

Keysight Spectrum Analyzer - Burst Power			
UM L RF S0Ω AC CORREC A → IFGain:Low	SENSE:INT SOURCE OFF Center Freq: 2.441000000 Trig: RF Burst Avg #Atten: 36 dB	ALIGN AUTO 09:17:14 BHz Radio St  Hold: 100/100	td: None Frequency
10 dB/div Ref 25.00 dBm			
	<mark>at jeda sjelet obratik produkaje</mark> n kom		Center Freq 2.441000000 GHz
-15.0			
0.00 s ResBw 3.00 MHz		Sweep 4.00 ms (	4.00 ms 60001 pt ) 3.000000 MHz
Output Power (Above Threshold Lvl) 12.256 dBm	Abs Amplitude The Rel Amplitude Thr Current Data	reshold 0.6495 d eshold -15.00 d	Bm B Freq Offset
Above Threshold Pts 42592	Output Pwr 12.264 dBm	Max Pt M 15.650 dBm -88	0 Hz 3.119 dBm
MSG		STATUS	

Plot 7-89. Average Conducted Power (3Mbps - Ch. 39) - ANT 2



Plot 7-90. Average Conducted Power (3Mbps - Ch. 78) - ANT 2

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#### 7.4 Band Edge Compliance §15.247 (d); RSS-247 [5.5]

#### **Test Overview and Limits**

EUT operates in hopping and non-hopping transmission mode. Measurement is taken at the highest point located outside of the emission bandwidth. *The maximum permissible out-of-band emission level is 20 dBc.* 

#### **Test Procedure Used**

ANSI C63.10-2013 - Section 6.10.4

#### **Test Settings**

- 1. Start and stop frequency were set such that the band edge would be placed in the center of the plot
- 2. Span was set large enough so as to capture all out of band emissions near the band edge
- 3. RBW = 100kHz
- 4. VBW = 300kHz
- 5. Detector = Peak
- 6. Number of sweep points  $\geq 2 \times \text{Span/RBW}$
- 7. Trace mode = max hold
- 8. Sweep time = auto couple
- 9. The trace was allowed to stabilize

#### Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-3. Test Instrument & Measurement Setup

#### Test Notes

Out of band conducted spurious emissions at the band edge were investigated for all data rates in hopping and non-hopping modes. The worst case emissions were found with the EUT transmitting at 3 Mbps. Band edge emissions were also investigated with the EUT transmitting in all data rates. Plots of the worst case emissions are shown below.

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# Antenna 1







Plot 7-92. Band Edge Plot (Bluetooth with Hopping Disabled, ANT1 - 3 Mbps - Ch. 78)

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Plot 7-94. Band Edge Plot (Bluetooth with Hopping Enabled, ANT1 - 3 Mbps)

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## Antenna 2







Plot 7-96. Band Edge Plot (Bluetooth with Hopping Disabled, ANT2 - 3 Mbps - Ch. 78)

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<sup>9.0 02/01/201</sup> 









Plot 7-98. Band Edge Plot (Bluetooth with Hopping Enabled, ANT2 - 3 Mbps)

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#### 7.5 Carrier Frequency Separation §15.247 (a.1); RSS-247 [5.1(2)]

#### **Test Overview and Limit**

Measurement is made with EUT operating in hopping mode. The minimum permissible channel separation for this system is 2/3 the value of the 20dB BW.

#### Test Procedure Used

ANSI C63.10-2013 - Section 7.8.2

#### **Test Settings**

- 1. Span = Wide enough to capture peaks of two adjacent channels
- 2. RBW = 30% of channel spacing. Adjust as necessary to best identify center of each individual channel
- 3. VBW ≥ RBW
- 4. Sweep = Auto
- 5. Detector = Peak
- 6. Trace mode = max hold
- 7. The trace was allowed to stabilize.
- 8. Marker-delta function used to determine separation between peaks of the adjacent channels

#### Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-4. Test Instrument & Measurement Setup

#### Test Notes

The EUT complies with the minimum channel separation requirement when it is operating in 1x/EDR mode using 79 channels and when operating in AFH mode using 20 channels.

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# Antenna 1

Frequency [MHz]	Data Rate [Mbps]	Mod.	Power Scheme	Channel No.	Min. Channel Separation [MHz]
2402	1.0	GFSK	ePA	0	0.681
2441	1.0	GFSK	ePA	39	0.680
2480	1.0	GFSK	ePA	78	0.680
2402	2.0	π/4-DQPSK	ePA	0	0.886
2441	2.0	π/4-DQPSK	ePA	39	0.885
2480	2.0	π/4-DQPSK	ePA	78	0.887
2402	3.0	8DPSK	ePA	0	0.871
2441	3.0	8DPSK	ePA	39	0.864
2480	3.0	8DPSK	ePA	78	0.862

Table 7-8. Minimum Channel Separation – ANT1

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Plot 7-99. Channel Spacing Plot (Bluetooth) - ANT1

## Antenna 2

Frequency [MHz]	Data Rate [Mbps]	Mod.	Power Scheme	Channel No.	Min. Channel Separation [MHz]
2402	1.0	GFSK	ePA	0	0.680
2441	1.0	GFSK	ePA	39	0.680
2480	1.0	GFSK	ePA	78	0.681
2402	2.0	π/4-DQPSK	ePA	0	0.884
2441	2.0	π/4-DQPSK	ePA	39	0.885
2480	2.0	π/4-DQPSK	ePA	78	0.883
2402	3.0	8DPSK	ePA	0	0.863
2441	3.0	8DPSK	ePA	39	0.864
2480	3.0	8DPSK	ePA	78	0.865

Table 7-9. Minimum Channel Separation – ANT2

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Plot 7-100. Channel Spacing Plot (Bluetooth) – ANT2

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#### 7.6 Time of Occupancy §15.247 (a.1.iii); RSS-247 [5.1(4)]

#### **Test Overview and Limit**

Measurement is made while EUT is operating in hopping mode with the spectrum analyzer set to zero span. The maximum permissible time of occupancy is 400 ms within a period of 400ms multiplied by the number of hopping channels employed.

#### **Test Procedure Used**

ANSI C63.10-2013 - Section 7.8.4

#### **Test Settings**

- 1. Span = zero span, centered on a hopping channel
- 2. RBW  $\leq$  channel spacing and >> 1/T, where T is expected dwell time per channel
- 3. Sweep = as necessary to capture entire dwell time. Second plot may be required to demonstrate two successive hops on a channel
- 4. Trigger is set with appropriate trigger delay to place pulse near the center of the plot
- 5. Detector = peak
- 6. Trace mode = max hold
- 7. Marker-delta function used to determine transmit time per hop

#### Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-5. Test Instrument & Measurement Setup

#### Test Notes

None

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## Antenna 1



Plot 7-101. Time of Occupancy Plot (Bluetooth) – ANT1

#### **Bluetooth Time of Occupancy Calculation**

Typically, Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s. Since 1x/EDR modes use 5 transmit and 1 receive slot, for a total of 6 slots, the Bluetooth transmitter is actually hopping at a rate of 1600 / 6 = 266.67 hops/s/slot

- o 400ms x 79 hopping channels = 31.6 sec (Time of Occupancy Limit)
- o Worst case BT has 266.67 hops/second (for 1x/EDR modes with DH5 operation)
- o 266.67 hops/second / 79 channels = 3.38 hops/second (# of hops/second on one channel)
- 3.38 hops/second/channel x 31.6 seconds = 106.67 hops (# hops over a 31.6 second period)
- o 106.67 hops x 2.904 ms/channel = 309.77 ms (worst case dwell time for one channel in 1x/EDR modes)

With AFH, the number of channels is reduced to a minimum of 20 channels and the channel hopping rate is reduced by 50% to 800 hops/s. AFH mode also uses 6 total slots so the Bluetooth transmitter hops at a rate of 800 / 6 = 133.3 hops/s/slot

- 400ms x 20 hopping channels = 8 sec (Time of Occupancy Limit)
- Worst case BT has 133.3 hops/second/slot (for AFH mode with DH5 operation)
- o 133.3 hops/s / 20 channels = 6.67 hops/second (# of hops/second on one channel)
- 6.67 hops/s / channel x 8 seconds = 53.34 hops (# hops over a 8 second period)
- 53.34 hops x 2.904 ms/channel = 154.90 ms (worst case dwell time for one channel in AFH mode)

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## Antenna 2

🔤 Keysight Spe	ctrum Analyzer - Sw	/ept SA									
L L	RF 50 Ω	2 DC	CORREC	SEN Trig Dela	VSE:INT	#Ava Tvp	ALIGN AUTO	02:15:24 AM	1 Oct 27, 2020	F	requency
			PNO: Wide ↔ IFGain:Low	#Atten: 3	o 0 dB	#*( <b>1</b> 8 1)p	<b>A</b>	TYF DE	896 ms		Auto Tune
10 dB/div Log <sub>w</sub>	Ref 20.00	dBm						-	2.65 dB		
										(	Center Freq
10.0										2.44	1000000 GHz
0.00											
10.0										2.44	Start Freq 1000000 GHz
-10.0											
-20.0									TRIG LVI		Stop Freq
-30.0										2.44	1000000 GHz
											CE Stan
-40.0	-X							<mark>   </mark> ∆2 —			1.000000 MHz
-50.0 4.414	NÚ É								. Although	<u>Auto</u>	Man
	[ '''							In London and	W JANNER .		Eron Offect
-60.0											0 Hz
-70.0											
											Scale Type
Center 2.4	41000000	GHz						s	pan 0 Hz	Log	Lin
Res BW 1.	0 MHz		#VBW	3.0 MHz			Sweep 4	.000 ms (	1001 pts)		
MSG							STATUS	5			

Plot 7-102. Time of Occupancy Plot (Bluetooth) – ANT2

#### **Bluetooth Time of Occupancy Calculation**

Typically, Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s. Since 1x/EDR modes use 5 transmit and 1 receive slot, for a total of 6 slots, the Bluetooth transmitter is actually hopping at a rate of 1600 / 6 = 266.67 hops/s/slot

- 400ms x 79 hopping channels = 31.6 sec (Time of Occupancy Limit)
- o Worst case BT has 266.67 hops/second (for 1x/EDR modes with DH5 operation)
- o 266.67 hops/second / 79 channels = 3.38 hops/second (# of hops/second on one channel)
- o 3.38 hops/second/channel x 31.6 seconds = 106.67 hops (# hops over a 31.6 second period)
- 106.67 hops x 2.896 ms/channel = 308.91 ms (worst case dwell time for one channel in 1x/EDR modes)

With AFH, the number of channels is reduced to a minimum of 20 channels and the channel hopping rate is reduced by 50% to 800 hops/s. AFH mode also uses 6 total slots so the Bluetooth transmitter hops at a rate of 800 / 6 = 133.3 hops/s/slot

- 400ms x 20 hopping channels = 8 sec (Time of Occupancy Limit)
- Worst case BT has 133.3 hops/second/slot (for AFH mode with DH5 operation)
- o 133.3 hops/s / 20 channels = 6.67 hops/second (# of hops/second on one channel)
- 6.67 hops/s / channel x 8 seconds = 53.34 hops (# hops over a 8 second period)
- 53.34 hops x 2.896 ms/channel = 154.47 ms (worst case dwell time for one channel in AFH mode)

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#### 7.7 Number of Hopping Channels §15.247 (a.1.iii); RSS-247 [5.1(4)]

#### **Test Overview and Limit**

Measurement is made while EUT is operating in hopping mode. *This frequency hopping system must employ a minimum of 15 hopping channels.* 

#### Test Procedure Used

ANSI C63.10-2013 - Section 7.8.3

#### **Test Settings**

- 1. Span = frequency of band of operation (divided into two plots)
- 2. RBW < 30% of channel spacing or 20dB bandwidth, whichever is smaller.
- 3. VBW ≥ RBW
- 4. Sweep = auto
- 5. Detector = peak
- 6. Trace mode = max hold
- 7. Trace was allowed to stabilize

#### Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-6. Test Instrument & Measurement Setup

#### Test Notes

The frequency spectrum was broken up into two sub-ranges to clearly show all of the hopping frequencies. In AFH mode, this device operates using 20 channels so the requirement for minimum number of hopping channels is satisfied.

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Plot 7-103. Low End Spectrum Channel Hopping Plot (Bluetooth) – ANT1



Plot 7-104. High End Spectrum Channel Hopping Plot (Bluetooth) – ANT1

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Plot 7-105. Low End Spectrum Channel Hopping Plot (Bluetooth) – ANT2



Plot 7-106. High End Spectrum Channel Hopping Plot (Bluetooth) – ANT2

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#### 7.8 Conducted Spurious Emissions §15.247 (d); RSS-247 [5.5]

#### **Test Overview and Limit**

Conducted out-of-band spurious emissions were investigated from 30MHz up to 25GHz to include the 10<sup>th</sup> harmonic of the fundamental transmit frequency. *The maximum permissible out-of-band emission level is 20 dBc.* 

#### Test Procedure Used

ANSI C63.10-2013 - Section 7.8.8

#### **Test Settings**

- 1. Start frequency was set to 30MHz and stop frequency was set to 25GHz (separated into two plots per channel)
- 2. RBW = 1MHz\* (See note below)
- 3. VBW = 3MHz
- 4. Detector = Peak
- 5. Trace mode = max hold
- 6. Sweep time = auto couple
- 7. The trace was allowed to stabilize

#### **Test Setup**

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-7. Test Instrument & Measurement Setup

#### **Test Notes**

Out-of-band conducted spurious emissions were investigated for all data rates and the worst case emissions were found with the EUT transmitting at #REF!Mbps. The display line shown in the following plots is the limit at 20dB below the fundamental emission level measured in a 100kHz bandwidth. However, the traces in the following plots are measured with a 1MHz RBW to reduce test time, so the display line may not necessarily appear to be 20dB below the level of the fundamental in a 1MHz bandwidth.

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🔤 Keys	sight Specti	rum Ar	alyzer - Swe	pt SA												
L <mark>XI</mark>		RF	50 Ω	AC	COR	REC		SEN	ISE:INT	#Ava Tvr	ALIGN AU	TO 07:08	8:57 PM TRACE	Oct 05, 2020	F	requency
					PN	IO: Fast		Trig: Free	Run				TYP			
					IFG	Sain:Low	_	#Atten: 2	ав							Auto Tune
		B - 6	45 00 -	B								MKF1 3. -4	.180 3.10	) 2 GHZ		
Log	/div	Rer	15.00 a	Bm									0.10			
																Center Freq
5.00															5.0	15000000 GHz
														DL1 -2.50 dBm		
-5.00																Start From
															3	3141111124
-15.0																
25.0																
-29.0																Stop Freq
-35.0															10.0	00000000 GHz
						▲1										
-45.0				. w.đ		a marine			and the state of the state	and the second	here with the second	and a second	ور به اور از ا	All Revealed in the second		CF Step
	الالارداد المحاد	la de la	Billion and State	-	- Andread	يداند خدادات		and the second	مرونيون مريونيون مرونيون مريونيون	اللهم بمتعلم من ألال م	Strange of the	and the second state	(1) (Carlos	an a	Auto	Man
-55.0	and the second	ل الم تبيان														
																Fred Offset
-65.0																0 Hz
-75.0																
								,								Scale Type
Start	30 MH	z										Sto	p 10.	000 GHz	Log	Lin
#Res	BW 1.	0 M	Hz			#VI	BW 3	.0 MHz		5	weep	18.00 m	ıs (3	0001 pts)		
MSG											ST	ATUS				

Plot 7-109. Conducted Sp	ourious Plot (Bluetooth,	, 1#REF!Mbps – Cl	າ. 39)
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Plot 7-110. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps - Ch. 39)

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Keysight Spectrum Analyzer - Swept SA					
<b>RF</b> 50 Ω AC	CORREC	SENSE:INT	ALIGN AUTO	07:13:07 PM Oct 05, 2020	Frequency
	PNO: Fast ↔ T IFGain:Low #	rig: Free Run Atten: 26 dB	mitg type.itino		Auto Tuno
10 dB/div Ref 15.00 dBm			Mk	(r1 3.097 1 GHz -43.893 dBm	Auto Tune
5.00				DI 1 -2 30 dBm	Center Freq 5.015000000 GHz
-15.0					Start Freq 30.000000 MHz
-25.0					Stop Freq 10.000000000 GHz
-45.0			an Dengah kata satu barang satu kapanan panatah Manadakan kanada an Mili Satu kanada manganan		CF Step 997.000000 MHz <u>Auto</u> Man
-66.0					Freq Offset 0 Hz
-75.0					Scale Type
Start 30 MHz #Res BW 1.0 MHz	#VBW 3.	0 MHz	Sween 18	Stop 10.000 GHz	
MSG	<b>~~D~··</b> ························	• • • • • • • • • • • • • • • • • • • •	STATUS	s	

Plot 7-111. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps - Ch. 78)



Plot 7-112. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps - Ch. 78)

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## Antenna 2







Plot 7-114. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps – Ch. 0)

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🔤 Keysight Spec	trum Analyzer - Swept SA									×
L <mark>XI</mark>	RF 50 Ω AC	CORREC	SENS	E:INT	#Avg Type	ALIGN AUTO e: RMS	07:47:31 PI TRAC	1 Oct 05, 2020 E 1 2 3 4 5 6	Frequency	
10 dB/div	Ref 15.00 dBm	PNO: Fast ↔ IFGain:Low	#Atten: 26	Run dB		Mk	r1 3.04( -44.0	6 6 GHz 88 dBm	Auto Tur	ne
5.00								DL1 -3.22 dBm	Center Fre 5.015000000 GH	eq Hz
-5.00									Start Fre 30.000000 Mi	eq Hz
-25.0									Stop Fre 10.000000000 GF	eq Hz
-45.0					lagazişinterelenenin neralaşını gerenenin				CF Ste 997.000000 Mi <u>Auto</u> Ma	ep Hz an
-65.0									Freq Offs 0 I	et Hz
-75.0	H7						Stop 10	000 GHz	Scale Typ	pe _in
#Res BW	I.0 MHz	#VBW	3.0 MHz		S	weep 18	.00 ms (3	0001 pt <u>s)</u>		
MSG						STATUS				

Plot 7-115. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps - Ch. 39)



Plot 7-116. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps - Ch. 39)

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🔤 Keysight Spe	trum Analyzer - Swept SA						
L)XI	RF 50 Ω AC	CORREC	SENSE:II	#Avg Type	ALIGN AUTO E: RMS	07:51:07 PM Oct 05, 20 TRACE 1 2 3 4	Frequency
10 dB/div	Ref 15.00 dBm	PNO: Fast 🔸 IFGain:Low	Trig: Free Ru #Atten: 26 dB	n	Mki	1 3.286 9 GH -43.918 dB	Z Auto Tune
5.00						DI 1 2 21 d	Center Freq 5.015000000 GHz
-5.00							Start Freq 30.000000 MHz
-25.0							Stop Freq 10.000000000 GHz
-45.0			in a state of the		litti film yana daga	n an	CF Step 997.000000 MHz <u>Auto</u> Man
-65.0							Freq Offset 0 Hz
Start 30 M	Hz					Stop 10.000 GF	Scale Type z Log <u>Lin</u>
#Res BW	1.0 MHz	#VBW	3.0 MHz	S	weep 18.	00 ms (30001 pt	s)
MSG					STATUS		

Plot 7-117. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps - Ch. 78)



Plot 7-118. Conducted Spurious Plot (Bluetooth, 1#REF!Mbps - Ch. 78)

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# 7.9 Radiated Spurious Emission Measurements – Above 1GHz §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

#### **Test Overview and Limit**

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at maximum power and at the appropriate frequencies. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

# All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-10 per Section 15.209 and RSS-Gen (8.9).

Frequency	Field Strength [µV/m]	Measured Distance [Meters]	
Above 960.0 MHz	500	3	

Table 7-10. Radiated Limits

#### Test Procedure Used

ANSI C63.10-2013 – Section 6.6.4.3

#### Test Settings Average Field Strength Measurements per Section 4.1.4.2.3 of ANSI C63.10-2013

- 1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
- 2. RBW = 1MHz
- 3. VBW = 1kHz  $\ge$  1/ $\tau$  Hz, where  $\tau$  = pulse width in seconds
- 4. Averaging type was set to RMS to ensure that video filtering was applied in the power domain
- 5. Detector = peak
- 6. Sweep time = auto
- 7. Trace mode = max hold
- 8. Trace was allowed to stabilize

#### Peak Field Strength Measurements per Section 4.1.4.2.2 of ANSI C63.10-2013

- 1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
- 2. RBW is set depending on measurement frequency, as specified in Table 7-11 below
- 3. VBW = 3MHz
- 4. Detector = peak
- 5. Sweep time = auto couple
- 6. Trace mode = max hold
- 7. Trace was allowed to stabilize

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Frequency	RBW			
9 – 150kHz	200 – 300Hz			
0.15 – 30MHz	9 – 10kHz			
30 – 1000MHz	100 – 120kHz			
> 1000MHz	1MHz			
Table 7-11. RBW as a Function of Frequency				

#### Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-8. Radiated Test Setup >1GHz

#### Test Notes

- 1. All emissions lying in restricted bands specified in §15.205 and Section 8.10 of RSS-Gen are below the limit shown in Table 7-10.
- 2. No significant radiated emissions were found in the 2310 2390MHz restricted band.
- 3. The antenna is manipulated through typical positions, polarity and length during the tests. The EUT is manipulated through three orthogonal planes.
- 4. This unit was tested with its standard battery.
- 5. The spectrum is measured from 9kHz to the 10<sup>th</sup> harmonic and the worst-case emissions are reported.
- 6. The duty cycle correction factor was not applied to noise floor measurements.
- 7. The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. Any emissions found to be within 20dB of the limit are fully investigated and the results are shown in this section.
- 8. The "-" shown in the following RSE tables are used to denote a noise floor measurement.

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#### Sample Calculation

- ο Field Strength Level [dBµV/m] = Analyzer Level [dBm] + 107 + AFCL [dB/m] + Duty Cycle Correction [dB]
- o AFCL [dB/m] = Antenna Factor [dB/m] + Cable Loss [dB]
- Margin [dB] = Field Strength Level  $[dB\mu V/m]$  Limit  $[dB\mu V/m]$

#### **Duty Cycle Correction Factor Calculation**

- Channel hop rate = #REF! hops/second (#REF! Mode)
- Adjusted channel hop rate for DH5 mode = #REF! hops/second
- Time per channel hop = 1 / #REF! hops/second = #REF! ms
- Time to cycle through all channels = #REF! x #REF! channels = #REF! ms
- Number of times transmitter hits on one channel = 100 ms / #REF! ms = #REF! time(s)
- Worst case dwell time = #REF! ms
- Duty cycle correction factor = 20log<sub>10</sub>(#REF!ms/100ms) = #REF! dB

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### Radiated Spurious Emission Measurements (1 – 18GHz) §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

### Antenna 1



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### Radiated Spurious Emission Measurements (1 – 18GHz) §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

### Antenna 2



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### Radiated Spurious Emission Measurements (1 – 18GHz) §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]



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EUT Type:

Test Dates:



### Radiated Spurious Emissions Measurements (Above 18GHz) §15.209; RSS-Gen [8.9]



Plot 7-128. Radiated Spurious Plot above 18GHz

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### Radiated Spurious Emission Measurements §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

ANT1

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	н	-	-	-82.09	9.23	34.14	53.98	-19.84
4804.00	Peak	н	-	-	-69.98	9.23	46.25	73.98	-27.73
12010.00	Avg	н	-	-	-85.18	22.67	44.49	53.98	-9.49
12010.00	Peak	н	-	-	-72.87	22.67	56.80	73.98	-17.18

Table 7-12. Radiated Measurements-ANT1

Worst Case Mode: Worst Case Data Rate: Measurement Distance: Operating Frequency: Channel:

Bluetooth
1 Mbps
3 Meters
2441MHz
39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	Avg	н	-	-	-82.23	9.37	34.14	53.98	-19.84
4882.00	Peak	н	-	-	-70.39	9.37	45.98	73.98	-28.00
7323.00	Avg	н	-	-	-84.01	14.98	37.97	53.98	-16.01
7323.00	Peak	н	-	-	-72.42	14.98	49.56	73.98	-24.42
12205.00	Avg	н	-	-	-85.02	22.08	44.06	53.98	-9.92
12205.00	Peak	н	-	-	-73.30	22.08	55.78	73.98	-18.20

Table 7-13. Radiated Measurements-ANT1

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# Radiated Spurious Emission Measurements §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	78

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	Н	-	-	-82.36	9.40	34.04	53.98	-19.94
4960.00	Peak	н	-	-	-70.74	9.40	45.66	73.98	-28.32
7440.00	Avg	Н	-	-	-84.46	15.58	38.12	53.98	-15.85
7440.00	Peak	Н	-	-	-71.88	15.58	50.70	73.98	-23.27
12400.00	Avg	Н	-	-	-85.25	22.81	44.56	53.98	-9.42
12400.00	Peak	Н	-	-	-72.75	22.81	57.06	73.98	-16.92

Table 7-14. Radiated Measurements-ANT1

Worst Case Mode:
Worst Case Data Rate:
Measurement Distance:
Operating Frequency:
Channel:

Bluetooth
1 Mbps
3 Meters
2402MHz
0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	н	-	-	-82.46	9.23	33.77	53.98	-20.21
4804.00	Peak	н	-	-	-69.62	9.23	46.61	73.98	-27.37
12010.00	Avg	н	-	-	-85.19	22.67	44.48	53.98	-9.50
12010.00	Peak	н	-	-	-72.92	22.67	56.75	73.98	-17.23

Table 7-15. Radiated Measurements with WCP-ANT1

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## ANT2

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	н	-	-	-79.38	7.22	34.84	53.98	-19.14
4804.00	Peak	н	-	-	-67.79	7.22	46.43	73.98	-27.55
12010.00	Avg	н	-	-	-80.89	18.11	44.22	53.98	-9.76
12010.00	Peak	н	-	-	-69.13	18.11	55.98	73.98	-18.00

Table 7-16. Radiated Measurements-ANT2

Worst Case Mode: Worst Case Data Rate: Measurement Distance: Operating Frequency: Channel:

Bluetooth	
1 Mbps	
3 Meters	
2441MHz	
39	

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	Avg	н	-	-	-79.77	7.86	35.09	53.98	-18.89
4882.00	Peak	н	-	-	-67.68	7.86	47.18	73.98	-26.80
7323.00	Avg	н	-	-	-79.67	12.08	39.41	53.98	-14.57
7323.00	Peak	н	-	-	-67.17	12.08	51.91	73.98	-22.07
12205.00	Avg	н	-	-	-80.81	18.16	44.35	53.98	-9.63
12205.00	Peak	Н	-	-	-68.63	18.16	56.53	73.98	-17.45

Table 7-17. Radiated Measurements-ANT2

FCC ID: A3LSMG998U		MEASUREMENT REPORT (CERTIFICATION)	SAMSUNG	Approved by: Quality Manager
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# Radiated Spurious Emission Measurements §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	78

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	Н	-	-	-79.66	7.13	34.47	53.98	-19.51
4960.00	Peak	Н	-	-	-68.27	7.13	45.86	73.98	-28.12
7440.00	Avg	Н	-	-	-79.91	12.17	39.26	53.98	-14.72
7440.00	Peak	н	-	-	-68.17	12.17	51.00	73.98	-22.98
12400.00	Avg	Н	-	-	-81.06	18.09	44.03	53.98	-9.95
12400.00	Peak	н	-	-	-69.67	18.09	55.42	73.98	-18.56

Table 7-18. Radiated Measurements-ANT2

FCC ID: A3LSMG998U		MEASUREMENT REPORT (CERTIFICATION)	SAMSUNG	Approved by: Quality Manager
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## **Dual BT**

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2402MHz
Channel:	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	Н	251	76	-79.00	7.22	-22.50	12.72	53.98	-41.26
4804.00	Peak	н	251	76	-67.21	7.22	0.00	47.01	73.98	-26.97
7206.00	Avg	Н	379	266	-79.60	11.45	-22.50	16.35	53.98	-37.63
7206.00	Peak	Н	379	266	-67.17	11.45	0.00	51.28	73.98	-22.70
12010.00	Avg	Н	-	-	-80.61	18.11	0.00	44.50	53.98	-9.48
12010.00	Peak	н	-	-	-68.24	18.11	0.00	56.87	73.98	-17.11

Table 7-19. Radiated Measurements-Dual

Worst Case Mode: Worst Case Data Rate: Measurement Distance: **Operating Frequency:** Channel:

Bluetooth
1 Mbps
3 Meters
2441MHz
39

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4882.00	Avg	н	-	-	-79.80	7.86	0.00	35.06	53.98	-18.92
4882.00	Peak	н	-	-	-67.36	7.86	0.00	47.50	73.98	-26.48
7323.00	Avg	н	-	-	-79.71	12.08	0.00	39.37	53.98	-14.61
7323.00	Peak	н	-	-	-66.61	12.08	0.00	52.47	73.98	-21.51
12205.00	Avg	н	-	-	-80.80	18.16	0.00	44.36	53.98	-9.62
12205.00	Peak	н	-	-	-68.91	18.16	0.00	56.25	73.98	-17.73

Table 7-20. Radiated Measurements-Dual

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# Radiated Spurious Emission Measurements §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	78

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4960.00	Avg	Н	114	343	-79.56	7.13	-22.50	12.07	53.98	-41.90
4960.00	Peak	Н	114	343	-67.80	7.13	0.00	46.33	73.98	-27.65
7440.00	Avg	Н	387	234	-79.84	12.17	-22.50	16.83	53.98	-37.15
7440.00	Peak	Н	387	234	-67.34	12.17	0.00	51.83	73.98	-22.15
12400.00	Avg	Н	-	-	-81.08	18.09	0.00	44.01	53.98	-9.97
12400.00	Peak	н	-	-	-69.21	18.09	0.00	55.88	73.98	-18.10

Table 7-21. Radiated Measurements-Dual

	Bluetooth
	1 Mbps
	3 Meters
	2402MHz
_	0

Frequency [MHz]	Detector	Ant. Pol. [H/V]	Antenna Height [cm]	Turntable Azimuth [degree]	Analyzer Level [dBm]	AFCL [dB/m]	Duty Cycle Correction [dB]	Field Strength [dBµV/m]	Limit [dBµV/m]	Margin [dB]
4804.00	Avg	н	207	282	-79.67	7.22	-22.50	12.05	53.98	-41.93
4804.00	Peak	н	207	282	-68.04	7.22	0.00	46.18	73.98	-27.80
7206.00	Avg	н	265	180	-79.59	11.45	-22.50	16.36	53.98	-37.62
7206.00	Peak	н	265	180	-68.01	11.45	0.00	50.44	73.98	-23.54
12010.00	Avg	н	-	-	-80.67	18.11	0.00	44.44	53.98	-9.54
12010.00	Peak	н	-	-	-68.51	18.11	0.00	56.60	73.98	-17.38

Table 7-22. Radiated Measurements with WCP-Dual

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# 7.10 Radiated Restricted Band Edge Measurements §15.205 §15.209 §15.247 (d); RSS-Gen [8.9]

The radiated restricted band edge measurements are measured with an EMI test receiver connected to the receive antenna while the EUT is transmitting. Two different amplitude offsets were used depending on whether peak or average measurements were measured. The average measurements use a duty cycle correction factor (DCCF).

The amplitude offset shown in the following plots for average measurements was calculated using the formula:

Offset (dB) = (Antenna Factor + Cable Loss + Attenuator) - Preamplifier Gain + DCCF

Worst Case Mode:	Bluetooth
Worst Case Data Rate:	1 Mbps
Measurement Distance:	3 Meters
Operating Frequency:	2480MHz
Channel:	78



Plot 7-129. Radiated Restricted Upper Band Edge Measurement (Average) – ANT1



Plot 7-131. Radiated Restricted Upper Band Edge Measurement with WCP (Average) – ANT1



Plot 7-130. Radiated Restricted Upper Band Edge Measurement (Peak) – ANT1



Plot 7-132. Radiated Restricted Upper Band Edge Measurement with WCP (Peak) – ANT1

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Plot 7-133. Radiated Restricted Upper Band Edge Measurement (Average) – ANT2



Plot 7-135. Radiated Restricted Upper Band Edge Measurement with WCP (Average) – ANT2



Plot 7-137. Radiated Restricted Upper Band Edge Measurement (Average) – Dual BT



Plot 7-139. Radiated Restricted Upper Band Edge Measurement with WCP (Average) – Dual BT



Plot 7-134. Radiated Restricted Upper Band Edge Measurement (Peak) – ANT2



Plot 7-136. Radiated Restricted Upper Band Edge Measurement with WCP (Peak) – ANT2



Plot 7-138. Radiated Restricted Upper Band Edge Measurement (Peak) – DUAL BT



Plot 7-140. Radiated Restricted Upper Band Edge Measurement with WCP (Peak) – Dual BT

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#### 7.11 Radiated Spurious Emissions Measurements – Below 1GHz §15.209; RSS-Gen [8.9]

#### **Test Overview and Limit**

All out of band radiated spurious emissions are measured with a spectrum analyzer connected to a receive antenna while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for radiated spurious emissions. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.

# All out of band emissions appearing in a restricted band as specified in Section 15.205 of the Title 47 CFR and Table 6 of RSS-Gen (8.10) must not exceed the limits shown in Table 7-23 per Section 15.209 and RSS-Gen (8.9).

Frequency	Field Strength [μV/m]	Measured Distance [Meters]
0.009 – 0.490 MHz	2400/F (kHz)	300
0.490 – 1.705 MHz	24000/F (kHz)	30
1.705 – 30.00 MHz	30	30
30.00 – 88.00 MHz	100	3
88.00 – 216.0 MHz	150	3
216.0 – 960.0 MHz	200	3
Above 960.0 MHz	500	3

Table 7-23. Radiated Limits

#### **Test Procedures Used**

ANSI C63.10-2013

#### **Test Settings**

#### **Quasi-Peak Field Strength Measurements**

- 1. Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
- 2. RBW = 120kHz (for emissions from 30MHz 1GHz)
- 3. Detector = quasi-peak
- 4. Sweep time = auto couple
- 5. Trace mode = max hold
- 6. Trace was allowed to stabilize

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### Test Setup

The EUT and measurement equipment were set up as shown in the diagrams below.



Figure 7-9. Radiated Test Setup < 30Mhz





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#### Test Notes

- 1. All emissions lying in restricted bands specified in §15.205 and RSS-Gen (8.10) are below the limit shown in Table 7-23.
- 2. The broadband receive antenna is manipulated through vertical and horizontal polarizations during the tests. The EUT is manipulated through three orthogonal planes.
- 3. This unit was tested with its standard battery.
- 4. The spectrum is investigated using a peak detector and final measurements are recorded using CISPR quasi peak detector. The worst-case emissions are reported however emissions whose levels were not within 20dB of the respective limits were not reported.
- 5. Emissions were measured at a 3 meter test distance.
- 6. Emissions are investigated while operating on the center channel of the mode, band, and modulation that produced the worst case results during the transmitter spurious emissions testing.
- 7. No spurious emissions were detected within 20dB of the limit below 30MHz.
- 8. The results recorded using the broadband antenna is known to correlate with the results obtained by using a tuned dipole with an acceptable degree of accuracy. The VSWR for the measurement antenna was found to be less than 2:1.
- The wide spectrum spurious emissions plots shown on the following pages are used only for the purpose of emission identification. There were no emissions detected in the 30MHz – 1GHz frequency range, as shown in the subsequent plots.

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# Radiated Spurious Emissions Measurements (Below 1GHz) §15.209; RSS-Gen [8.9]



Plot 7-141. Radiated Spurious Plot below 1GHz

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# 7.12 Line Conducted Measurement Data §15.207; RSS-Gen [8.8]

#### **Test Overview and Limit**

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.

# All conducted emissions must not exceed the limits shown in the table below, per Section 15.207 and RSS-Gen (8.8).

Frequency of emission	Conducted Limit (dBµV)		
	Quasi-peak	Average	
0.15 - 0.5	66 to 56*	56 to 46*	
0.5 - 5	56	46	
5 - 30	60	50	

Table 7-24. Conducted Limits

\*Decreases with the logarithm of the frequency.

#### **Test Procedures Used**

ANSI C63.10-2013, Section 6.2

#### Test Settings

#### **Quasi-Peak Field Strength Measurements**

- 1. Analyzer center frequency was set to the frequency of the spurious emission of interest
- 2. RBW = 9kHz (for emissions from 150kHz 30MHz)
- 3. Detector = quasi-peak
- 4. Sweep time = auto couple
- 5. Trace mode = max hold
- 6. Trace was allowed to stabilize

#### Average Field Strength Measurements

- 1. Analyzer center frequency was set to the frequency of the spurious emission of interest
- 2. RBW = 9kHz (for emissions from 150kHz 30MHz)
- 3. Detector = RMS
- 4. Sweep time = auto couple
- 5. Trace mode = max hold
- 6. Trace was allowed to stabilize

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### Test Setup

The EUT and measurement equipment were set up as shown in the diagram below.



Figure 7-11. Test Instrument & Measurement Setup

### Test Notes

- 1. All modes of operation were investigated and the worst-case emissions are reported using mid channel. The emissions found were not affected by the choice of channel used during testing.
- 2. The limit for an intentional radiator from 150kHz to 30MHz are specified in 15.207 and RSS-Gen (8.8).
- 3. Corr. (dB) = Cable loss (dB) + LISN insertion factor (dB)
- 4. QP/AV Level (dB $\mu$ V) = QP/AV Analyzer/Receiver Level (dB $\mu$ V) + Corr. (dB)
- 5. Margin (dB) = QP/AV Limit (dB $\mu$ V) QP/AV Level (dB $\mu$ V)
- 6. Traces shown in plot are made using a peak detector.
- 7. Deviations to the Specifications: None.

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Plot 7-144. Line-Conducted Test Plot (L1) with WCP



Plot 7-145. Line-Conducted Test Plot (N) with WCP

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## 8.0 CONCLUSION

The data collected relate only to the item(s) tested and show that the **Samsung Portable Handset FCC ID: A3LSMG998U** is in compliance with Part 15 Subpart C (15.247) of the FCC Rules.

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