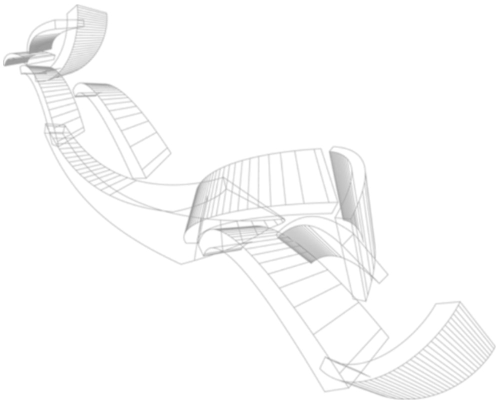


LS telcom

LS MULTI COPTER PROJECTS AND SERVICES (PTY) LTD

ANECHOIC CHAMBER MEASUREMENTS

1 Introduction

LS telcom developed its own anechoic chamber in South Africa with turntable for performance compliance testing. Our chamber is 8m X 4.5m X 4.5m meter in size and cover the frequency range from 100MHz to 9 GHz.

The chamber was originally developed for antenna pattern and UAV RF characterisation and to determine the RF immunity of the UAV against interference from other sources. The is currently being used to perform electromagnetic interference (EMI) and electromagnetic compatibility (EMC) testing on all different electronic equipment. We also perform bulk antenna testing in order to determine the average gain as well as standard deviation for a batch of antennas of other electronic equipment.

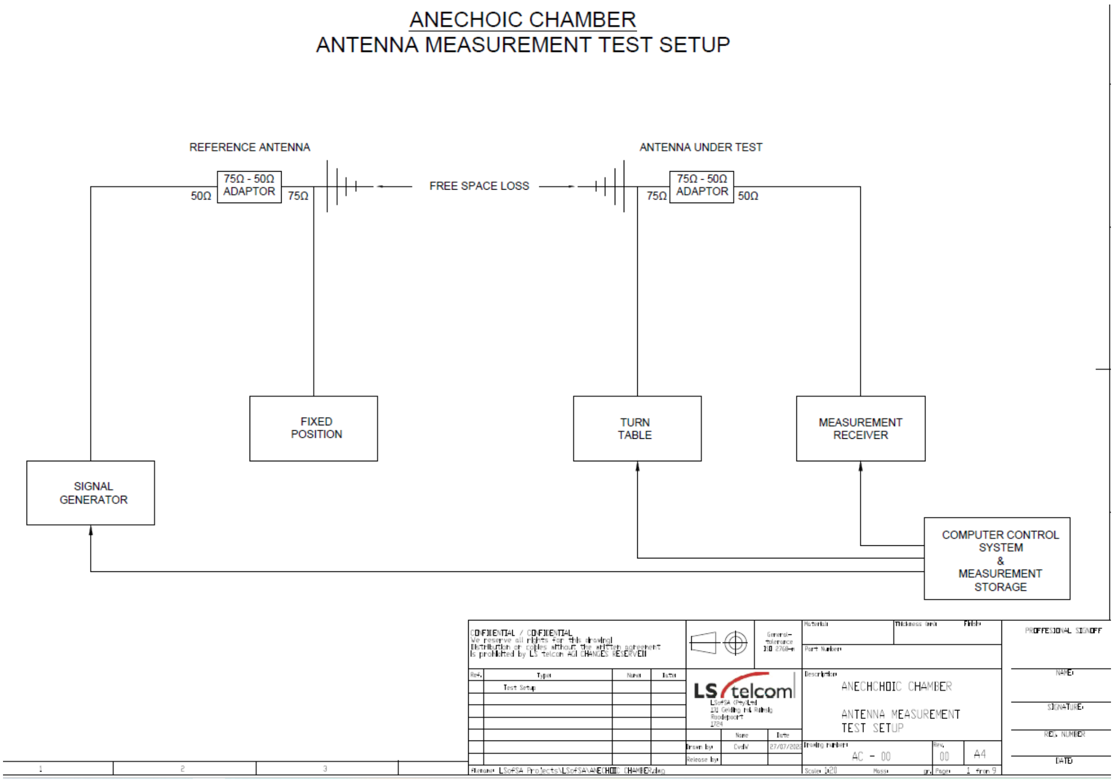
The chamber is equipped with auto report generation especially where standard functions such as antenna pattern and gain testing is involved. The chamber is constantly being improved by adding automated measurement procedures to improve the efficiency of the chamber measurements.

We have recently added 5G test devices to our chamber in order to perform basic tests on 5G devices.

2 Typical Anechoic Chamber Measurement

The anechoic chamber measurements vary from in-house measurements to pre-compliance and compliance measurements for equipment specification and defined standards. The standard measurement set-up in the chamber is virtually always the same when different RF measurements are performed. There will always be a radio frequency source and a measurement device present when performing measurements in the chamber. There will also be a device under test of which some RF characteristic is measured. A picture of the anechoic chamber is included below:

The typical measurement setup for antenna testing is shown below:



The following testing are typically performed in the chamber:

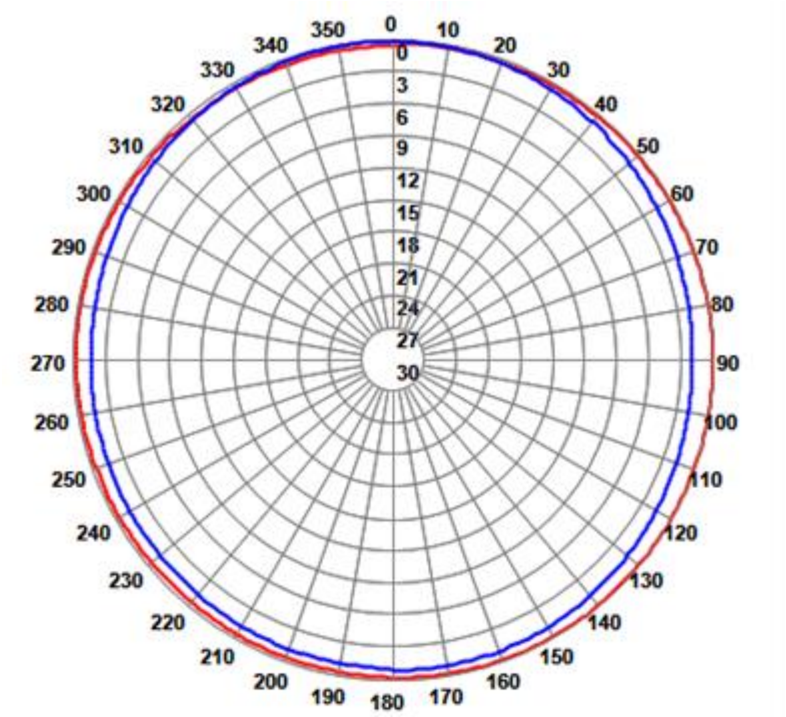
- Antenna pattern testing
- Antenna gain testing
- Antenna impedance testing
- EMI and EMC testing
- Interference, in-band radiation, out of band radiation, harmonic and intermodulation measurements
- 5G testing

The different tests performed in the chamber are described separately below.

2.1 Antenna Pattern Testing

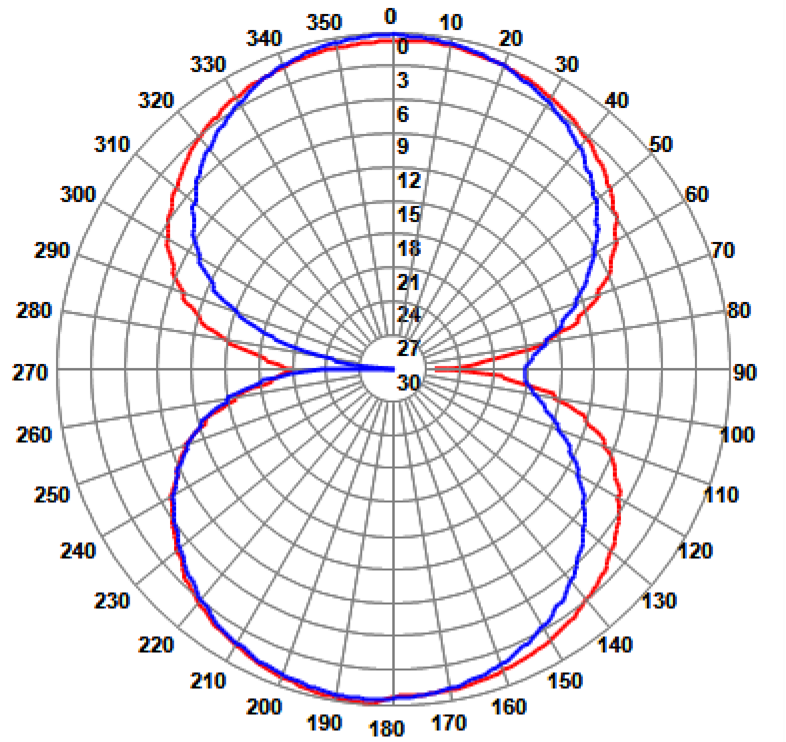
Antenna pattern testing will normally include an elevation pattern and an azimuth pattern for a specific polarisation. A combination of the two patterns will produce a 3D pattern. There can also be more than one elevation pattern for an azimuth pattern if it is a more complex antenna system. The antenna pattern will also change with a change in frequency even if the frequency still fall within the operating frequency range of the antenna. We include typical antenna pattern measurements for both the azimuth and elevation for different frequencies below:

Antenna azimuth pattern for two frequencies



175 MHz	Visible		Nay	Altered
234 MHz	Visible		Nay	Altered

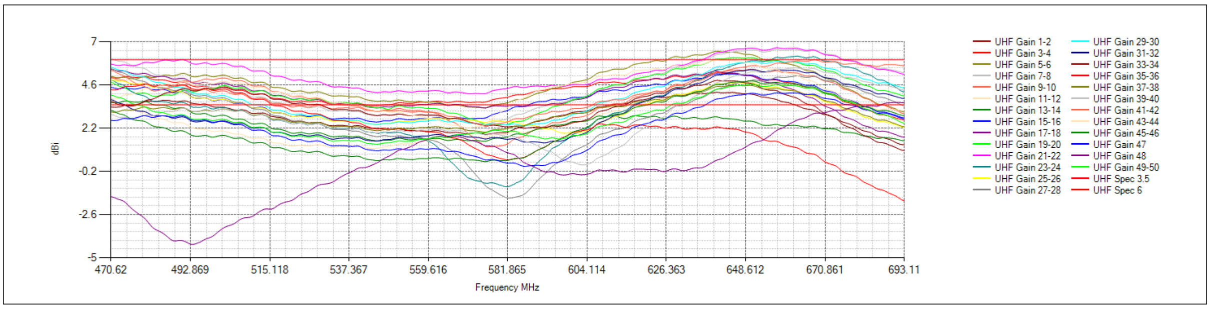
Antenna elevation pattern for two frequencies



175 MHz	Visible		Nay	Altered
234 MHz	Visible		Nay	Altered

2.2 Antenna Gain Testing

The antenna gain will normally be quoted for a specific frequency in the band or for the centre of the frequency band it is designed for. In reality the antenna gain can differ over the frequency band with several dB's. The gain curves below provide the results for a batch of antennas over the defined frequency band. It can also be seen that some antennas are completely faulty and others vary quite drastically in gain over the frequency band.



From the measured results and the quoted gain figures we can produce statistics that states the standard deviation and gain variance of the performance for the batch of antennas. The gain specified for the antenna gain curves above is between 3.5 dBi and 6 dBi. It can clearly be seen that the antenna does not reach the specification.

We can also measure the opposite polarisation of the antenna in order to determine the polarisation discrimination of the antenna. The polarisation discrimination is a function of frequency and as the frequency increase the polarisation discrimination will increase.

2.3 EMI and EMC Testing

We can measure electromagnetic interference and electromagnetic compatibility in the anechoic chamber. We can bombard a device with a range of interference signals at various intensity levels to determine at which frequency and level it will fail to operate. This method was used to determine the level of interference that will cause our drones to fail in operation. This assisted us a lot with our UAV flight path planning when measuring broadcast transmit antennas, all around the world.

2.4 Interference, In-band Radiation, Out-of-band Radiation, Harmonics and Intermodulation Measurements

Our anechoic chamber allows us to perform measurements at levels much lower that the outdoor noise limited environment. We can therefore perform tests on equipment to identify out of band radiation as well as measuring of harmonic levels to determine if the equipment is operating within the national and international specified limits. These types of tests are not limited to radio equipment but all types of electrical devices such a microwave oven's, LED lights, solar panels etc.

2.5 5G Testing

The 5G spectrum analyser delivers the highest levels of RF performance available in a handheld, touchscreen spectrum analyzer, with a displayed average noise level (DANL) of -164 dBm and Third Order Intercept (TOI) of +20 dBm (typical). This makes measurements such as spectrum clearing, radio alignment, harmonic, and distortion even more accurate than previously possible. For modulation measurements on digital systems, 110 MHz modulation bandwidth coupled with best-in-class phase noise performance maximizes measurement precision, while ±0.5 dB typical amplitude accuracy provides confidence when testing transmitter power and spurious.

RTSA spans of 22 MHz to 110 MHz (option dependent) provide capability for cellular interference monitoring to full ISM band signal analysis. In addition to being a full span swept tuned spectrum analyzer, all versions include a spectrogram display that helps monitor the RF spectrum for intermittent or interfering signals. Integrated channel power and occupied bandwidth measurements simplify the measuring and characterizing of common radio transmission. IQ data capture of 5G frames enables the capture and saving of IQ data for off-line processing on a PC using standard data analysis tools.

A key part of 5G NR signals is the synchronization signal block (SSB). Decoding the SSB can reveal the important cell characteristics, like cell ID, frequency error, and beam powers. Making measurements on the SSB allows transmitter testing on a live gNB. As well as displaying beam ID, the RSRP is graphed for each of the beams in the SSB. In order to properly decode the signal, the user must know center frequency, bandwidth, and subcarrier spacing of the signal under test. This can be entered manually or by using a 3GPP-defined band and absolute radio-frequency channel number (ARFCN). It is also critical to know the frequency position of the SSB relative to the center frequency of the signal. This can also be entered manually as an offset from center or by entering the global synchronization channel number (GSCN). In some cases, especially in mmWave, a single transmitter can be transmitting up to eight carriers simultaneously. Up to eight individual carriers to be set up and measured sequentially in a loop to ensure all are working correctly.

Where direct access to an RF test connector is not possible, 5G NR installation testing must be performed OTA with a directional antenna or waveguide horn antenna. Because the SSB is always transmitted, the easiest way to test an active gNB is to make measurements on these elements. All active beams in the signal, typically 8 beams for radios in the 3 GHz to 6 GHz.

3 Advantages to Broadcast Industry Players

Our anechoic chamber offers the following advantages to the broadcast industry:

- EMI and EMC pre-compliance testing of broadcast equipment.
- In and out Batch testing of receive and transmit antennas to determine standard deviation and gain variances.
- Antenna pattern measurements for both E and H fields.
- Out of band radiation measurements including harmonics on broadcast equipment.
- Sensitivity tests of receiver equipment.
- Calibration of antenna mounting on UAV’s for yaw, pitch and roll.