Fixed Ku-band terminal performance

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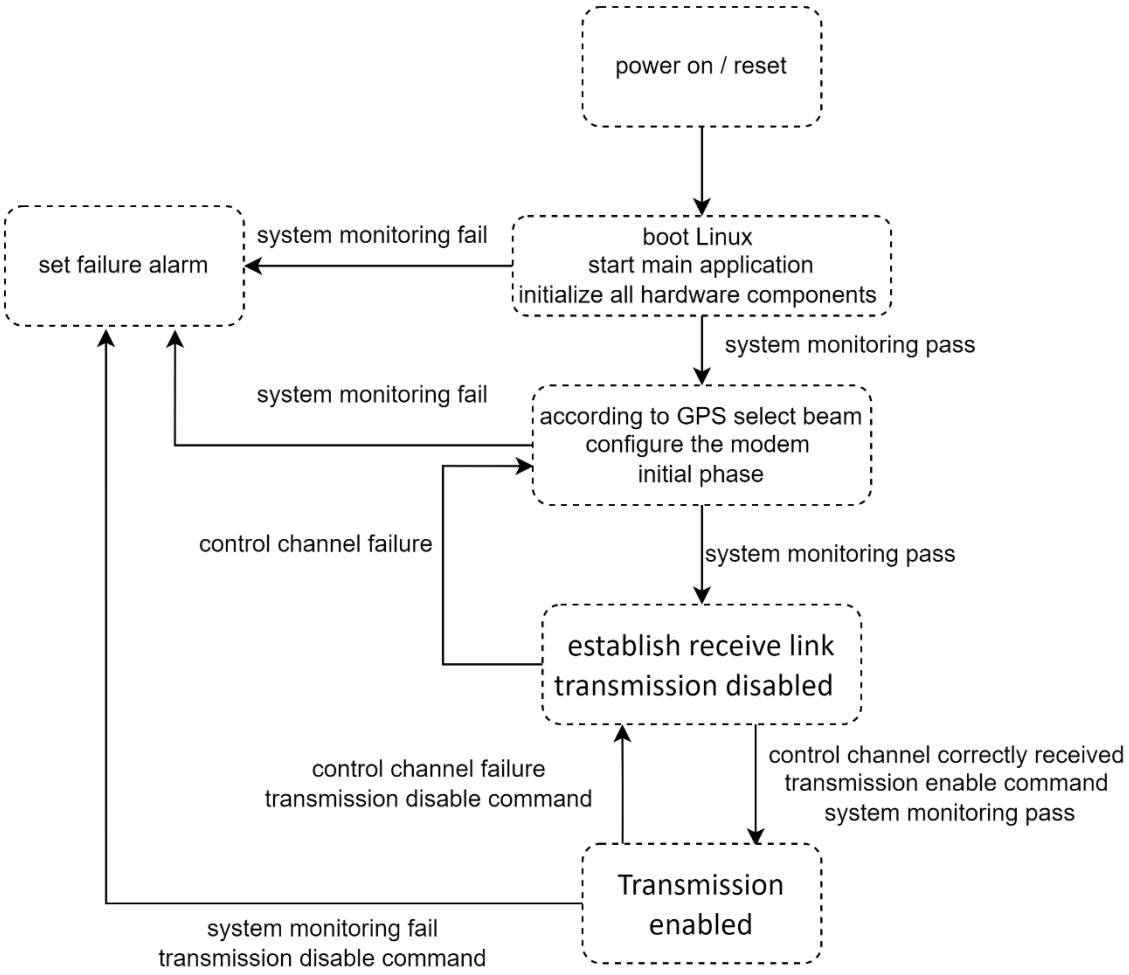
1 Control and Monitoring Functions

Control and Monitoring Functions a mechanism designed to facilitate spectrum sharing with other devices in the Wireless network.

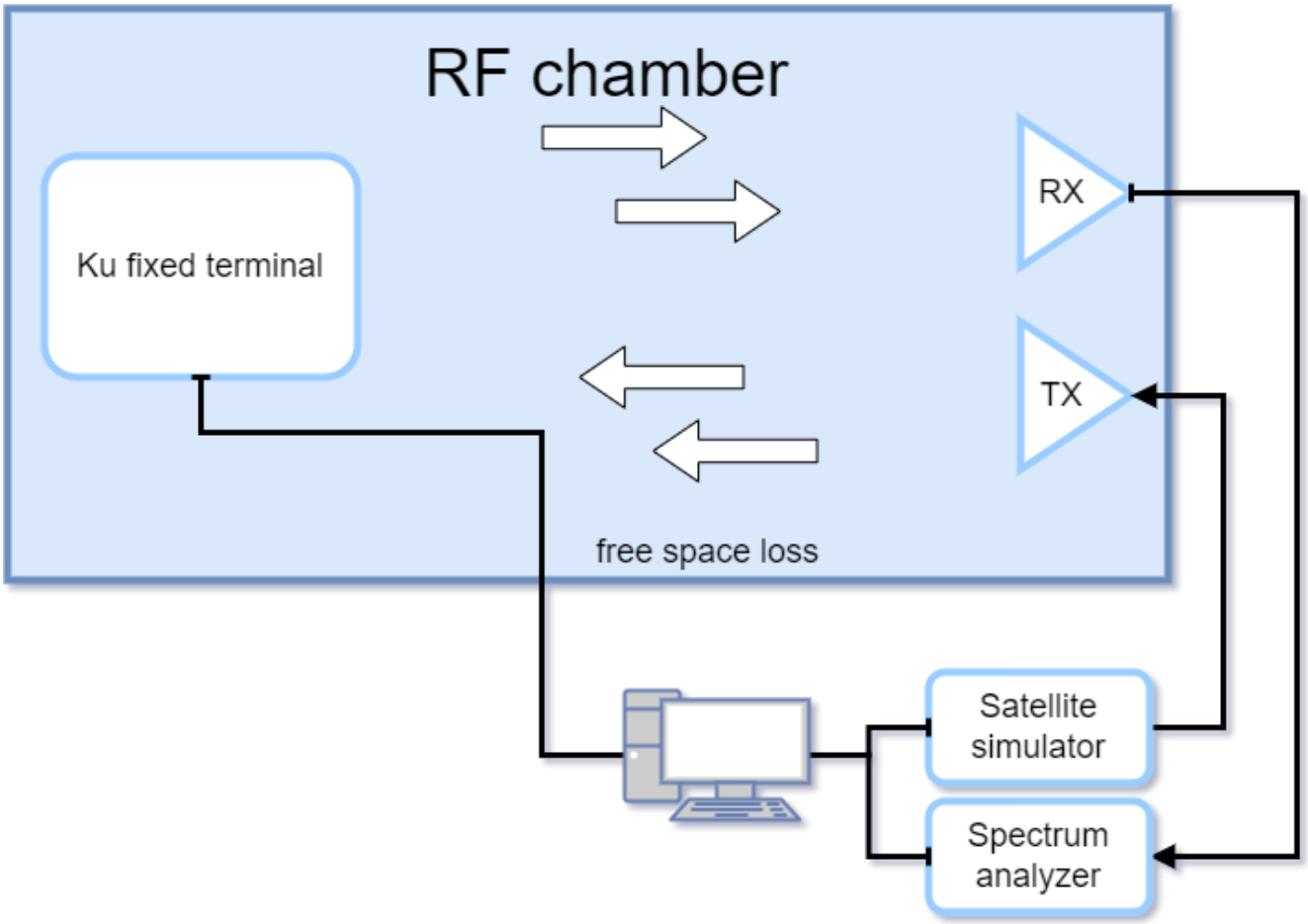
This mechanism makes sure our devices won't interfere with other users by waiting for the RX link to start before transmitting

These measurements were performed under normal test conditions.

1.1 CMF state diagram



1.2 Setup diagram:



Setup components:

- "Ku fixed terminal" – EUT
- "Spectrum Analyzer" - used to measure the time between the Rx link opened to the EUT transmit
- "Satellite simulator" - hiSky lab equipment to simulate a Satellite for measurements
- "RX" – RX antenna for the EUT and "Satellite simulator" to the "Spectrum analyzer"
- "TX" – TX antenna for the "Satellite simulator"

1.3 Testing results:

- Processor monitoring - in this test we ensure the transition stops whenever the processor senses a sub-system failure.
  We also ensure that the Tx disabling is taking less than 50ms after the subsystem failure.
- Transmit subsystem monitoring – in this test we ensure that our EUT inhibits transmission in case of:
  - Loss of frequency lock
  - absence of Local Oscillator (LO) output signal

  No later than 50ms seconds after any of these fault conditions of the transmit frequency generation sub-system occurs, the EUT enterED the "non-valid" state until the transmit sub-system monitoring function has determined that all fault conditions have been cleared.

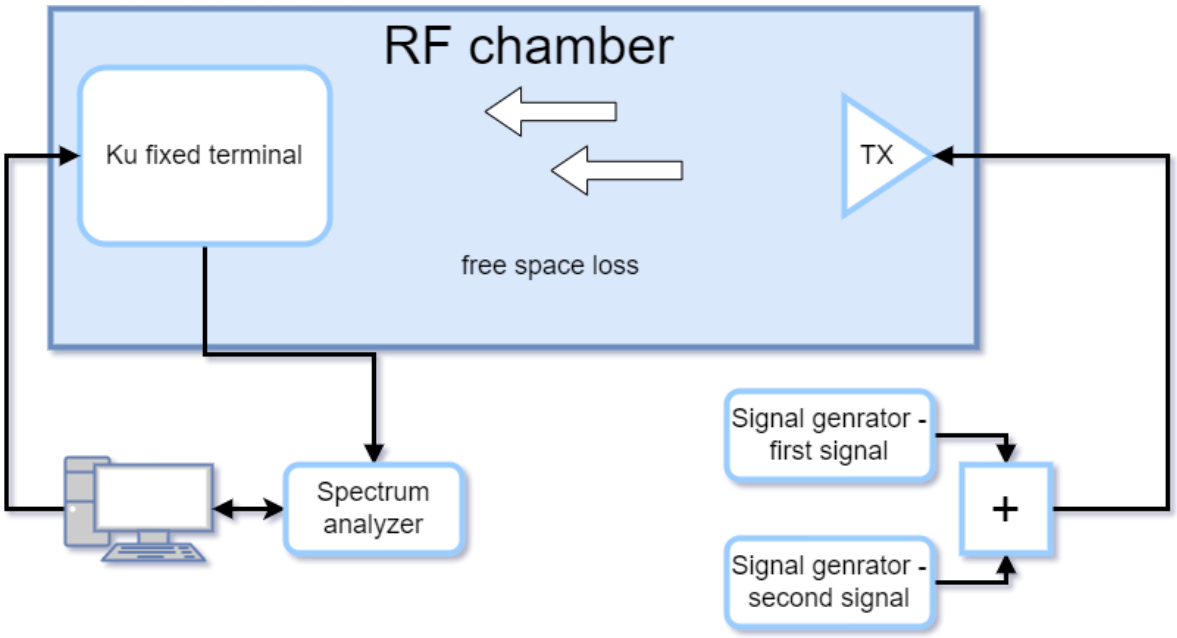
- Power-on/Reset – we checked that the EUT stops transmitting in less than 50ms from the moment we reset it. We also checked that there is no transmitting during power-on (until every sub-process is done and the RX link is acquired)
- Control Channel (CC) and Response Channel (RC) – we ensure that the EUT cannot transmit unless it correctly receives the CC messages from the ACF. We also ensure that in case the EUT didn't receive the correct command after a period of less than 1 sec, the EUT entered a "non–valid" state and stops transmitting.
- Network control commands – in this test we ensure that the EUT can retain a unique identification in the network and receive commands from the ACF through its CC(s) and execute those commands.
  We ensure that the EUT stops transmitting in less than 50ms after getting "Transmission Disable commands".
- Initial burst transmission – in this test we make sure that:
  - The EUT won't start the transmission of initial bursts before having confirmation by the local means of determination of the cessation of emissions or from the ACF via an external control channel.
  - The duty cycle of the burst retransmission does not exceed 0.2 %
  - Each burst is not carrying more than the minimum number of data bytes excluding the burst preambles and the FEC coding bits necessary to establish synchronization
  - The initial burst is transmitted at an EIRP no greater than the maximum allowed.
  - The duration between two successive bursts is not less than the required ACF response time as declared by the applicant
- Inhibition of transmissions – the EUT stops transmitting in case of loss of receive carriers. The EUT enters to "transmission disable" mode in less the 50mS

Test	Time	Status
Processor monitoring	<50mS	pass
Transmit subsystem monitoring	<50mS	pass
Power-on/Reset	<50mS	Pass
Control Channel (CC) and Response Channel (RC)	-	Pass
Network control commands	<50mS	Pass
Initial burst transmission	-	Pass
Inhibition of transmissions	<50mS	pass

2 Blocking performance

The Blocking performance is a measure of how well the receiver blocks high power signals outside the “receive frequency” that can prevent the reception of signals inside the receive frequency band.

2.1 Setup diagram



Setup components:

- “Ku fixed terminal” – EUT
- “Signal generator – first signal” - the in-band signal generator
- “Signal generator – out of band signal” – the out of band signal generator
- Combiner – used to combine “Satellite simulator” and “Signal generator” signal
- “ANT” – Horn 14dBi Ku antenna, used to transmit the signal to the EUT
- PC – for controlling
- “Spectrum analyzer” – for measuring the receiver compression point

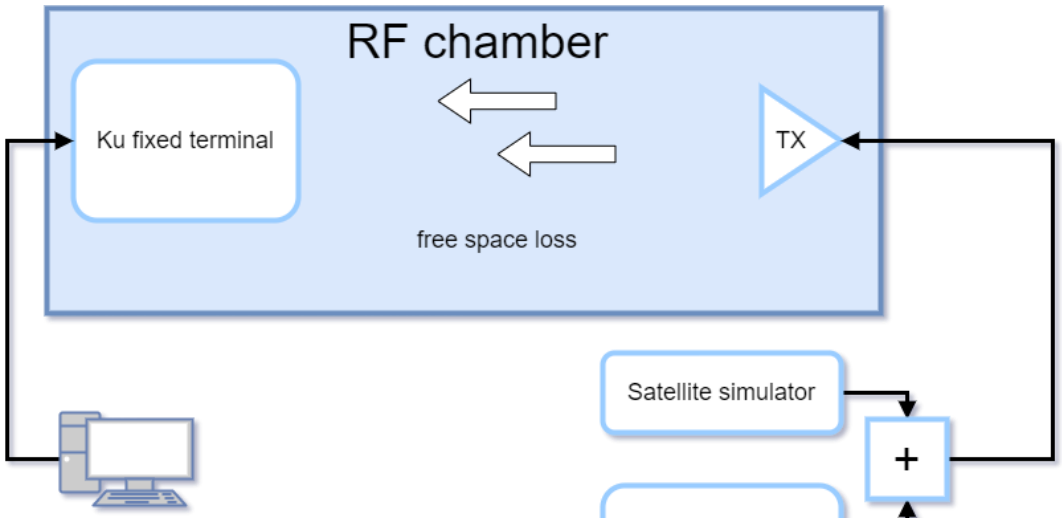
2.2 Results

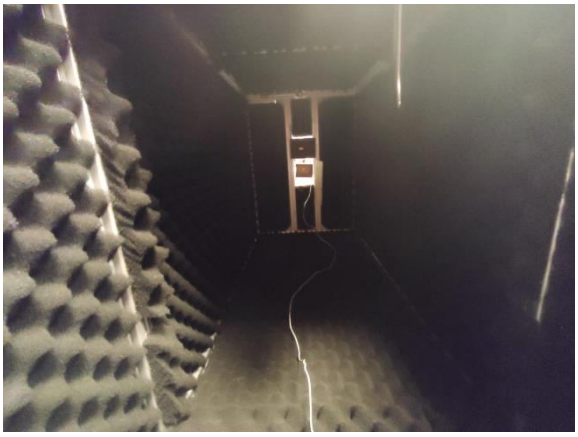
Frequency	Gain compression (dB)
Below 9GHz	0.23
9 to 10GHz	0.2
12 to 16GHz	0.4
Above 16GHz	0.3

3 Receiver Adjacent Channel Rejection

The receiver adjacent channel rejection is a measure of the receiver's ability to receive a wanted signal at its assigned channel frequency in the presence of an unwanted signal at a given frequency offset from the center frequency of the assigned channel, without this unwanted signal causing degradation of the performance of the receiver beyond minimum performance criteria.

3.1 Setup diagram





Setup components:

- "Ku fixed terminal" – EUT
- "Satellite simulator" – hiSky lab equipment to simulate a Satellite for measurements
- "Signal generator" – used for transmitting an interfering signal in the adjusted channel
- Combiner – used to combine "Satellite simulator" and "Signal generator" signal
- "ANT" – Horn 14dBi Ku antenna, used to transmit the signal to the EUT
- PC – for analyzing the BER of the EUT

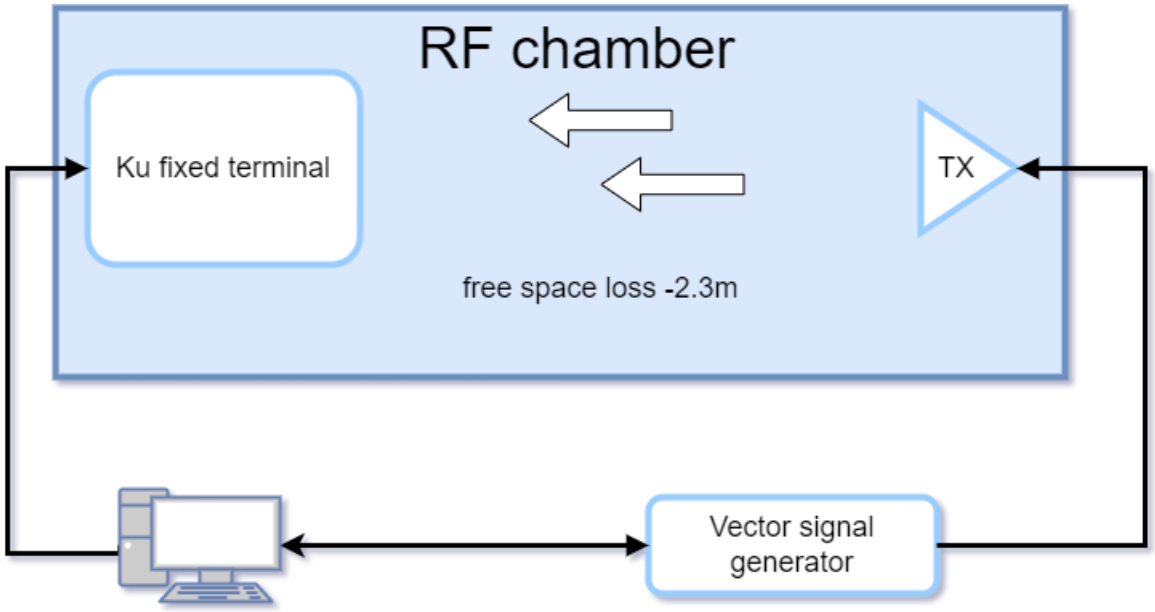
3.2 Results

Signal	Test result	Limit
Adjacent Carrier	0.3dB	0.5dB

4 Sensitivity

Sensitivity is the measure of the smallest signal the receiver can receive and demodulate properly (BER of 1e-6).

Setup diagram:



- Modulation – BPSK
- Symbol rate - 40 SPS
- Spread factor – 16

Setup components:

- PC - used to send foretold burst of modulated bits to the "Vector signal generator"
  - Also, use to compare the foretold bits and those how received by the terminal.
- "Ku fixed terminal" – EUT
- "Vector signal generator" – used to transmit the modulated bits to the terminal.
- "ANT" – antenna with known performance, connected to "Vector signal generator"

Setup procedure:

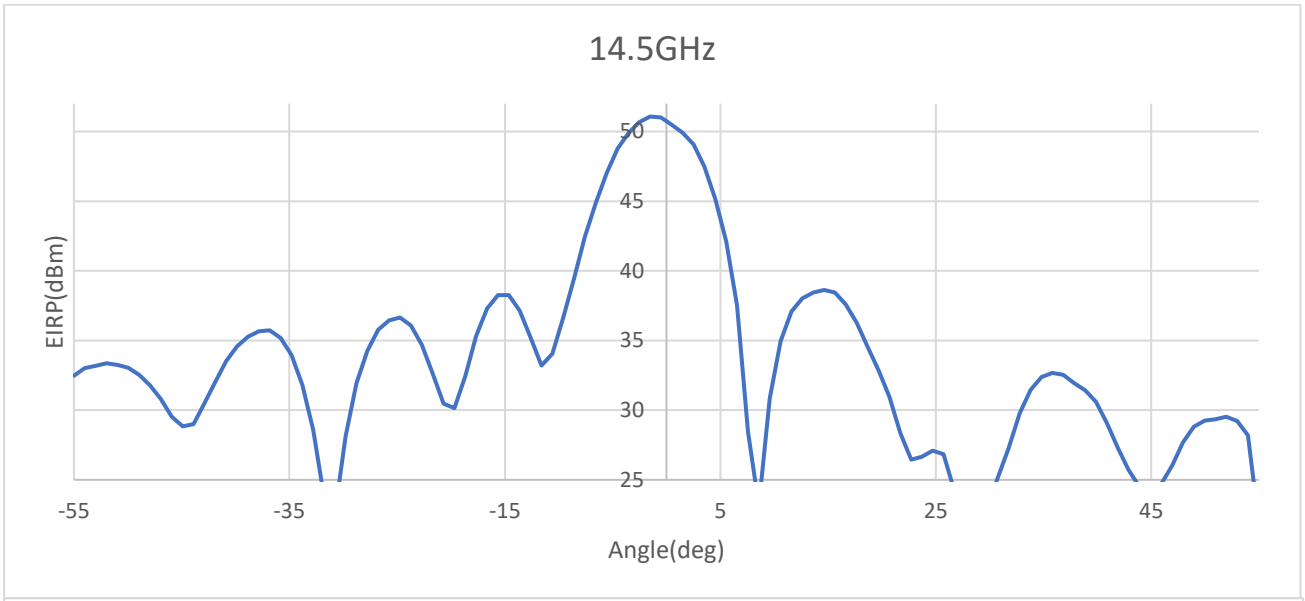
- Step 1 - load 1e9 foretold modulated bits to the vector signal generator
- Step 2 – transmit them using a "Vector signal generator" to the EUT
- Step 3 – compare the foretold bits with those received by the EUT
  - Calculate the ratio between wrong bits to overall
- Step 4 – if the ratio is lower than 1e-6 repeat the previous steps with lower power transmission until you reach the ratio of 1e-6
- Step 4 – calculation of Sensitivity
  - $Loss_{free\ space}(dB) = +32.5 + 20\log(f(MHz)) + 20\log(d(Km)) - G_{tx\ antenna}$
  - $Senstivity(dBm) = Tx_{power} - Loss_{free\ space}$

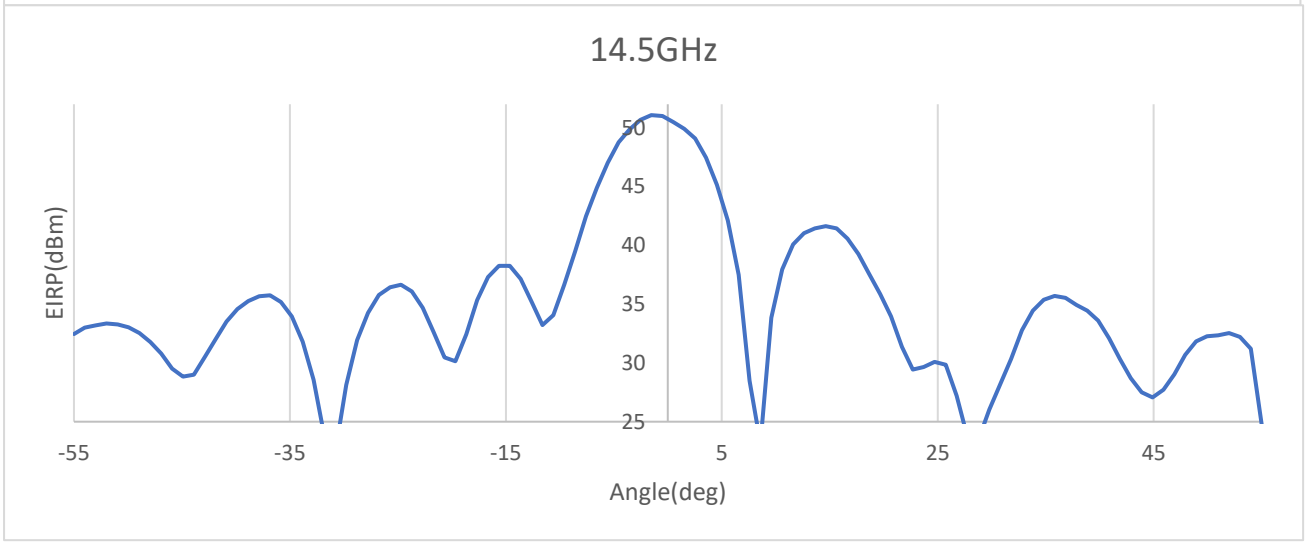
Results:

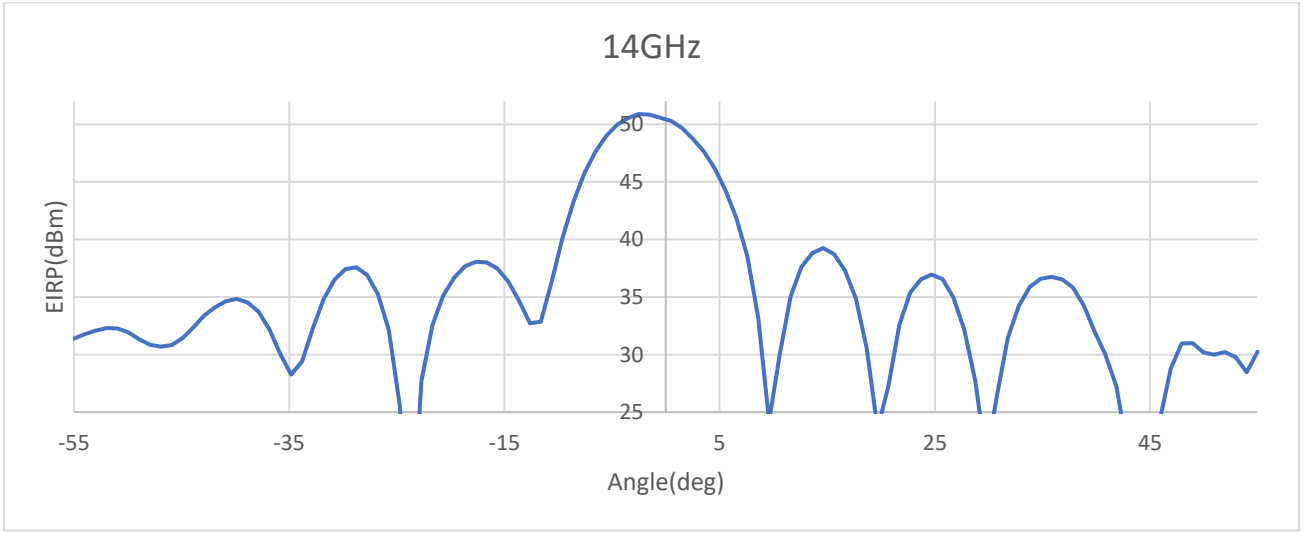
$Frequency\ (GHz)$	10.7	11.5	12	12.5
$Senstivity(dBm)$	-151.1	-150.5	-150.4	-150.1

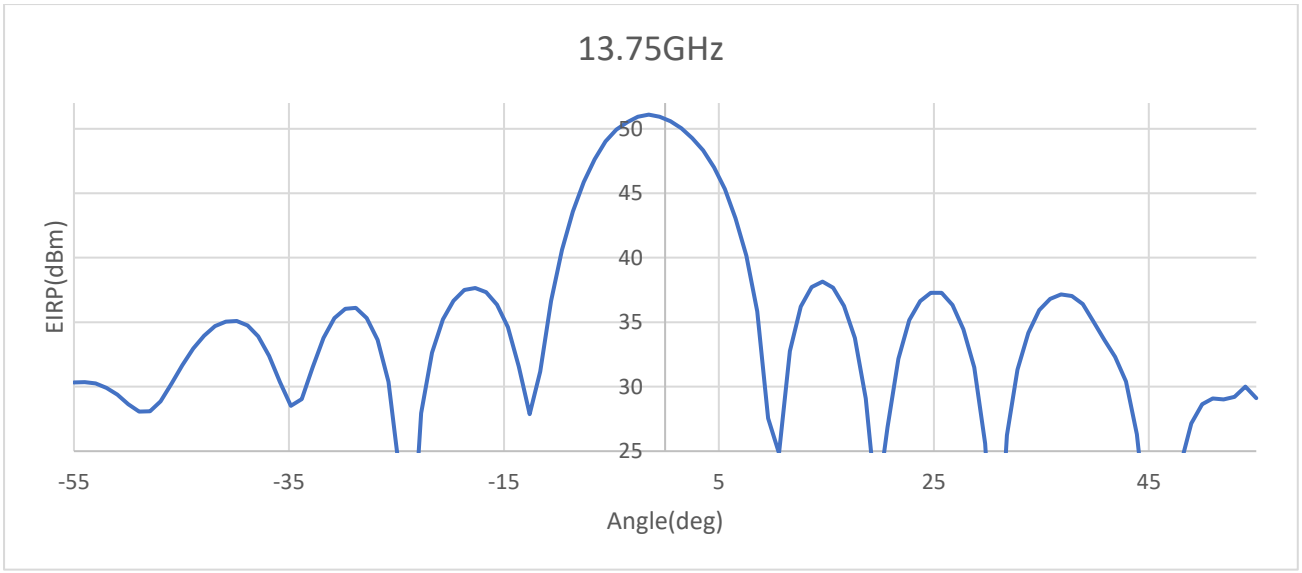
12 Antenna pattern results

12.1 TX

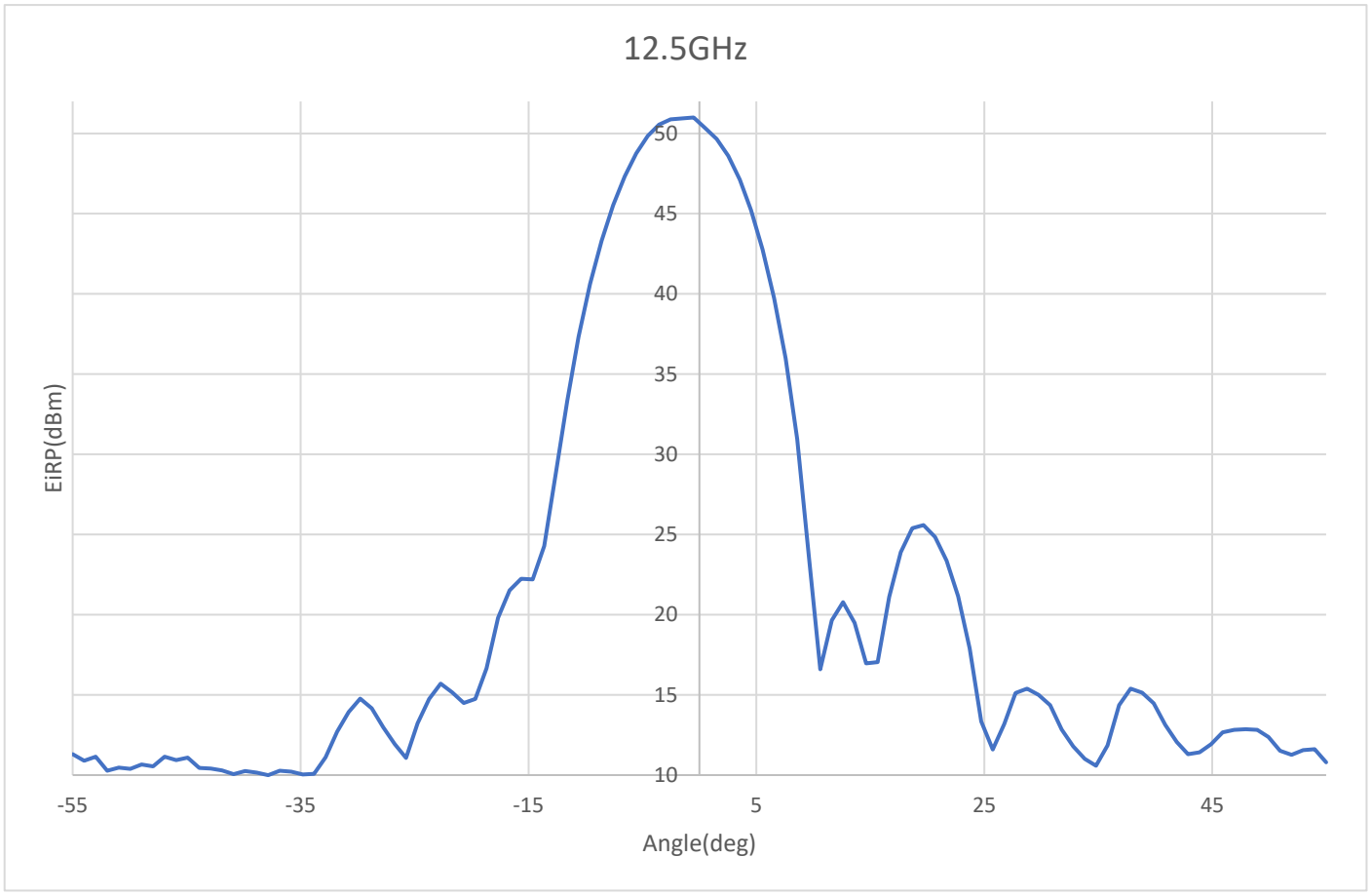


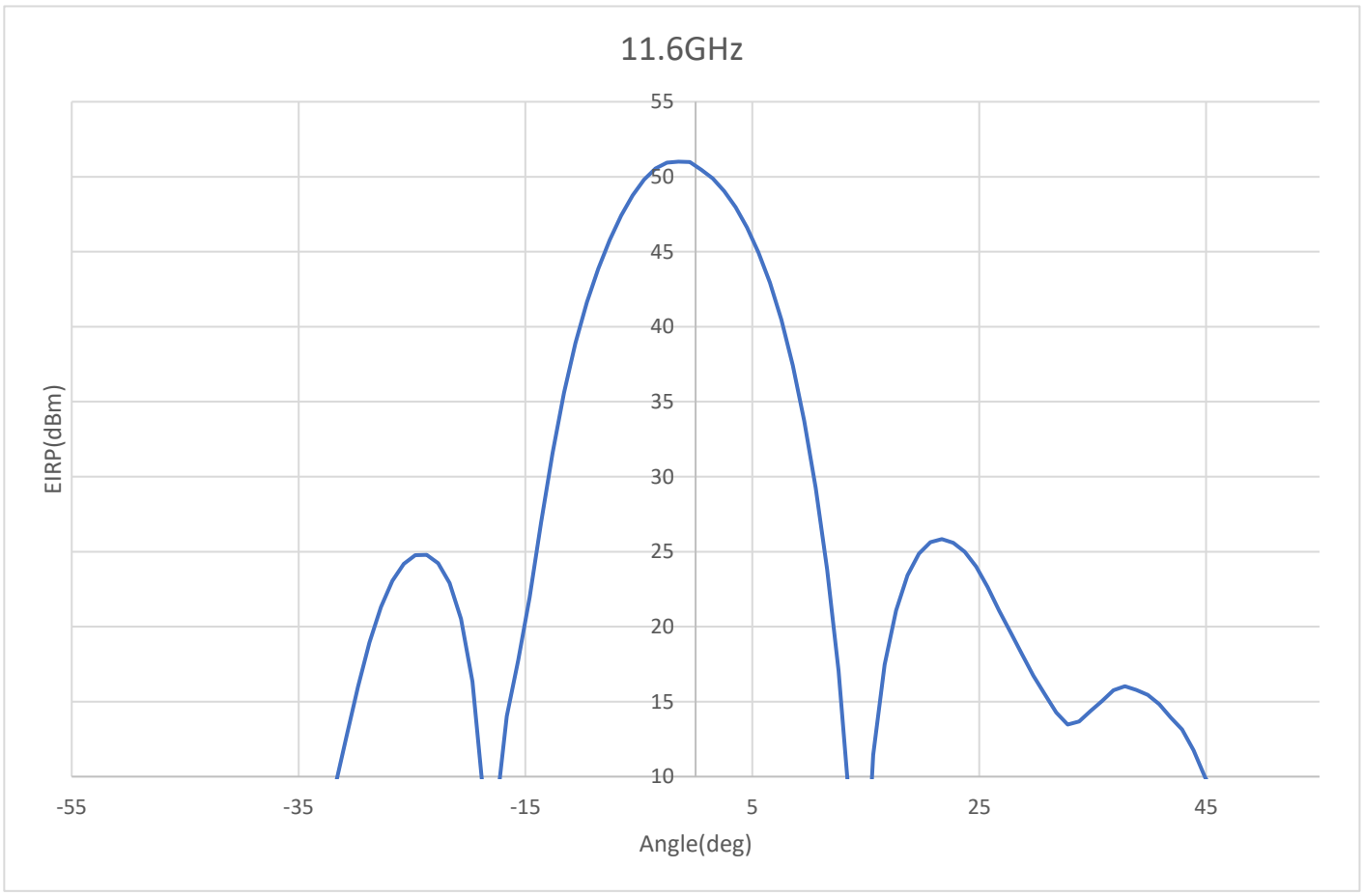


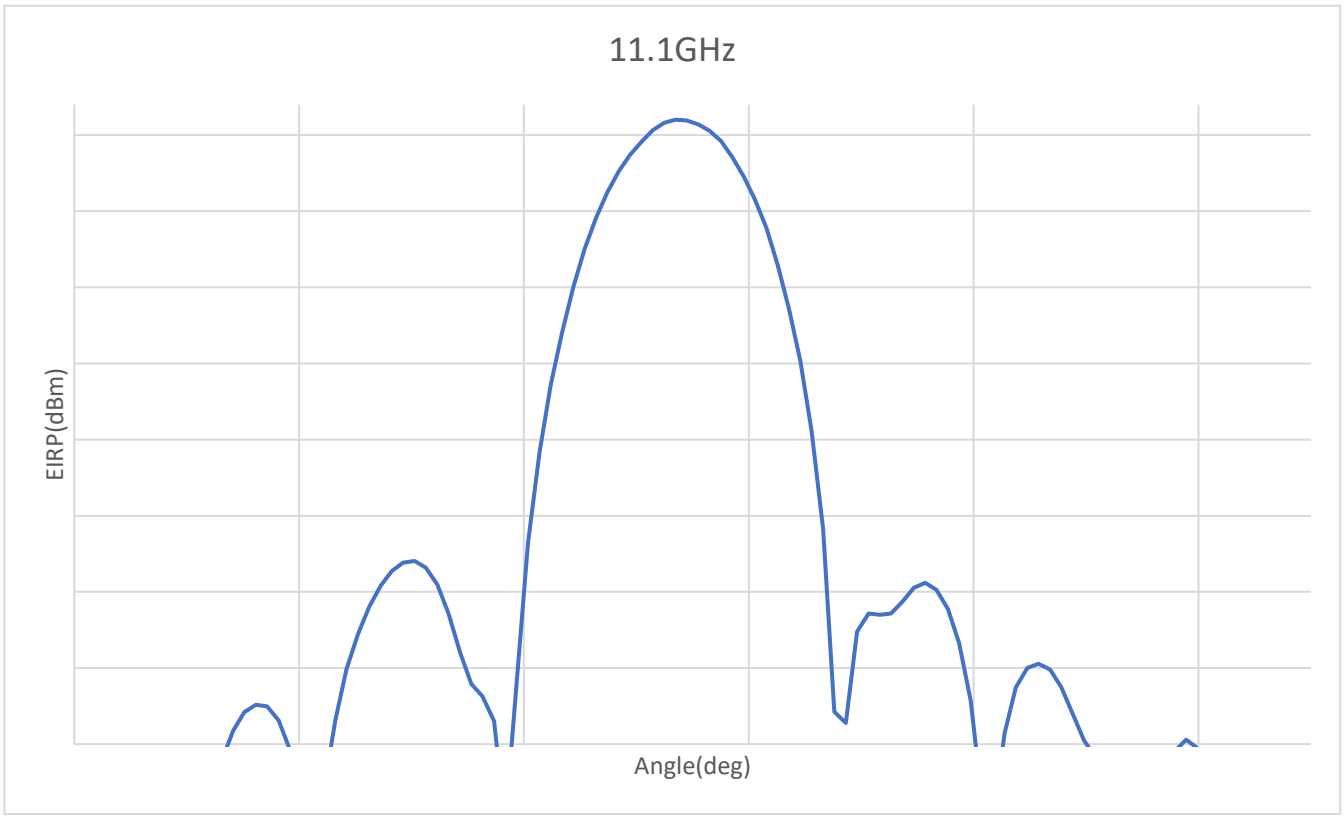


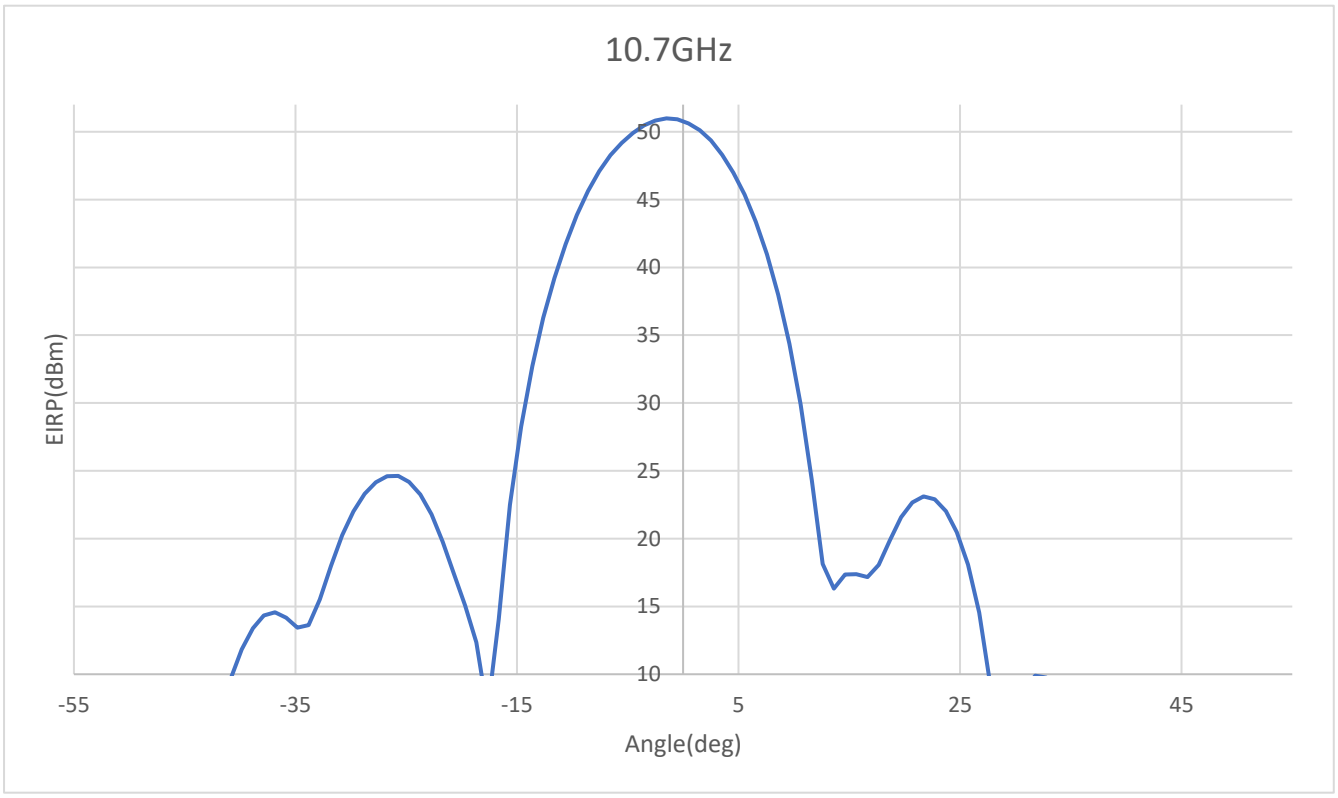

13.75GHz
EIRP(dBm)
50
45
40
35
30
25
-55
-35
-15
5
25
45
Angle(deg)

12.2 RX


12.5GHz
EiRP(dBm)
50
45
40
35
30
25
20
15
10
-55
-35
-15
5
25
45
Angle(deg)


11.6GHz
EIRP(dBm)
55
50
45
40
35
30
25
20
15
10
-55
-35
-15
5
25
45
Angle(deg)


11.1GHz
EIRP(dBm)
Angle(deg)


10.7GHz
EIRP(dBm)
50
45
40
35
30
25
20
15
10
-55
-35
-15
5
25
45
Angle(deg)