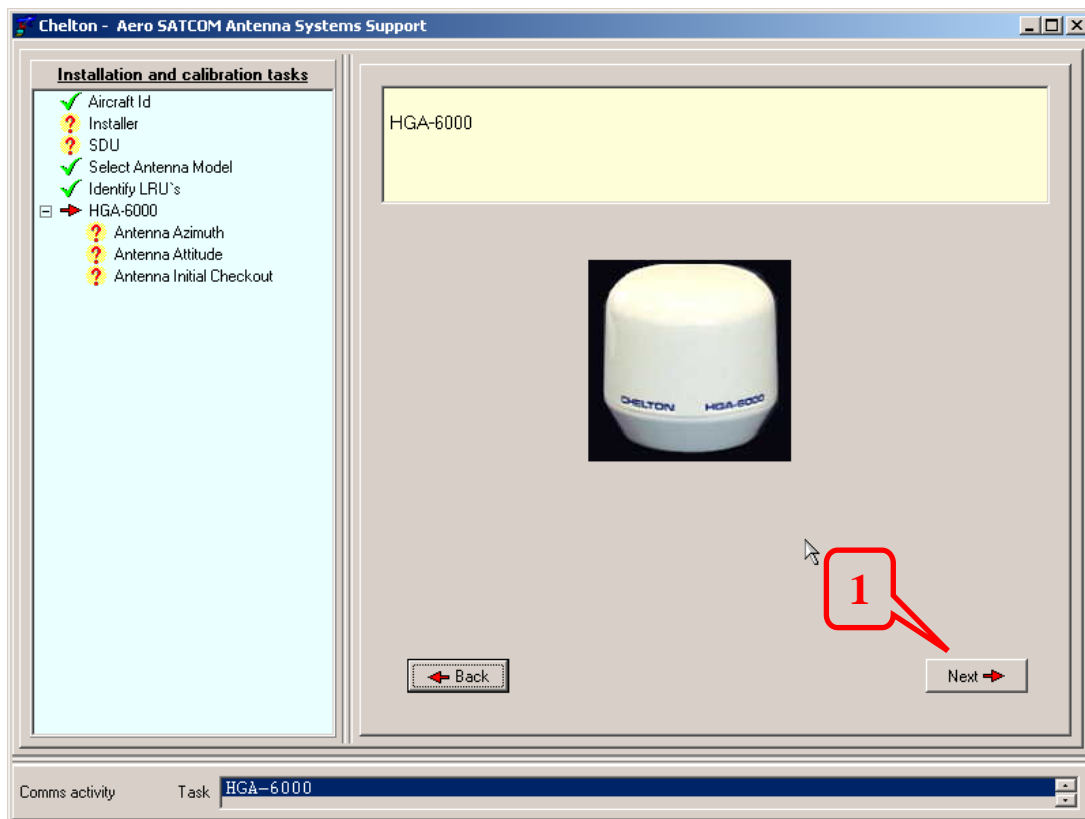
Step 6: Select (1) and click on (2)



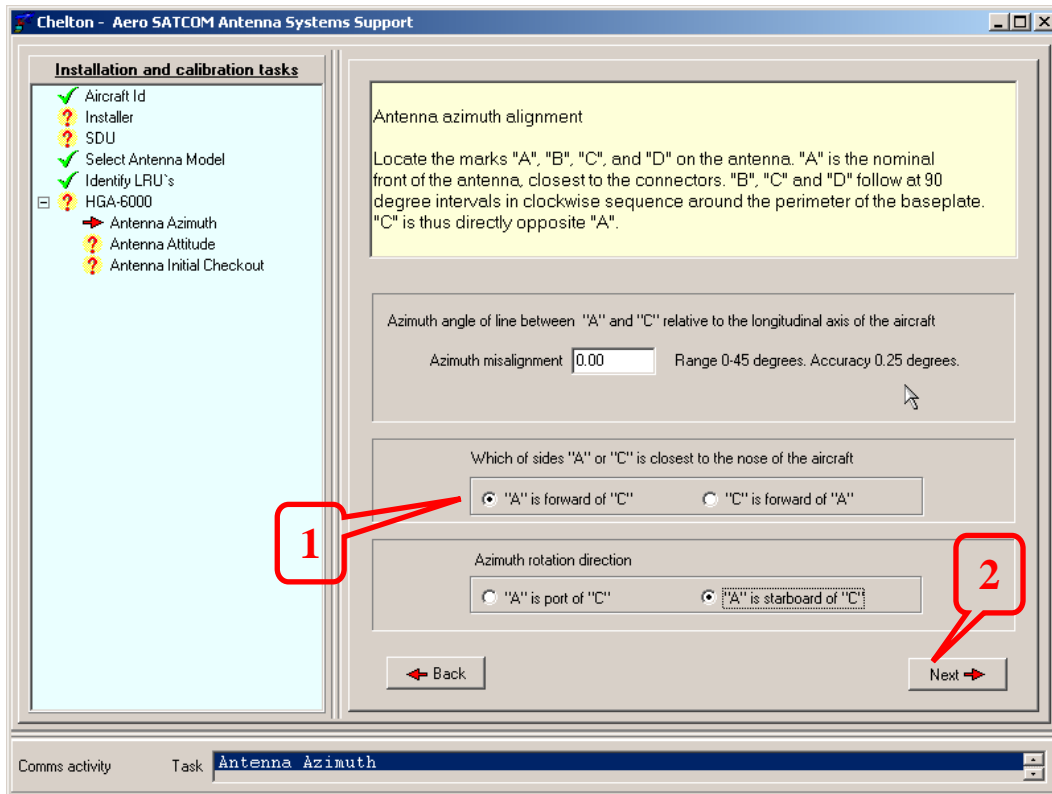
Step 7: Do NOT select any at (1), click on (2)



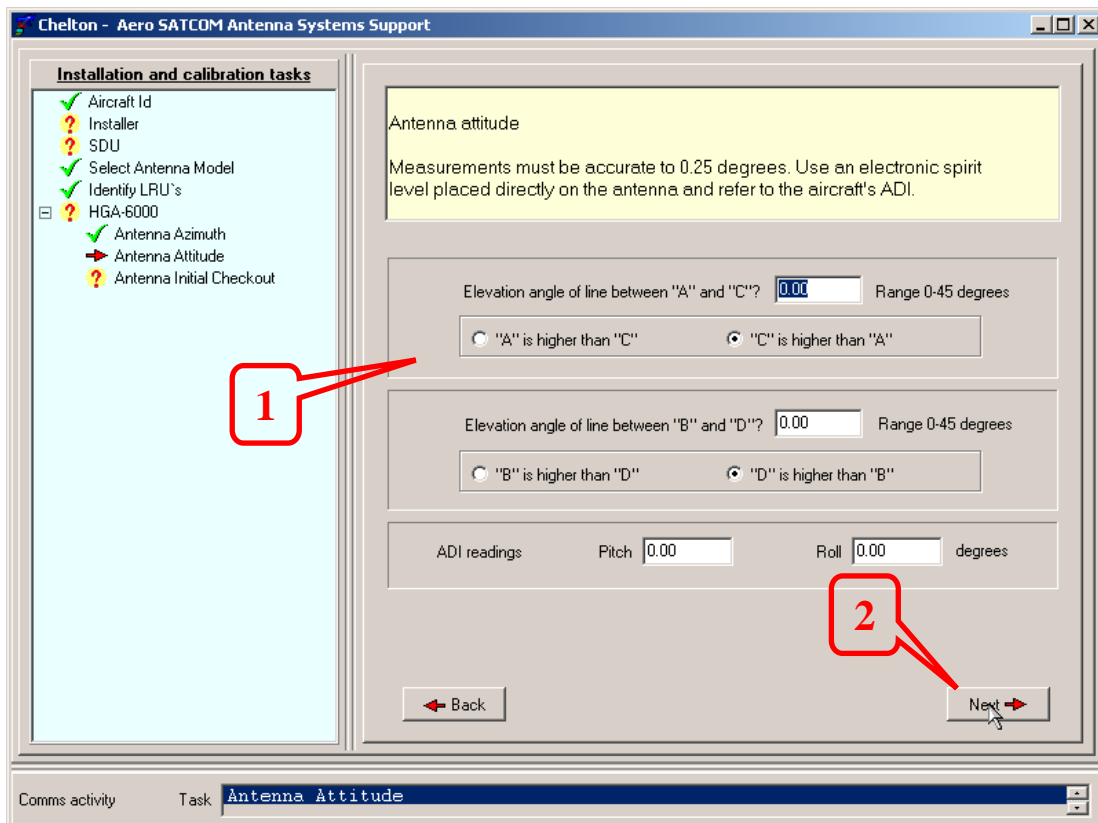
Step 8: Click on (1)



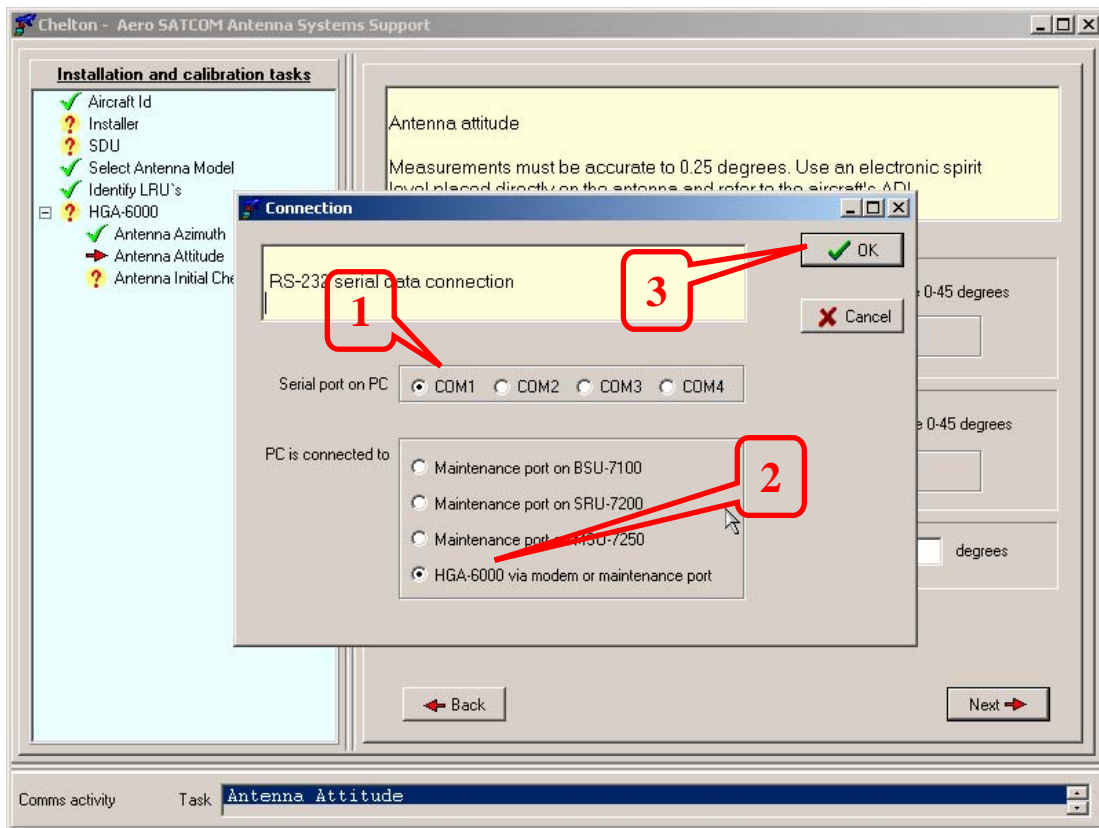
Step 9: If "Antenna" was selected in Step 5, fill in and select (1), click on (2).
If "SDU" was selected in Step 5, skip to step 11.



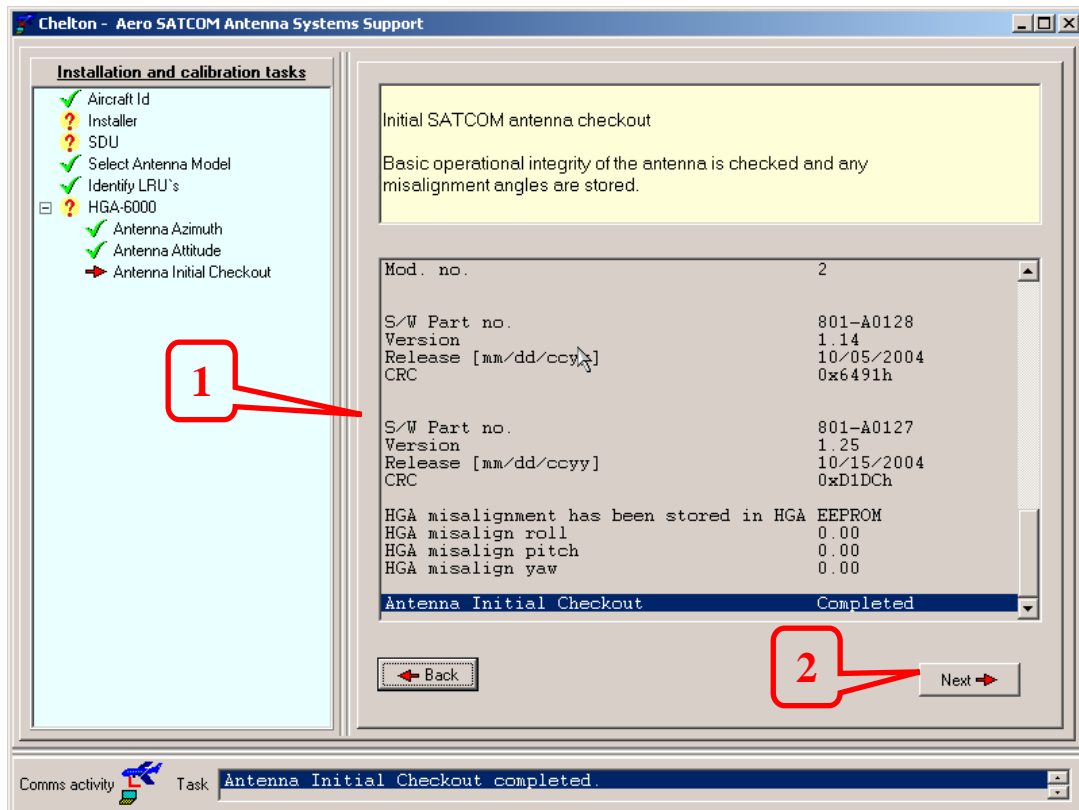
Step 10: Fill in and select (1), click on (2)



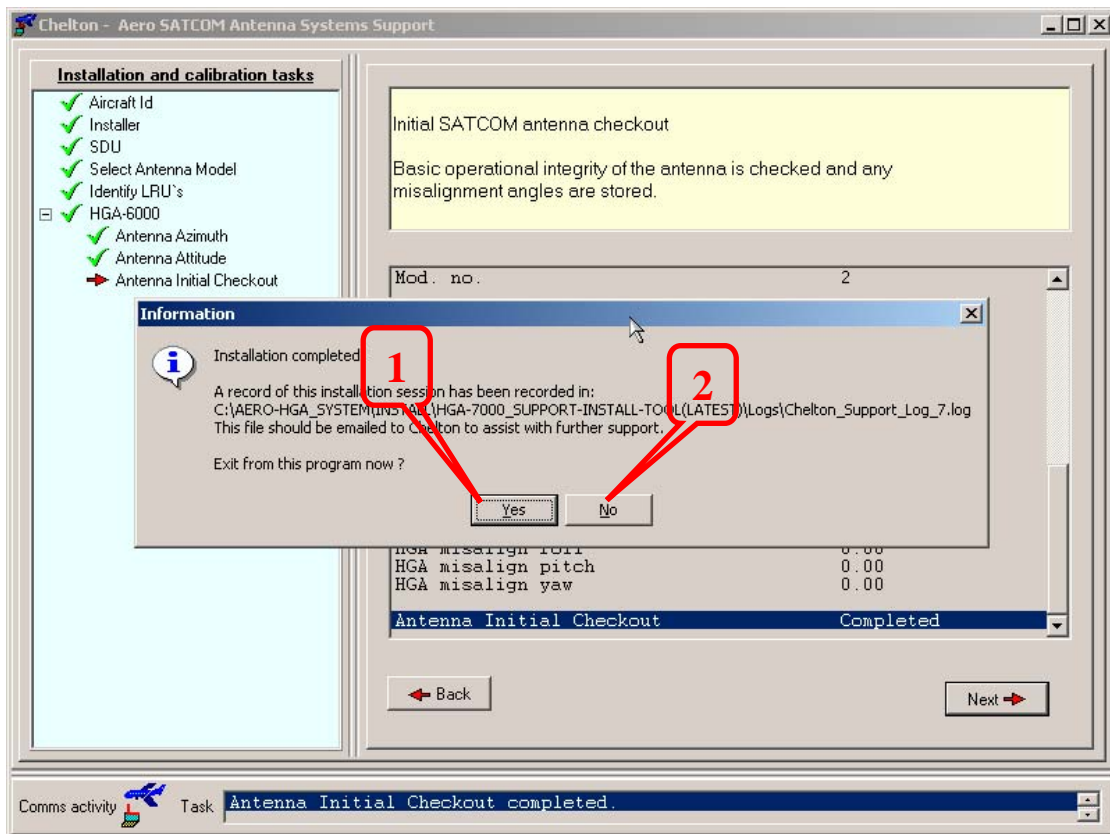
Step 11: Select (1), (2), then click on (3)



Step 12: See results at (1), click on (2)



Step 13: Click on (1) if you want to exit application, click on (2) if you want to stay in program



Step 14: View log file in Log directory

