



element

Masimo Corporation

PCB Antenna

Antenna Pattern Measurements

Report: MASI0856.0 Rev. 1, Issue Date: January 12, 2023



Approved by:

Johnny Candelas, Operations Manager

This report must not be used to claim product certification, approval, or endorsement by A2LA or any agency of the U.S. Government. This Report shall not be reproduced, except in full without written approval of the laboratory.

REVISION HISTORY



Revision Number	Description	Date (yyyy-mm-dd)	Page Number
01	Included Reference Antenna Plots	2023-01-11	17-18
	Revised comments in Polar Plots	2023-01-11	8-19

ACCREDITATIONS AND AUTHORIZATIONS



United States

FCC - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

A2LA - Each laboratory is accredited by A2LA to ISO / IEC 17025, and as a product certifier to ISO / IEC 17065 which allows Element to certify transmitters to FCC and IC specifications.

Canada

ISED - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

European Union

European Commission – Recognized as an EU Notified Body validated for the EMCD and RED Directives.

United Kingdom

BEIS – Recognized by the UK as an Approved Body under the UK Radio Equipment and UK EMC Regulations.

Australia/New Zealand

ACMA - Recognized by ACMA as a CAB for the acceptance of test data.

Korea

MSIT / RRA - Recognized by KCC's RRA as a CAB for the acceptance of test data.

Japan

VCCI - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

Taiwan

BSMI – Recognized by BSMI as a CAB for the acceptance of test data.

NCC - Recognized by NCC as a CAB for the acceptance of test data.

Singapore

IDA – Recognized by IDA as a CAB for the acceptance of test data.

Israel

MOC – Recognized by MOC as a CAB for the acceptance of test data.

Hong Kong

OFCA – Recognized by OFCA as a CAB for the acceptance of test data.

Vietnam

MIC – Recognized by MIC as a CAB for the acceptance of test data.

SCOPE

For details on the Scopes of our Accreditations, please visit:

[California](#)

[Minnesota](#)

[Oregon](#)

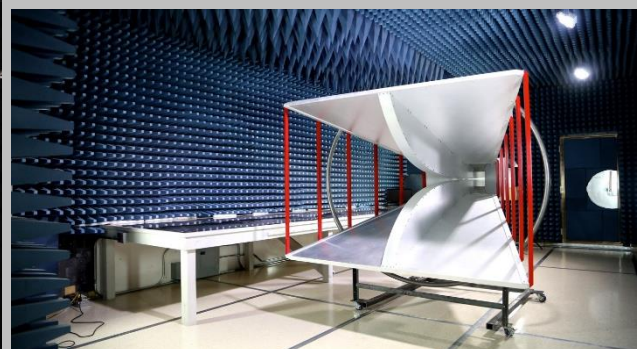
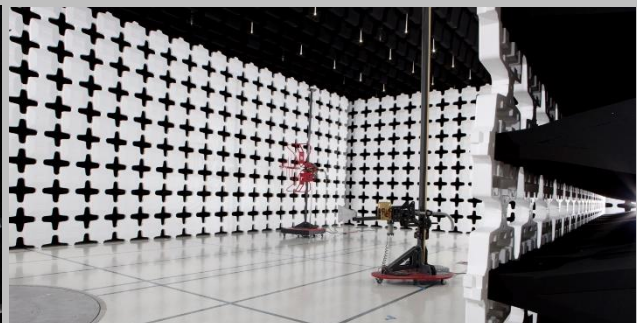
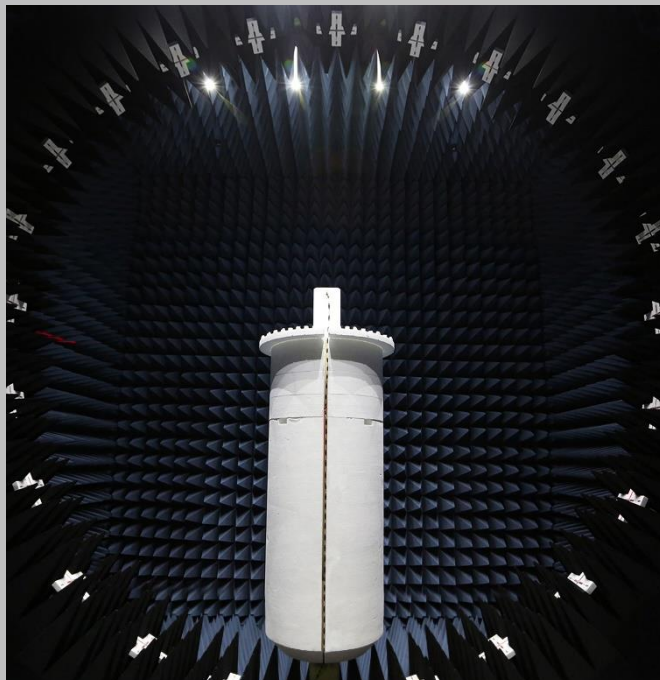
[Texas](#)

[Washington](#)

FACILITIES



California Labs OC01-17 41 Tesla Irvine, CA 92618 (949) 861-8918	Minnesota Labs MN01-11 9349 W Broadway Ave. Brooklyn Park, MN 55445 (612)-638-5136	Oregon Labs EV01-12 6775 NE Evergreen Pkwy #400 Hillsboro, OR 97124 (503) 844-4066	Texas Labs TX01-09 3801 E Plano Pkwy Plano, TX 75074 (469) 304-5255	Washington Labs NC01-05 19201 120 th Ave NE Bothell, WA 98011 (425)984-6600
A2LA				
Lab Code: 3310.04	Lab Code: 3310.05	Lab Code: 3310.02	Lab Code: 3310.03	Lab Code: 3310.06
Innovation, Science and Economic Development Canada				
2834B-1, 2834B-3	2834E-1, 2834E-3	2834D-1	2834G-1	2834F-1
BSMI				
SL2-IN-E-1154R	SL2-IN-E-1152R	SL2-IN-E-1017	SL2-IN-E-1158R	SL2-IN-E-1153R
VCCI				
A-0029	A-0109	A-0108	A-0201	A-0110
Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRR, MIC, MOC, NCC, OFCA				
US0158	US0175	US0017	US0191	US0157



PRODUCT DESCRIPTION



Client and Equipment under Test (EUT) Information

Company Name:	Masimo Corporation
Address:	52 Discovery
City, State, Zip:	Irvine, CA 92618
Test Requested By:	Anami Joshi
EUT:	PCB Antenna
First Date of Test:	November 23, 2023
Last Date of Test:	November 23, 2023
Receipt Date of Samples:	November 23, 2023
Equipment Design Stage:	Production
Equipment Condition:	No Damage
Purchase Authorization:	Verified

Information Provided by the Party Requesting the Test

Functional Description of the EUT:
PCB Antenna
Testing Objective:
To obtain 2D antenna pattern measurements and calculated antenna performance values.

CONFIGURATIONS



Configuration MASI0846- 1

EUT			
Description	Manufacturer	Model/Part Number	Serial Number
Baby Sensor	Masimo Corporation	None Specified	09

MODIFICATIONS



Equipment Modifications

Item	Date	Test	Modification	Note	Disposition of EUT
1	2022-11-23	2D Polar Plots	Tested as delivered to Test Station.	No EMI suppression devices were added or modified during this test.	Scheduled testing was completed.

2D POLAR PLOTS

Testing was performed using the mode(s) of operation and configuration(s) noted within the report. The individuals and/or the organization requesting the test provided the modes, configurations and settings used to complete the evaluation. The actual test parameters are specified in the test data, this includes items such as investigated frequency range (scanned) and test levels. The testing methods and performance specifications, as well as the test site used for the evaluation are indicated in the test data. The test data represents the configuration / operating mode/ model that produced the highest emission levels as compared to the specification limit.

MODES OF OPERATION

Continuously Transmitting: Low channel, 2402 MHz, CW
Continuously Transmitting: Mid channel, 2440 MHz, CW
Continuously Transmitting: High channel, 2480 MHz, CW

CONFIGURATIONS INVESTIGATED

MASI0846 - 1

FREQUENCY RANGE INVESTIGATED

Start Frequency	2402 MHz	Stop Frequency	2480 MHz
-----------------	----------	----------------	----------

SAMPLE CALCULATIONS

Max Absolute Gain of AUT = $G_{ref} - (E_{ref} - E_{aut}) + L_c$

Where:

G_{ref} = gain of reference antenna (dBi)

E_{ref} = electric field strength in dBuV/m

E_{aut} = electric field strength in dBuV/m

L_c = AUT setup loss

TEST EQUIPMENT

Description	Manufacturer	Model	ID	Last Cal.	Cal. Due
Cable	Northwest EMC	1-8GHz RE Cable	OCJ	2022-02-09	2023-02-09
Analyzer - Spectrum Analyzer	Agilent	N9010A	AFJ	2022-01-12	2023-01-12
Antenna - Double Ridge	ETS Lindgren	3115	AIR	2022-07-19	2024-07-19
Generator - Signal	Agilent	E8257D	TGU	2020-11-03	2023-11-03
Attenuator	Fairview Microwave	SA18H-06	TKU	2022-01-18	2023-01-18
Antenna - Double Ridge	EMCO	3115	AHE	2022-09-01	2024-09-01

TEST DESCRIPTION

Measurements were performed in a semi-anechoic chamber. RF absorbing cones were placed on the floor between the measurement antenna and the AUT. The AUT was placed on a 1.8 m high block of foam.

The reference antenna was placed at the center of the 1.8 m block of foam. A CW signal was provided to the reference antenna from a calibrated signal generator through a length of RF Cable. To reduce the effects of the RF cable, the RF cable was lined with ferrite cores running down the length of the cable with a spacing of 10cm between each ferrite. A reference plot was collected.

The AUT was then put into the chamber in place of the reference antenna. The AUT was connected to the signal generator using the RF same cable and connector setup. A polar plot was then collected at the antenna height of maximum field strength. This plot was then compared to the reference antenna scan, and, using the antenna gain (dBi) of the reference antenna the absolute gain of the AUT was calculated.

2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	Not worst case			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **114.0876**

Azimuth at Maximum **78°**

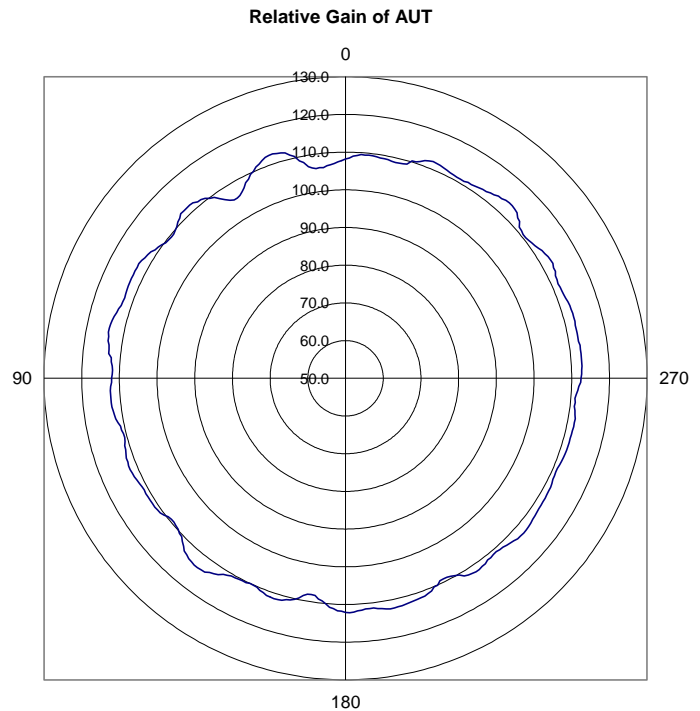
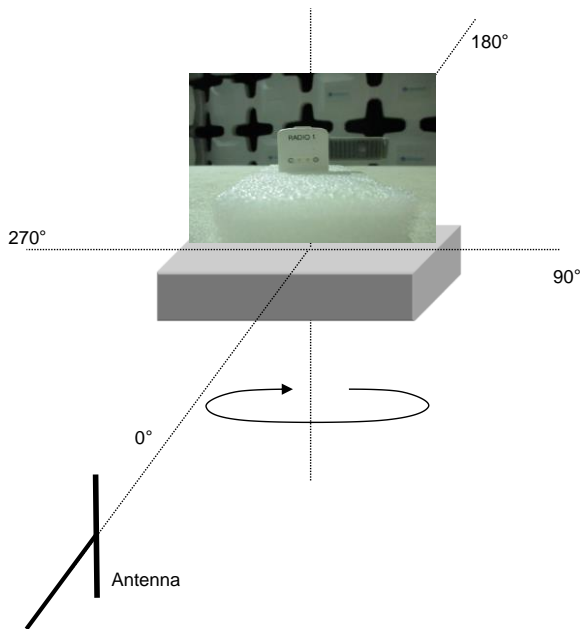
Measurement Antenna Polarity **Vertical**
Antenna Under Test (AUT) Polarity **Vertical**

Minimum Amplitude (dBuV/m) **105.7876**

Azimuth at Minimum **31°**

3 dB Beamwidth **46°**

Run #	5	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	---	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	Not worst case			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **111.8876**

Azimuth at Maximum **345°**

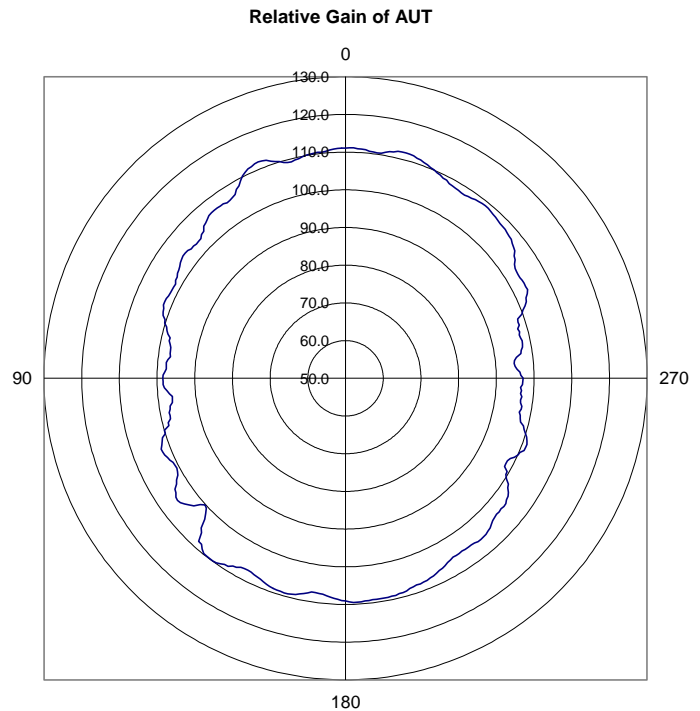
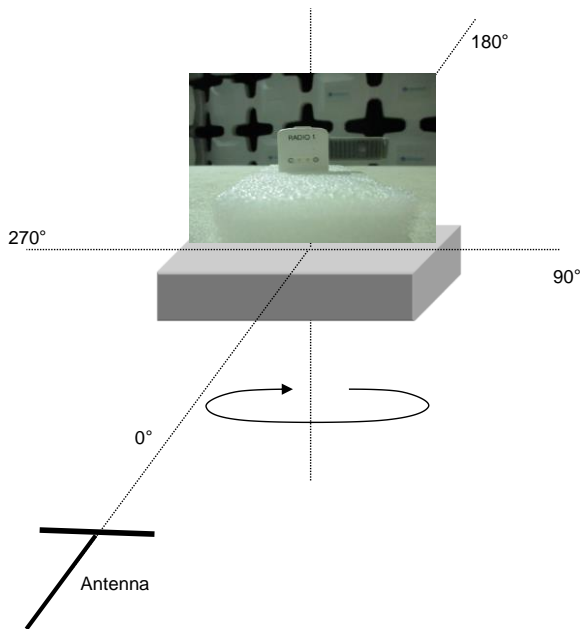
Measurement Antenna Polarity **Horizontal**
Antenna Under Test (AUT) Polarity **Vertical**

Minimum Amplitude (dBuV/m) **94.88761**

Azimuth at Minimum **274°**

3 dB Beamwidth **57°**

Run #	6	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	---	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	Not worst case			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **107.2876**

Azimuth at Maximum **108°**

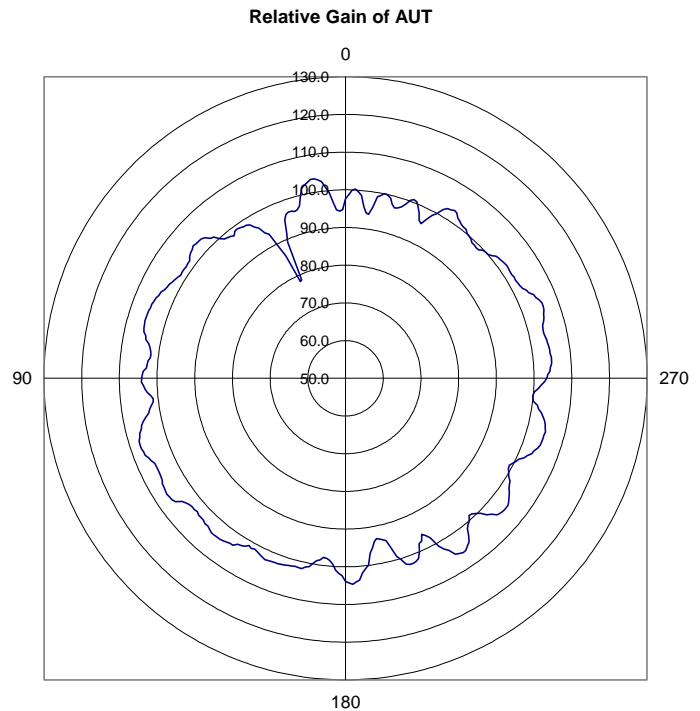
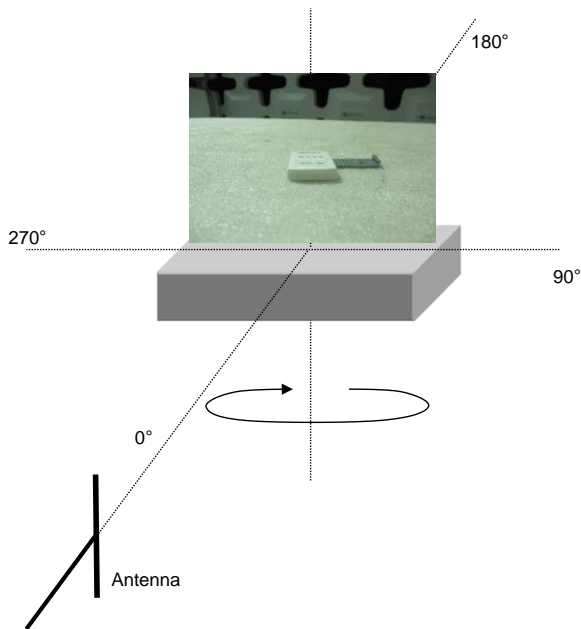
Measurement Antenna Polarity **Vertical**
Antenna Under Test (AUT) Polarity **Horizontal**

Minimum Amplitude (dBuV/m) **78.28761**

Azimuth at Minimum **24°**

3 dB Beamwidth **26°**

Run #	7	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	---	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	Worst case			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **116.2876**

Azimuth at Maximum **45°**

Measurement Antenna Polarity **Horizontal**

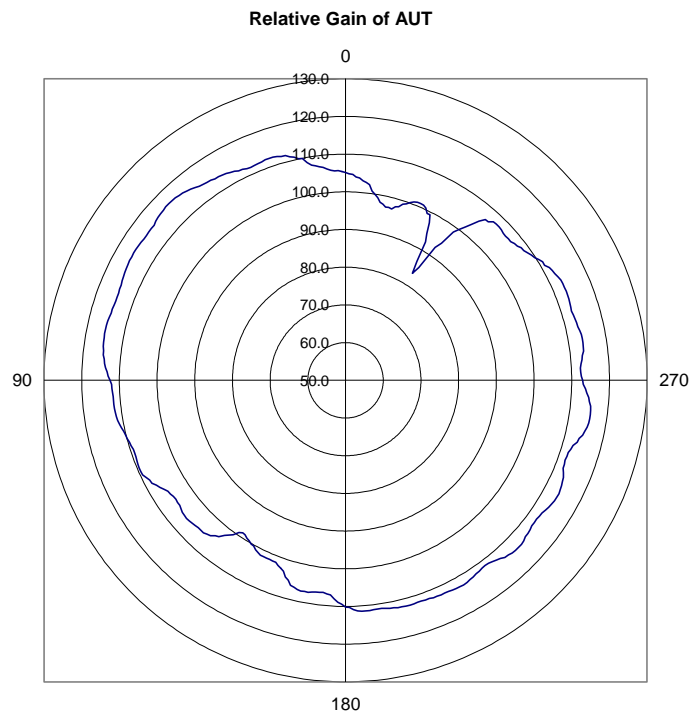
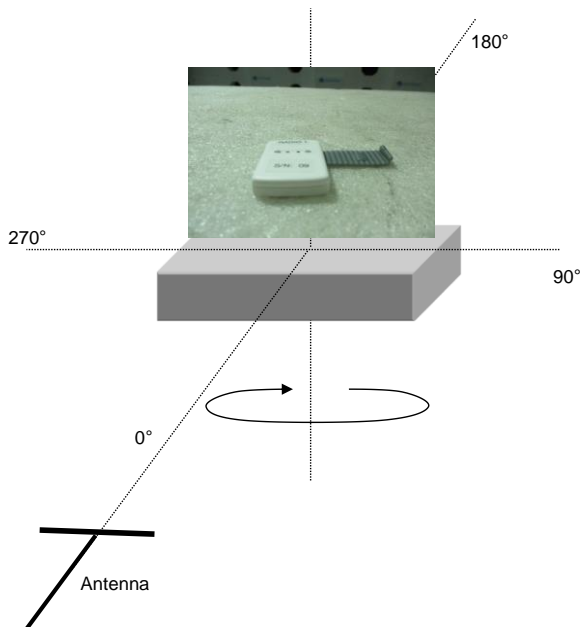
Minimum Amplitude (dBuV/m) **83.48761**

Antenna Under Test (AUT) Polarity **Horizontal**

Azimuth at Minimum **327°**

3 dB Beamwidth **59°**

Run #	8	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	---	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	Not worst case			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **114.2876**

Azimuth at Maximum **318°**

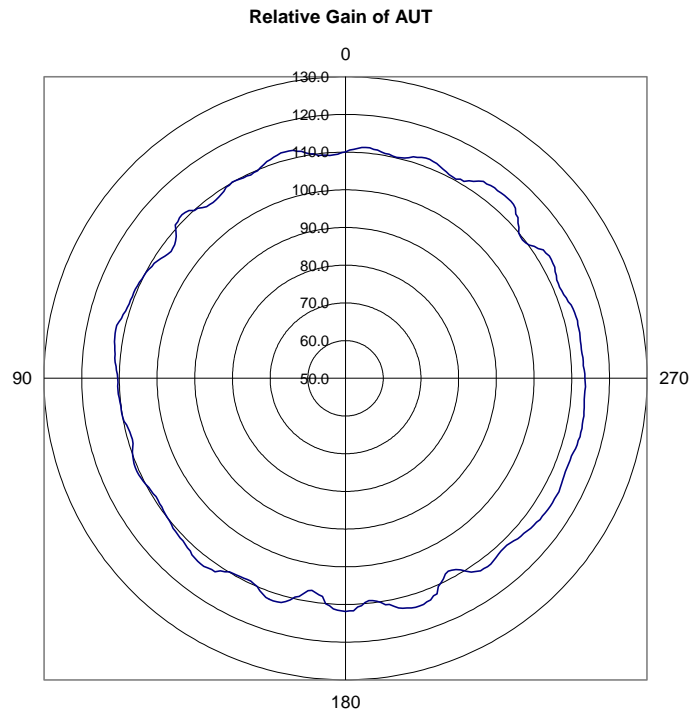
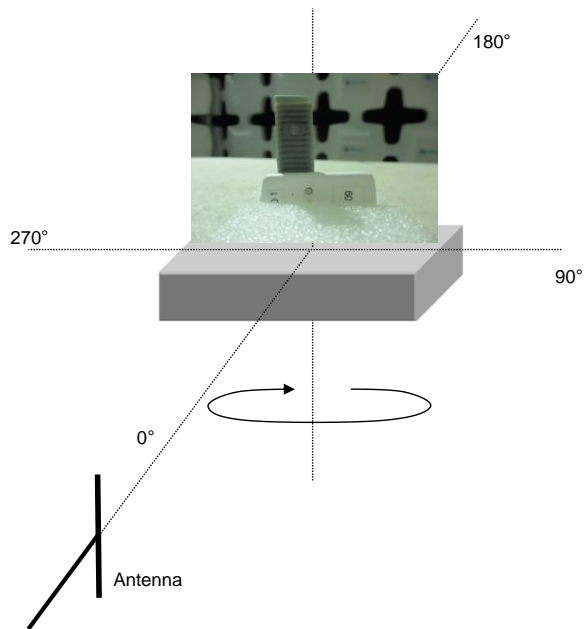
Measurement Antenna Polarity **Vertical**
Antenna Under Test (AUT) Polarity **on Side**

Minimum Amplitude (dBuV/m) **106.9876**

Azimuth at Minimum **170°**

3 dB Beamwidth **18°**

Run #	9	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	---	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	Not worst case			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **112.9876**

Azimuth at Maximum **19°**

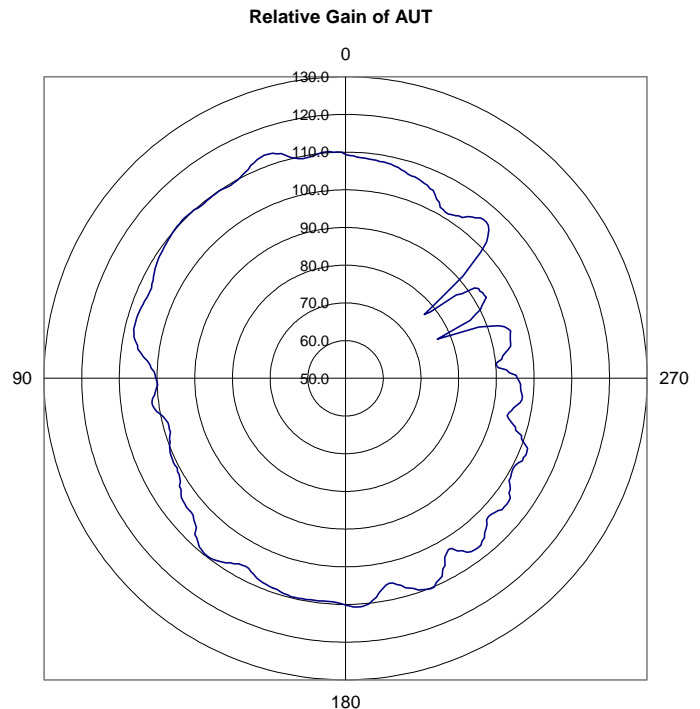
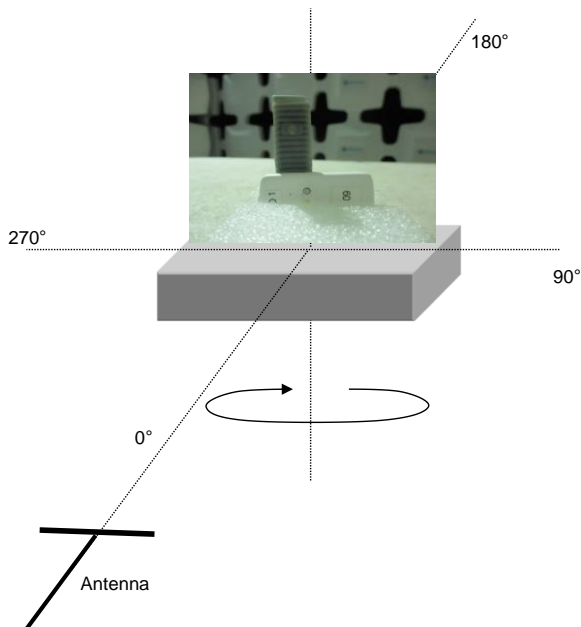
Measurement Antenna Polarity **Horizontal**
Antenna Under Test (AUT) Polarity **on Side**

Minimum Amplitude (dBuV/m) **76.48761**

Azimuth at Minimum **292°**

3 dB Beamwidth **15°**

Run #	10	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	----	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Mid channel, 2440 MHz, CW			
Deviations:	None			
Comments:	Polar plot of mid channel with worst case antenna polarity and EUT orientation. Low channel polar plot run # 8 still worst case.			

Frequency (MHz) **2440**

Maximum Amplitude (dBuV/m) **114.5317**

Azimuth at Maximum **281°**

Measurement Antenna Polarity **Horizontal**

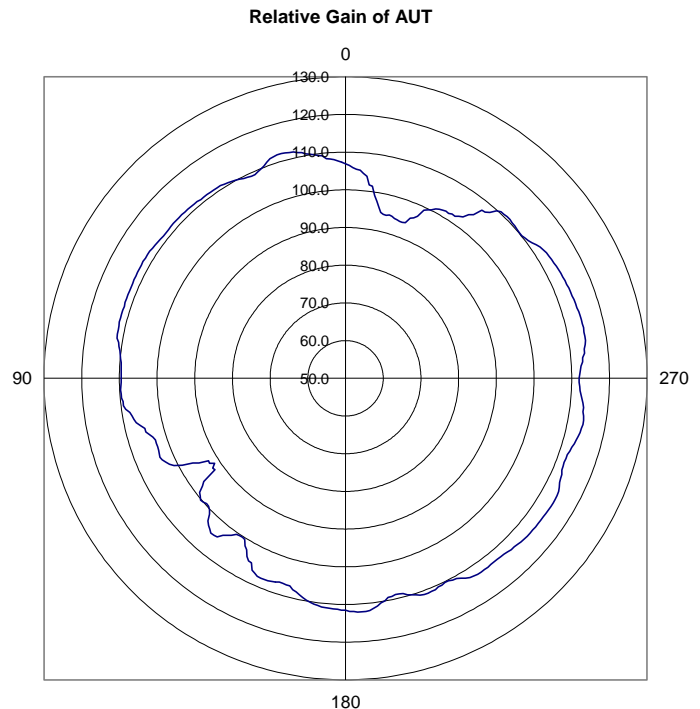
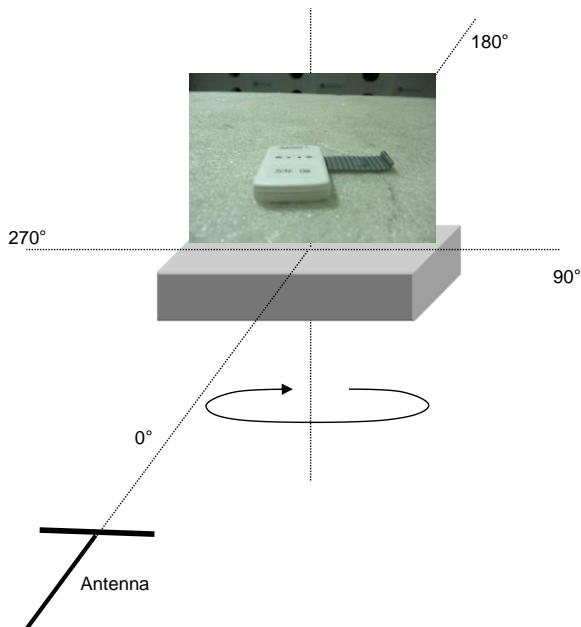
Minimum Amplitude (dBuV/m) **91.43173**

Antenna Under Test (AUT) Polarity **Horizontal**

Azimuth at Minimum **122°**

3 dB Beamwidth **96°**

Run #	11	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	----	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: High channel, 2480 MHz, CW			
Deviations:	None			
Comments:	Polar plot of high channel with worst case antenna polarity and EUT orientation. Low channel polar plot run # 8 still worst case.			

Frequency (MHz) **2480**

Maximum Amplitude (dBuV/m) **115.634**

Azimuth at Maximum **68°**

Measurement Antenna Polarity **Horizontal**

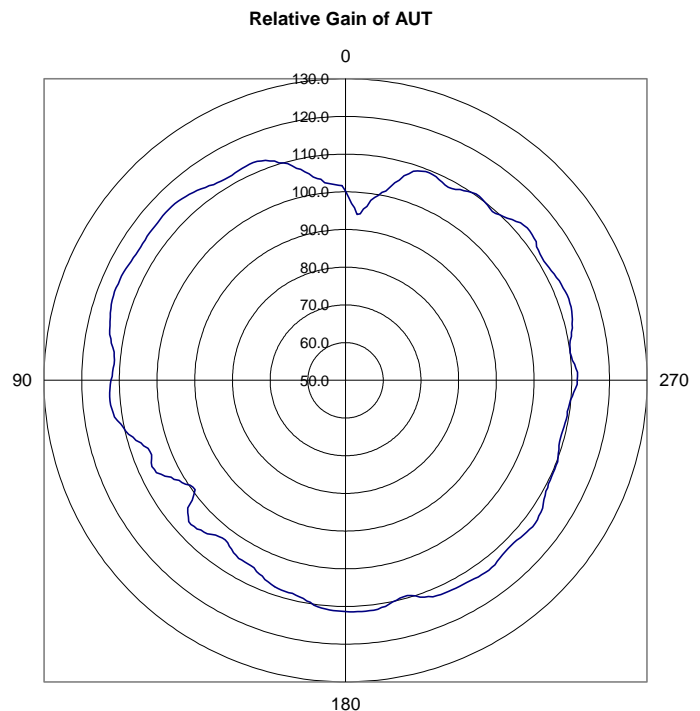
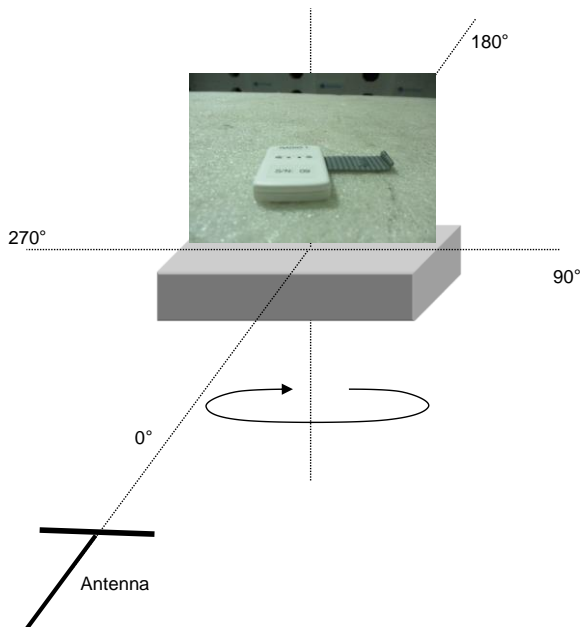
Minimum Amplitude (dBuV/m) **94.134**

Antenna Under Test (AUT) Polarity **Horizontal**

Azimuth at Minimum **355°**

3 dB Beamwidth **48°**

Run #	12	Test Distance (m)	3	Antenna Height(s)	1.5		
--------------	----	--------------------------	---	--------------------------	-----	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	20.7 °C	
Job Site:	OC10	Humidity:	47.7% RH	
Serial Number:	AHE	Barometric Pres.:	1015 mbar	
EUT:	Reference Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	None			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **128.1876**

Azimuth at Maximum **359°**

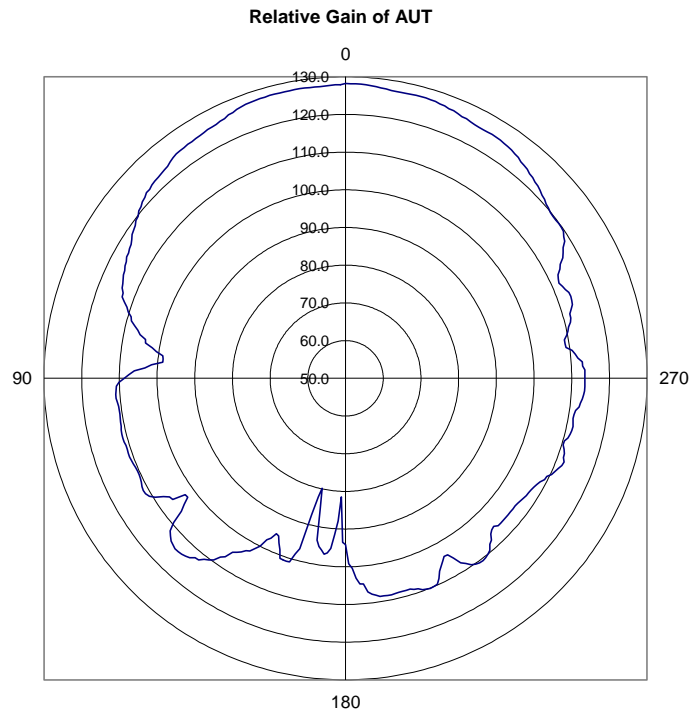
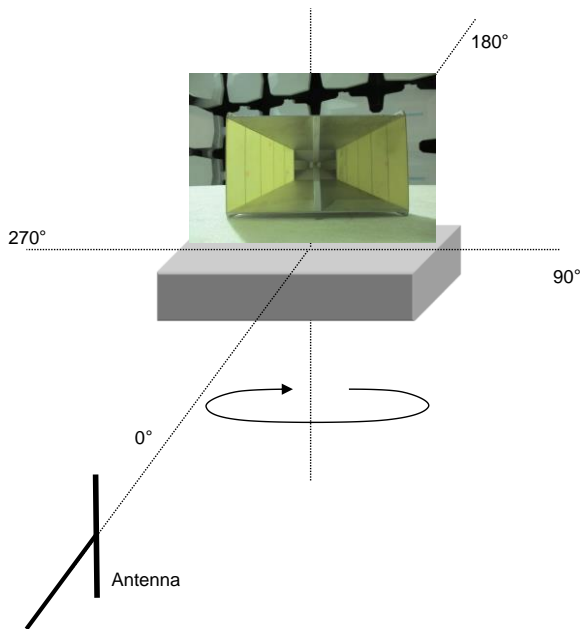
Measurement Antenna Polarity **Vertical**
Antenna Under Test (AUT) Polarity **Vertical**

Minimum Amplitude (dBuV/m) **79.78761**

Azimuth at Minimum **167°**

3 dB Beamwidth **64°**

Run #	16	Test Distance (m)	3	Antenna Height(s)	1		
--------------	----	--------------------------	---	--------------------------	---	--	--



2D POLAR PLOTS



EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	20.7 °C	
Job Site:	OC10	Humidity:	47.9% RH	
Serial Number:	AHE	Barometric Pres.:	1014 mbar	
EUT:	Reference Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	None			

Frequency (MHz) **2402**

Maximum Amplitude (dBuV/m) **127.5876**

Azimuth at Maximum **2°**

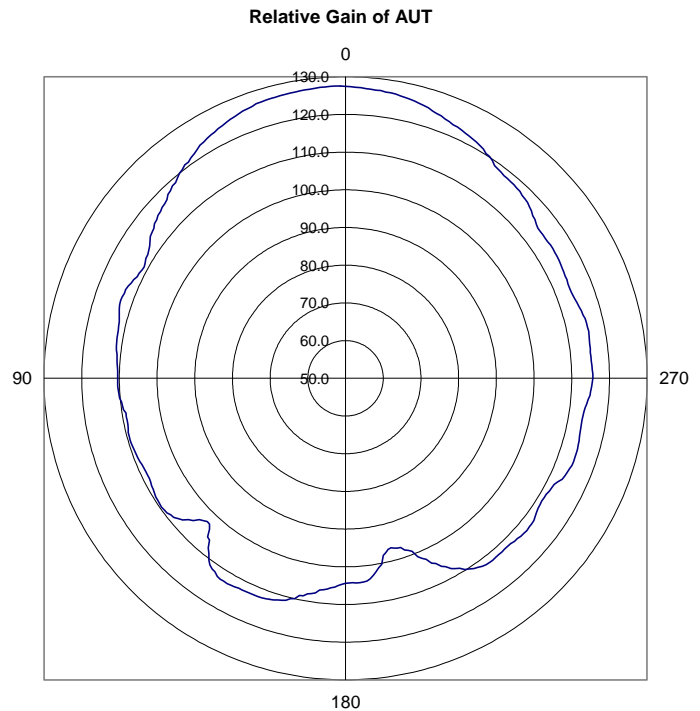
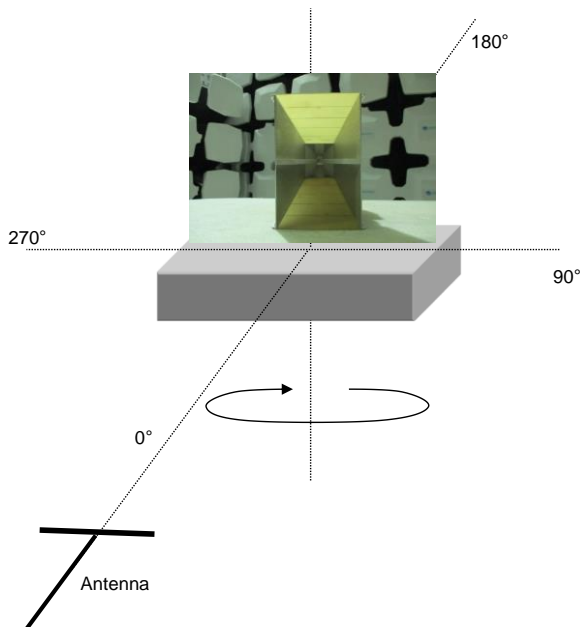
Measurement Antenna Polarity **Horizontal**
Antenna Under Test (AUT) Polarity **Horizontal**

Minimum Amplitude (dBuV/m) **96.58761**

Azimuth at Minimum **194°**

3 dB Beamwidth **44°**

Run #	18	Test Distance (m)	3	Antenna Height(s)	1		
--------------	----	--------------------------	---	--------------------------	---	--	--



ABSOLUTE GAIN



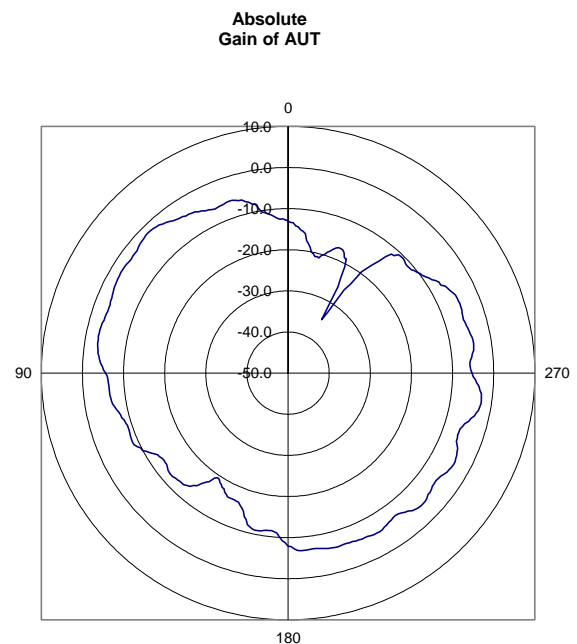
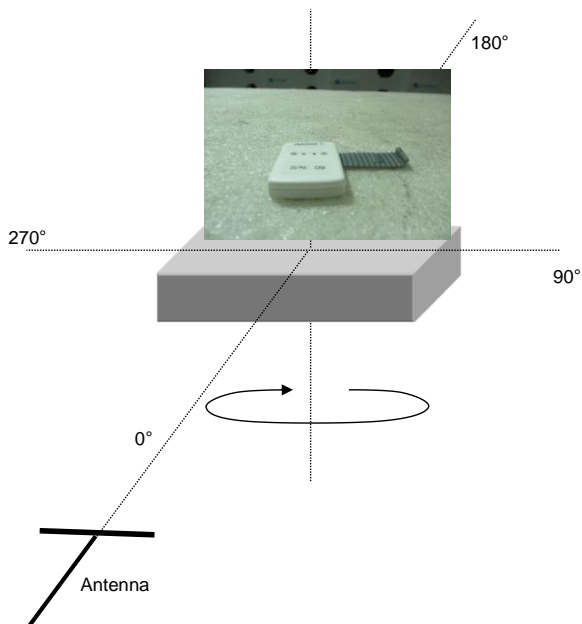
EmiR5 2022.07.06.0

PSA-ESCI 2022.08.23.0

Work Order:	MAI0846	Date:	2022-11-23	
Project:	None	Temperature:	18.3 °C	
Job Site:	OC10	Humidity:	36.1% RH	
Serial Number:	09	Barometric Pres.:	1021 mbar	
EUT:	PCB Antenna			Tested by: Nolan De Ramos
Configuration:	1			
Customer:	Masimo Corporation			
Attendees:	Anami Joshi			
EUT Power:	Battery			
Operating Mode:	Continuously Transmitting: Low channel, 2402 MHz, CW			
Deviations:	None			
Comments:	Worst case			

Frequency	2402	Absolute Gain of Reference Antenna (dBi)	9.47
Measurement Antenna Polarity	Horizontal	Reference Antenna Relative Gain Max (dBuV/m)	127.59
Antenna Under Test (AUT) Polarity	Horizontal	AUT Relative Gain Max (dBuV/m)	116.29
Maximum Absolute Gain of AUT (dBi)	-1.83	Difference (Reference Antenna - AUT) (dB)	11.30
Average Absolute Gain of AUT (dBi)	-8.65	AUT Setup Loss (dB)	0
		Correction Factor (Convert Relative to Absolute Gain) (dB)	118.12
3 dB Beamwidth	59°		
		Reference Antenna Measured Input Power (dBm)	6.00
		EUT Conducted Output Power (dBm)	6.00
		Power Delta (Antenna Power-Output Power) (dB)	0.00

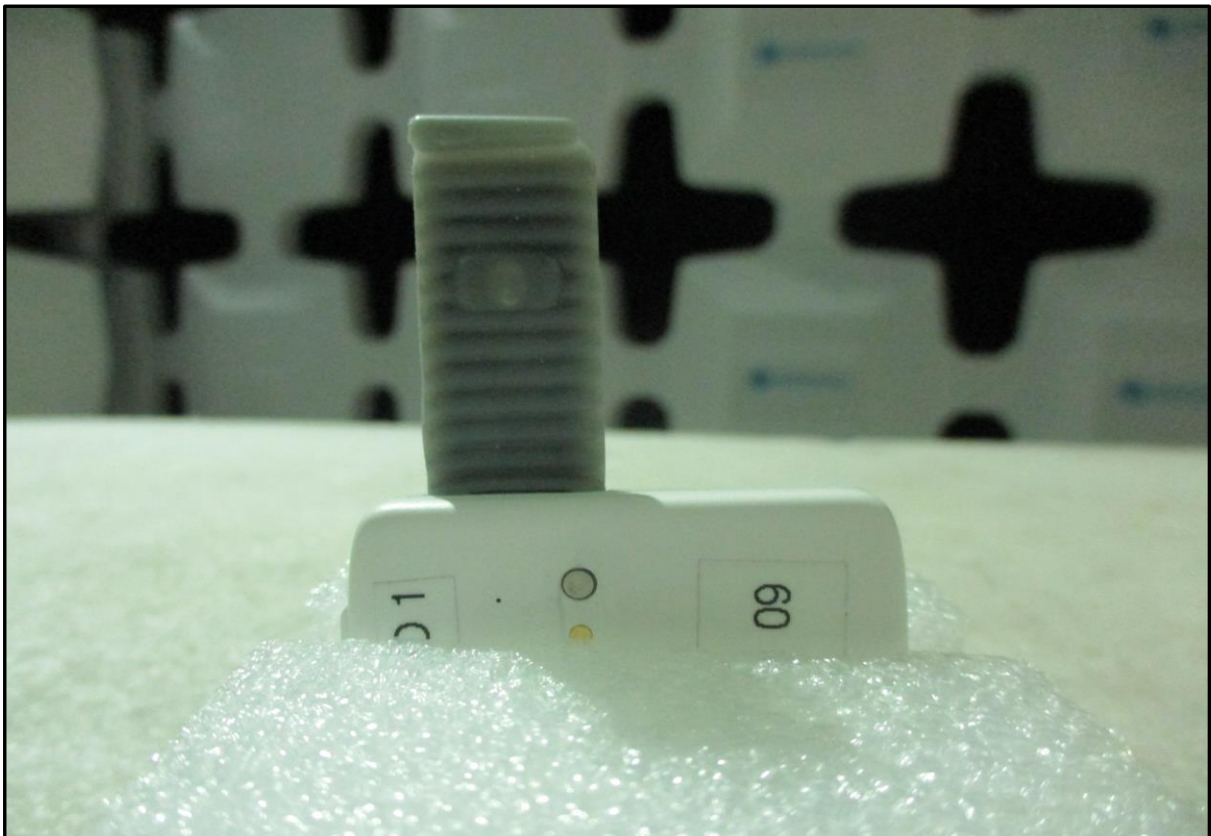
Run #	Test Distance (m)	Antenna Height(s)	Results
-------	-------------------	-------------------	---------



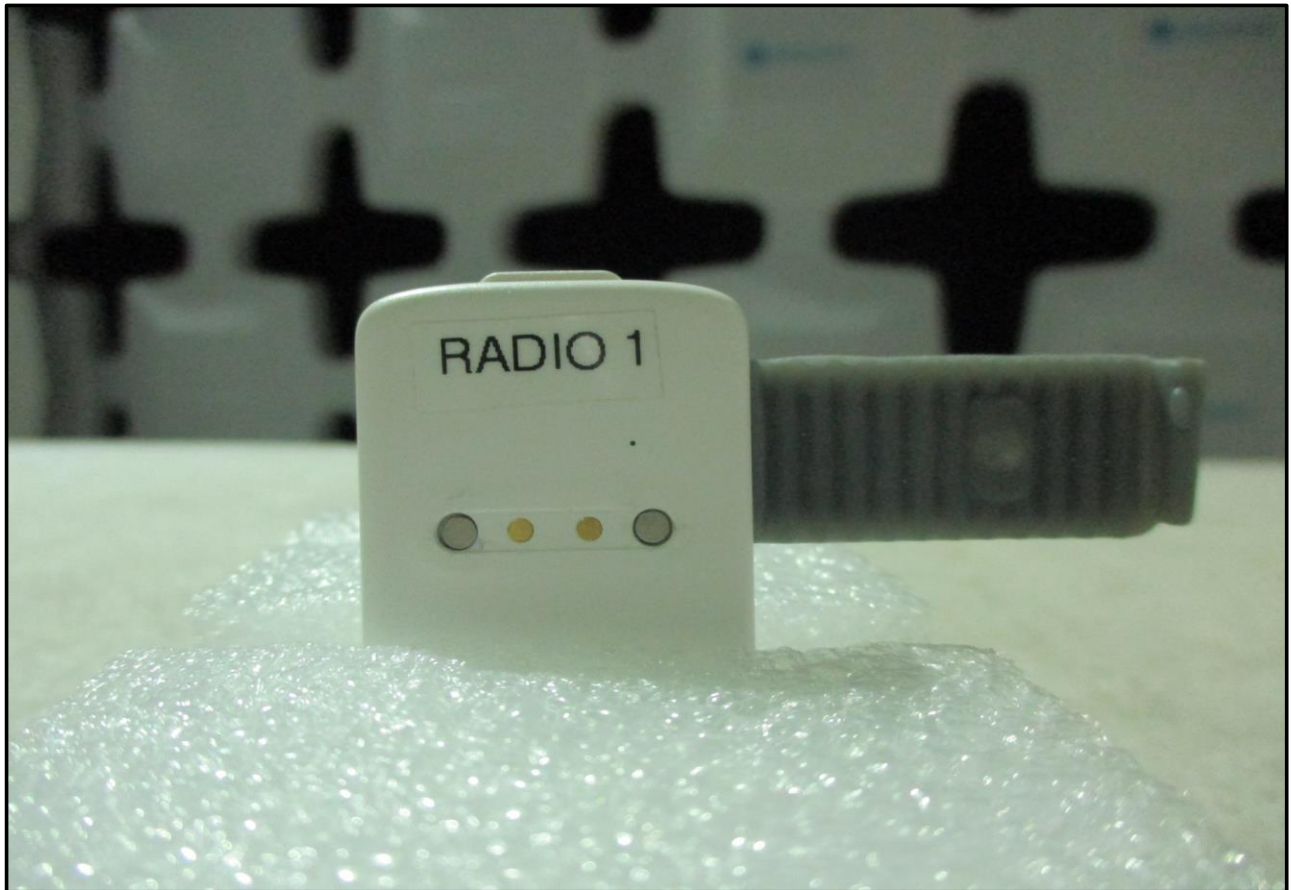
2D POLAR PLOTS



PSA-ESCI 2022.08.23.0



2D POLAR PLOTS



End of Test Report