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Volume I - ESOG Module 120 - Issue 4.0
ANTENNA AND VSAT TYPE APPROVALS
30 July 2008

EUTELSAT S.A.

SYSTEMS OPERATIONS GUIDE

ESOG Module 120

ANTENNA AND VSAT TYPE APPROVALS

Issue 4.0

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FOREWORD

The Eutelsat S.A. Systems Operations Guide (ESOG) is published to provide all Eutelsat S.A. space segment users with information that is necessary for successful operation of earth stations within the Eutelsat S.A. satellite system.

The ESOG consists of 2 Volumes. They contain, in modularised form, all the necessary details, which are considered important for the operations of earth stations.

Volume I concentrates on Earth Station and Antenna Approvals, System Management and Policy aspects.

Volume II describes the initial line-up of satellite links between earth stations and the commissioning of earth stations for Eutelsat S.A. services. The modules which are contained in this Volume relate to the services provided via Eutelsat S.A. satellites

The ESOG can be obtained either by requesting a printed version to Eutelsat S.A. or in Acrobat format from the Eutelsat S.A. Web:

<http://www.eutelsat.com>

Paris, 30-07-2008

OVERVIEW ESOG MODULES

VOLUME I

EUTELSAT S.A. SYSTEM MANAGEMENT AND POLICIES

Earth Station Standards.....	Module 100
Earth Station Access and Approval Procedures.....	Module 110
Earth Station Type Approval.....	Module 120
Earth Station Verification Assistance (ESVA).....	Module 130
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VOLUME II

EUTELSAT S.A. SYSTEMS OPERATIONS AND PROCEDURES

Digital Services Handbook.....	Module 210
VSAT Handbook.....	Module 230
SKYPLEX Handbook.....	Module 240
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1. INTRODUCTION

The type approval of earth station antennas depends on the ability to manufacture the antenna system with repeated precision. If this cannot be guaranteed, then to demonstrate minimum compliance with Eutelsat S.A specifications, the continual submission of test data on every station is necessary.

Recent developments now make it possible to manufacture certain types of antennas with repeated precision. Other earth station equipment (LNA, HPA, U/C, D/C etc.) can also be repeatedly manufactured precisely. This now allows Eutelsat S.A. to offer a type approval procedure for two configurations; i.e. the antenna system including the feed and the complete earth station (VSAT). This procedure makes provision for the manufacturer to liaise directly with Eutelsat S.A. for the type approval programme.

Eutelsat S.A. Operators will then be able to introduce type approved antenna/earth station units, without the need for full verification testing or certification of the performance characteristics by simply notifying Eutelsat S.A. as foreseen within the application form.

For VSAT terminals, the same procedure applies in principle. Nevertheless, under certain conditions, relaxations are possible, as will be described further on.

2. GENERAL

2.1. Step-by-Step Process

The basic steps to be followed by the applicant to obtain type approval are:

1. Obtain Eutelsat S.A. Documentation as appropriate.
2. Notify Eutelsat S.A. of the intention to qualify an antenna or a VSAT for "Type Approval".
3. Provide Eutelsat S.A. with the required technical information.
4. Review Meeting with Eutelsat S.A.
5. Conduct, under coordination and control of Eutelsat S.A., type approval verification testing.
6. Evaluate, in coordination with Eutelsat S.A., test results.
7. Produce "Type Approval Verification Test Report" for submission to Eutelsat S.A.
8. Obtain " Eutelsat S.A. Type Approval Certification" for equipment in question.

2.2. Data to be Submitted

The data that should be submitted to allow Eutelsat S.A. to study the cases needs to include the following details:

- Antenna/VSAT drawings (tridimensional view plus front view, side view and top view) with dimensions;
- Measured electrical characteristics, including RF patterns of the antenna/VSAT and details on the radio unit design in case of VSATs;
- Wind load test/analysis results;
- Description of the manufacturing process (integrity, repeatability ...) for all antenna/VSAT subsystems (reflector, feed, mount etc);
- Analysis of the mechanical margins and predictions of variations that could influence the electrical performance;
- Quality Assurance and Control Procedures (ISO 9001 etc.);
- Current testing procedure and proposed test plan;
- Packaging and shipment handling;
- Any other details that could influence the repeatability of the manufacturing or on-site installation process;
- Operating instructions including assembly manual.

All information supplied to Eutelsat S.A. will be treated in the strictest confidence and not disclosed to any third party

2.3. Applicable Earth Station Standards

The Eutelsat S.A. standard applied for type approvals is the EESS 502 (standard M). The standard is available on request to esapproval@eutelsat.fr.

2.4. Engineering Support

Eutelsat S.A. will provide engineering support in order to witness the actual type approval tests as necessary together with arranging the necessary initial meetings relating to the test plan and design review.

2.5. Design Review

Eutelsat S.A. will arrange, after reviewing the submitted data from the applicant relating to the earth station's antenna system or VSAT, for a meeting to discuss the technical aspects and confirm the programme of tests.

2.6. Type Approval Tests

The tests relating to type approval are considered in the next section but the final programme of tests should be agreed at the design review meeting.

2.7. Financial Charges

There is a charge fixed by Eutelsat S.A. which will be levied on the applicant for this "Type Approval Certification" and engineering support.

2.8. Test Facilities

The applicant seeking type approval of his equipment shall provide all in - plant (or other) testing facilities, any support materials and staff over the entire period of testing, according to Eutelsat S.A. requirements.

A full description of the test facilities shall be provided to assess the suitability of them for the Eutelsat S.A type approval campaign.

3. TYPE APPROVAL TESTS

3.1. Antenna Tests

The minimum tests to be performed to obtain the type approval status are listed in the following table:

ANTENNA TEST ITEM	
MANDATORY	TRANSMIT GAIN AND E.I.R.P.
	TRANSMIT COPOLAR PATTERN
	TRANSMIT CROSSPOLAR PATTERN
	TRANSMIT CROSSPOLAR DISCRIMINATION
OPTIONAL	RECEIVE ANTENNA GAIN
	RECEIVE CROSSPOLAR DISCRIMINATION
	RECEIVE COPOLAR PATTERN
	RECEIVE CROSSPOLAR PATTERN
	RECEIVE G/T

Typical templates describing the tests to be performed are shown in Figg. 1 to 4.

The purpose of the tests will be to determine the mean electrical performance characteristics of the antenna series and the statistical deviations.

They are therefore identical in scope to those verification tests performed on Eutelsat S.A. standard antennas (ESVA Tests), with the provision that a limited number of units are tested and the performance characteristics statistically determined.

For guidance on the Eutelsat S.A. requirements, an extract in the Eutelsat S.A. requirements, in terms of antenna sidelobe pattern is provided in Annex C.

An agreed number of units will be tested and every effort will be made to ensure that the units are "typical" and representative of units operating in the field. Thus, it is essential that the units to be tested are:

- assembled and installed in accordance with the processes described for normal operations by personnel possessing levels of skill and experience that would be expected in the field.
- selected at random.

It is suggested that sample units be randomly selected at rate to be agreed.

If the antenna system has a large number of mechanical components, Eutelsat S.A. may request that samples be randomly selected at a rate, based upon the projected length of the production run.

3.2. VSAT Tests

In addition to the antenna tests, the applicant shall provide data on the VSAT transceivers. The data will primarily focus on stability aspects of RF amplifier stages.

These aspects will be addressed during the design review phase of the VSAT type approval and defined on a case by case basis in cooperation with the manufacturer concerned.

Details on VSAT ODU (Outdoor Units) type approval are shown in ESOG Module 160.

3.3. Mobile Antenna tests

For the specific case of antennas for aeronautical, maritime and land mobile, additional tests on the tracking system will be performed to assess the Beam Pointing Error (BPE).

Test facilities to assess the BPE shall be made available by the applicant in order to simulate movements on the 3 axis, at predetermined speeds and accelerations.

The maximum acceptable BPE is normally set to $\pm 0.2^\circ$.

Tests witnessed by: on date: performed @ test range:

ANTENNA ASSEMBLY S/N: FEED ASSEMBLY S/N:

FREQUENCY (GHz)		10.70 ÷ 12.75	13.75	14.0	14.25	14.5
PLANE, POLARISATION						
AZ (E-PLANE), HOR POL	SL PEAK [÷ 9.2°]					
	SL PEAK [9.2° ÷ 48°]					
	XPD					
AZ (H-PLANE), VER POL	SL PEAK [÷ 9.2°]					
	SL PEAK [9.2° ÷ 48°]					
	XPD					
EL (H-PLANE), HOR POL	SL PEAK [÷ 9.2°]					
	XPD					
EL (E-PLANE), VER POL	SL PEAK [÷ 9.2°]					
	XPD					
AZ (E-PLANE), HOR POL	SL PEAK [48° ÷ 180°]					
AZ (H-PLANE), VER POL	SL PEAK [48° ÷ 180°]					
AZ, HOR + 20° POL	SL PEAK [÷ 9.2°]					
	XPD					
AZ, HOR - 20° POL	SL PEAK [÷ 9.2°]					
	XPD					
AZ, VER + 20° POL	SL PEAK [÷ 9.2°]					
	XPD					
AZ, VER - 20° POL	SL PEAK [÷ 9.2°]					
	XPD					
GAIN TX HOR / VER POL						
GAIN RX HOR / VER POL						

Note 1: in reporting values [all values in dB] under AZ or EL cuts, indicate the available margin with respect to the EESS masks (EESS 502 refers).

Note 2: in reporting values under XPD (Cross-Polar Discrimination) cuts, indicate the worst case measured XPD value at the -1 dB contour of the main beam.

Note 3: additional measurements of the 9 points XPD shall be performed, in line with ESOG Vol I Module 130 Par. 7.2, for both H and V polarisations at the frequencies indicated, see Fig. 3.

FIG. 1: KU-BAND TYPE APPROVAL SPREADSHEET

Antenna Diameter : Mask starts at = 100 /D (or 1°) =

(REPEAT FOR MINIMUM THREE ANTENNA SYSTEMS)

Tests witnessed by: on date: performed @ test range:
 ANTENNA ASSEMBLY S/N: FEED ASSEMBLY S/N:

<i>FREQUENCY (GHz)</i>		3.60 ÷ 4.20	5.85	6.135	6.425
<i>PLANE, POLARISATION</i>					
AZ (E-PLANE), RHCP	SL PEAK [÷ 9.2°] SL PEAK [9.2° ÷ 48°] XPD				
AZ (H-PLANE), LHCP	SL PEAK [÷ 9.2°] SL PEAK [9.2° ÷ 48°] XPD				
EL (H-PLANE), RHCP	SL PEAK [÷ 9.2°] XPD				
EL (E-PLANE), LHCP	SL PEAK [÷ 9.2°] XPD				
AZ (E-PLANE), RHCP	SL PEAK [48° ÷ 180°]				
AZ (H-PLANE), LHCP	SL PEAK [48° ÷ 180°]				
AZ, RHCP + 20° POL	SL PEAK [÷ 9.2°] XPD				
AZ, RHCP - 20° POL	SL PEAK [÷ 9.2°] XPD				
AZ, LHCP + 20° POL	SL PEAK [÷ 9.2°] XPD				
AZ, LHCP - 20° POL	SL PEAK [÷ 9.2°] XPD				
GAIN TX RHCP / LHCP					
GAIN RX RHCP / LHCP					

Note 1: in reporting values [all values in dB] under AZ or EL cuts, indicate the available margin with respect to the EESS masks (EESS 502 refers).

Note 2: in reporting values under XPD (Cross-Polar Discrimination) cuts, indicate the worst case measured XPD value at the -1 dB contour of the main beam.

Note 3: additional measurements of the 9 points XPD shall be performed, in line with ESOG Vol I Module 130 Par. 7.2, for both H and V polarisations at the frequencies indicated, see Fig. 3.

FIG. 2: C-BAND TYPE APPROVAL SPREADSHEET

Antenna Diameter : Mask starts at = 100 /D (or 1°) =

(REPEAT FOR MINIMUM THREE ANTENNA SYSTEMS)

Position	HOR POL	VER POL	HOR / VER $\pm 20^\circ$
1			
2			
3			
4			
5			
6			
7			
8			
9			

Frequency*: GHz

Positions

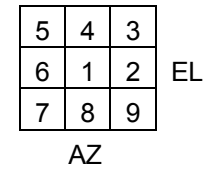


FIG.3: KU-BAND NINE POINT BOX CROSSPOLAR DISCRIMINATION TESTS

* Frequency of tests = at least one in the Receive side
at least three in the Transmit side

Position	RHCP	LHCP	RHCP / LHCP $\pm 20^\circ$
1			
2			
3			
4			
5			
6			
7			
8			
9			

Frequency*: GHz

Positions

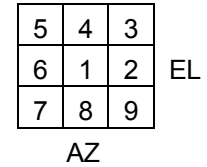


FIG.4: C-BAND NINE POINT BOX CROSSPOLAR DISCRIMINATION TESTS

* Frequency of tests = at least one in the Receive side
at least three in the Transmit side

4. EUTELSAT S.A. CERTIFICATION

Based on the successful completion, demonstration, technical verification and certification of all mandatory electrical performance characteristics, Eutelsat S.A. will issue a type approval certificate to the applicant.

A unique type approval number will be assigned by Eutelsat S.A. to the certificate which will also contain a list of each piece of equipment (or equipment configuration) that was part of the testing.

The list of type approved antennas and VSATs and their relevant configurations is published and regularly updated in the Eutelsat S.A. Web site.

5. FUTURE OPERATIONS

If following the type approval, the equipment undergoes a modification, that will affect either the configuration applied for or the repeatability of the tests, Eutelsat S.A. must be advised. Any further action will be agreed with the applicant but may require further testing, depending on the extent of the modification.

In case of major changes affecting the antenna optics (new dish, new feed, new radome if applicable etc.), a new full type approval campaign may be necessary.

If also during operations a problem occurs which raises concern about the repeatability of the measurements, Eutelsat S.A. reserves the right to require the tests to be repeated and to review the position regarding the continued certification.

Finally, it shall be understood that prior to commencement of operation of a type approved earth station, registration must take place in the normal way, by applying for Approval to Access, as described in ESOG Module 110.

Annex A - Request for Type Approval

To request Type Approval, complete the form as shown on the next page and forward to the Head of Ground Segment Operations at Eutelsat S.A. The mail address is indicated in the Operational Contact List at the back of every ESOG Module.

APPLICATION FOR EARTH STATION EQUIPMENT TYPE APPROVAL

To: Head of Ground Segment Operations

Ref: Date:.....

From:
.....

This is to request type approval of the following earth station antenna/equipment for operation in the Eutelsat S.A. space segment, based on the procedures as described in ESOG Volume I, Module 120:

(insert antenna/equipment details)

The anticipated number of production units will be per year/total.

Technical details of a complete unit and the proposed type approval tests including test procedures are attached for your information.

It is suggested that all testing is to be undertaken at:
from: to:

Full Company details:
Name:
Address:
.....

Telephone: Facsimile:
E-mail:
Responsible Company Official:

Signature:

Annex B - Request for VSAT Type Approval

To request Type Approval of a VSAT terminal equipment, complete the form as shown on the next page and forward to the Head of Ground Segment Operations at Eutelsat S.A. The mail address is indicated in the Operational Contact List at the back of every ESOG Module.

APPLICATION FOR EUTELSAT S.A. TYPE APPROVAL OF A VSAT TERMINAL EQUIPMENT

To: Head of Ground Segment Operations

Date: Ref.:

1. GENERAL TERMINAL DATA

System Manufacturer/Vendor:

Model (including options):

Anticipated number of production units (per year):

2. ANTENNA DATA

Manufacturer:

Model (including options):

<p>Antenna Type</p> <table style="width: 100%; border-collapse: collapse;"> <tr><td><input type="checkbox"/></td><td>Front fed</td></tr> <tr><td><input type="checkbox"/></td><td>Cassegrain</td></tr> <tr><td><input type="checkbox"/></td><td>Gregorian</td></tr> <tr><td><input type="checkbox"/></td><td>Offset Front fed</td></tr> <tr><td><input type="checkbox"/></td><td>Offset Cassegrain</td></tr> <tr><td><input type="checkbox"/></td><td>Offset Gregorian</td></tr> <tr><td><input type="checkbox"/></td><td>Other (describe):</td></tr> </table>	<input type="checkbox"/>	Front fed	<input type="checkbox"/>	Cassegrain	<input type="checkbox"/>	Gregorian	<input type="checkbox"/>	Offset Front fed	<input type="checkbox"/>	Offset Cassegrain	<input type="checkbox"/>	Offset Gregorian	<input type="checkbox"/>	Other (describe):	<p>Main Reflector</p> <table style="width: 100%; border-collapse: collapse;"> <tr><td><input type="checkbox"/></td><td>Circular</td><td>Diameter:</td><td>m</td></tr> <tr><td><input type="checkbox"/></td><td>Non. Circ.</td><td>Hor. Axis:</td><td>m</td></tr> <tr><td></td><td></td><td>Ver. Axis:</td><td>m</td></tr> </table>	<input type="checkbox"/>	Circular	Diameter:	m	<input type="checkbox"/>	Non. Circ.	Hor. Axis:	m			Ver. Axis:	m
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<input type="checkbox"/>	Electrical																										

	Frequency Bands	Gain	Tsys	G/T EL
Rx	<input type="checkbox"/> 3.60 - 4.20 dBi at GHz K dB/K at °
Rx	<input type="checkbox"/> 10.70 - 10.95 dBi at GHz K dB/K at °
Rx	<input type="checkbox"/> 10.95 - 11.20	..... dBi at GHz	..... K	..... dB/K at °
Rx	<input type="checkbox"/> 11.20 - 11.70	..... dBi at GHz	..... K	..... dB/K at °
Rx	<input type="checkbox"/> 11.70 - 12.50	..... dBi at GHz	..... K	..... dB/K at °
Rx	<input type="checkbox"/> 12.50 - 12.75	..... dBi at GHz	..... K	..... dB/K at °
Rx	<input type="checkbox"/> 19.70 - 20.20	..... dBi at GHz	..... K	..... dB/K at °
Rx	<input type="checkbox"/> 21.40 - 22.00	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 5.80 - 6.40	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 12.75 - 13.00	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 13.00 - 13.25	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 13.75 - 14.00	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 14.00 - 14.50	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 17.30 - 18.10	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 18.10 - 18.40	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 27.50 - 28.60	..... dBi at GHz	..... K	..... dB/K at °
Tx	<input type="checkbox"/> 29.50 - 30.00	..... dBi at GHz	..... K	..... dB/K at °

Antenna Pointing Accuracy (including satellite movement): ± °

Transmit Main Lobe 3 dB Beamwidth: ° at GHz

Receive Main Lobe 3 dB Beamwidth: ° at GHz

Transmit Crosspolar Discrimination (worst case) at the -1 dB contour: dB at GHz in the H / V plane

Receive Crosspolar Discrimination (worst case) at the -1 dB contour: dB at GHz in the H / V plane

6. CERTIFICATION

Complete this application with the following mandatory documents:

- Transmit radiation patterns, for at least one frequency and two polarisations, co- and crosspolar with duly indicated horizontal and vertical scales
- Overview drawing of complete antenna system
- Commercial documentation/datasheets

The applicant certifies that the information provided to Eutelsat S.A. in this application and in the attached documents describes as close as possible the properties and performance of the VSAT terminal concerned. Any technical modifications introduced to this system in future will be reported to Eutelsat S.A. immediately.

Responsible Company Officer:

Place: Date:

Signature/Company Stamp:

Annex C - Antenna Sidelobe Pattern (Extract of EESS 502)

Over the full extent of the antenna transmit frequency bands, it is recommended that the gain of the antenna sidelobe peaks should not exceed:

$29 - 25 \log_{10}\theta$	dBi	for	α^*	$< \theta \leq$	7°
+8	dBi	for	7°	$< \theta \leq$	9.2°
$32 - 25 \log_{10}\theta$	dBi	for	9.2°	$< \theta \leq$	48°
-10	dBi	for	48°	$< \theta$	

In addition, in the case of linear polarization it is recommended that in the cross-polarization plane, the gain of the antenna sidelobe peaks should not exceed:

$19 - 25 \log_{10} \theta$	dBi	for	1.8°	$< \theta \leq$	7°
-2	dBi	for	7°	$< \theta \leq$	9.2°

Where θ is the angle, in degrees, between the main beam axis and any direction towards the geostationary satellite orbit and within the bounds between 3° North and 3° South of the geostationary satellite orbit (as seen from the centre of the earth).

For antennas with a D/λ^{**} ratio less than or equal to 30, over the full extent of the antenna transmit frequency bands, it is recommended that the gain of the antenna sidelobe peaks should not exceed:

$32 - 25 \log_{10}\theta$	dBi	for	α^*	$< \theta \leq$	48°
-10	dBi	for	48°	$< \theta$	

* $\alpha=1^\circ$ or $(100\lambda/D)$ whichever is the greater, where D is the antenna diameter and λ is the carrier wavelength.

** In case of non circular apertures, D is the dimension of the antenna aperture in the plane of the geostationary orbit.

EUTELSAT S.A. OPERATIONS CONTACT POINTS

<p>Eutelsat S.A. CSC e-mail: csc@eutelsat.fr</p>	<p>Voice: +33-1-45.57.06.66 Fax: +33-1-45.75.07.07</p>
<p>Ground Segment Operations</p> <p>Earth Station Approval and Line-up Office e-mail: esapproval@eutelsat.fr</p> <p>Type Approval e-mail: typeapproval@eutelsat.fr</p>	<p>Voice: +33-1-53.98.48.11 Fax: +33-1-53.98.37.41</p> <p>Voice: +33-1-53.98.39.25 +33-1-53.98.46.13</p> <p>Voice: +33-1-53.98.48.16</p>
<p>Resource Engineering Group</p> <p>e-mails : dsvplan@eutelsat.fr</p> <p>ltplan@eutelsat.fr</p>	<p>Voice: +33-1-53.98.42.50 Fax: +33-1-53.98.30.00</p>
<p>Eutelsat S.A. Booking Office e-mail: booking@eutelsat.fr</p>	<p>Voice: +33-1-53.98.47.07 Fax: +33-1-53.98.37.37</p>
<p>Mailing Address</p>	<p>Eutelsat S.A. 70, rue Balard F-75502 PARIS Cedex 15 FRANCE</p>
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