

MB13 Beam Steer Declarations for FCC Testing

Measurements from Nov 2020 Supplier CDR

Feb 14, 2022



Purpose: Show antenna pattern measurements to support FCC Declare for MB13 2.4GHz Phased Array minimum and maximum beam gain

Plots included:

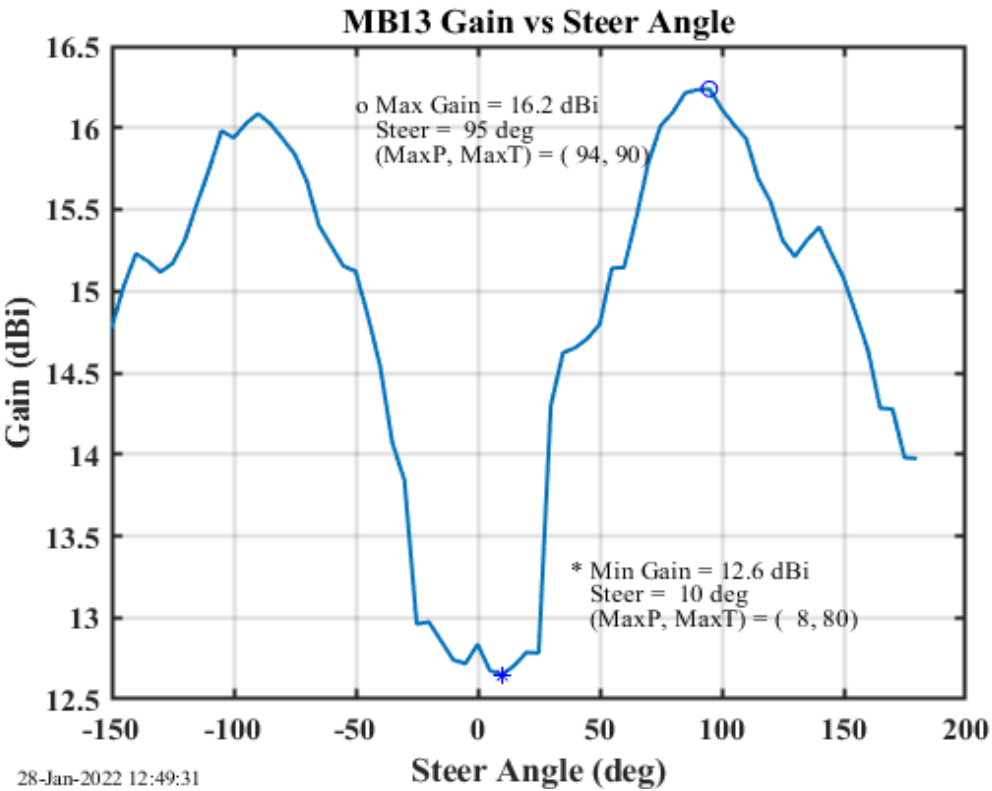
- **Peak beam gain vs steer angle**
- **Azimuth and Theta patterns for a set of steer angles**

- MB13 is a multiband antenna supporting:
 - Terrestrial Bands:
 - Passive, OMNI antenna
 - Supports multiple terrestrial (LTE, WCDMA) frequency bands.
 - ATG Bands (894-896MHz Tx):
 - Passive, OMNI antenna
 - Dual polarity (H & V)
 - Lower gain than Gogo's EVDO / LTE ATG grant.
 - 2.4GHz Band: Active Phased Array antenna
 - Input signal Level= -55dBm to -15dBm
 - Maximum Peak Beam Gain = 16.2dBi, Min Peak Beam Gain = 12.6dBi
 - Circuit gain varies to keep total transmit gain at 51dBi and total EIRP at <36dBm
 - Steers only in azimuth in 1deg steps from -150deg to +150deg
 - Single polarity (Vertical). (No MIMO)

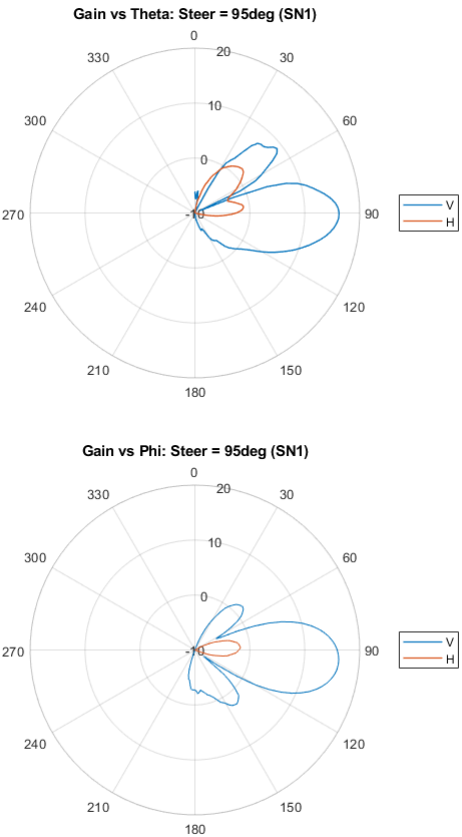
FCC Declare for MB13 Min/Max Beam Gain

The plots show maximum and minimum MB13 antenna beam gain. FCC testing will only be done for maximum and minimum beam gains.

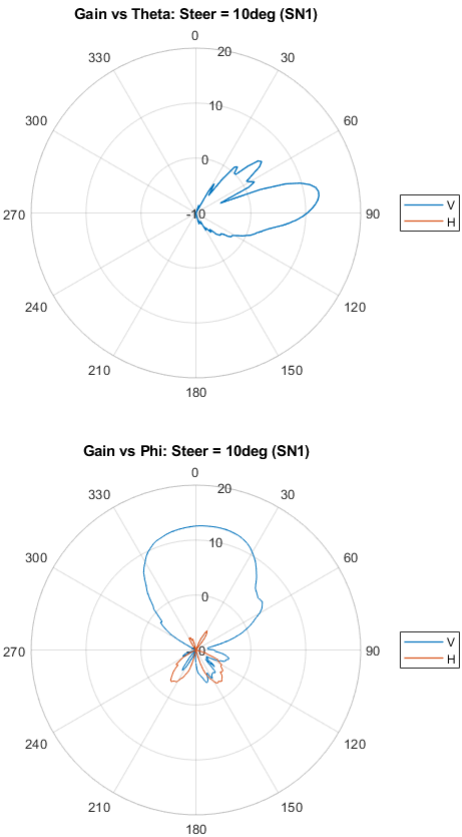
Source: First RF CDR (Nov 2020) for MB13 Serial #4.



Max Gain Patterns

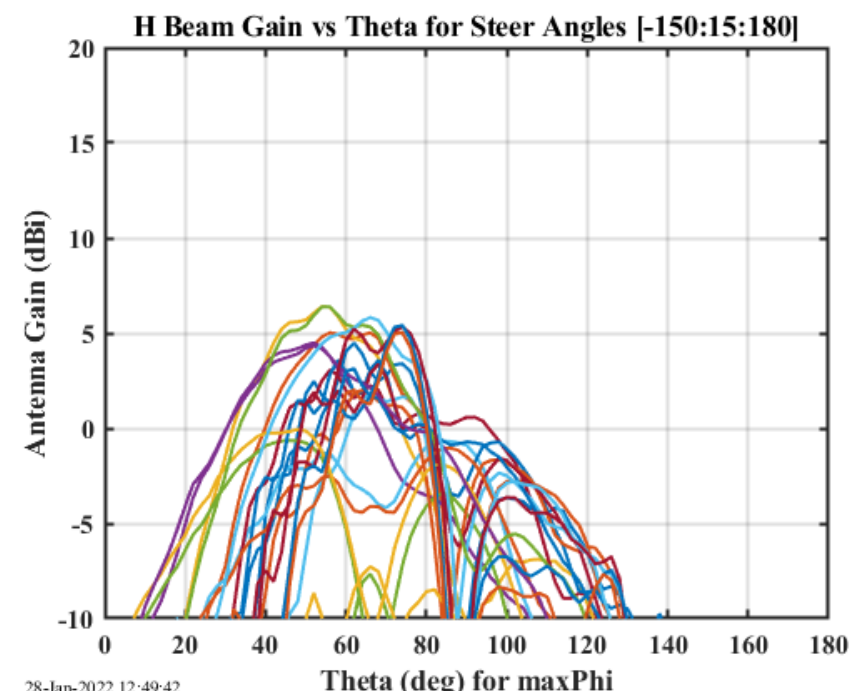
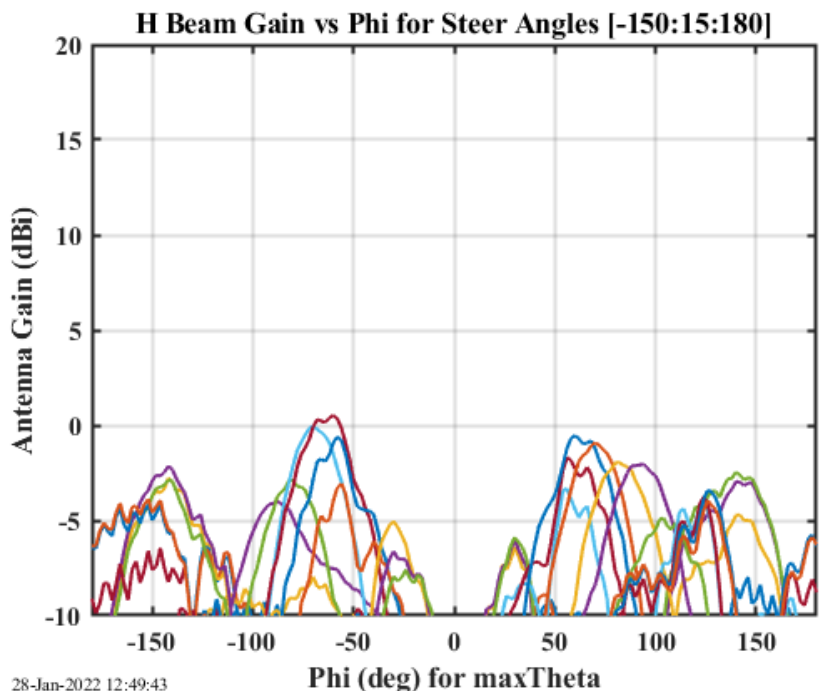
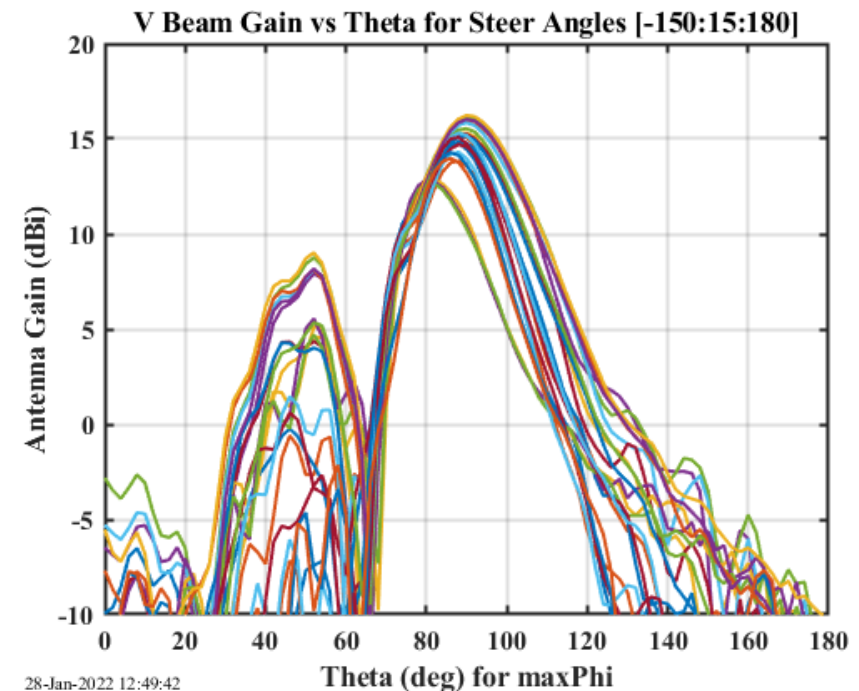
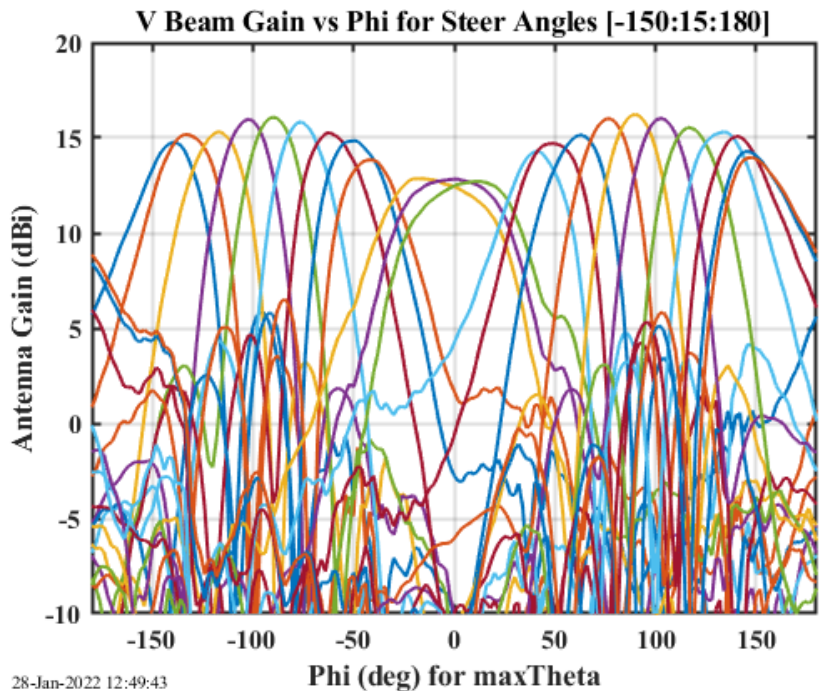


Min Gain Patterns



Azimuth and Theta patterns

- These plots show Azimuth and Theta patterns for a set of steer angles ranging from -150 to +180 deg in 15deg steps.



FRF-274 TLA RANGE TEST PROCEDURE

This is a truncated / redacted version of FIRST RF full TLA Range Test Procedure for the FRF-274. This information has been provided in support of the FCC certification process.

Michael Goulder 2025-09-05

1 Introduction

Pictures can be found in the confidential operationa description exhibit

Figure 1: MB13 Antenna (TLA P/N FRF-51210) showing the four RF connectors.

This automated test procedure guides the user on each step while also simultaneously providing pass / fail results. A complete listing of the range tests performed by this ATP can be found in **Error! Reference source not found..** This antenna contains both passive antennas and active antennas which require power and configuration via a custom interface board, the ATI. Carefully read the setup instructions before proceeding.

2 Required Equipment

2.1 Test Equipment

The following test equipment is required. Unless designated by an asterisk, alternates are acceptable by the applicable engineering organization.

Table 1: Test Equipment

QTY	PART NUMBER	DESCRIPTION
1	FRF-34165	FIRST RF 50' Antenna Range
2	ETS Lindgren 3164-06	Quad Ridge Horn
1	BK Precision 9111	16V, 4A capable power supply
1	Tripp-Lite U336-000-R	USB to Ethernet adapter
1	FRF-53448	Antenna Test Interface Assembly
1	N/A	ATI power cable
1	Fairview Microwave SM4767	SMA to TNC Adapters
3	Fairview Microwave STT1841	50 Ohm TNC Loads

Table 2: Test Fixtures

QTY	PART NUMBER	DESCRIPTION
1	N/A	Gogo 1.5m radius cylindrical ground plane
1	FRF-53449	FRF-274 range adapter plate
4	92319A754	Nylon 6/6 Plastic Hex Standoff, 3/8" Hex, 1" Long, 8-32 Female Thread

3 Setup & Calibration

3.1 Range Setup

3.1.1 Ensure all range connections are made per Figure 2.

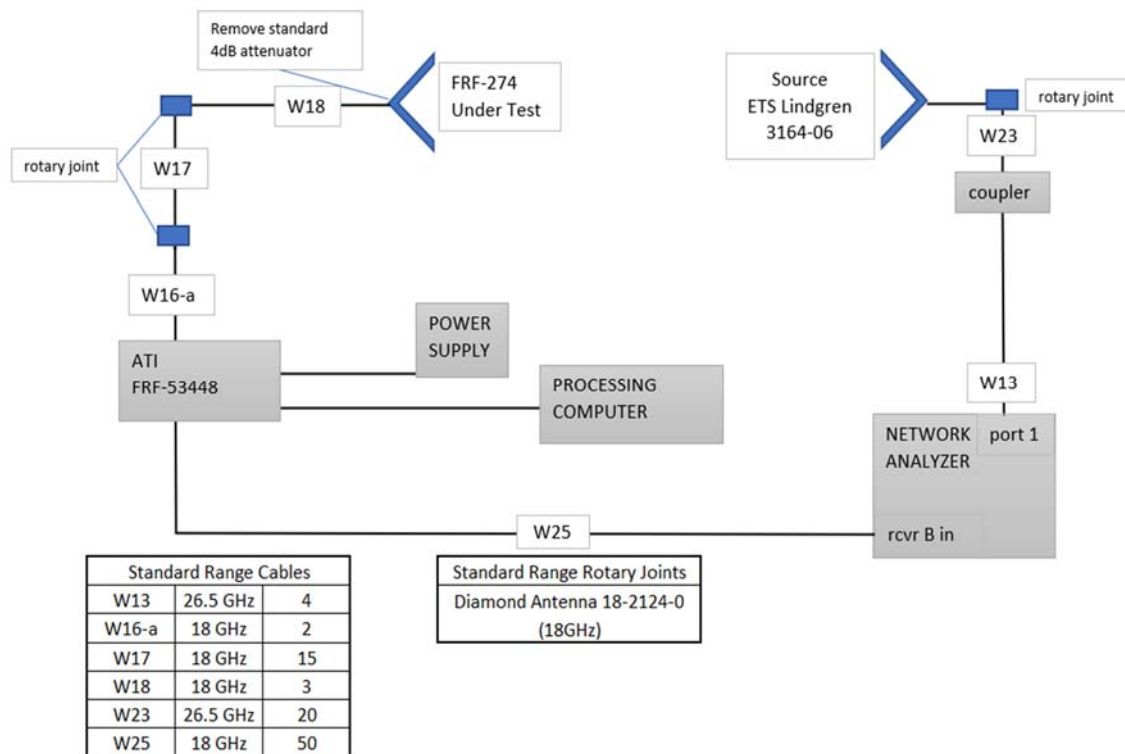


Figure 2 Block Diagram of Range set up

3.1.2 Calibration

Properly configure the ATI for range calibration

3.1.3 Calibrate the FIRST RF 50' Antenna Range for horizontal polarization over a minimum bandwidth of 850-2500 MHz with a minimum frequency resolution of 1 MHz using ETS Lindgren 3164-06 open boundary quad ridge horns as both the source and gain standard antennas.

3.1.4 After calibrating, verify that no major failures have occurred by comparing the system response at the time of calibration with the previous time the range was calibrated in the same way. After accounting for system changes such as replaced components, the system response should be within approximately ± 3 dB of the previous calibration response. If it is not, the system should be inspected and re-calibrated.

3.2 Ground Plane Installation and Orientation

Install the Gogo 1.5m radius cylindrical ground plane as shown in Figure 3. When correctly installed the arrow on the face of the ground plane will be pointing towards the range door. Orient the ground plane such that the face of the ground plane where the AUT is mounted will be in line with the table axis of rotation, and an AUT, when mounted, will be level.

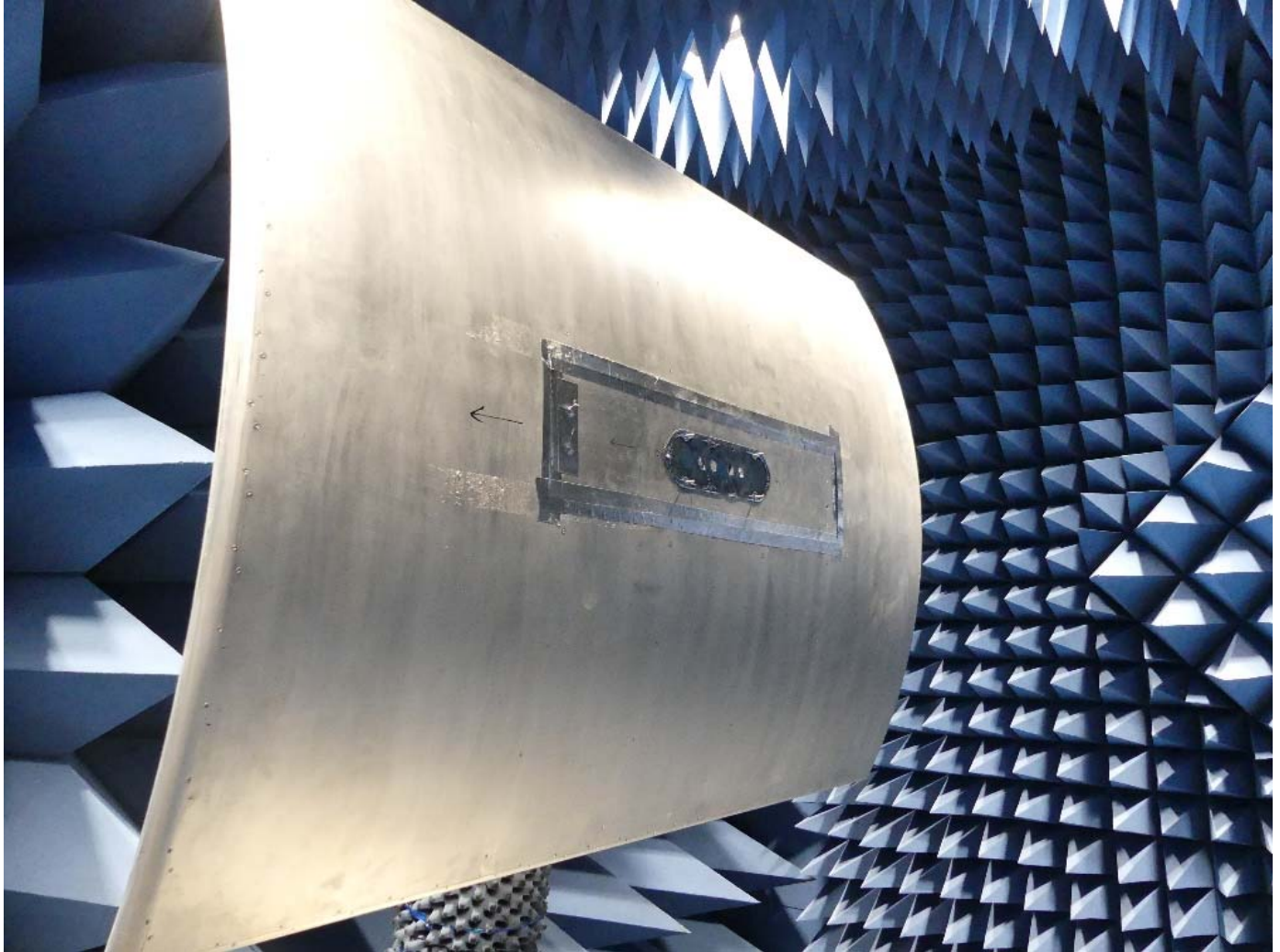


Figure 3 Ground Plane Installed

TLA VSWR TEST PROCEDURE

This is a truncated / redacted version of FIRST RF full TLA VSWR Test Procedure for the FRF-274. This information has been provided in support of the FCC certification process.

Michael Goulder 2025-09-05



1 Introduction

Pictures can be found in the confidential operationa description exhibit

Figure 1-1: MB13 Antenna (TLA P/N FRF-51210) showing the four RF connectors.

This ATP measures the VSWR of all four ports of the MB13 antenna, in addition to providing the antenna with the relevant electronic information of the particular Top Level Assembly (TLA). The VSWR of this antenna, especially J4, is particularly sensitive to the size of the ground plane. Due to this, this test requires a specific ground plane to ensure accurate results.

2 Required Equipment

Table 1: Test Equipment

Qty	Part No.	Description
1 (of any)	P9370A or above	Keysight Vector Network Analyzer Acceptable models: P9370A, P9371A, P9372A, P9373A, P9374A, P9375A
1 (of any)	N4691D N7550A N4691B 85052D	E-Cal Module E-Cal Module E-Cal Module Mechanical Standard
1	FRF-54154	ATP, TLA, VSWR GROUNDPLANE
1	FRF-51115	ANTENNA TEST INTERFACE ATP
1	FRF-54036	ENCLOSURE, ATI, LID
1	FRF-54037	ENCLOSURE, ATI, BASE
1	n/a	16V, 4A capable power supply
1	n/a	USB to Ethernet adapter
1	n/a	CAT5 cable
1	n/a	ATI Power Cable
2	n/a	SMA to TNC Adapters
2	n/a	>12" RF test cable rated to a VSWR of <1.25:1 at 6GHz
1	n/a	Breakover Torque Wrench (7-10 in-lbs.)

3 Hardware Setup

This section details first time setup requirements that do not need to be repeated in subsequent tests unless the hardware or software is changed.

3.1 Test Equipment Setup

3.1.1 Verify that the test equipment is setup up in accordance with block diagram in Figure 3-1. The complete setup is shown in Figure 3-2.

3.1.2 Torque all SMA connections to 7-10 in-lb.

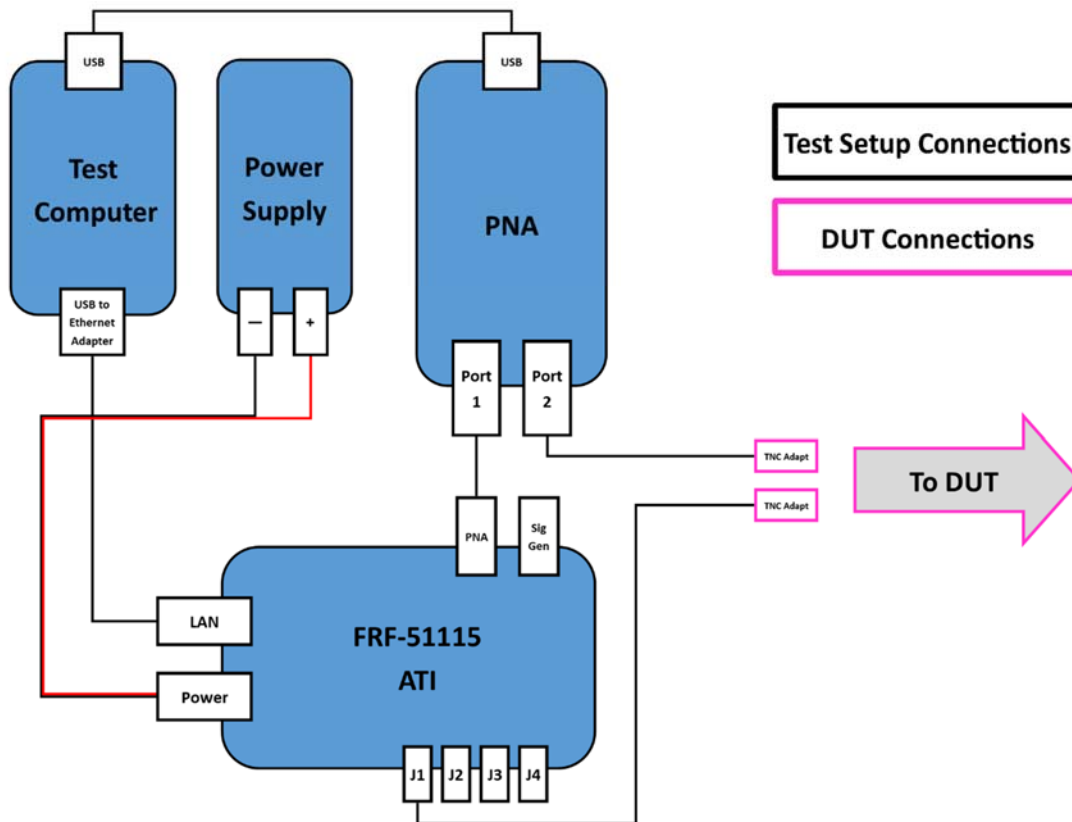


Figure 3-1 Test Setup Block Diagram showing connections between hardware and Device Under Test (DUT)



Pictures can be found in the confidential operationa description exhibit

Figure 3-2 FRF-54058-ATP Setup

4 Testing Procedure

4.1 Connect the Device Under Test (DUT).

- 4.1.1 Place DUT on the ground plane (FRF-54154). The locating pegs should be inside the grounding bushings, and antenna positioned so the Forward Direction of Flight is facing away from the operator. See Figure 4-1.

Pictures can be found in the confidential operationa description exhibit

Figure 4-1 DUT on Ground Plane

Pictures can be found in the confidential operationa description exhibit

Figure 4-2 DUT Side Profile

- 4.1.2 Connect the cable from the network analyzer's Port 1 to DUT J1
- 4.1.3 Connect the cable from the network analyzer's Port 2 to DUT J2.