Japan Test Report

Equipment	:	**2.4 GHz Bluetooth Low Energy Module**
Model No.	:	**SaBLE-x-R2**
Brand Name	:	**Laird**
Applicant	:	**Laird Technologies, Inc.**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**ARIB STD-T66 Ver. 3.7**
Received Date	:	**Apr. 25, 2017**
Tested Date	:	**May 10, 2017**

Measurement was conducted by the following test method:
the test method of Ordinance Concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment in Annex 1, the Ministry of Internal Affairs and Communication notification in Annex "43" of Article 88, Paragraph 1 or the test method more than equivalent.

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:	**Approved by:**
James Fan / Assistant Manager	**Gary Chang / Manager**

Testing Laboratory 2732

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Release Record

Report No.	Version	Description	Issued Date
JR742502	Rev. 01	Initial issue	Jun. 13, 2017

Summary of Test Results

Ref. Std. Clause	Description	Result
3.2(2)(3)	Antenna Power	Pass
3.2(4)	Frequency Tolerance	Pass
3.2(6)	Transmitter Spurious Emission	Pass
3.2(7)	Occupied Bandwidth	Pass
3.2(8)	Spreading Bandwidth	Pass
3.2(9)	Spreading Factor	Pass
3.3(1)	Receiver Emission	Pass
3.4.1	Interference prevention function	Pass

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

Power Type	DC 1.8V & DC 3.3V from host
Type(s) of Modulation / Technology	GFSK = 1Mbps, 2Mbps, 125 kbps, 500 kbps
Frequency Range (MHz)	2402 ~ 2480 MHz
Total Channel Number	40
HW Version	1.0
SW Version	1.0

1.1.2 Accessories

N/A

1.1.3 Antenna Details

Ant. No.	Model	Type	Connector	Gain (dBi)
1	On module PCB trace antenna	On-Board Trace antenna	NA	0

Note: Please refer to Appendix B for more details about antenna pattern and other information.

1.1.4 Antenna Power

For 125 kbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.50	3.184	3.184

For 500 kbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.50	3.236	3.236

For 1Mbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.50	3.273	3.273

For 2Mbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.00	2.710	2.710

1.1.5 Channel List

Frequency band (MHz)				2400~2483.5			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	9	2422	18	2442	28	2462
0	2404	10	2424	19	2444	29	2464
1	2406	38	2426	20	2446	30	2466
2	2408	11	2428	21	2448	31	2468
3	2410	12	2430	22	2450	32	2470
4	2412	13	2432	23	2452	33	2472
5	2414	14	2434	24	2454	34	2474
6	2416	15	2436	25	2456	35	2476
7	2418	16	2438	26	2458	36	2478
8	2420	17	2440	27	2460	39	2480

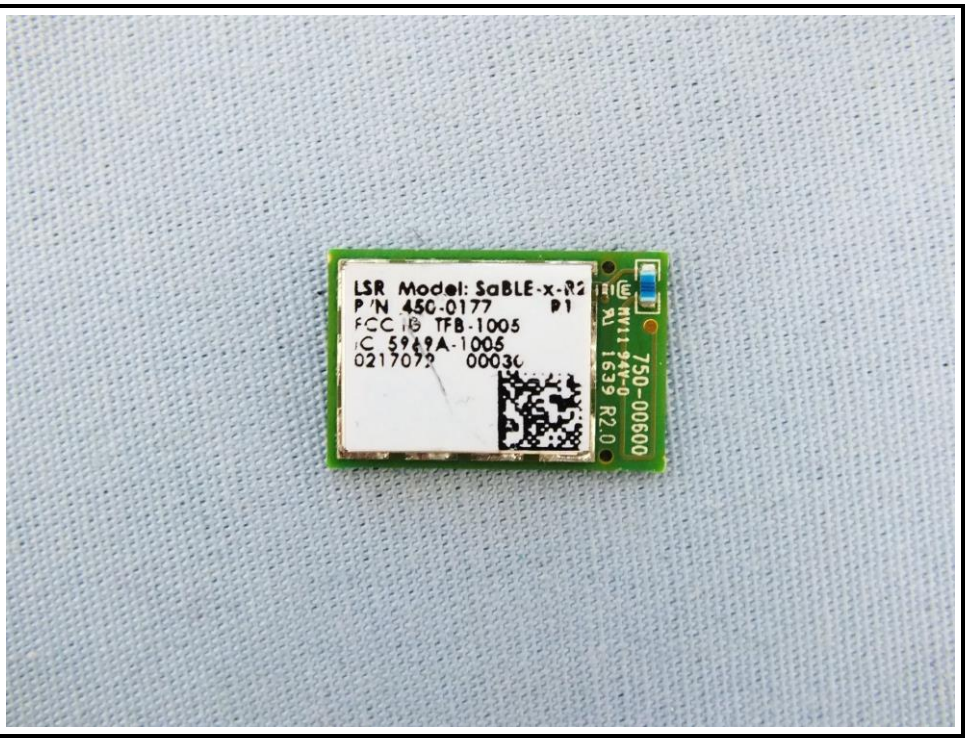
1.1.6 Test Tool and Power Setting

Test Tool
Bluetooth RF Eval Tool, Version: 8.7.0.0

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/125 kbps	5	5	5
GFSK/500 kbps	5	5	5
GFSK/1Mbps	5	5	5
GFSK/2Mbps	4	4	4

1.1.7 Protection Method for High Frequency and Modulation Section

Protected Method	Description
Shielded case	RF and Modulation components are covered with shielding case and this shielding case is soldered

Photo	

1.2 Test Equipment and Calibration Data

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	ROHDE&SCHWARZ	FSV40	101486	Nov. 15, 2016	Nov. 14, 2017
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Nov. 21, 2016	Nov. 20, 2017
Power Meter	Anritsu	ML2495A	1241002	Oct. 06, 2016	Oct. 05, 2017
Power Sensor	Anritsu	MA2411B	1207366	Oct. 06, 2016	Oct. 05, 2017
Signal Generator	R&S	SMB100A	175727	Oct. 19, 2016	Oct. 18, 2017
Note 1: Calibration Interval of instruments listed above is one year. Note 2: Above instruments are calibrated by Electronics Testing Center					

1.3 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

ARIB STD-T66 Ver. 3.7

1.4 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty	
Parameters	**Uncertainty**
Frequency error	±33.988 Hz
Bandwidth	±33.988 Hz
Conducted power	±0.537 dB
TX Conducted emission	±2.308 dB
RX Conducted emission	±2.525 dB

2 Test Configuration

2.1 Testing Location and Conditions

Test Site	Site Category	Ambient Condition	Tested By
TH01-WS	OVEN Room	24℃ / 67%	Chris Zeng

2.2 Supporting Units

Support Unit	Brand	Model	FCC ID
Notebook	DELL	Latitude E5430	DoC

2.3 The Worst Test Modes and Channel Details

For 125 kbps, 500 kbps

Test item	Mode	Test Frequency (MHz)
Antenna Power Frequency Tolerance	BT LE	2402 / 2440 / 2480

For 1Mbps, 2Mbps

Test item	Mode	Test Frequency (MHz)
Antenna Power Frequency Tolerance Transmitter Spurious Emission Occupied Bandwidth Spreading Bandwidth Collateral Emission of Receiver Spreading Factor Interference prevention function	BT LE	2402 / 2440 / 2480

3 Transmitter Test Results

3.1 Antenna Power

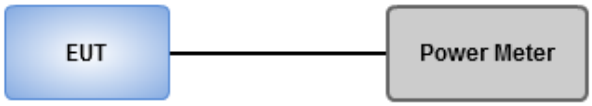
3.1.1 Limit of Antenna Power

Mode	Limit	Tolerance
1) FH, FH+DS, FH+OFDM	3 mW / MHz	+20 % , -80 %
2) OFDM(Narrow- bandwidht), DS	10 mW / MHz	
3) Other than 1) & 2)	10mW	
4) OFDM (Wide-band)	5 mW / MHz	

3.1.2 Test Procedures

Measure the total power by Power Meter

3.1.3 Test Setup



3.1.4 Test Result of Maximum Transmit Power

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results 2. Antenna Power (Conducted Power)

3.2 Frequency Tolerance

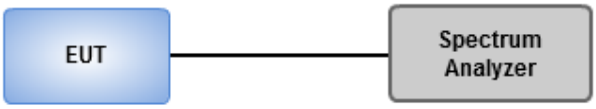
3.2.1 Limit of Frequency Tolerance

Frequency tolerance shall be +/- 50ppm.

3.2.2 Test Procedures

1. Set Span = 150kHz, RBW = 1kHz, VBW = 30kHz, Sweep time = Auto, detector = Peak.
2. Use Peak search function to find the max peak value and record this value (RF).
3. Calculate frequency tolerance by below formula
   FT(ppm) = { (RF) – (MF) / (MF) } × 1000000
   (FT: Frequency Tolerance, RF: Reading Frequency, MF: Measurement Frequency.)

3.2.3 Test Setup



3.2.4 Test Result of Frequency Tolerance

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results

3.3 Occupied Bandwidth

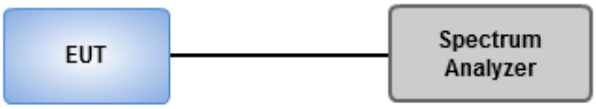
3.3.1 Limit of Occupied Bandwidth

Mode	Limit (MHz)
FH	83.5
FH+DS	83.5
FH+OFDM	83.5
OFDM(Narrow- bandwidht), DS	26
Others	26
OFDM (Wide-band)	38

3.3.2 Test Procedures

1. Set Span = 40MHz, RBW = VBW = 300kHz, detector = Peak, Sweep time = Auto.
2. Enable OBW function of spectrum analyzer to measure OBW and capture test plot.

3.3.3 Test Setup



3.3.4 Test Result of Occupied Bandwidth

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results

3.4 Spreading Bandwidth and Factor

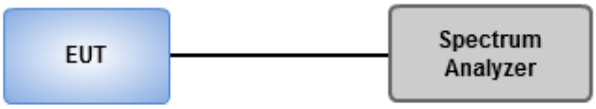
3.4.1 Limit of Spreading Bandwidth and Factor

Item	Limit
Spreading bandwidth	≥ 500kHz
Spreading factor for DSSS (operates at 2400~2483.5 MHz)	≥ 5
Spreading factor for DSSS (operates at 2471~2497 MHz)	≥ 10

3.4.2 Test Procedures

1. Set Span = 20MHz, RBW = VBW = 300kHz, detector = Peak, Sweep time = Auto.
2. Enable OBW (90%) function of spectrum analyzer to measure OBW (90%) and capture test plot.

3.4.3 Test Setup



3.4.4 Test Result of Spreading Bandwidth and Factor

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results

3.5 Transmitter Spurious Emissions

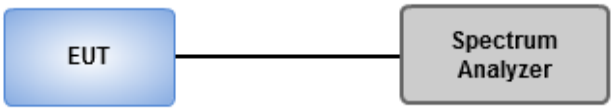
3.5.1 Limit of Transmitter Spurious Emissions

Item	Limits
Tx Spurious Emission	≤ 2.5 μW (2387MHz > f ; 2496.5MHz < f).
	≤ 25 μW. (2387MHz ≤ f < 2400MHz) and (2483.5MHz < f ≤ 2496.5MHz).

3.5.2 Test Procedures

1. Set EUT to transmit at rated power and channel to perform test.
2. Set RBW = VBW = 1MHz, Detector type = Peak, Sweep time = Auto.
3. Following above setting of spectrum analyzer to measure spurious emission of 30~12500 MHz.

3.5.3 Test Setup



3.5.4 Test Result of Transmitter Spurious Emissions

For 1Mbps & 2Mbps

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results 4. Unwanted Emission Intensity

3.6 Interference prevention function

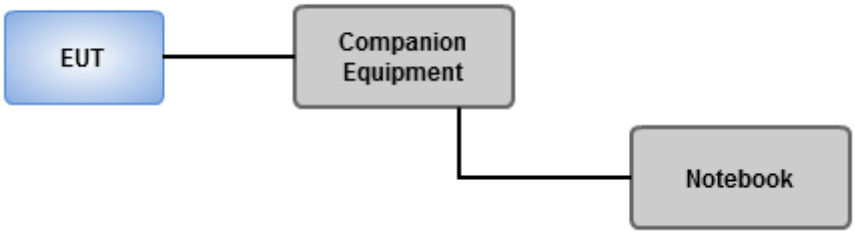
3.6.1 Limit of Interference Prevention Function

Limits
The identification code shall be 48 bits long

3.6.2 Test Procedures

1. Set EUT under operating mode and link up with companion equipment
2. Check communication status between EUT and companion equipment is normal
3. Confirm the MAC address of EUT

3.6.3 Test Setup



3.6.4 Test Result of Interference Prevention Function

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results

4 Receiver Test Results

4.1 Receiver Spurious Emissions

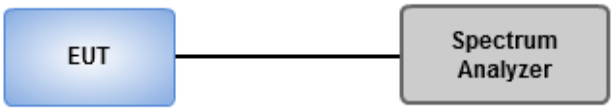
4.1.1 Limit of Receiver Spurious Emissions

Item	Limits
Rx Spurious Emission	≤ 4nW (f < 1GHz).
	≤ 20nW (1GHz ≤ f).

4.1.2 Test Procedures

1. Set EUT under receiving condition to perform test
2. Set RBW = VBW = 100kHz, detector = Peak, Sweep time = Auto for emission measurement below 1GHz.
3. Set RBW = VBW=1MHz, detector = Peak, Sweep time = Auto for emission measurement above 1GHz.

4.1.3 Test Setup

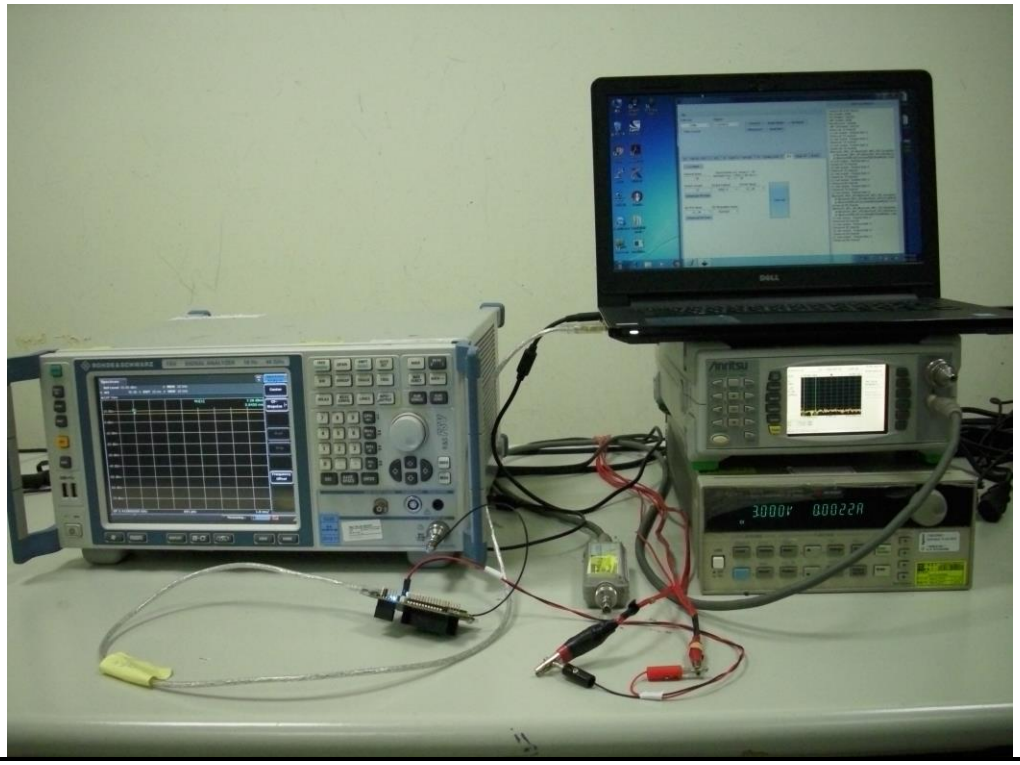


4.1.4 Test Result of Receiver Spurious Emissions

For 1Mbps & 2Mbps

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results 5. Limitation of Collateral Emission of Receiver

5 Photographs of the Test Configuration



6 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information

Tel: 886-3-271-8666
Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

==END==

Appendix A 19-BLE (1Mbps)

1. Test Results

Testing for Electrical Specification	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Measured Frequency		MHz	2402.0014	2440.0003	2480.0024	2402.0020	2440.0021	2480.0010	2402.0021	2440.0022	2479.9930	
	Frequency Error		ppm	0.58	0.12	0.95	0.83	0.86	0.40	0.87	0.90	2.82	Limit ≦ 50 ppm
	Occupied Bandwidth		MHz	1.69	1.71	1.66	1.70	1.71	1.71	1.70	1.71	1.71	Limit ≦ 26 MHz (RB/VB : 300kHz)
	Spread-spectrum Bandwidth		MHz	0.86	0.87	0.87	0.87	0.87	0.87	0.87	0.88	0.88	
	Unwanted Emission Intensity (Power emission within 1MHz bandwidth)	※ 1	μW	0.0215	0.0172	0.0148	0.0169	0.0168	0.0164	0.0215	0.0154	0.0149	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.7345	0.3019	0.3209	0.7511	0.3389	0.3099	0.7340	0.2962	0.3464	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.4385	0.3668	0.3612	0.4385	0.4444	0.3717	0.4390	0.3984	0.3835	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.4315	0.3818	9.9345	0.3466	0.3557	11.0922	0.4318	0.3752	9.9699	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5596	1.7573	1.6650	1.8319	1.7448	1.6311	1.5599	1.4687	1.6223	Limit ≦ 2.5 μW (-26 dBm)
	Antenna Power (Measured Power)		mW	3.266	3.069	2.924	3.273	3.076	2.931	3.192	2.999	2.858	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)		mW	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error		mW	-0.234	-0.431	-0.576	-0.227	-0.424	-0.569	-0.308	-0.501	-0.642	
			%	-6.69	-12.31	-16.45	-6.47	-12.11	-16.26	-8.81	-14.31	-18.35	Limit + 20% ~ - 80%
	Limitation of Collateral Emission of Receiver	※ 6	nW	0.1446	0.2164	0.2288	0.0335	0.4295	0.0831	0.0732	0.1410	0.1849	Limit ≦ 4 nW (-54 dBm)
		※ 7	nW	4.1908	2.8738	1.9741	4.3442	2.9358	1.8705	4.3680	2.7259	1.9660	Limit ≦ 20 nW (-47 dBm)
	Radio Interference Prevention Function		ID Code	Good, MAC Address :B0:91:22:64:B9:1D									
			Carrier Sense	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR: Not Require

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

2. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	1.77	1.50	1.29	1.77	1.50	1.29	1.77	1.50	1.29	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	Duty Factor = 10 × 10Log$_{10}$(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	5.14	4.87	4.66	5.15	4.88	4.67	5.04	4.77	4.56	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	3.266	3.069	2.924	3.273	3.076	2.931	3.192	2.999	2.858	
	Antenna Power Error	mW	-0.234	-0.431	-0.576	-0.227	-0.424	-0.569	-0.308	-0.501	-0.642	
		%	-6.69	-12.31	-16.45	-6.47	-12.11	-16.26	-8.81	-14.31	-18.35	Limit + 20% ~ - 80%
	Tranmsitter ON$_{Time}$	msec	0.4034									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter (ON+OFF)$_{Time}$	msec	0.6220									
	Tranmsitter Duty Cycle	%	64.86%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	5.15	On-Board Trace antenna	0.00			-	-		0.00	5.15	360.00	Good	
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

International Certification Corp.

4. Unwanted Emission Intensity

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
Unwanted Emission Intensity	Unwanted Emission Frequency	※ 1	MHz	666.32	960.23	616.85	863.23	790.48	911.73	993.21	935.01	693.48	RBW : 100 kHz ; VBW : 100 kHz
		※ 2	MHz	2385.61	2313.49	2178.26	2385.61	2348.16	1979.92	2386.31	2324.59	2370.36	
		※ 3	MHz	2400.00	2398.19	2388.26	2400.00	2393.40	2389.57	2400.00	2396.89	2395.83	RBW : 1 MHz ; VBW : 1 MHz
		※ 4	MHz	2489.90	2494.26	2483.55	2492.39	2483.98	2483.50	2489.28	2495.48	2483.60	
		※ 5	MHz	10544.32	10526.81	10521.81	11163.28	12496.25	10533.06	12493.75	12477.49	10628.10	
	Cable Loss	※ 1	dB	0.76	0.87	0.73	0.83	0.81	0.85	0.88	0.86	0.77	
		※ 2	dB	1.48	1.46	1.42	1.48	1.47	1.36	1.48	1.46	1.47	
		※ 3	dB	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	
		※ 4	dB	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	
		※ 5	dB	4.60	4.59	4.58	4.95	5.68	4.59	5.68	5.67	4.65	
	Spectrum Raw	※ 1	dBm	-0.76	-48.51	-49.04	-48.55	-48.55	-48.69	-47.56	-48.97	-49.03	
		※ 2	dBm	-1.48	-36.66	-36.36	-32.72	-36.17	-36.45	-32.82	-36.75	-36.08	
		※ 3	dBm	-1.48	-35.84	-35.90	-35.06	-35.00	-35.78	-35.06	-35.48	-35.64	
		※ 4	dBm	-1.50	-35.68	-21.52	-36.10	-35.99	-21.05	-35.14	-35.76	-21.51	
		※ 5	dBm	-4.60	-32.14	-32.37	-32.33	-33.26	-32.46	-33.75	-34.00	-32.54	
	Unwanted Emission Intensity	※ 1	dBm	-46.68	-47.64	-48.30	-47.72	-47.74	-47.84	-46.68	-48.11	-48.26	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	dBm	-31.34	-35.20	-34.94	-31.24	-34.70	-35.09	-31.34	-35.28	-34.60	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	dBm	-33.58	-34.36	-34.42	-33.58	-33.52	-34.30	-33.58	-34.00	-34.16	Limit ≦ 25 μW (-16 dBm)
		※ 4	dBm	-33.65	-34.18	-20.03	-34.60	-34.49	-19.55	-33.65	-34.26	-20.01	Limit ≦ 25 μW (-16 dBm)
		※ 5	dBm	-28.07	-27.55	-27.79	-27.37	-27.58	-27.88	-28.07	-28.33	-27.90	Limit ≦ 2.5 μW (-26 dBm)
	Unwanted Emission Intensity	※ 1	μW	0.0215	0.0172	0.0148	0.0169	0.0168	0.0164	0.0215	0.0154	0.0149	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.7345	0.3019	0.3209	0.7511	0.3389	0.3099	0.7340	0.2962	0.3464	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.4385	0.3668	0.3612	0.4385	0.4444	0.3717	0.4390	0.3984	0.3835	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.4315	0.3818	9.9345	0.3466	0.3557	11.0922	0.4318	0.3752	9.9699	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5596	1.7573	1.6650	1.8319	1.7448	1.6311	1.5599	1.4687	1.6223	Limit ≦ 2.5 μW (-26 dBm)

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

5. Limitation of Collateral Emission of Receiver

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks	
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480		
Limitation of Collateral Emission	Spurious Emission Frequency	※ 6	MHz	30.00	30.00	30.00	62.01	30.00	62.01	62.01	30.00	31.94	1st	30MHz～1000MHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 6	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	MHz										3rd	
		※ 7	MHz	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	1st	1000MHz～12.5GHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 7	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	MHz	-	-	-	-	-	-	-	-	-	3rd	
	Cable Loss	※ 6	dB	0.26	0.26	0.26	0.29	0.26	0.29	0.29	0.26	0.26	1st	
		※ 6	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dB	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dB	1.71	1.72	1.73	1.71	1.72	1.73	1.71	1.72	1.73	1st	
		※ 7	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dB	-	-	-	-	-	-	-	-	-	3rd	
	Spectrum Raw	※ 6	dBm	-68.14	-66.39	-66.14	-74.45	-63.41	-70.51	-71.06	-68.25	-67.07	1st	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-52.07	-53.70	-55.32	-51.91	-53.61	-55.55	-51.89	-53.93	-55.34	1st	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	dBm	-68.40	-66.65	-66.40	-74.74	-63.67	-70.80	-71.35	-68.51	-67.33	1st	Limit ≦ 4 nW (-54 dBm)
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	RBW : 100 kHz ; VBW : 100 kHz
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-53.78	-55.42	-57.05	-53.62	-55.32	-57.28	-53.60	-55.64	-57.06	1st	Limit ≦ 20 nW (-47 dBm)
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	RBW : 1 MHz ; VBW : 1 MHz
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	nW	0.1446	0.2164	0.2288	0.0335	0.4295	0.0831	0.0732	0.1410	0.1849	Total Emission Power	
		※ 6	nW	0.1446	0.2164	0.2288	0.0335	0.4295	0.0831	0.0732	0.1410	0.1849	1st	Limit ≦ 4 nW (-54 dBm)
		※ 6	nW	-	-	-	-	-	-	-	-	-	2nd	RBW : 100 kHz ; VBW : 100 kHz
		※ 6	nW	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	nW	4.1908	2.8738	1.9741	4.3442	2.9358	1.8705	4.3680	2.7259	1.9660	Total Emission Power	
		※ 7	nW	4.1908	2.8738	1.9741	4.3442	2.9358	1.8705	4.3680	2.7259	1.9660	1st	Limit ≦ 20 nW (-47 dBm)
		※ 7	nW	-	-	-	-	-	-	-	-	-	2nd	RBW : 1 MHz ; VBW : 1 MHz
		※ 7	nW	-	-	-	-	-	-	-	-	-	3rd	

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
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※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
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※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

Calibration Result

1. Linearity Check

SG Output (dBm)	Spectrum Raw (dBm)	Power Meter Raw (dBm)	Remark
0	-1.3	-0.93	・SG Test Frequency：2450 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.34	-5.88	
-10	-11.17	-10.84	
0	-1.64	-1.66	・SG Test Frequency：5250 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.6	-6.62	
-10	-11.48	-11.58	

2. Frequency Accuracy Confirmation

SG Output (dBm)	Spectrum Raw (MHz)	Freqquency Error (ppm)	Remark
2450	2450.0002	0.0816	・SG Output：0dBm ・RWB：30 kHz；VBW：30 kHz：SP：300kHz ・Limit ≦ 10% of frequency error limits
5250	5250.0012	0.2286	

3. Cable Loss

SG Output (MHz)	Power Meter Raw Without Cable (dBm)	Power Meter Raw With Cable (dBm)	Cable Loss (dB)	Remark
1000	-0.23	-1.11	0.88	・SG Output：0dBm
2450	-0.87	-2.36	1.49	
5250	-1.67	-3.43	1.76	
12500	-3.69	-9.37	5.68	
26000	-5.55	-19.13	13.58	

Appendix A 19-BLE (2Mbps)

1. Test Results

Testing for Electrical Specification	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Measured Frequency		MHz	2402.0014	2440.0003	2480.0024	2402.0020	2440.0021	2480.0010	2402.0021	2440.0022	2479.9930	
	Frequency Error		ppm	0.58	0.12	0.95	0.83	0.86	0.40	0.87	0.90	2.82	Limit ≦ 50 ppm
	Occupied Bandwidth		MHz	2.18	2.18	2.19	2.17	2.18	2.19	2.18	2.18	2.19	Limit ≦ 26 MHz (RB/VB : 300kHz)
	Spread-spectrum Bandwidth		MHz	1.37	1.37	1.39	1.36	1.38	1.39	1.36	1.38	1.39	
	Unwanted Emission Intensity (Power emission within 1MHz bandwidth)	※ 1	μW	0.0169	0.0227	0.0171	0.0177	0.0172	0.0164	0.0174	0.0201	0.0180	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.0011	0.9520	0.3690	0.0018	1.0419	0.3657	0.0016	0.7577	0.3181	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.3447	1.2556	0.3899	0.3374	1.1953	0.3876	0.3679	1.1731	0.4105	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.3838	1.1052	0.0119	0.3438	0.8676	0.0120	0.4169	1.1107	0.0120	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5967	1.6754	1.8750	1.7237	1.6724	2.1965	1.5948	1.5091	2.0039	Limit ≦ 2.5 μW (-26 dBm)
	Antenna Power (Measured Power)		mW	2.704	2.443	2.193	2.710	2.449	2.198	2.642	2.388	2.143	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)		mW	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error		mW	-0.296	-0.557	-0.807	-0.290	-0.551	-0.802	-0.358	-0.612	-0.857	
			%	-9.87	-18.55	-26.91	-9.66	-18.36	-26.74	-11.92	-20.41	-28.57	Limit + 20% ~ - 80%
	Limitation of Collateral Emission of Receiver	※ 6	nW	0.0042	0.1087	0.0053	0.0044	0.0022	0.0066	0.0044	0.0023	0.0041	Limit ≦ 4 nW (-54 dBm)
		※ 7	nW	3.5799	2.8126	1.8236	3.5447	2.8128	1.8534	3.7163	2.8531	1.9702	Limit ≦ 20 nW (-47 dBm)
	Radio Interference Prevention Function		ID Code	Good, MAC Address :B0:91:22:64:B9:1D									
			Carrier Sense	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR: Not Require

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
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※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

2. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	-1.74	-2.18	-2.65	-1.74	-2.18	-2.65	-1.74	-2.18	-2.65	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	Duty Factor = 10 × 10Log_{10}(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	4.32	3.88	3.41	4.33	3.89	3.42	4.22	3.78	3.31	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	2.704	2.443	2.193	2.710	2.449	2.198	2.642	2.388	2.143	
	Antenna Power Error	mW	-0.296	-0.557	-0.807	-0.290	-0.551	-0.802	-0.358	-0.612	-0.857	
		%	-9.87	-18.55	-26.91	-9.66	-18.36	-26.74	-11.92	-20.41	-28.57	Limit + 20% ~ - 80%
	Tranmsitter ON_{Time}	msec	0.2185									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter $(ON+OFF)_{Time}$	msec	0.6262									
	Tranmsitter Duty Cycle	%	34.89%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	4.33	On-Board Trace antenna	0.00			-	-		0.00	4.33	360.00	Good	
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

International Certification Corp.

4. Unwanted Emission Intensity

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
Unwanted Emission Intensity	Unwanted Emission Frequency	※ 1	MHz	942.77	39.70	903.00	879.72	910.76	909.79	692.51	816.67	830.25	RBW : 100 kHz ; VBW : 100 kHz
		※ 2	MHz	2384.92	2374.52	2377.29	2387.00	2384.23	2380.76	2386.31	2377.29	2373.13	
		※ 3	MHz	2399.99	2397.53	2399.51	2399.99	2399.57	2398.34	2400.00	2399.75	2395.10	RBW : 1 MHz ; VBW : 1 MHz
		※ 4	MHz	2494.11	2494.76	2483.50	2496.05	2493.81	2483.50	2494.20	2493.51	2483.51	
		※ 5	MHz	12386.21	4879.83	4959.86	4803.56	11217.05	2496.50	10913.19	4878.58	10544.32	
	Cable Loss	※ 1	dB	0.86	0.26	0.85	0.84	0.85	0.85	0.77	0.82	0.82	
		※ 2	dB	1.48	1.47	1.48	1.48	1.48	1.48	1.48	1.48	1.47	
		※ 3	dB	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	
		※ 4	dB	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	
		※ 5	dB	5.62	1.72	1.73	1.71	4.99	1.50	4.81	1.72	4.60	
	Spectrum Raw	※ 1	dBm	-46.85	-46.17	-46.83	-46.67	-46.81	-47.01	-46.82	-46.16	-46.62	
		※ 2	dBm	-58.13	-28.74	-32.85	-56.04	-28.34	-32.89	-56.40	-29.73	-33.50	
		※ 3	dBm	-33.15	-27.53	-32.61	-33.24	-27.75	-32.64	-32.86	-27.83	-32.39	
		※ 4	dBm	-32.66	-28.07	-47.73	-33.14	-29.12	-47.70	-32.30	-28.05	-47.72	
		※ 5	dBm	-22.35	-26.04	-25.54	-25.93	-22.78	-25.08	-23.16	-26.50	-22.39	
	Unwanted Emission Intensity	※ 1	dBm	-47.71	-46.44	-47.68	-47.51	-47.66	-47.86	-47.59	-46.97	-47.44	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	dBm	-59.61	-30.21	-34.33	-57.52	-29.82	-34.37	-57.87	-31.21	-34.97	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	dBm	-34.63	-29.01	-34.09	-34.72	-29.23	-34.12	-34.34	-29.31	-33.87	Limit ≦ 25 μW (-16 dBm)
		※ 4	dBm	-34.16	-29.57	-49.23	-34.64	-30.62	-49.19	-33.80	-29.54	-49.21	Limit ≦ 25 μW (-16 dBm)
		※ 5	dBm	-27.97	-27.76	-27.27	-27.64	-27.77	-26.58	-27.97	-28.21	-26.98	Limit ≦ 2.5 μW (-26 dBm)
	Unwanted Emission Intensity	※ 1	μW	0.0169	0.0227	0.0171	0.0177	0.0172	0.0164	0.0174	0.0201	0.0180	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.0011	0.9520	0.3690	0.0018	1.0419	0.3657	0.0016	0.7577	0.3181	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.3447	1.2556	0.3899	0.3374	1.1953	0.3876	0.3679	1.1731	0.4105	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.3838	1.1052	0.0119	0.3438	0.8676	0.0120	0.4169	1.1107	0.0120	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5967	1.6754	1.8750	1.7237	1.6724	2.1965	1.5948	1.5091	2.0039	Limit ≦ 2.5 μW (-26 dBm)

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
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※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

5. Limitation of Collateral Emission of Receiver

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks	
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480		
Limitation of Collateral Emission	Spurious Emission Frequency	※ 6	MHz	119.24	119.24	120.21	107.60	304.51	119.24	107.60	304.51	119.24	1st	30MHz～1000MHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 6	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	MHz	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	MHz	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	1st	1000MHz～12.5GHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 7	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	MHz	-	-	-	-	-	-	-	-	-	3rd	
	Cable Loss	※ 6	dB	0.37	0.37	0.37	0.35	0.55	0.37	0.35	0.55	0.37	1st	
		※ 6	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dB	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dB	1.71	1.72	1.73	1.71	1.72	1.73	1.71	1.72	1.73	1st	
		※ 7	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dB	-	-	-	-	-	-	-	-	-	3rd	
	Spectrum Raw	※ 6	dBm	-84.15	-70.00	-83.12	-83.89	-87.15	-82.14	-83.87	-86.88	-84.20	1st	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-56.17	-57.23	-59.12	-56.21	-57.23	-59.05	-56.01	-57.16	-58.78	1st	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	dBm	-83.78	-69.64	-82.76	-83.54	-86.60	-81.77	-83.52	-86.33	-83.83	1st	Limit ≦ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-54.46	-55.51	-57.39	-54.50	-55.51	-57.32	-54.30	-55.45	-57.05	1st	Limit ≦ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	nW	0.0042	0.1087	0.0053	0.0044	0.0022	0.0066	0.0044	0.0023	0.0041	Total Emission Power	
		※ 6	nW	0.0042	0.1087	0.0053	0.0044	0.0022	0.0066	0.0044	0.0023	0.0041	1st	Limit ≦ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
		※ 6	nW	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	nW	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	nW	3.5799	2.8126	1.8236	3.5447	2.8128	1.8534	3.7163	2.8531	1.9702	Total Emission Power	
		※ 7	nW	3.5799	2.8126	1.8236	3.5447	2.8128	1.8534	3.7163	2.8531	1.9702	1st	Limit ≦ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
		※ 7	nW	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	nW	-	-	-	-	-	-	-	-	-	3rd	

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

Calibration Result

1. Linearity Check

SG Output (dBm)	Spectrum Raw (dBm)	Power Meter Raw (dBm)	Remark
0	-1.3	-0.93	・SG Test Frequency：2450 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.34	-5.88	
-10	-11.17	-10.84	
0	-1.64	-1.66	・SG Test Frequency：5250 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.6	-6.62	
-10	-11.48	-11.58	

2. Frequency Accuracy Confirmation

SG Output (dBm)	Spectrum Raw (MHz)	Freqquency Error (ppm)	Remark
2450	2450.0002	0.0816	・SG Output：0dBm ・RWB：30 kHz；VBW：30 kHz：SP：300kHz ・Limit ≦ 10% of frequency error limits
5250	5250.0012	0.2286	

3. Cable Loss

SG Output (MHz)	Power Meter Raw Without Cable (dBm)	Power Meter Raw With Cable (dBm)	Cable Loss (dB)	Remark
1000	-0.23	-1.11	0.88	・SG Output：0dBm
2450	-0.87	-2.36	1.49	
5250	-1.67	-3.43	1.76	
12500	-3.69	-9.37	5.68	
26000	-5.55	-19.13	13.58	

Appendix A 19-BLE (125kbps)

1. Test Results

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Antenna Power (Measured Power)	mW	3.177	3.006	2.864	3.184	3.013	2.871	3.105	2.938	2.799	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)	mW	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error	mW	-0.323	-0.494	-0.636	-0.316	-0.487	-0.629	-0.395	-0.562	-0.701	
		%	-9.23	-14.11	-18.17	-9.02	-13.91	-17.98	-11.30	-16.07	-20.03	Limit + 20% ~ - 80%

2. Antenna Power (Conducted Power)

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	1.65	1.41	1.20	1.65	1.41	1.20	1.65	1.41	1.20	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	Duty Factor = 10 × $10Log_{10}$(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	5.02	4.78	4.57	5.03	4.79	4.58	4.92	4.68	4.47	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	3.177	3.006	2.864	3.184	3.013	2.871	3.105	2.938	2.799	
	Antenna Power Error	mW	-0.323	-0.494	-0.636	-0.316	-0.487	-0.629	-0.395	-0.562	-0.701	
		%	-9.23	-14.11	-18.17	-9.02	-13.91	-17.98	-11.30	-16.07	-20.03	Limit + 20% ~ - 80%
	Tranmsitter ON_{Time}	msec	0.4034									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter $(ON+OFF)_{Time}$	msec	0.6220									
	Tranmsitter Duty Cycle	%	64.86%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	5.03	On-Board Trace antenna	0.00			-	-		0.00	5.03	360.00	Good	
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

Appendix A 19-BLE (500kbps)

1. Test Results

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Antenna Power (Measured Power)	mW	3.228	3.041	2.891	3.236	3.048	2.897	3.155	2.972	2.825	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)	mW	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error	mW	-0.272	-0.459	-0.609	-0.264	-0.452	-0.603	-0.345	-0.528	-0.675	
		%	-7.76	-13.12	-17.41	-7.54	-12.92	-17.22	-9.86	-15.10	-19.29	Limit + 20% ~ - 80%

2. Antenna Power (Conducted Power)

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	1.72	1.46	1.24	1.72	1.46	1.24	1.72	1.46	1.24	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	Duty Factor = 10 × $10Log_{10}$(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	5.09	4.83	4.61	5.10	4.84	4.62	4.99	4.73	4.51	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	3.228	3.041	2.891	3.236	3.048	2.897	3.155	2.972	2.825	
	Antenna Power Error	mW	-0.272	-0.459	-0.609	-0.264	-0.452	-0.603	-0.345	-0.528	-0.675	
		%	-7.76	-13.12	-17.41	-7.54	-12.92	-17.22	-9.86	-15.10	-19.29	Limit + 20% ~ - 80%
	Tranmsitter ON_{Time}	msec	0.4034									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter $(ON+OFF)_{Time}$	msec	0.6220									
	Tranmsitter Duty Cycle	%	64.86%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	5.10	On-Board Trace antenna	0.00			-	-		0.00	5.10	360.00	Good	
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													

Calibration Result

1. Linearity Check

SG Output (dBm)	Spectrum Raw (dBm)	Power Meter Raw (dBm)	Remark
0	-1.3	-0.93	・SG Test Frequency：2450 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.34	-5.88	
-10	-11.17	-10.84	
0	-1.64	-1.66	・SG Test Frequency：5250 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.6	-6.62	
-10	-11.48	-11.58	

2. Frequency Accuracy Confirmation

SG Output (dBm)	Spectrum Raw (MHz)	Freqquency Error (ppm)	Remark
2450	2450.0002	0.0816	・SG Output：0dBm ・RWB：30 kHz；VBW：30 kHz：SP：300kHz ・Limit ≦ 10% of frequency error limits
5250	5250.0012	0.2286	

3. Cable Loss

SG Output (MHz)	Power Meter Raw Without Cable (dBm)	Power Meter Raw With Cable (dBm)	Cable Loss (dB)	Remark
1000	-0.23	-1.11	0.88	・SG Output：0dBm
2450	-0.87	-2.36	1.49	
5250	-1.67	-3.43	1.76	
12500	-3.69	-9.37	5.68	
26000	-5.55	-19.13	13.58	

Appendix B. Antenna Information

SaBLE-x™ *Bluetooth® Smart* (BLE) Module

FEATURES

- Built in CC2640F128 Bluetooth Smart (BLE 4.1) System-On-Chip (SOC) 5x5mm RHB package with 15 GPIOs
- 128 kB Flash / 20 kB SRAM
- RF Output Power: +5 dBm
- RF Receive Sensitivity: -96 dBm
- Size: 11.6mm x 17.9mm x 2.4mm
- Operating Voltage: 1.8V to 3.8V
- Operating Temperature: -40 to +85C
- 8.4 mA Transmit Mode (+5 dBm)
- 7.4 mA Receive Mode
- 1µA Standby (SRAM/CPU retention and RTC running) with quick 100 µs start up
- 200nA Shutdown
- 61µA/MHz Active CPU Current
- Drivers, Bluetooth Low Energy Controller, and bootloader in ROM
- Flexible peripheral set
- On board 32 kHZ and 24 MHz Crystals
- Worldwide Acceptance:
  FCC (USA), IC (Canada),
  ETSI (Europe), Giteki (Japan), and
  C-Tick (AU/NZ)
- REACH and RoHS compliant

APPLICATIONS

- Consumer electronics
- Mobile phone accessories
- Sports & Fitness equipment
- HID applications
- Home and Building Automation, Lighting Control, Alarm and Security
- Electronic Shelf Labeling, Proximity Tags

DESCRIPTION

LSR would like to announce a low-cost and low-power consumption module which has all of the *Bluetooth Smart* 4.1 functionalities.

The SaBLE-x module fully supports the single mode *Bluetooth* Low Energy operation, and the output power can support class 2. The module provides the ability to either put your entire application into the integrated ARM Cortex M3 microcontroller, or use the module in Network Processor mode in conjunction with the microcontroller of your choice. RF Core's dedicated ARM Cortex M0 improves system performance and frees up FLASH memory for custom applications.

Need to get to market quickly? Not an expert in *Bluetooth* Low Energy? Need a custom antenna? Do you need help with your host board? LSR Design Services will be happy to develop custom hardware or software, or help integrate the design. Contact us at sales@lsr.com or call us at 262-375-4400.

ORDERING INFORMATION

Order Number	Description
450-0119C	SaBLE-x Module, PCB Trace Antenna (Cut Tape)
450-0119R	SaBLE-x Module, PCB Trace Antenna (Tape & Reel)
450-0144C	SaBLE-x Module, External Antenna Port (Cut Tape)
450-0144R	SaBLE-x Module, External Antenna Port (Tape & Reel)
450-0150	SaBLE-x Evaluation Kit, PCB Trace Antenna
450-0141	SaBLE-x Development Kit, PCB Trace Antenna

Table 1 Orderable Model Numbers

MODULE ACCESSORIES

	Order Number	Description
	**001-0001**	2.4 GHz Dipole Antenna with Reverse Polarity SMA Connector
	**080-0001**	U.FL to Reverse Polarity SMA Bulkhead Cable 105mm
	**001-0014**	2.4 GHz FlexPIFA Antenna
	**001-0015**	2.4 GHz FlexNotch Antenna

Table 2 Module Accessories

BLOCK DIAGRAM

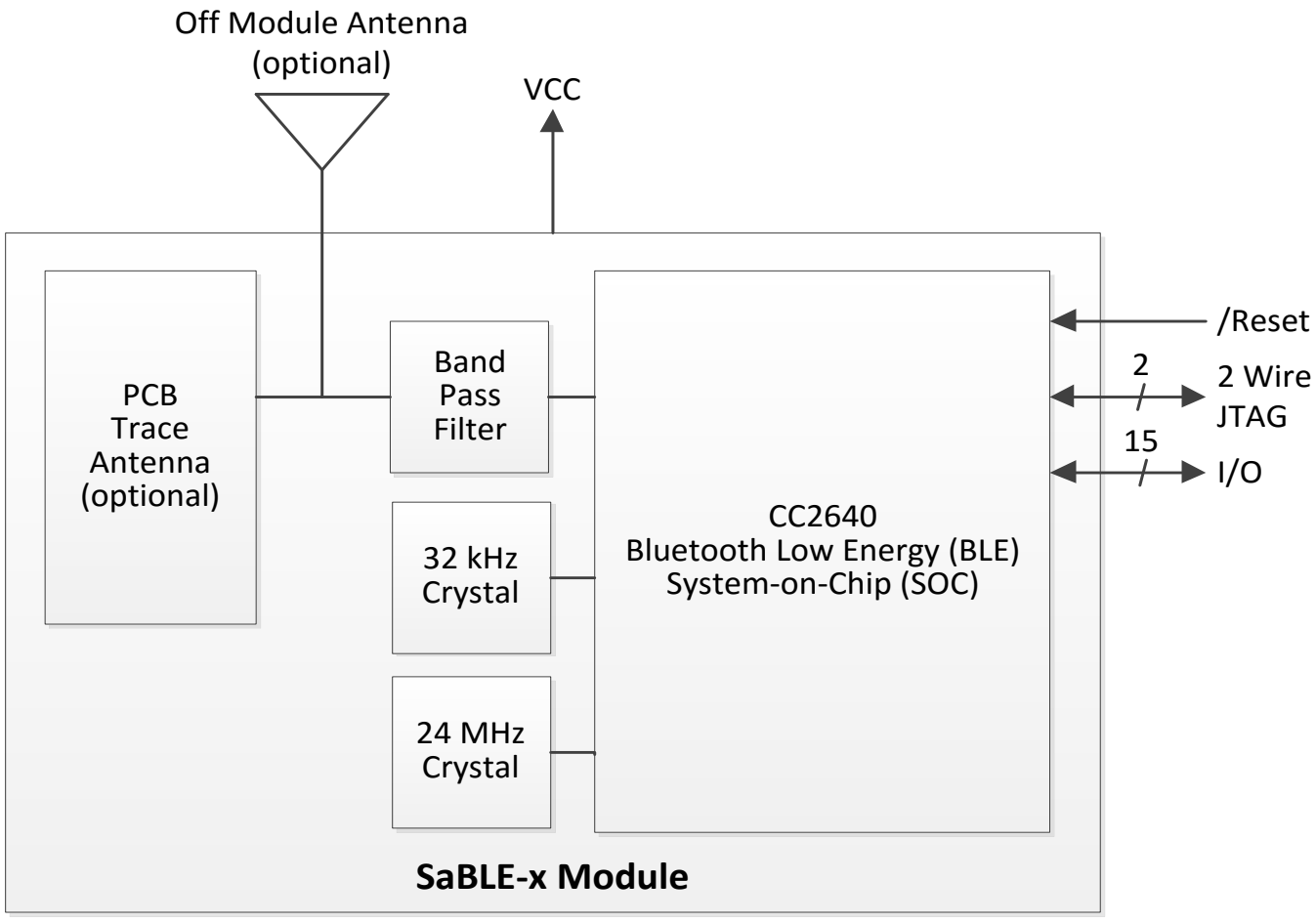

Figure 1 SaBLE-x Module Block Diagram

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FOOTPRINT AND PIN DEFINITIONS

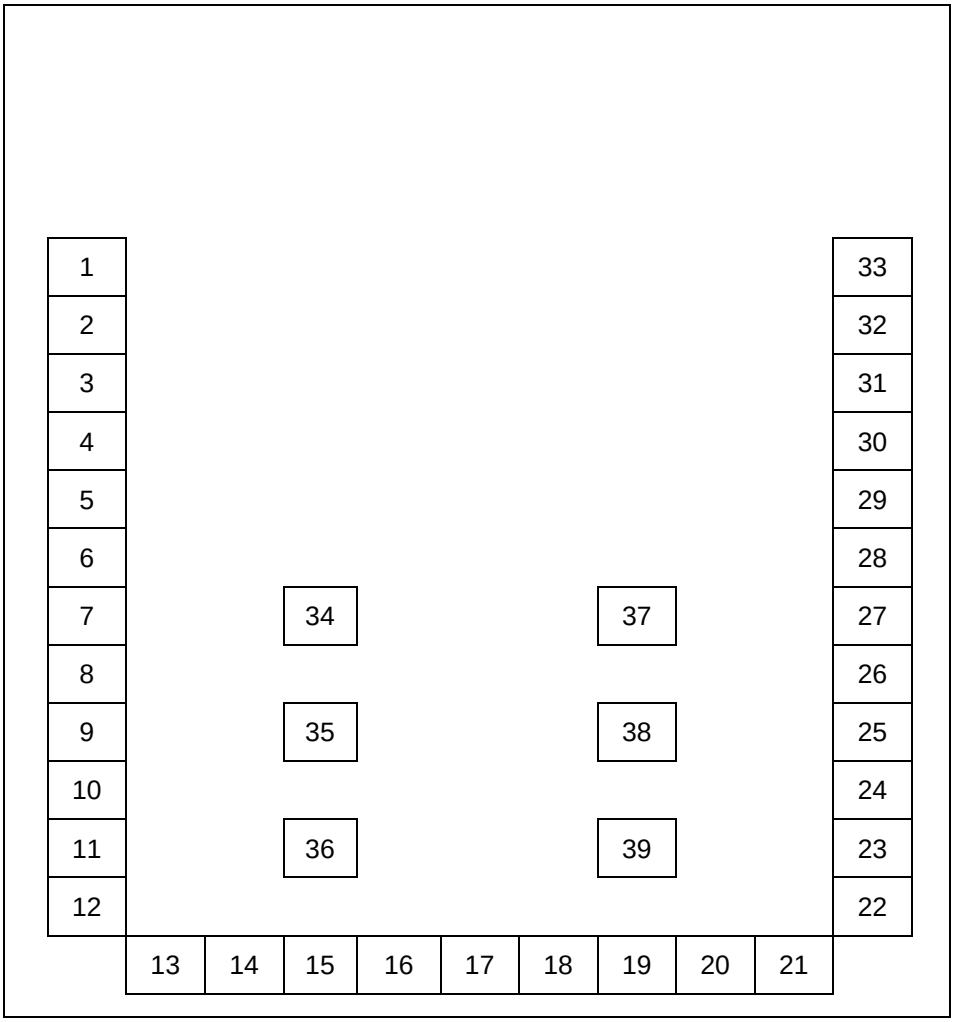


Figure 2 SaBLE-x Module Footprint (Viewed From Top)

PIN DESCRIPTIONS

Module Pin	Name	I/O Type	Description
1	RF OUT	RF	ANTENNA, 50 OHMS
2	GND	GND	GROUND
3	GND	GND	GROUND
4	NC	-	NO CONNECT (DO NOT CONNECT)
5	NC	-	NO CONNECT (DO NOT CONNECT)
6	/RESET	DI	ACTIVE LOW RESET. 100kΩ PULL-UP
7	JTAG TCKC	DI/DIO	JTAG TCKC
8	JTAG TMSC	DIO	JTAG TMSC
9	NC	-	NO CONNECT (DO NOT CONNECT)
10	NC	-	NO CONNECT (DO NOT CONNECT)
11	VCC	PI	POWER SUPPLY TO MODULE
12	VCC	PI	POWER SUPPLY TO MODULE
13	DIO 5/JTAG TDO	DIO	GPIO, JTAG TDO, LED DRIVING CAPABILITY
14	DIO 6/JTAG TDI	DIO	GPIO, JTAG TDI, LED DRIVING CAPABILITY
15	DIO 4	DIO	GPIO, ULP SENSOR INTERFACE, LED DRIVING CAPABILITY
16	DIO 3	DIO	GPIO, ULP SENSOR INTERFACE, LED DRIVING CAPABILITY
17	DIO 2	DIO	GPIO, ULP SENSOR INTERFACE, LED DRIVING CAPABILITY
18	DIO 1/BOOT RX	DIO	GPIO, ULP SENSOR INTERFACE, BOOTLOADER RX (UART0)
19	DIO 0/BOOT TX	DIO	GPIO, ULP SENSOR INTERFACE, BOOTLOADER TX (UART0)
20	DIO 7	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
21	DIO 8	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
22	GND	GND	GROUND
23	DIO 10	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
24	DIO 9	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
25	NC	-	NO CONNECT (DO NOT CONNECT)
26	NC	-	NO CONNECT (DO NOT CONNECT)
27	NC	-	NO CONNECT (DO NOT CONNECT)
28	NC	-	NO CONNECT (DO NOT CONNECT)
29	DIO 11	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
30	DIO 12	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
31	DIO 13	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
32	DIO 14	DIO	GPIO, ANALOG INPUT, ULP SENSOR INTERFACE
33	GND	GND	GROUND
34-39	GND	GND	GROUND AND THERMAL RELIEF PADS

PI = Power Input GND = Ground DI = Digital Input DO = Digital Output DIO = Digital Input/Output AI = Analog Input
RF = Bi-directional RF Port Note: See the Texas Instruments CC2640 datasheet and user guide for further details on the I/O.

Table 3 SaBLE-x Pin Descriptions

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Symbol	Description	Min	Max	Unit
VCC	Digital Input Supply Voltage	-0.3	4.1	V
Voltage on any digital pin		-0.3	VCC+0.3, max 4.1	V
Input RF level			+5	dBm

Table 4 Absolute Maximum Ratings[1]

Recommended Operating Conditions

Test conditions: Ambient Temp = 25°C

Symbol	Min	Typ	Max	Unit
VCC	1.8	3.3	3.8	V

Table 5 Recommended Operating Conditions

General Characteristics

Characteristic	Description
Model Name	SaBLE-x
Product Description	Bluetooth Low Energy Wireless Module
Dimension	11.63 mm x 17.86 mm x 2.4 mm (W*L*T)
Operating temperature	-40°C to 85°C
Storage temperature	-40°C to 85°C
Humidity	Operating Humidity 10% to 95% Non-Condensing Storage Humidity 5% to 95% Non-Condensing
Weight	0.75g +/- 0.05g

Table 6 General Characteristics

[1] Under no circumstances should exceeding the ratings specified in the Absolute Maximum Ratings section be allowed. Stressing the module beyond these limits may result permanent damage to the module that is not covered by the warranty.

DC Characteristics

Parameter	Test Conditions	Min	Typ	Max	Unit
Input low-to-high transition with hysteresis	Transition from 0→1, T_A= 25C, VCC=1.8V		1.07		V
Input high-to-low transition with hysteresis	Transition from 1→0, T_A= 25C, VCC=1.8V		0.74		V
Input hysteresis	Difference between 0→1 and 1→0.		0.33		V
Input low-to-high transition with hysteresis	Transition from 0→1, T_A= 25C, VCC=3.8V		1.94		V
Input high-to-low transition with hysteresis	Transition from 1→0, T_A= 25C, VCC=3.8V		1.54		V
Input hysteresis	Difference between 0→1 and 1→0.		0.40		V
Logic-0 output voltage, 4 mA pins	Output load 4 mA, T_A= 25C, VCC=1.8V		0.26		V
Logic-1 output voltage, 4 mA pins	Output load 4 mA, T_A= 25C, VCC=1.8V		1.54		V
Logic-0 output voltage, 8 mA pins	Output load 8 mA, T_A= 25C, VCC=1.8V		0.21		V
Logic-1 output voltage, 8 mA pins	Output load 8 mA, T_A= 25C, VCC=1.8V		1.58		V
Logic-0 output voltage, 4 mA pins	Output load 4 mA, T_A= 25C, VCC=3.0V		0.33		V
Logic-1 output voltage, 4 mA pins	Output load 4 mA, T_A= 25C, VCC=3.0V		2.72		V
Logic-0 output voltage, 8 mA pins	Output load 8 mA, T_A= 25C, VCC=3.0V		0.28		V
Logic-1 output voltage, 8 mA pins	Output load 8 mA, T_A= 25C, VCC=3.0V		2.68		V
Input pullup current	Vpad=0V, T_A= 25C, VCC=1.8V		72		uA
Input pulldown current	Vpad=1.8V, T_A= 25C, VCC=1.8V		22		uA
Input pullup current	Vpad=0V, T_A= 25C, VCC=3.8V		277		uA
Input pulldown current	Vpad=3.8V, T_A= 25C, VCC=3.8V		113		uA

Table 7 SaBLE-x Module Bluetooth General DC Characteristics

General Power Consumption

T_A = 25°C

Parameter	Test Conditions	Min	Typical Average Current				Max	Unit
			1.8V	3.0V	3.3V	3.8V		
Shutdown	No clocks running, no data retention				200			nA
Standby 1	With RTC, CPU, RAM and partial register retention. XOSC_LF				1.2			uA
Standby 2	With Cache, RTC, CPU, RAM and partial register retention. XOSC_LF				2.7			uA
Idle	Supply Systems and RAM powered.				550			uA
Active	Core running CoreMark				1.45mA + 31uA/MHz			
Radio Recieive			11.8	7.9	7.4	7.0		mA
Radio Transmit	+5 dBm output power		13.6	9.0	8.4	7.9		

Table 8 SaBLE-x Module Bluetooth TX & RX Current Consumption Specifications

RF Characteristics

Measured on LSR SaBLE-x External Antenna Development Board reference design, with T_A = 25°C, VDD = 3.3 V, fc = 2440 MHz, LEDs disabled, DC to DC disabled**,** measured at RF connector.

Parameter	Test Conditions	Min	Typical				Max	Unit
			1.8V	3.0V	3.3V	3.8V		
	TRANSMIT SECTION							
Output Power	CH 0 (2402 MHZ)		5.3	5.2	5.3	5.3		dBm
	CH 19 (2440 MHZ)		4.7	4.7	4.7	4.8		
	CH 39 (2480 MHZ)		4.4	4.6	4.5	4.6		
Spurious emission conducted measurement	f < 1 GHz		-43					dBm
	f > 1 GHz		-46					dBm
RF frequency range	Programmable in 1-MHz steps	2402					2480	MHz
	RECEIVE SECTION							
Receiver sensitivity	CH 0 (2402 MHZ)		-96.1	-95.7	-94.4	-93.8		dBm
	CH 19 (2440 MHZ)		-95.8	-95.6	-95.0	-94.5		
	CH 39 (2480 MHZ)		-95.9	-95.7	-95.3	-95.0		
Saturation	BER < 0.1%				4			dBm
Co-channel rejection	Wanted signal –67 dBm				-6			dB
Frequency error tolerance	Including both initial tolerance and drift. Sensitivity better than -67dBm, 250 byte payload. BER 0.1%	-250					250	KHz
Intermodulation	Minimum interferer level				-36			dBm

Table 9 Bluetooth RF Characteristics

Wakeup Timing

Shutdown

Shutdown is similar to holding the device in reset with two exceptions:

1. It latches the state of IO prior to shutting down.
2. It consumes 0.1 uA, versus approximately 37 uA.

Figure 3 shows the response time to wake up from shutdown by using a wake up pin. The pin is configured to wake the device up on a negative edge. Once the device wakes it drives an awake pin low:

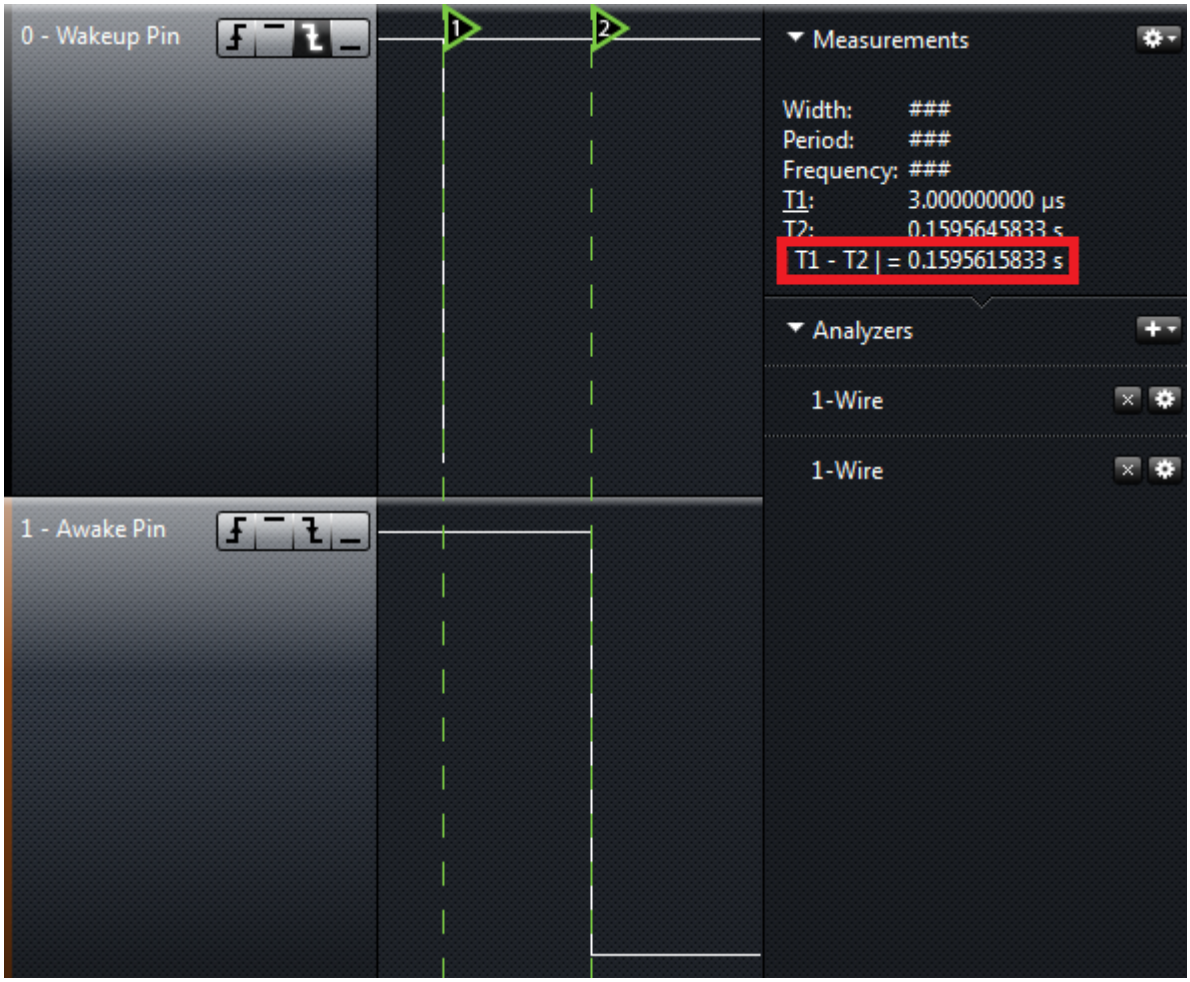


Figure 3 SaBLE-x Module Waking from Shutdown Timing Diagram

In **Figure 3** it shows the module taking approximately 160ms to wake.

Standby

Standby is a low power mode policy. When configured correctly in code the software goes into standby.

Figure 4 shows the response time to wake up from standby using a wake up pin. The method is the same as described in the shutdown section:

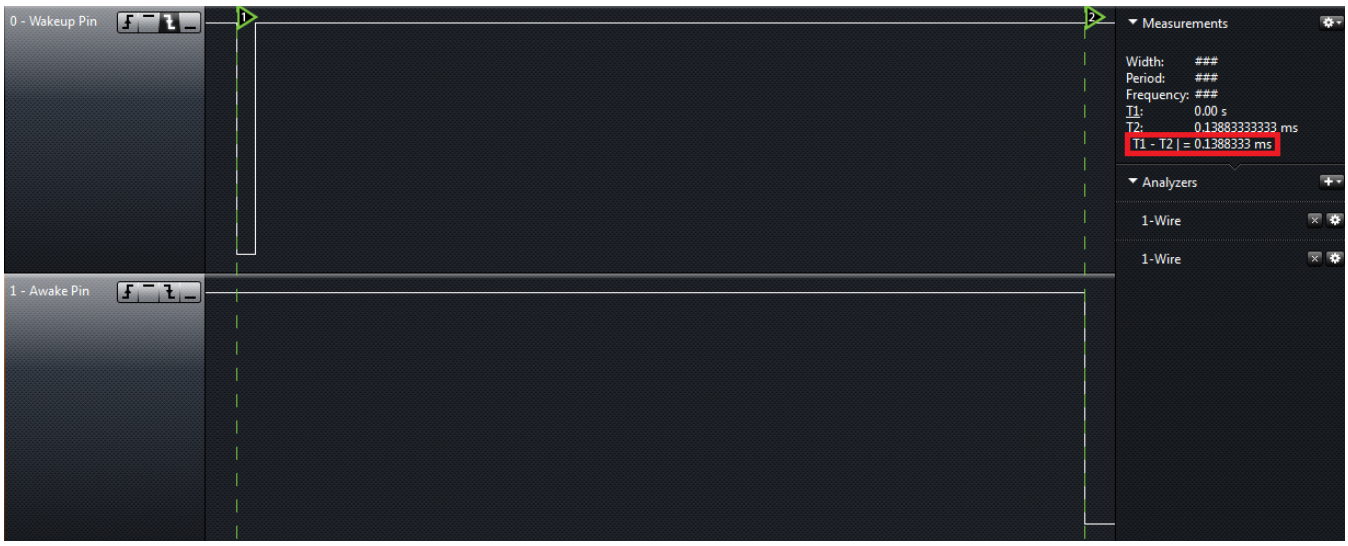


Figure 4 SaBLE-x Module Waking from Standby Timing Diagram

In **Figure 4** it shows the module taking approximately 139 us to wake.

MODULE OUTPUT CONFIGURATION

The SaBLE-x module uses the CC2640 5x5 mm RHB package with 15 GPIOs and the RF front end was configured as differential output with external bias. In order to configure the proper biasing, the correct package type must be selected in software. This configuration also selects the correct board file for the SaBLE-x module. To make this change the application compiler include options must be changed from 7ID to 5XD. Refer to **Figure 5**. The corresponding board file is located at that directory as well.

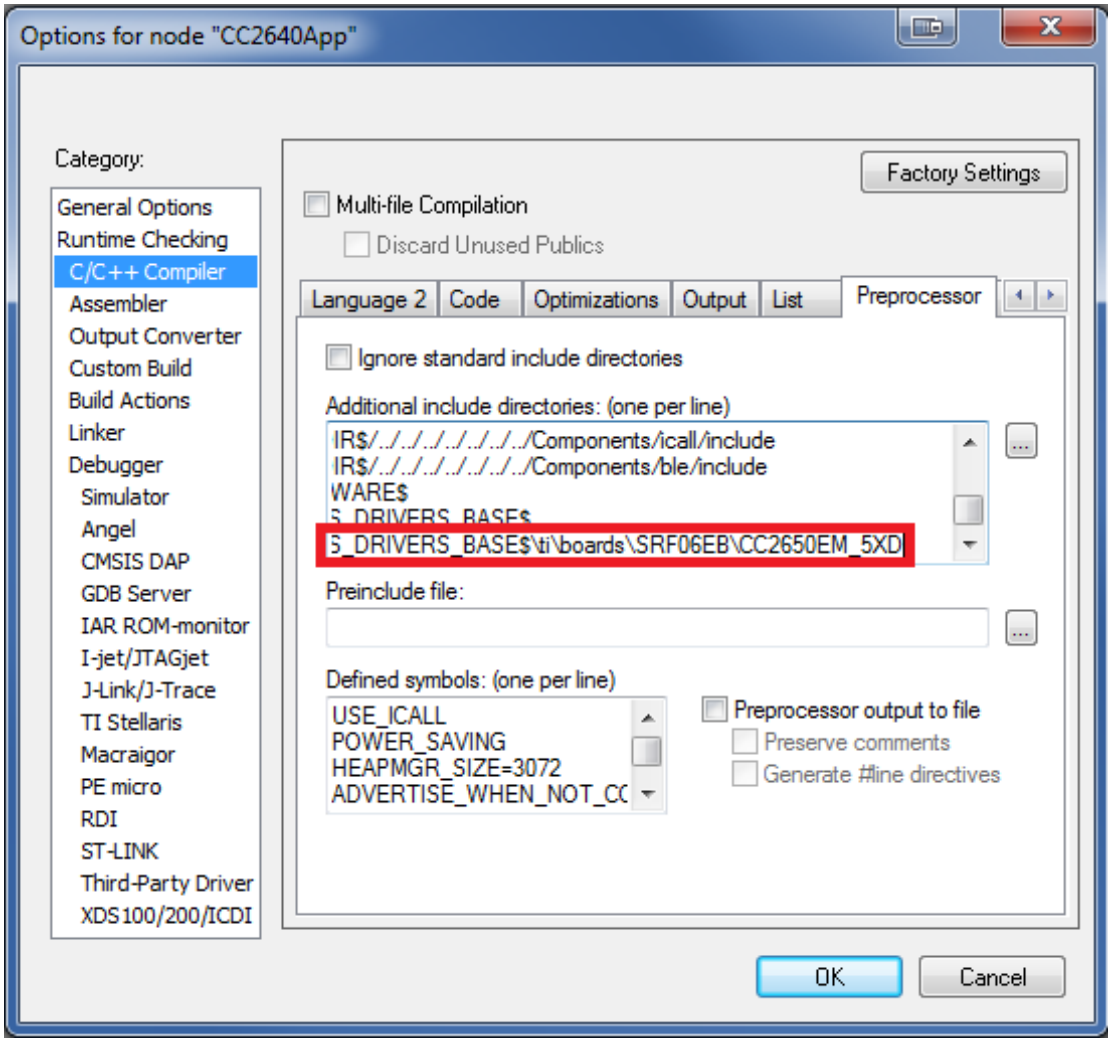


Figure 5 Selection of SaBLE-x Package Type

Furthermore, the default transmit power on boot can be set in bleUserConfig.c:

```
// Default Tx Power Index
#define DEFAULT_TX_POWER                12
```

Figure 6 Selection of SaBLE-x Default Tx Power on Boot

This value is the index into the following table in bleUserConfig.c:

```
// Tx Power Values (Pout, IB, GC, TC)
const txPwrVal_t txPowerTable[] =
  { { TX_POWER_MINUS_21_DBM, GEN_TX_POWER_VAL( 0x07, 3, 0x0C ) },
    { TX_POWER_MINUS_18_DBM, GEN_TX_POWER_VAL( 0x09, 3, 0x0C ) },
    { TX_POWER_MINUS_15_DBM, GEN_TX_POWER_VAL( 0x0B, 3, 0x0C ) },
    { TX_POWER_MINUS_12_DBM, GEN_TX_POWER_VAL( 0x0B, 1, 0x14 ) },
    { TX_POWER_MINUS_9_DBM,  GEN_TX_POWER_VAL( 0x0E, 1, 0x19 ) },
    { TX_POWER_MINUS_6_DBM,  GEN_TX_POWER_VAL( 0x12, 1, 0x1D ) },
    { TX_POWER_MINUS_3_DBM,  GEN_TX_POWER_VAL( 0x18, 1, 0x25 ) },
    { TX_POWER_0_DBM,        GEN_TX_POWER_VAL( 0x21, 1, 0x31 ) },
    { TX_POWER_1_DBM,        GEN_TX_POWER_VAL( 0x14, 0, 0x42 ) },
    { TX_POWER_2_DBM,        GEN_TX_POWER_VAL( 0x18, 0, 0x4E ) },
    { TX_POWER_3_DBM,        GEN_TX_POWER_VAL( 0x1C, 0, 0x5A ) },
    { TX_POWER_4_DBM,        GEN_TX_POWER_VAL( 0x24, 0, 0x93 ) },
    { TX_POWER_5_DBM,        GEN_TX_POWER_VAL( 0x30, 0, 0x93 ) } };
```

Figure 7 Table Indexed by DEFAULT_TX_POWER Value

SOLDERING RECOMMENDATIONS

Recommended Reflow Profile for Lead Free Solder

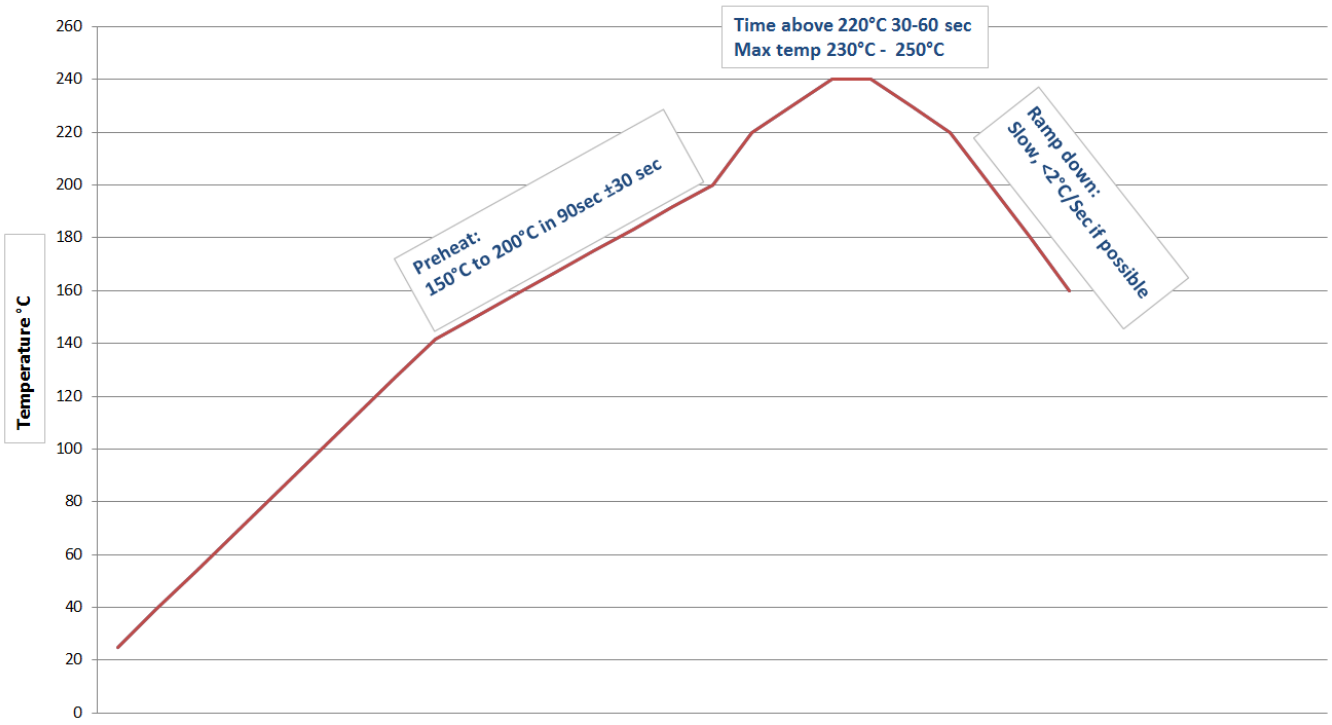


Figure 8 Recommended Soldering Profile

Note: The quality of solder joints on the surface mount pads where they contact the host board should meet the appropriate IPC Specification. See IPC-A-610-D Acceptability of Electronic Assemblies, section 8.2.1 "Bottom Only Terminations."

CLEANING

In general, cleaning the populated modules is strongly discouraged. Residuals under the module cannot be easily removed with any cleaning process.

- Cleaning with water can lead to capillary effects where water is absorbed into the gap between the host board and the module. The combination of soldering flux residuals and encapsulated water could lead to short circuits between neighboring pads. Water could also damage any stickers or labels.
- Cleaning with alcohol or a similar organic solvent will likely flood soldering flux residuals into the RF shield, which is not accessible for post-washing inspection. The solvent could also damage any stickers or labels.
- Ultrasonic cleaning could damage the module permanently.

OPTICAL INSPECTION

After soldering the Module to the host board, consider optical inspection to check the following:

- Proper alignment and centering of the module over the pads.
- Proper solder joints on all pads.
- Excessive solder or contacts to neighboring pads, or vias.

REWORK

The module can be unsoldered from the host board if the Moisture Sensitivity Level (MSL) requirements are met as described in this datasheet.

Never attempt a rework on the module itself, e.g. replacing individual components. Such actions will terminate warranty coverage.

SHIPPING, HANDLING, AND STORAGE

Shipping

Bulk orders of the SaBLE-x modules are delivered in reels of 1,000.

Handling

The SaBLE-x modules contain a highly sensitive electronic circuitry. Handling without proper ESD protection may damage the module permanently.

Moisture Sensitivity Level (MSL)

Per J-STD-020, devices rated as MSL 4 and not stored in a sealed bag with desiccant pack should be baked prior to use.

Devices are packaged in a Moisture Barrier Bag with a desiccant pack and Humidity Indicator Card (HIC). Devices that will be subjected to reflow should reference the HIC and J-STD-033 to determine if baking is required.

If baking is required, refer to J-STD-033 for bake procedure.

Storage

Per J-STD-033, the shelf life of devices in a Moisture Barrier Bag is 12 months at <40ºC and <90% room humidity (RH).

Do not store in salty air or in an environment with a high concentration of corrosive gas, such as Cl2, H2S, NH3, SO2, or NOX.

Do not store in direct sunlight.

The product should not be subject to excessive mechanical shock.

Repeating Reflow Soldering

Only a single reflow soldering process is encouraged for host boards.

AGENCY CERTIFICATIONS

FCC ID: TFB-1002, 15.247

IC ID: 5969A-1002, RSS 210

CE: Compliant to standards EN 60950-1, EN 300 328, and EN 301 489

Giteki: 209-J00169

RCM

AGENCY STATEMENTS

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This portable transmitter with its antenna complies with FCC/IC RF exposure limits for general population / uncontrolled exposure.

FCC CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

Industry Canada Statements

This device complies with Industry Canada License-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

This device has been designed to operate with the antenna(s) listed below, and having a maximum gain of 0 dBi (PCB Trace), 2.0 dBi (LSR 2.4 GHz Dipole), 2.0 dBi (LSR 2.4 GHz FlexPIFA), and 2.0 (LSR 2.4 GHz FlexNotch). Antennas not included in this list or having a gain greater than 0 dB, 2.0 dBi, 2.0 dBi, and 2.0 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

List of all Antennas Acceptable for use with the Transmitter

1) On module PCB trace antenna.
2) LSR 001-0001 center-fed 2.4 GHz dipole antenna and LSR 080-0001 U.FL to Reverse Polarity SMA connector cable.
3) LSR 001-0014 2.4 GHz FlexPIFA antenna.
4) LSR 001-0015 2.4 GHz FlexNotch antenna.

Cet appareil est conforme aux normes d'Industrie Canada exempts de licence RSS (s). L'opération est soumise aux deux conditions suivantes: (1) cet appareil ne peut pas provoquer d'interférences et (2) cet appareil doit accepter toute interférence, y compris les interférences qui peuvent causer un mauvais fonctionnement de l'appareil.

Pour réduire le risque d'interférence aux autres utilisateurs, le type d'antenne et son gain doiventêtre choisis de manière que la puissance isotrope rayonnée équivalente (PIRE) ne dépasse pascelle permise pour une communication réussie.

Cet appareil a été conçu pour fonctionner avec l'antenne (s) ci-dessous, et ayant un gain maximum de 0 dBi (PCB Trace), 2,0 dBi (LSR 2.4 GHz Dipole), 2,0 dBi (LSR 2.4 GHz FlexPIFA), et 2,0 dBi (LSR 2.4 GHz FlexNotch). Antennes pas inclus dans cette liste ou présentant un gain supérieur à 0 dB, 2,0 dBi, 2,0 dBi, et 2,0 dBi sont strictement interdites pour une utilisation avec cet appareil. L'impédance d'antenne requise est de 50 ohms.

Liste de toutes les antennes acceptables pour une utilisation avec l'émetteur

1) Le module d'antenne PCB trace.
2) LSR 001-0001 centre-fed 2,4 GHz antenne dipôle et LSR 080-0001 U.FL pour inverser câble connecteur SMA à polarité.
3) LSR 001-0014 antenne FlexPIFA 2,4 GHz.
4) LSR 001-0015 antenne FlexNotch 2,4 GHz.

OEM RESPONSIBILITIES TO COMPLY WITH FCC AND INDUSTRY CANADA REGULATIONS

The SaBLE-xModule has been certified for integration into products only by OEM integrators under the following conditions:

The antennas for this transmitter must not be co-located with any other transmitters except in accordance with FCC and Industry Canada multi-transmitter procedures. Co-location means having a separation distance of less than 20 cm between transmitting antennas.

As long as the two conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

IMPORTANT NOTE: In the event that these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and Industry Canada authorization.

Le module de SaBLE-xa été certifié pour l'intégration dans des produits uniquement par des intégrateurs OEM dans les conditions suivantes:

Les antennes pour ce transmetteur ne doit pas être co-localisés avec les autres émetteurs sauf en conformité avec la FCC et Industrie Canada multi-émetteur procédures. Co-localisation des moyens ayant une distance de séparation inférieure à 20 cm entre les antennes d'émission.

Tant que les deux conditions précitées sont réunies, les tests de transmetteurs supplémentaires ne seront pas tenus. Toutefois, l'intégrateur OEM est toujours responsable de tester leur produit final pour toutes les exigences de conformité supplémentaires requis avec ce module installé (par exemple, les émissions appareil numérique, les exigences de périphériques PC, etc.)

NOTE IMPORTANTE: Dans le cas où ces conditions ne peuvent être satisfaites (pour certaines configurations ou de co-implantation avec un autre émetteur), puis la FCC et Industrie autorisations Canada ne sont plus considérés comme valides et l'ID de la FCC et IC numéro de certification ne peut pas être utilisé sur la produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'un distincte de la FCC et Industrie Canada l'autorisation.

OEM LABELING REQUIREMENTS FOR END-PRODUCT

The SaBLE-x module is labeled with its own FCC ID and IC Certification Number. The FCC ID and IC certification numbers are not visible when the module is installed inside another device, as such the end device into which the module is installed must display a label referring to the enclosed module. The final end product must be labeled in a visible area with the following:

"**Contains Transmitter Module FCC ID: TFB-1002"**

"**Contains Transmitter Module IC: 5969A-1002"**

or

"**Contains FCC ID: TFB-1002"**

"**Contains IC: 5969A-1002"**

The OEM of the SaBLE-x module must only use the approved antenna(s) listed above, which have been certified with this module.

Le module de SaBLE-x est étiqueté avec son propre ID de la FCC et IC numéro de certification. L'ID de la FCC et IC numéros de certification ne sont pas visibles lorsque le module est installé à l'intérieur d'un autre appareil, comme par exemple le terminal dans lequel le module est installé doit afficher une etiquette faisant référence au module ci-joint. Le produit final doit être étiqueté dans un endroit visible par le suivant:

"Contient Module émetteur FCC ID: TFB-1002"
"Contient Module émetteur IC: 5969A-1002"

ou

"Contient FCC ID: TFB-1002"
"Contient IC: 5969A-1002"

Les OEM du module SaBLE-x ne doit utiliser l'antenne approuvée (s) ci-dessus, qui ont été certifiés avec ce module.

OEM END PRODUCT USER MANUAL STATEMENTS

The OEM integrator should not provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.

Other user manual statements may apply.

L'intégrateur OEM ne devraient pas fournir des informations à l'utilisateur final sur la façon d'installer ou de supprimer ce module RF ou modifier les paramètres liés RF dans le manuel utilisateur du produit final.

Autres déclarations manuel de l'utilisateur peuvent s'appliquer.

EUROPE

CE Notice

This device has been tested and certified for use in the European Union. See the Declaration of Conformity (DOC) for specifics.

If this device is used in a product, the OEM has responsibility to verify compliance of the final product to the EU standards. A Declaration of Conformity must be issued and kept on file as described in the Radio and Telecommunications Terminal Equipment (R&TTE) Directive.

The 'CE' mark must be placed on the OEM product per the labeling requirements of the Directive.

Declaration of Conformity (DOC)

The DOC can be downloaded from the LSR Wiki.

BLUETOOTH CERTIFICATION

The SaBLE-x module has been certified as a Component (Tested) and has a QDID of 66911.

ANTENNA INFORMATION

LSR Dipole Antenna

See antenna datasheet.

LSR FlexPIFA

See antenna datasheet.

LSR FlexNotch

See antenna datasheet.

PCB Trace Antenna

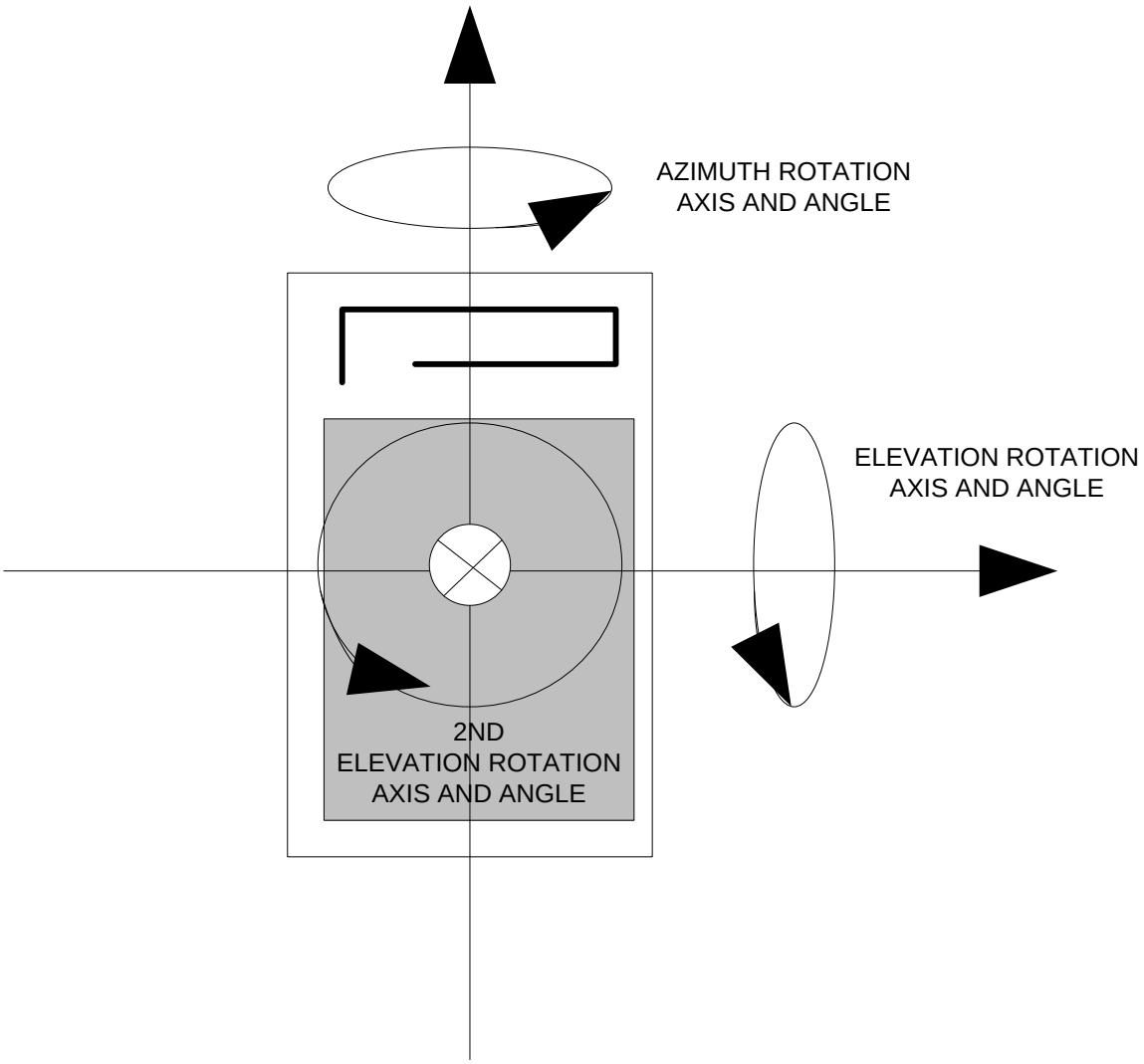


Figure 9 PCB Trace Antenna Pattern Measurement Planes

Orientation	Frequency (MHz)	Polarization	Peak Gain (dBi)	Average Gain(dBi)	Average Total Gain (P) (dBi)	Average Total Gain - (F,P) (dBi)	Average Total Gain - (O,F,P) (dBi)
Azimuth	2402	Vertical	0.0	-3.6	-3.5	-5.1	-6.5
Azimuth	2402	Horizontal	-6.6	-13.5			
Azimuth	2440	Vertical	-1.7	-5.1	-4.8		
Azimuth	2440	Horizontal	-1.7	-13.4			
Azimuth	2480	Vertical	-4.3	-7.9	-7.9		
Azimuth	2480	Horizontal	-11.5	-15.9			
Elevation	2402	Vertical	-7.3	-11.4	-5.6	-6.8	
Elevation	2402	Horizontal	-1.2	-5.7			
Elevation	2440	Vertical	-7.9	-12.6	-6.5		
Elevation	2440	Horizontal	-7.9	-6.6			
Elevation	2480	Vertical	-11.0	-15.9	-6.5		
Elevation	2480	Horizontal	-4.2	-9.1			
2nd Elevation	2402	Vertical	-7.3	-11.4	-7.2	-8.3	
2nd Elevation	2402	Horizontal	-1.2	-5.7			
2nd Elevation	2440	Vertical	-7.9	-12.6	-7.8		
2nd Elevation	2440	Horizontal	-7.9	-6.6			
2nd Elevation	2480	Vertical	-11.0	-15.9	-10.4		
2nd Elevation	2480	Horizontal	-4.2	-9.1			

Table 10 PCB Trace Antenna Gain Summary

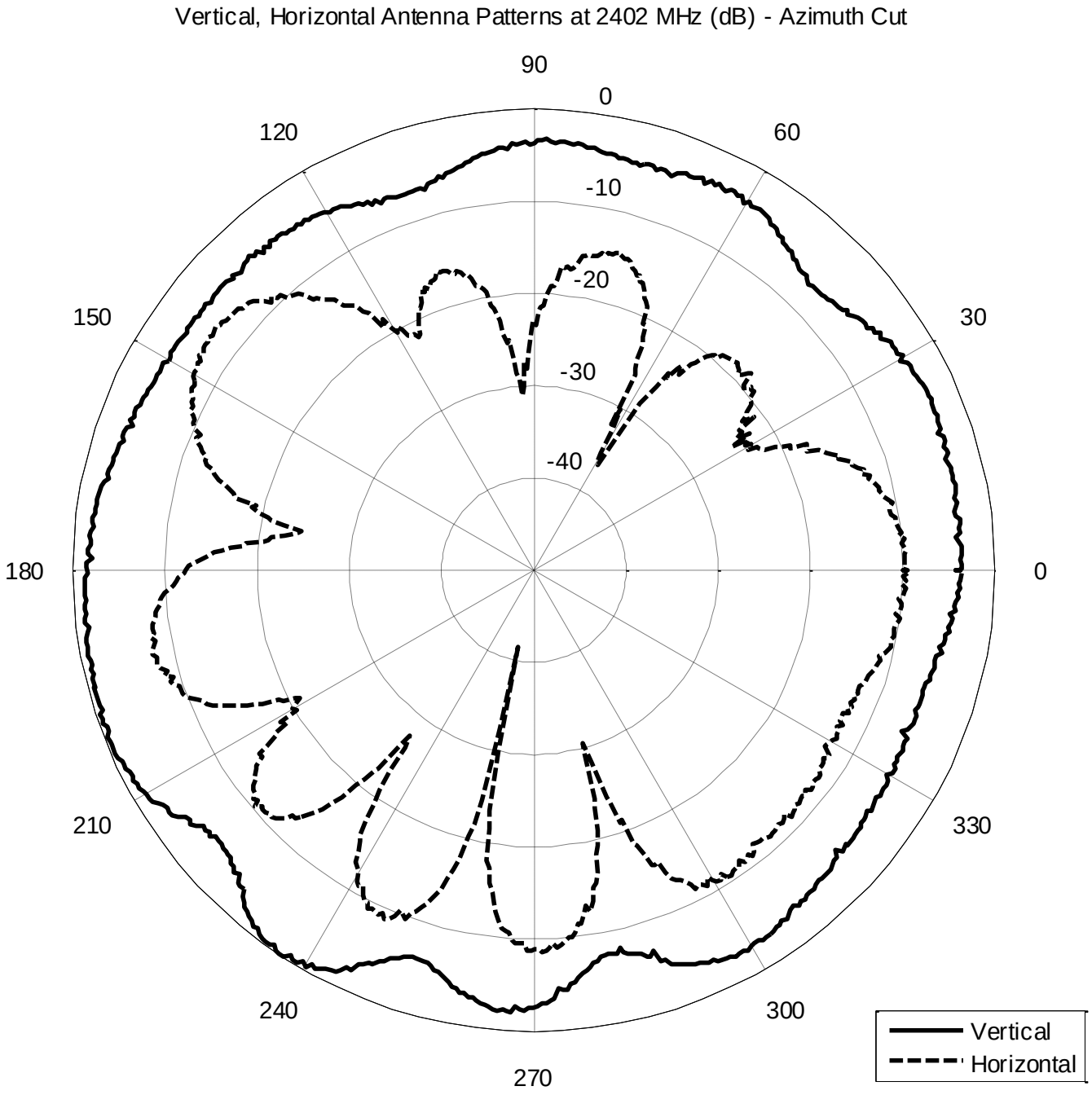


Figure 10 PCB Trace Antenna Pattern (Azimuth @ 2402 MHz)

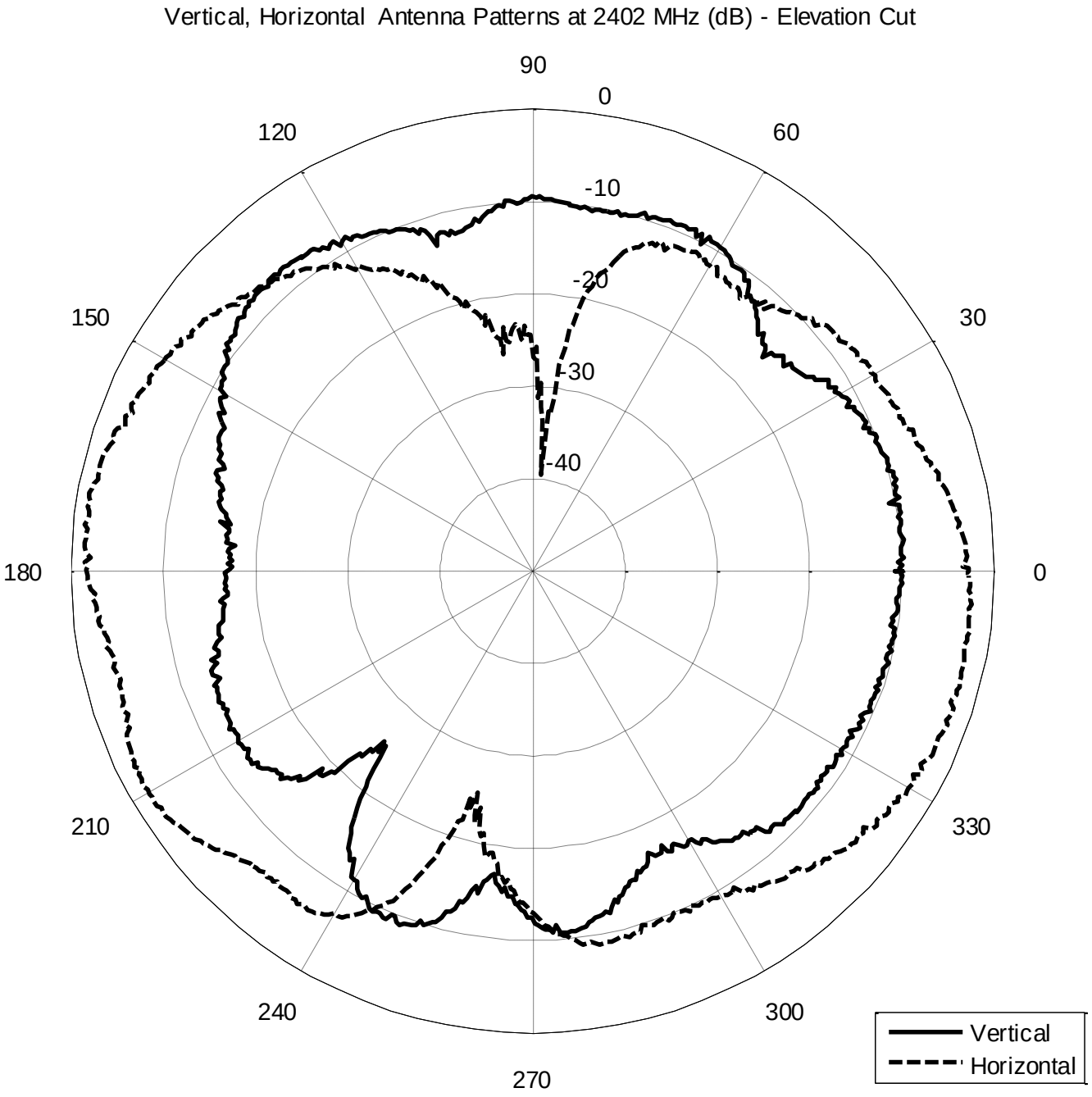


Figure 11 PCB Trace Antenna Pattern (Elevation @ 2402 MHz)

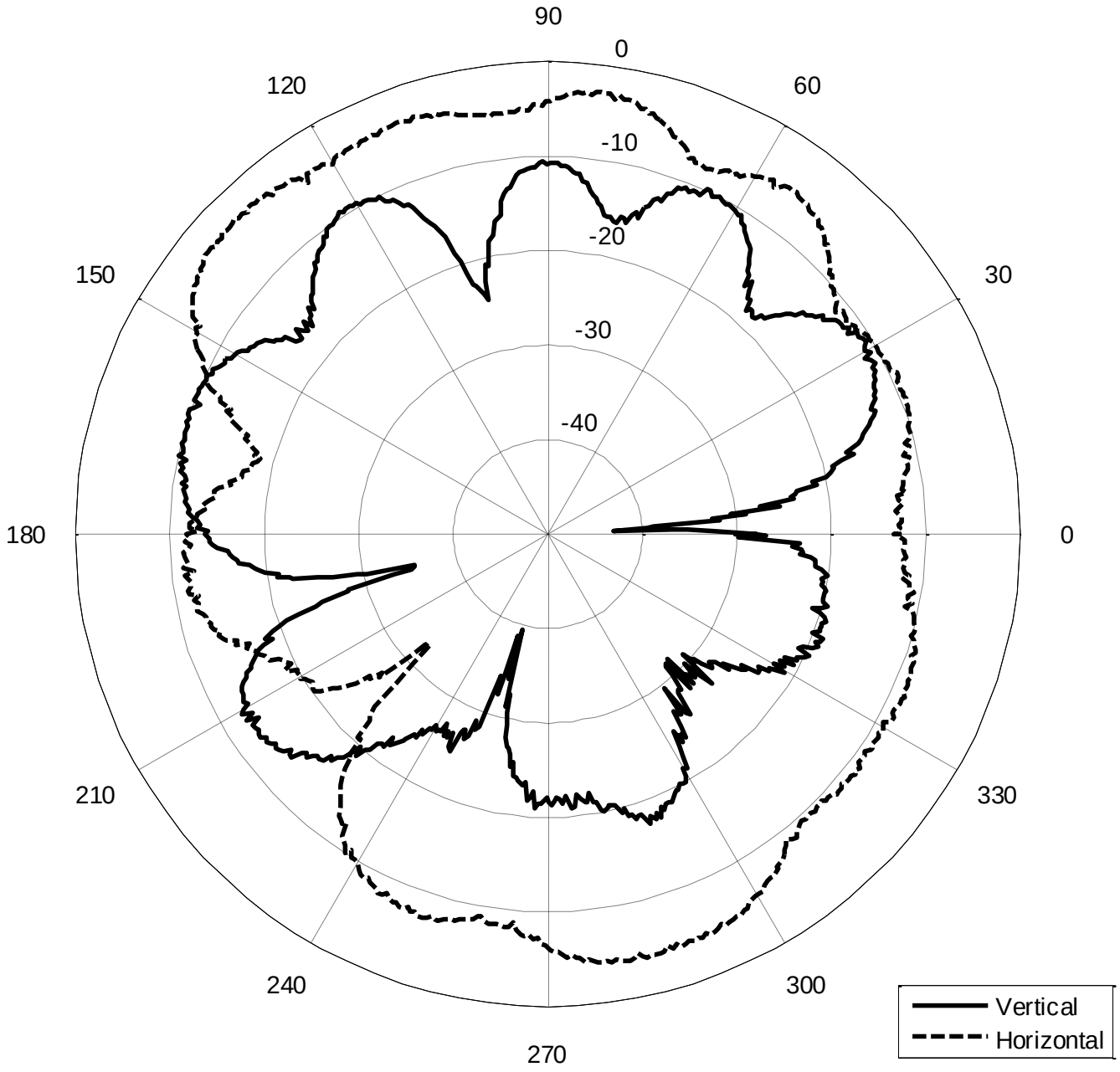


Figure 12 PCB Trace Antenna Pattern (2nd Elevation @ 2402 MHz)

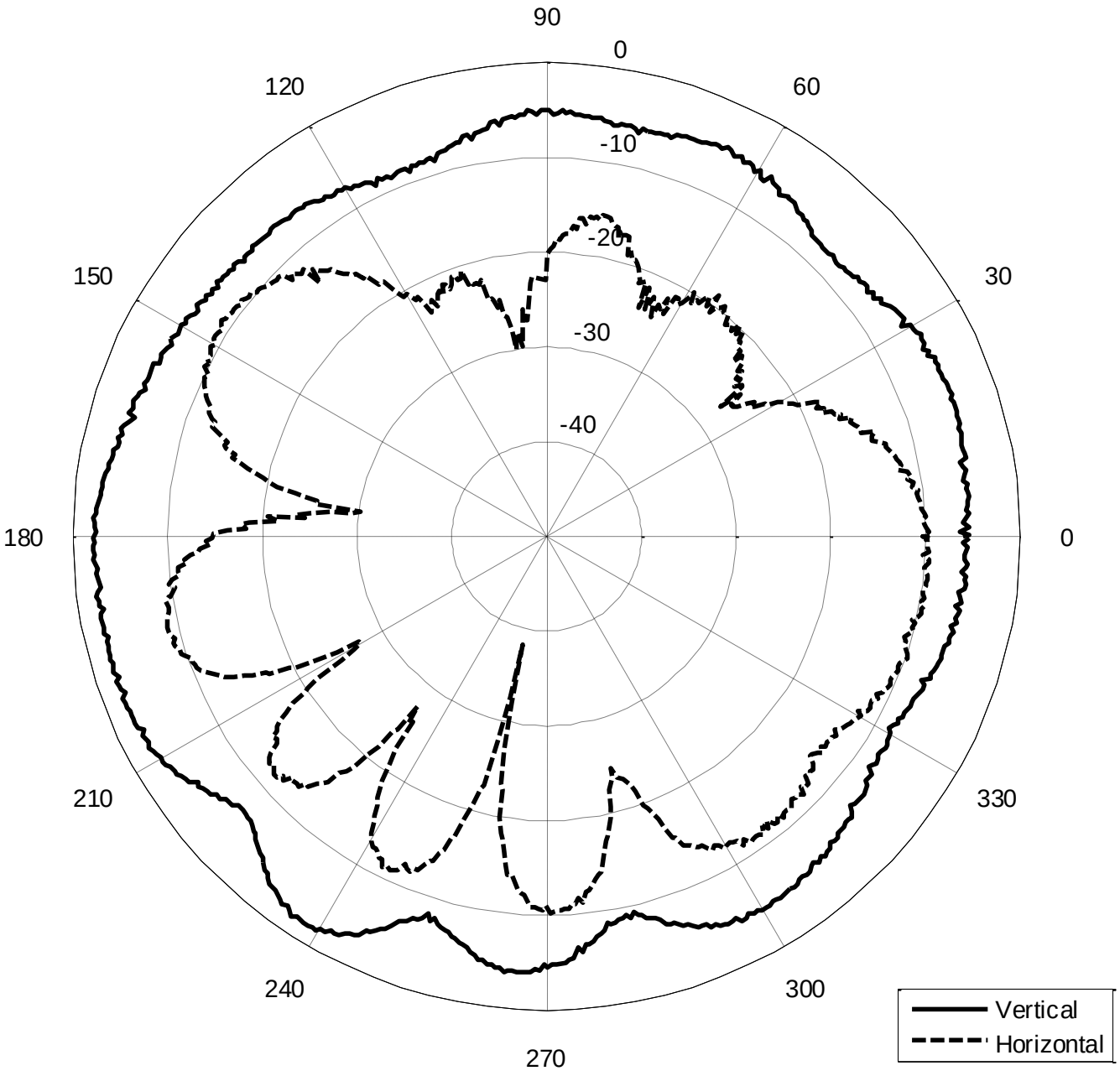


Figure 13 PCB Trace Antenna Pattern (Azimuth @ 2440 MHz)

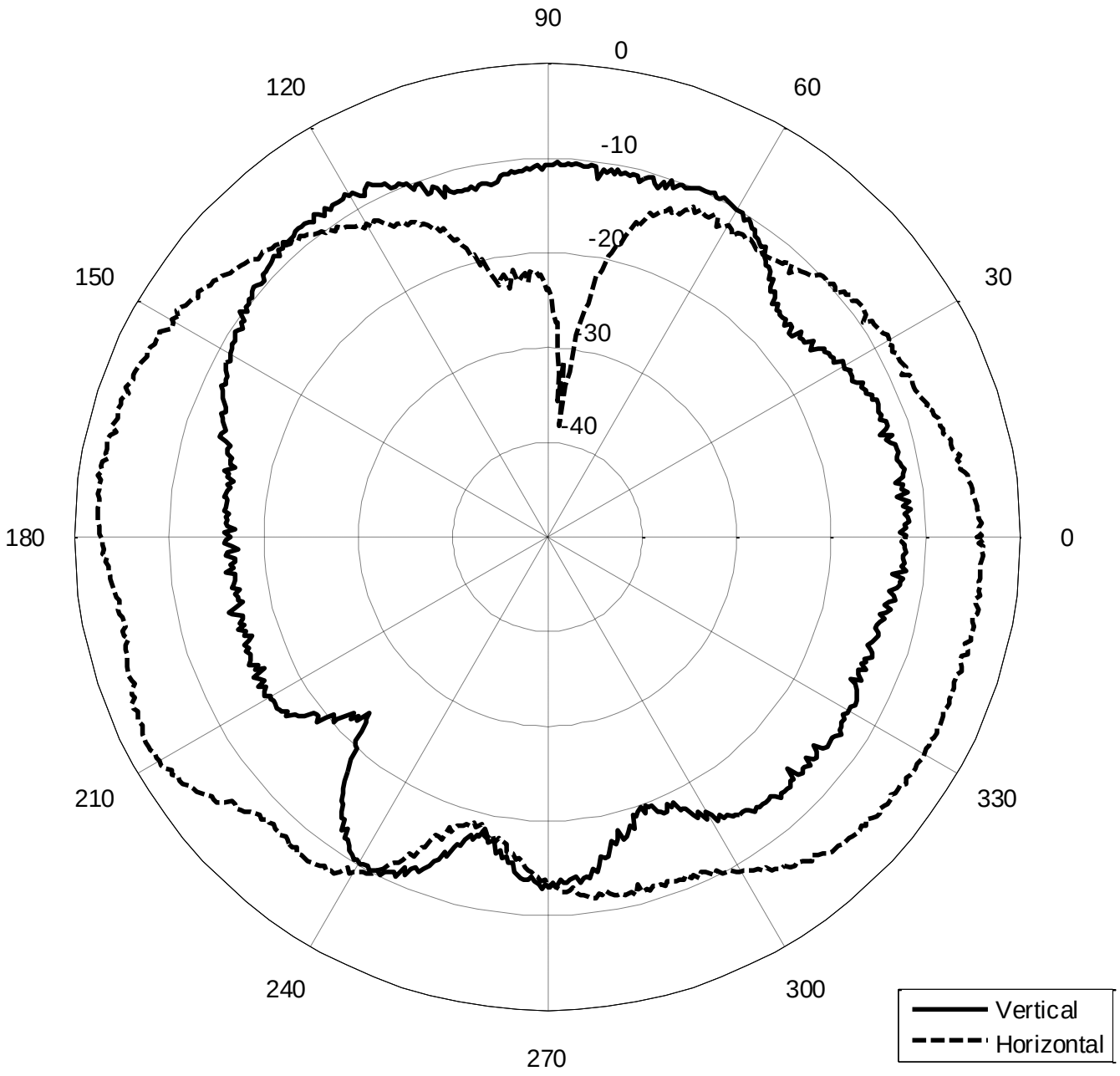


Figure 14 PCB Trace Antenna Pattern (Elevation **@ 2440 MHz)**

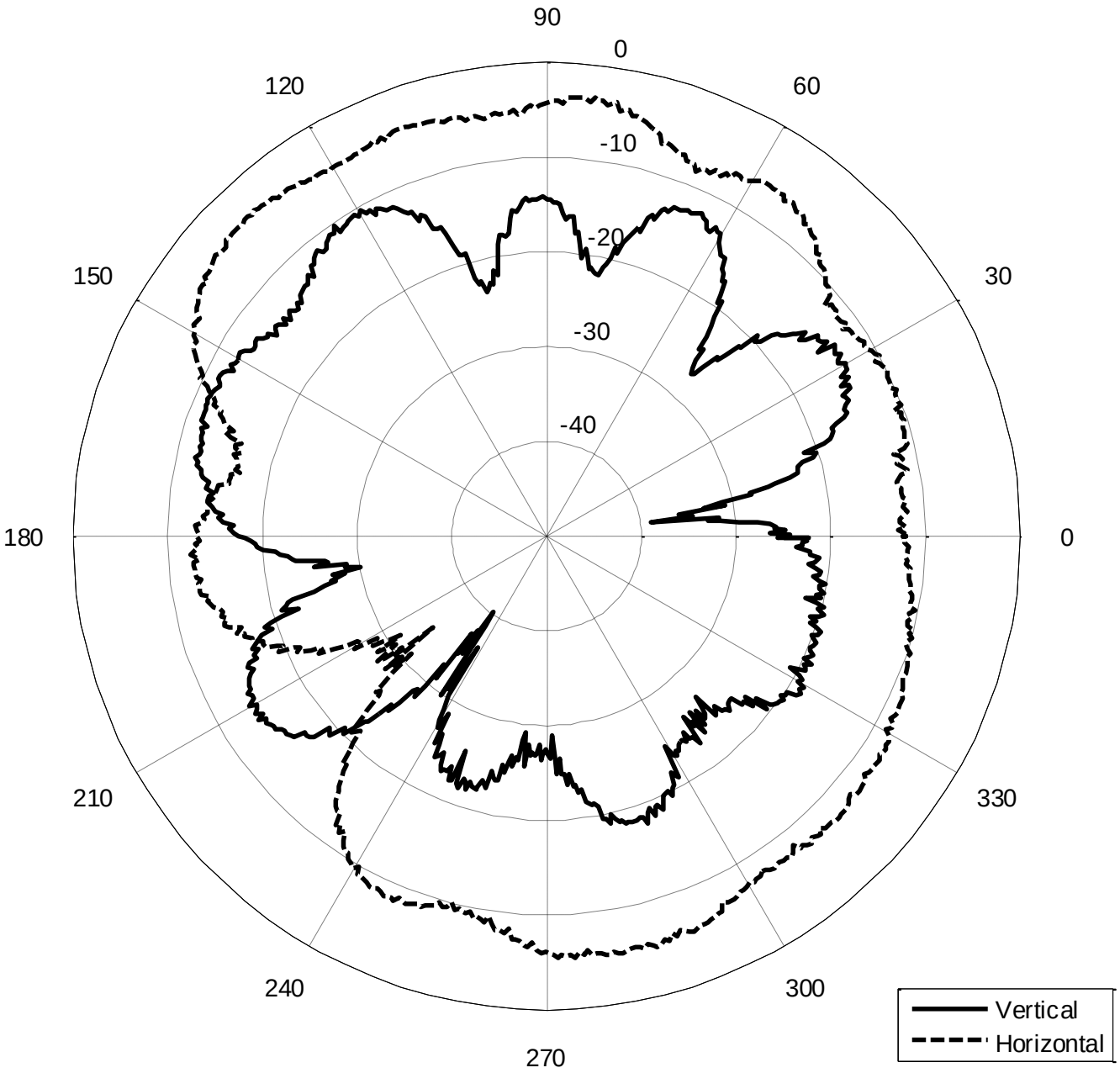


Figure 15 PCB Trace Antenna Pattern (2nd Elevation **@ 2440 MHz)**

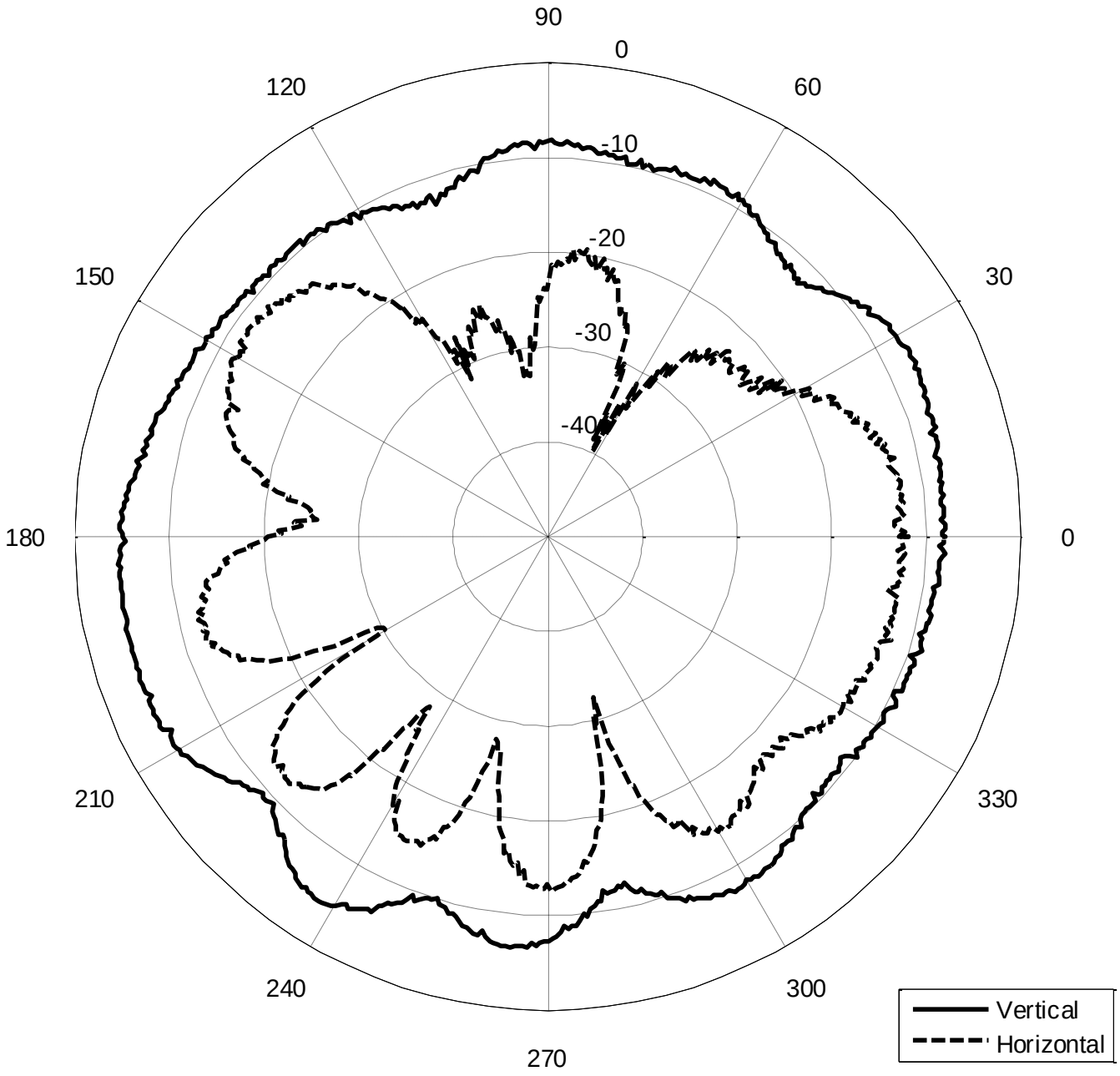


Figure 16 PCB Trace Antenna Pattern (Azimuth @ 2480 MHz)

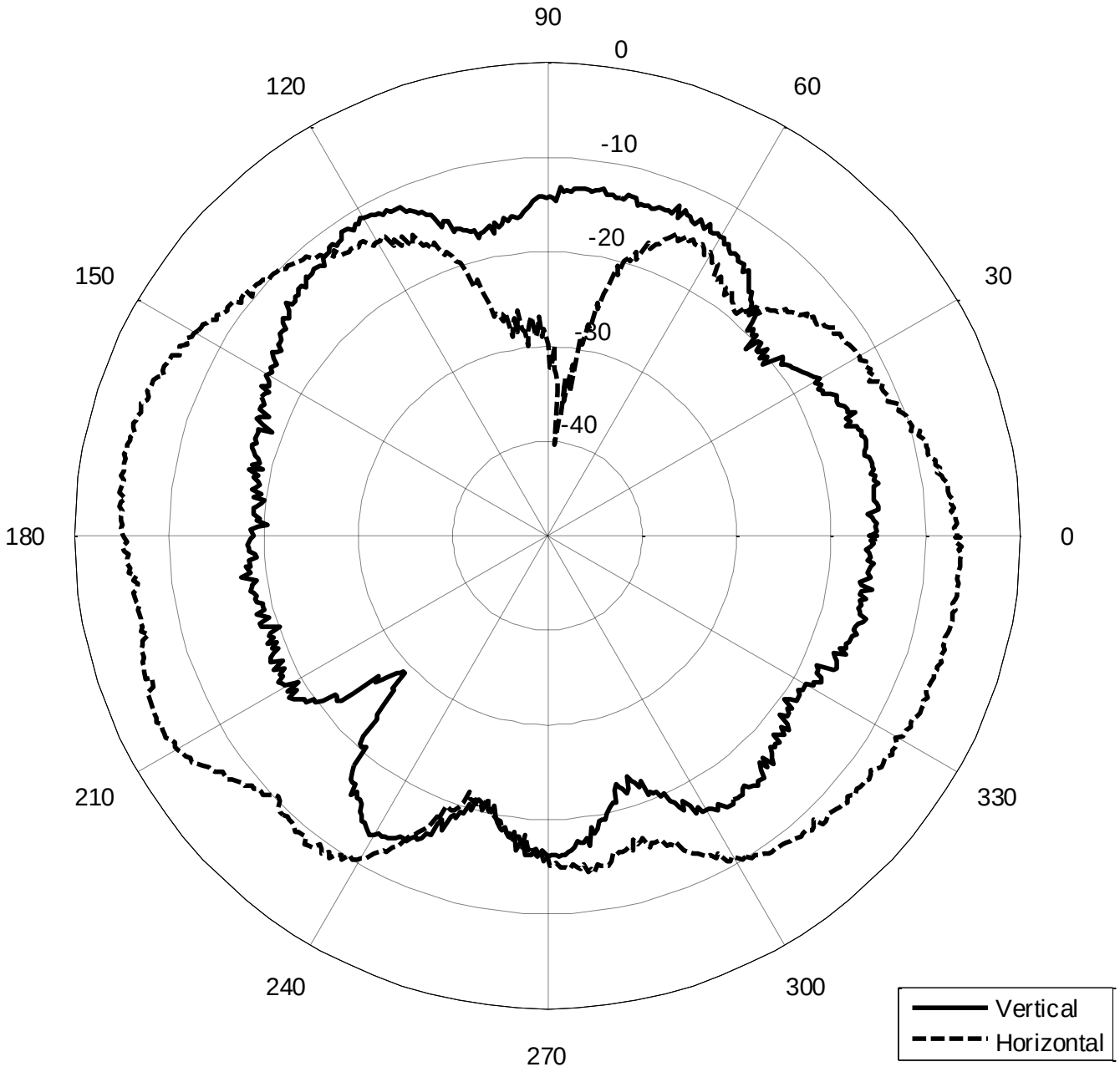


Figure 17 PCB Trace Antenna Pattern (Elevation **@ 2480 MHz)**

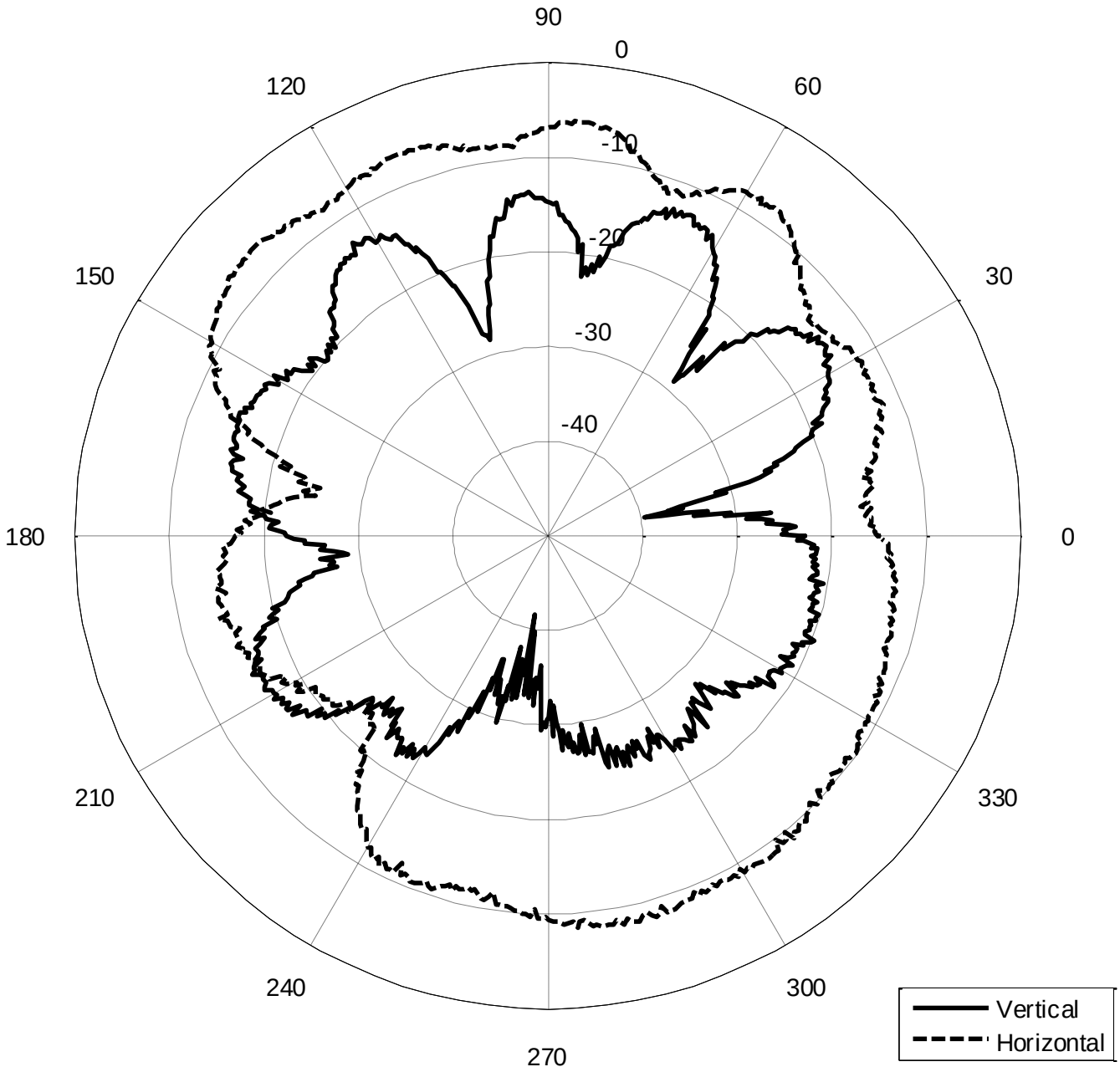


Figure 18 PCB Trace Antenna Pattern (2nd Elevation **@ 2480 MHz)**

MECHANICAL DATA

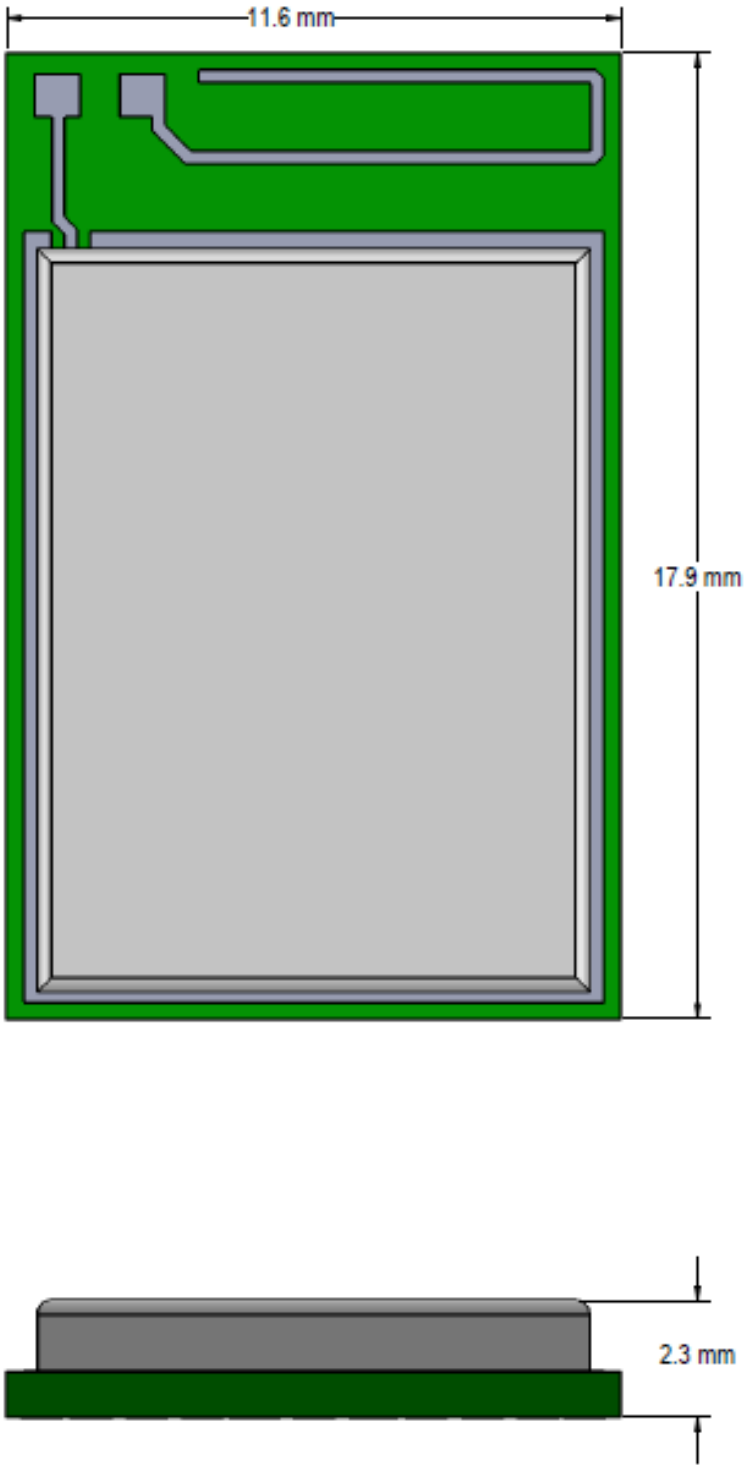


Figure 19 Module Mechanical Dimensions (Maximum Module Height = 2.4mm)

PCB FOOTPRINT

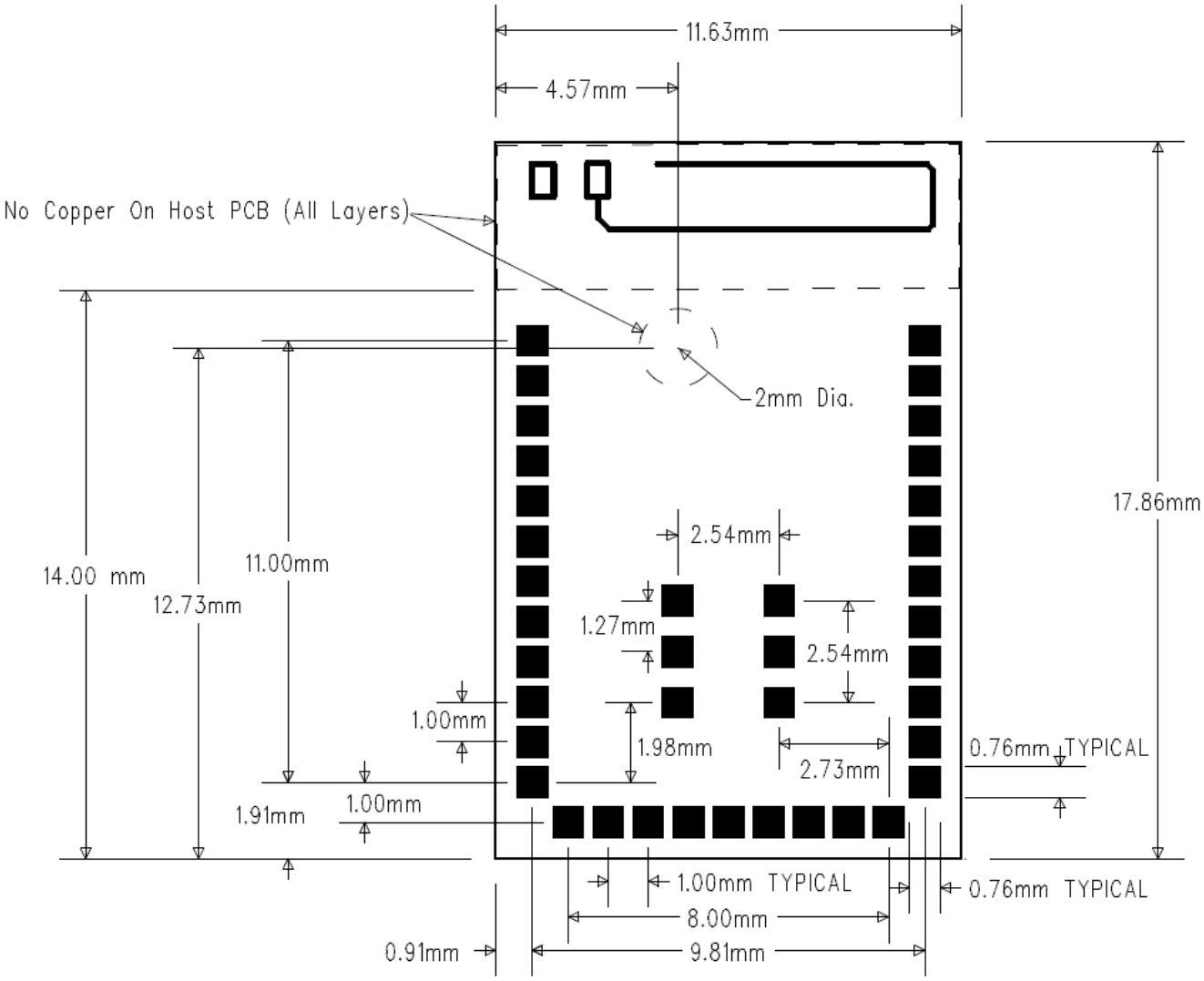
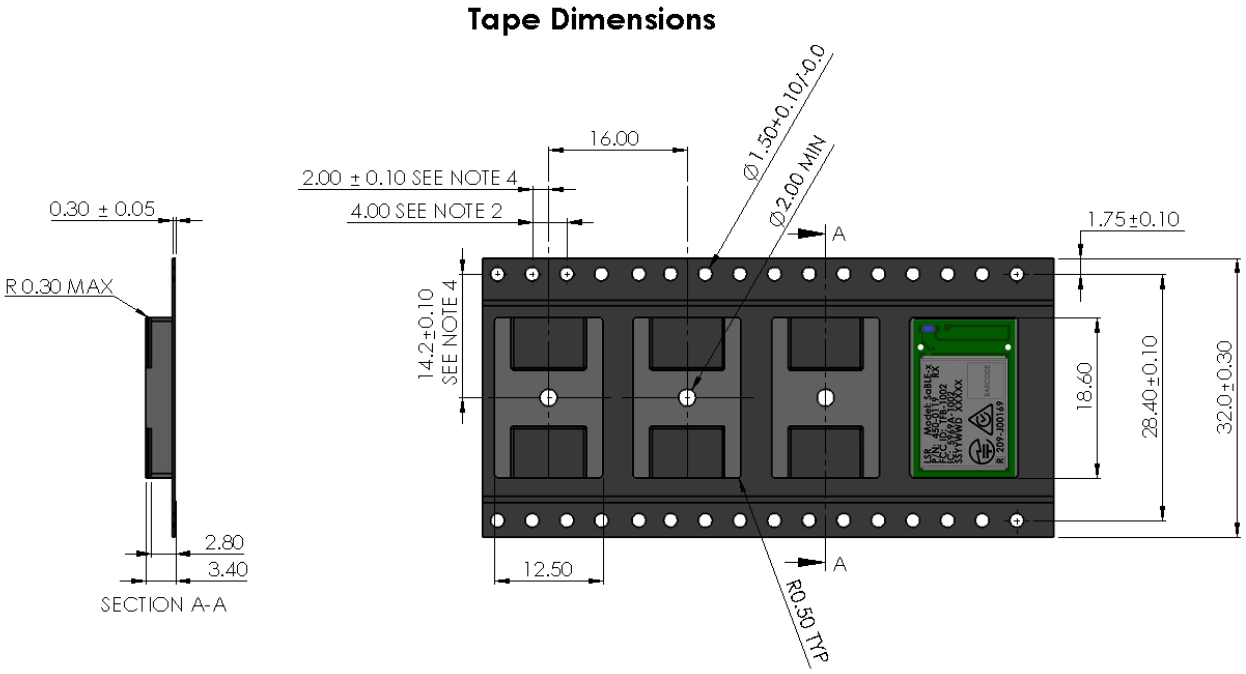


Figure 20 SaBLE-x Recommended PCB Footprint (Viewed from Top)

Tape & Reel Dimensions



NOTES:
1. DIM in mm.
2. 10 Sprocket Hole Pitch Cumulative Tolerance ± 0.2mm.
3. Camber in Compliance with EIA 481.
4. Pocket Position Relative to Sprocket Hole Measured as True Position of Pocket, not Pocket Hole
5. A Full Reel contains 1000 Modules

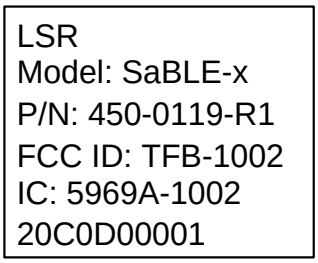
(Module Must Be in this Orientation when Feeding Tape)

Figure 21 Tape and Reel Specification

DEVICE MARKINGS

Rev 1 Devices

- Initial release.

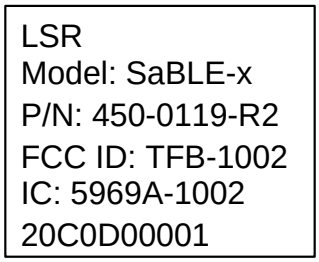


The shield on the 450-0119 / 450-0144 modules contains the following information:

- LSR Model: SaBLE-x
- Part Number and Revision:
  - Part Number: 450-0119 or 450-0144
  - Revision: -RX (where X is the latest revision)
- FCC ID: TFB-1002
- IC: 5969A-1002
- Manufacturer Information

Rev 2 Devices

- Updated component value based on updates to the CC2640 reference design.

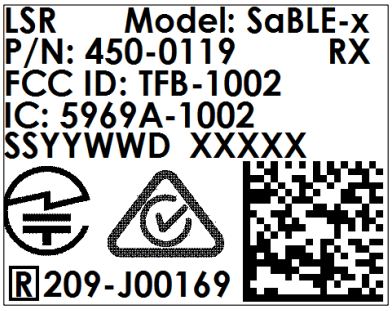


The shield on the 450-0119 / 450-0144 modules contains the following information:

- LSR Model: SaBLE-x
- Part Number and Revision:
  - Part Number: 450-0119 or 450-0144
  - Revision: -RX (where X is the latest revision)
- FCC ID: TFB-1002
- IC: 5969A-1002
- Manufacturer Information

Rev 3 Devices

- Updated the label to include Giteki and Australia/New Zealand EMC marking information.
- Updated the label to include a date code.



The shield on the 450-0119 / 450-0144 modules contains the following information:

- LSR Model: SaBLE-x
- Part Number and Revision:
  - Part Number: 450-0119 or 450-0144
  - Revision: -RX (where X is the latest revision)
- FCC ID: TFB-1002
- IC: 5969A-1002
- SSYYWWD = Date Code (YY=Year, WW=Week)
- XXXXX = Incremental Serial Number
- 2D Barcode Format is Data Matrix Standard

CONTACTING LSR

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