MUTUAL RECOGNITION OF PERFORMANCE MEASUREMENT GUIDELINES AND PROCEDURES FOR SATELLITE SYSTEM OPERATOR TYPE APPROVALS

GSOA-101

GSOA Revision (0), May-2024

This Mutual Recognition Arrangement (MRA) provides guidance for manufacturers and satellite operators pursuing GSOA MRA Testing and Satellite System Operator Type Approval for VSAT equipment.

Revision History:

Document	Status	Notes
MRA document implemented June 1999	Released	In use
GVF-101 Rev C	Released	Operator contacts and specifications are moved to GSOA-102. Incorporates rev. B, B1, B2, and B3 drafts, with final comments and ratification at MRA-WG meeting Amsterdam 23 Oct 2000.
GVF-101 Rev D	Draft	
GVF-101 Rev E	Released	Revision prepared by Stuart Coppedge [Thinkom]. Added section 4.3.1.6 et seq to address test requirements for Antennas with Changing Main beam Patterns vs. Scan angle.
GSOA-101 Rev 0	Released May 2024	Re-issue GVF-101 Rev E as GSOA-101 Rev 0 to maintain continuity with GVF-101 measurement guidelines following the merger of the GVF with GSOA in June 2023. (Contributors: Colin Robinson, Gavin Cox and Irina Petrov)

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1 INTRODUCTION

1.1 Purpose

This document is designed to facilitate mutual recognition by satellite operators of satellite ground equipment performance testing for the purposes of certifying equipment models, in order to eliminate the necessity of repeated factory or field testing.

This document is intended to serve the following purposes:

- Define equipment levels (antennas and earth stations)
- Define a complete set of mutually recognized tests for each equipment level ("MRA Testing")
- Define a process for assuring complete and accurate testing of equipment, and preparation of a file of test results and design review information ("Data Package")
- Define a process for the GSOA to authorize test witnesses ("Authorized Test Entities")
- Define the overall process for an initial Satellite System Operator Type Approval ("SSOTA")
- Define the process for follow-on Satellite System Operator Type Approvals

1.2 Background

An earth station is the ground-based equipment that transmits and receives signals to and from a satellite system. Satellite system operators desire to prevent users of their satellites from interfering with each other's signals and to protect against excessive use of transponder power and bandwidth resources. Under national laws and international treaties, satellite system operators also have certain responsibilities to protect other satellites and other radio communications services from interference. To these ends, satellite operators impose technical specifications on earth station equipment.

Correct and compliant operation of the earth station is the responsibility of the earth station owner and operator. An earth station owner-operator seeking to operate an earth station in a satellite system must have the earth station certified to comply with the relevant mandatory performance characteristics, such as pattern sidelobes and cross-polarization discrimination, as specified by the satellite system operator.

Compliance might be assured by either (i) verification testing each earth station after it is installed, or (ii) a program of Satellite System Operator Type Approvals.

Developments in earth station technology and advanced manufacturing quality control make it possible to replicate equipment with sufficient consistency and performance margin that an operator may issue an approval, i.e., (a "Satellite System Operator Type Approval," or OTA) for all installations of equipment of a certain type. Note that the SSOTA's are issued by the satellite operators and are independent from national or regional regulations.

Typically, smaller earth stations - such as Very Small Aperture Terminals (VSATs) - and those earth stations that do not require extensive or any individual antenna panel adjustment are good candidates for SSOTA.

When an earth station has an SSOTA, the earth station owner-operator can be assured that specified levels of compliance are met. This can greatly reduce or even negate the requirement for the individual testing of each earth station at its operational site. Thus, Satellite System Operator Type Approval can result in significant savings in cost, time and effort for the earth station operator and owner, the earth station manufacturer and the satellite system operator.

Individual operators have historically granted SSOTA only after extensive testing of manufacturer's equipment demonstrates consistent performance with margin. However, each operator has

required that the testing be repeated in order to grant their own SSOTA. The associated expense and delay acts to discourage manufacturers from applying for SSOTA's, and so products which would benefit end users and encourage the use of satellite solutions are not made available to the market with low installation cost.

The GSOA MRA Test process seeks to address this problem by defining a set of standardized measurements and independent oversight, resulting in a verified data package that a manufacturer may submit to multiple operators as part of SSOTA applications.

1.3 MRA Testing

This document defines a Data Package, comprising a set of measurements and reports, which together are sufficient to allow any satellite operator member of the GSOA to evaluate the equipment for Satellite System Operator Type Approval. To ensure that measurements are made in an impartial, accurate, and complete manner, and that the entire Data Package is complete, this document provides for impartial Authorized Test Entities to conduct, direct or witness testing and to review the Data Package.

This document describes the procedures and requirements for GSOA MRA Testing and preparation of the Data Package. The procedures are designed to ensure that all Operator Type Approved Antenna Models and Earth Stations will perform consistently without the need to repeat measurements in the field.

1.4 Equipment Levels

Because an earth station consists of several components, GSOA MRA testing can be conveniently categorized into two hierarchical levels: "Antenna Model" and "Earth Station Model," The Earth Station Model encompasses more equipment than the Antenna Model. See Section 10 (GLOSSARY) for details.

In a single GSOA MRA test process and SSOTA application a "family of configurations" may be approved. An example of a "family of configurations" is an Earth Station Model, which may be configured with LNA's of different noise temperature, and HPA's of different output power levels. Another example is a VSAT Terminal, which may be configured with up/down converters of various redundancy configurations and satellite modems with approved configuration options.

The tests involved in GSOA MRA testing a "family of configurations" will be determined on a case-by-case basis. In general, a baseline configuration will be fully tested. Then a series of delta tests, with associated calculations, will be performed to verify the other configurations are also compliant.

1.5 Satellite System Operator Type Approvals (SSOTA's)

Satellite Operator members of the Global Satellite Operator Association shall consider applications for SSOTA for equipment which has been MRA Tested. The operator shall recognize the MRA Testing Data Package as being complete and accurate, and not require any tests to be repeated. The operator may, however, require additional testing only if the operator's documented technical specifications include a characteristic that was not addressed by the MRA Test list in this document.
Operators may limit the size of antenna that can be Operator Type Approved for use on their system. Antennas requiring extensive individual panel alignment (e.g., antennas requiring theodolite panel alignment) are not considered suitable candidates.

Some operators may not recognize all three hierarchical levels of GSOA MRA testing.

Prior to being granted access to any satellite system, every operating Earth Station must be certified to be in compliance with the relevant mandatory specifications of the satellite operator.

Earth stations with SSOTA's will be granted operational access into satellite systems with no on-site verification testing for performance characteristics that were covered by the MRA Testing.

However, an earth station operator requesting access to such satellite systems must still submit an application to operate in the system as required by the satellite system operator, and provide documented proof that the earth station is Operator Type Approved. Examples of such documented proof include (i) the vendor's shipping document showing the SSOTA identification number; or (ii) the SSOTA certificate showing the appropriate manufacturer's part numbers or (iii) type approval certificate from manufacturer for specific units.

The GSOA recommends that the manufacturer include documentation with antenna shipments that show the SSOTA granted to that antenna. Further, the manufacturer should maintain records tying the SSOTA to the specific delivered antenna models and serial numbers.

1.6 Notifications and Confidentiality

1.6.1 Proprietary Data

Prior to issuance of an SSOTA, satellite operators shall treat all information regarding any manufacturer's MRA Testing and/or SSOTA application as confidential, unless permission is given by the manufacturer to divulge specific information.

GSOA member operators agree that the Data Package is considered the intellectual property of the manufacturer and subject to any confidentiality agreements made between the operator and the manufacturer. In the absence of any such agreements GSOA member operators agree that the Data Package is the manufacturer's proprietary information.

1.6.2 Public Notifications

After an SSOTA is issued, the satellite operator may make the information included in the SSOTA certificate available to the public at large on request by any means; for example, the operator's Web site. Operators may also maintain links to manufacturers' Web sites to allow further information to be found at the discretion of the manufacturer.

1.6.3 Role of the GSOA

The GSOA need not be routinely notified of MRA Testing activities, SSOTA applications or SSOTA issuances.
However, the GSOA may be delegated by a Satellite System Operator to perform the Type Approval process on its behalf, through one of its Authorized test Entities (ATE). In this case the Satellite System Operator will recognize and honor the GSOA Type Approval on an equal footing with those performed in the past. GSOA will maintain on its Web site a definitive list of SSOTA certifications for these Satellite System Operators. For those satellite System Operators not delegating to the GSOA the Type Approval process, the GSOA may maintain a list of SSOTA certifications, if so requested.

2 GSOA MRA TEST AND SATELLITE SYSTEM OPERATOR TYPE APPROVAL PROCESSES

2.1 First-time SSOTA Application and MRA Test Process

A manufacturer seeking the first Satellite System Operator Type Approval SSOTA) for a specific equipment configuration for the first time must follow the two-step MRA process. Some of these steps may be combined subject to agreement between the Primary Operator and the manufacturer. In general, testing, reports and declarations made for the purpose of conforming to national or regional regulations or quality control systems (for example, EU directives or ISO-9000) may be used as part of the Data Package where appropriate.

2.2 Secondary SSOTA Applications

A manufacturer seeking a Satellite System Operator Type Approval for a specific equipment configuration with a different operator must follow the process given in Figure 2. Some of these steps may be combined subject to agreement between the Secondary Operator or ATE as applicable and the manufacturer.

In order to qualify for this process, it is not necessary to have received an SSOTA certificate from the Primary Operator. It is necessary, however, that steps (1) through (6) of MRA two-step process are fully completed; i.e., the Data Package must be complete and signed off by an ATE.

2.3 Fees

The GSOA/ATE will agree on a fee with the manufacturer and agree on the time necessary to complete the program. The initial fee to review the preliminary test data shall be paid at the time the Phase 1 data is submitted. The balance of the fee due shall be paid after the Phase 1 tests are approved and Phase 2 testing is scheduled. Payment will be made by the manufacturer to the GSOA upon completion of the tests, whereupon GSOA will make payment to the ATE for services rendered, regardless of the outcome of the tests.

Regarding Primary Satellite Operator

1. **Manufacturer** chooses a Satellite Operator or GSOA/ATE and designates other Satellite Operators, as applicable.

2. **Manufacturer** submits to Satellite Operator or GSOA/ATE the relevant documentation, including product specification sheet, measured RF performance, description of the test range, test plans and schedules.

3. **Satellite Operator or GSOA/ATE** informs the manufacturer on the acceptability as a candidate for Type Approval and suitability of the test range and test schedule.

4. **Manufacturer** conducts Phase 1 tests (un-witnessed) and submits the results to the Satellite Operator or GSOA/ATE.

5. **Satellite Operator or GSOA/ATE** reviews the Phase 1 test report and informs the manufacturer on its acceptability.

6. **Manufacturer** conducts Phase 2 tests witnessed and signed off by the GSOA/ATE on at least three typical production units.

7. **Manufacturer** prepares the Phase 2 Test Report, and the final report, which will include the data package signed off by the GSOA/ATE, and other ancillary data (e.g. wind load performance, installation handbooks, bill of materials, antenna drawings, Quality Assurance and Control procedures, packaging and any other item requested by the Primary Operator or GSOA/ATE).

8. **Satellite Operator or GSOA/ATE** review the Final Report, compare the test results with the specific technical requirements, and, if applicable, Satellite Operator or the GSOA will issue the relevant Type Approval Certificate.

9. If the Satellite Operator or the GSOA decline to issue the type approval, the **Manufacturer** may make the necessary changes to the design and repeat partially or totally the process above.

Regarding Secondary Satellite Operator

1. **Manufacturer** Prepare and submit application and Final Report to Secondary Operator.

2. **Secondary Operator or GSOA/ATE** reviews and informs the manufacturer on acceptability of the relevant documentation.

3. **Secondary Operator or GSOA/ATE** review the Final Report and, if applicable, Satellite Operator or the GSOA issue the Type Approval Certificate.

4. If the Secondary Operator or the GSOA decline to issue the type approval, the **Manufacturer** may implement changes to the equipment and/or perform additional measurements.

2.3 Application for Satellite System Operator Type Approval (SSOTA) – COVER PAGE

(page 1 of 3)

Applicant Name							
Title							
Company Category		System Supplier		Antenna Manufacturer		Other (specify)	
Company Name							
Business Contact Name							
Title							
Address							
Telephone				Fax			
Email							
Technical Contact Name							
Title							
Address							
Telephone				Fax			
Email							
Satellite System Operator Type Approval Profile							
Equipment Level:		Antenna Model		Earth Station Model		VSAT Terminal	
Anticipated Number of Systems Manufactured/Sold per Year:							
Indicate:	New SSOTA		Modified SSOTA				
			The existing SSOTA # (for Modified SSOTA)				
Primary Operator and standard:							
List any other satellite operators and standards for which you may seek SSOTA in future:							

2.4 Application for SSOTA: Antenna Model profile

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Configuration Profile			
Manufacturer Name			
Antenna Model Number			Antenna Shape
Fixed ___or		Transportable ___	
Antenna (Check or describe type)	Axisymmetric: ___ Offset: ___	Front fed: ___ Dual Reflector:___	Other (please describe):
Diameter (meters to nearest 0.1m)		Dimensions if non-circular (meters x meters, to nearest 0.1m)	
Equivalent Circular Aperture			Is special feed alignment required to meet specification? (yes or no)
Feed/Feed System Part Number			
Feed system description:	Number of Ports:	Polarization Mode:	
Performance Profile			
Satellite Operator Standard			
Sidelobe Specification:		Cross-Pol Specification:	On Axis:_____ Off Axis:_____ at _____deg/dB
Transmit Frequency Range		to	
Receive Frequency Range		to	
Typical Gain dBi Transmit _____ Receive _____			
Antenna Temperature @ _____ degrees elevation			

2.5 Application for SSOTA: Earth Station Model profile

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Equipment Profile					
Earth Station Model:					
Does the Antenna Model have an existing SSOTA? Yes ___ No _____					
If yes, indicate the Primary Operator name and certification number of the antenna:					
Transceiver, block upconverter, ODU, SSPA, or HPA manufacturer and part number and description					
LNA/LNB/LNC manufacturer and part number (if separate from above)					
IFL cable type and length					
Performance Profile					
Nominal G/T _____dB/K @ _____GHz, _____Degrees elevation					
Transmit Spectrum Purity	power		dBc	Frequency	
Worst Case	power		dBw/4kHz	Frequency	
e.i.r.p. Stability and antenna pointing/steerability specifications (enter below or attach sheets)					

3 DESIGN REVIEW

3.1 Design Review Meeting

The manufacturer will conduct a design review at the manufacturer's facility, and shall arrange for representation at the design review by any subcontractors who provide elements or subsystems having a design that can potentially affect the space segment. This review shall particularly address all aspects of the earth station, antenna system or antenna model which bear on the continued technical and operational integrity of the satellite communications system.

The design review may take place at any time prior to sign-off of the Data Package by the ATE (Step 7 of the GSOA-MRA two-step process.

The design review shall address the following elements:

- Background to the production of the items under test (antenna, feed assemblies, LNA, etc.); How did the design and production of these items evolve from existing similar products? What is the marketing objective?
- Summary of the results of the tests performed and previously submitted.
- Comments on the production/manufacturing techniques.
- Comments on the test plans and procedures and test facilities (test range, test benches, anechoic chambers, test set-up and test equipment.)
- Summary of the comments on the available product documentation.
- Installation procedures.
- Quality control, including long term performance monitoring and frequency of sampling for monitoring the quality on an on-going basis.
- For Earth Station Models, detailed design and ongoing process control for prevention of spurious oscillations.
- Product specifications.
- Product packaging.
- Agreement on action items and corresponding due dates and assignment of responsibility for each action item. In particular, there should be an agreement about the scope and quantity of remaining tests to be performed by the applicant.

3.2 Design Review Report

Following the design review, the applicant shall prepare and submit a design review report to the Primary Operator and ATE. The report shall contain the following elements:

- A record of all agreed action items, due date and assigned responsibility for follow-up purposes.
- A description of how the manufacturing process, its associated quality control and installation procedure will ensure that the performance objectives can be achieved in future unverified field installations.
- Available test results from tests conducted after the witnessed test period.

Any proprietary information in the report should be clearly stated and specifically identified. Proprietary information submitted with the report will be disclosed to the Satellite Operator and to appropriate outside personnel who are selected to participate in evaluating the design and performance of the items tested. In such cases, the Satellite Operator shall require that the

outside personnel keep proprietary information confidential to the same degree and in the same manner as the Satellite Operator personnel.

The Design Review Material should particularly address all aspects of the proposed system that impact the technical and operational integrity of the system's performance within the Satellite Operator system. The Primary Operator and ATE will analyze the Design Review Material and report its acceptability to the Applicant.

Typical Design Review Material Outline

1. General Description and Specifications
   a. General Description
   b. System Configuration
   c. System Capability
   d. Optional Features
2. Mechanical Structure and Design
   a. Overview of the Structure, including the mount. Rigidity of the mount, pointing accuracy, ease of locking in place without pointing error being introduced by tightening, cross-pol alignment, range and means of adjustment, etc. shall be considered.
   b. Design Approach
   c. Assembly Process
   d. Operating Conditions, including wind loading analysis and/or measurement, survival and operating.
   e. Environmental Requirements and Constraints
3. General Electrical Specifications
   a. Performance Characteristics (Design Objectives)
   b. Performance Variations
      1) Nominal Expected Value:
      2) Standard Deviation:
      3) Maximum and Minimum Values
      4) The effects of interfacing this equipment with other components, e.g., blockage, mechanical distortion and stress; the effect on other RF equipment and mechanical integrity of other components or sub-systems with which the unit may be integrated

4. Quality Control Procedures
   a. Summary Description of Quality Control (QC) Plan
      1) production quality standards
      2) long-term maintenance quality standards
         (Refer to national/international standards of QC such as ISO 9000)
   b. Detailed Description of QC Process for Production and Testing
      1) objective electrical performance given the specified manufacturing tolerance
      2) objective electrical performance given the achieved manufacturing tolerance
      3) indicate number of units subjected to process
      4) provide justification for sampling strategy
   c. Detailed Description of Electrical Performance Maintenance
      NOTE: The manufacturer shall provide the procedure for maintenance of the electrical performance. This is a function of manufacturing complexity, required tolerances, and rate of production. The ATE and Primary Operator reserve the right to comment on the proposed maintenance process, and to require additional verification procedures. An analysis of the mechanical margins and tolerances of each major component, with a prediction of the range of deviation from nominal should be included.
      1) percent inspection of each sub-assembly
      2) percent range and bench testing of components
      3) justification for given percentages

d. Detailed Description of Improvement or Changes
    1) description of adjustment of manufacturing tolerances
    2) justification for production, testing, and maintenance of revised performance, including details of how the manufacturing techniques, assembly, installation and quality control procedures will ensure that the performance objectives can be achieved in future, unverified units installed in the field.
e. Procedures for inspection of sub-assemblies and assemblies (if available):
    1) visual inspection as well as inspection with tools
    2) identification of parts
    3) data sheets for data entry and reduction
    4) illustrations to facilitate inspection process
    5) analysis process for inspection data
    6) criteria for rejection
    7) rejection and disposal process
f. Supporting Data
    1) parts list
    2) hardware/tools list
    3) foundation structure
    4) site selection

5. Installation Requirements
    a. Shipment and Storage Requirements
    b. Scope of Assembly Processes
    c. Skill Level Requirements for Installers
    d. Installation Procedures
        1) overview
        2) contact information for customer assistance
        3) installation pre-requisite checklist
            a) antenna foundation
            b) shipment inspection
            c) list of tools needed for inspection
        4) unpacking instructions
        5) instructions and illustrations for installation of assemblies and sub-assemblies
            a) safety notices for handling large, heavy, or electrical components

6. Phase I Test Plan
    a. Scope of Tests
    b. Description of Tests
7. Phase II Test Plan
    a. Scope of Tests
    b. Description of Tests
8. Long Term Quality Assurance (if not already covered by ISO9000 – see above)
    a. Program of periodic retesting of field or sample units, review of lifetime of similar products, or accelerated lifetime testing, as appropriate, to include effects of all environmental factors such moisture, UV, sunlight, wind, sand, salt spray, etc.
    b. Manufacturing Equipment Maintenance and Calibration
    c. Corrosion resistance; selection of materials and coatings for design lifetime; maintenance instructions.

4 TEST REQUIREMENTS

The Applicant will be requested to perform a series of tests sufficient to demonstrate the compliance of the characteristics of the Antenna Model or Earth Station Model, or RF equipment with relevant satellite operator requirements.
The tests will normally be performed in two phases, Phase I tests and Phase II tests.

4.1 Objective

The Applicant must demonstrate through testing on suitable facilities, that the technical characteristics of the Antenna Model or Earth Station Model, when assembled in the field, meet or exceed the requirements specified.

4.2 Test Procedures

4.2.1 General

The Applicant will develop and submit a test plan along with test procedures. It is essential that the following principles be applied:

1. The proposed tests should address all applicable mandatory requirements.
2. The test plan shall include a test range capability report per section 4.2.2
3. The test plan shall include reference to the accuracy of each measurement, with respect to the performance specifications that the equipment is intended to meet.
4. The Earth Station Model shall be tested in as complete a system configuration as possible.
5. If a sub-system of a complete Earth Station model is tested separately, the applicant shall show how the results of the sub-system tests relate to the performance of the complete Earth Station Model.
6. Manufacturers are encouraged to extend the scope of the test program to include testing under environmental conditions consistent with the actual range over which the system is designed to operate.
7. Tests designed to demonstrate optional features shall be similar in scope to tests designed to satisfy mandatory requirements.
8. Applicant shall include proposed schedule and time line for completing tests.

IMPORTANT
The tests must be performed by the Applicant on suitable facilities in accordance with approved test procedures. Tests will not normally require access (transmission) to the Satellite Operator space segment.

4.2.2 Antenna Test Range Capability Report

The antenna test range capability report should include:

1. A description of the range facility.
2. Dimensions and characteristics of the source antenna(s) and source signal generating equipment.
3. A brief description of the means of operation of the transmitting end of the range and of the receiving end of the range should be included.
4. Summary of the dynamic range and accuracy of gain, pattern, and polarization discrimination measurements (and/or axial ratio, as appropriate).
5. Description and results of any periodic re-characterization of the ranges, due to changes such as equipment calibration, or changes in foliage, buildings, or ground surface near the path.
6. A description of the range characterization, including the measurement technique used, the results of those measurements and a summary description of the results. The tests should cover any relevant frequencies of operation that are used for the type approval.
7. Any relevant measurement data should be included, such as:

a) Dimensions of quiet zone.
b) Amplitude flatness and roll-off over the quiet zone.
c) Polarization discrimination, across the frequency band of interest, of all source feeds used.
d) Include all polarization senses.
e) Description of any shortcomings, limitations, interference or reflections inherent on the test range that may cause anomalies in antenna measurement data

4.2.3 Representative units

Tests should be performed on "typical" units. The typical unit should be identical to the production line unit in all performance characteristics and should be representative of units to be installed in the field.

4.3 Phase I And Phase II Test Requirements for GSOA MRA Testing

These tests are designed to allow complete evaluation of the equipment performance against the specifications for SSOTA for any satellite operator member of the GSOA.

Phase I and Phase 2 tests are the same. The manufacturer performs both. Phase 2 tests, however, are witnessed by the ATE and, optionally, the Primary Satellite Operator.

4.3.1 Antenna Model Tests

4.3.1.1 Transmit And Receive Band Antenna Gain Measurement

The objective of this test is to determine the antenna gain over the required transmit and receive frequency ranges. The antenna gain should be measured at low, mid, and high frequencies over the transmit and receive frequency bands.

4.3.1.2 Sidelobe Pattern Test

This test shall verify the antenna pattern sidelobe gain characteristics for transmit and receive frequencies. These tests must be performed for both polarizations (LHCP and RHCP or Vertical and Horizontal).

4.3.1.2.1 Angular Range of Pattern

1. Extreme near-in should cover ±2 to ± 10 times the 3-dB beamwidth for both co- and cross-pol.
2. Near-in should cover ± 10 to ± 25 times the 3-dB beamwidth for both co- and cross-pol.
3. Wide-angle azimuth cuts should cover ± 90° to ± 180° for co-pol only.
4. Wide-angle elevation cuts should cover ± 45° to ± 90° for co-pol only.

4.3.1.2.2 Transmit and Receive Band Radiation Patterns

1. When 3-dB and 10-dB beamwidths are used for calculating gain, extreme near-in co-polarized patterns should be measured for both azimuth and elevation plane cuts for each of two orthogonal polarizations at low, mid, and high frequencies over the transmit and receive bands.
2. Near-in co-polarized patterns should be measured for both azimuth and elevation plane cuts for each of two orthogonal polarizations at low, mid, and high frequencies over the transmit and receive bands.
3. Near-in cross-polarized patterns should be measured for both azimuth and elevation plane cuts for each of two orthogonal polarizations at low, mid, and high frequencies over the transmit and receive bands.
4. Cuts other than principal planes may be required, where the polarization and/or the antenna

RF axis are rotated, depending upon the configuration of the antenna, as may required by the target operator(s). (e.g. +/- 20 degrees)
5. Wide-angle co-polarized patterns should be measured for both azimuth and elevation plane cuts for each of two orthogonal polarizations at the mid-band transmit and receive frequency.

4.3.1.3 Cross-Polarization Isolation or Discrimination Contours

Although satisfaction of this specification is partially demonstrated by the cross-polar radiation patterns, further measurements are required. Cross-polarization isolation or discrimination should be measured at multiple frequencies at the signal beam peak and at defined near-in off-axis angles.

Satellite operators may specify criteria for:

- Isolation, discrimination, or voltage axial ratio (see glossary for distinction)
- Off-axis test angles, such as the pointing accuracy (typically 0.5 dB in the principal planes and 1 dB in the 45-degree planes), or the 0.5dB or 1.0dB gain-reduction angles.
- Polarization scheme, such as circular or linear.

The measurements made must cover the combination the above criteria required to demonstrate compliance with all of the Satellite Operators' standards for which approval may be sought.

For circularly polarized antennas, cross-polarization discrimination performance may be calculated from equivalent swept or point voltage axial ratio measurements.

Conversion from isolation to discrimination may be made by correcting for the reduction of co-polar gain at the test angles.

a. Basic measurement
Isolation contours which show measured cross-polar levels at discrete points near the beam peak at three or more frequencies over the transmit and receive bands are recommended.

b. Advanced measurement
If the antenna is intended to meet a polarization isolation specification of better than 27 dB, then its polarization isolation should be measured:
- over a far-field pattern range
- on a swept (or stepped, with a minimum of 20 spaced points) frequency basis
- both on- and off-axis
- for transmit and receive frequency bands
- at a 9-point rectangular pattern around the main beam, where the step size is the defined test angles. By default, step sizes of corresponding to 0.5dB (and optionally, in addition, 1dB) should be used.

4.3.1.4 Feed Measurements

The following measurements should be performed on the complete feed system, including two or four-port orthogonal mode transitions (OMTs), polarizers, waveguide transitions, circular waveguide extensions, and feed horn:
1. Co-polar and cross-polar primary radiation patterns
2. Swept frequency of transmit and receive band return loss for each feed port
3. Swept frequency of transmit and receive band port-to-port isolation for four-port feeds
4. Swept frequency of transmit-to-receive band isolation for each transmit port to each receive port
5. Swept frequency of transmit and receive band polarization discrimination or axial ratio, for each feed port
6. Swept frequency of transmit and receive band insertion loss for each feed port (may be done without feed horn)

4.3.1.5 Antenna Pointing/Tracking Accuracy and Beam Steerability Test

When the Antenna is equipped with automatic or manual steering capability, this test shall verify that the antenna beam is capable of being steered to and tracking the desired satellite.

4.3.1.6 Pattern Requirements for Antennas with Changing Main Beam Patterns vs. Scan

The reporting requirements up until now cover traditional antenna types where only a singular fixed pattern (at each frequency) is needed to describe its operation. Modern antenna technology includes a whole different class of architectures whose patterns change as the main beam is scanned in either Azimuth or elevation. For this class of antennas, a more thorough characterization is needed to fully characterize antenna performance and its potential contribution to adjacent satellite interference. This special class of antennas can generally be grouped into one of two subcategories described in the section to follow.

4.3.1.6.1 Sub-Categories of Antennas Whose Patterns Change with Main beam Scan

A. Top Mounted Gimbaled Fixed Beam Apertures
The first subcategory of antennas scans its main beam by mechanically steering via some type of mechanism. This mechanism could be the gimbal used to directly point and scan the main beam or perhaps a feed/horn which then illuminates a reflector surface. In either case, main beam scanning is achieved by mechanically steering the direct ray path to its intended target satellite. This class of antennas radiates patterns that change as the main beam scans in elevation, but the patterns generally always exhibit azimuth symmetry. Some examples include porch-swing reflectors, dual panel arrays, and motorized Cassegrain antennas.

B. Conformal Top-Mounted Phased Arrays.
In contrast to top mounted gimbaled fixed beam apertures, conformal top-mounted phased arrays achieve main beam steering by fundamentally changing the phasing of its individual radiator elements. In electronically scanned arrays (ESA), this is done through a beam steering controller that adjusts individual phase shifters located at the base of each radiator. Also included in this category are VICTS antennas that mechanically rotate individual platters in such a fashion to electronically steer the main beam. Phased arrays have patterns that change in elevation (and sometimes Az) and generally do not exhibit azimuth symmetry.

4.3.1.6.2 Pattern Reporting Requirements

The Global Satellite Operators Association recognizes the challenges presented by modern antenna technology, particularly those whose patterns change with main beam scan as described in 4.3.1.6.1.

The traditional cardinal plane cuts normally supplied for dish type antennas must be updated to reflect modern antenna technology which is ever changing due to emerging technologies. In today's world, taking two cardinal plane cuts is many times insufficient to fully reveal the operational weak points where an antenna's radiation patterns might be contributing to adjacent satellite interference. Thus, the best way for antenna manufacturers to gain confidence with satellite operators is to provide full hemispherical radiation patterns. These types of plots reveal much more than traditional cardinal plane cuts can, especially when the antenna is skewed away from the cardinal planes. Another reason to provide full hemispherical pattern plots is the traditional E/H-plane pattern cuts taken for antennas whose mechanical boresight do not point directly to the target satellite (i.e. Class B) do not hold the same meaning as it does for on-axis antennas (Class A). The satellite industry has traditionally allowed ϕ-cuts as measured in a far-field range to approximate Geostationary Plane (ie. GeoPlane) cuts, greatly reducing pattern reporting requirements. However, GeoPlane pattern cuts for Class B antennas must be precisely calculated using a generalized vector approach, and this calculation must start from a full hemispherical pattern plot.

These full hemispherical pattern plots may be taken in either a far-field or near-field range. Whichever range is chosen, the far-field pattern resolution shall be no coarser than $1/10^{th}$ the 3-dB beamwidth along a particular direction. For example, if the AUT is measured in a far-field range and has a 3-dB beamwidth of 2º along θ and 3º along ϕ, then the plots should be

sampled no coarser than 0.2º in θ and 0.3º in ϕ. The hemispherical pattern plots should cover both the forward and back hemispheres if the AUT's characteristic includes some expected spillover such as in a traditional dish antenna system.

Table 3. Near-Field and Far-Field Range Resolution Reporting Requirements

variable	Far-field range	Near-field range
(ϕ,θ) typical in far-field ranges	0:dθ:180°, dθ ≤ 0.1*$BW_θ$ 0:dϕ:360°, dϕ ≤ 0.1*$BW_ϕ$	same as (ϕ,θ) criteria for far-field range.
kx=sin(θ)*cos(ϕ) ky=sin(θ)*sin(ϕ) typical in near-field ranges	not used in far-field ranges	Adjacent points in lattice must be no coarser than 0.1*BW_x or 0.1*BW_y, respectively.

The table above constitutes resolution requirements for a single hemispherical pattern plot. Because these special antenna types can change patterns and characteristics vs. main beam scan as well as other parameters such as frequency and polarization, the following guidelines were prepared to ensure high fidelity data over the AUT's full range of expected operational use. The GSOA group requires full hemispherical pattern plots multiplexing the parameters shown in Table 4.

Table 4. Full Pattern Plot Parameters to Multiplex

Parameter	Requirement
elevation (must declare range of AUT)	15, 30, 45, 60, 75, 90° (depending on declared operational range)
frequency	low, middle, high
polarization	V, H, 45°
Radome orientation (in Az) wrt AUT	0, 90, 180, 270° for non-surface-of-revolution radomes
sample size to test manufacturing repeatability	3 production antennas; first unit should be characterized thoroughly while next two units tested to show unit-to-unit repeatability (see section 4.3.1.6.3)

4.3.1.6.3 Pattern Reporting Requirements

Because most antenna systems operate in the field with a radome, the GSOA group requires all testing be performed with the radome installed. Radome types will be classified into two distinct categories depending on whether they can be classified as a surface-of-revolution type radome. A surface-of-revolution radome is one in which its 3D model can be formed by taking a 2D curve and revolving it around a fixed axis 360°. Radamés which cannot be classified as a surface-of-revolution radome must further multiplex radome Azimuth orientations of 0°, 90°, 180° and 270° (wrt the aperture) into the testing requirements shown in Table 4. **Note that this requirement extends to traditional dish antennas as well.** While many dish based systems utilize surface of revolution type radome, the overall system response when configured with the radome will show some variance over Azimuth owing to reflections off the radome and the ensuing multipath so it is important to characterize this variation.

4.3.1.6.4 Dataset Management & Permissible Exemptions

The Global Satellite Operators Association primary goal is to protect satellite operators from noncompliant earth station terminals causing adjacent satellite interference issues. Simultaneously however, this must be balanced against antenna manufacturers needs to keep testing/reporting requirements down to a manageable set. The GSOA group recognizes that multiplexing all variables shown in Table 4 can lead to hundreds if not thousands of full

hemispherical pattern plots. The size of such a package is impractical and allowances must be made to reduce the dataset where it is sensible to do so. As such, the group permits proper reduction in the dataset in certain cases:

1. The back hemisphere (|θ|>90 º) may be omitted for apertures who directly forward radiate energy towards their intended target and inherently have no fundamental leakage out the backside (ie. reflector spillover). In many cases, these forward radiating antennas are mounted on top of a ground plane (ie. on top of a car or aircraft) that further eliminates any possibility of backward radiation. Such an exemption is also needed when a near-field range is used for measurements because near-field ranges inherently only provide accurate forward hemispherical patterns and are not well adapted for precise backside radiation patterns.

2. If an antenna can be shown to exhibit minimal artifacts (sidelobes, grating lobes, etc.) away from the main beam area, then the resolution reporting requirements (ie. dϕ and dθ in Table 3) away from the main beam can be relaxed to 5deg increments for angles between 10° and 180° off-axis from the main beam peak. Such antennas must first show full hemispherical pattern plots with sufficient resolution as specified in Table 3 at center band before this allowance can be made.

3. If the antenna patterns are benign over frequency, showing no additional interesting or harmful artifacts over the band, then it is permissible to reduce frequency reporting requirements to just center band. Such an antenna must first show through full-hemispherical pattern plots with sufficient resolution at the band edges and demonstrate that the beamwidths follow expected frequency scaling behaviors.

4. At least three units should be tested to help characterize unit-to-unit variation. The first unit should be characterized as thoroughly as possible over the parameters shown in Table 4. The next two units should be used to show the consistency between units in the most important antenna metrics (Gain, first adjacent sidelobes, overall pattern quality, etc.). The GSOA group reserves the right to request testing of additional metrics as needed to help characterize repeatability on a particular antenna's stress points.

5. As noted in Table 4, antenna manufacturers must declare the operational range of the antenna to permit testing over a reduced set of elevation angles. To the extent the pointing of a particular antenna product is controlled via software, the antenna manufacture must demonstrate this range will not be exceeded in the software control.

4.3.2 Earth Station Model

In addition to the Antenna Model GSOA MRA tests, the following measurements are required for Earth Station Model GSOA MRA testing:

4.3.2.1 Receiving System: Figure of Merit (G/T) Test

This test shall verify that the receive gain and figure of merit meet the requirements specified in the Earth Station performance documents.
1. Low-noise receiver (LNA/LNB/LNC) noise temperature should be measured over the frequency bands of interest.

2. Low-noise receiver (LNA/LNB/LNC) gain vs. frequency response should be measured over the frequency bands of interest.
3. Total system temperature elevation profiles should be measured at five or more frequencies over the band of interest for various elevation angles (ranging from 5° to 50°), referenced to the

low-noise receiver (LNA/LNB/LNC) input port where it connects the OMT or filter at each receive port.

4. The gain–to–system noise temperature ratio ("G/T"), referenced to the low-noise receiver (LNA/LNB/LNC) input port, will be measured over the frequency bands of interest. If antenna receive gain has already been measured according to section 4.3.1.1, then G/T may be calculated using system temperature data from point 3 above.

4.3.2.2 Transmit e.i.r.p. power and frequency Stability Tests

If transmit RF equipment is supplied with the Earth Station Model, then the transmit e.i.r.p. power and frequency stability shall be measured. Transmit amplifier/converter gain and conversion frequency drift must be demonstrated over time and temperature variations.

The manufacturer's specified temperature range (e.g. +50C to –40C) with a 10 degree/hour gradient should be tested, cycling over a 12-hour minimum period.

The manufacturer-recommended or included IF cable of maximum rated length shall be included in the test and shall be subjected to the temperature variations.

If a reference frequency signal is provided by an indoor unit, the type of indoor unit shall be defined and a typical unit used for the test.

With constant input signal power and frequency, and with the output signal at the minimum rated transmit power or in small-signal mode, the transmitter output signal level and frequency.

Power measurement accuracy should be +/- 0.1dB relative to the initial measurement. Frequency accuracy should be +/- 100 Hz.

4.3.2.3 Spurious oscillation tests

This test measures unintended oscillation of the transmitter or HPA. The test procedure shall be defined as part of design review, with the following as an example:

With the transmitter at the lowest rated operating temperature, connect a coupler to the output, followed by a low-loss tuner device. The tuner shall be capable of creating an impedance with any phase angle and any magnitude (up to the equivalent of 0.3 dB return loss), at any frequency at which the internal RF amplifiers have positive gain. The coupler shall be connected to a spectrum analyzer set to maximum sweep range TBD.

While adjusting the tuner device, observe the spectrum analyzer for any oscillation or increase in noise floor.

The test should be made at the minimum operating temperature of the HPA. If the HPA has a built-in output isolator, then the tuner device may be omitted from the test.

4.3.2.4 Amplitude Response

Transmit amplifier gain vs. frequency over the bands of interest should be measured to verify the amplitude and frequency response of the amplifier.
It is recommended that a minimum of three frequencies at three power levels be measured at ambient temperature. Extreme temperatures can be measured at mid band only. The power levels include the maximum operating power level, –3dB and –6dB back off levels. The measured frequencies will include points in the low, mid and high band.

4.3.2.5 RF and Spectrum Tests

4.3.2.5.1 General Radio Frequency Requirements

This test of capability is designed to verify that the Earth Station Model complies with the bandwidth and the frequency bands of operation for the standards for which Satellite System Operator Type Approval is desired.

4.3.2.5.2 Emission Constraints Test

The emission constraints test should show that the Earth Station Model complies with spurious emission requirements of the Satellite Operator(s) by calculation from antenna pattern data, when used with an ideal modulator.

4.3.2.6 Spurious Emissions - Sidebands

This test will characterize spurious emissions close to the carrier but outside the allocated bandwidth. If national/regional specifications exceed the requirements of the desired SSOTA, then data previously taken to demonstrate compliance with those standards may be used to fulfill this requirement.

This test is to be performed for:

- Lowest manufacturer-rated operating power
- Highest manufacturer-rated operating power

At three frequencies:

- Low, mid, and high end of the operating band

With the carrier operating in CW (unmodulated) and continuous (non-burst) mode, measure all spurious signals outside the minimum allocated bandwidth up to +/- 10 times the maximum allocated bandwidth. Verify that each spurious signal follows the carrier frequency; if not, it is classified as a General spurious emission. Measurement accuracy shall be +/- 1dB. Measure all spurious signals that exceed –70dBc.

4.3.2.7 Spurious Emissions – General

This test characterizes wideband spurious emissions. If national/regional specifications exceed the requirements of the desired SSOTA, then data previously taken to demonstrate compliance with those standards may be used to fulfill this requirement.

4.3.2.7.1 Spurious Emissions – Carrier-related

Enable the carrier at the maximum rated transmit power in CW (unmodulated) and continuous (non-burst) mode. Gradually adjust the carrier frequency from the low end of the operating band to the high end. Note any spurious signal which exceeds –70 dBc and characterize the behavior of its frequency Fs with respect to the carrier frequency Fc according to the formula:

$$Fs = a.Fc + b$$

Also calculate, verify, and note if the spurious signal crosses the carrier signal (i.e. there exists an Fs within the operating band for which Fc = Fs).

Spurious signal number	a	b (MHz)	Worst case level dBc	Crossing frequency (if any)
1				
2				
etc.				

4.3.2.7.2 Spurious Emissions – Carrier-independent

Disable the IF carrier. Measure all spurious signals in the manufacturer's rated satellite band that exceed –70 dBc from the minimum rated transmit power.

4.3.2.8 Transmit e.i.r.p. power and frequency stability tests

Perform tests to verify EIRP and frequency stability of the terminal over time and temperature.

The recommended temperature range of +50 to –20c with a 10 degree/hour gradient should be tested, cycling over a 12-hour minimum period.

The manufacturer-recommended or included IF cable of maximum rated length shall be included in the test and shall be subjected to the temperature variations.

Measurements shall be made at the minimum and maximum rated transmit powers. Automatic Level Control, compression limiting, master station feedback, or equivalent methods may be enabled in the transmitter provided that all associated equipment required for operation is defined and is used in the field.

The transmitter output signal level and frequency should be recorded.

Power measurement accuracy should be +/- 0.1dB relative to the initial measurement. Frequency measurement accuracy should be 100 Hz.

4.3.2.9 Spurious oscillation tests

Conduct tests per section 4.3.2.3. This test is not required to be repeated if spurious oscillation tests were performed on the RF components as an Earth Station Model.

5 PHASE I TESTS

5.1 Evaluation of Phase I Test Results

Upon completion of the Phase I tests, the Applicant will prepare and submit a Phase I test report to the Primary Operator or GSOA/ATE.

The Primary Operator or GSOA/ATE will:

(i) Review the test results for compliance with the requirements in this document for MRA Testing.
(ii) Review the test results for compliance with the requirements for Satellite System Operator Type Approval

If they are found to be complete and indicate compliance with the relevant Satellite Operator requirements, the Primary Operator or GSOA/ATE will notify the applicant. Coordination for the Phase II process may commence only after this notification.

5.2 Typical Phase I Test Report Outline

1. Scope of Tests
2. Description of Tests
3. Test Procedures
    a. Measurement Approach
    b. Test Equipment
    c. Test Set-Up
    d. Measurement Procedures
4. Test Results Analysis
    a. Test Results Summary in a format similar to that shown in Table 1 (for Antenna Models) or equivalent (for Earth Station Models).
    b. Computation Technique for Verifying the Test Results
    c. Analysis of Tests Results
5. Presentation of Test Results
6. Conclusion

Table 1 Phase 1 Test Results Performance Summary (Antenna Model)

TRANSMIT

PARAMETER	MANDATORY PERFORMANCE		MEASURED PERFORMANCE		
TRANSMIT SIDELOBE					
TRANSMIT GAIN			Gain(dBi)	Freq. (GHz)	Efficiency (%)
LHCP or Horizontal	none				
RHCP or Vertical	none				
TRANSMIT ISOLATION	Minimum[1]	Average	Minimum[1]	Average	
LHCP or Horizontal					
RHCP or Vertical					

[1] Indicate page or chart number from which this minimum is derived.

RECEIVE

PARAMETER	DESIGN OBJECTIVE		MEASURED PERFORMANCE		
RECEIVE SIDELOBE					
RECEIVE GAIN			Gain(dBi)	Freq. (GHz)	Efficiency (%)
LHCP or Horizontal					
RHCP or Vertical					
RECEIVE ISOLATION	Minimum[1]	Average	Minimum[1]	Average	
LHCP or Horizontal					
RHCP or Vertical					

Antenna Temperature		K @ 10^{O} elevation		K @ 10^{O} elevation

[1] Indicate page or chart number from which this minimum is derived.

Where appropriate, statements should be included to explain how the certified values were derived, e.g., averages, median, averages of averages, averages of minimal, etc. Tables used to derive these values should be identified for easy review and verification, e.g., the average value of isolation is the average of the minimum values for each of the nine points measured; the minimum value is the smallest of these numbers.

6 PHASE 2 TESTS AND DATA PACKAGE SIGN-OFF

The objective of verification testing is to measure the repeatability of the performance characteristics of the Antenna Model or Earth Station Model.

The tests are designed to verify that, under operational conditions, every SSOTA Antenna Model, or Earth Station Model, assembled in accordance with the instructions described in the GSOA MRA test documentation, will meet the applicable mandatory Satellite Operator requirements.

6.1 Phase 2 Testing

Phase 2 tests for Antenna Models or Earth Station Models are the same as the Phase 1 tests defined in Section 4. Appropriate tests may be added to the test plan to verify optional capabilities.

At least **three units**, representative of typical production units, assembled in accordance with a defined set of instructions that will form part of the GSOA MRA test documentation, will be selected at random and used in the Phase II testing in order to ensure adherence to the GSOA MRA test specifications.

Phase 2 testing shall be witnessed by the Authorized Test Entity (ATE), and optionally, by the Primary Satellite Operator. The ATE and/or Primary Satellite Operator may choose the selection and assembly configuration options of units to be tested.

6.2 Phase 2 Test Report and ATE Sign-Off

The results of Phase 2 Testing shall be recorded in the Phase 2 Test Report and must be signed by the ATE. The ATE's signature represents certification that the Phase 2 measurements were accurate and complete according to this document.

The Phase 2 Test Report shall include:

- List of the Tests
- Test Procedures
- Raw Data
- Reporting and Analysis of Test Results
- Test Results Summary in a Format Similar to Section 5.2

The manufacturer shall incorporate the Phase 2 Test Report into the MRA Test Data Package.

6.3 Data Package ATE Sign-Off

After incorporation of the Phase 2 Test Report, the ATE shall review the entire MRA Test Data Package for completeness. The ATE's signature represents certification that the data package is complete according to this document.

7 FINAL SSOTA REPORT

Upon completion of the Phase II tests, the Applicant must submit a final report specifically addressing the performance specifications of the Primary Operator. Section 7.2 provides a typical final report outline. The report shall:

1. Include a copy of the MRA Test Data Package, signed off by the ATE.
2. Indicate how the test results, and the analysis thereof, lead to a determination of the performance characteristics of the model under test.
3. Provide details of the measurement procedures, and show how (and why) the raw data is processed to obtain specified performance characteristics. Calculations should be clearly shown, together with conclusions.
4. Analyze the variation of each measured characteristic observed during the verification tests in conjunction with the design review value.
5. Include procedures required for on-site installation and adjustments necessary to ensure compliance.
6. Include the Applicant's certification that the tests have been conducted according to the approved procedures and that the Antenna Model or Earth Station Model meets the SSOTA requirements. A certification form is given in Section 8.
7. Include the results of each test, including any previous test results that may have been unsuccessful.
8. Contain a description of design or component changes made during the course of testing together with the purpose and justification for each change.

7.1 Evaluation of SSOTA Final Report

The Satellite Operator or GSOA/ATE will review the final report to ensure that it is complete and indicates compliance with the applicable Satellite Operator requirements.
If the system for which SSOTA is sought fails to meet any of the mandatory performance requirements, the Satellite Operator or GSOA/ATE will advise the Applicant of the area in which the performance is lacking and will request corrective action and future retest, before proceeding with the SSOTA process.

7.2 Typical SSOTA Final Report Outline

A. MRA Test Data Package
   1) Design Review Report per section 3.2.
   2) Phase I Test Report
   3) Phase II Test Report
B. Applicant Certification according to Section 8.

8 MANUFACTURER'S CERTIFICATION FOR SSOTA

The certification required for SSOTA is shown below and must be submitted as part of the final report.

Testing undertaken for certification and SSOTA will be witnessed by:
1. A representative from the Satellite Operator's organization or,
2. A certified test witness appointed by the Satellite Operator.

GSOA MRA testing may be undertaken at an independent and certified test agency using an accredited test facility that is acceptable to the Satellite Operator. The test results shall be certified by the test agency and submitted to the Satellite Operator.

8.1 Applicant Certification

The Applicant hereby certifies:

1. That all tests have been made according to the procedures in GSOA-101.
2. That all test results are included in the GSOA MRA Test Data Package and have been witnessed and approved as accurate and complete by a GSOA Authorized Test Entity.
3. That the GSOA MRA Test Data Package will be archived for later reference by the GSOA.
4. That future Antenna Models or Earth Station Models manufactured with the same design will meet the applicable requirements defined in the Satellite System Operator Type Approval.
5. That each system manufactured or assembled with the same model number will be of the same design as that upon which the tests were performed.
6. That each system manufactured or assembled with the same model number will be tested and certified using test procedures approved by the GSOA or Satellite Operator.
7. That each system manufactured or assembled with the same model number will meet the applicable mandatory Satellite Operator requirements.
8. That the GSOA or Satellite Operator will be notified of any changes, e.g., subsystem model changes, specification changes, etc. to the equipment included in this SSOTA.
9. That each system will be supplied with the installation and operation documentation.
10. Units will be tested according to the following sample plan (describe):

Manufacturing sample plan

NAME	
TITLE	
DATE	
ADDRESS	
TELEPHONE #	
FACSIMILE email	

Signature: _____

9 SATELLITE SYSTEM OPERATOR TYPE APPROVAL (SSOTA)

9.1 Certificate

When the final report indicates full compliance with the applicable requirements, the Satellite Operator or GSOA will:

1. Issue an SSOTA certification to the Applicant in the form of the example (GSOA/Intelsat type approval for Ku band) in Table 2.
2. Assign a unique "SSOTA IDENTIFICATION NUMBER".

Table 2 Satellite System Operator Type Approval Certificate Example

<Date>

To <*Applicant name*>
<*Company name and address*>

Subject: Type Approval of <*Description of the antenna and of the relevant standards*>

Reference: _____.

We are pleased to inform you that effective <*day month year*> the <*description of the antenna*> is hereby granted approval as a GSOA/INTELSAT type approved Antenna Model (GSOA/I*AnnnAAA*) to operate on the Intelsat Satellite System. Our examination of the data submitted confirms compliance with IESS- 601 for standard G Antenna Models.
Antenna Model certified by <*Company name*>:

1.0 Manufacturer:

2.0 Antenna Details:

3.0 Approval code: GSOA/I<*AnnnAAA*>

4.0 Approval date: <*day month year*>

5.0 Antenna size:

6.0 Standards:

7.0 Restrictions:

7.1 Operation of Antenna Models using this Type Approved Antenna Model within a leased transponder must be in accordance with an approved transmission plan.

7.2 All new individual Antenna Models intended for operation under this Type Approval must be installed according to the manufacturer's specifications.

7.3. All new individual Antenna Models under this Type Approval must be equipped with the following components of <*Company name* manufacture:

Reflector part numbers:

- Main reflector
- Sub-reflector
-

<*n*>-Port Tx/Rx Feed Assembly part numbers:

- <*Type*> Horn
- Cross-Pol OMT with WR75 WG interface)

SSPA and LNB

- SSPA <*rating manufacturer and model*>
- LNB <*manufacturer and model*>

8.0 Performance characteristics from test results:

Transmit Gain, (Horiz Pol) (Normalized) Value at 14.25 GHz: *xxx* dBi, Efficiency: *xxx* %
Transmit Isolation, (Horiz Pol), Average @-1 dB contour: >-*xxx* dB, Minimum: -*xxx* dB

Transmit Gain, (Vert Pol) (Normalized),Value at 14.25 GHz: *xxx* dBi, Efficiency: *xxx* %
Transmit Isolation, (Vertical Pol), Average @- 1 dB contour: >-*xxx* dB, Minimum: -*xxx* dB

Receive Gain, (Hor Pol) (Normalized), Value at 11.70 GHz: *xxx* dBi, Efficiency: *xxx* %
Receive Gain, (Vert Pol) (Normalized), Value at 11.70 GHz: *xxx* dBi, Efficiency: *xxx* %

Receive G/T, calculated, (Vert Pol), Value at *xxx* GHz @ *xxx*° elevation with *xxx* K LNB: *xxx* dB/K

Side Lobe Level: 32 - 25 Log θ dBi until 26.3°

Maximum Operating Wind Speed: *xxx* m/s

Sincerely,

Signature name and address of the GSOA/Intelsat ATE

9.2 Modifications to MRA Tested Systems

Prior to modifying or adding new capabilities to an existing MRA tested and Operator Type Approved equipment, the Manufacturer should notify the GSOA MRA and all satellite operators who have issued SSOTA's for that equipment. The notification should include a detailed description of the changes and the manufacturer's assessment of the effect of those changes upon the performance of the original MRA tested system.

It is the responsibility of each satellite operator to notify the Applicant If the proposed modifications or changes are determined to require re-testing.

The Manufacturer will then be required to submit a test plan together with procedures for retest to demonstrate if and how the change will effect compliance with the applicable mandatory Satellite Operator requirements.
Any changes to the Data Package shall be approved by an ATE. Any retest shall be witnessed by an ATE.

Upon successful completion of retest, the Satellite Operator or GSOA will, if necessary, issue a new SSOTA certificate and a new SSOTA identification number or amend the existing SSOTA to document the change.

Partial verification tests may be required when a GSOA MRA tested Antenna Model or Earth Station Model is integrated with other hardware not included in the original GSOA MRA tested system, to form an operational Earth Station. These subsets of testing will normally be those not performed as part of the GSOA MRA testing, e.g., G/T and e.i.r.p. /frequency stability.

9.3 Monitoring

Because of system discipline requirements, any Satellite Operator who has issued an SSOTA may monitor for continued compliance with the applicable mandatory requirements. The Satellite Operator retains the right to require a review of the GSOA MRA testing or a repeat of on-site verification tests if there is evidence that field deployed units have become non-compliant or are experiencing operational problems.

10 GLOSSARY

Applicant	See **Manufacturer**
Antenna Model	Consists of the antenna reflector, the sub-reflector (if so equipped), the feed system including but not limited to the OMT, transmit-reject filter, and other passive components, the mount, and pointing devices.
Approving Agency	The entity granting the SSOTA for operation on a system or systems; typically the satellite operator or another entity authorized by the satellite operator or operators.
Approved Test Entity (ATE)	An organization or individual authorized by the GSOA T-WG to witness GSOA MRA Testing and to certify the completeness and accuracy of the measurement results and of the Data Package.
Cross-Pol Discrimination	The ratio of gain in a given polarization to gain in the opposite polarization, both at a given angle theta from the main beam. Theta = 0 implies on-axis; otherwise implies off-axis.
Cross-Pol Isolation	The ratio of gain in a given polarization on the axis of the main beam, to gain in the opposite polarization at a given angle theta off-axis from the main beam.
Data Package	See **MRA Testing Data Package**
Earth Station Model	An Antenna Model together with attached RF equipment, such as LNA, LNB, or LNC, transceiver, block-upconverter, HPA, SSPA, RF head, or ODU, which is (a) attached or adjacent to the antenna, and (b) implements frequency conversion and amplification. Redundancy switching equipment may be included. The inter-facility link (IFL) cabling must be included or defined.
GSOA	Global Satellite Operator Association
GSOA MRA Testing (or MRA Testing)	The process of gathering design and quality control information and a regime of sample testing which results in a MRA Testing Data Package. MRA Testing does not require evaluation of the equipment performance against any particular specifications; however, it is intended to achieve complete and accurate results which may be used by any satellite operator to decide on issuance of an SSOTA without further measurements.
GSOA MRA WG	Global Satellite Operator Association Mutual Recognition Arrangement Working
Low Noise Amplifier (LNA)	An active device that when combined with an appropriate antenna is used to amplify signals received from a satellite.
Manufacturer	The organization which is responsible for configuration and quality control of the equipment undergoing GSOA MRA testing and Satellite System Operator Type
MRA Testing Data Package	The results of Phase 1 and Phase 2 measurements, witnessed and signed by an Authorized Test Entity, together with the manufacturer's Design Review materials.
Polarization Discrimination	See **Cross-Pol Discrimination**
Polarization Isolation	See **Cross-Pol Isolation**
Primary Operator	The satellite operator who oversees the GSOA MRA Test process and who is first
Satellite Operator	The organization which is responsible for management of transponder resources on a designated set of satellites, and which fulfills the obligations of an operator of a communications space station under the regulations of the national laws and/or international treaties applicable to that organization.
Satellite System Operator Type Approval (SSOTA)	An approval given by a specific satellite operator for use of designated equipment on that operator's satellites with limited or no on-site verification testing. SSOTA is granted based upon evaluation of the design and satisfactory completion of tests that demonstrate that the design meets the Satellite Operator requirements.

Secondary Operator	A satellite operator, other than the Primary Operator, who is applied to by the manufacturer after completion of the MRA Testing process.
XPD	See Cross-Pol Discrimination

11 AUTHORIZED TEST ENTITY (ATE) SELECTION PROCESS

The GSOA MRA Test Entity Selection Process is as follows:

Any GSOA Member may nominate a candidate at any time. Candidates may be individuals or organizations. To make a nomination, the nominating GSOA Member shall submit the following information via email to the Chair of the Technology Working Group (T-WG) regarding Mutual Recognition Arrangement (MRA) matters.

- Organization or individual name
- Contact information including telephone and email
- Brief summary of nominee's experience, the applicability of the experience to MRA Testing, and resources (such as personnel and facilities) that the nominee has available.

The nominee shall also make detailed information available to GSOA satellite operator members on request by email and telephone.

The (T-WG) Chair will circulate the nominations to all GSOA satellite operator members, with copies to MRA Working Group members. The GSOA VP MarCom & Membership shall provide the complete list of GSOA operator member contacts to the (T-WG) Chair. The (T-WG) in conjunction with the GSOA VP MarCom & Membership will accept and count votes by email, fax, or mail. GSOA Satellite Operators may vote "yes", "no," or "abstain" as regards the candidate test entity's competency in each MRA equipment level, i.e. Antenna model and/or Earth Station Model.

If more information is needed, it is the responsibility of the voting Satellite Operator to contact the nominee directly.

If more information is needed regarding a test entity, the test entity or their sponsor will coordinate the preparation and submission of a proposal, which will be made directly to the other GSOA Satellite Operators.

For each equipment level, final approval of a test entity requires a unanimous vote by all GSOA satellite operators. Abstention from a vote is registered as approval of the test entity. If a satellite operator does not vote within 45 days after notification by the T-WG) Chair then their vote shall be counted as an abstention.

A nominee who does not receive approval by vote may be renominated.

Manufacturers have veto power in assignment of the Authorized Test Entity by the satellite operator for each SSOTA process.

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