

# RXTX-3033 (Pyxis 2S)

## Antenna Performance Measurement

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Company: Leap Development B.V.  
Author: Jan ten Thije

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## 1. Contents

|                                                         |    |
|---------------------------------------------------------|----|
| 1. Contents .....                                       | 2  |
| 2. Document revision history .....                      | 3  |
| 3. Client.....                                          | 3  |
| 3. Preface .....                                        | 3  |
| 4. Description of measurement.....                      | 3  |
| 4.1. Equipment used.....                                | 3  |
| 4.2. Measurement / execution .....                      | 4  |
| 5. Measurements .....                                   | 5  |
| 5.1. S11 Parameters Results .....                       | 5  |
| 5.2. Radiated Results .....                             | 7  |
| 5.3. Efficiency Determination using Radiated Power..... | 12 |
| 5.3.1 Test setup for efficiency measurements.....       | 12 |
| 5.3.2. Efficiency Determination.....                    | 15 |
| 6. Antenna Drawing.....                                 | 15 |
| 7. Test results .....                                   | 16 |

## 2. Document revision history

| Revision | Date             | Author        | Description             |
|----------|------------------|---------------|-------------------------|
| 0.1      | January 20, 2025 | Jan ten Thije | Initial setup & release |
| 1.0      | January 27, 2025 | Mart Vlas     | Review and Release      |
|          |                  |               |                         |
|          |                  |               |                         |

## 3. Client

Tyro Products B.V.  
Bedrijvenpark Twente 299  
7602 KK Almelo  
Contact person: Mr. John Nijkrake

## 3. Preface

Tyro Products has modified the firmware of the RXTX-3033 (Pyxis 2S) remote control to make it suitable for Northern America and Canada. This device uses Tyro design pcb-trace antenna. Leap Development tuned the antenna for optimum performance.

The purpose of this measurement is to measure the antenna Peak Gain, directivity and efficiency. The antenna tuning process is not described here because it's beyond the scope of this document.

## 4. Description of measurement

### 4.1. Equipment used

- Spectrum analyzer Rigol DSA875TG [9kHz~7.5GHz with tracking Generator] with EMC package
- Vector Network Analyzer (VNA) Copper Mountain Planar R54 [85MHz ~5.4GHz]
- Aaronia 30100 Biconical Antenna.
- Molex Antenna 105263 (Reference Antenna)
- Signal Generator Agilent E2245B
- Eaton Log periodic Antenna 96005
- Low Noise Amplifier [40dB]
- Full Anechoic chamber with Rotation platform synchronized with analyzer sweep
- Device Under Test (DUT): RXTX-3033 (Pyxis 2S), pcb serial# 21160219 (QR code sticker)

## 4.2. Measurement / execution

First we perform a S11 parameter measurement. This gives insight in the Return Loss, Voltage Standing Wave Ratio and Impedance. If needed we will tune the antenna for optimum performance.

To determine the antenna's efficiency there are two common methods.

The "Wheeler cap method" and the radiated power measurement method.

The Wheeler Cap Method is intended for mechanical small antennas. The actual antenna is small, but the overall enclosure is relatively large, making the radiated power method the preferred option.

We will perform the Radiated Power measurements rotating the DUT over 360 degrees. Measurement will be performed with the DUT in vertical, horizontal and on-the-side orientation. Measurements will be performed at 902.75, 915.00 and 927.25MHz.



## 5. Measurements

### 5.1. S11 Parameters Results

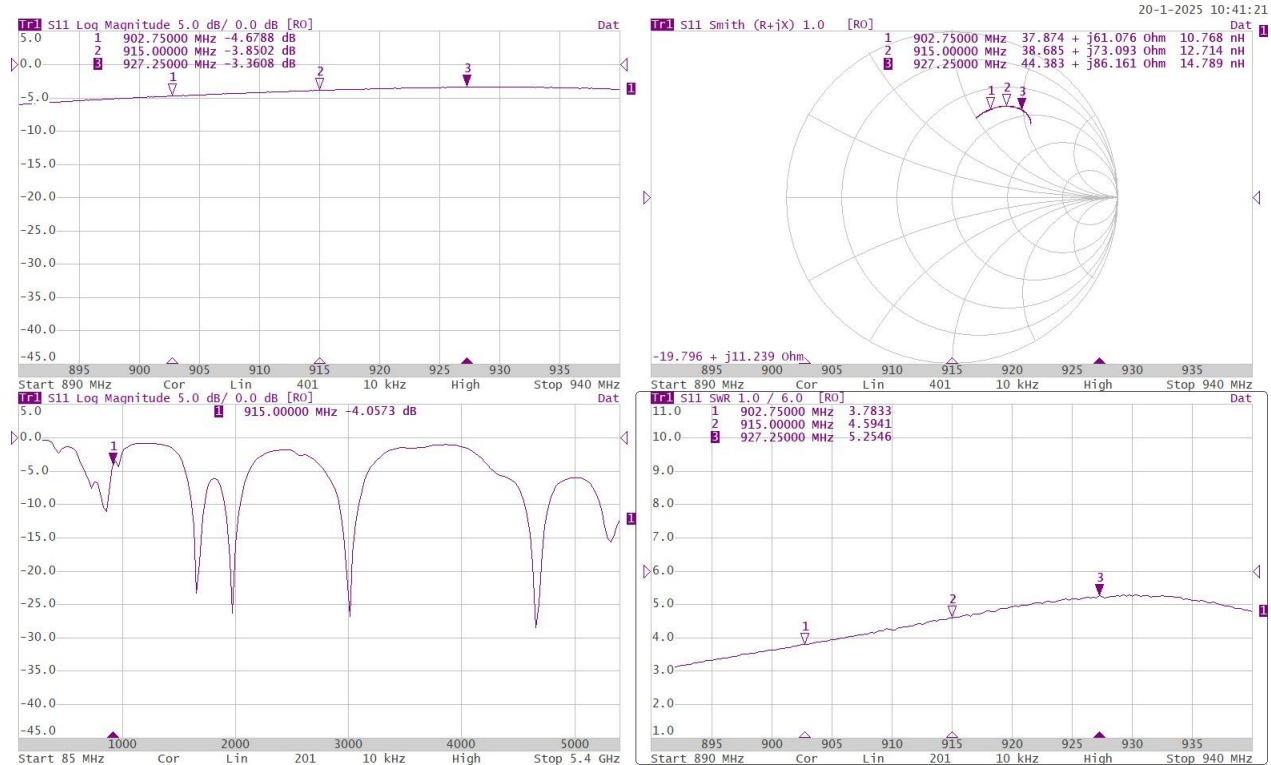


FIGURE 7 INITIAL S11 PARAMETERS

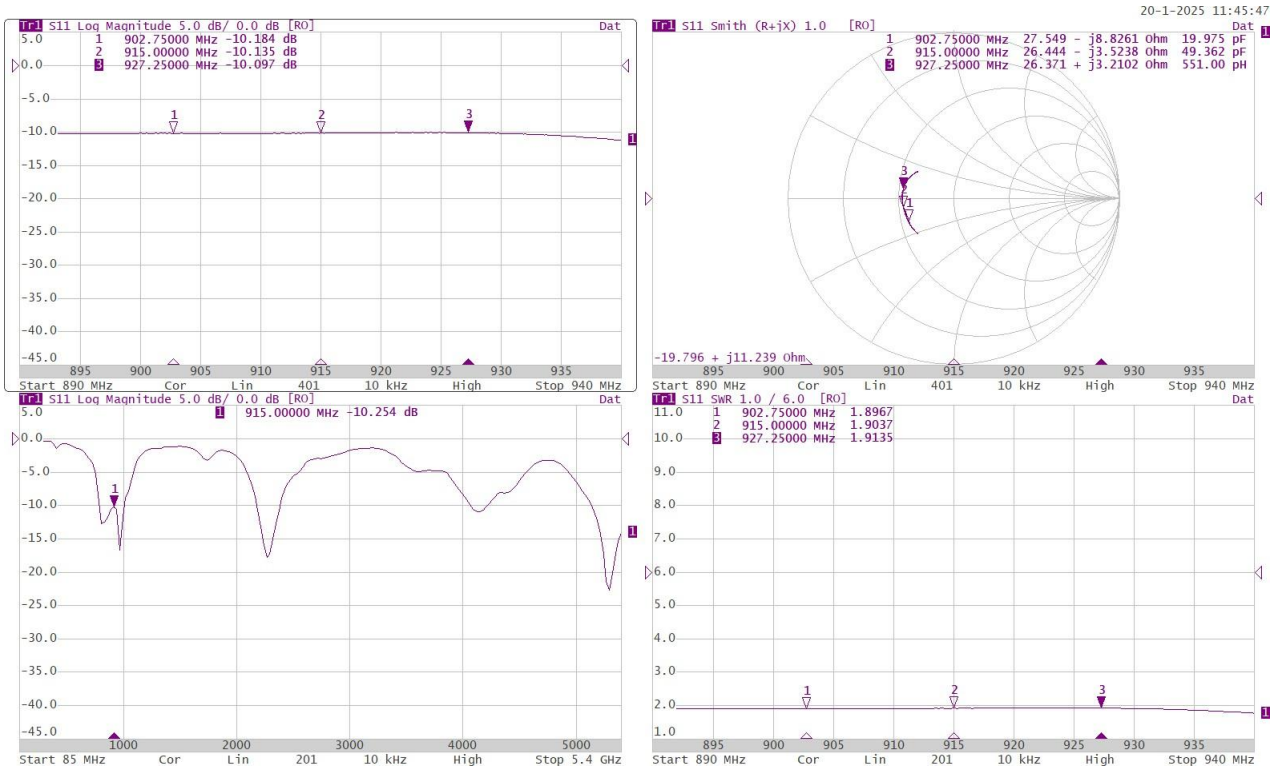


FIGURE 8 FINAL RESULT AFTER TUNING THE ANTENNA

Figure 6 represent the S11 parameters with the antenna trace cut 18mm shorter.

In the pcb design there is no provision for a LC matching network. Therefore the antenna can't be tuned to exactly 50 Ohms.

Figure 6 shows that the VSWR < 1:2, meaning that at least 90% of the RF power will go into the antenna.

Reflections can cause distortion of the radiation patterns.

During the measurements we found that the battery and the emergency button load the antenna heavily. As a result, holding the DUT in hand or in free space has minimum influence.

## 5.2. Radiated Results

Radiation Pattern  
DUT Horizontal

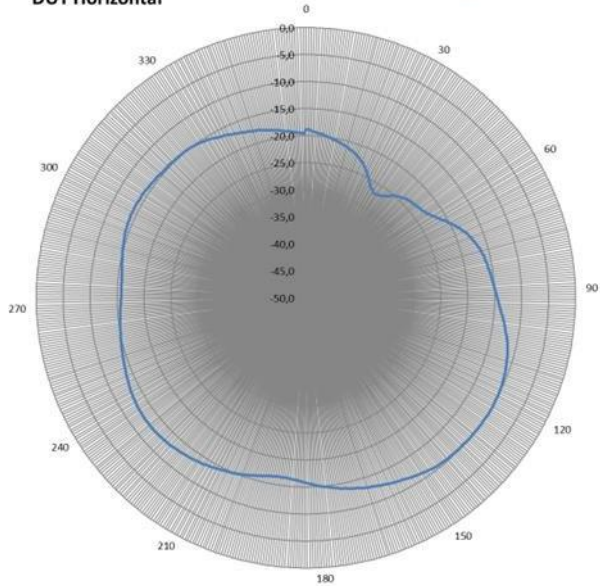


FIGURE 9

Peak Gain is -9.9dBi  
Enclosed power is 0.00633mW  
 $\cong 10 * \text{Log}(0.00633) = -22.0\text{dBm}$

Radiation Pattern  
DUT Horizontal

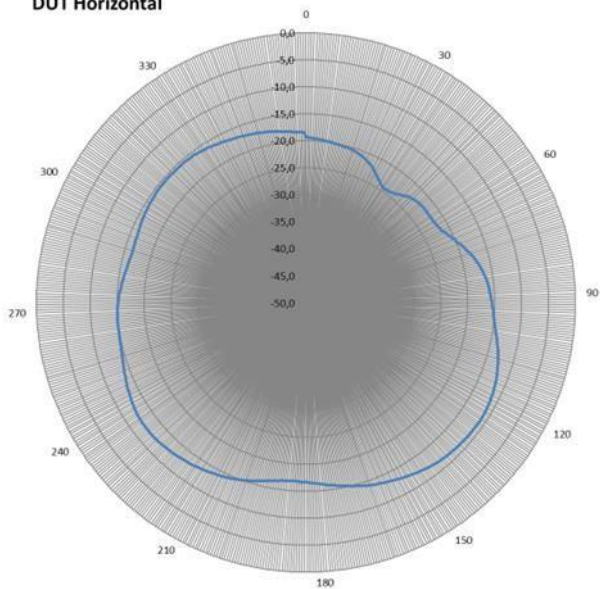


FIGURE 10

Peak Gain is -11.0dBi  
Enclosed power is 0.00433mW  
 $\cong 10 * \text{Log}(0.00433) = -23.6\text{dBm}$



Radiation Pattern  
DUT Horizontal

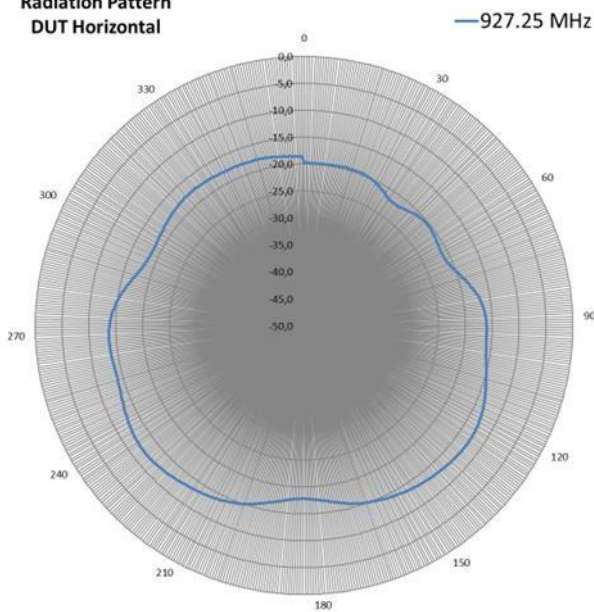


FIGURE 11

Peak Gain is -12.1dBi  
Enclosed power is 0.00316mW  
 $\equiv 10 \cdot \log(0.00316) = -25.0\text{dBm}$

Radiation Pattern  
DUT Vertical

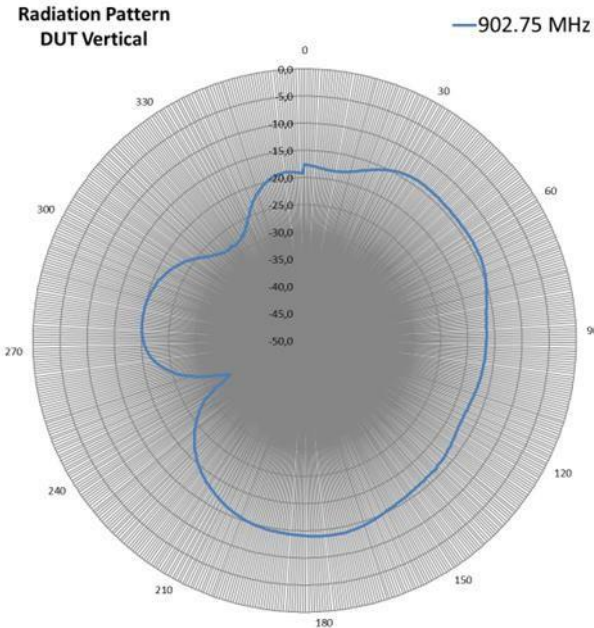


FIGURE 12

Peak Gain is -13.8dBi  
Enclosed power is 0.00171mW  
 $\equiv 10 \cdot \log(0.00171) = -27.7\text{dBm}$

Radiation Pattern  
DUT Vertical

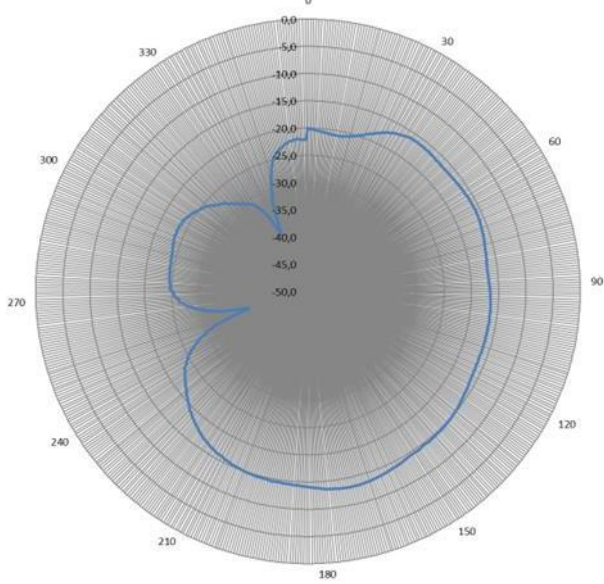


FIGURE 13

Peak Gain is -13.2dBi  
Enclosed power is 0.0016mW  
 $\equiv 10 * \text{Log}(0.0016) = -28\text{dBm}$

Radiation Pattern  
DUT Vertical

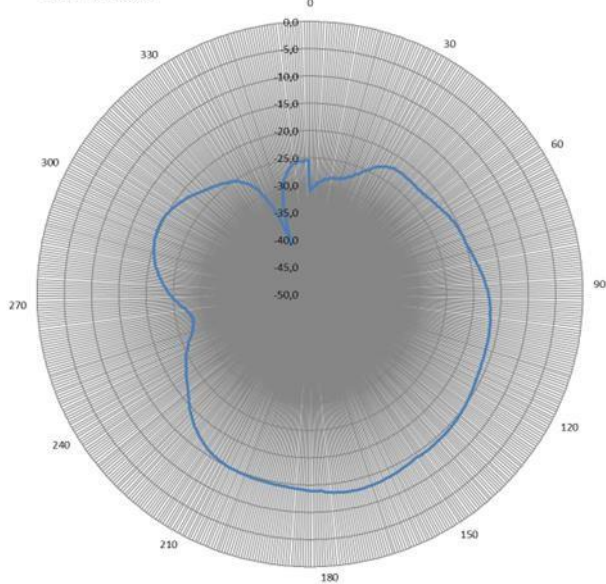


FIGURE 14

Peak Gain is -13.1dBi  
Enclosed power is 0.00147mW  
 $\equiv 10 * \text{Log}(0.00147) = -28.3\text{dBm}$

**Radiation Pattern  
DUT on the side**

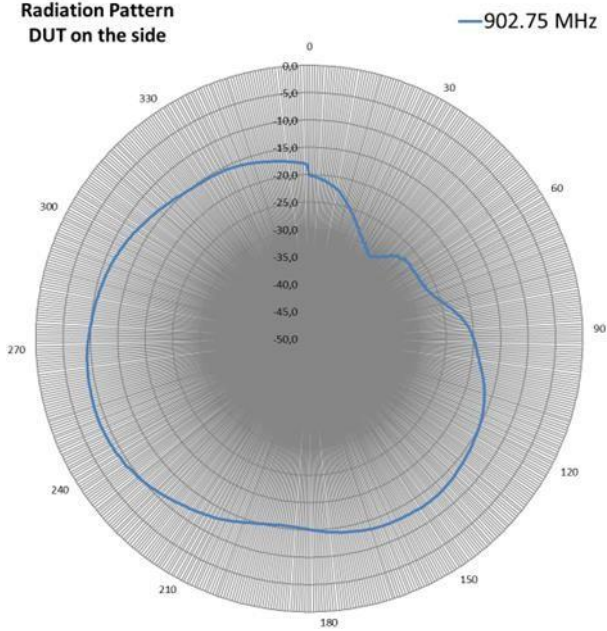


FIGURE 15

Peak Gain is -8.7dBi  
 Enclosed power is 0.0103mW  
 $\equiv 10 \cdot \log(0.0103) = -19.9\text{dBm}$

**Radiation Pattern  
DUT on the side**

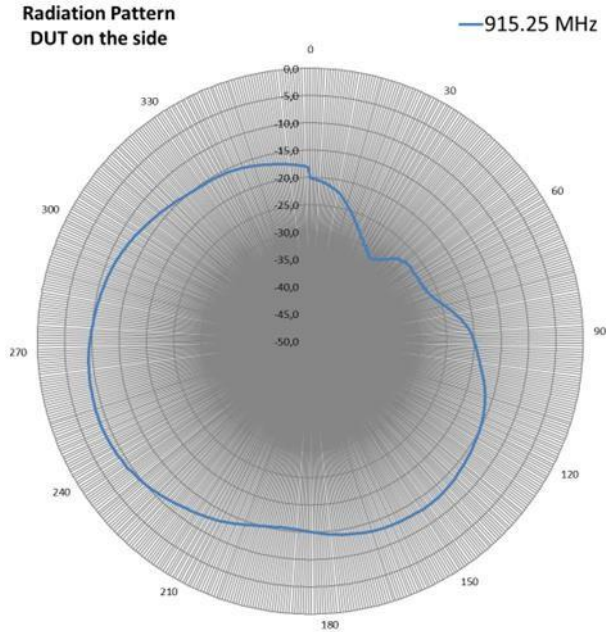


FIGURE 16

Peak Gain is -9.2dBi  
 Enclosed power is 0.00835mW  
 $\equiv 10 \cdot \log(0.00835) = -20.8\text{dBm}$



Radiation Pattern  
DUT on the side

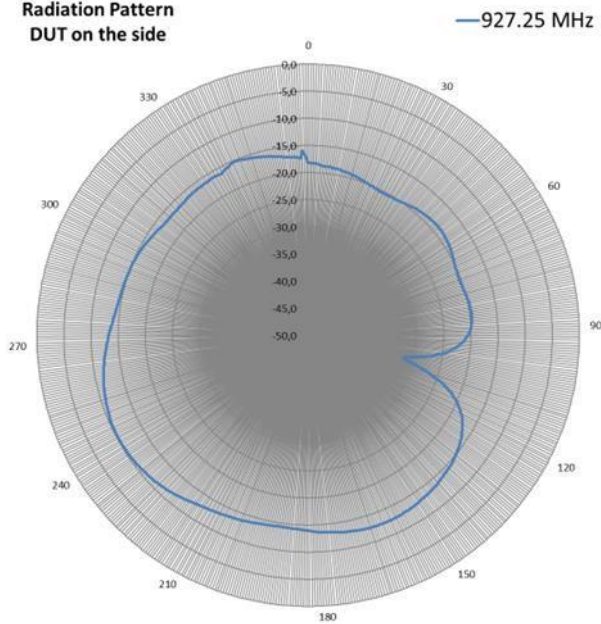


FIGURE 17

Peak Gain is -10.2dBi  
Enclosed power is 0.00531mW  
 $\equiv 10 * \text{Log}(0.00531) = -22.7\text{dBm}$

### 5.3. Efficiency Determination using Radiated Power

The radiation patterns are buildup of 601 sweep points resulting in 601 circle segments.

The enclosed power in a radiation pattern can be approached by summing all segments using the formula below. Using this calculation also on a reference antenna with a known efficiency, and comparing both results will give an idea of the efficiency of the DUT antenna.

$$P = \sum_{n=1}^{n=601} \frac{\left( \left( 10^{\frac{\text{Signal Level [dBm]}}{10}} \right)^2 * \tan(\alpha) \right)}{2}$$

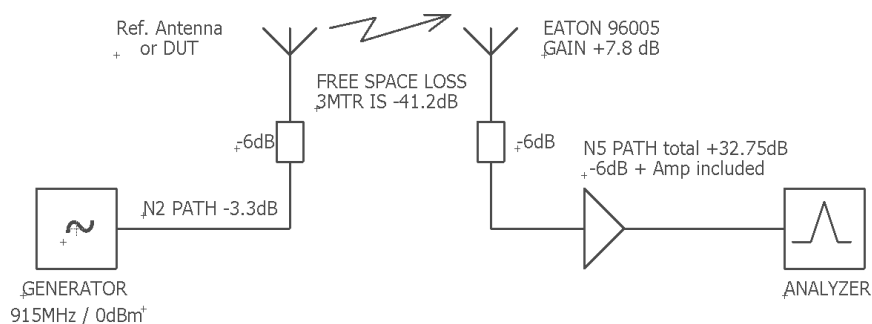
$$\alpha = 360^\circ / 601$$

$$\tan(\alpha) = Y(\text{segment}) / X(\text{segment})$$

$$\text{Power volume of one segment is } (X * Y) / 2$$

Formula 1

#### 5.3.1 Test setup for efficiency measurements



This is the antenna test setup.

Unfortunately we can't measure the spherical radiated power with our setup.

Alternatively we compare the DUT radiated power to the radiated power of a reference antenna with known efficiency.

The radiated power is measured at the low band, mid band and high band frequencies. Than this is done with the DUT in all three orientations.

**Radiation Pattern  
BicoLOG 30100  
Dipole Antenna**

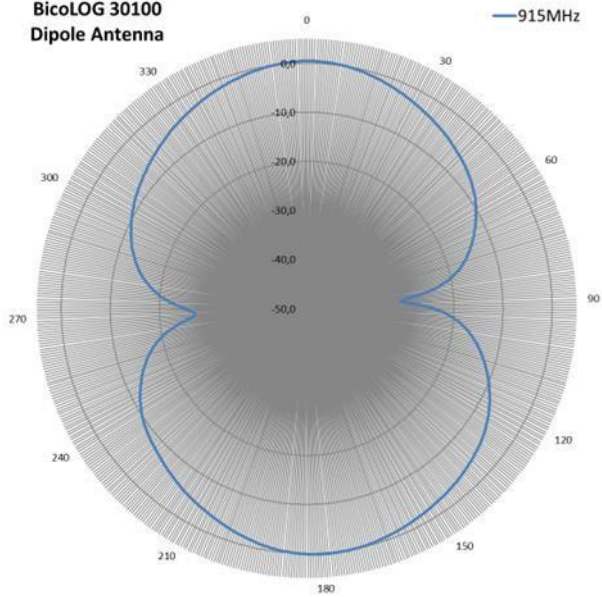
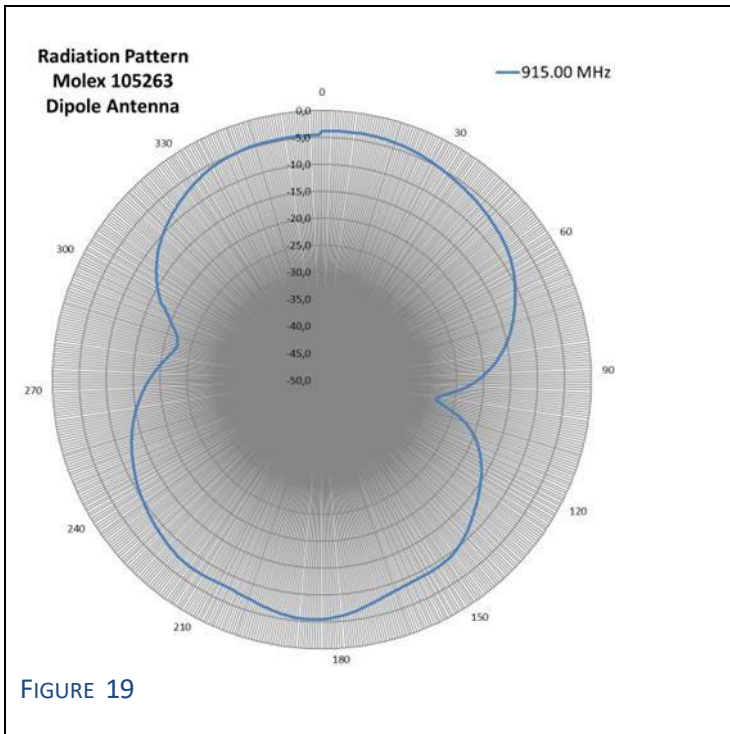


FIGURE 18

Radiation pattern of the Aaronia BicoLOG 30100  
Gain max. is 1.1dBi

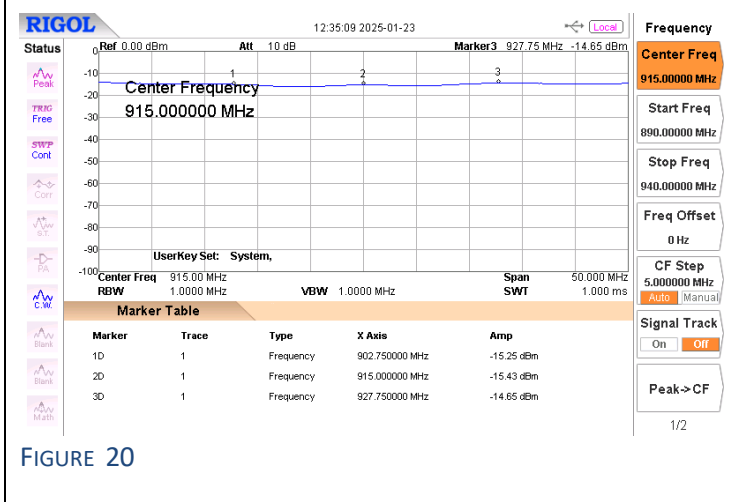
This is used as a gain reference for all  
measurements.



Reference Antenna: Molex 105263

Peak gain level is -3.7dBi @915MHz

Total radiated power, using formula 1,  
is 0.11910 mW  
i.e.  $10 \cdot \log(0.11910) = -9.2\text{dBm}$



Reference Antenna: Molex 105263

Flatness within 915MHz frequency band.

### 5.3.2. Efficiency Determination

$$Efficiency(\eta) = \frac{Pradiated}{Pin}$$

Efficiency of the Reference Antenna is specified to be > -1.7dB i.e 0.676 i.e. 67.6%

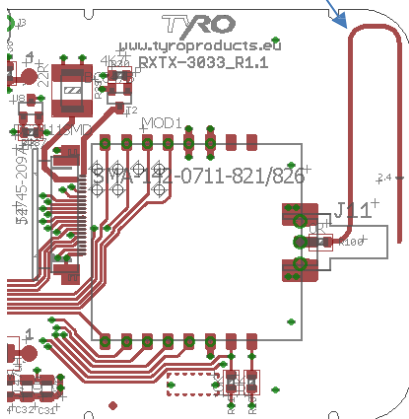
Reference Antenna Pradiated measured = 0.11910 mW -> Pin\_antenna = (0.11910 mW/0.676) = 0.17618mW

DUT Antenna Pradiated Measured =0.004256 (Total average power in radiation patterns of figure 9 to 20)

Efficiency DUT Antenna is than (0.004256/0.1191) = 0.0357 i.e. 3.57% or -14.5dB

## 6. Antenna Drawing

The pcb-trace antenna



Final layout of the trace antenna after cutting of 18mm. total trace length is now 58.5mm

## 7. Test results

We determined the efficiency using the average radiated power using the results from the plots in figure 9 tot figure 17.

- The maximum gain of the antenna is -8.7dBi (from figure 15)
- The efficiency is 3.87% (please note that this is an indicative value)

===== # =====