Test Report # 317212

Equipment Under Test:	X3 Pak Alert SE7
Test Date(s):	8/15/17, 8/17/27, 8/18/17, 8/21/17 – 8/25/17, & 8/29/17
Prepared for:	Tyco/ Scott Health and Safety Attn: Craig Parkulo 4320 Goldmine Road Monroe, NC 28110

Report Issued by: Coty Hammerer, EMC Engineer

Signature: Coty Hammerer Date: 10/9/17

Report Reviewed by: Adam Alger, Quality Systems Engineer

Signature: Date: 9/18/17

Report Constructed by: Coty Hammerer, EMC Engineer

Signature: Coty Hammerer Date: 9/13/17

CONTENTS

Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope
A2LA Certificate Number: 1255.01
Scope of accreditation includes all test methods listed herein, unless otherwise noted.

Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492

Government of Canada

Innovation, Science and Economic Development Canada

ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4
File Number: IC 3088A-2
File Number: IC 3088A-3

1 TEST REPORT SUMMARY

During **8/15/17, 8/17/17, 8/18/17, 8/21/17 – 8/25/17, & 8/29/17** the Equipment Under Test (EUT), **X3 Pak Alert SE7**, as provided by **Tyco/ Scott Health and Safety** was tested to the following requirements:

Requirement	Description	Specification	Method	Compliant
FCC: 15.247 (a)(2) IC: RSS-247 5.2 (1)	Digital Modulation System 6 dB bandwidth	500 kHz	ANSI C63.10	Yes
FCC: 2.1049 IC: RSS-GEN 6.6	Occupied Bandwidth	Reported	ANSI C63.10	Yes
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (4)	Maximum Conducted Output Power	30 dBm	ANSI C63.10	Yes
FCC: 15.247 (e) IC: RSS-247 5.2 (2)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	ANSI C63.10	Yes
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	ANSI C63.10	Yes
FCC: 15.247 (d) IC: RSS-GEN 8.10	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Yes
FCC: 2.1055 (d) IC: RSS-GEN 6.11	Frequency Stability	Reported	ANSI C63.10	Yes

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	Tyco/ Scott Health and Safety
Contact Person	Craig Parkulo
Address	4320 Goldmine Road Monroe, NC 28110

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	X3 Pak Alert SE7
Model Number	200451
Serial Number	Engineering Sample
Additional Information	802.15.4 Proprietary Radio is single channel only (2425 MHz)
FCC ID	TSE201160
IC ID	6453A-201160
HVIN	201160

2.2 Product Description

The SCOTT PAK-TRACKER Locator System is a two part electronic system consisting of a PAK-TRACKER Transmitter, which is integrated into the PAK- ALERT SE + distress alarm, and a PAK-TRACKER Hand Held Receiver, which is a directional receiver or “sniffer” used to locate the signal coming from the PAK-TRACKER Transmitter.

The PAK-TRACKER Transmitter works in conjunction with the PAK-ALERT SE + distress alarm. A short time after activation of the full alarm, the unit begins transmitting a signal with a unique ID number that can be received by the PAK-TRACKER Hand Held Receiver.

The PAK-TRACKER Hand Held Receiver is then used as a directional sensor to lead the rescue crew to the downed user. By pointing the PAK-TRACKER Hand Held Receiver in the direction of the strongest signal, the rescue crew can follow the signal to the downed user.

A BLE radio transceiver is provided as a tunnel for accessing stored data concerning PAK operation.

2.3 Modifications Incorporated for Compliance

None noted at time of test

2.4 Deviations and Exclusions from Test Specifications

None noted at time of test

2.5 Additional Information

The EUT was powered via 6 (AA) batteries. The BLE Radio was tested at low, mid, and high channels: 2402, 2440, and 2480 MHz. The 802.15.4 Radio only operates on one channel (2425 MHz). The Radios were programmed via Android device using the Nordic Semiconductor nRF Connect Version 4.10. For Radiated measurements the EUT was tested in 3 orientations.

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15.247	-	2017
RSS-247	2	2017
CFR 47 Part 15.209	-	2017
ICES-003	6	2013
ANSI C63.10	-	2017
RSS-GEN	4	2014
FCC KDB 558074 D01 DTS Meas. Guidance V04	-	2017

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

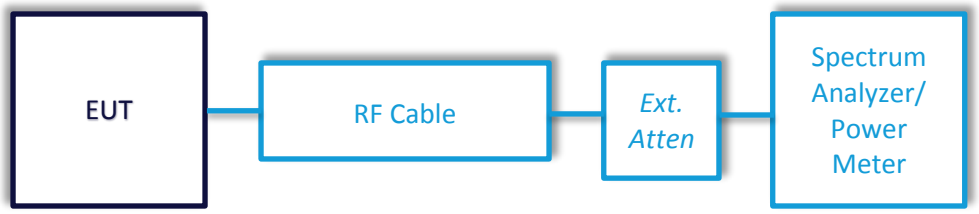
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



5.1.1 Antenna Port Conducted Emissions – Peak Output Power

Operator	Khairul Aidi Zainal
QA	Coty Hammerer
Test Date	8/25/17 & 8/29/17
Location	Conducted Measurement Area
Temp. / R.H.	72F/ 53%
Requirement	CFR 47 Part 15.247 (b) (3)
Method	FCC KDB 558074 D01 DTS Meas. Guidance V04, Section 9.1.1

Limits:

Frequency (MHz)	Limit (dBm)
2402	30
2425	30
2440	30
2480	30

Test Parameters

Frequency	2402, 2425, 2440, 2480 MHz
Settings	BLE: RBW=1 MHz, VBW=3 MHz, Span =3 MHz 802.15.4: RBW=3 MHz, VBW= 8 MHz, Span=10 MHz
EUT	Powered via bench top power supply at 3.3VDC
EUT	Programmed with Android Phone
EUT	Modulated Output, 1 Mbps data rate for BLE

Instrumentation

Laird
Smart Technology. Delivered.

Date: 25-Aug-2017 Test: Conducted Measurements Job #: C-2791

PE: Coty Hammerer Customer: Tyco/Scott Health and Safety Quote #: 317212

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002	218652-001	6/29/2016	9/22/2017	Active Verification
3	EE 960054	Multimeter	HP	971A	JP40011152	1/5/2017	1/5/2018	Active Calibration
4	EE 960169	DC Power Supply	Tenma	72-8350A	MG371512549	7/12/2016	10/5/2017	Active Verification

Tested By: Khairul Aidi Zainal Quality Assurance: Coty Hammerer

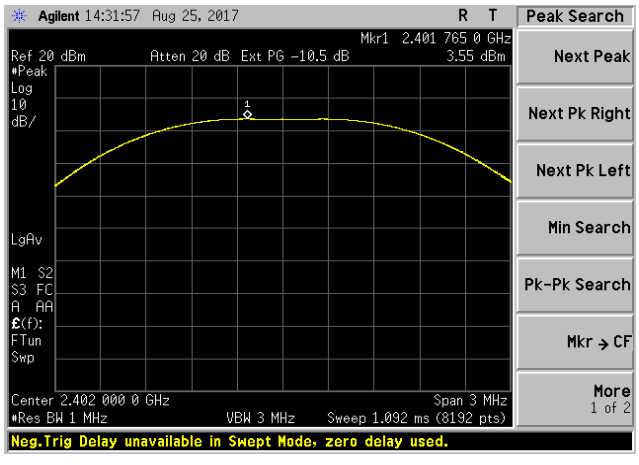
Table - BLE

1MBPS				
Channel	Frequency (MHz)	Peak Output power (dBm)	Limit (dBm)	Margin (dB)
Lowest	2402.0	3.6	30.0	26.5
Middle	2440.0	3.8	30.0	26.3
Highest	2480.0	3.6	30.0	26.4

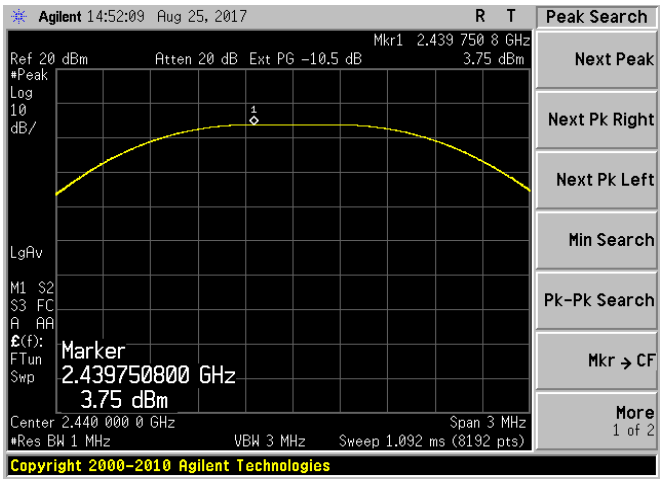
Table – 802.15.4

Frequency (MHz)	Peak Output power (dBm)	Limit (dBm)	Margin (dB)
2425.0	19.0	30.0	11.0

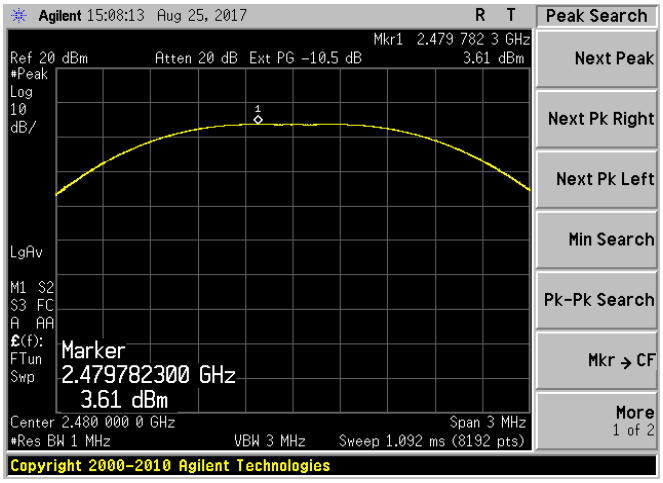
Plots - BLE



2402 MHz

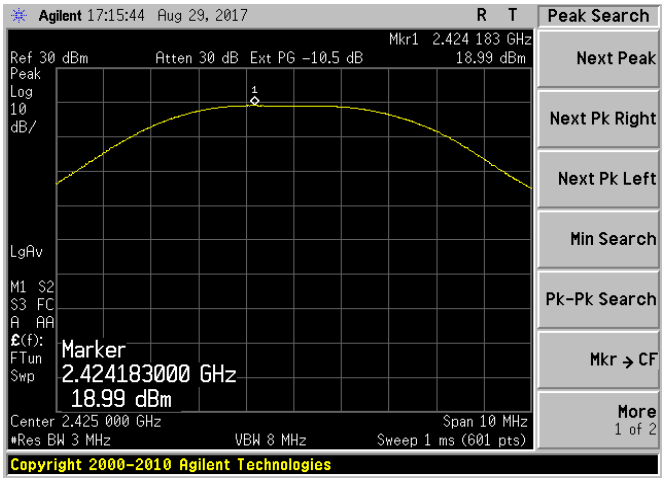


2440 MHz



2480 MHz

Plots – 802.15.4



2425 MHz

5.1.2 Antenna Port Conducted Emissions – DTS BW and 99% BW

Operator	Khairul Aidi Zainal
QA	Coty Hammerer
Test Date	8/25/17 & 8/29/17
Location	Conducted Measurement Area
Temp. / R.H.	72F/ 53%
Requirement	CFR 47 Part 15.247 (a) (2)
Method	FCC KDB 558074 D01 DTS Meas. Guidance V04, Section 8.2 (option 2), ANSI C63.10 section 6.9.3

Limits – DTS BW

Frequency (MHz)	Limit (MHz)
2402	0.5
2425	0.5
2440	0.5
2480	0.5

Test Parameters

Frequency	2402, 2425, 2440, 2480 MHz
Settings	BLE: RBW=100 kHz, VBW=300 kHz, Span =2 MHz 802.15.4: RBW=100 kHz, VBW=300 kHz, Span=5 MHz
EUT	Powered via bench top power supply at 3.3VDC
EUT	Programmed with Android Phone
EUT	Modulated Output, 1 Mbps data rate for BLE

Instrumentation

Laird
Smart Technology. Delivered.

Date : 25-Aug-2017 Test : Conducted Measurements Job # : C-2791

PE: Coty Hammerer Customer : Tyco/Scott Health and Safety Quote #: 317212

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002	218652-001	6/29/2016	9/22/2017	Active Verification
3	EE 960054	Multimeter	HP	971A	JP40011152	1/5/2017	1/5/2018	Active Calibration
4	EE 960169	DC Power Supply	Tenma	72-8350A	MG371512549	7/12/2016	10/5/2017	Active Verification

Tested By: Khairul Aidi Zainal Quality Assurance: Coty Hammerer

Table – BLE

Channel	Frequency (MHz)	DTS Bandwidth (MHz)	Limit (MHz)	Margin (MHz)
Lowest	2402.0	0.71	0.50	0.21
Middle	2440	0.68	0.50	0.18
Highest	2480.0	0.70	0.50	0.20

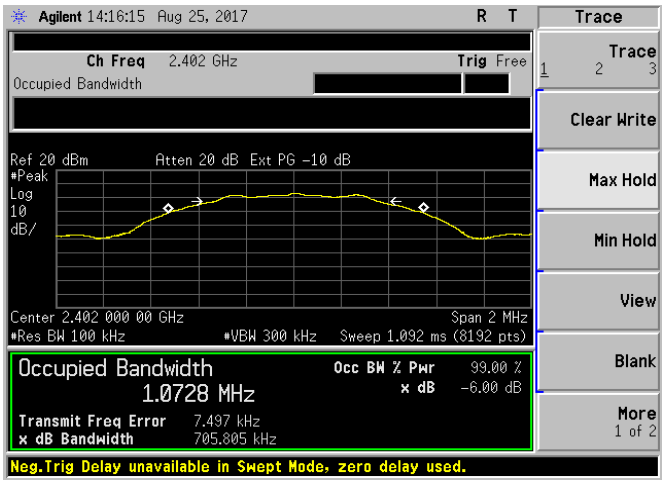
Channel	Frequency (MHz)	99% Bandwidth (MHz)
Lowest	2402.0	1.06
Middle	2440.0	1.10
Highest	2480.0	1.05

Table – 802.15.4

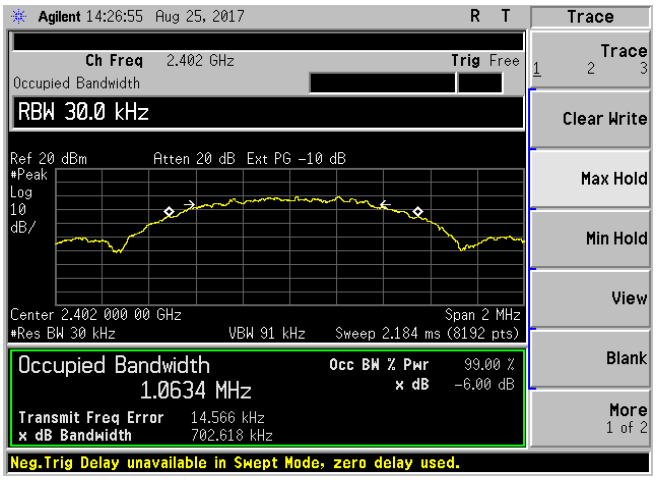
Frequency (MHz)	DTS Bandwidth (MHz)	Limit (MHz)	Margin (MHz)
2425.0	1.63	0.50	1.13

Frequency (MHz)	99% Bandwidth (MHz)
2425.0	2.57

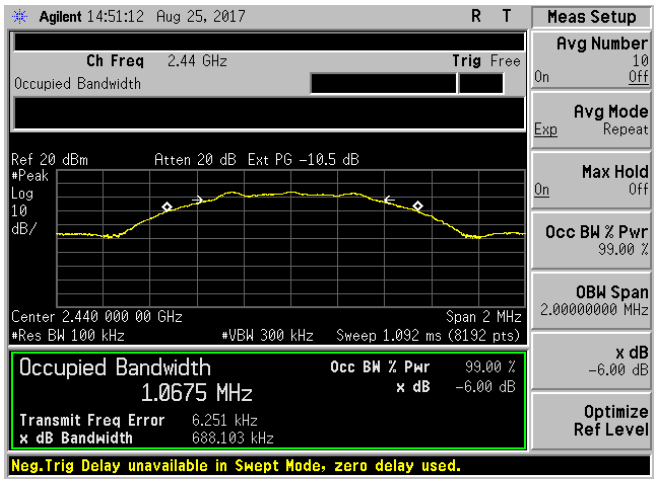
Plots - BLE



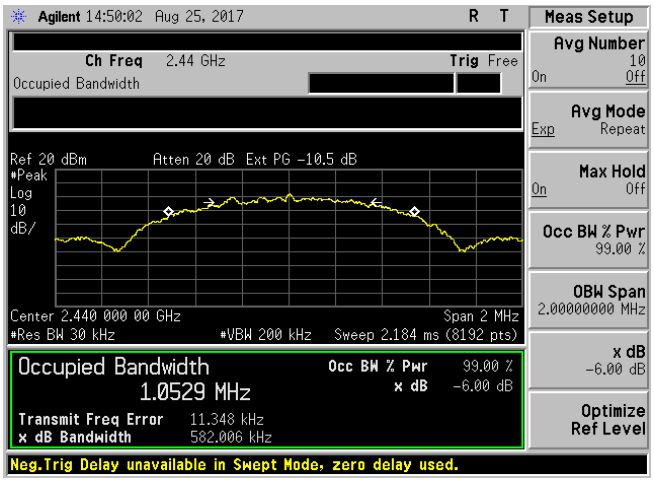
2402 MHz, DTS BW



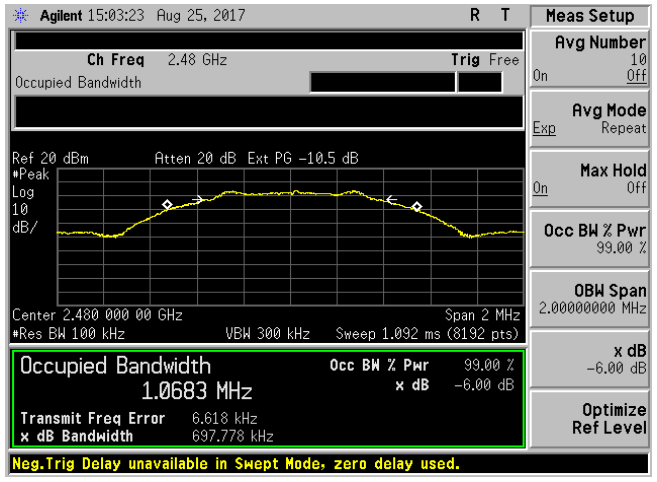
2402 MHz, 99% BW



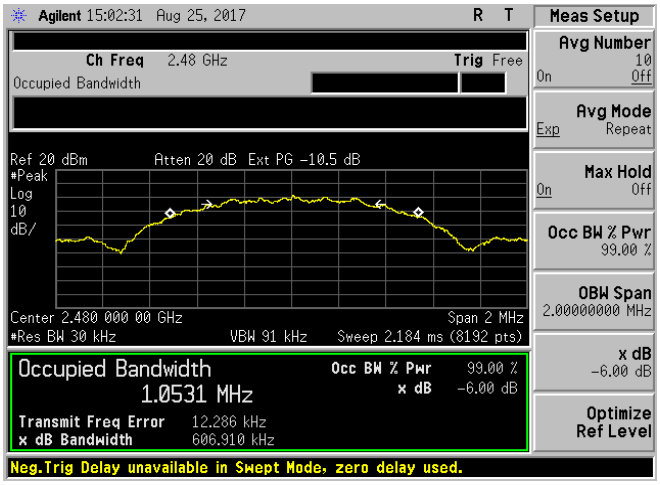
2440 MHz, DTS BW



2440 MHz, 99% BW

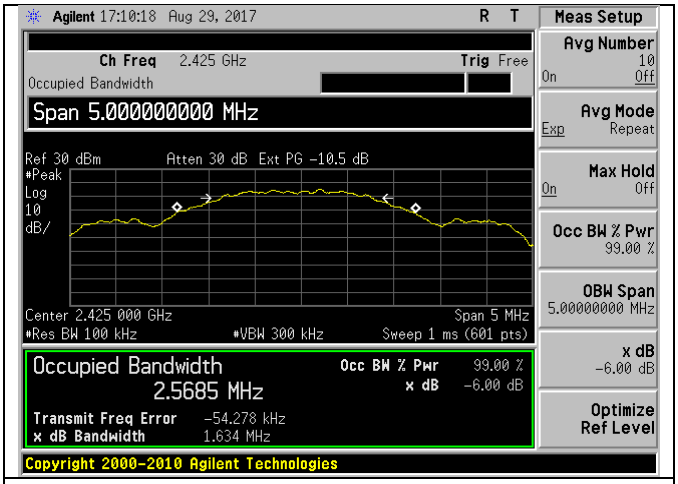


2480 MHz, DTS BW



2480 MHz, 99% BW

Plots – 802.15.4



2425 MHz, DTS BW & 99% BW

5.1.3 Antenna Port Conducted Emissions – Power Spectral Density

Operator	Khairul Aidi Zainal
QA	Coty Hammerer
Test Date	8/25/17 & 8/29/17
Location	Conducted Measurement Area
Temp. / R.H.	72F/ 53%
Requirement	CFR 47 Part 15.247 (b) (3)
Method	FCC KDB 558074 D01 DTS Meas. Guidance V04, Section 10.2

Limits:

Frequency (MHz)	Limit (dBm)
2402	8
2425	8
2440	8
2480	8

Test Parameters

Frequency	2402, 2425, 2440, 2480 MHz
Settings	BLE: RBW=100 kHz, VBW=300 kHz, Span =1.5 times the DTS BW 802.15.4: RBW=3 kHz, VBW= 9.1 kHz, Span =1.5 times the DTS BW
EUT	Powered via bench top power supply at 3.3VDC
EUT	Programmed with Android Phone
EUT	Modulated Output, 1 Mbps data rate for BLE

Instrumentation

Laird
Smart Technology. Delivered.

Date: 25-Aug-2017 Test: Conducted Measurements Job #: C-2791

PE: Coty Hammerer Customer: Tyco/Scott Health and Safety Quote #: 317212

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002	218652-001	6/29/2016	9/22/2017	Active Verification
3	EE 960054	Multimeter	HP	971A	JP40011152	1/5/2017	1/5/2018	Active Calibration
4	EE 960169	DC Power Supply	Tenma	72-8350A	MG371512549	7/12/2016	10/5/2017	Active Verification

Tested By: Khairul Aidi Zainal Quality Assurance: Coty Hammerer

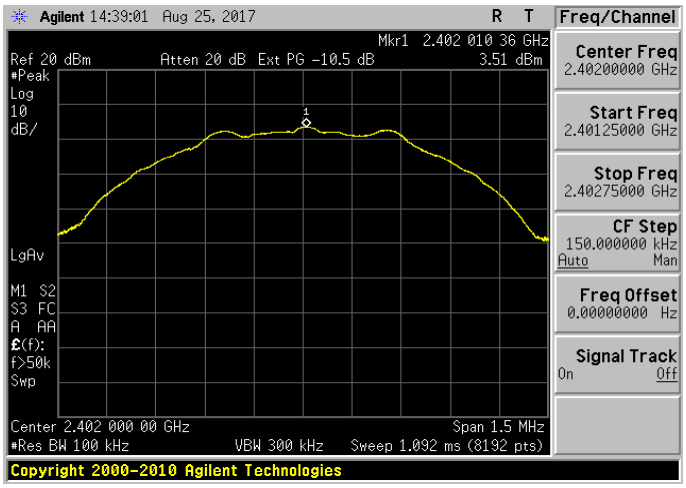
Table – BLE

Channel	Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
Lowest	2402.0	3.5	8.0	4.5
Middle	2440.0	3.6	8.0	4.4
Highest	2480.0	3.5	8.0	4.5

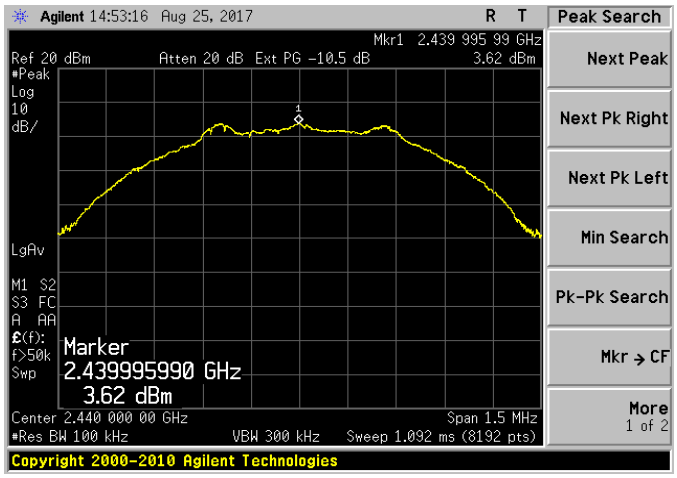
Table – 802.15.4

Frequency (MHz)	PSD (dBm)	Limit (dBm)	Margin (dB)
2425.0	3.2	8.0	4.8

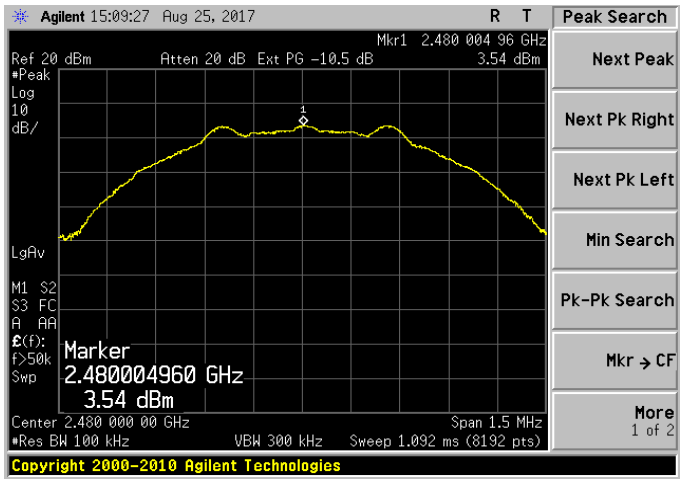
Plots - BLE



2402 MHz

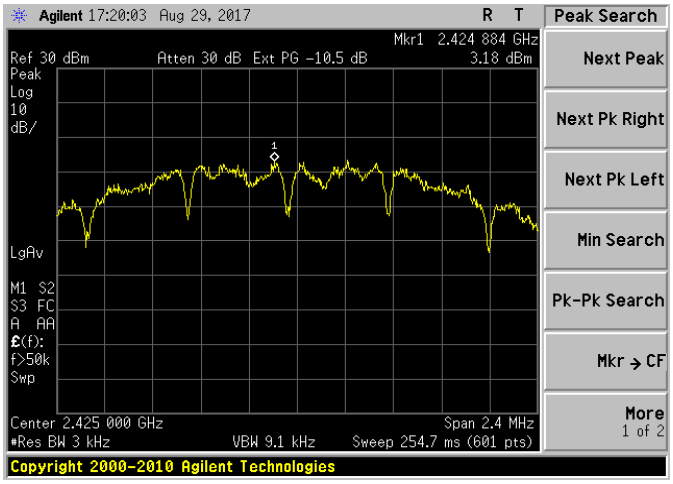


2440 MHz



2480 MHz

Plots – 802.15.4



2425 MHz

5.1.4 Antenna Port Conducted Emissions – Band-Edges

Operator	Khairul Aidi Zainal
QA	Coty Hammerer
Test Date	8/25/17 & 8/29/17
Location	Conducted Measurement Area
Temp. / R.H.	72F/ 53%
Requirement	CFR 47 Part 15.247 (a) (2)
Method	FCC KDB 558074 D01 DTS Meas. Guidance V04, Section 11

Limits – DTS BW

Frequency (MHz)	Limit (MHz)
2402	≥20 dBc
2425	≥20 dBc
2480	≥20 dBc

Test Parameters

Frequency	2400 – 2402 MHz LBE, 2480 to 2483.5 MHz UBE for BLE
Settings	BLE: RBW=100 kHz, VBW=300 kHz, Span =2 MHz 802.15.4: RBW=100 kHz, VBW=300 kHz, Span=5 MHz
EUT	Powered via bench top power supply at 3.3VDC
EUT	Programmed with Android Phone
EUT	Modulated Output, 1 Mbps data rate for BLE
Notes	Need ≥ 20 dBc between Fundamental and Operating Band min and max frequencies

Instrumentation

Laird
Smart Technology. Delivered.

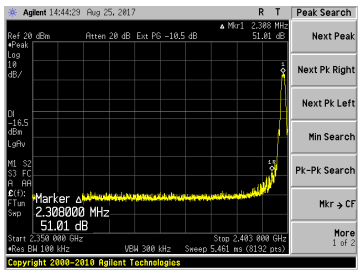
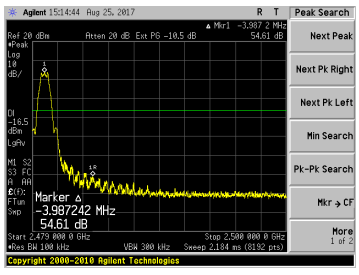
Date: 25-Aug-2017 Test: Conducted Measurements Job #: C-2791

PE: Coty Hammerer Customer: Tyco/Scott Health and Safety Quote #: 317212

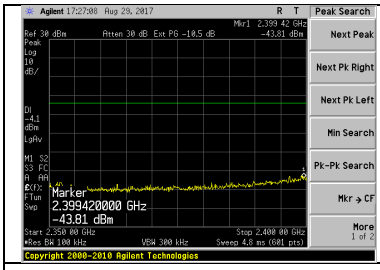
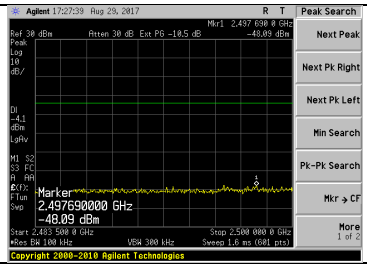
No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002	218652-001	8/29/2016	9/22/2017	Active Verification
3	EE 960054	Multimeter	HP	971A	JP40011152	1/5/2017	1/5/2018	Active Calibration
4	EE 960169	DC Power Supply	Tenma	72-8350A	MG371512549	7/12/2016	10/5/2017	Active Verification

Tested By: Khairul Aidi Zainal Quality Assurance: Coty Hammerer

Plots - BLE

	
LBE	UBE

Plots -802.15.4

	
LBE	UBE

Note: the 802.15.4 Reference Level is 15.94 dBm (Refer to Page 25). Therefore Taking 15.94 dBm - 43.81dBm for the LBE plot above the > 20 dBc margin is met with a result of 59.75 dBc. For the UBE the margin is 64.03 dBc. The >20 dBc margin is met.

5.1.5 Antenna Port Conducted Emissions – Conducted Spurious in 100 kHz BW

Operator	Khairul Aidi Zainal
QA	Coty Hammerer
Test Date	8/25/17 & 8/29/17
Location	Conducted Measurement Area
Temp. / R.H.	72F/ 53%
Requirement	CFR 47 Part 15.247 (d)
Method	FCC KDB 558074 D01 DTS Meas. Guidance V04, Section 11

Limits:

Frequency (MHz)	Limit (dBm)
2402	-16.5
2425	-4.1
2440	-16.4
2480	-16.5

Test Parameters

Frequency	2402, 2425, 2440, 2480 MHz
Settings	BLE: RBW=100 kHz, VBW=300 kHz 802.15.4: RBW=100 kHz, VBW= 300 kHz
EUT	Powered via bench top power supply at 3.3VDC
EUT	Programmed with Android Phone
EUT	Modulated Output, 1 Mbps data rate for BLE
Notes	All emissions >20 dBc from limit lines at all frequencies tested

Instrumentation

Laird
Smart Technology. Delivered.

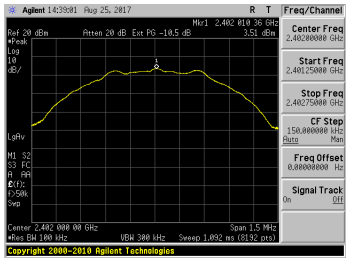
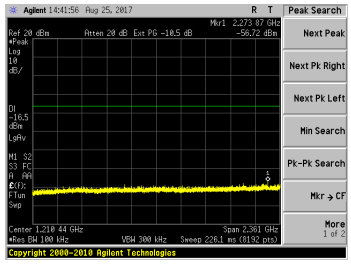
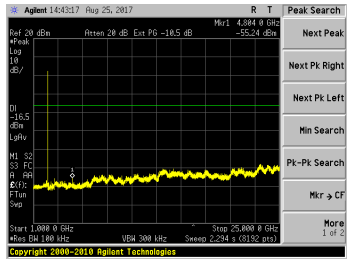
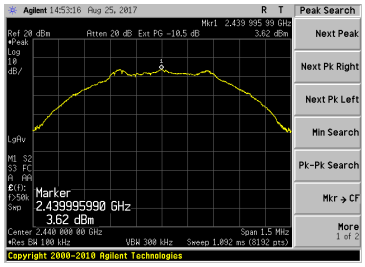
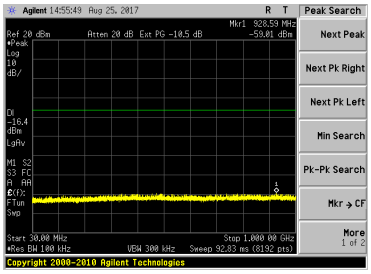
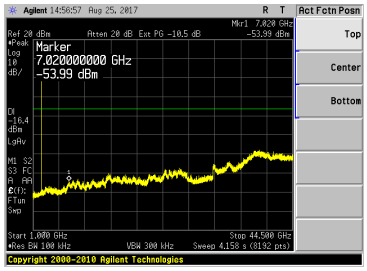
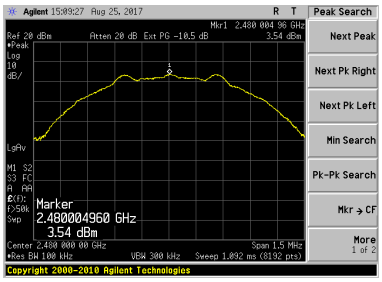
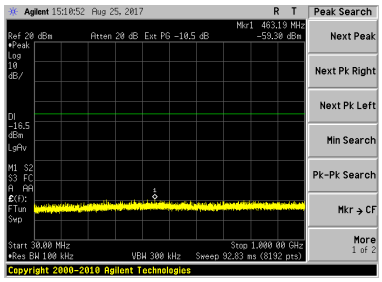
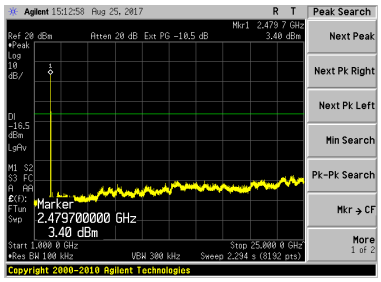
Date : 25-Aug-2017 Test : Conducted Measurements Job # : C-2791

PE: Coty Hammerer Customer : Tyco/Scott Health and Safety Quote #: 317212

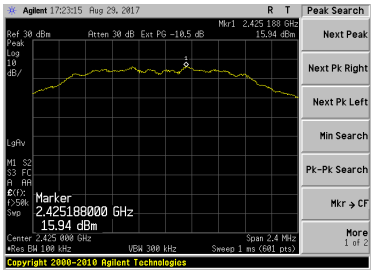
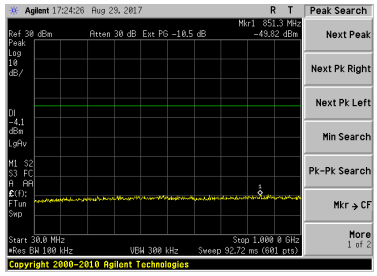
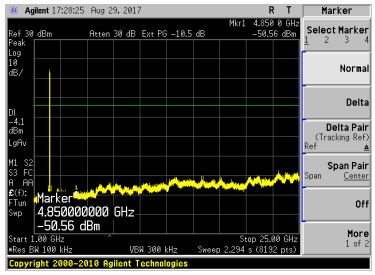
No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002	218652-001	6/29/2016	9/22/2017	Active Verification
3	EE 960054	Multimeter	HP	971A	JP40011152	1/5/2017	1/5/2018	Active Calibration
4	EE 960169	DC Power Supply	Tenma	72-8350A	MG371512549	7/12/2016	10/5/2017	Active Verification

Tested By: Khairul Aidi Zainal Quality Assurance: Coty Hammerer

Plots - BLE

		
Reference Level, Low Ch.	30 MHz – 1 GHz, Low Ch.	1 GHz – 25 GHz, Low Ch.
		
Reference Level, Mid Ch.	30 MHz – 1 GHz, Mid Ch.	1 GHz – 25 GHz, Mid Ch.
		
Reference Level, High Ch.	30 MHz – 1 GHz, High Ch.	1 GHz – 25 GHz, High Ch.

Plots – 802.15.4 – 2425 MHz

		
Reference Level	30 MHz – 1 GHz	1 GHz – 25 GHz

5.1.6 Antenna Port Conducted Emissions – Frequency Stability

Operator	Khairul Aidi Zainal
QA	Coty Hammerer
Test Date	8/25/17 & 8/29/17
Location	Conducted Measurement Area
Temp. / R.H.	72F/ 53%
Requirement	CFR 47 Part 2.1055 (d)
Method	ANSI C63.10

Limits:

Not Applicable

Test Parameters

Frequency	2402, 2425, 2440, 2480 MHz
Settings	BLE: RBW=100 kHz, VBW=300 kHz Proprietary: RBW=100 kHz, VBW= 300 kHz Analyzer displaying frequency to the nearest 10th of a Hz
EUT	Powered via bench top power supply at nominal voltage and ± 15% of nominal voltage when possible otherwise at rated min and max operating voltages
EUT	Programmed with Android Phone
EUT	Unmodulated Output, 1 Mbps data rate for BLE

Instrumentation

Laird
Smart Technology. Delivered.

Date: 25-Aug-2017 Test: Conducted Measurements Job #: C-2791

PE: Coty Hammerer Customer: Tyco/Scott Health and Safety Quote #: 317212

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration
2	AA 960160	UTiFLEX Cable	Micro-Coax	UFC142A-0-0720-2002	218652-001	6/29/2016	9/23/2017	Active Verification
3	EE 960054	Multimeter	HP	971A	JP40011152	1/5/2017	1/5/2018	Active Calibration
4	EE 960163	DC Power Supply	Tenma	72-8350A	MG371512549	7/13/2016	10/5/2017	Active Verification

Tested By: Khairul Aidi Zainal Quality Assurance: Coty Hammerer

Table – BLE

	Supply Voltage			
	2.8VDC	3.3VDC	3.9VDC	Freq Deviation
Low channel (Hz)	2402009328	2402009608	2402009836	508
Middle channel (Hz)	2440009473	2440010015	2440010019	546
High channel (Hz)	2480009686	2480010092	2480010234	548

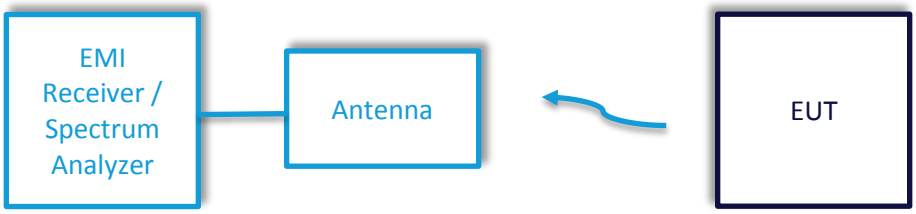
Table – 802.15.4

Supply Voltage			
7.7VDC	9.0VDC	9.9VDC	Freq Deviation
2424953924	2424953754	2424953506	418

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBµV/m) Margin (dB) = Limit (dBµV/m) - Corrected Reading (dBµV/m) Example at 4000 MHz: Reading = 40 dBµV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBµV/m Average Limit = 20 log (500) = 54 dBµV/m Margin = 54 dBµV/m - 50.8 dBµV/m = 3.2 dB

Block Diagram



5.2.1 Radiated – Antenna Gain from Fundamental, Duty Cycle

Operator	Coty Hammerer
QA	Khairul Aidi Zainal
Test Date	8/15/17
Location	Chamber 3
Temp. / R.H.	70 F/ 54%
Requirement	CFR 47 part 15.247
Method	ANSI C63.10

Test Parameters

Frequency	2425 MHz, 2402 MHz
Distance	3m
Settings	RBW=1 MHz, VBW=3 MHz
Settings	Peak Detector
EUT	6 AA Batteries power EUT
Example Calculation	Field Strength at 3m (dBµV/m) – 95.23 = E.I.R.P E.I.R.P= P_{out} (dBm) + G_{ant} 116.74 dBµV/m @3m – 95.23 = 21.51 21.51 = 19 dBm + G_{ant} G_{ant} = 21.51 – 19 = +2.51dBi for the Proprietary custom antenna The BLE chip antenna has a published Gain of +0.5 dBi Peak

Instrumentation

Laird
Smart Technology. Delivered.

Date : 15-Aug-2017 Test : Radiated Emissions Job # : C-2791

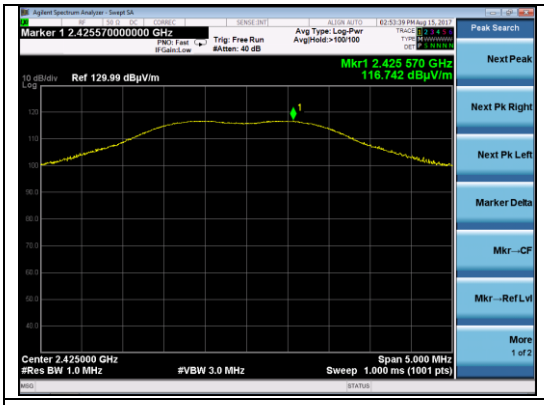
PE: Coty Hammerer Customer : Tyco/Scott Health and Safety Quote #: 317212

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Spectrum Analyzer	Agilent	N9010A	MY53400296	12/22/2016	12/22/2017	Active Calibration
2	AA 960171	Cable - low loss 6m	A.H. Systems, Inc.	SAC-26G-6	386	3/31/2016	10/2/2017	Active Verification
3	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	8/30/2017	8/30/2018	Active Calibration

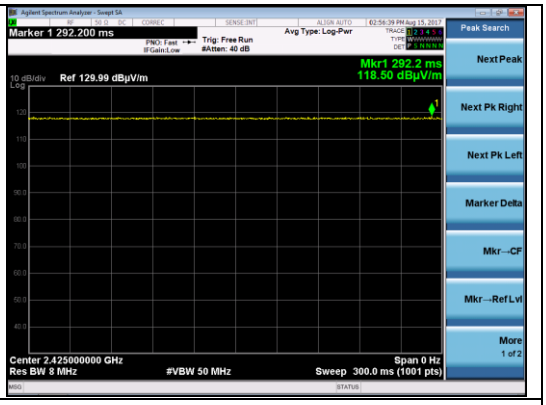
Tested By: Coty Hammerer Quality Assurance: Khairul Aidi Zainal

Note: The proprietary Duty Cycle was found to be 100%. The BLE Duty Cycle was found to be 95.45%.

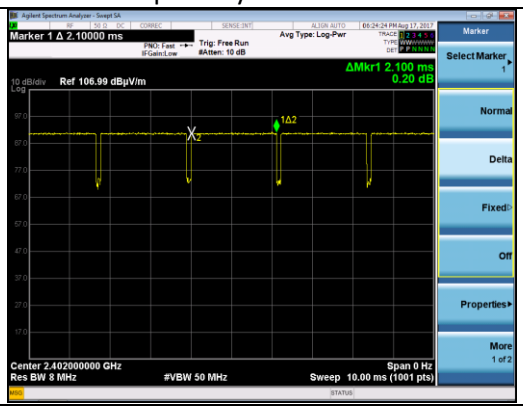
Plots



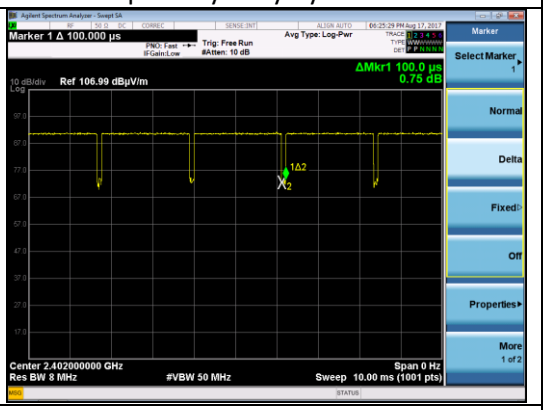
Proprietary Fundamental



Proprietary Duty Cycle = 100%

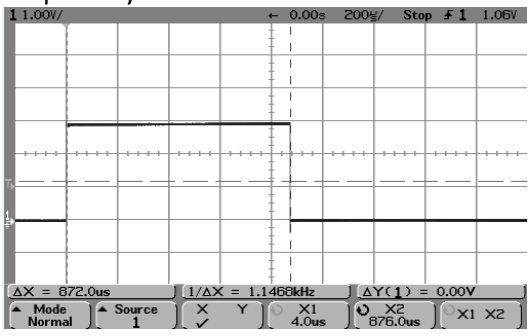


BLE On Time

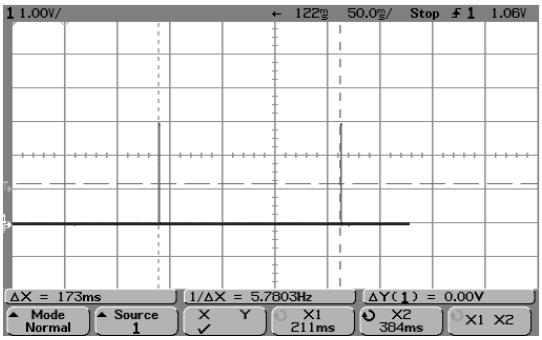


BLE Off Time

Proprietary Radio On Time When Used In Final Product Application:



Proprietary Radio Repeat Rate When Used In Final Product Application:



Note: Since Repeat Rate is > 100ms, 100ms will be used for Duty Cycle Correction

Duty Cycle = Time On/ 100ms
0.872ms/ 100ms = 0.00872 dB
20log(0.0087) = -41.2 dB, which will be applied to the Peak measurement for a corrected Average value
For example:

At 2.277 GHz the Peak reading was measured to be 60.37 dBuV/m.

Applying the D.C. Correction yields 60.37 dBuV/m – 41.2 dB = 19.17 dBuV/m which is now compared to the Average limit of 54 dBuV/m resulting in a passing margin of 33.83 dB.

5.2.2 Radiated Emissions

Operator	Coty Hammerer
QA	Khairul Aidi Zainal
Test Date	8/15/17, 8/17/17, 8/18/17, 8/22/17, 8/23/17, & 8/24/17
Location	Chamber 3
Temp. / R.H.	70 F/ 54%
Requirement	CFR 47 part 15.209 CFR 47 part 15.205 RSS-GEN section 6.13
Method	ANSI C63.10

Limits:

Frequency (MHz)	Field Strength (µV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
>960	500	3

Test Parameters

Frequency	30 MHz – 25 GHz
Distance	3 meters
Settings	RBW=1 MHz, VBW=3 MHz for > 1 GHz RBW= 120 kHz, VBW= 1.2 MHz for < 1 GHz
Settings	Peak Detector
EUT	6 AA Batteries power EUT
Notes	Average measurements were performed with a 510 Hz VBW determined by the following equation [1/ (minimum transmitter on time] as specified in ANSI C63.10 section 4.1.4.2.3 f).

Instrumentation

Laird
Smart Technology. Delivered.

Date : 15-Aug-2017 Test : Radiated Emissions Job # : C-2791

PE: Coty Hammerer Customer : Tyco/Scott Health and Safety Quote #: 317212

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	Spectrum Analyzer	Agilent	N9010A	MY53400296	12/22/2016	12/22/2017	Active Calibration
2	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	7/22/2016	8/29/2017	Active Calibration
3	AA 960171	Cable - low loss 6m	A.H. Systems, Inc.	SAC-26G-6	386	3/31/2016	8/29/2017	Active Verification
4	AA 960154	High Pass Filter 2.4 GHz	KWM	HPF-L-14186	7272-02	7/25/2016	8/24/2017	Active Calibration
5	AA 960174	Small Horn Antenna	ETS Lindgren	3116C-PA	00206880	5/1/2017	5/1/2018	Active Calibration
6	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
7	AA 960128	Biconical Antenna	ETS Lindgren	3110B	00062899	4/13/2017	4/13/2018	Active Calibration
8	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4955	4/17/2017	4/17/2018	Active Calibration
9	AA 960153	High Pass Filter 2.4 GHz	KWM	HPF-L-14186	7272-04	5/3/2017	5/3/2018	Active Calibration
10	EE 960146	Standard Gain Horn Ant. w/ LNA	EMCO / Adv. Micr	3160-09 / WLA622-4	9809-1120 / 16060001	4/10/2017	4/10/2018	Active Calibration

Tables – 802.15.4

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT Orientation	Notes
97.30	1.45	0.00	26.91	43.50	16.59	Vertical	Vertical	Emission Not EUT Related

Frequency (GHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading After D.C. Correction (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Antenna Polarity	EUT Orientation	EUT Channel (MHz)
2.277	2.27	326	60.37	19.17	54.00	34.83	Horizontal	Vertical	2425
2.277	1.00	304	57.74	16.54	54.00	37.46	Vertical	Vertical	2425
2.573	1.26	286	60.17	18.97	54.00	35.03	Vertical	Vertical	2425
2.573	1.52	336	58.51	17.31	54.00	36.69	Horizontal	Vertical	2425
2.573	1.46	237.00	58.11	16.91	54.00	37.09	Horizontal	Flat	2425

The above emissions at 2.277 and 2.573 GHz are temporally modulation products from the proprietary radio fundamental transmitting. This is due to the test mode transmitting < 1mS packets 4 times per second. Therefore, Duty Cycle correction was utilized for the above emissions in the 2 GHz range.

Peak Frequency (MHz)	Peak Measurement (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (db)	Average Frequency (MHz)	D.C. Corrected Avg Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2388.32	60.39	74.00	13.61	2390.00	19.19	54.00	34.81
2498.70	59.04	74.00	14.96	2497.95	17.84	54.00	36.16

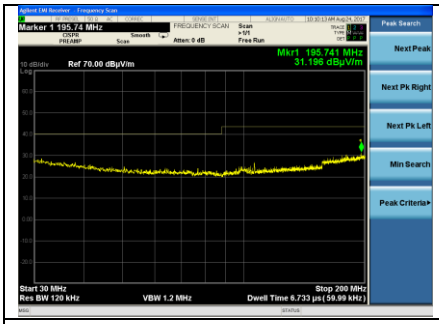
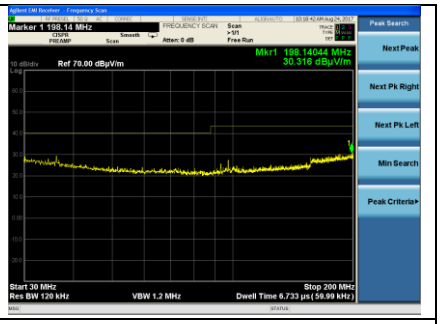
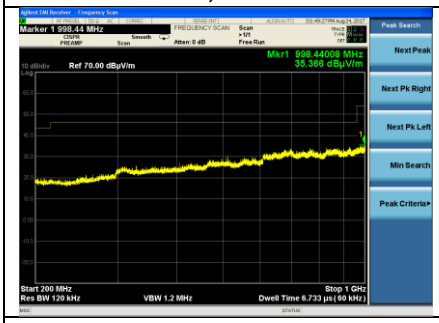
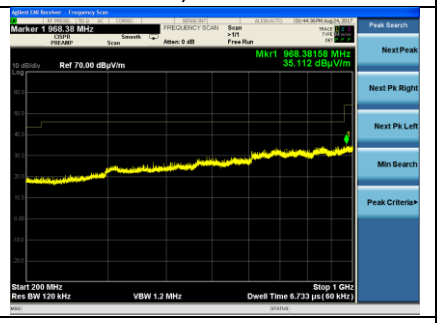
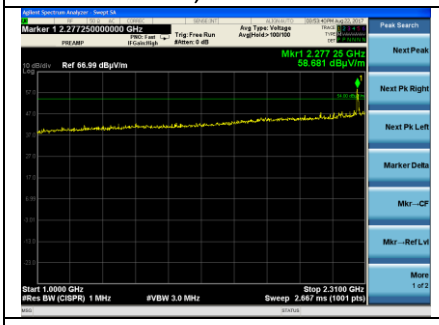
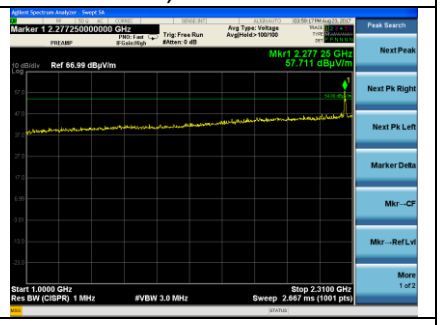
15.205 Restricted Band Emissions – Band Edges

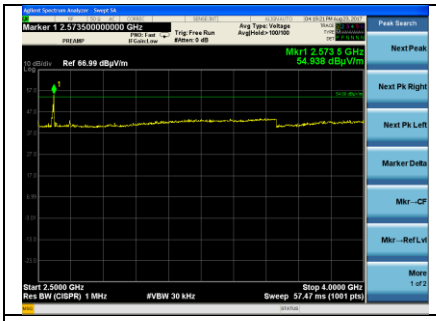
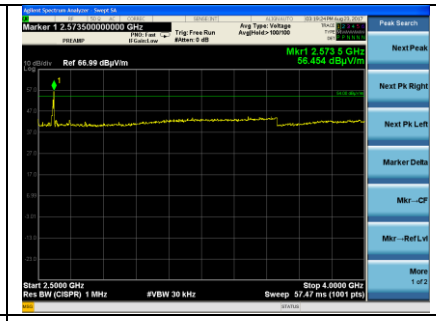
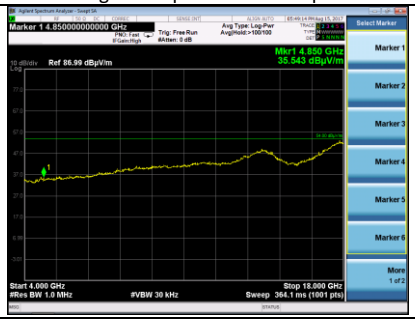
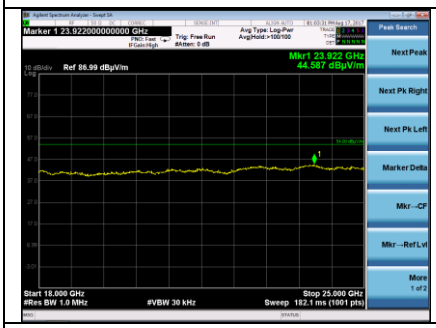
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	D.C. Corrected Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Antenna Polarity	EUT orientation
12125.00	1.18	280.00	53.80	12.60	54.00	41.40	Vertical	Vertical
12125.00	1.00	170.60	53.47	12.27	54.00	41.73	Vertical	Side

15.205 Restricted Band Emissions – Transmitter Harmonics

Plots – 802.15.4 – Worst Case

Note: These plots show the Quasi-Peak Limit for Measurements < 1 GHz and the Average Limit for Measurements > 1 GHz while using Peak Trace Data.

	
Horizontal, 30-200 MHz	Vertical, 30-200 MHz
	
Horizontal, 200-1000 MHz	Vertical, 200-1000 MHz
	
Horizontal, 1-2.31 GHz, Above emission is a modulation product temporally related to the transmitter fundamental. This is due to the test mode used transmitting < 1mS packets 4 times per second.	Vertical, 1-2.31 GHz, Above emission is a modulation product temporally related to the transmitter fundamental. This is due to the test mode used transmitting < 1mS packets 4 times per second.

	
Horizontal, 2.5–4 GHz, Reduced VBW, Above emission is a modulation product temporally related to the transmitter fundamental. This is due to the test mode used transmitting < 1mS packets 4 times per second.	Vertical, 2.5–4 GHz, Reduced VBW, Above emission is a modulation product temporally related to the transmitter fundamental. This is due to the test mode used transmitting < 1mS packets 4 times per second.
	
Horizontal, 4-18 GHz, Reduced VBW	Vertical, 4-18 GHz, Reduced VBW
	
Horizontal, 18-25 GHz, Reduced VBW	Vertical, 18-25 GHz, Reduced VBW

Tables - BLE

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation	Notes
375.00	1.25	53.00	26.54	47.00	20.46	V	Vertical	Emission Not EUT Related

Peak Frequency (MHz)	Peak Measurement (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (db)	Average Frequency (MHz)	Average Measurement (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)
2381.52	64.33	74.00	9.67	2389.20	45.38	54.00	8.62
2485.78	62.87	74.00	11.13	2485.25	44.58	54.00	9.42

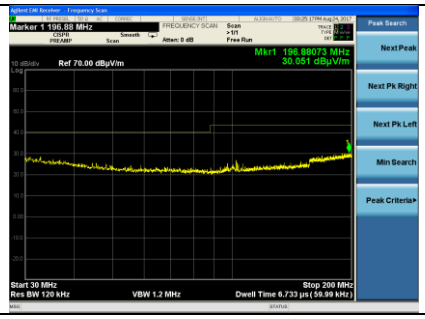
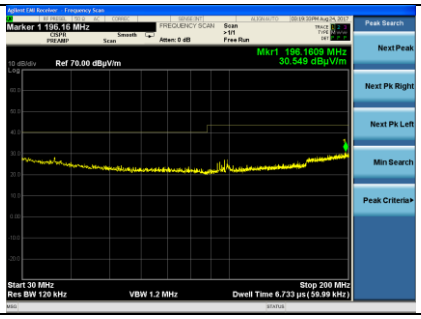
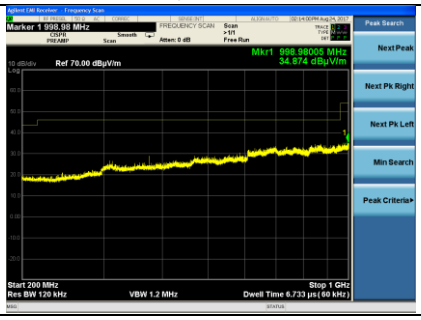
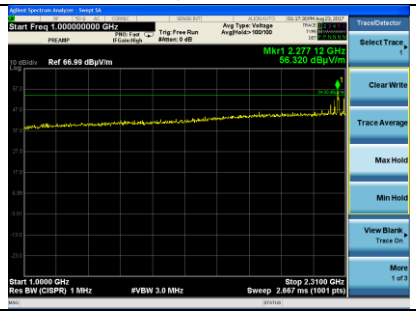
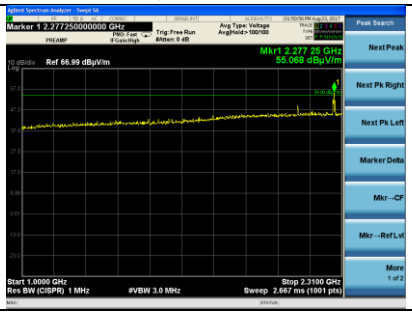
15.205 Restricted Band Emissions – Band Edges

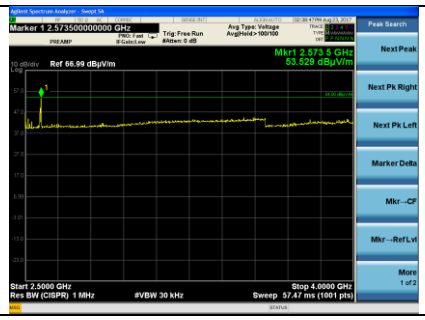
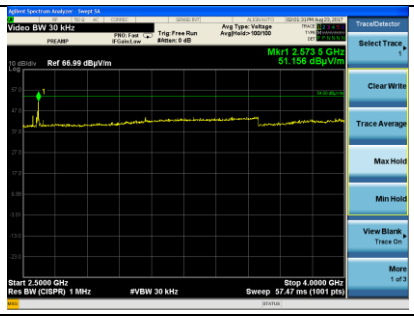
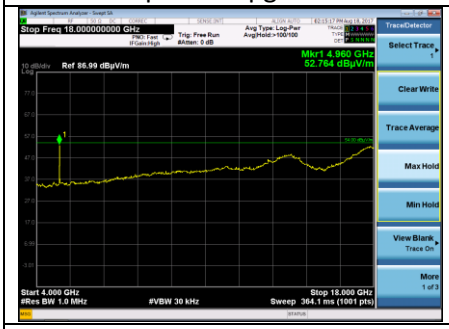
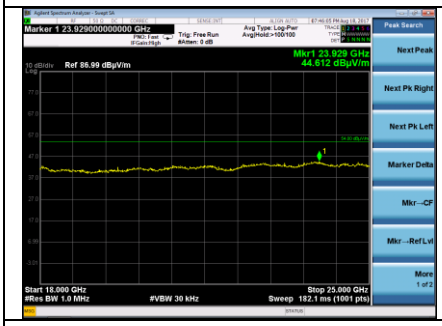
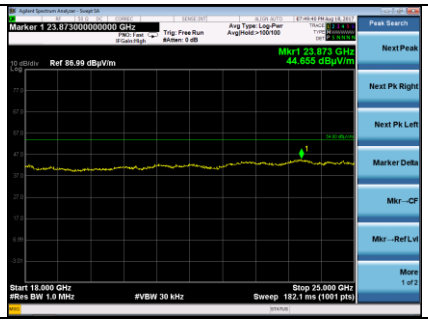
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Avg Margin (dB)	Antenna Polarity	EUT orientation
4804.00	1.00	117.50	52.84	47.73	54.00	6.27	Horizontal	Vertical
4804.00	1.57	66.00	54.14	49.50	54.00	4.50	Vertical	Vertical
4804.00	1.90	78.00	50.30	44.90	54.00	9.10	Horizontal	Side
4804.00	1.34	277.00	53.29	48.73	54.00	5.27	Vertical	Side
4804.00	1.09	291.70	51.70	47.21	54.00	6.79	Vertical	Flat
4880.00	1.67	64.00	53.50	49.16	54.00	4.84	Horizontal	Vertical
4880.00	1.60	86.00	54.08	49.65	54.00	4.35	Vertical	Vertical
4880.00	3.30	269.00	55.00	50.91	54.00	3.09	Vertical	Side
4880.00	1.10	289.50	53.86	49.14	54.00	4.86	Vertical	Flat
4960.00	2.26	50.00	56.95	52.74	54.00	1.26	Horizontal	Vertical
4960.00	1.00	67.30	52.65	47.72	54.00	6.28	Vertical	Vertical
4960.00	3.38	274.00	54.60	50.10	54.00	3.90	Vertical	Side
4960.00	1.14	67.40	53.48	47.74	54.00	6.26	Vertical	Flat

15.205 Restricted Band Emissions – Transmitter Harmonics

Plots – BLE – Worst Case

Note: These plots show the Quasi-Peak Limit for Measurements < 1 GHz and the Average Limit for Measurements > 1 GHz while using Peak Trace Data.

	
Horizontal, 30-200 MHz	Vertical, 30-200 MHz
	
Horizontal, 200-1000 MHz	Vertical, 200-1000 MHz
	
Horizontal, 1-2.31 GHz Note: Emissions due to Proprietary Radio. Refer to explanation under 1-4 GHz plots on pg. 34 and 35.	Vertical, 1-2.31 GHz Note: Emissions due to Proprietary Radio. Refer to explanation under 1-4 GHz plots on pg. 34 and 35.

	
Horizontal, 2.5–4 GHz, Reduced VBW Note: Emissions due to Proprietary Radio. Refer to explanation under 1-4 GHz plots on pg. 34 and 35.	Vertical, 2.5–4 GHz, Reduced VBW Note: Emissions due to Proprietary Radio. Refer to explanation under 1-4 GHz plots on pg. 34 and 35.
	
Horizontal, 4-18 GHz, Reduced VBW	Vertical, 4-18 GHz, Reduced VBW
	
Horizontal, 18-25 GHz, Reduced VBW	Vertical, 18-25 GHz, Reduced VBW

6 REVISION HISTORY

Version	Date	Notes	Person
0	9/17/17	Initial Draft	Coty Hammerer
1	9/18/17	Corrections	Coty Hammerer
2	10/9/17	FCC/IC IDs Added	Coty Hammerer
3	11/1/17	TCB Comments Addressed	Coty Hammerer

END OF REPORT