EXHIBIT 6

SCHLUMBERGER TECHNOLOGY CORPORATION SECTION 25.222 COMPLIANCE REPORT

In response to the Federal Communications Commission (the "Commission" or "FCC") Report and Order establishing the ESV rules,[1] as set forth in Section 25.222 of the FCC's Regulations, the applicant herein, Schlumberger Technology Corporation ("Schlumberger"), submits the following information with respect to the Schlumberger Oilfields UK Plc 1.2 meter Ku-band reflector antenna ("1.2 Meter Antenna") and with respect to the Schlumberger Oilfields UK Plc 2.4 Meter Ku-band reflector antenna ("2.4 Meter Antenna") for which it seeks authority in this application to transmit Earth Stations on Board Vessels ("ESVs") using the above-mentioned antenna models (the 1.2 Meter Antenna and the 2.4 Meter Antenna collectively are referred to herein as the "Antennas").

Schlumberger has developed and tested a system designed to implement the requirements outlined in Section 25.222 of the FCC's Regulations. A description of this system, along with actual test data, are presented in this report. This report describes how Schlumberger complies with all requirements of Section 25.222 of the FCC's Regulations as well as the underlying ESV Order.

The data included herein are supported by the attached June 7, 2006, 1.2 Meter Antenna Test Report and by the attached October 10, 2008, 2.4 Meter Antenna Test Report.

[1] In the *Matter of Procedures to Govern the Use of Satellite Earth Stations on Board Vessels in the 5925-6425 MHz/3700-4200 MHz Bands and 14.0-14.5 GHz/11.7-12.2 GHz Bands,* Report and Order, FCC 204-286, IB-Docket No. 02-10, Adopted December 15, 2004, Released January 6, 2005, *recon.* Order on Reconsideration, FCC 09-63, Adopted July 30, 2009, Released July 31, 2009 ("ESV Order").

ANTENNA POINTING ERROR

The Antennas have an RF mute function that ensures compliance with Section 25.222(a) of the FCC's Regulations. The Antennas have the following applicable specifications:

- Pointing Accuracy..<0.2°
  Tx Mute Function
- Maximum angle off boresight when Tx is disabled ....<0.5°
- Maximum angle off boresight when Tx is enabled ....<0.2°

In order to protect adjacent satellites from spurious emissions and interference, the RF mute facility in the Antennas is designed automatically to suppress RF transmissions in the event of malfunction and/or misalignment between the terminal and the object satellite.

Under normal operating conditions, the stabilized Antennas align and track the object satellite to within a tracking accuracy of ±0.1° RMS. The Antennas employ a suite of highly stable and accurate velocity sensors, inclinometers, and position transducers to maintain satellite tracking and antenna altitude positioning within strict tolerances.

In general terms, these instruments are used to generate two (2) frames of reference for the operation of the platform. The normal frame of reference is derived from the velocity sensors and generates an inertial position for the reflectors of the Antennas. The second frame, called the "instrument frame of reference," is derived from a combination of inclinometer measurements and absolute angular data sourced from the high precision position transducers, mounted directly on the three (3) axes of freedom for the platform.

These frames of reference are used within a digital signal processing algorithm to set up two (2) control loops, the Torque Loop and the Velocity Loop, which are adjusted to optimize the control system with the mechanical assembly. The final drive to the 3 axes stabilized platform is accomplished through the use of low speed dc torque motors, driven by a high frequency PWM dc signal to provide direct proportional precision torque control of each axis. These control features maintain the attitude of the Antennas to within an accuracy of ±0.1° RMS or 0.2° peak for normal operating conditions.

Under extraordinary, or non-operational, conditions, the tracking accuracy of the Antennas can decrease. This decrease can be caused by a number of unforeseen or unavoidable conditions. For example, heavy seas take the pitch, roll, yaw, and heave of the vessel beyond the specifications for the Antennas. Similarly, such deviations can occur due to mechanical vibration from an external source or due to failure of the terminal sensors or drive motors. Under these conditions, the control system of the Antennas, which automatically monitors the AGC level from the terminal receiver, immediately engages the RF mute facility at a preset AGC threshold corresponding to a misalignment angle for the Antennas of 0.5° peak. Hysteresis is deployed within the control loop such that the RF transmissions will not resume until the attitude of the Antennas returns to within the peak tracking accuracy window of 0.2°. This capability ensures that Schlumberger's ESV operations would be in compliance with Section 25.222 (a) of the FCC's Regulations.

In addition to the instantaneous AGC level, a number of other system parameters are continuously monitored by the control system of the Antennas to allow immediate alarm and RF mute activation so that operation would cease if the parameters in Section 25.222 (a) of the FCC's Regulations are not being met. These capabilities include monitoring and supervision of the following parameters:

- Modem acquisition and synchronization lock.
- Normal frame of reference angles.
- Comparison between calculated and absolute antenna attitude for vessel latitude, longitude, and heading.
- Accelerometer and heading reference historic data.

In all cases, the RF mute facility is activated within 100ms of the primary alarm condition signaling.

U.S. CONTACT INFORMATION

Schlumberger's contact information is as follows:

Schlumberger Technology Corporation Network Operations Center ("Schlumberger NOC")
7147 Reynolds Dr.
Sedalia, CO 80135
Phone: (303) 470-2524
Email: cdais@sedalia.oilfield.slb.com
Qualified operators are on duty 24 hours a day, 365 days per year.

Schlumberger has standard escalation procedures in place for all types of incidents. Customers and any regulatory agency may contact the Schlumberger NOC to obtain information about a particular system and to resolve interference issues.

Technical personnel at the Schlumberger NOC have the authority and capability to remotely access equipment on the ESV to terminate emissions in case of suspected interference. All Schlumberger systems are equipped with an out-of-band management system which serves as a backup switching system for increased operational availability. In case the main system should ever go down and the satellite modem must be muted, the satellite modem will be reached via the out-of-band management system.

ANTENNA RADIATION GUIDELINES

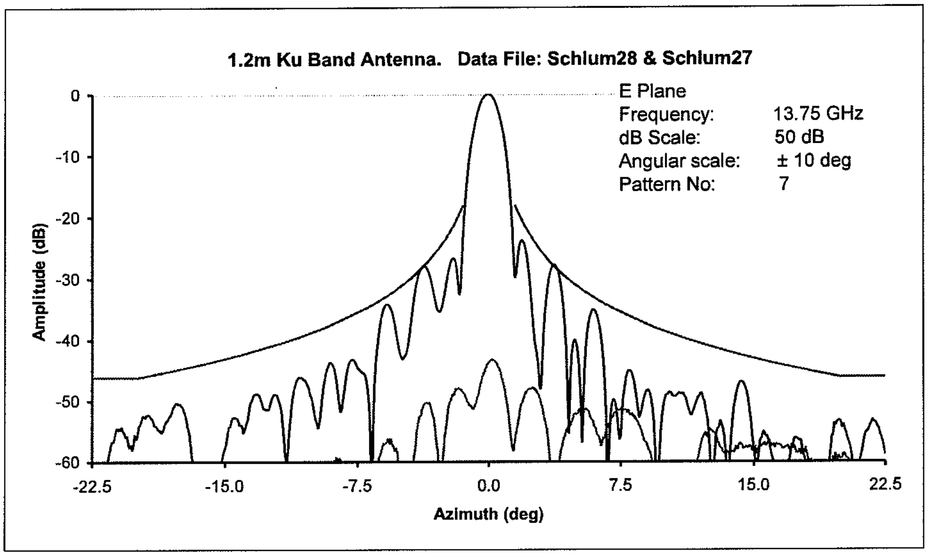
See Form 312, Q. 28, Exhibit 1.

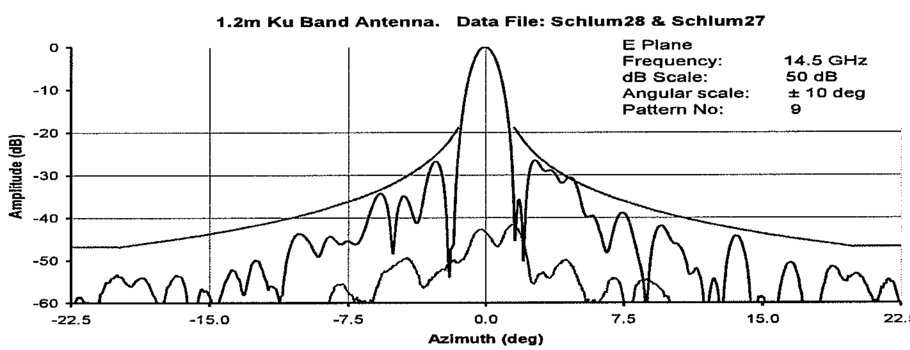
ESV GEOGRAPHIC AREA OF OPERATION

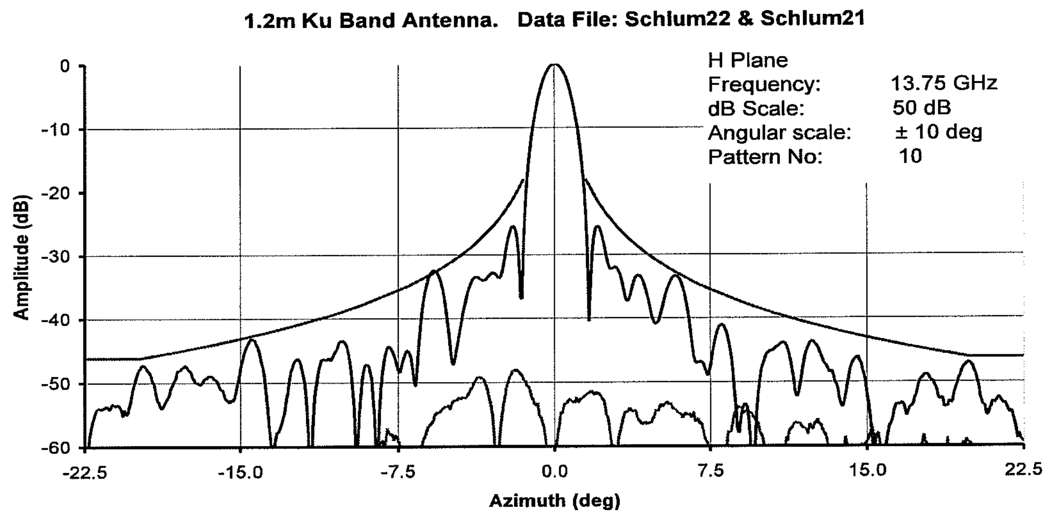
The geographic area where the ESVs will operate is the Gulf of Mexico. As set forth in its response to Q. E29 in Exhibit B of this application, Schlumberger requests authority to operate 20 1.2 Meter Antenna ESVs and 20 2.4 Meter Antennas in the Gulf of Mexico.

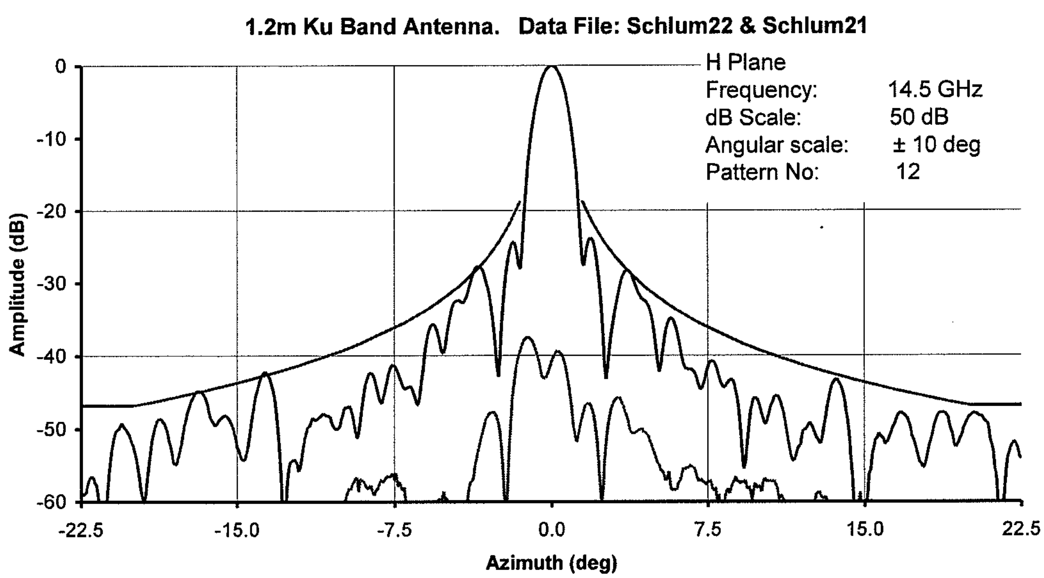
DEMONSTRATION TO SATISFY OFF-AXES EIRP EMISSIONS REQUIREMENTS

Schlumberger certifies that the 1.2 Meter Antenna and the 2.4 Meter Antenna reflector and transmitter systems meet the requirements set forth in Sections 25.209(a) and (b) of the FCC's Regulations (*see* response to Q. E15 in Schedule B, Form 312, and in Exhibit 4 of this application). Schlumberger further certifies: (i) that the transmit EIRP power density for the 1.2 Meter Antenna reflector system and for the 2.4 Meter Antenna reflector system, respectively, is shown to be 28.03 dBW/4kHz corresponding to an input power density, and (ii) that the antenna flange of -15 dB/W/4kHz for the 1.2 Meter Antenna and the antenna flange of -14.3dBW/4kHz for the 2.4 Meter Antenna is less than the -14dB/W/4kHz specified in Section 25.222 (b) of the FCC's Regulations.


1.2m Ku Band Antenna. Data File: Schlum28 & Schlum27
E Plane
Frequency: 13.75 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 7
Amplitude (dB)
0
-10
-20
-30
-40
-50
-60
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)


1.2m Ku Band Antenna. Data File: Schlum28 & Schlum27
E Plane
Frequency: 14.5 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 9
Amplitude (dB)
0
-10
-20
-30
-40
-50
-60
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)


1.2m Ku Band Antenna. Data File: Schlum22 & Schlum21
H Plane
Frequency: 13.75 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 10
Amplitude (dB)
0
-10
-20
-30
-40
-50
-60
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)


1.2m Ku Band Antenna. Data File: Schlum22 & Schlum21
H Plane
Frequency: 14.5 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 12
Amplitude (dB)
0
-10
-20
-30
-40
-50
-60
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)

The corresponding radiation patterns for the 2.4 Meter Antenna are set forth in the applicable attached Test Report.

VESSEL TRACKING

Schlumberger has designed, tested and implemented a system to record the vessel's location, transmit frequency, channel bandwidth and satellite in full compliance with Section 25.222 of the FCC's Regulations. The system records this information every 5 minutes.

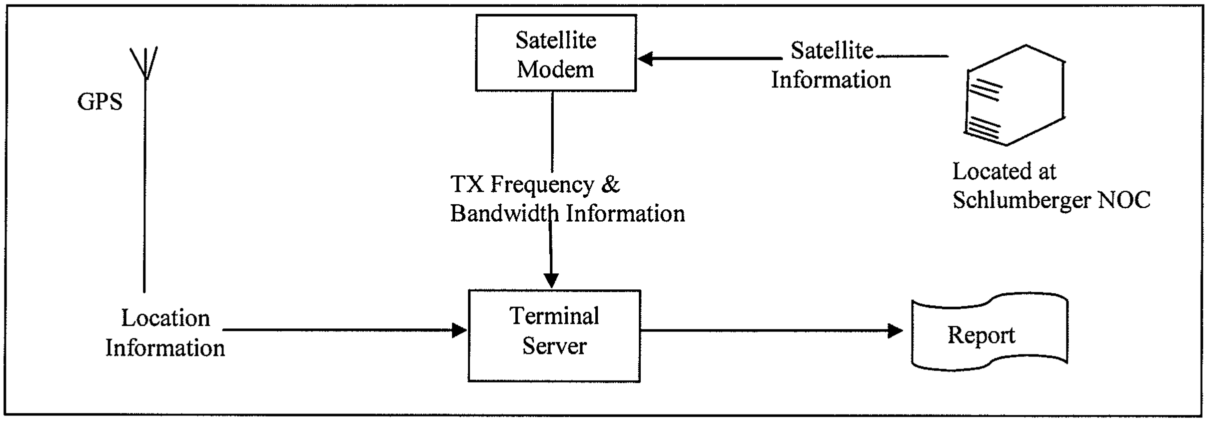
1. An external Global Positioning System ("GPS") is deployed with every one of Schlumberger's stabilized antennas. The GPS feeds position information to a Terminal Server that also performs a basic logging function. As the Terminal Server receives raw GPS data, it is spooled to a file. The Terminal Server closes the file at midnight, daily.

2. The data received from the GPS is in NMEA-0183 standard (National Marine Electronics Association). NMEA-0183 is a voluntary industry standard that defines electrical signal requirements, data transmit protocol, timing and specific sentence formats for a 4800 baud serial data bus. NMEA has become a standard protocol for interfacing navigational devices, such as a GPS. NMEA settings for RS232 interface are:

Baudrate:	4800
Data bits:	8
Stop bits:	1 or 2
Parity:	none
Handshake:	none

3. In addition, the satellite name, frequency, channel bandwidth, time and date are included in the daily file. The satellite name is manually entered at commissioning and is updated if the satellite changes. This information is kept at a server located at the Schlumberger NOC. The transmit frequency and channel bandwidth are extracted from the satellite modem. The time and date are retrieved from the Terminal Server.

4. Once the file is received at the Schlumberger NOC via File Transfer Protocol ("FTP"), the data are formatted in a Structured Query Language ("SQL") database. This database is backed up daily.



VESSELS OF FOREIGN REGISTRY

In the event that Schlumberger must operate foreign-registered vessels, it will maintain detailed information on each vessel as well as a point of contact for the relevant administration responsible for licensing the ESV in compliance with Section 25.222 of the FCC's Regulations.

U.S. CONTROL OF ESV HUB EARTH STATION

The ESVs operated by Schlumberger will be controlled by the Hub earth station at the Schlumberger NOC, which is located in Sedalia, Colorado (*see* responses to Q. E1-9 in Exhibit B of this application).

FREQUENCY COORDINATION

The ESVs operated by Schlumberger will not operate within 125 Km of the NASA TDRSS facilities in Guam or White Sands, New Mexico.

FREQUENCY COORDINATION

The ESVs operated by Schlumberger will not operate within 45 Km of the radio observatory on St. Croix; within 125 Km of the radio observatory on Maauna Kea; or within 90 Km of the Arecibo Observatory on Puerto Rico. ESVs operated by Schlumberger will operate in the Gulf of Mexico as described above.

ACCEPTANCE OF INTERFERENCE

Schlumberger does not seek authority in this application to operate on the 10.95-11.2 GHz (space-to-Earth) and 11.45-11.7 GHz (space-to-Earth) frequency bands.

POWER LIMITS TOWARD THE HORIZON

Maximum Power Density towards the Horizon

The calculations in the *Power Density* section of this report show that the ESVs under study will have an on-axis maximum e.i.r.p. density at the antenna flange of -14.3 $dBW/4KH_Z$ for emission designator 2M00G1D for the 1.2 Meter Antenna.

To calculate the e.i.r.p. density toward the horizon, it is necessary to determine the elevation angle at which the ESV will operate. Schlumberger's lowest elevation angle currently is set to be 38.5°. At this angle, the antenna gain is 32-25log (38.5°) = -7.6 dBi.[2] Therefore, the maximum e.i.r.p. density toward the horizon is:

Power Density toward the Horizon = 5.0 dBW/MH_Z – 7.6 dBi = 2.6 dBW/MH_Z

This result is 15.1 dB lower than the required maximum allowed of 12.5 dBW/MH_Z. In fact, the ESV would remain compliant with the elevation angle being as low as 9.6°.

Maximum EIRP towards the Horizon

Under a similar analysis, the e.i.r.p. towards the horizon is 40.5 dBW – 42.5 dBi + 32 – 25log (38.5°) = -9.6 dBW. This result is 25.9 dB lower than the required maximum allowed of 16.3 dBW. The ESVs would remain compliant with the elevation angle as low as 5.3°.

A similar analysis for the 2.4 Meter Antenna with emission designator 4M00G1D shows a power density of 3 dBW/MHz and a maximum e.i.r.p. of -9dBW.

MINIMUM ELEVATION ANGLE

Schlumberger's ESVs primarily will operate in the Gulf of Mexico and will access a range of satellites. This range is currently defined by PAS-9 at 58° W (most eastern) to Satmex V at 116.8° W (most western).

A typical location in the Gulf of Mexico can be defined at:

Latitude: 29.3° North

Longitude: 93.42° West

After performing look angle calculations, the elevation angles for the two (2) extreme points in the range yield the following results:

[2] Calculated according to 47 C.F.R. §25.209

Satellite	Elevation
Most Eastern	38.5°
Most Western	47.3°

Therefore, the elevation angles for Schlumberger's proposed ESVs will operate well above the required 5° elevation angle minimum.

ALSAT AUTHORITY

Schlumberger requests that ALSAT authority be granted with this application. Since Schlumberger is requesting ALSAT authority, it is asking the Commission for authority to operate in the 14000 – 14500 MH_Z (earth-to-space) and 11700 – 12200 MH_Z (space-to-earth domestic) frequency bands.[3]

The proposed ESVs will communicate with Schlumberger hub antennas authorized under call sign E7818 in Sedalia, Colorado.

MULTIPLE ACCESS

Schlumberger will use TDMA technology for its proposed ESV operations.

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[3] *In the Matter of Satellites Mexicanos, S.A. de C.V. Petition for Declaratory Ruling,* DA 00-1793, File No. SAT-PDR-19991214-00131 (adopted October 2, 2000, Released October 3, 2000).

ANTENNA SYSTEMS

Test Report for the Schlumberger Oilfields UK Plc 1.2 metre Ku Band Reflector Antenna

Frequency: 13.75 – 14.5 GHz
Model No: KU12LR

C P Wood

ERA Document No: 12698/TR001
Issue 04
ERA Project 51-ST-12698

Commercial-in-Confidence

Client : Schlumberger
Stoneywood Park
Dyce, Aberdeen

Client Reference : PO No: QGBH01856A

ERA Report Checked by:

G Y Philippou
Antenna Systems

Approved by:

B Claydon
Business Development Manager
Antenna Systems

07 June 2006
Ref. 12698/TR001

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ERA Technology Ltd	*1 copy*
Project File	*1 copy*

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ERA Technology Ltd
Cleeve Road
Leatherhead
Surrey KT22 7SA
UK
Tel : +44 (0) 1372 367000
Fax: +44 (0) 1372 367099
E-mail: info@era.co.uk

Read more about ERA Technology on our Internet page at: http://www.era.co.uk/

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1. Introduction

This document describes the laboratory and range measurements undertaken at ERA Technology for the 1.2 metres linearly polarised Ku band reflector antenna required to demonstrate the performance of the system. The reflector system is a single front fed circularly symmetric configuration with the feed supported at the focus of the reflector by four struts in the diagonal planes. The main reflector is a paraboloid and the feed chain consists of a choked corrugated feed horn and a two port Orthomode Transducer (OMT) providing orthogonally polarised transmit and receive functions simultaneously. The mounting of the struts on the main reflector supports the feed chain and the design of this fixture ensures that the feed horn can be precisely integrated with the main reflector in the correct manner.

The feed chain components are all manufactured from aluminium using CNC machining. The feed chain is assembled and checked in the laboratory for VSWR and port-to-port isolation.

The Test Plan and procedures undertaken at ERA are consistent with *IEEE Standard Test Procedures for Antennas ANSI/IEEE Std 149-1979.*

2. Objective

The objective of the Tests is to measure the radiation patterns and gain of the 1.2 metres front fed antenna at Ku band operating in linear polarisation.

3. Testing Site

All testing has been undertaken at the ERA laboratories and outdoor far field range located as follows:

ERA Technology Ltd
Cleeve Road
Leatherhead
Surrey
KT22 7SA
UK

Antenna Systems Business Unit
Head of Business Unit: Dr Robert Pearson
Tel: +44 (0) 1372367129
Fax: +44 (0) 1372367467
e-mail: robert.pearson@era.co.uk

4. Identification of Item for Testing

The item tested consisted of a 1.2 metres circularly symmetric reflector and a Ku band feed chain at the focus of the reflector. A photograph of the configuration on the ERA far field range is shown in Figure 1, whilst Figure 2 shows detail of the feed chain. The unit is identified by Model No:KU12LR.

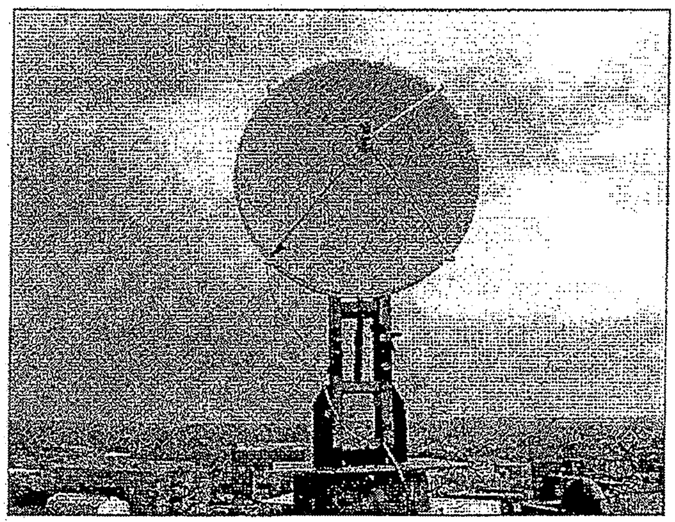


Figure 1: 1.2 metres Ku band reflector on ERA far field range

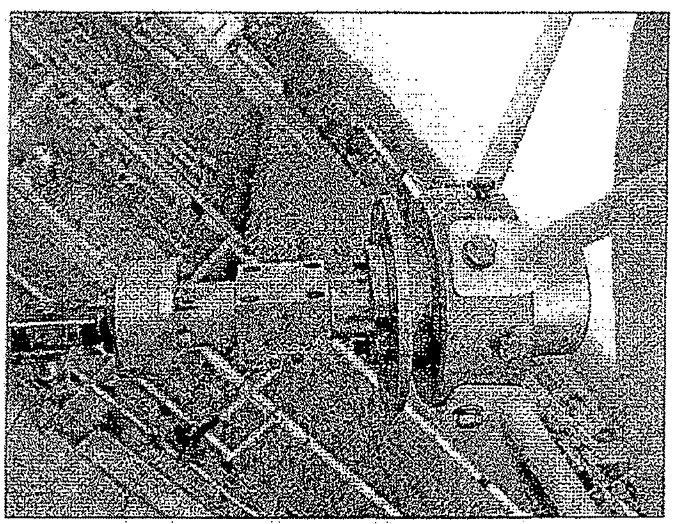


Figure 2:Detail of feed chain of 1.2 metres Ku band reflector

5. Electrical Specification

The electrical specification for the antenna is given in Table 1. This is consistent with Recommendations ITU-R-S580 and ITU-R-S465 and Eutelsat Standard M.

Table 1: Specification and Measurement Matrix

Parameter	Specification	Measurement
Frequency	Rx: 10.95 – 12.75 GHz Tx: 13.75 – 14.50 GHz	Rx: 10.95 – 12.75 GHz Tx: 13.75 – 14.50 GHz
Polarisation	Orthogonal Linear	Orthogonal Linear
Gain	> 42.6 dBi at 14.0 GHz	42.67 dBi at 13.75 GHz
Full 3dB beamwidth	1.2° (Nominal)	1.2° (mid-band)
Off-axis Co-polar Gain Tx Band (Note 1)	29-25log(θ) dBi for $(100\lambda/D)° < \theta < 20°$ -3.5 dBi for $20° < \theta < 26.3°$ 32-25log(θ) dBi for $26.3° < \theta < 48°$ -10 dBi for $48° < \theta < 180°$	Section 7; Patterns plots
On-axis Cross-polar Gain, Tx Band	-35 dB within 1dBcontour (relative to co-polar peak)	Section 7; Patterns plots
Off-axis Cross-polar Gain, Tx Band	19-25log(θ) dBi for $(100\lambda/D)° < \theta < 7°$ -0.1-2.4log(θ) dBi for $7° < \theta < 26.3°$ 32-25log(θ) dBi for $26.3° < \theta < 48°$ -10 dBi for $48° < \theta < 180°$	Section 7; Patterns plots
VSWR Tx Band	1.3:1	1.29:1
Isolation (feed only without transmit reject filter)	>40 dB for 13.75-14.5 GHz >40 dB for 10.95-12.75 GHz	>50 dB for 13.75-14.5 GHz >45 dB for 10.95-12.75 GHz
Waveguide port	WG17/WR75	WG17/WR75

Note 1: In the plane of geostationary orbit, the envelope may be exceeded by no more than 10% of the sidelobes.

6. Quality Control Procedures

ERA Technology Ltd operates a Quality Management System that is registered, by BSI, as complying with BS EN ISO 9001:2000 including the TickIt requirements. (Registration number FM1303). The Company maintains other Quality Management System Accreditations and Certifications that are linked either to a specific market, technology or Client.

Our Quality Management System is defined in general terms by a Quality Manual and in detail by a series of Quality Procedures. These documents, and other relevant material, are provided to all ERA staff via our Intranet. This Quality Management System is implemented so as to meet the specific contractual and technical requirements of each individual project.

The Quality Assurance Manager is responsible to the Managing Director for defining the Quality Management System, maintaining it and, when needed, for continually improving the processes and standards. The Quality Assurance Manager is also responsible for identifying quality problems and initiating effective solutions. Individual Project Quality is devolved down from the Heads of Business Units to the Department Managers and, for day-to-day activities, to Project Managers. Quality Assurance Representatives are appointed from the engineering staff to give local support quality and provide a link between their departments and the Quality Assurance Manager.

Copies of our Quality Manual, ISO 9001 Certification and UKAS Accreditation are available either on request or from our web site http://www.era.co.uk/corporate/qualityassurance.asp. Copies of our other approvals are available on request.

7. Measurements

7.1 Introduction

Measurements of antenna radiation patterns and gain were undertaken using ERA's 220 metre far field test range. The range comprises a remotely controlled primary transmitter unit and a receive facility located in a purpose-built test tower 15 metre in height. The receive facility is equipped with programmable *Scientific Atlanta* positioners, receivers and automatic data logging equipment. The transmitter site is furnished with a series of transmit points to cover the various bands. For Ku band the transmitter is a reflector about 900 mm diameter and it utilises a linearly polarised feed chain. The transmitter can be rotated around its axis to align the polarisation as required.

Detailed surveys of this test range have been carried out in the most commonly used microwave bands that indicate co-polar reflectivity better than -50 dB and cross-polar isolations better than 55 dB.

7.2 Test Equipment

The test equipment used in the laboratory and test range measurements are listed in Tables 2 and 3 respectively.

Table 2: Laboratory Equipment Check List

Project No:	51-ST-12698	**Phase:**	1	**Engineer:**	MMD
Project Title	**1.2 metre Ku Band Antenna Testing**				
Measurement:	Tune and Test			**Date:**	02 May 2006

Equipment Used	Serial No.	Calibration Date	Tick Box
Amplitude analyser 8757A	2706A2326	15/09/2005	
Sweep oscillator mainframe 8350B	2649U02154	15/09/2005	
RF plug-in 83550A 8-20 GHz	2741A00528	15/09/2005	
RF plug-in 86260B 10-15.5 GHz	2417A00655	Indication only	
Frequency counter EIP578	374	Indication only	
HP5342A	1916A01711	24/10/2005	
Plotter 7550A	2520A12676	Indication only	
Detector 11664E	02229	15/09/2005	
Detector 11664E	02172	15/09/2005	
Detector 11664E	04878	15/09/2005	
Detector 11664D	00626	14/02/2005	
Detector 11664D	00627	14/02/2005	
Detector 11664D	00632	14/02/2005	
Waveguide coupler WG17132-10	582	Indication only	
Waveguide coupler WG17132-20	220	Indication only	
Waveguide coupler WG17132-20	183	Indication only	
Waveguide to coax transitions WG17094-NF10	53	Indication only	
Waveguide to coax transitions WG17093-NF10	1384	Indication only	
Waveguide to coax transitions WG17093-NF10	1927	Indication only	

Equipment Used	Serial No.	Calibration Date	Tick Box
Test cables used:			
Rosenberger 18 GHz	924201	Indication only	
Rosenberger 18 GHz	924202	Indication only	
Rosenberger 40 GHz	924701	Indication only	
Rosenberger 40 GHz	924702	Indication only	
Wiltron semi-rigid 3670 K50-2	101003	Indication only	
Wiltron semi-rigid 3670 K50-2	301010	Indication only	
Other: 5061-5359	847015	Indication only	
Vector Network Analyser - Wiltron 360 comprising:			
VNA 800-251	919003	13/12/2005	✓
Source 360Ss69	916002	13/12/2005	✓
Test set 3621A	912012	13/12/2005	✓
HP8753B VNA	2824U04058	13/12/2005	✓
Calibration Kits:			
WG6 Flann 06708	21	Indication only	
WG15 Flann 15708	23	Indication only	
WG16 Maury X7005	Individually marked	Indication only	
WG17 Flann 17708	21	Indication only	✓
WG18 Flann 18708	21	Indication only	
WG20 Flann 20708	23	Indication only	
WG22 Flann 22708	24	Indication only	
Wiltron Coaxial Kit 3652-1	80024	13/12/2005	
HP 7mm Cal Kit 85031B	2541A00868	13/12/2005	
Other Equipment:			
HP "N" type Fixed 6B Attenuator Type 8419B	23557	Indication only	
Flann Waveguide to coax transitions Type 17091	25 and 26	Indication only	

ERA TECHNOLOGY

Table 3: Antenna Systems Range Equipment List

Equipment Used	Serial No.	Calibration Date	Tick Box
For range testing of antenna assembly:			
Scientific Atlanta Positioner Az/El/Az 55150A-1	72AG	Indication Only	✓
Scientific Atlanta Positioner Polarisation 56060-18	489	Indication Only	✓
Flann Standard Gain Horn Model No. 17240		Indication Only	✓
Dell Computer with Midas Software	DTOHZOJ	Indication Only	✓
Agilent 20 GHz Lo Source 83623B	3844A01682	09/02/2006	✓
Agilent 50 GHz RF Source 83650B	3844A01529	09/02/2006	✓
Agilent Receiver 8530A	3901A00722	09/02/2006	✓
Agilent Test Mixer Module 85320A-H50	2944A00942	09/02/2006	✓
Agilent Ref Mixer Module 85320B	2944A00156	09/02/2006	✓
Agilent Lo/IF distribution Unit 85309A	3224A00707	09/02/2006	✓
Orbit Pos. Controller AL-4806-3A	91	Indication Only	✓
Orbit Pos. Controller AL-4906-3A	292	Indication Only	✓

7.3 Laboratory Tests

The feed chain was measured in the laboratory. The return loss measurements were swept frequency over 13.75 – 14.5 GHz, whilst isolation was measured over10.95 – 14.5 GHz. The following were measured:

i) Return loss at Tx port.

ii) Port-to-port isolation.

The measurements are given in Figures 3 and 4 and summarised in Table 4.

When measuring the return loss, the unused port was terminated in waveguide load and for all measurements the horn was radiating into free-space or suitable anechoic shield.

Typical measurement accuracy after 12-term vector error correction can be read directly from graphs provided by the analyser manufacturer for reflection coefficient and transmission loss. The errors are Root-Sum-Squares (RSS) calculations of the contributions of residual directivity, load and source match, frequency response, isolation, network analyser dynamic accuracy and connector repeatability. This gives:

i) Return loss of 20 dB : Uncertainty (Reflection coefficient) =0.017 dB (RSS)

ii) Return loss of 15 dB : Uncertainty (Reflection coefficient) =0.019 dB (RSS)

Table 4: Laboratory Measurements

	Frequency	Figure	Measured Value	VSWR
Return loss	13.75 - 14.50 GHz	Figure 3	18.0 dB	1.29:1
Isolation Tx - Rx	10.95 - 12.75 GHz 13.75 - 14.50 GHz	Figure 4	>45 dB >50 dB	-

7.4 Antenna Range Measurements

7.4.1 Introduction

The procedures undertaken at ERA are consistent with *IEEE Standard Test Procedures for Antennas ANSI/IEEE Std 149-1979*. The measurements were undertaken using a linearly polarised Ku band transmit source.

The antenna under test (AUT) was installed on the positioner and the mixer connected to the relative antenna port.

7.4.2 Pattern measurements procedure

For antenna pattern measurements:

i) Select the frequencies; co-polarise the transmitter with the AUT and steer the AUT to receive maximum signal. Set azimuth and elevation indications to zero.

ii) Rotate the required axis and record the co-polar pattern.

iii) Rotate transmitter polarisation by 90° and record the cross-polar pattern.

iv) Repeat for other frequency bands.

All the measurements were taken by rotating in azimuth. For the elevation cut measurements the AUT was rotated by 90° and the measurements taken with the AUT rotated in azimuth. Patterns were taken ±180° or a narrower limited range with the angular increment 0.2° or less, as described in the Range Measurements Plan, Section 7.6.

7.4.3 Gain measurements procedure and results

The antenna gain measurements were performed by comparing with a commercially available linearly polarised Standard Gain Horn (SGH):

i) Locate Standard Gain Horn (SGH) on antenna mount.

ii) Select frequencies; co-polarise the transmitter with the AUT and steer the AUT to receive maximum signal. Set azimuth and elevation indications to zero.

iii) Record the co-polar signal from the AUT.

iv) Record the signal from the SGH.

v) Repeat iii) and iv).

The AUT gain was determined by the average of the two measurements taken. Table 5 gives the gain computations.

Table 5: Measured Gain

Frequency GHz	13.75	14.125	14.50
AUT dB	-24.27	-24.60	-21.64
SGH dB	-40.42	-40.81	-37.99
Diff dB	16.15	16.21	16.35
SGH Gain dBi	26.52	26.73	26.92
AUT Gain dBi	42.67	42.94	43.27

7.4.4 Far field range measurement uncertainties

Typical far field range measurements uncertainties are given in Table 6.

Table 6: Far field Range measurement uncertainties

Parameter	Value
Mutual Coupling	0.0 dB
Tx Amplitude Taper (0.25 dB)	0.1 dB
Reflections (Elevated Range)	0.01 dB
Frequency Stability	0.01%
Power Level	< ± 0.05 dB
Standard Gain Horn	± 0.25 dB
Spacing Tx to AUT	0.04 dB
Tx isolation	0.01 dB
Total RSS (Root-Sum-Square)	**0.28 dB**

The overall accuracy of the gain measurements undertaken using a commercial Standard Gain Horn is estimated to ±0.28 dB.

7.4.5 Range measurements plan

The Test Plan for the range measurements is given in Table 7. All the measurements were recorded by rotating in azimuth. The elevation cut measurements were recorded by rotating in azimuth after turning the AUT by 90°. Since the AUT is linearly polarised, the cuts in Table 7 are identified as E-plane or H plane cuts. For example, for a vertically polarised antenna, E-plane is the elevation cut and H-plane is the azimuth cut. Co-polar and cross-polar component patterns were taken for ±180° in θ, the angular increment 0.2°. Co-polar and cross-polar measurements were taken for ±22.5° and ±10° in θ with the angular increment 0.075° and 0.025° respectively.

All the measurements were recorded as ASCII text files in amplitude (dB) and phase (deg). The data were then processed in Excel spreadsheets in the format required by Anatel and supplied with the Test Report.

The recorded patterns are included in this Test Report and identified by the Pattern Number as given in Table 7. Table 8 summarises the sidelobe level deviations above the specified template.

Table 7: Range measurements Test Plan

				Pattern Number		
Angular scale degrees	Scale dB	Cut	Component	Tx Frequency GHz		
				13.75	14.125	14.50
±10	50	E-Plane	Co & Cross	1	2	3
±10	50	H-Plane	Co & Cross	4	5	6
±22.5	60	E-Plane	Co & Cross	7	8	9
±22.5	60	H-plane	Co & Cross	10	11	12
±180	80	E-Plane	Co & Cross	13	14	15
±180	80	H-plane	Co & Cross	16	17	18
Gain			Co	✓	✓	✓

Table 8: Sidelobe level deviations

	Frequency					
	13.75 GHz		14.125 GHz		14.5 GHz	
Range	E-plane	H-Plane	E-plane	H-Plane	E-plane	H-Plane
0° – 90°	0.4 dB	0.5 dB	2.6 dB	1.0dB	0.4 dB	0.2 dB
90° – 180°	7.3 dB	7.6 dB	9.8 dB	12.8 dB	10.2 dB	13.0 dB

7.4.6 Antenna range Test Log sheet

ANTENNA RANGE TEST LOG SHEET			
TITLE:	Schlumberger 1.2m Reflector	OPERATOR:	CPW
PROJECT NO:	12698	DATE:	2 May 2006
DESCRIPTION:	1.2m Reflector with ERA feed 1155.	FREQUENCIES:	13.75, 14.125, 14.50 GHz
TEST PLAN:	As test Plan 12698/TP001	DATAFILE DIRECTORY:	Data/Schlumberger_12698

DATA FILE NAME		
PATTERN	CO-POLAR	CROSS-POLAR
±10° 50 dB Co & X E-Plane	schlum 29	schlum 30
±10° 50 dB Co & X H-Plane	schlum 19	schlum 20
±22.5° 60 dB Co & X E-Plane	schlum 28	schlum 27
±22.5° 60 dB Co & X H-Plane	schlum 22	schlum 21
±178.6° 80 dB Co & X E-Plane	schlum 25	schlum 26
±178.6° 80 dB Co & X H-Plane	schlum 23	schlum 24

SET-UP FILE NAMES:		DIRECTORY:	
PROCESSED DATA FILE NAMES:		AZ/EL ALIGNMENT:	Yes
TX EQUIPMENT USED:			
COMMENTS:			

MODEL: DATE: Page 1
DEVICE ID: OPERATOR: MND

SWEEP DATA

START: 13.7403 GHz	GATE START:	-	ERROR CORR:	12 - TERM
STOP: 14.5000 GHz	GATE STOP:	-	AVERAGING:	1 PTS
STEP: 0.0213 GHz	GATE:	-	IF BNDWDTH:	REDUCED
	WINDOW:	-		

------------ CH3 ------------

PARAMETER:	S11
NORMALIZATION:	OFF
REFERENCE PLANE:	0.0000 mm
SMOOTHING:	0.0 PERCENT
DELAY APERTURE:	-

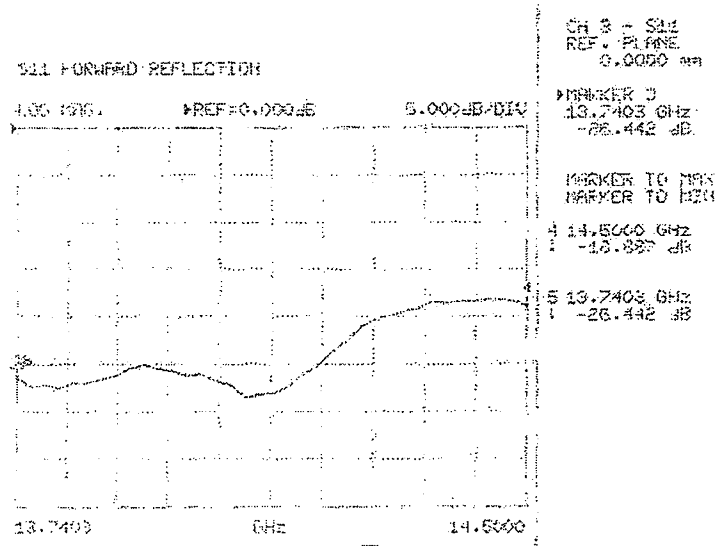


Figure 3: Measured return Loss

ERA TECHNOLOGY

MODEL: DATE: Page 1
DEVICE ID: OPERATOR: KMD

SWEEP DATA
START: 10.9500 GHz GATE START: -
STOP: 14.5000 GHz GATE STOP: -
STEP: 0.0213 GHz GATE: -
WINDOW: -

ERROR CORR: 12 - TERM
AVERAGING: 1 PTS
IF BNDWDTH: REDUCED

	CH3
PARAMETER:	S21
NORMALIZATION:	OFF
REFERENCE PLANE:	0.0000 mm
SMOOTHING:	0.0 PERCENT
DELAY APERTURE:	-

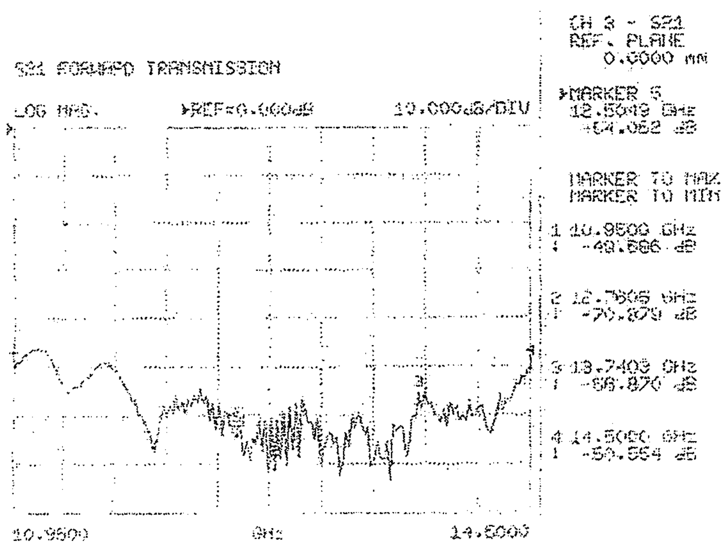
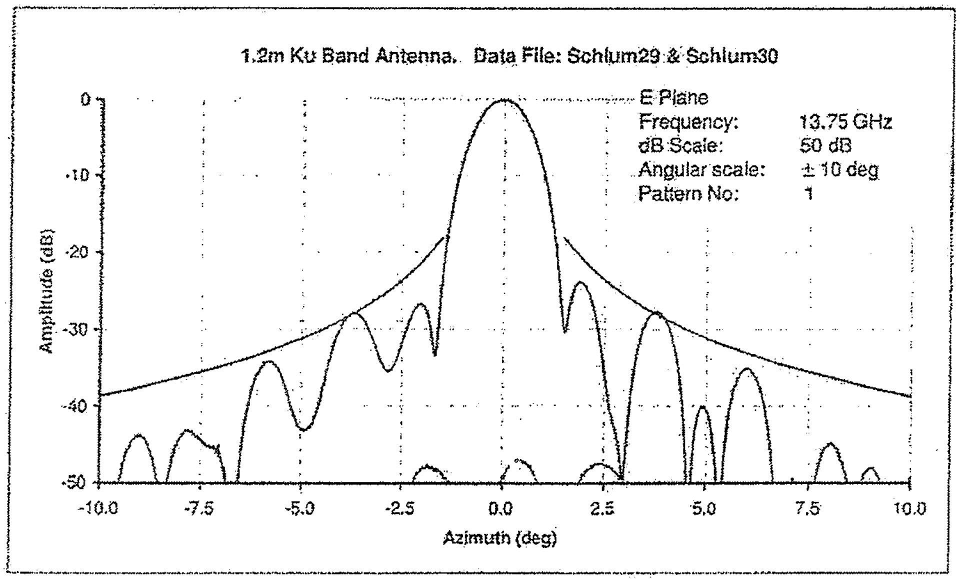
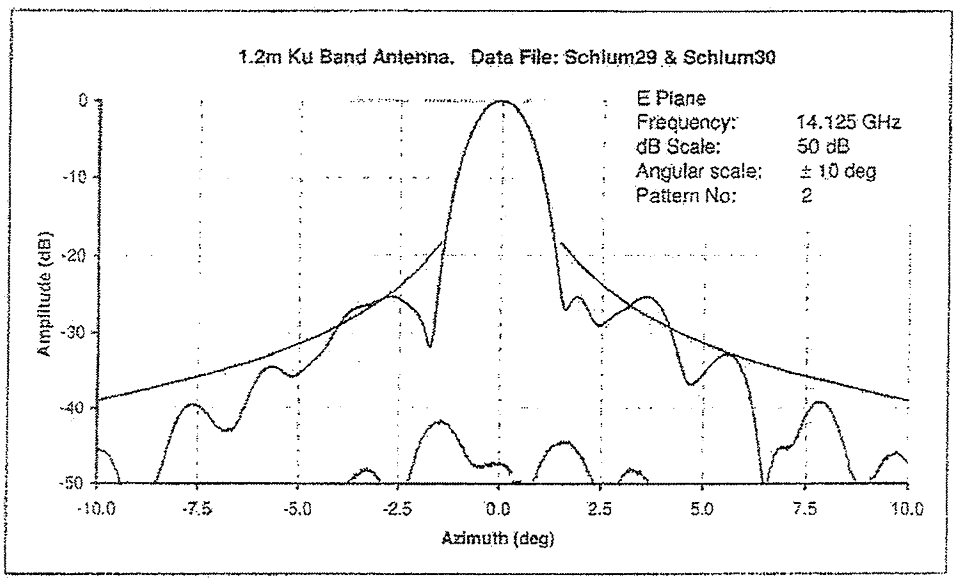


Figure 4: Measured Port to Port isolation


1.2m Ku Band Antenna. Data File: Schlum29 & Schlum30
E Plane
Frequency: 13.75 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 1
Amplitude (dB)
0
-10
-20
-30
-40
-50
-10.0
-7.5
-5.0
-2.5
0.0
2.5
5.0
7.5
10.0
Azimuth (deg)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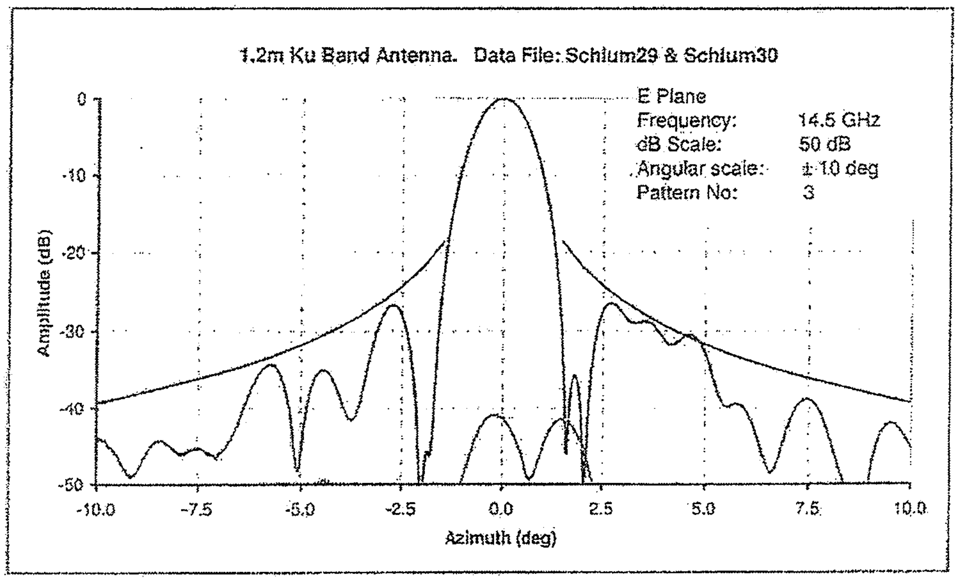
E Plane
Frequency: 14.125 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 2
Amplitude (dB)
0
-10
-20
-30
-40
-50
-10.0
-7.5
-5.0
-2.5
0.0
2.5
5.0
7.5
10.0
Azimuth (deg)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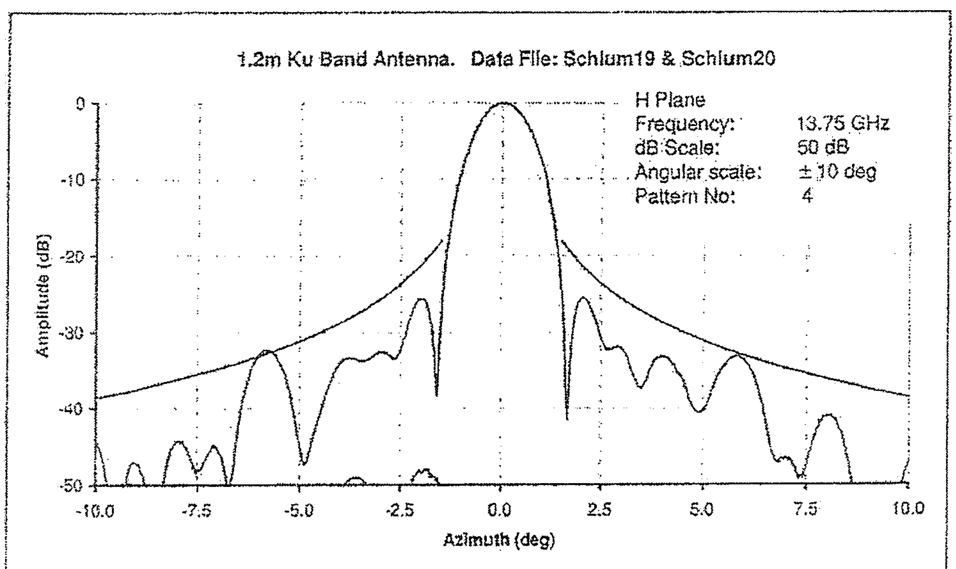
E Plane
Frequency: 14.5 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 3
Amplitude (dB)
0
-10
-20
-30
-40
-50
-10.0
-7.5
-5.0
-2.5
0.0
2.5
5.0
7.5
10.0
Azimuth (deg)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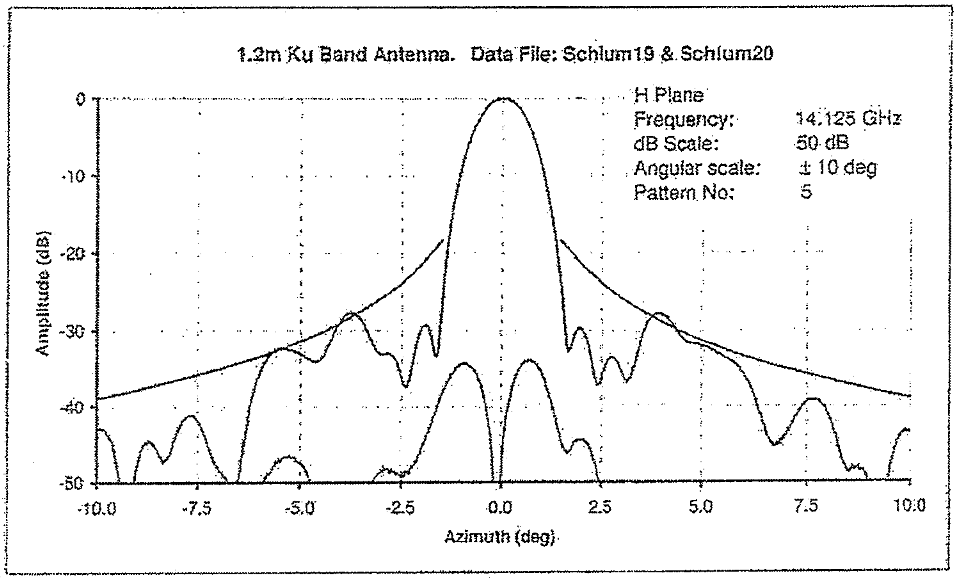
H Plane
Frequency: 13.75 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 4
Amplitude (dB)
0
-10
-20
-30
-40
-50
-10.0
-7.5
-5.0
-2.5
0.0
2.5
5.0
7.5
10.0
Azimuth (deg)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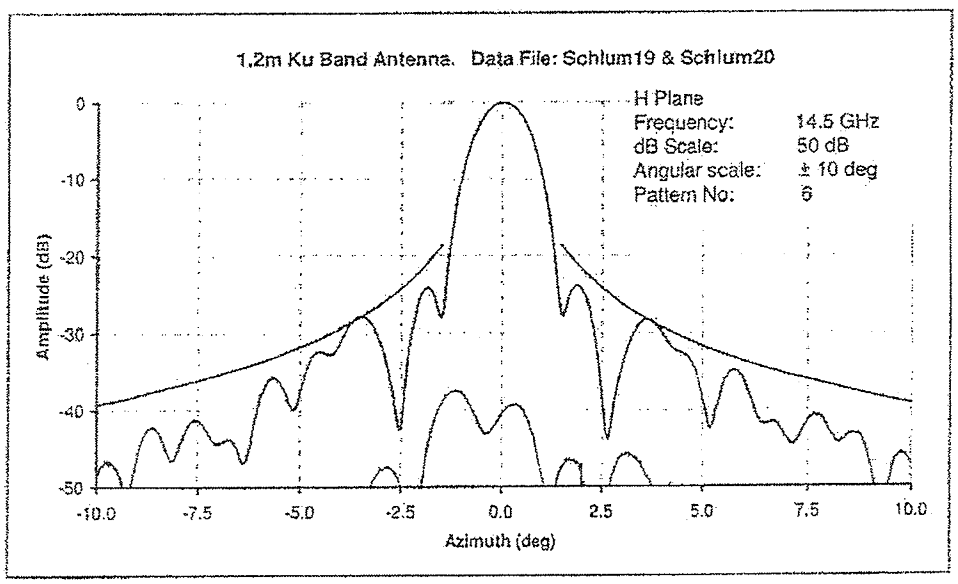
H Plane
Frequency: 14.125 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 5
Amplitude (dB)
0
-10
-20
-30
-40
-50
-10.0
-7.5
-5.0
-2.5
0.0
2.5
5.0
7.5
10.0
Azimuth (deg)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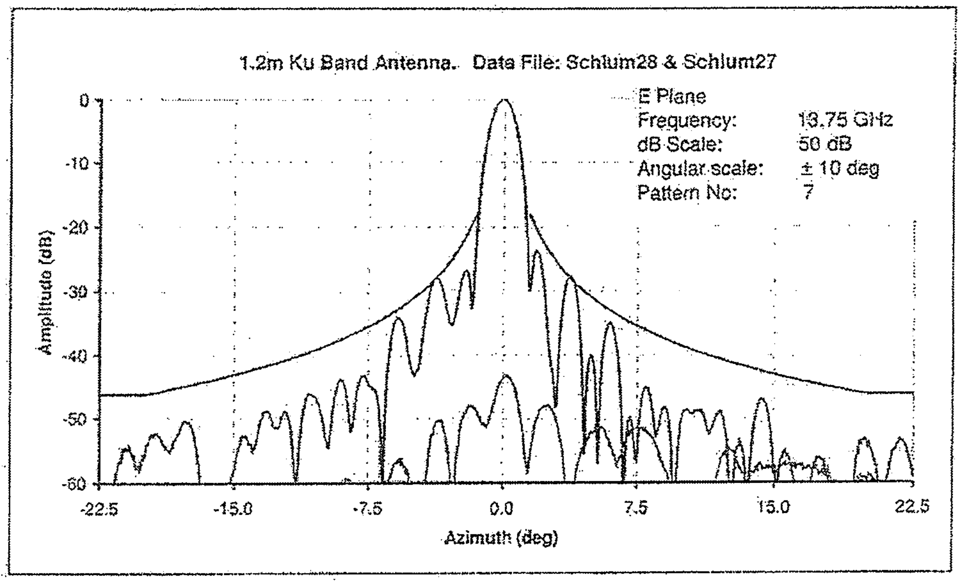
H Plane
Frequency: 14.5 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 6
Amplitude (dB)
0
-10
-20
-30
-40
-50
-10.0
-7.5
-5.0
-2.5
0.0
2.5
5.0
7.5
10.0
Azimuth (deg)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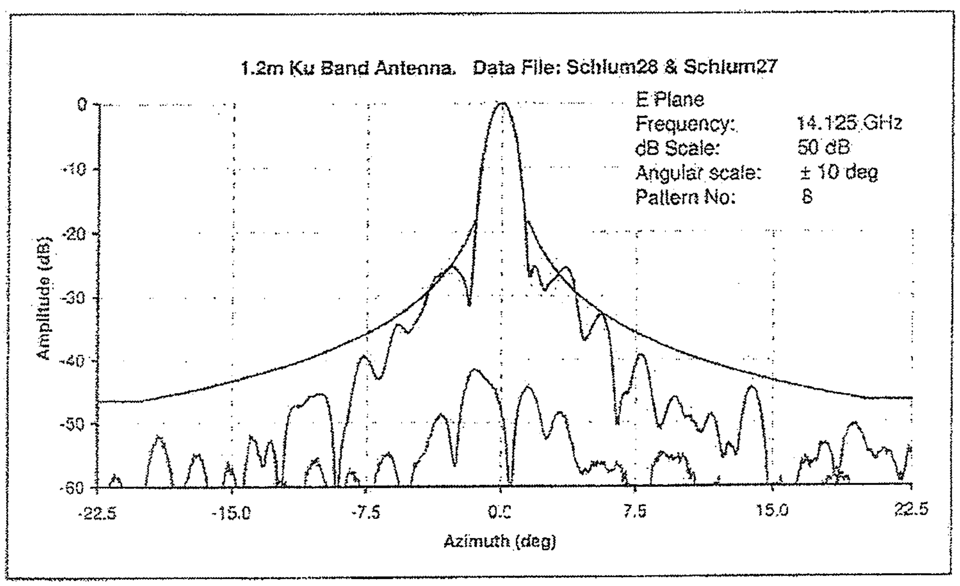
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 7
Amplitude (dB)
Azimuth (deg)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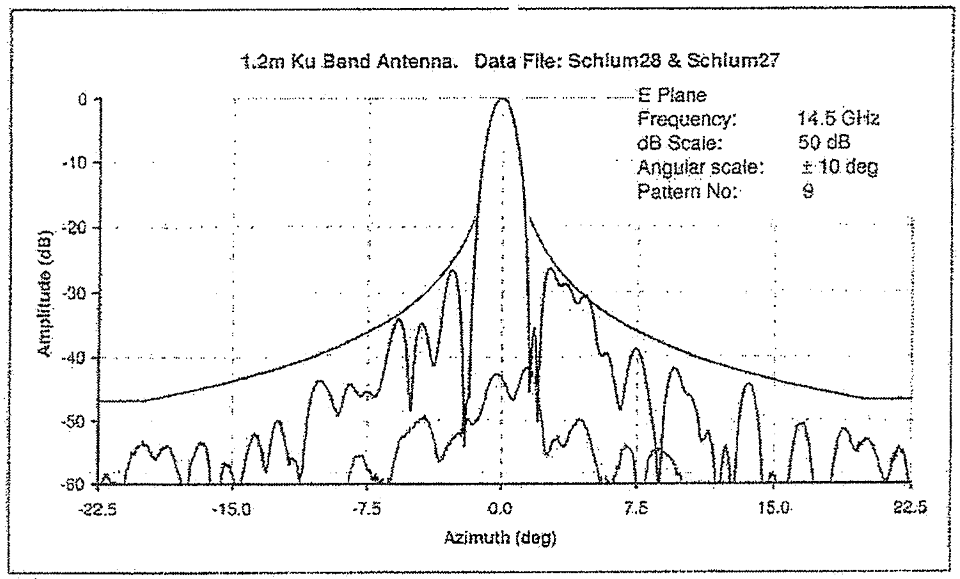
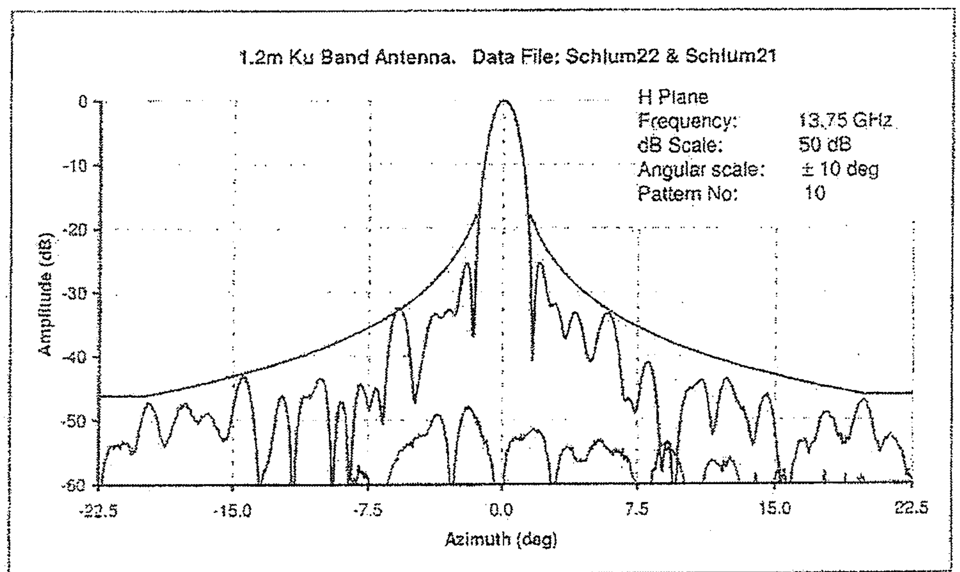
E Plane
Frequency: 14.125 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 8
Amplitude (dB)
Azimuth (deg)


1.2m Ku Band Antenna. Data File: Schlum28 & Schlum27
E Plane
Frequency: 14.5 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 9
Amplitude (dB)
0
-10
-20
-30
-40
-50
-60
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)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H Plane
Frequency: 13.75 GHz
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Angular scale: ± 10 deg
Pattern No: 10
Amplitude (dB)
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-10
-20
-30
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-50
-60
-22.5
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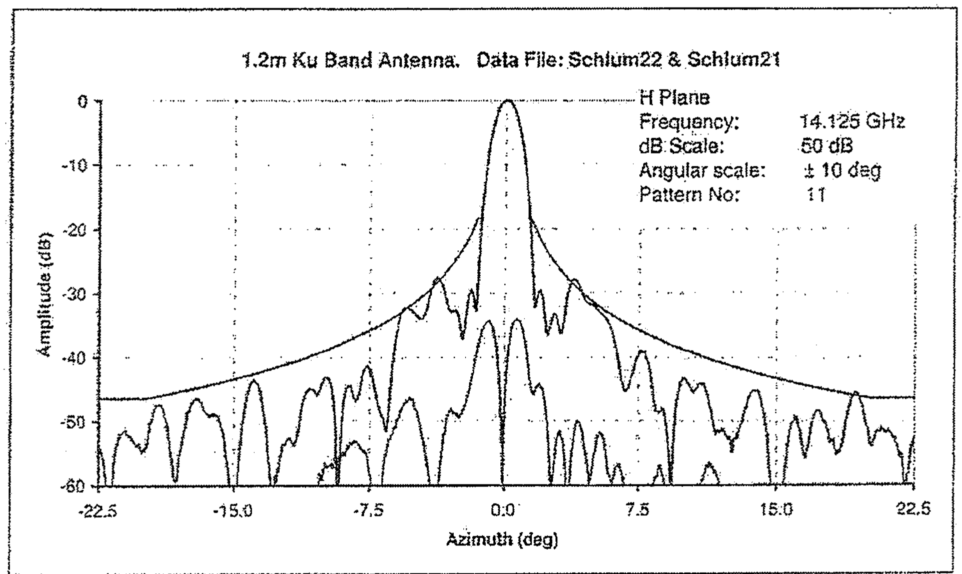
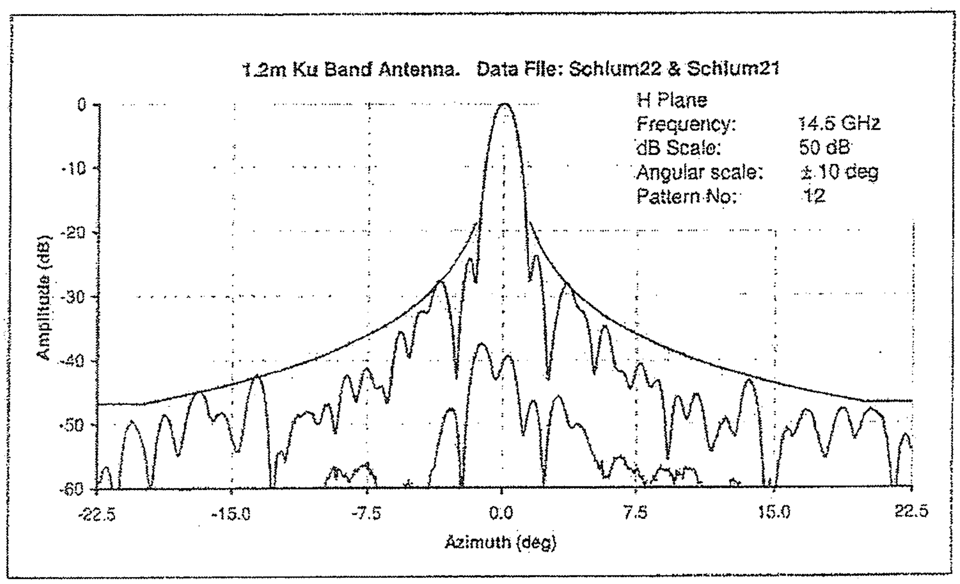
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)


1.2m Ku Band Antenna. Data File: Schlum22 & Schlum21
H Plane
Frequency: 14.125 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 11
Amplitude (dB)
0
-10
-20
-30
-40
-50
-60
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)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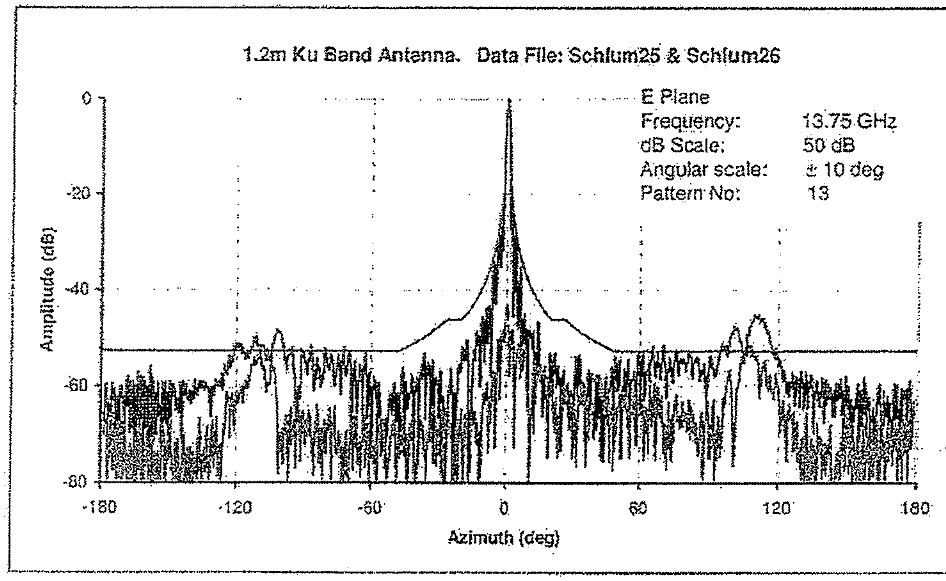
H Plane
Frequency: 14.5 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 12
Amplitude (dB)
0
-10
-20
-30
-40
-50
-60
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)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E Plane
Frequency: 13.75 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 13
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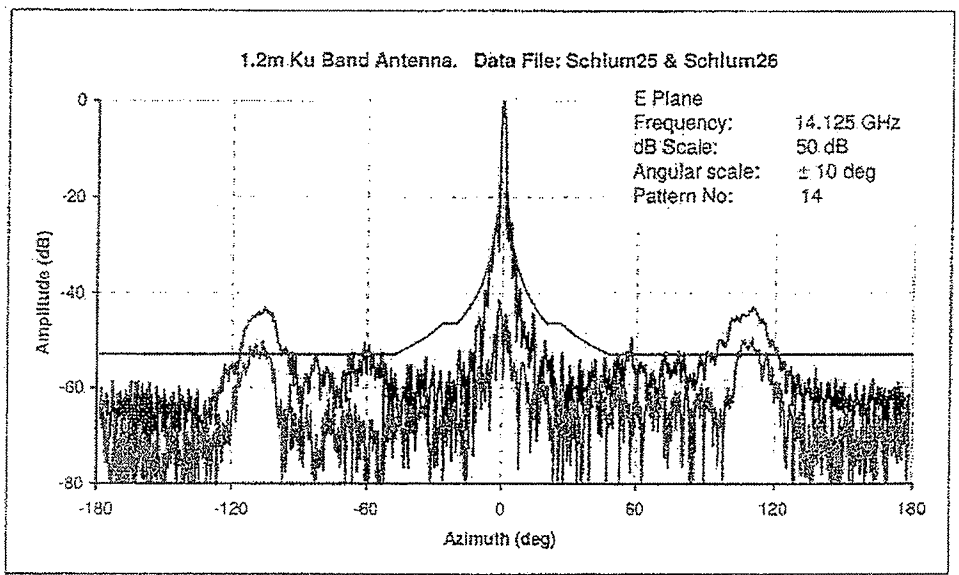
-40
-60
-80
-180
-120
-60
0
60
120
180
Azimuth (deg)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Frequency: 14.125 GHz
dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 14
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-120
-60
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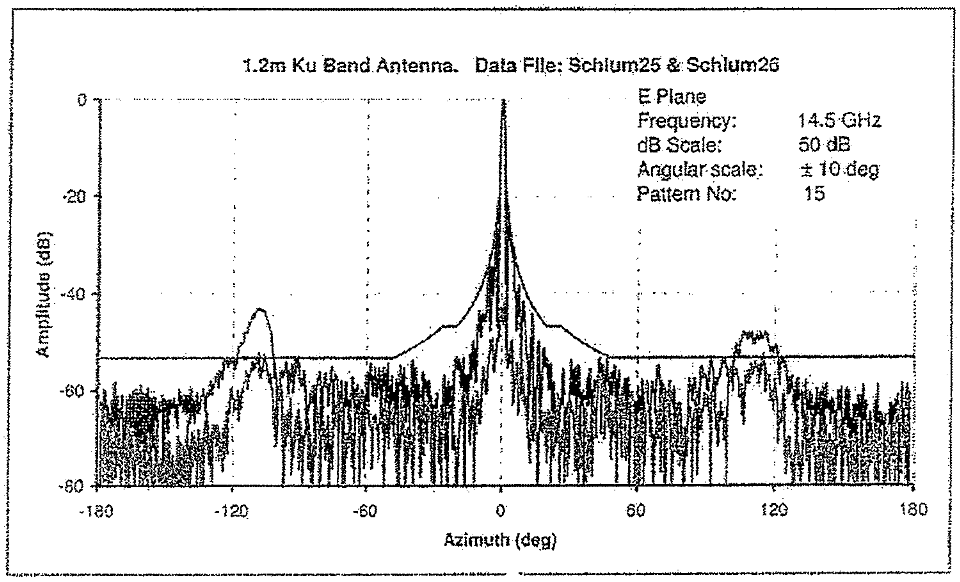
60
120
180
Azimuth (deg)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dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 15
Amplitude (dB)
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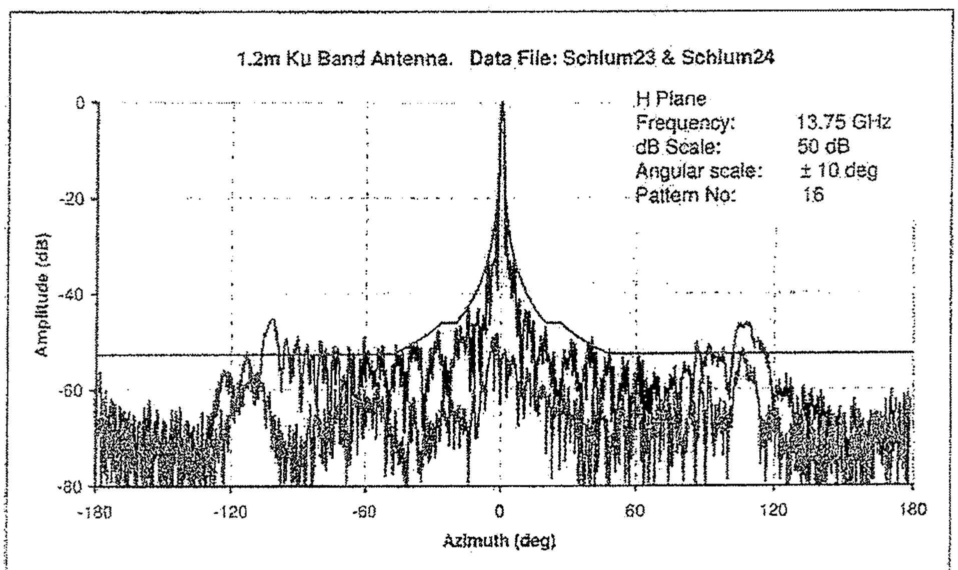
-60
0
60
120
180
Azimuth (deg)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H Plane
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dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 16
Amplitude (dB)
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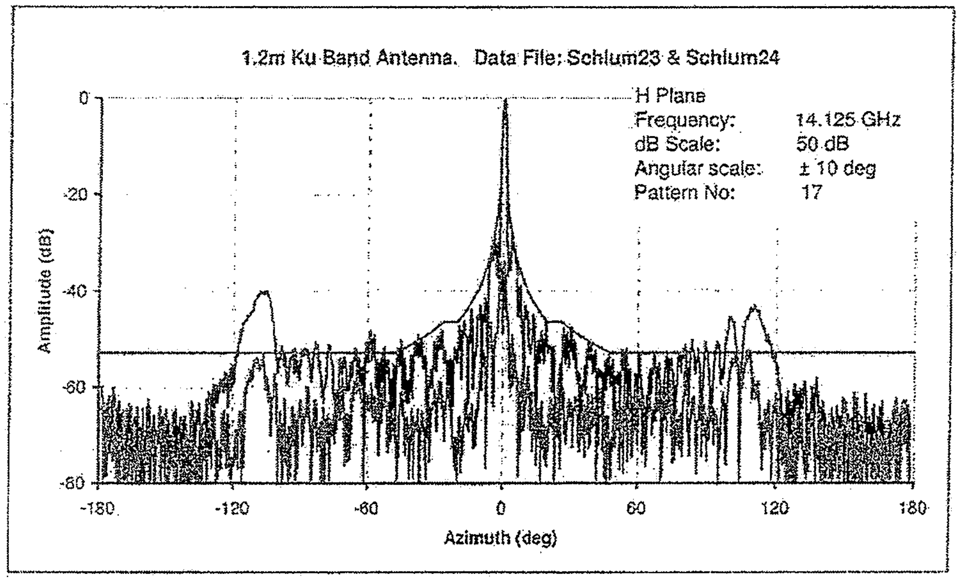
-80
-180
-120
-60
0
60
120
180
Azimuth (deg)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dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 17
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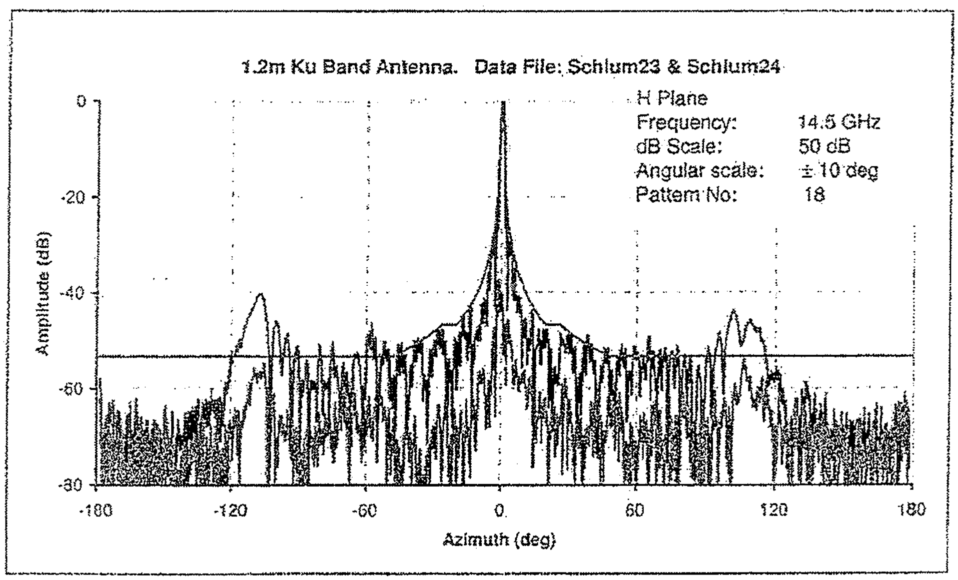
-60
0
60
120
180
Azimuth (deg)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dB Scale: 50 dB
Angular scale: ± 10 deg
Pattern No: 18
Amplitude (dB)
0
-20
-40
-60
-80
-180
-120
-60
0
60
120
180
Azimuth (deg)

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ERA TECHNOLOGY

ERA Technology Ltd, Cleeve Road
Leatherhead, Surrey, KT22 7SA, UK
Tel: +44 (0) 1372 367000 • Fax: +44 (0) 1372 367099
info@era.co.uk • www.era.co.uk

ERA Business Unit: ANTENNA & ELECTRONIC SYSTEMS

Report Title:

Schlumberger Oilfields UK Plc
2.4 metre Ku Band Reflector Antenna
Frequency: 13.75 – 14.5 GHz
Model No: KU24LR

Author(s): M M Drew

Client: Schlumberger
Stoneywood Park
Dyce, Aberdeen

Client Reference: PO No: QGBC00166A

ERA Project Number: 51-SA-12755

ERA Report Number: 12755/TR001

Report Version: Issue 1

Document Control: Commercial-in-Confidence

ERA Report Checked by:

G Y Philippou
Antenna Systems

Approved by:

R A Pearson
Antenna Systems

10 October 2008
Ref. 12755/TR001

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ERA Technology Ltd
Cleeve Road
Leatherhead
Surrey KT22 7SA
UK
Tel : +44 (0) 1372 367000
Fax: +44 (0) 1372 367099
E-mail: info@era.co.uk

Read more about ERA Technology on our Internet page at: http://www.era.co.uk/

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1. Introduction

This document describes the laboratory and range measurements undertaken at ERA Technology for the 2.4 metres linearly polarised Ku band reflector antenna required to demonstrate the performance of the system. The reflector system is a single front fed circularly symmetric configuration with the feed supported at the focus of the reflector by four struts in the diagonal planes. The main reflector is a paraboloid and the feed chain consists of a choked corrugated feed horn and a two port Orthomode Transducer (OMT) providing orthogonally polarised transmit and receive functions simultaneously. The mounting of the struts on the main reflector supports the feed chain and the design of this fixture ensures that the feed horn can be precisely integrated with the main reflector in the correct manner.

The feed chain components are all manufactured from aluminium using CNC machining. The feed chain is assembled and checked in the laboratory for VSWR and port-to-port isolation.

The Test Plan and procedures undertaken at ERA are consistent with *IEEE Standard Test Procedures for Antennas ANSI/IEEE Std 149-1979.*

2. Objective

The objective of the Tests is to measure the radiation patterns and gain of the 2.4 metres front fed antenna at Ku band operating in linear polarisation.

3. Testing Site

All testing has been undertaken at the ERA laboratories and outdoor far field range located as follows:

ERA Technology Ltd
Cleeve Road
Leatherhead
Surrey
KT22 7SA
UK

Antenna & Electronic Systems Business Unit
Director of Business Unit: Dr Robert Pearson
Tel: +44 (0) 1372367129
Fax: +44 (0) 1372367467
e-mail: robert.pearson@era.co.uk

4. Identification of Item for Testing

The item tested consisted of a 2.4 metres circularly symmetric reflector and a Ku band feed chain at the focus of the reflector. A photograph of the configuration on the ERA far field range is shown in Figure 1, whilst Figure 2 shows detail of the feed chain. The unit is identified by Model No:KU24LR.

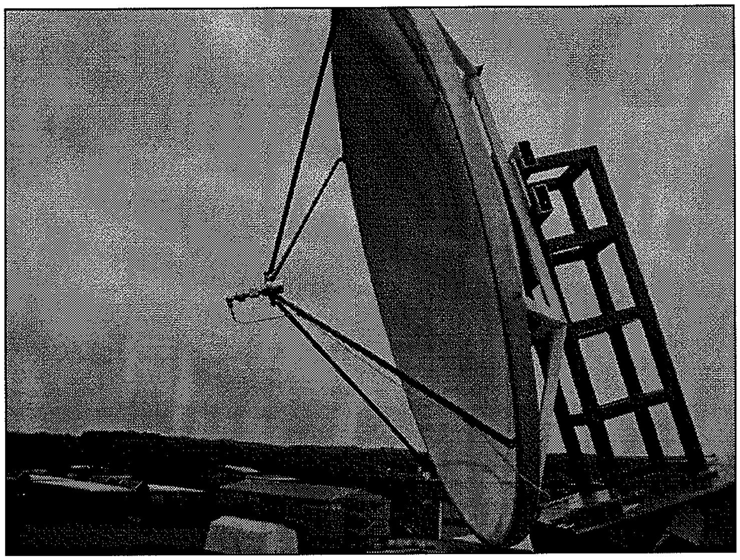


Figure 1: 2.4 metres Ku band reflector on ERA far field range

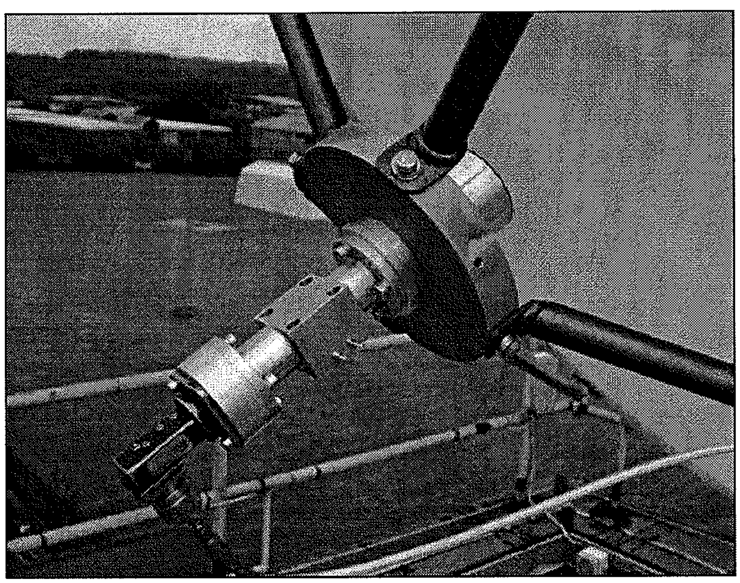


Figure 2: Detail of feed chain of 2.4 metres Ku band reflector

5. Electrical Specification

The electrical specification for the antenna is given in Table 1. This is consistent with Recommendations ITU-R-S580 and ITU-R-S465 and Eutelsat Standard M.

Table 1: Specification and Measurement Matrix

Parameter	Specification	Measurement
Frequency	Rx: 10.95 – 12.75 GHz Tx: 13.75 – 14.50 GHz	Rx: 10.95 – 12.75 GHz Tx: 13.75 – 14.50 GHz
Polarisation	Orthogonal Linear	Orthogonal Linear
Gain	> 48.6 dBi at 14.0 GHz	49.0 dBi at 14.0 GHz
Full 3dB beamwidth	0.6° (Nominal)	0.6° (mid-band)
Off-axis Co-polar Gain Tx Band (Note 1)	29-25log(θ) dBi for (100λ/D)°<θ<20° -3.5 dBi for 20°<θ<26.3° 32-25log(θ) dBi for 26.3°<θ<48° -10 dBi for 48°<θ<180°	Section 7; Patterns plots
On-axis Cross-polar Gain, Tx Band	-35 dB within 1dBcontour (relative to co-polar peak)	Section 7; Patterns plots
Off-axis Cross-polar Gain, Tx Band	19-25log(θ) dBi for (100λ/D)°<θ<7° -0.1-2.4log(θ) dBi for 7°<θ<26.3° 32-25log(θ) dBi for 26.3°<θ<48° -10 dBi for 48°<θ<180°	Section 7; Patterns plots
VSWR Tx Band	1.3:1	1.21:1
Isolation (feed only without transmit reject filter)	>40 dB for 13.75-14.5 GHz >40 dB for 10.95-12.75 GHz	>48 dB for 13.75-14.5 GHz >45 dB for 10.95-12.75 GHz
Waveguide port	WG17/WR75	WG17/WR75

Note 1: In the plane of geostationary orbit, the envelope may be exceeded by no more than 10% of the sidelobes.

6. Quality Control Procedures

ERA Technology Ltd operates a Quality Management System that is registered, by BSI, as complying with BS EN ISO 9001:2000 including the TickIt requirements. (Registration number FM1303). The Company maintains other Quality Management System Accreditations and Certifications that are linked either to a specific market, technology or Client.

Our Quality Management System is defined in general terms by a Quality Manual and in detail by a series of Quality Procedures. These documents, and other relevant material, are provided to all ERA staff via our Intranet. This Quality Management System is implemented so as to meet the specific contractual and technical requirements of each individual project.

The Quality Assurance Manager is responsible to the Managing Director for defining the Quality Management System, maintaining it and, when needed, for continually improving the processes and standards. The Quality Assurance Manager is also responsible for identifying quality problems and initiating effective solutions. Individual Project Quality is devolved down from the Heads of Business Units to the Department Managers and, for day-to-day activities, to Project Managers. Quality Assurance Representatives are appointed from the engineering staff to give local support quality and provide a link between their departments and the Quality Assurance Manager.

Copies of our Quality Manual, ISO 9001 Certification and UKAS Accreditation are available either on request or from our web site http://www.era.co.uk/corporate/qualityassurance.asp. Copies of our other approvals are available on request.

7. Measurements

7.1 Introduction

Measurements of antenna radiation patterns and gain were undertaken using ERA's 220 metre far field test range. The range comprises a remotely controlled primary transmitter unit and a receive facility located in a purpose-built test tower 15 metre in height. The receive facility is equipped with programmable *Scientific Atlanta* positioners, receivers and automatic data logging equipment. The transmitter site is furnished with a series of transmit points to cover the various bands. For Ku band the transmitter is a reflector about 900 mm diameter and it utilises a linearly polarised feed chain. The transmitter can be rotated around its axis to align the polarisation as required.

Detailed surveys of this test range have been carried out in the most commonly used microwave bands that indicate co-polar reflectivity better than -50 dB and cross-polar isolations better than 55 dB.

For the 2.4 metres reflector at Ku band the far field defined by $2D^2/\lambda$ is approximately 530 metres. The ERA far field range is 220 metres. For the range measurements the feed chain can be displaced to refocus the antenna at the range at which the measurements are made in accordance with *IEEE Standard Test Procedures for Antennas ANSI/IEEE Std 149-1979.*

7.2 Test Equipment

The test equipment used in the laboratory and test range measurements are listed in Tables 2 and 3 respectively.

Table 2: Laboratory Equipment Check List

Project No:	**51-ST-12755**	**Phase :**	**1**	**Engineer:**	MMD
Project Title	**2.4 metre Ku Band Antenna Testing**				
Measurement:	Tune and Test			**Date:**	11 September 2008

Equipment Used	**Serial No.**	**Calibration Date**	**Tick Box**
Anritsu Network Analyser 37269D	075102	25 Jan 2008	
Anritsu Network Analyser 37397C	R1056	7 Feb 2008	✓
Rosenberger 18 GHz	924201	Indication only	✓
Rosenberger 18 GHz	924202	Indication only	✓
Rosenberger 40 GHz	924701	Indication only	
Rosenberger 40 GHz	924702	Indication only	
Wiltron semi-rigid 3670 K50-2	101003	Indication only	
Wiltron semi-rigid 3670 K50-2	301010	Indication only	
WG6 Flann 06708	21	Indication only	
WG15 Flann 15708	23	Indication only	
WG16 Maury X7005	Individually marked	Indication only	
WG17 Flann 17708	21	Indication only	
WG18 Flann 18708	21	Indication only	
WG20 Flann 20708	23	Indication only	

	WG22 Flann 22708	24	Indication only	
	Wiltron Coaxial Kit 3652-1	80024	7 Feb 2008	✓
	HP 7mm Cal Kit 85031B	2541A00868	25 Jan 2008	

Table 3: Antenna Systems Range Equipment List

Equipment Used	Serial No.	Calibration Date	Tick Box
For range testing of antenna assembly:			
Scientific Atlanta Positioner Az/El/Az 55150A-1	72AG	Indication Only	✓
Scientific Atlanta Positioner Polarisation 56060-18	489	Indication Only	✓
Flann Standard Gain Horn Model No. 17240		Indication Only	✓
Dell Computer with Midas Software	DTOHZOJ	Indication Only	✓
Agilent 20 GHz Lo Source 83623B	3844A01682	29 Jan 2008	✓
Agilent 50 GHz RF Source 83650B	3844A01529	29 Jan 2008	
Agilent Receiver 8530A	3901A00722	29 Jan 2008	✓
Agilent Test Mixer Module 85320A-H50	2944A00942	29 Jan 2008	✓
Agilent Test Mixer Module 18GHz	2944A00258	29 Jan 2008	✓
Agilent Ref Mixer Module 85320B	2944A00156	29 Jan 2008	✓
Agilent Lo/IF distribution Unit 85309A	3224A00707	29 Jan 2008	✓
Orbit Pos. Controller AL-4806-3A	91	Indication Only	✓
Orbit Pos. Controller AL-4906-3A	292	Indication Only	✓

7.3 Laboratory Tests

The feed chain was measured in the laboratory. The return loss measurements were swept frequency over 13.75 – 14.5 GHz, whilst isolation was measured over 10.95 – 14.5 GHz. The following were measured:

i) Return loss at Tx port.

ii) Port-to-port isolation.

The measurements are given in Figures 3 and 4 and summarised in Table 4.

When measuring the return loss, the unused port was terminated in waveguide load and for all measurements the horn was radiating into free-space or suitable anechoic shield.

Typical measurement accuracy after 12-term vector error correction can be read directly from graphs provided by the analyser manufacturer for reflection coefficient and transmission loss. The errors are Root-Sum-Squares (RSS) calculations of the contributions of residual directivity, load and source match, frequency response, isolation, network analyser dynamic accuracy and connector repeatability. This gives:

i) Return loss of 20 dB : Uncertainty (Reflection coefficient) =0.017 dB (RSS)

ii) Return loss of 15 dB : Uncertainty (Reflection coefficient) =0.019 dB (RSS)

Table 4: Laboratory Measurements

	Frequency	Figure	Measured Value	VSWR
Return loss	13.75 - 14.50 GHz	Figure 3	20.6 dB	1.21:1
Isolation Tx - Rx	10.95 - 12.75 GHz 13.75 - 14.50 GHz	Figure 4	> 45 dB > 48 dB	-

7.4 Antenna Range Measurements

7.4.1 Introduction

The procedures undertaken at ERA are consistent with *IEEE Standard Test Procedures for Antennas ANSI/IEEE Std 149-1979*. The measurements were undertaken using a linearly polarised Ku band transmit source.

The antenna under test (AUT) was installed on the positioner and the mixer connected to the relative antenna port.

7.4.2 Pattern measurements procedure

For antenna pattern measurements:

i) Select the frequencies; co-polarise the transmitter with the AUT and steer the AUT to receive maximum signal. Set azimuth and elevation indications to zero.

ii) Rotate the required axis and record the co-polar pattern.

iii) Rotate transmitter polarisation by 90° and record the cross-polar pattern.

iv) Repeat for other frequency bands.

All the measurements were taken by rotating in azimuth. For the elevation cut measurements the AUT was rotated by 90° and the measurements taken with the AUT rotated in azimuth. Patterns were taken ±180° or a narrower limited range with the angular increment 0.2° or less, as described in the Range Measurements Plan, Section 7.4.5.

7.4.3 Gain measurements procedure and results

The antenna gain measurements were performed by comparing with a commercially available linearly polarised Standard Gain Horn (SGH):

i) Locate Standard Gain Horn (SGH) on antenna mount.

ii) Select frequencies; co-polarise the transmitter with the AUT and steer the AUT to receive maximum signal. Set azimuth and elevation indications to zero.

iii) Record the co-polar signal from the AUT.

iv) Record the signal from the SGH.

v) Repeat iii) and iv).

The AUT gain was determined by the average of the two measurements taken. Table 5 gives the gain computations.

Table 5: Measured Gain

Frequency GHz	13.75	14.125	14.50
AUT dB	-21.1	-22.9	-20.9
SGH dB	-43.4	-45.2	-42.9
Diff dB	22.3	22.3	22.0
SGH Gain dBi	26.5	26.7	26.9
AUT Gain dBi	**48.8**	**49.0**	**48.9**

7.4.4 Far field range measurement uncertainties

Typical far field range measurements uncertainties are given in Table 6.

Table 6: Far field Range measurement uncertainties

Parameter	Value
Mutual Coupling	0.0 dB
Tx Amplitude Taper (0.25 dB)	0.1 dB
Reflections (Elevated Range)	0.01 dB
Frequency Stability	0.01%
Power Level	< ± 0.05 dB
Standard Gain Horn	± 0.25 dB
Spacing Tx to AUT	0.04 dB
Tx isolation	0.01 dB
Total RSS (Root-Sum-Square)	**0.28 dB**

The overall accuracy of the gain measurements undertaken using a commercial Standard Gain Horn is estimated to ±0.28 dB.

7.4.5 Range measurements plan

The Test Plan for the range measurements is given in Table 7. All the measurements were recorded by rotating in azimuth. The elevation cut measurements were recorded by rotating in azimuth after turning the AUT by 90°. Since the AUT is linearly polarised, the cuts in Table 7 are identified as E-plane or H plane cuts. For example, for a vertically polarised antenna, E-plane is the elevation cut and H-plane is the azimuth cut. Co-polar and cross-polar component patterns were taken for ±180° in θ, the angular increment 0.2°. Co-polar and cross-polar measurements were taken for ±22.5° and ±10° in θ with the angular increment 0.05°.

All the measurements were recorded as ASCII text files in amplitude (dB) and phase (deg). The data were then processed in Excel spreadsheets in the format required by Anatel and supplied with the Test Report.

The recorded patterns are included in this Test Report and identified by the Pattern Number as given in Table 7. Table 8 summarises the sidelobe level deviations above the specified template.

Table 7: Range measurements Test Plan

				Pattern Number		
Angular scale degrees	**Scale dB**	**Cut**	**Component**	**Tx Frequency GHz**		
				13.75	**14.125**	**14.50**
±10	70	E-Plane	Co & Cross	1	2	3
±10	70	H-Plane	Co & Cross	4	5	6
±22.5	70	E-Plane	Co & Cross	7	8	9
±22.5	70	H-plane	Co & Cross	10	11	12
±180	80	E-Plane	Co & Cross	13	14	15
±180	80	H-plane	Co & Cross	16	17	18
Gain			Co	✓	✓	✓

Table 8: Sidelobe level deviations

	Frequency					
	13.75 GHz		14.125 GHz		14.5 GHz	
Range	**E-plane**	**H-Plane**	**E-plane**	**H-Plane**	**E-plane**	**H-Plane**
0° – 90°	0.0 dB	2.0 dB	0.0 dB	1.3 dB	0.0 dB	2.5 dB
90° – 180°	6.5 dB	7.9 dB	9.1 dB	7.7 dB	4.5 dB	5.5 dB

7.4.6 Antenna range Test Log sheet

ANTENNA RANGE TEST LOG SHEET			
TITLE:	Schlumberger 2.4m Reflector	OPERATOR:	MMD
PROJECT NO:	12755	DATE:	11 September 2008
DESCRIPTION:	2.4m Reflector with ERA feed 037/08	FREQUENCIES:	13.75, 14.125, 14.50 GHz
TEST PLAN:	As test Plan 12755/TP001	DATAFILE DIRECTORY:	Data/Schlumberger_12755

DATA FILE NAME		
PATTERN	CO-POLAR	CROSS-POLAR
±10º 70 dB Co & X E-Plane	SCH 4	SCH 5
±10º 70 dB Co & X H-Plane	SCH	SCH 1
±22.5º 70 dB Co & X E-Plane	SCH 4	SCH 5
±22.5º 70 dB Co & X H-Plane	SCH	SCH 1
±178.6º 80 dB Co & X E-Plane	SCH 7	SCH 6
±178.6º 80 dB Co & X H-Plane	SCH 3	SCH 2

SET-UP FILE NAMES:		DIRECTORY:	
PROCESSED DATA FILE NAMES:		AZ/EL ALIGNMENT:	Yes
TX EQUIPMENT USED:			
COMMENTS: .			

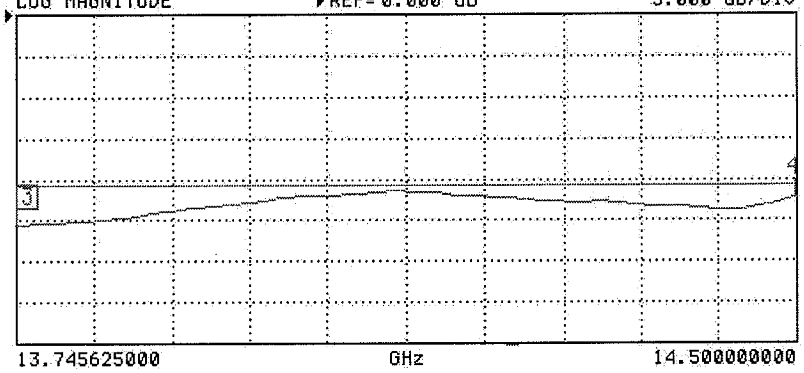
Anritsu
Discover What's Possible™

490 Jarvis Drive
Morgan Hill, Ca 95037 - 2809
TEL 408 - 778 - 2000
FAX 408 - 778 - 0239

VNA: 37269D

```
MODEL:        DMS Ku Feed         DATE:       10/08/2008   12:12
DEVICE ID:    A                   OPERATOR:  Peter Stock
Side Port Tx/Tx to Rx
START:        13.745625000 GHz    GATE START:      -          ERROR CORR:  12-TERM
STOP:         14.500000000 GHz    GATE STOP:       -          AVERAGING:  100 PTS
STEP:          0.008875000 GHz    GATE:            -          IF BNDWDTH:  1 KHz
                                  WINDOW:          -
                        -----------CH1-----------    -----------CH3-----------
PARAMETER:                        -S11-                        -S21-
NORMALIZATION:                     OFF                          OFF
REFERENCE PLANE:              0.0000    mm               0.0000    mm
SMOOTHING:                    0.0 PERCENT                0.0 PERCENT
DELAY APERTURE:                     -                            -
```

S11 FORWARD REFLECTION
LOG MAGNITUDE ▸REF= 0.000 dB 5.000 dB/DIV



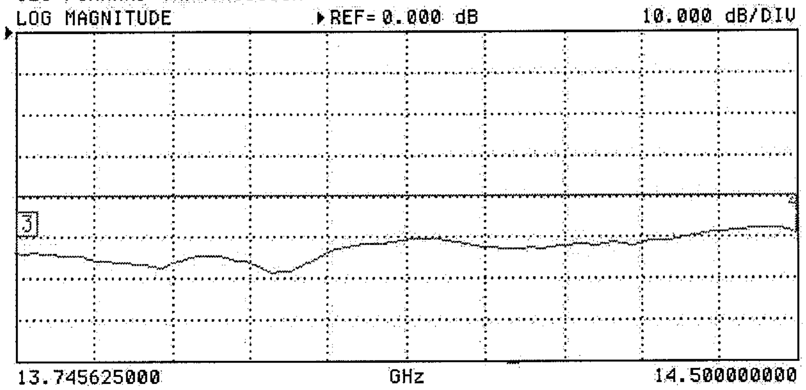

```
CH 1 - S11
  0.0000 mm REF
  0.000 dB OFFSET
  0.00°    OFFSET

▸MARKER 3
 13.745625000 GHz
   -25.611 dB

MARKER TO MAX
MARKER TO MIN

4  14.500000000 GHz
   -22.248 dB
```

S21 FORWARD TRANSMISSION
LOG MAGNITUDE ▸REF= 0.000 dB 10.000 dB/DIV



MARKER READOUT
FUNCTIONS

Figure 3: Measured return loss & isolation

Anritsu
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490 Jarvis Drive
Morgan Hill, Ca 95037 - 2809
TEL 408 - 778 - 2000
FAX 408 - 778 - 0239

VNA: 37269D

MODEL: DMS Ku Feed
DEVICE ID: A
Port to Port Isolation
START: 10.950000000 GHz
STOP: 14.500000000 GHz
STEP: 0.008875000 GHz

DATE: 10/08/2008 13:36
OPERATOR: Peter Stock

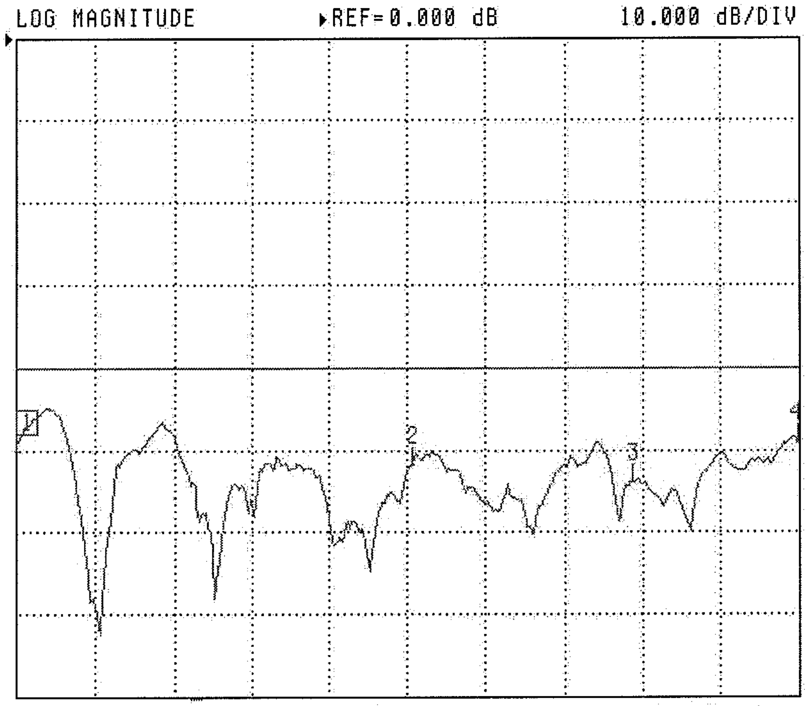
GATE START: -
GATE STOP: -
GATE: -
WINDOW: -

ERROR CORR: 12-TERM
AVERAGING: 100 PTS
IF BNDWDTH: 1 KHz

-----------CH3-----------
PARAMETER: -S21-
NORMALIZATION: OFF
REFERENCE PLANE: 0.0000 mm
SMOOTHING: 0.0 PERCENT
DELAY APERTURE: -

S21 FORWARD TRANSMISSION

LOG MAGNITUDE ▸REF=0.000 dB 10.000 dB/DIV



CH 3 - S21
0.0000 mm REF
0.000 dB OFFSET
0.00° OFFSET

▸MARKER 1
10.950000000 GHz
-50.112 dB

MARKER TO MAX
MARKER TO MIN

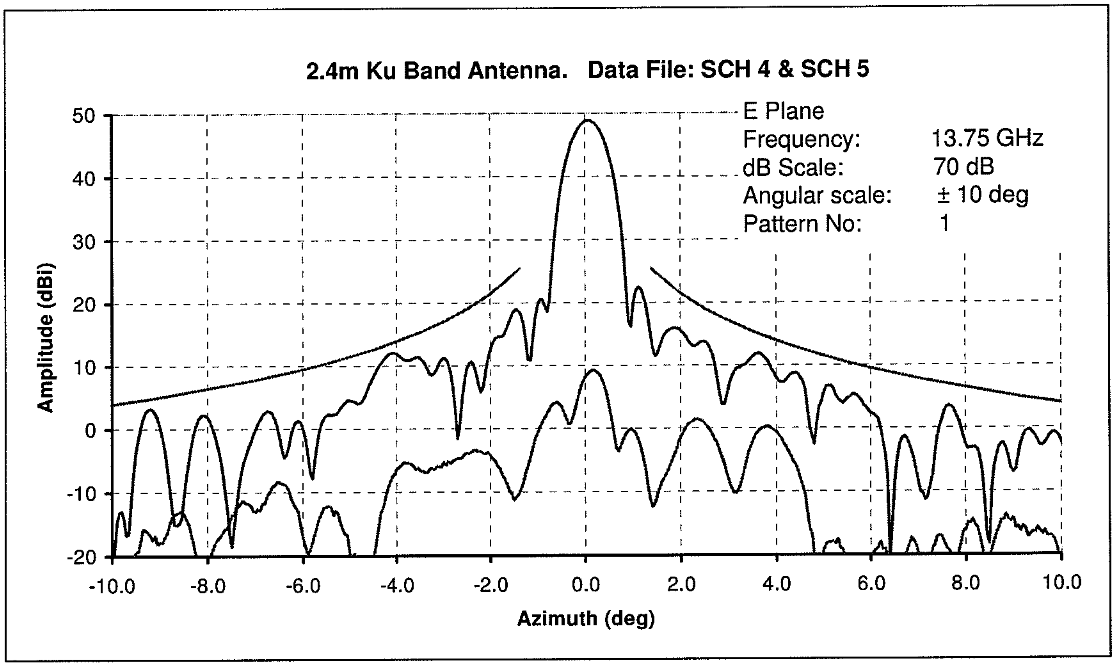
2 12.751625000 GHz
-51.802 dB

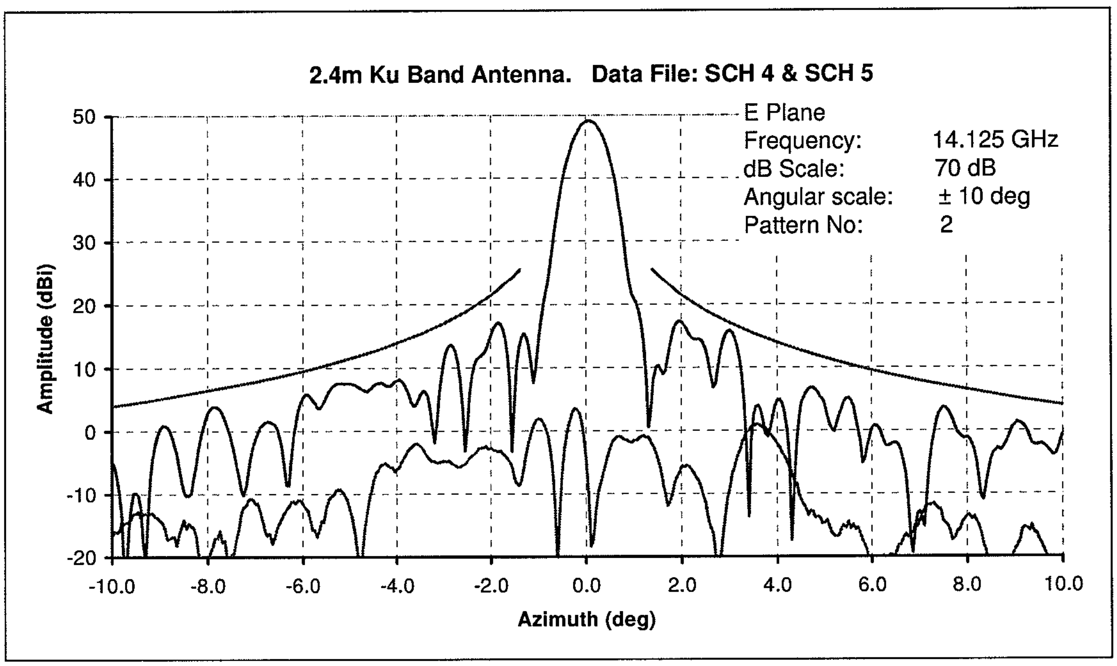
3 13.745625000 GHz
-53.855 dB

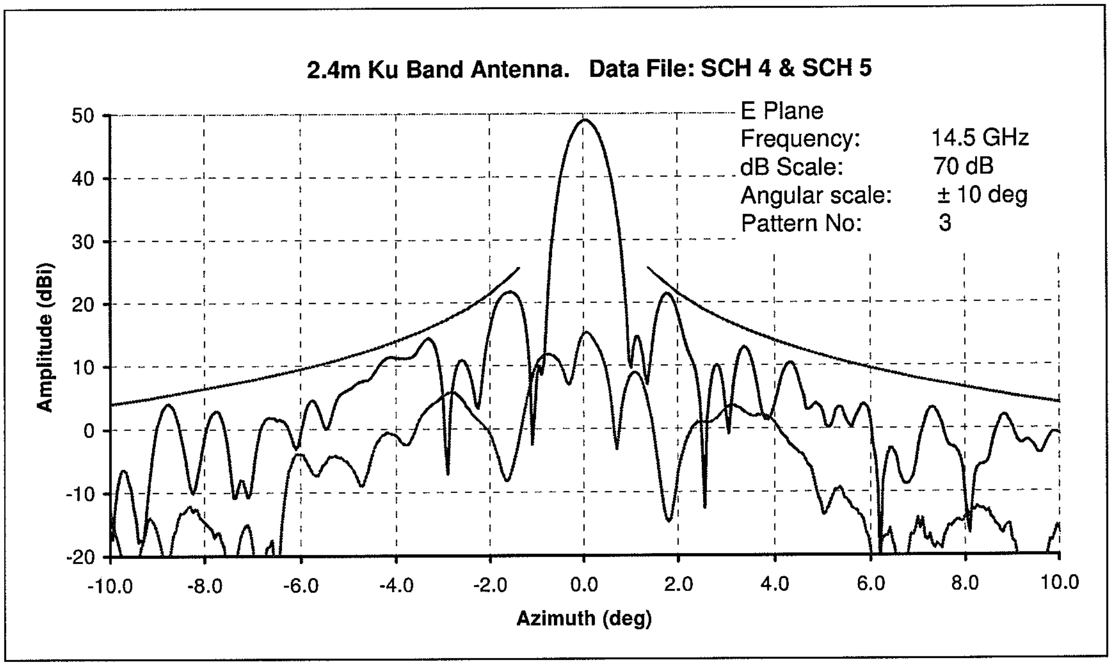
4 14.500000000 GHz
-49.115 dB

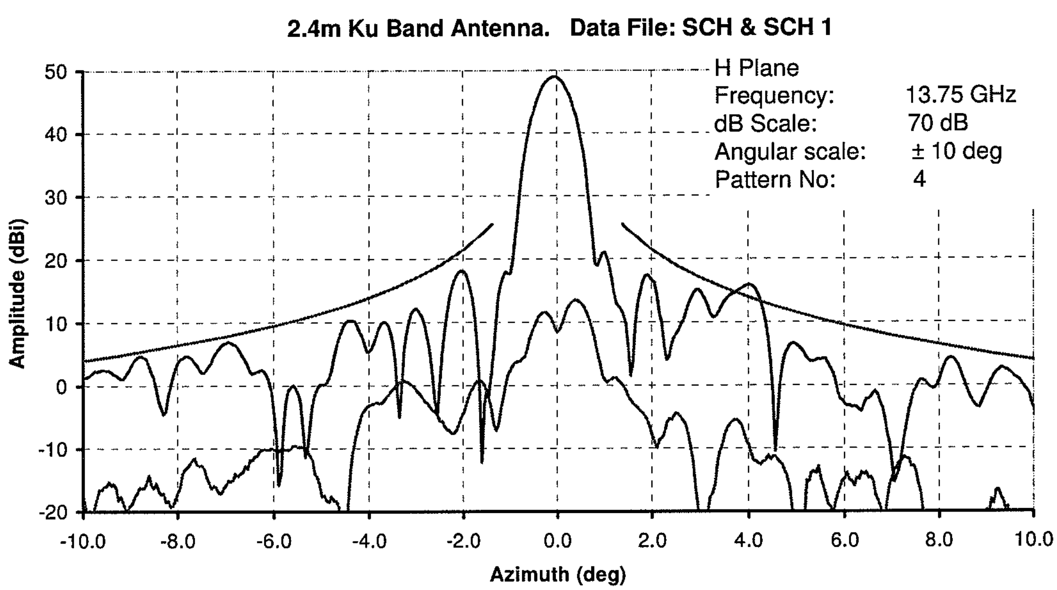
MARKER READOUT
FUNCTIONS

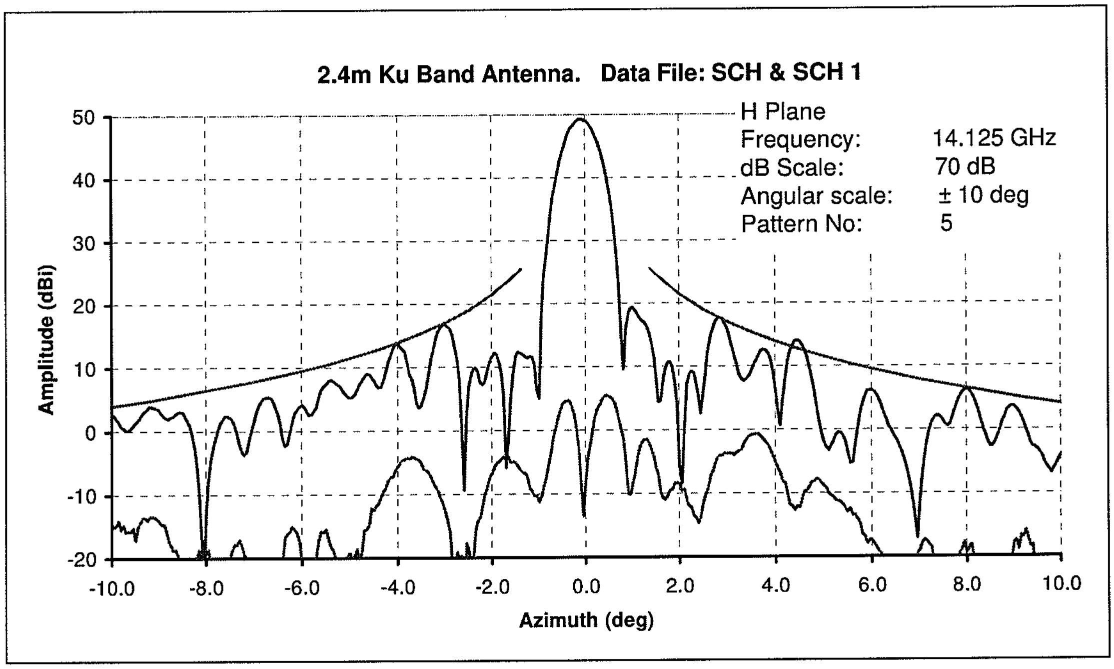
Figure 4: Measured Port to Port isolation

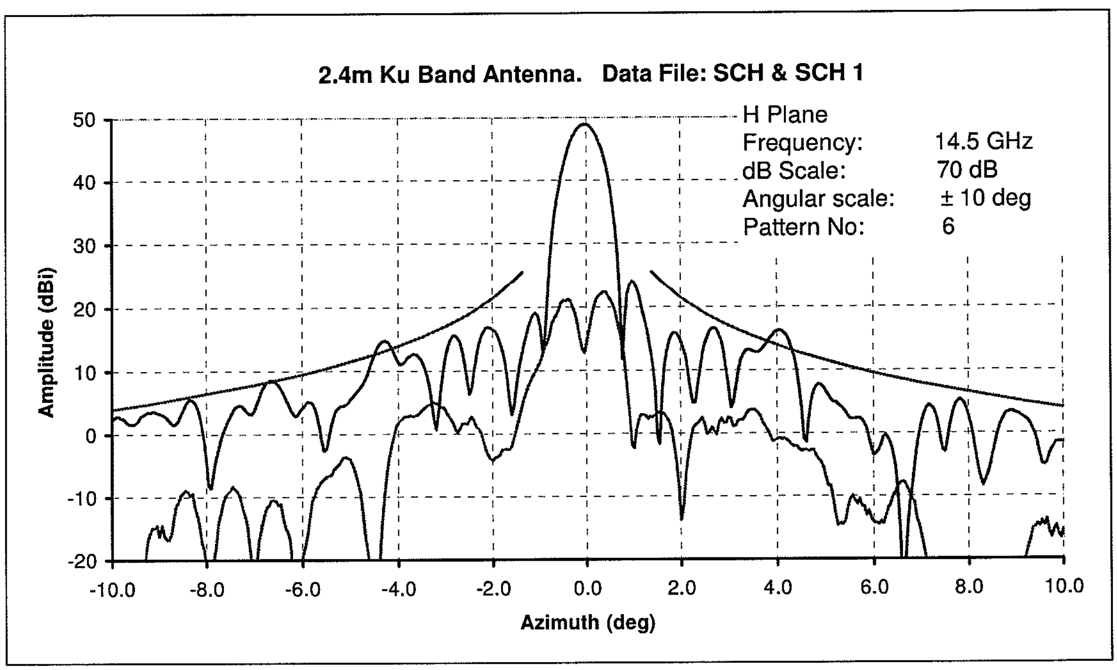

2.4m Ku Band Antenna. Data File: SCH 4 & SCH 5
E Plane
Frequency: 13.75 GHz
dB Scale: 70 dB
Angular scale: ± 10 deg
Pattern No: 1
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Azimuth (deg)

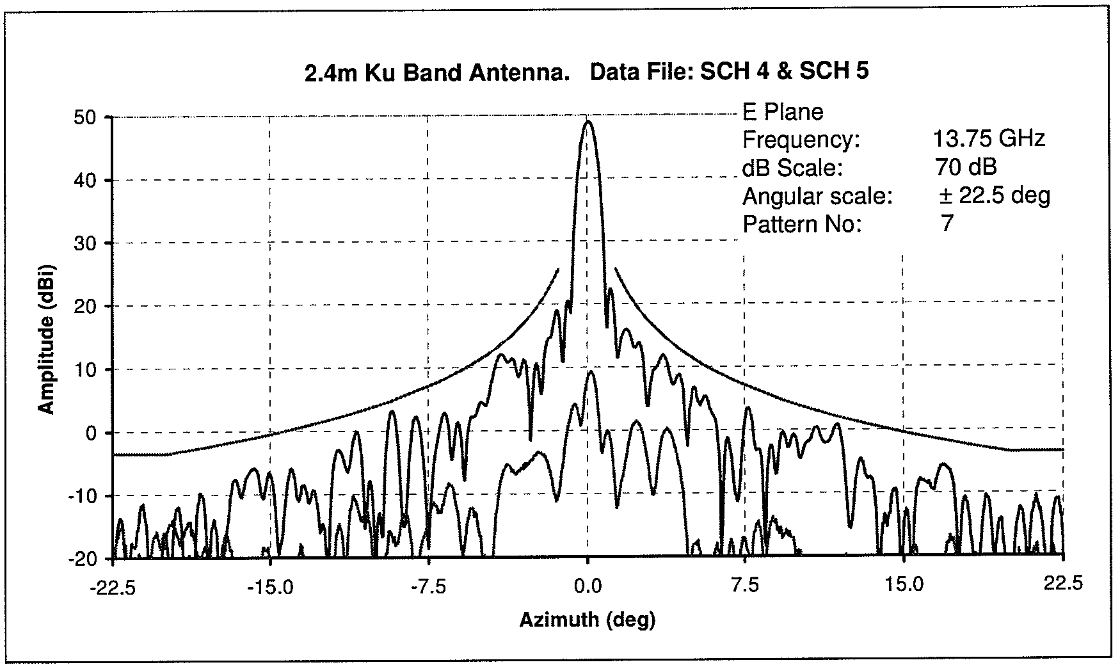

2.4m Ku Band Antenna. Data File: SCH 4 & SCH 5
E Plane
Frequency: 14.125 GHz
dB Scale: 70 dB
Angular scale: ± 10 deg
Pattern No: 2
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Azimuth (deg)

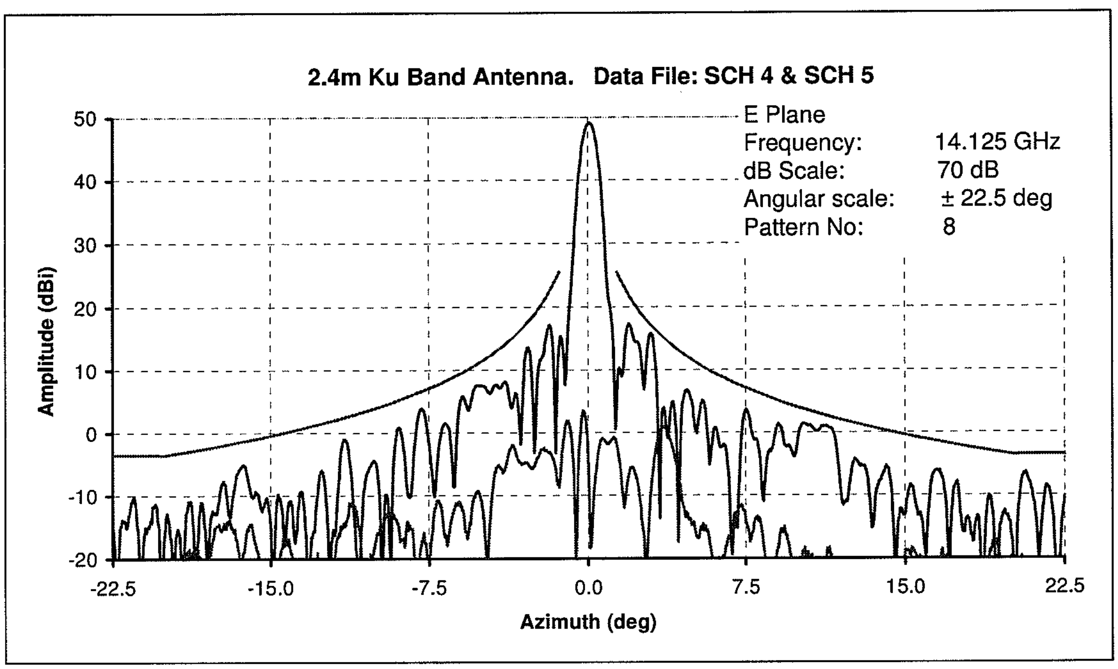

2.4m Ku Band Antenna. Data File: SCH 4 & SCH 5
E Plane
Frequency: 14.5 GHz
dB Scale: 70 dB
Angular scale: ± 10 deg
Pattern No: 3
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Azimuth (deg)

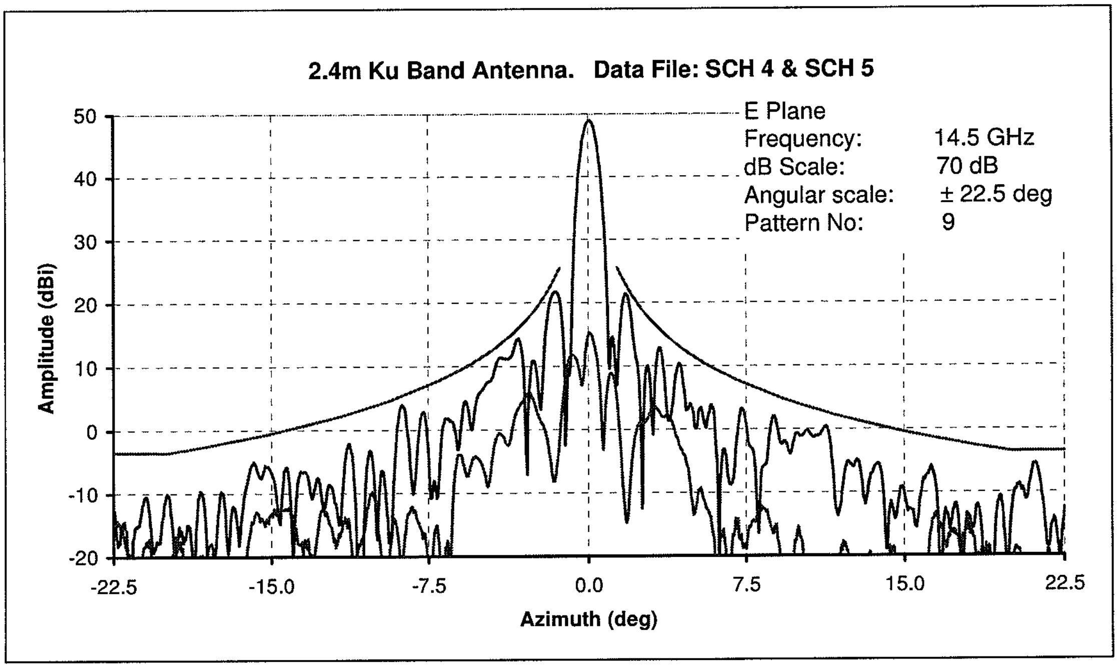

2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 13.75 GHz
dB Scale: 70 dB
Angular scale: ± 10 deg
Pattern No: 4
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Azimuth (deg)

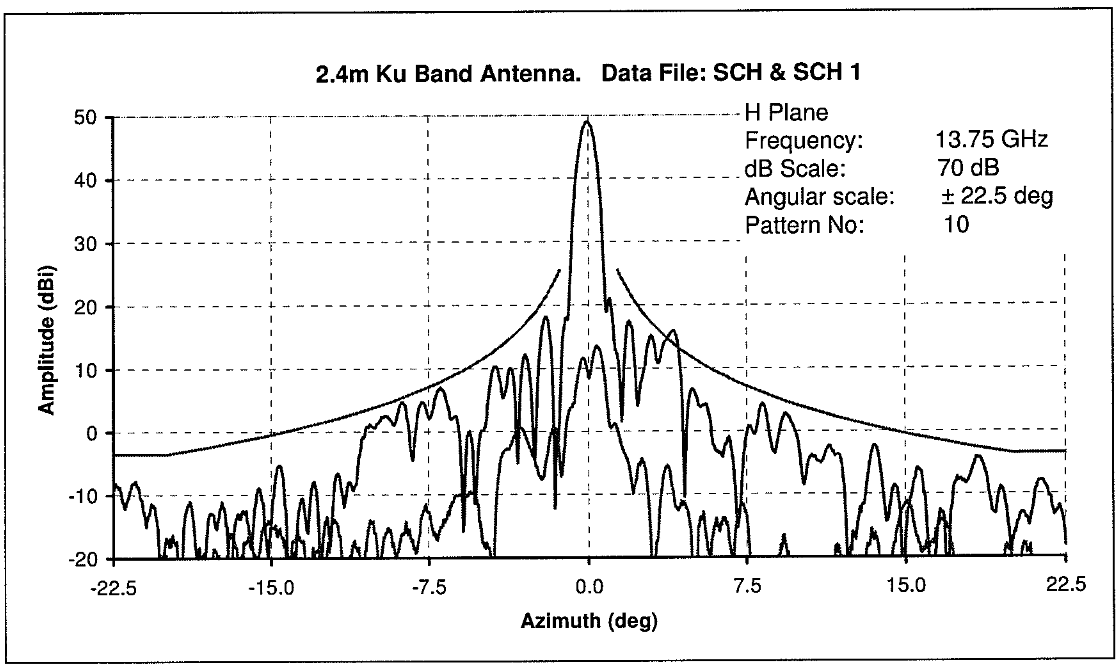

2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 14.125 GHz
dB Scale: 70 dB
Angular scale: ± 10 deg
Pattern No: 5
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Azimuth (deg)

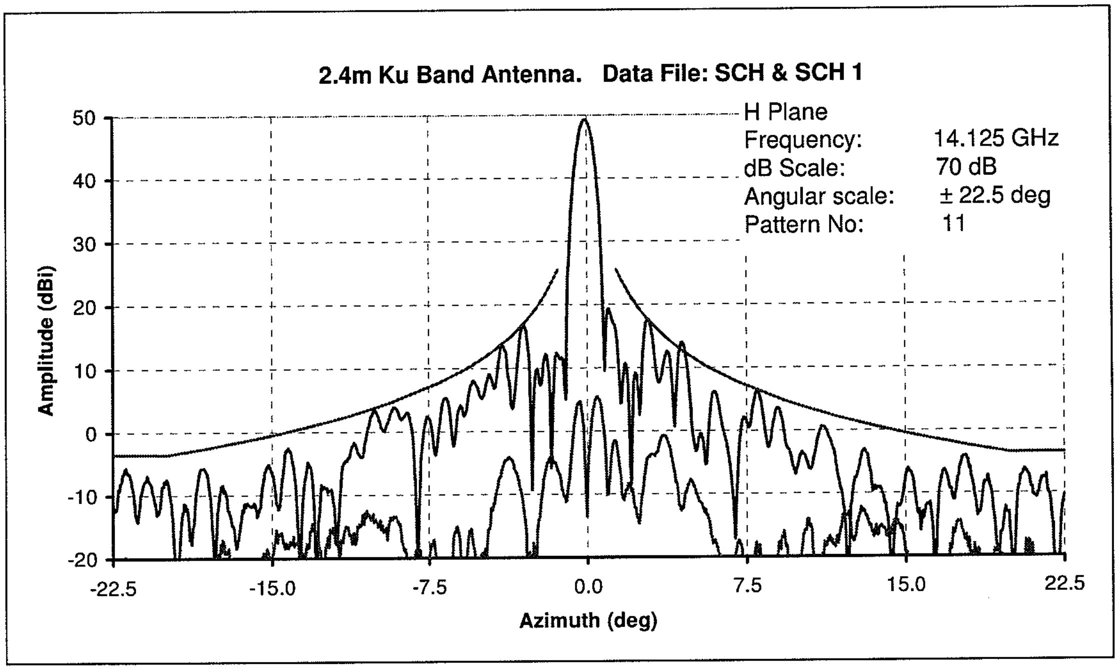

2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 14.5 GHz
dB Scale: 70 dB
Angular scale: ± 10 deg
Pattern No: 6
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-10.0
-8.0
-6.0
-4.0
-2.0
0.0
2.0
4.0
6.0
8.0
10.0
Azimuth (deg)

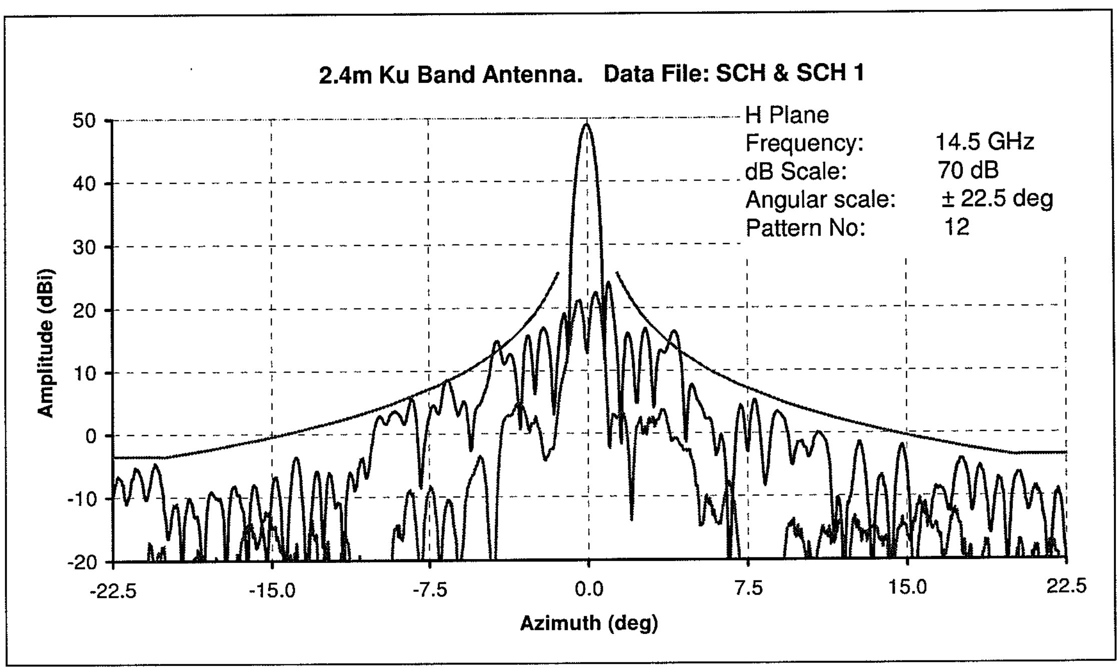

2.4m Ku Band Antenna. Data File: SCH 4 & SCH 5
E Plane
Frequency: 13.75 GHz
dB Scale: 70 dB
Angular scale: ± 22.5 deg
Pattern No: 7
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)

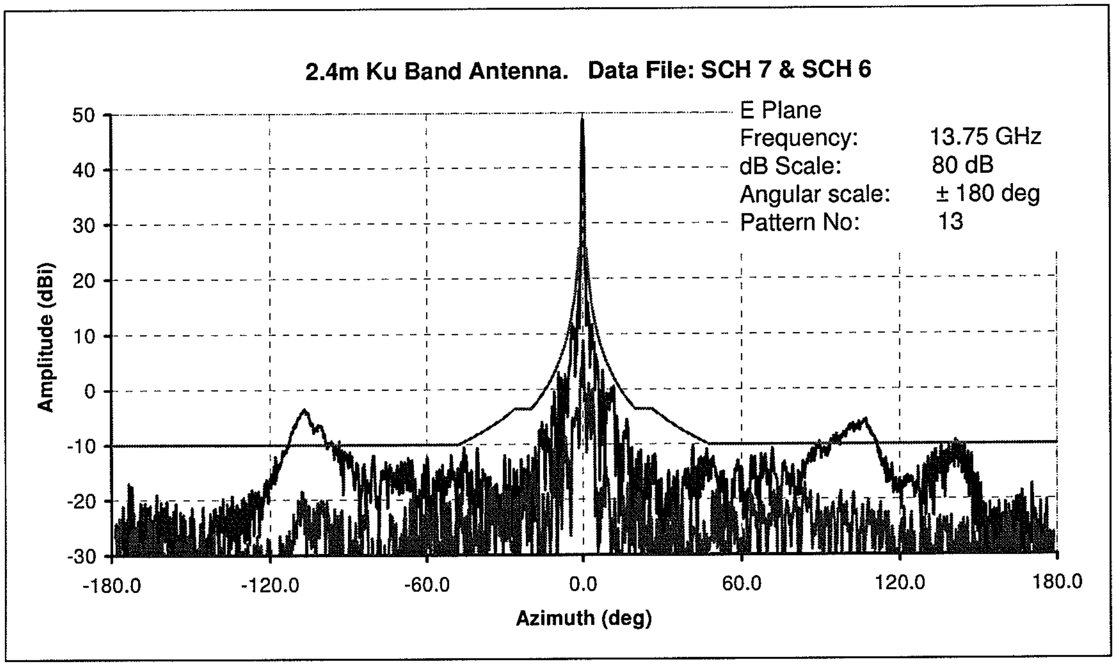

2.4m Ku Band Antenna. Data File: SCH 4 & SCH 5
E Plane
Frequency: 14.125 GHz
dB Scale: 70 dB
Angular scale: ± 22.5 deg
Pattern No: 8
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)

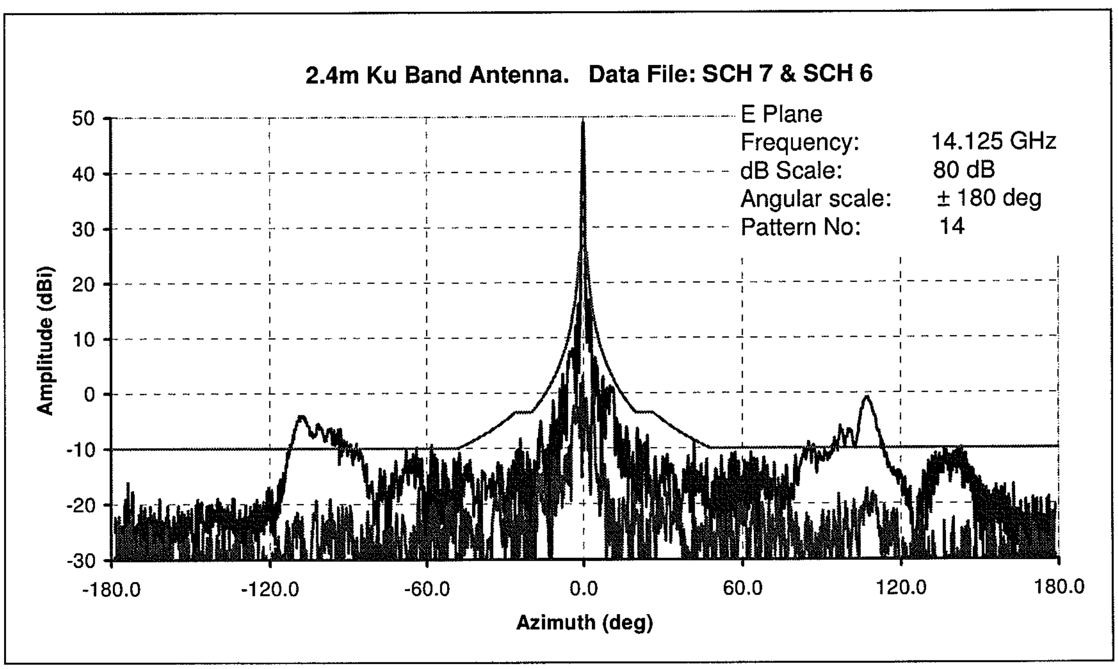

2.4m Ku Band Antenna. Data File: SCH 4 & SCH 5
E Plane
Frequency: 14.5 GHz
dB Scale: 70 dB
Angular scale: ± 22.5 deg
Pattern No: 9
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)

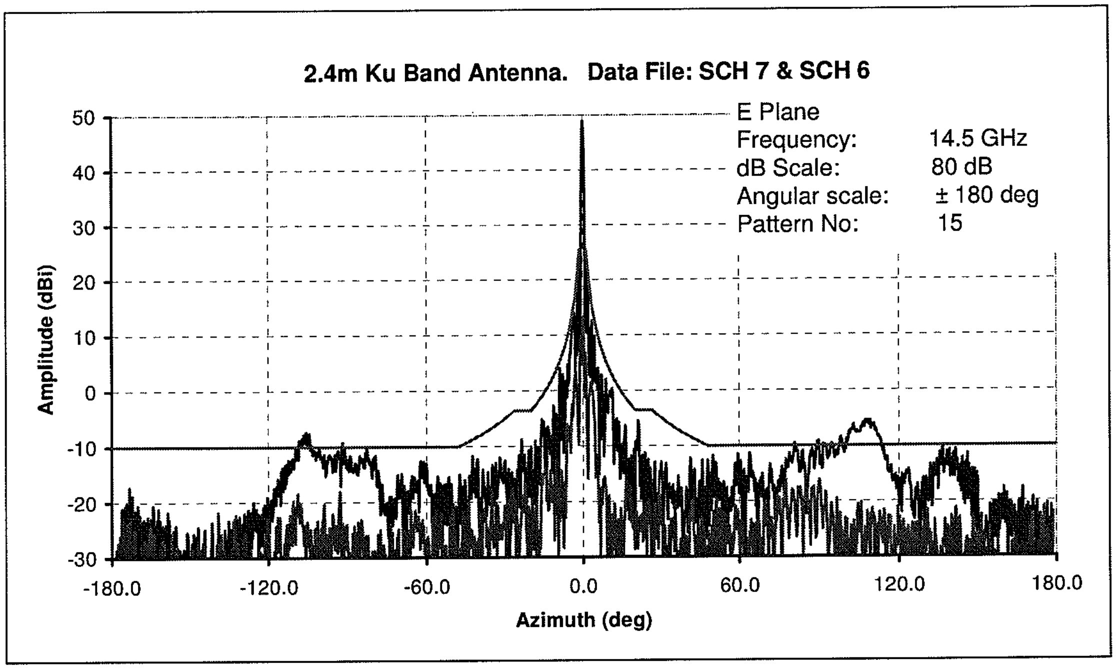

2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 13.75 GHz
dB Scale: 70 dB
Angular scale: ± 22.5 deg
Pattern No: 10
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)

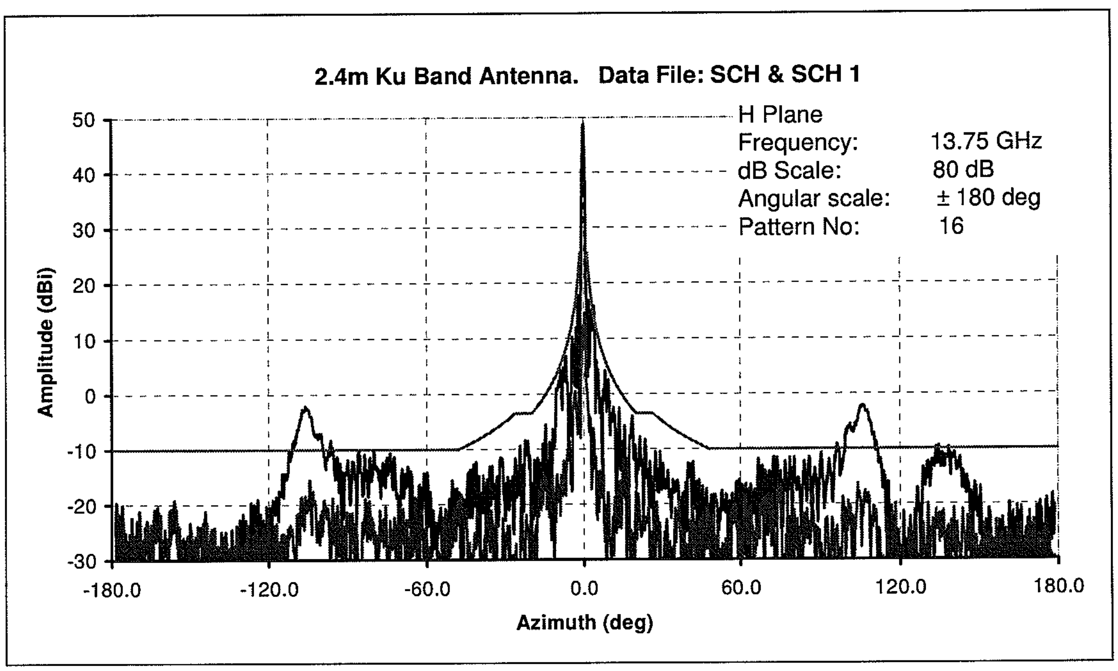

2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 14.125 GHz
dB Scale: 70 dB
Angular scale: ± 22.5 deg
Pattern No: 11
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)

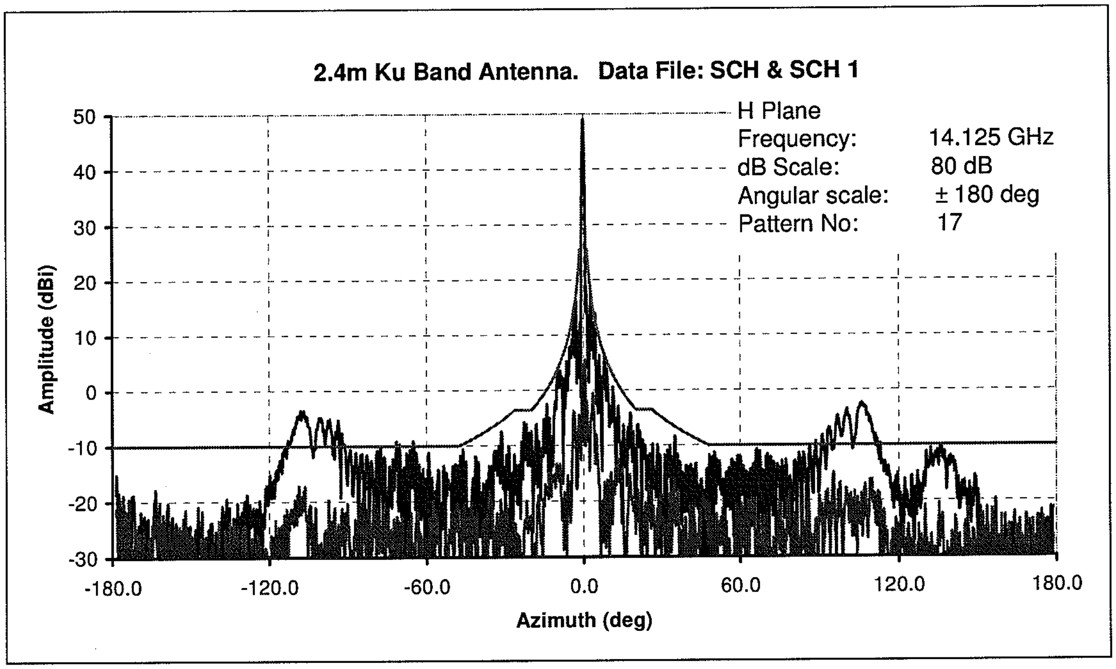

2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 14.5 GHz
dB Scale: 70 dB
Angular scale: ± 22.5 deg
Pattern No: 12
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-22.5
-15.0
-7.5
0.0
7.5
15.0
22.5
Azimuth (deg)

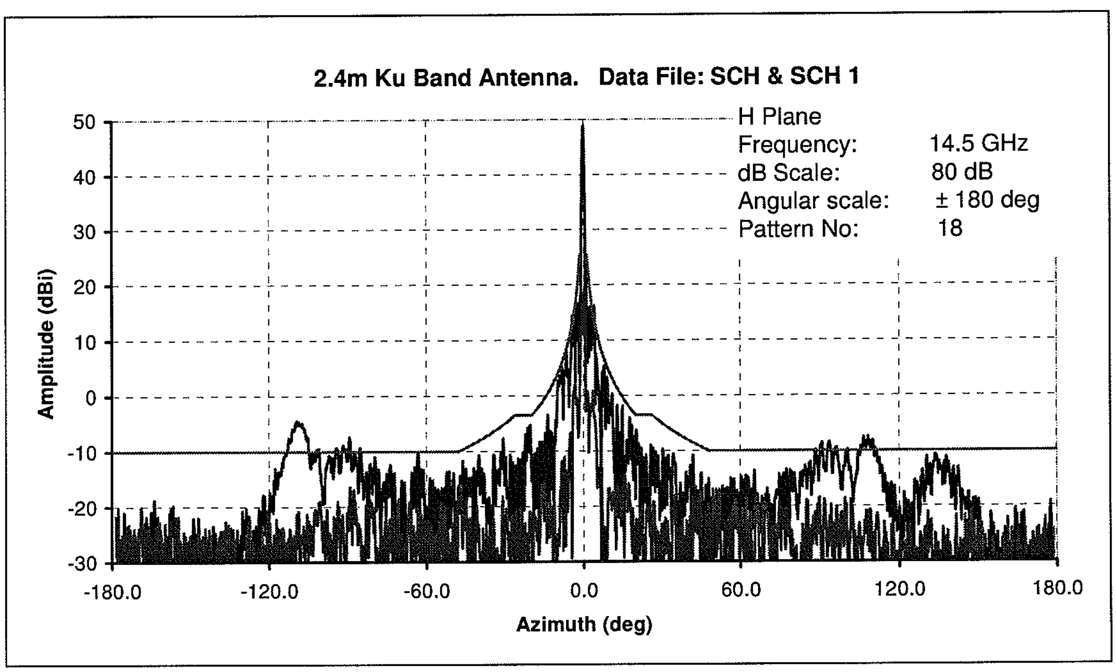

2.4m Ku Band Antenna. Data File: SCH 7 & SCH 6
E Plane
Frequency: 13.75 GHz
dB Scale: 80 dB
Angular scale: ± 180 deg
Pattern No: 13
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-30
-180.0
-120.0
-60.0
0.0
60.0
120.0
180.0
Azimuth (deg)


2.4m Ku Band Antenna. Data File: SCH 7 & SCH 6
E Plane
Frequency: 14.125 GHz
dB Scale: 80 dB
Angular scale: ± 180 deg
Pattern No: 14
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-30
-180.0
-120.0
-60.0
0.0
60.0
120.0
180.0
Azimuth (deg)


2.4m Ku Band Antenna. Data File: SCH 7 & SCH 6
E Plane
Frequency: 14.5 GHz
dB Scale: 80 dB
Angular scale: ± 180 deg
Pattern No: 15
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-30
-180.0
-120.0
-60.0
0.0
60.0
120.0
180.0
Azimuth (deg)


2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 13.75 GHz
dB Scale: 80 dB
Angular scale: ± 180 deg
Pattern No: 16
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-30
-180.0
-120.0
-60.0
0.0
60.0
120.0
180.0
Azimuth (deg)


2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 14.125 GHz
dB Scale: 80 dB
Angular scale: ± 180 deg
Pattern No: 17
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-30
-180.0
-120.0
-60.0
0.0
60.0
120.0
180.0
Azimuth (deg)


2.4m Ku Band Antenna. Data File: SCH & SCH 1
H Plane
Frequency: 14.5 GHz
dB Scale: 80 dB
Angular scale: ± 180 deg
Pattern No: 18
Amplitude (dBi)
50
40
30
20
10
0
-10
-20
-30
-180.0
-120.0
-60.0
0.0
60.0
120.0
180.0
Azimuth (deg)