



ANTENNA TEST REPORT
for the
CMCR001 BLUETOOTH ANTENNA

WLL REPORT# 18408-01 REV 0

Prepared for:

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Antenna Test Report

for the

Stanley Black & Decker, Inc.
CMCR001 Bluetooth Antenna

WLL Report# 18408-01 Rev 0

November 6, 2023

Prepared by:

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Steven D. Koster
President



Abstract

This report has been prepared on behalf of Stanley Black & Decker, Inc. to document the testing/design of the CMCR001 Bluetooth Antenna. The information provided within this report is only applicable to the device herein documented as the EUT.

Testing was performed in the Free-space Anechoic Chamber Test-site (FACT) 3m chamber of Washington Laboratories, Ltd, located at 4840 Winchester Boulevard, Frederick, MD 21703.

Revision History	Description of Change	Date
Rev 0	Initial Release	November 6, 2023



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1 Introduction

1.1 Test Scope

Testing was to determine the antenna gain of the PCB antenna.

1.2 Contract Information

Customer:	Stanley Black & Decker, Inc.
Purchase Order Number:	PO526132
Quotation Number:	74310

1.3 Test and Support Personnel

Washington Laboratories, LTD	Koster
Customer Representative	Matt Schrader



1.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory (ISED Canada Number 3035A).



2 Equipment Under Test

2.1 EUT Identification & Description

The results obtained relate only to the item(s) tested.

Table 1: Device Summary

EUT Name, Model(s) Tested:	CMCR001 - ANT Bluetooth Antenna
Manufacturer	Dongguan Finemost Electronics Co., Ltd
Antenna Gain	+ 0.45 dBi

The Stanley Black & Decker, Inc. CMCR001 Bluetooth Antenna is linearly polarized Meander Line Antenna. Figure 1 shows the area of the PCB that needs to be blank. Figure 2 shows the trace antenna on the PCB. Figure 3 shows the antenna dimensions. Figure 4 shows the module and antenna location on the board.



Figure 1: Antenna blanking area

The PCB under module ANT should be blanked without extra PP.
Or optimize ANT matching circuit is needed.

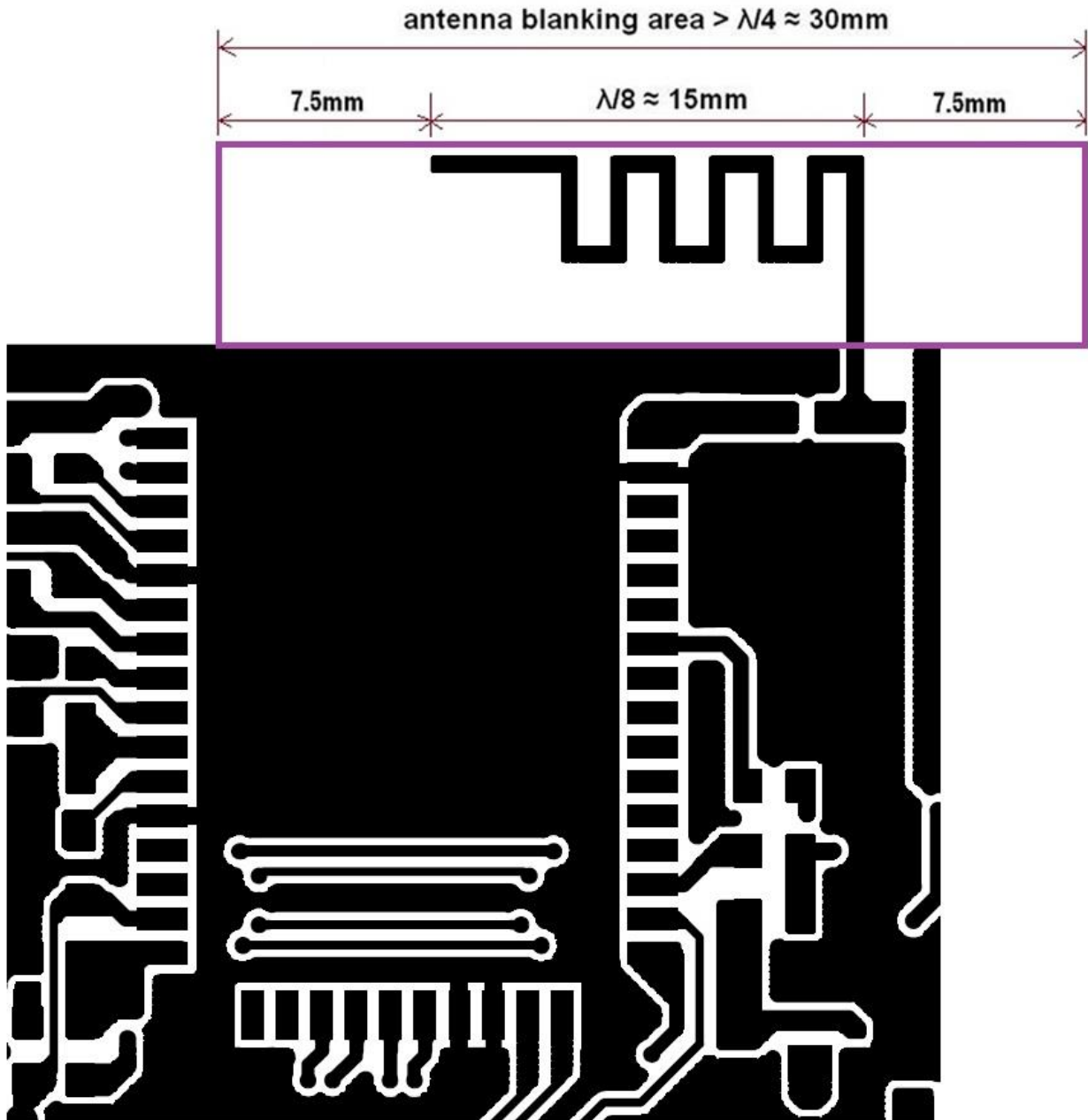




Figure 2: Antenna on the PCB

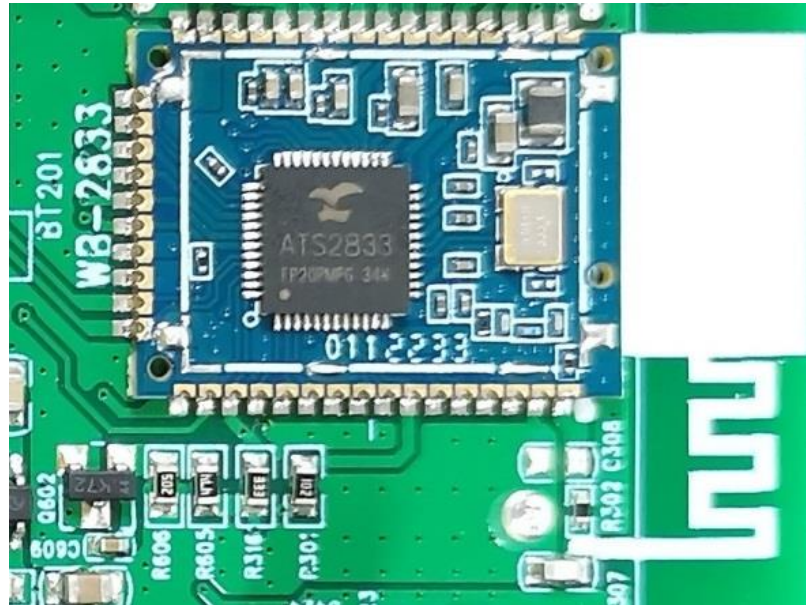




Figure 3: Antenna Dimensions

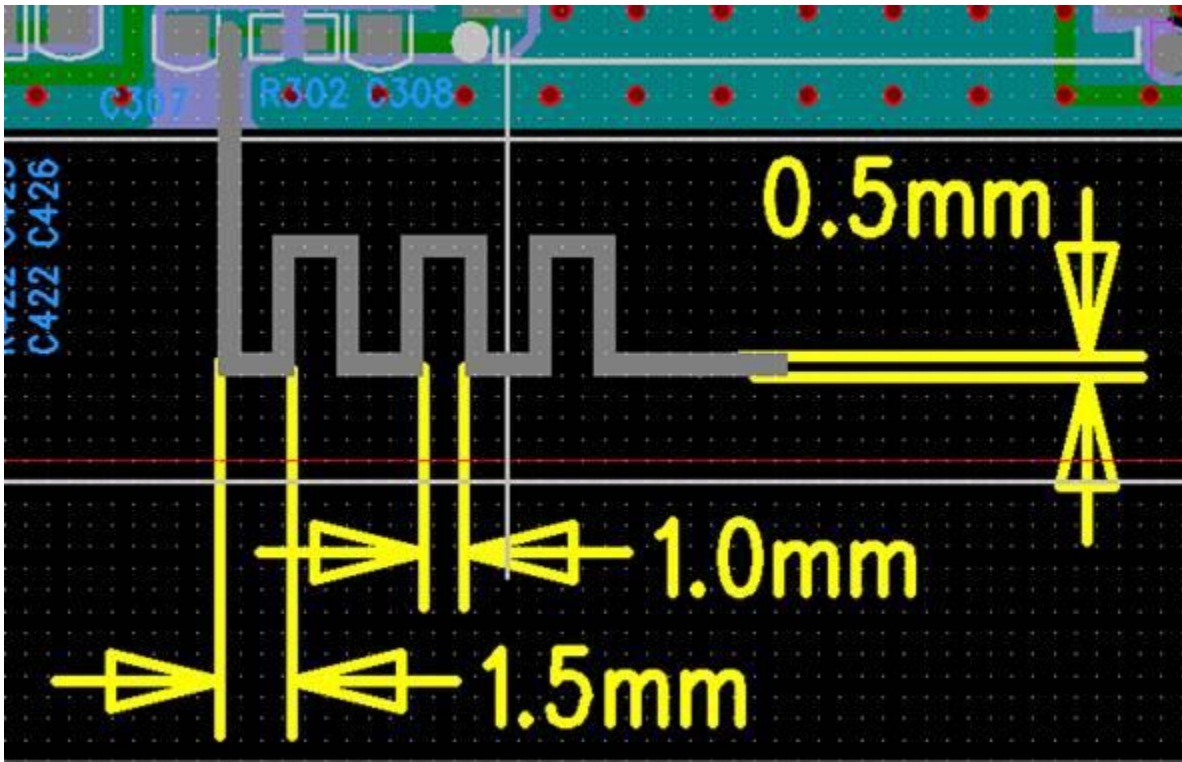




Figure 4: Complete board showing antenna location





2.2 Test Configuration

The CMCR001 Bluetooth Antenna was configured with a SMA cable coupled right before the AUT. Figure 5 shows the test configuration of the EUT. Figure 6 shows the test setup.

Figure 5: EUT Test Configuration

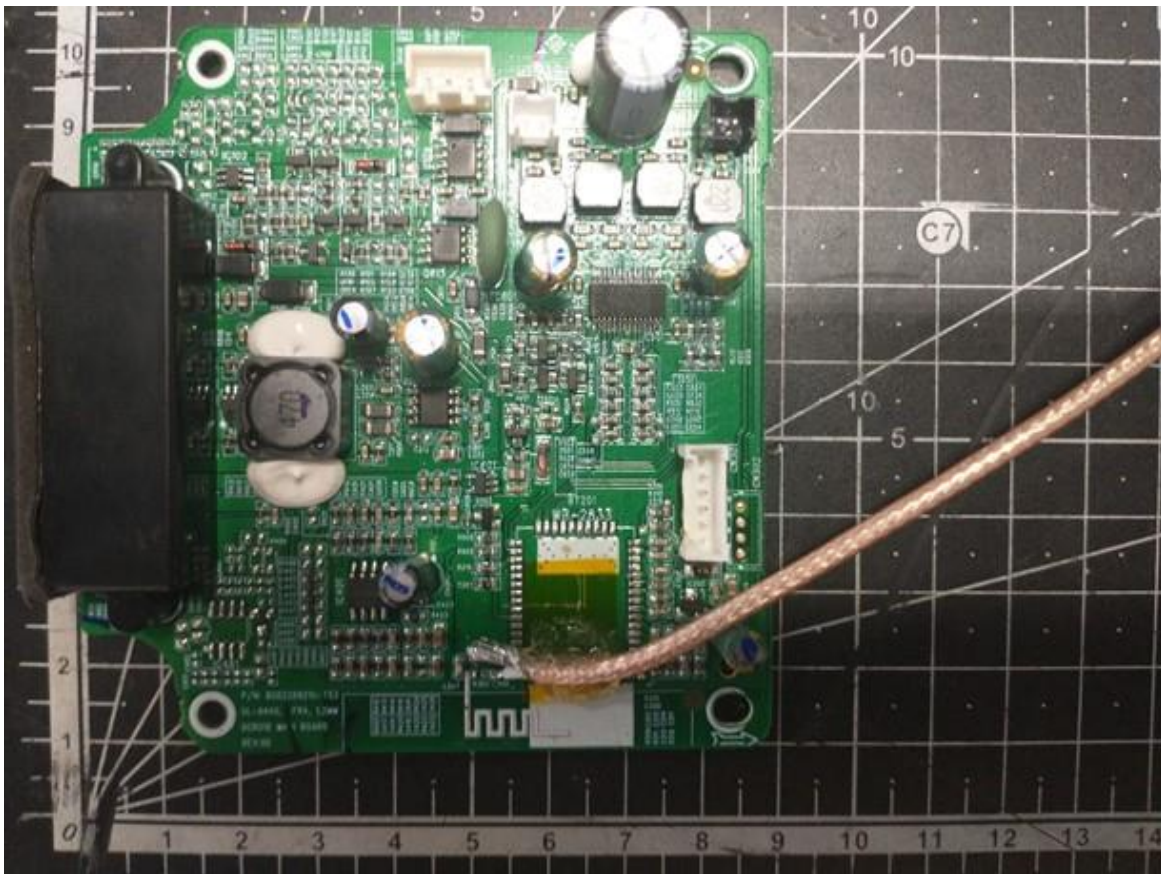
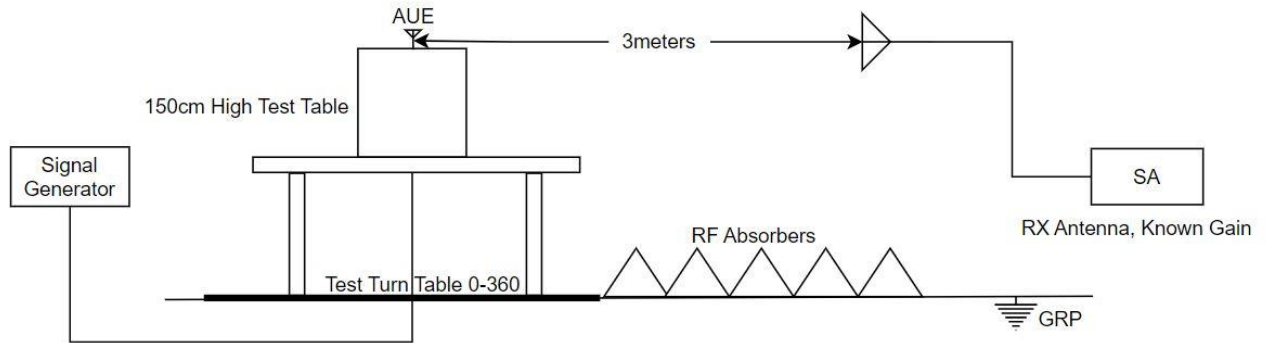




Figure 6: Test setup



2.2.1 Test Equipment

Table 2 shows a list of the test equipment used for data measurements along with the calibration information.

Table 2: Test Equipment List

Test Name: Unknown Antenna Gain Eval.		Test Date:	11/3/2023
Asset #	Manufacturer/Model	Description	Cal. Due
00425	ARA DRG-118/A	ANTENNA DRG 1-18GHZ	11/7/2024
00605	AGILENT HP N1911A	POWER METER	6/21/2025
00934	HP/AGILENT 8648D	SIGNAL GENERATOR	5/12/2024
00942	AGILENT MXA-N9020A	SPECTRUM ANALYZER	12/19/2024



3 Test Results

3.1 Antenna Pattern

3.1.1 Test Procedure

Testing was performed on the CMCR001 Bluetooth Antenna on November 3, 2023. A test frequency was chosen in the center of the intended unlicensed band. A 2450MHz CW signal was applied to the SMA cable coupled right before the AUT (Antenna Under Test). All cable losses (RX & TX) were measured at the test frequency prior to the evaluation. A pre-verification was performed with two known gain antennas prior to the scans.

The AUT was setup and verified to be transmitting, a worst case orientation scan was performed (shown in Table 3). The measurement receiver was placed in max hold and the turn table was set to a 12%RPM. The three orthogonal planes of the AUT were evaluated in regards to both polarities of the receive antenna for the pre-liminary evaluation.

Figure 7 & Table 3 Shows the results for the AUT being placed in the Z-Axis & the receive antenna being placed in the Horizontal position for the evaluation.

The highest Gain (dBi) was found to be at 144 degrees, yielding a Gain of 0.45 dBi.

Table 3: Worst Case Orientation test data

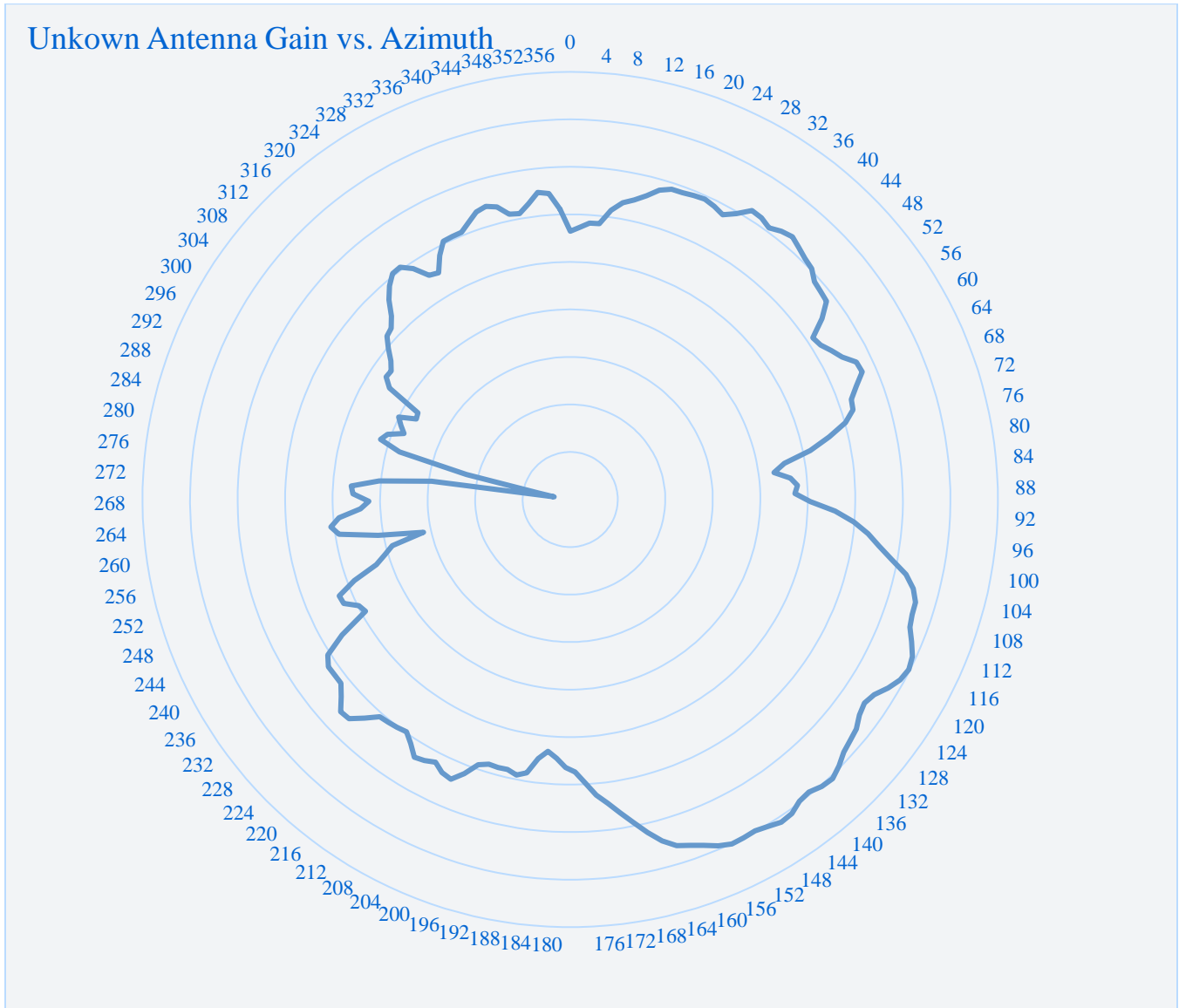
RX Ant Polarity	Orientation	SA RAW [Prx] (dBm)	Ptx (dBm)	Grx (dB)	Ltx (dB)	Lfsi (db)	Lrx	Gtx (dBi)	Turn Table (Degrees)	Trace	Table RPM Setting (%)
V	X	-52.87	0	9.50	-4.03	-49.76	3.731	-4.85	0-360	Max Hold	12
V	Y	-49.3	0	9.50	-4.03	-49.76	3.731	-1.28	0-360	Max Hold	12
V	Z	-52.72	0	9.50	-4.03	-49.76	3.731	-4.70	0-360	Max Hold	12
H	X	-47.75	0	9.50	-4.03	-49.76	3.731	0.27	0-360	Max Hold	12
H	Y	-50.2	0	9.50	-4.03	-49.76	3.731	-2.18	0-360	Max Hold	12
H	Z	-47.57	0	9.50	-4.03	-49.76	3.731	0.45	0-360	Max Hold	12

1.Orientation (RX Antenna, EUT PCB Trace in Y Axis Configuration) used for gain plot shown in Figure 7.

2. SA Setting, RBW: 100kHz, VBW: 300kHz



Figure 7: Rx Measurement antenna vertical, AUT PCB Orientation in Y axis



*Measured in two-degree increments, see following test table data.

*Ref Level: 5dBic



Table 4: Highest gain measured at 2450 MHz test data

SA RAW [Prx] (dBm)	Ptx (dBm)	Grx (dBi)	Ltx (dB)	Lfsl (db)	Lrx	Gtx (dBi)	Turn Table Degrees
-45.57	0	9.50	-4.03	-49.76	3.731	0.45	144

3.1.2 Radiated Data Reduction and Reporting

The Following calculation was used to determine the unknown antenna gain of the PCB Trace Antenna.

$$G_{TX} = (((P_{RX} + G_{RX} + L_{RX}) - L_{FSL})) + L_{TX}$$

G_{TX} : Unknown Antenna Gain (dBic)

P_{RX} : Measured by the Spectrum Analyzer on the receive side (dBm)

G_{RX} : Known Antenna gain (dBi)

L_{RX} : Measured Loss on the Receiver side (-dB), i.e. Cable & Connector loss

L_{FSL} : Calculated based on Frequency. Note: Assumes two Antennas @ 0dBi

L_{TX} : Measured Loss on the Transmit side before AUT (Antenna under test)



3.1.3 Test Data

The test data results are provided in the tables below.

Table 5: Unknown antenna gain at 2450 MHz vs. Azimuth test data.

SA RAW [Prx] (dBm)	Ptx (dBm)	Grx (dB)	Ltx (dB)	Lfsl (db)	Lrx	Gtx (dBi)	Turn Table Degrees
-59.775	0	9.50	-4.03	-49.76	3.731	-11.75	0
-59.364	0	9.50	-4.03	-49.76	3.731	-11.34	2
-58.858	0	9.50	-4.03	-49.76	3.731	-10.84	4
-58.830	0	9.50	-4.03	-49.76	3.731	-10.81	6
-57.272	0	9.50	-4.03	-49.76	3.731	-9.25	8
-56.303	0	9.50	-4.03	-49.76	3.731	-8.28	10
-55.776	0	9.50	-4.03	-49.76	3.731	-7.76	12
-55.076	0	9.50	-4.03	-49.76	3.731	-7.05	14
-54.158	0	9.50	-4.03	-49.76	3.731	-6.14	16
-53.672	0	9.50	-4.03	-49.76	3.731	-5.65	18
-53.637	0	9.50	-4.03	-49.76	3.731	-5.62	20
-53.490	0	9.50	-4.03	-49.76	3.731	-5.47	22
-53.379	0	9.50	-4.03	-49.76	3.731	-5.36	24
-53.643	0	9.50	-4.03	-49.76	3.731	-5.62	26
-54.042	0	9.50	-4.03	-49.76	3.731	-6.02	28
-53.234	0	9.50	-4.03	-49.76	3.731	-5.21	30
-52.099	0	9.50	-4.03	-49.76	3.731	-4.08	32
-52.191	0	9.50	-4.03	-49.76	3.731	-4.17	34
-52.586	0	9.50	-4.03	-49.76	3.731	-4.57	36
-52.106	0	9.50	-4.03	-49.76	3.731	-4.09	38
-51.813	0	9.50	-4.03	-49.76	3.731	-3.79	40
-52.246	0	9.50	-4.03	-49.76	3.731	-4.23	42
-52.608	0	9.50	-4.03	-49.76	3.731	-4.59	44
-52.870	0	9.50	-4.03	-49.76	3.731	-4.85	46
-53.599	0	9.50	-4.03	-49.76	3.731	-5.58	48
-53.758	0	9.50	-4.03	-49.76	3.731	-5.74	50
-53.935	0	9.50	-4.03	-49.76	3.731	-5.91	52
-55.387	0	9.50	-4.03	-49.76	3.731	-7.37	54



-57.349	0	9.50	-4.03	-49.76	3.731	-9.33	56
-57.049	0	9.50	-4.03	-49.76	3.731	-9.03	58
-56.379	0	9.50	-4.03	-49.76	3.731	-8.36	60
-55.719	0	9.50	-4.03	-49.76	3.731	-7.70	62
-54.622	0	9.50	-4.03	-49.76	3.731	-6.60	64
-54.499	0	9.50	-4.03	-49.76	3.731	-6.48	66
-55.643	0	9.50	-4.03	-49.76	3.731	-7.62	68
-56.633	0	9.50	-4.03	-49.76	3.731	-8.61	70
-56.816	0	9.50	-4.03	-49.76	3.731	-8.80	72
-57.959	0	9.50	-4.03	-49.76	3.731	-9.94	74
-59.980	0	9.50	-4.03	-49.76	3.731	-11.96	76
-62.240	0	9.50	-4.03	-49.76	3.731	-14.22	78
-65.173	0	9.50	-4.03	-49.76	3.731	-17.15	80
-66.387	0	9.50	-4.03	-49.76	3.731	-18.37	82
-64.733	0	9.50	-4.03	-49.76	3.731	-16.71	84
-64.061	0	9.50	-4.03	-49.76	3.731	-16.04	86
-64.374	0	9.50	-4.03	-49.76	3.731	-16.35	88
-62.748	0	9.50	-4.03	-49.76	3.731	-14.73	90
-60.124	0	9.50	-4.03	-49.76	3.731	-12.10	92
-58.085	0	9.50	-4.03	-49.76	3.731	-10.06	94
-56.470	0	9.50	-4.03	-49.76	3.731	-8.45	96
-55.158	0	9.50	-4.03	-49.76	3.731	-7.14	98
-53.624	0	9.50	-4.03	-49.76	3.731	-5.60	100
-51.834	0	9.50	-4.03	-49.76	3.731	-3.81	102
-50.717	0	9.50	-4.03	-49.76	3.731	-2.70	104
-50.111	0	9.50	-4.03	-49.76	3.731	-2.09	106
-50.057	0	9.50	-4.03	-49.76	3.731	-2.04	108
-49.838	0	9.50	-4.03	-49.76	3.731	-1.82	110
-49.110	0	9.50	-4.03	-49.76	3.731	-1.09	112
-48.396	0	9.50	-4.03	-49.76	3.731	-0.38	114
-48.153	0	9.50	-4.03	-49.76	3.731	-0.13	116
-48.456	0	9.50	-4.03	-49.76	3.731	-0.44	118
-49.123	0	9.50	-4.03	-49.76	3.731	-1.10	120
-50.013	0	9.50	-4.03	-49.76	3.731	-1.99	122
-50.383	0	9.50	-4.03	-49.76	3.731	-2.36	124
-50.059	0	9.50	-4.03	-49.76	3.731	-2.04	126
-49.433	0	9.50	-4.03	-49.76	3.731	-1.41	128
-49.153	0	9.50	-4.03	-49.76	3.731	-1.13	130



-48.832	0	9.50	-4.03	-49.76	3.731	-0.81	132
-48.201	0	9.50	-4.03	-49.76	3.731	-0.18	134
-47.716	0	9.50	-4.03	-49.76	3.731	0.30	136
-47.883	0	9.50	-4.03	-49.76	3.731	0.14	138
-48.297	0	9.50	-4.03	-49.76	3.731	-0.28	140
-48.142	0	9.50	-4.03	-49.76	3.731	-0.12	142
-47.569	0	9.50	-4.03	-49.76	3.731	0.45	144
-47.465	0	9.50	-4.03	-49.76	3.731	0.56	146
-47.807	0	9.50	-4.03	-49.76	3.731	0.21	148
-48.109	0	9.50	-4.03	-49.76	3.731	-0.09	150
-48.015	0	9.50	-4.03	-49.76	3.731	0.01	152
-47.984	0	9.50	-4.03	-49.76	3.731	0.04	154
-48.397	0	9.50	-4.03	-49.76	3.731	-0.38	156
-49.008	0	9.50	-4.03	-49.76	3.731	-0.99	158
-49.523	0	9.50	-4.03	-49.76	3.731	-1.50	160
-49.914	0	9.50	-4.03	-49.76	3.731	-1.89	162
-50.822	0	9.50	-4.03	-49.76	3.731	-2.80	164
-52.061	0	9.50	-4.03	-49.76	3.731	-4.04	166
-53.402	0	9.50	-4.03	-49.76	3.731	-5.38	168
-54.637	0	9.50	-4.03	-49.76	3.731	-6.62	170
-55.809	0	9.50	-4.03	-49.76	3.731	-7.79	172
-56.799	0	9.50	-4.03	-49.76	3.731	-8.78	174
-58.158	0	9.50	-4.03	-49.76	3.731	-10.14	176
-59.357	0	9.50	-4.03	-49.76	3.731	-11.34	178
-59.816	0	9.50	-4.03	-49.76	3.731	-11.80	180
-60.755	0	9.50	-4.03	-49.76	3.731	-12.73	182
-61.426	0	9.50	-4.03	-49.76	3.731	-13.41	184
-60.554	0	9.50	-4.03	-49.76	3.731	-12.53	186
-58.895	0	9.50	-4.03	-49.76	3.731	-10.87	188
-58.478	0	9.50	-4.03	-49.76	3.731	-10.46	190
-58.872	0	9.50	-4.03	-49.76	3.731	-10.85	192
-58.806	0	9.50	-4.03	-49.76	3.731	-10.79	194
-58.899	0	9.50	-4.03	-49.76	3.731	-10.88	196
-58.477	0	9.50	-4.03	-49.76	3.731	-10.46	198
-57.096	0	9.50	-4.03	-49.76	3.731	-9.08	200
-56.030	0	9.50	-4.03	-49.76	3.731	-8.01	202
-56.283	0	9.50	-4.03	-49.76	3.731	-8.26	204
-56.962	0	9.50	-4.03	-49.76	3.731	-8.94	206



-56.555	0	9.50	-4.03	-49.76	3.731	-8.53	208
-56.333	0	9.50	-4.03	-49.76	3.731	-8.31	210
-57.330	0	9.50	-4.03	-49.76	3.731	-9.31	212
-58.120	0	9.50	-4.03	-49.76	3.731	-10.10	214
-57.913	0	9.50	-4.03	-49.76	3.731	-9.89	216
-57.766	0	9.50	-4.03	-49.76	3.731	-9.74	218
-57.621	0	9.50	-4.03	-49.76	3.731	-9.60	220
-56.453	0	9.50	-4.03	-49.76	3.731	-8.43	222
-55.265	0	9.50	-4.03	-49.76	3.731	-7.24	224
-55.132	0	9.50	-4.03	-49.76	3.731	-7.11	226
-56.217	0	9.50	-4.03	-49.76	3.731	-8.20	228
-57.099	0	9.50	-4.03	-49.76	3.731	-9.08	230
-57.120	0	9.50	-4.03	-49.76	3.731	-9.10	232
-57.082	0	9.50	-4.03	-49.76	3.731	-9.06	234
-57.720	0	9.50	-4.03	-49.76	3.731	-9.70	236
-60.107	0	9.50	-4.03	-49.76	3.731	-12.09	238
-63.477	0	9.50	-4.03	-49.76	3.731	-15.46	240
-63.139	0	9.50	-4.03	-49.76	3.731	-15.12	242
-61.794	0	9.50	-4.03	-49.76	3.731	-13.77	244
-61.686	0	9.50	-4.03	-49.76	3.731	-13.67	246
-63.756	0	9.50	-4.03	-49.76	3.731	-15.74	248
-66.504	0	9.50	-4.03	-49.76	3.731	-18.48	250
-67.649	0	9.50	-4.03	-49.76	3.731	-19.63	252
-68.674	0	9.50	-4.03	-49.76	3.731	-20.65	254
-72.224	0	9.50	-4.03	-49.76	3.731	-24.20	256
-67.443	0	9.50	-4.03	-49.76	3.731	-19.42	258
-63.421	0	9.50	-4.03	-49.76	3.731	-15.40	260
-62.674	0	9.50	-4.03	-49.76	3.731	-14.65	262
-63.608	0	9.50	-4.03	-49.76	3.731	-15.59	264
-65.92	0	9.50	-4.03	-49.76	3.731	-17.90	266
-66.837	0	9.50	-4.03	-49.76	3.731	-18.82	268
-65.144	0	9.50	-4.03	-49.76	3.731	-17.12	270
-64.94	0	9.50	-4.03	-49.76	3.731	-16.92	272
-67.827	0	9.50	-4.03	-49.76	3.731	-19.81	274
-73.326	0	9.50	-4.03	-49.76	3.731	-25.31	276
-86.317	0	9.50	-4.03	-49.76	3.731	-38.30	278
-84.58	0	9.50	-4.03	-49.76	3.731	-36.56	280
-76.809	0	9.50	-4.03	-49.76	3.731	-28.79	282



-69.389	0	9.50	-4.03	-49.76	3.731	-21.37	284
-67.088	0	9.50	-4.03	-49.76	3.731	-19.07	286
-67.614	0	9.50	-4.03	-49.76	3.731	-19.59	288
-69.196	0	9.50	-4.03	-49.76	3.731	-21.18	290
-68.592	0	9.50	-4.03	-49.76	3.731	-20.57	292
-67.991	0	9.50	-4.03	-49.76	3.731	-19.97	294
-69.74	0	9.50	-4.03	-49.76	3.731	-21.72	296
-69.574	0	9.50	-4.03	-49.76	3.731	-21.55	298
-65.682	0	9.50	-4.03	-49.76	3.731	-17.66	300
-64.757	0	9.50	-4.03	-49.76	3.731	-16.74	302
-64.841	0	9.50	-4.03	-49.76	3.731	-16.82	304
-64.173	0	9.50	-4.03	-49.76	3.731	-16.15	306
-63.139	0	9.50	-4.03	-49.76	3.731	-15.12	308
-62.182	0	9.50	-4.03	-49.76	3.731	-14.16	310
-61.958	0	9.50	-4.03	-49.76	3.731	-13.94	312
-61.079	0	9.50	-4.03	-49.76	3.731	-13.06	314
-59.646	0	9.50	-4.03	-49.76	3.731	-11.63	316
-58.573	0	9.50	-4.03	-49.76	3.731	-10.55	318
-57.782	0	9.50	-4.03	-49.76	3.731	-9.76	320
-57.715	0	9.50	-4.03	-49.76	3.731	-9.69	322
-58.640	0	9.50	-4.03	-49.76	3.731	-10.62	324
-60.131	0	9.50	-4.03	-49.76	3.731	-12.11	326
-60.442	0	9.50	-4.03	-49.76	3.731	-12.42	328
-58.912	0	9.50	-4.03	-49.76	3.731	-10.89	330
-57.739	0	9.50	-4.03	-49.76	3.731	-9.72	332
-57.700	0	9.50	-4.03	-49.76	3.731	-9.68	334
-57.676	0	9.50	-4.03	-49.76	3.731	-9.66	336
-56.951	0	9.50	-4.03	-49.76	3.731	-8.93	338
-56.177	0	9.50	-4.03	-49.76	3.731	-8.16	340
-55.929	0	9.50	-4.03	-49.76	3.731	-7.91	342
-56.282	0	9.50	-4.03	-49.76	3.731	-8.26	344
-57.305	0	9.50	-4.03	-49.76	3.731	-9.28	346
-57.478	0	9.50	-4.03	-49.76	3.731	-9.46	348
-56.593	0	9.50	-4.03	-49.76	3.731	-8.57	350
-55.522	0	9.50	-4.03	-49.76	3.731	-7.50	352
-55.742	0	9.50	-4.03	-49.76	3.731	-7.72	354
-57.463	0	9.50	-4.03	-49.76	3.731	-9.44	356

