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# Application Note 005

**Active Steering MCD Algorithm**
**Test Result for ETH-LORA-M-AX-01 (V1.2)**

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# Application Note 005

## Active Steering MCD Algorithm
## Test Result for ETH-LORA-M-AX-01 (V1.2)

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## OVERVIEW

The Ethertronics LoRa module ETH-LORA-M-AX-01 (V1.2) embeds two antenna RF technology to maximize antenna performances:

- Closed loop Impedance Matching (IM) to maximize the power transferred to the antenna when the antenna is detuned by its environment.
- Active Steering Technologies to maximize link connectivity. With that feature, the radiation pattern of the active steering antenna is driven by Ethertronics Modal Cognitive Diversity (MCD) algorithm in order to enhance RF budget link and increase reliability and range.

The purpose of this document is to show the result of the active steering MCD technology embedded in the module ETH-LORA-M-AX-01 (V1.2).

This document is divided in the following parts:

- General description
- MCD Result
- Conclusion

### REQUIREMENT

To perform the test of the MCD algorithm the items below are needed.

**Hardware Tools:**

1. EtherLoRa module ETH-LORA-M-AX-01 (V1.2).
2. USB-UART Cable (FTDI USB-UART TTL Cable)
3. Computer with Windows OS
4. LoRa Gateway
5. Vector Network Analyzer (VNA)
6. Anechoic chamber

**Software Tools:**

1. Driver for USB-UART cable
2. Ethertronics EtherLoRa ETH-LORA-M-AX-01 Control Tool

### SCOPE

This document focuses on the active steering technology (and its' algorithm, MCD). This algorithm is running independently of the other RF technology (Closed Loop Impedance Matching (IM) algorithm) and but can only be used with an active steering antenna in active configuration of this module. In this document, an embedded active steering PCB antenna is used.

## GENERAL DESCRIPTION

### MCD ALGORITHM

The active steering algorithm MCD is developed by Ethertronics to perform active steering capabilities of the multi radiation patterns antenna in order to improve the link budget and sensitivity. In addition, the interference to the neighbour devices can be reduced when the gain of the antenna is steered to the right direction (LoRa gateway). The MCD algorithm predicts the best antenna configuration for the next data packet in order to optimize the LoRa communication and data transmission rate.

#### BLOCK DIAGRAM OF THE MODULE USED WITH AN ETHERTRONICS ACTIVE STEERING ANTENNA

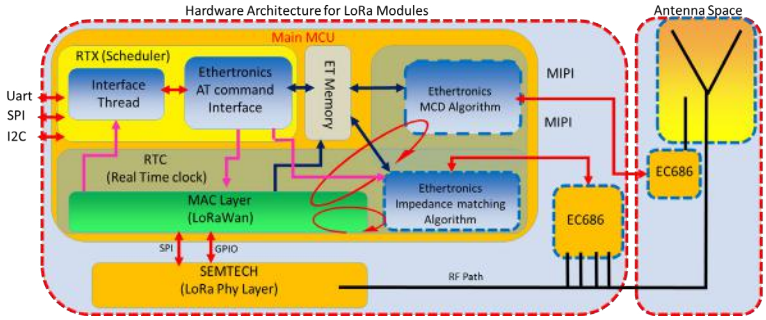



**Figure 1**

### ACTIVE EVALUATION BOARD

To facilitate the final product developers, Ethertronics has built a completed active evaluation board (EVB) for ETH-LORA-M-AX-01 (V1.2). In order to test the functionalities of the MCD algorithm, an active evaluation board is used. This evaluation board comes with test connectors to communicate with ETH-LORA-M-AX-01 using AT commands via UART interface. This board is also provided with Ethertronics' Active Steering antenna for ISM Band which covers the LoRa frequencies (868/915 MHz).

### ACTIVE EVB (TOP VIEW)

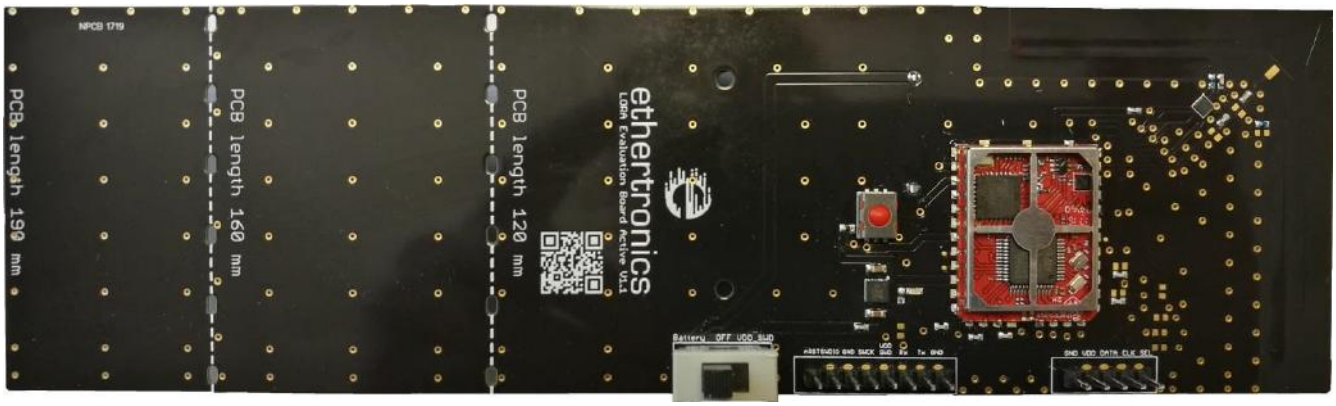



Figure 2

### ACTIVE EVB (BOTTOM VIEW)

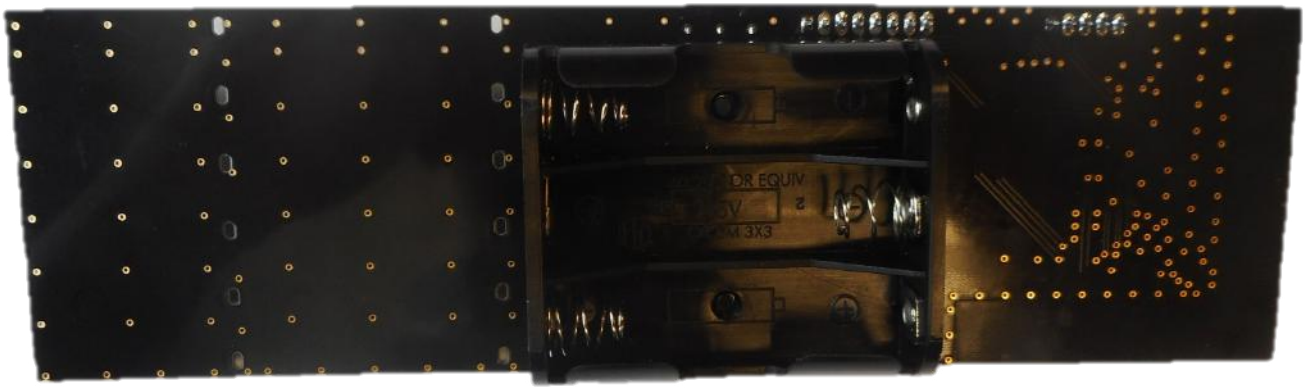


Figure 3

### ACTIVE EVB COMPONENTS

| Component | Position | Function | Description |
|---|---|---|---|
| ETH-LORA-M-AX-01 | Top | LoRa Module | Module to communicate LoRa communication |
| Active Steering PCB Antenna | Top | Active Antenna with EC686 | Emit/receive the signal |
| Push Button | Top | Reset button | Reset the ETH-LORA-M-AX-01 |
| Test connectors 1 | Top | UART/Power Supply | To communicate using AT Commands and to supply the voltage to the module |
| Test connectors 2 | Top | EC686 MIPI interface | To communicate directly with the external EC686 via MIPI interface |
| Toggle switch | Top | Power Supply selection | To select the power supply whether from Battery or Test connector |
| Battery holder | Bottom | Place for 3 AA batteries | To supply the voltage to the module |

Table 1

For more information about the active evaluation board, please refer to LoRa_Module_Application_Note_4-Active Steering Evaluation Board document from www.avx.com/products/modules/lora-module.

### SETUP CONDITION

The measurement has been done for LoRa EU-868 band. In the first phase the measurement of gain of the active steering PCB antenna has been done. Based on the result of the first phase, two positions are created to evaluate the MCD algorithm.

### GAIN MEASUREMENT SETUP

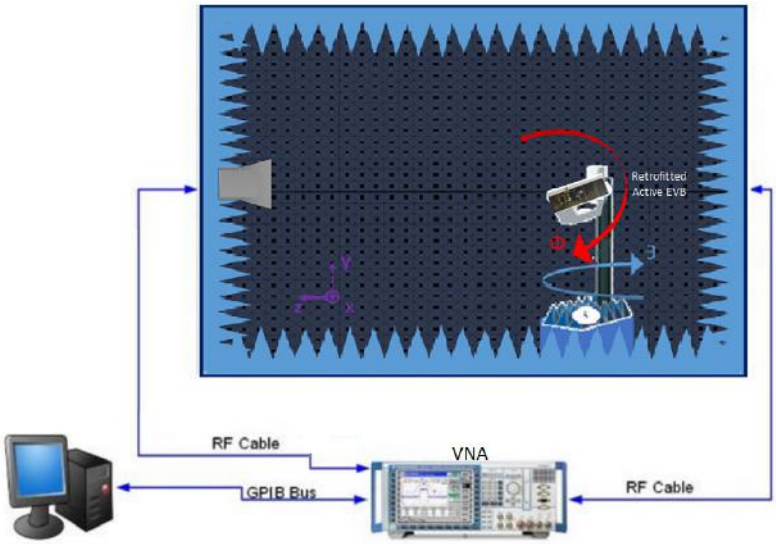



**Figure 4**

For the gain measurement, the active EVB is modified to connect the RF cable on the PCB. The device is then measured inside Ethertronics' anechoic chamber. Using Ethertronics' measurement and post processing software installed on the PC, the gain measurement is obtained.

- The measurement software controls the motors inside the chamber and also controls the VNA.
- The post processing software calculates the gain based on the values retrieved from the VNA.

### RSSI MEASUREMENT SETUP


**Figure 5**

The control software is installed on the PC host. User can use this software to communicate with the module ETH-LORA-M-AX-01 using AT commands. The procedures are as follow:

1. Setup the MCD algorithm parameters if necessary
2. Initiate the join procedure using OTAA with gateway
3. Start the MCD algorithm
4. Start the listener to collect information necessary and the state of the algorithm
5. Send the message to the gateway every 20 seconds
6. For every response of the gateway, the information is logged for the post processing.

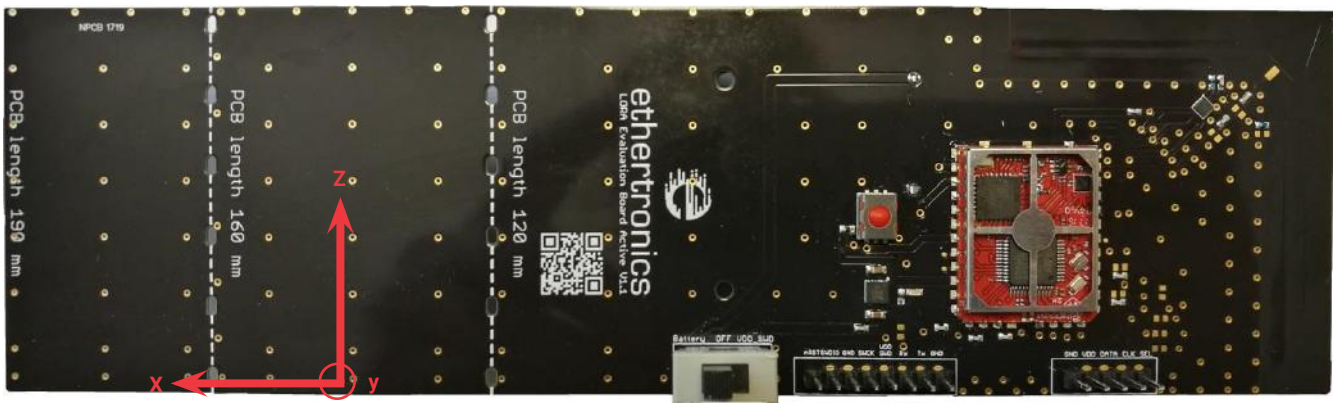
## RESULT

### ANTENNA GAIN MEASUREMENT (PASSIVE TESTS)

The eval board ETH-LORA-M-AX-01 (V1.2) has a patented Ethertronics Active Steering antenna which can exhibit up to two modes, meaning three different radiation patterns.

Any of the two radiation pattern can be considered as equivalent to the radiation pattern of a typical passive antenna (mounted in different position).

The axes of the measurement are as follow:




#### RADIATION PATTERNS FOR EU-ISM 868MHZ

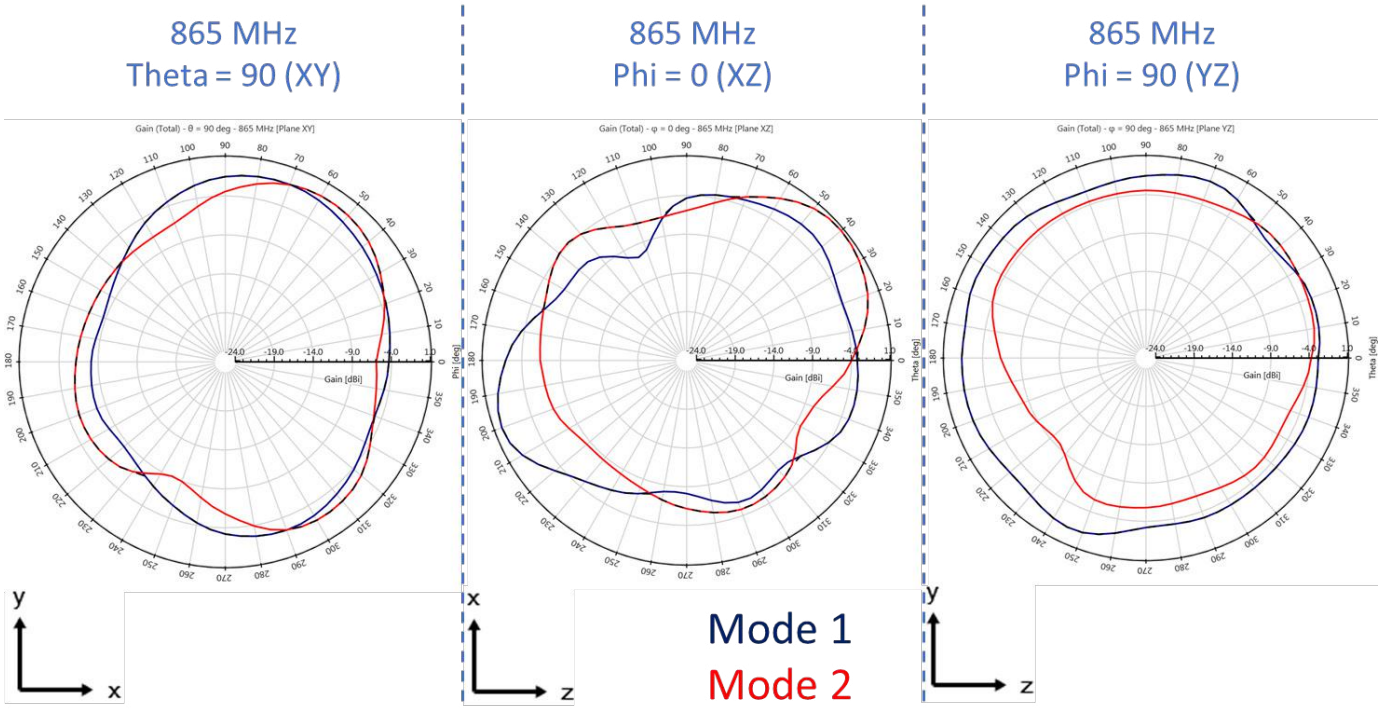



**Figure 6**

### RSSI MEASUREMENT (ACTIVE TESTS)

Active measurements with the LoRa module were performed in anechoic chamber equipped with a LoRa gateway. Active measurements with the LoRa module were performed with the EVB in two different positions.

#### POSITION 1

#### POSITIONING OF THE DEVICE AND THE GATEWAY IN POSITION 1 (TOP VIEW)

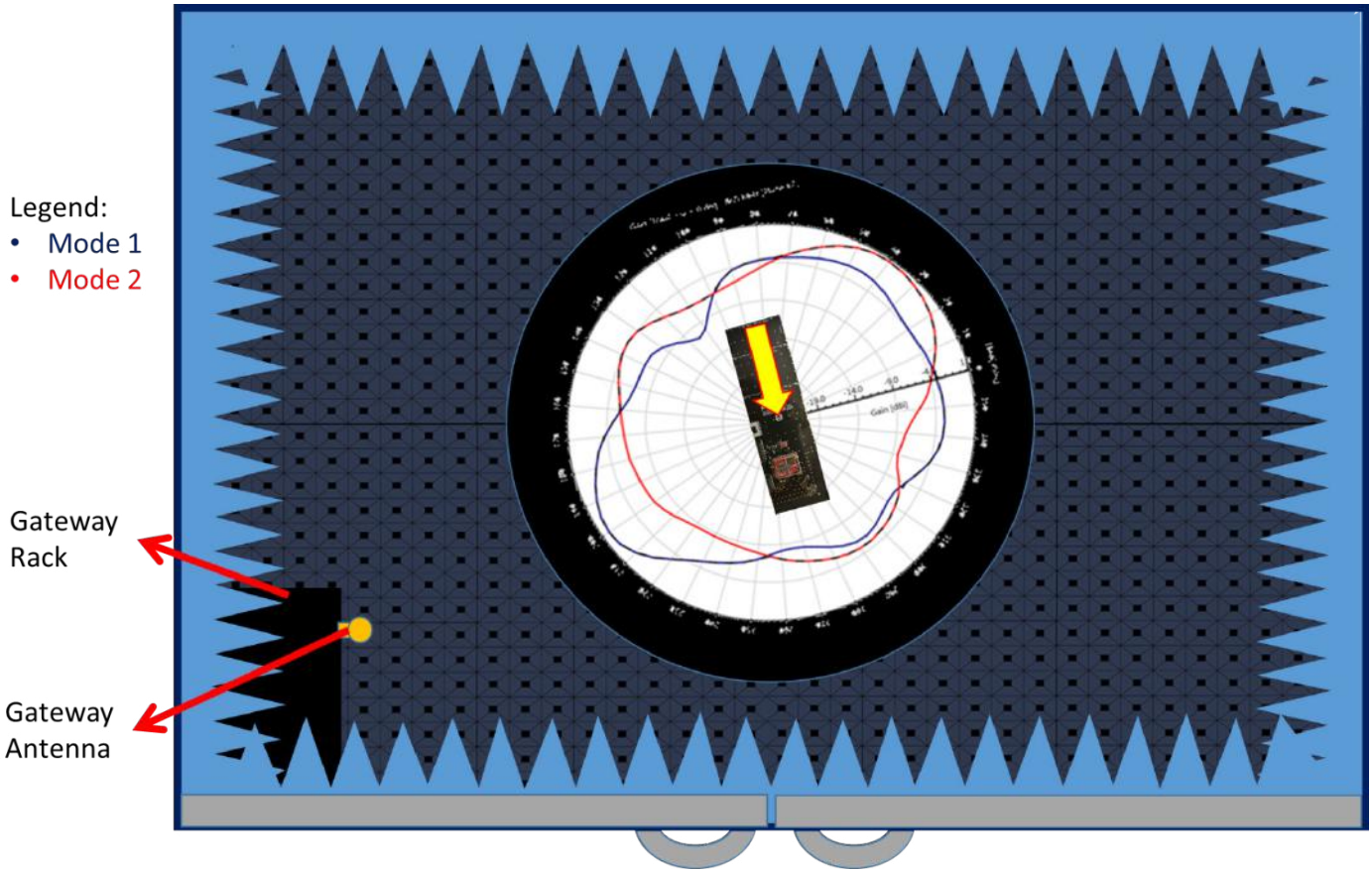



**Figure 7**

In this position, the mode 1 should be selected by the MCD algorithm because the mode 1 has a better gain than the mode 2 (see the **blue** curve of the gain pattern towards the gateway antenna in the picture above).

### RSSI AND MCD MODE IN POSITION 1

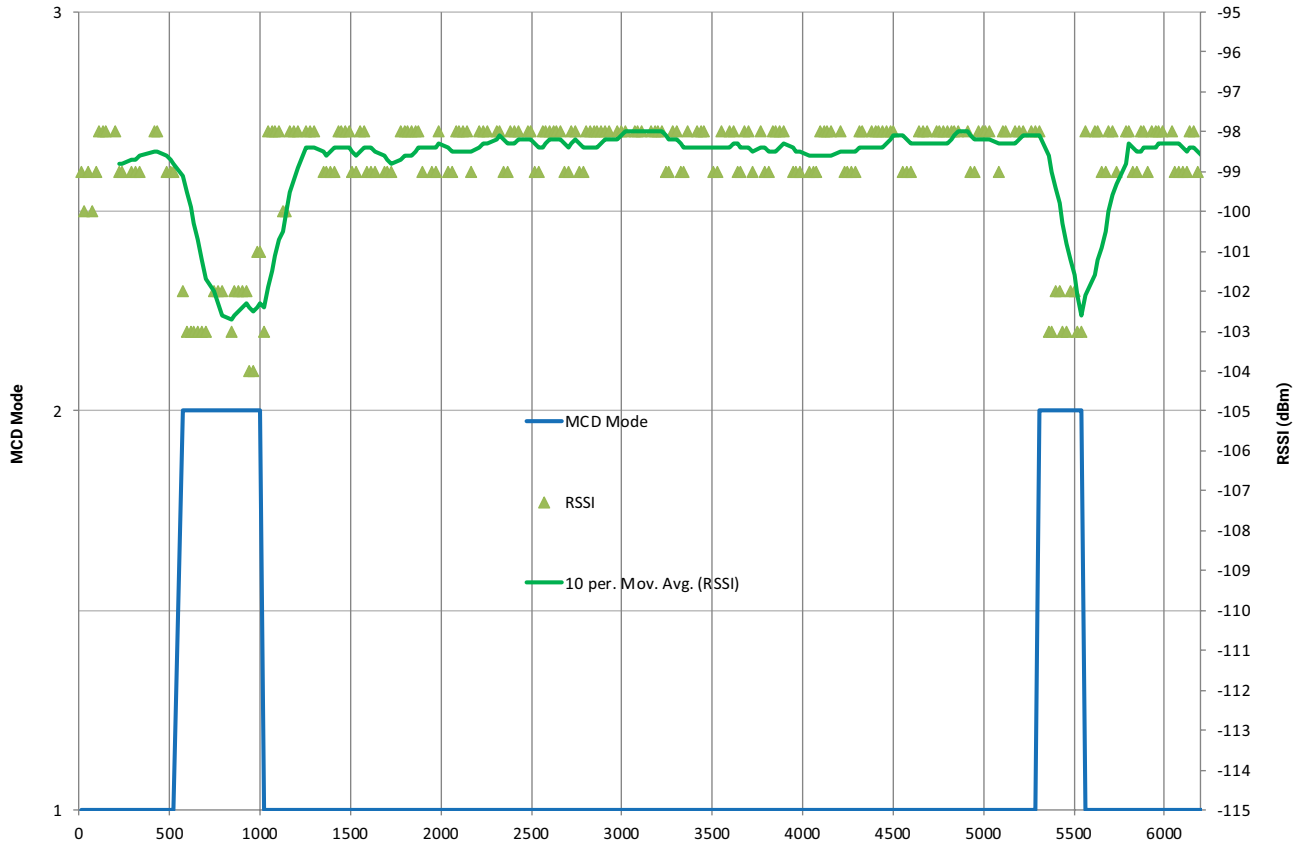



**Figure 8**

The MCD algorithm converges to mode 1 in the position 1. The RSSI measurement shows that the mode 1 has the better RSSI values and the MCD has selected the best mode.

POSITION 2

POSITIONING OF THE DEVICE AND THE GATEWAY IN POSITION 2 (TOP VIEW)

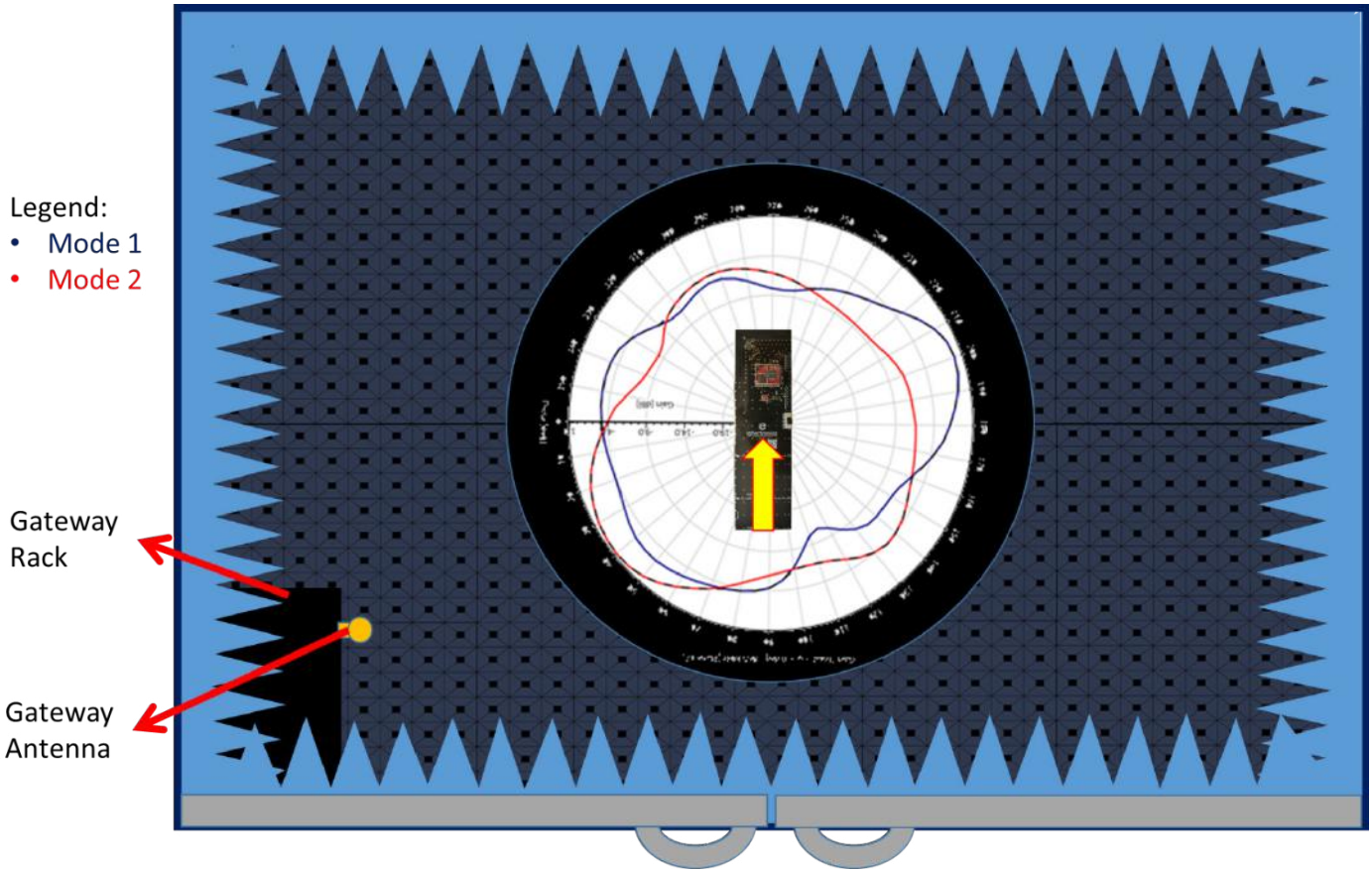



Figure 9

RSSI AND MCD MODE IN POSITION 2

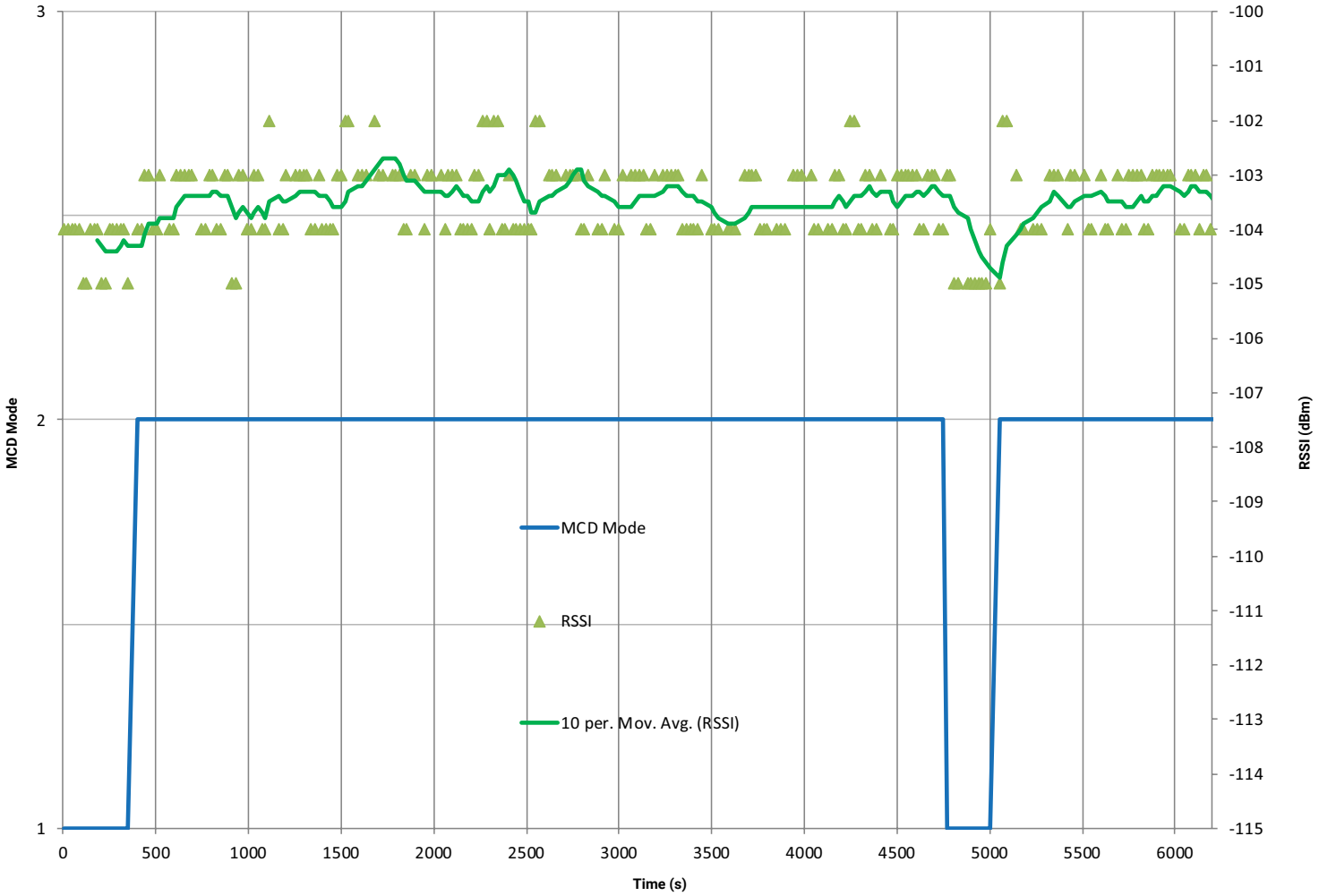



Figure 10

## CONCLUSION

From the passive tests:

- In position 1, the mode 1 has a better gain than the mode 2.
- In position 2, the mode 2 has a better gain than the mode 1.

### GAIN MEASUREMENT SUMMARY

| Description | | Gain (XZ cut) |
|---|---|---|
| Position 1 | Mode 1 | ~0dBi |
| | Mode 2 | ~-7dBi |
| | Achievable Improvement | ~7dB |
| Position 2 | Mode 1 | ~-4dBi |
| | Mode 2 | ~0dBi |
| | Achievable Improvement | ~4dB |

**Table 2**

From the active measurements with the module connected to the gateway, it appears that the MCD algorithm has always selected the best mode leading to the best RSSI value of each positions.

| Description | | RSSI |
|---|---|---|
| Position 1 | Mode 1 | ~-98.5dBm |
| | Mode 2 | ~-103dBm |
| | Achievable Improvement | ~4.5dB |
| Position 2 | Mode 1 | ~-105dBm |
| | Mode 2 | ~-103dBm |
| | Achievable Improvement | ~2dB |

**Table 3**

When changing between mode, the improvement, in that test, can reach up to 4.5dB

## LIST OF ABBREVIATIONS

LoRa: Long range
IM: Impedance Matching
MCD: Modal Cognitive Diversity
USB: Universal Serial Bus
TTL: Transistor–transistor logic level
UART: Universal Asynchronous Receiver/Transmitter
OS: Operating System
VNA: Vector Network Analyzer
EU: European Union
RF: Radio Frequency
ISM: industrial, Scientific and Medical
EVB: Evaluation Board
OTAA: Over The Air Activation
DUT: Device Under Test
RSSI: Received Signal Strength Indicator

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ethertronics®

AN AVX GROUP COMPANY


**Americas**
+(1) 858.550.3820
eth.usasales@avx.com

**Europe**
+33 (0) 4 93 74 30 71
eth.europesales@avx.com

**Asia**
Korea: 82.31.436.2290
China: 886.2.2655.7966


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