

Test report No.: KES-RF-16T0094-R1 Page (1 ) of (22)

## **TEST REPORT**

# Part 15 Subpart C 15.231

Equipment under test Vehicle Security Gateway

Model name ST-900-CF

FCC ID KL7ST-900-CF

Applicant Savi Technology Inc.

Manufacturer Dae Kyung Philippines, Inc.

Date of test(s) 2016.10.04 ~ 2016.11.10

Date of issue 2016.11.10

#### **Issued** to

**Savi Technology Inc.** 3601 Eisenhower Avenue, STE 280, Alexandria VA 22304 Tel: +1-571-227-7950 / Fax: +1-571-227-7960

## Issued by

KES Co., Ltd.

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Test and report completed by :	Report approval by :
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Test report No .: KES-RF-16T0094-R1 Page (2) of (22)

### **Revision history**

Revision	Date of issue	Test report No.	Description
-	2016.10.17	KES-RF-16T0094	Initial
R1	2016.11.10	KES-RF-16T0094-R1	Retest a Transmission time and added a test plot of duty cycle



Test report No .: KES-RF-16T0094-R1 Page (3) of (22)

## **TABLE OF CONTENTS**

1.	General	information	4
	1.1.	EUT description	
	1.2.	Test configuration	4
	1.3.	Device modifications	
	1.4.	Derivation model information	4
	1.5.	Frequency/channel operations	5
	1.6.	Worst case configuration	5
2.	Summar	y of tests	6
3.	Test resu	lts	7
	3.1.	Field strength of fundamental and the field strength of spurious emission	7
	3.2.	Bandwidth of operation frequency	16
	3.3.	Transmission time	17
	3.4.	Duty cycle correction factor	18
	3.5.	AC conducted emissions	19
App	endix A.	Measurement equipment	21
App	endix B.	Test setup photos	22



#### 1. General information

Applicant:	Savi Technology Inc.
Applicant address:	3601 Eisenhower Avenue, STE 280, Alexandria VA 22304
Test site:	KES Co., Ltd.
Test site address:	C-3701, 40, Simin-daero 365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, Korea
	473-21, Gayeo-ro, Yeoju-si, Gyeonggi-do, Korea
FCC rule part(s):	15.231
FCC ID:	KL7ST-900-CF
Test device serial No.:	☑ Production □ Pre-production □ Engineering

#### **1.1. EUT description**

L	
Equipment under test	Vehicle Security Gateway
Frequency range	Tx:433.92 MHz
	Rx:433.92 MHz
	GSM 850 : 824.2 M₂ ~ 848.8 M₂
	PCS 1900: 1850.2 MHz ~ 1909.8 MHz
Modulation technique	433.92 MHz : FSK
	GSM : GMSK
Number of channels	433.92 MHz : 1ch
	GSM 850 : 125ch, GSM 1900 : 300ch
Antenna specification	433.92 UHF Antenna type: PCB, Peak gain: -0.97 dBi
	GSM 850 Antenna type: PCB, Peak gain: -0.30 dBi
	GSM 1900 Antenna type: PCB, Peak gain: -1.70 dBi
Power source	External Power : DC 24.0 V / 2A
	Backup Battery : DC 3.7 V / 1400 mAh Li-polymer battery
NT 4	

#### Note:

1. Certificated GSM/GPRS module is mounted in the EUT as following

- Applicant: Shanghai Simcom Ltd.
- FCC Identifier : UDV-20160416
- Model: SIM808

2. The installed module is completed identical as original.

#### **1.2.** Test configuration

The <u>Savi Technology, Inc. Vehicle Security Gateway FCC ID: KL7ST-900-CF</u> was tested per the guidance of ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

#### **1.3.** Device modifications

N/A

#### 1.4. Derivation model information

N/A

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#### **1.5.** Frequency/channel operations

Ch.	Frequency (Mz)
01	433.92

#### 1.6. Worst case configuration

The EUT was investigated in each of its External power mode and Battery mode. All radiated test and power line conducted test was performed with the EUT set to transmit mode. The test results shown in the following sections represent the worst case emissions for External power mode.



Test report No .: KES-RF-16T0094-R1 Page (6) of (22)

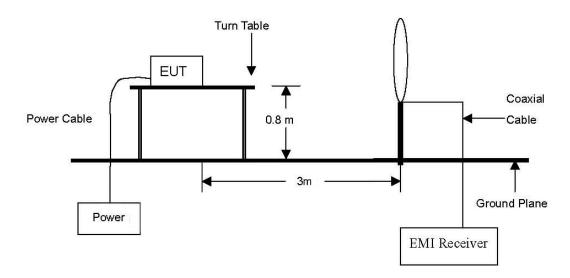
2. Summary of	tests	
Reference	Parameter	Test results
15.209(a) 15.231(b)	Radiated emission, Spurious emission and Field Strength of Fundamental	Pass
15.231(c)	Bandwidth of operation frequency	Pass
15.231(a)	Transmission time	Pass
15.207(a)	AC conducted emissions	Pass



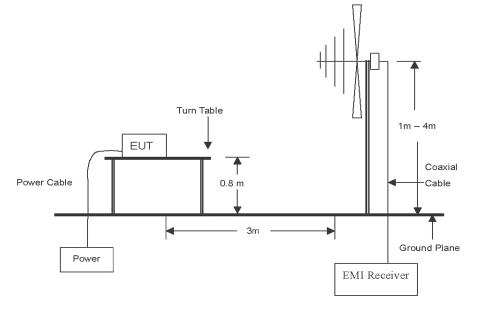
#### 3. Test results

# **3.1.** Field strength of fundamental and the field strength of spurious emission Test setup

The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz Emissions.



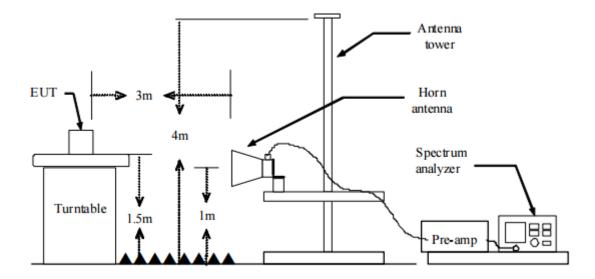
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 Mz to 1 Gz emissions.



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The diagram below shows the test setup that is utilized to make the measurements for emission from 1  $\mathbb{G}\mathbb{Z}$  to the tenth harmonic of the highest fundamental frequency or to 40  $\mathbb{G}\mathbb{Z}$  emissions, whichever is lower.



#### Test procedure below 30 Mz

- 1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
- 3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum hold mode.

#### Test procedure above 30 MHz

- 1. Spectrum analyzer settings for f < 1 GHz:
  - ① Span = wide enough to fully capture the emission being measured
  - $\bigcirc$  **RBW** = 100 kHz
  - ③ VBW  $\ge$  RBW
  - ④ Detector = Peak detection (PK) or Quasi-peak detection (QP)
  - (5) Sweep time = auto
  - 6 Trace = max hold
- 2. Spectrum analyzer settings for  $f \ge 1$  GHz: Peak
  - ① Analyzer center frequency was set to the frequency of the radiated spurious emission of interest
  - 2 RBW = 1 M/z
  - ③ VBW  $\ge$  3 Mz
  - (4) Detector = peak
  - $\bigcirc$  Sweep time = auto
  - 6 Trace = max hold
  - $\bigcirc$  Trace was allowed to stabilize



#### Note.

- 1. f < 30 Mz, extrapolation factor of 40 dB/decade of distance.  $F_d = 40\log(D_m/Ds)$ 
  - $f \ge 30$  MHz, extrapolation factor of 20 dB/decade of distance.  $F_d = 20\log(D_m/Ds)$  Where:
    - $F_d$  = Distance factor in dB
    - $D_m$  = Measurement distance in meters
    - $D_s$  = Specification distance in meters
- 2.  $CF(Correction factors(dB)) = Antenna factor(dB/m) + Cable loss(dB) + or Amp. gain(dB) + or F_d(dB)$
- 3. Field strength( $dB\mu N/m$ ) = Level( $dB\mu N$ ) + CF (dB) + or DCF(dB)
- 4. Margin(dB) = Limit(dB $\mu$ V/m) Field strength(dB $\mu$ V/m)
- 5. The fundamental of the EUT was investigated in three orthogonal orientations X, Y and Z, it was determined that <u>Y orientation</u> was worst-case orientation; therefore, all final radiated testing was performed with the EUT in <u>Y orientation</u>.
- 6. The emissions are reported however whose levels were not within 20 dB of respective limits were not reported.



#### Limit

According to 15.209(a), for an intentional radiator devices, the general required of field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the following values :

Frequency (Mz)	Distance (Meters)	Radiated (µN/m)
$0.009 \sim 0.490$	300	2400/F(kHz)
0.490 ~ 1.705	30	24000/F(kHz)
$1.705 \sim 30.0$	30	30
30~88	3	100**
88~216	3	150**
216~960	3	200**
Above 960	3	500

\*\*Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands  $54 \sim 72$  Mb,  $76 \sim 88$  Mb,  $174 \sim 216$  Mb or  $470 \sim 806$  Mb. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

According to 15.231(b), in addition to the provisions of section 15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental frequency (Mz)	Field strength of fundamental (microvolts / meter)	Field strength of spurious emission (microvolts / meter)
$40.66 \sim 40.70$	2,250	225
$70 \sim 130$	1,250	125
130 ~ 174	1,250 to 3,750**	125 to 375**
$174 \sim 260$	3,750	375
$260 \sim 470$	3,750 to 12,500**	375 to 1,250**
Above 470	12,500	1,250

\*\*Where F is the frequency in Mz, the formulas for calculating the maximum permitted fundamental field strengths are as follows: for the band 130 ~ 174 Mz,  $\mu$ /m at 3 meters = 56.81818(F) - 6136.3636; for the band 260 ~ 470 Mz,  $\mu$ /m at 3 meters = 41.6667(F) - 7083.333. The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.



#### **Field strength**

#### Test results

Mode:	FSK
Distance of measurement:	3 meter
Channel:	1

Frequency (歴2)	Level (dBµV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBµN/m)	Limit (dBµN/m)	Margin (dB)
422.02 75.02	Peak	Н	17.43	-	93.05	100.83	7.78	
433.92	433.92 75.62	Average	Н	17.43	-20.93	72.12	80.83	8.71
433.92 72.70	Peak	V	17.43	-	90.13	100.83	10.70	
	Average	V	17.43	-20.93	69.20	80.83	11.63	

#### **Test plots**

Horizontal // Peak			Vertical // Peak			
Spectrum 2 (X)		Spectrum	Spectrum 2 🛞			
	W 100 kHz W 300 kHz Mode Auto FFT	Ref Level 87.0 Att	0 dBμV			
e 1Pk Max		• 1Pk Max				
80 d8µV	M1[1]	75.62 dBµV 433.9200 MHz 80 dBµV	M1[1]	72.70 d8pV 433.9200 MHz		
70 d8µV		70 dBµV				
60 d8µV		60 dBµV				
50 d8µV		50 dBµV		P U		
40 dBµV		40 dBµV				
30 dBµV		30 dBµV				
20 dBµV		20 dBµV				
10 dBµV	men manne	10 dBuV		mmm		
o dBuV-		0 d8µV				
-10 dBµV		-10 dBµV				
CF 433.92 MHz	691 pts Measuring	Span 10.0 MHz CF 433.92 MHz		Span 10.0 MHz		

#### Note.

- 3m Average Limit(dBµV/m) = 20log[41.6667(F(Mlz)-7083.3333) = 80.83
   3m Peak Limit(dBµV/m) = Average limit + 20 = 100.83
   Average Field strength = Peak Field strength + Duty Cycle Correction Factor
- 2. Duty Cycle Correction Factor :  $20\log(Ton / 100 \text{ ms}) = 20\log(8.986 / 100) = -20.93$ Tx on time = 8.986 ms

Tx  $_{on+off} \geq 100 \text{ ms}$  (pulse train is 100 ms)



#### Spurious emission

Test results	(Below 30	MHz)				
Mode:		FSK				
Distance of measurement:		3 meter				
Channel:		1				
Frequency	Level	Ant. Pol.	CF	F <sub>d</sub>	Field strength	

# Frequency<br/>(Mz)Level<br/>(dB $\mu$ N)Ant. Pol.<br/>(H/V)CF<br/>(dB)Fd<br/>(dB)Field strength<br/>(dB $\mu$ N/m)Limit<br/>(dB $\mu$ N/m)Margin<br/>(dB)No spurious emissions were detected within 20 dB of the limit

#### Test plots (Below 30 Mz)

	Horizon	Vertical							
Spectrum 2	8		E						
Ref Level 57.00 dBµV	RBW (6dB) 200 Hz			Ref Level 57.00 dBµV	RBW (6dB) 2				
Att 0 dB SWT 13. 1Pk Max	4 ms  VBW 3 kHz	Mode Auto FFT		Att 0 dB s	SWT 13.4 ms 🖷 VBW	3 kHz Mode Auto	FFT		
		M1[1]	-2.71 d8µV	AFR PRO		M1[1]		-1.62 dB	
50 dBuV			95.210 kHz	S0 dBµV			7 7	94.800 k	
40 dBµV				40 dBµV					
HU OBUV				40 0800					
i0 dBµV				30 dBµV			-		
20 dBuV				20 dBuV-					
U 08µV				20 d8µv					
l0 dBµV		_		10 dBµV					
		1.00				411			
) dBµV		X		0 dBµV-		1			
10 dBpV	manute to some of the party to	to have been been been	user sharehousehouse	-10 dBuV	washing marker and the	there have were	and the second states and s	- all the manufactures	
						792,002			
20 dBµV				-20 dBµV					
30 dBµV				-30 dBµV			_		
40 dBµV-	691 pts		Stop 150.0 kHz	-40 dBµV- Start 9.0 kHz		1 pts		Stop 150.0 kH	
M1 1 95.:		Measuring		M1 1	94.8 kHz -1.62 d		asuring 🚺	KINID 🦇	
Spectrum Spectrum 2 Ref Level 57.00 dBµV	<ul> <li>RBW (6dB) 9 kHz</li> </ul>			Spectrum Spectr Ref Level 57.00 dBµV	rum 2 🛞 🖷 RBW (6d8) 9	kHz			
Spectrum         Spectrum 2           Ref Level 57.00 dBμV         att         0 dB         SWT 2.1	<ul> <li>RBW (6dB) 9 kHz</li> </ul>	ode Auto FFT	, Ţ	Spectrum Spectr Ref Level 57.00 dBµV	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto F#		(	
Spectrum 2 Ref Level 57.00 dBµV Att 0 dB SWT 2.1 01Pk Max	<ul> <li>RBW (6dB) 9 kHz</li> </ul>		.20 dBpV	Spectrum Spectr Ref Lovel 57.00 dBµV Att 0 dB s @1Pk Max	rum 2 🛞 🖷 RBW (6d8) 9	kHz		5.91 d8	
Spectrum 2 Ref Level 57.00 dBµV Att 0 dB SWT 2.1 01Pk Max	<ul> <li>RBW (6dB) 9 kHz</li> </ul>	ode Auto FFT	, Ţ	Spectrum Spectr Ref Level 57.00 dByV Att 0 db s	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto F#		5.91 d8	
Spectrum         Spectrum 2           Ref Level 57.00 dBµV         0 dB         swr 2.1           Att         0 dB         swr 2.1           50 dBµV         0         swr 2.1	<ul> <li>RBW (6dB) 9 kHz</li> </ul>	ode Auto FFT	.20 dBpV	Spectrum Spectr Ref Lovel 57.00 dBµV Att 0 dB s @1Pk Max	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto F#		5.91 d8	
Spectrum         Spectrum 2           Ref Level 57.00 dBµV         0 dB swT 2.1           Att         0 dB swT 2.1           50 dBµV         0           40 dBµV         0	<ul> <li>RBW (6dB) 9 kHz</li> </ul>	ode Auto FFT	.20 dBpV	Spectrum         Spectrum           Ref Level 57.00 dBµV         Att         0 dB s           Ø 1Pk Max         0 dB s         50 dBµV         40 dBµV	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto F#		5.91 d8	
Spectrum         Spectrum 2           Ref Level 57.00 dbµV         0 db swT 2.1           Att         0 db swT 2.1           10k Max         0 db swT 2.1           10 dbµV         0 db swT 2.1	<ul> <li>RBW (6dB) 9 kHz</li> </ul>	ode Auto FFT	.20 dBpV	Spectrum         Spectrum           Ref Level 57.00 dbµ/ Att         0 db s           0 1Pk Max         50 dbµ/	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto F#		5.91 d8	
Spectrum         Spectrum 2           Ref Level 57.00 dbµV         0 db swr 2.1           Att         0 db swr 2.1           1Pk Max         0 db swr 2.1           50 dbµV         0           10 dbµV         0	<ul> <li>RBW (6dB) 9 kHz</li> </ul>	ode Auto FFT	.20 dBpV	Spectrum         Spectrum           Ref Level 57.00 dBµV         Att         0 dB s           Ø 1Pk Max         0 dB s         50 dBµV         40 dBµV	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto F#		5.91 d8	
Spectrum         Spectrum 2           Ref Level         57.00 dBµV           Att         0 dB           91% Max           30 dBµV           40 dBµV           20 dBµV	<ul> <li>RBW (6dB) 9 kHz</li> </ul>	ode Auto FFT	.20 dBpV	Spectrum         Spectrum           Ref Lavel 57.00 d8µV         Att         0 d8           #18k Max         0 d8         S0 d8µV         40 d8µV           40 d8µV         30 d8µV         20 d8µV         40 d8µV	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto F#		5.91 d8	
Spectrum         Spectrum 2           Ref Level 57.00 dbµV         0 db swT 2.1           Att         0 db swT 2.1           10% Max         0 db swT 2.1           100 dbµV         0	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	5.20 dBpV 172.0 kHz	Spectrum         Spectrum           Ref Lavel 57.00 d8µV         Att         0 d8           #19k Max         0 d8         9           \$0 d8µV         40         40           40 d8µV         20         40           20 d8µV         10         40	rum 2 (3)	kHz kHz Mode Auto FI M1[1]	FT	5.91 da 172.0 k	
Spectrum         Spectrum 2           Ref Level 57.00 dBµV         0 dB swT 2.1           Att         0 dB swT 2.1           50 dBµV         0           40 dBµV         0           20 dBµV         0           10 dBµV         0           10 dBµV         0	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	.20 dBpV	Spectrum         Spectrum           Ref Lavel 57.00 d8µV         Att         0 d8           #19k Max         0 d8         9           \$0 d8µV         40         40           40 d8µV         20         40           20 d8µV         10         40	rum 2 🛞 🖷 RBW (6d8) 9	kHz kHz Mode Auto FI M1[1]	FT	5.91 da 172.0 k	
Spectrum         Spectrum 2           Ref Level 57.00 dBµV 0 dB         0 dB         swr 2.1           1Pk Max         0 dB         swr 2.1           1Pk Max         0 dB (0,0)         swr 2.1           10 dBµV         0         swr 3.1	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	5.20 dBpV 172.0 kHz	Spectrum         Spectrum           Ref Level 57.00 dBµV         0 dB s           Att         0 dB s           9 IPk Max         0 dB s           50 dBµV         40 dBµV           40 dBµV         20 dBµV           20 dBµV         10 dBµV           0 dBµV         0 dBµV	rum 2 (3)	kHz kHz Mode Auto FI M1[1]	FT	5.91 da 172.0 k	
Spectrum         Spectrum 2           Ref Level 57.00 dBµV 0 dB         0 dB         swr 2.1           1Pk Max         0 dB         swr 2.1           1Pk Max         0 dB (0,0)         swr 2.1           10 dBµV         0         swr 3.1	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	5.20 dBpV 172.0 kHz	Spectrum         Spectrum           Ref Lavel 57.00 d8µV         Att         0 d8           #19k Max         0 d8         9           \$0 d8µV         40         40           40 d8µV         20         40           20 d8µV         10         40	rum 2 (3)	kHz kHz Mode Auto FI M1[1]	FT	5.91 dB 172.0 k	
Spectrum         Spectrum 2           Ref Level 57.00 dbµ/ Att         0 db         swr 2.1           19k Max         0 db         swr 2.1           10 dbµ/ 10 dbµ/         0 db         swr 2.1           10 dbµ/ 10 dbµ/         0 db         swr 2.1           10 dbµ/ 10 dbµ/         0 dbµ/ 10 dbµ/         0 dbµ/ 10 dbµ/           10 dbµ/ 10 dbµ/         10 dbµ/         0 dbµ/	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	5.20 dBpV 172.0 kHz	Spectrum         Spectrum           Ref Level 57.00 dBµV         0 dB s           Att         0 dB s           9 IPk Max         0 dB s           50 dBµV         40 dBµV           40 dBµV         20 dBµV           20 dBµV         10 dBµV           0 dBµV         0 dBµV	rum 2 (3)	kHz kHz Mode Auto FI M1[1]	FT	5.91 dB 172.0 k	
Spectrum         Spectrum         2           Ref Level         57.00 dbµV         0 db         swrt 2.1           Att         0 db         swrt 2.1         0 db         swrt 2.1           91Pk Max         0 db         swrt 2.1         0 db yv	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	5.20 dBpV 172.0 kHz	Spectrum         Spectrum           Ref Level 57.00 dbµ/ Att         0 db y           0 db y         0 db y           1Pk Max         0 db y           50 dbµ/ 40 dbµ/         0 db y           30 dbµ/ 30 dbµ/         0 db y           20 dbµ/ 10 dbµ/         0 db y           -10 dbµ/ -20 dbµ/         0 dbµ/	rum 2 (3)	kHz kHz Mode Auto FI M1[1]	FT	5.91 din 172.0 k	
Spectrum         Spectrum         2           Ref Level         57.00 dBµV         0 dB         swrt 2.1           Att         0 dB         swrt 2.1         0 dB         swrt 2.1           D1Pk Max         0 dB µV         0         swrt 2.1         0           30 dBµV         0         0         swrt 2.1         0         swrt 2.1           30 dBµV         0         0         swrt 2.1         0         swrt 2.1           30 dBµV         0         0         swrt 2.1         0         swrt 2.1           10 dBµV         0         swrt 3.1         10 dBµV         10 dBµV         10         swrt 3.1         10         swrt 3.1         10         swrt 3.1         swrt 3.1         swrt 3.1         10         swrt 3.1         swrt 3.1 <t< td=""><td>(6dB) 9 kHz ms • VBW 100 kHz Mi</td><td>MI[1]</td><td>5.20 dBpV 172.0 kHz</td><td>Spectrum         Spectrum           Ref Level 57.00 dbµV         0 db s           Att         0 db s           9 IPk Max         0 db s           50 dbµV         0 db s           40 dbµV         0 db y           30 dbµV         0 dbµV           20 dbµV         0 dbµV           10 dbµV         0 dbµV           -10 dbµV         0 dbµV</td><td>rum 2 (3)</td><td>kHz kHz Mode Auto FI M1[1]</td><td>FT</td><td>5.91 dB 172.0 k</td></t<>	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	5.20 dBpV 172.0 kHz	Spectrum         Spectrum           Ref Level 57.00 dbµV         0 db s           Att         0 db s           9 IPk Max         0 db s           50 dbµV         0 db s           40 dbµV         0 db y           30 dbµV         0 dbµV           20 dbµV         0 dbµV           10 dbµV         0 dbµV           -10 dbµV         0 dbµV	rum 2 (3)	kHz kHz Mode Auto FI M1[1]	FT	5.91 dB 172.0 k	
Spectrum         Spectrum 2           Ref Level 57.00 dBµY         0 dB swT 2.1           19k Max         0 dB swT 2.1           19k Max         0 dB swT 2.1           10 dBµY         0	Image: Billing of the second	MI[1]	5.20 dBpv 172.0 kHz	Spectrum         Spectrum           Ref Level 57.00 dbµV         att 0 db s           Att 0 db s         0 db s           ● 1Pk Max         50 dbµV           50 dbµV         40 dbµV           30 dbµV         20 dbµV           10 dbµV         10 dbµV           -20 dbµV         -30 dbµV           -30 dbµV         -40 dbµV	rum 2 ③	Here Here Male Auto FF Male	FT	5.91 da 172.0 k	
Spectrum         Spectrum         2           Ref Level         57.00 dbµV         0 db         SWT 2.1           Att         0 db         SWT 2.1         0 db         SWT 2.1           10 dbµV         0 db         SWT 2.1         0 db         SWT 2.1           10 dbµV         0 db         SWT 2.1         0 dbµV         0 dbµV           10 dbµV         0 dbµV         0 dbµV         0 dbµV         0 dbµV           10 dbµV         0 dbµV         0 dbµV         0 dbµV         0 dbµV           20 dbµV         0 dbµV	(6dB) 9 kHz ms • VBW 100 kHz Mi	MI[1]	5.20 dBpV 172.0 kHz	Spectrum         Spectrum           Ref Level 57.00 dbµv         Att           Att         0 db s           9 IPk Max         0 db s           50 dbµv         40 dbµv           40 dbµv         20 dbµv           20 dbµv         20 dbµv           10 dbµv         -10 dbµv           -10 dbµv         -20 dbµv           -30 dbµv         -30 dbµv           -30 dbµv         -30 dbµv           -30 dbµv         -30 dbµv           -30 dbµv         -30 dbµv	rum 2 ③	kHz kHz Mode Auto FI M1[1]	FT	5.91 da 172.0 k	
Spectrum         Spectrum 2           Ref Level 57.00 dbµV         0 db swT 2.1           1Pk Max         0 db swT 2.1           1Pk Max         0 db swT 2.1           00 dbµV         0           10 dbµV         0           00 dbµV         0           10 dbµV         0           10 dbµV         0           10 dbµV         0           20 dbµV         0           20 dbµV         0           10 dbµV	Image: Second	nde Auto FFT	5.20 dBpv 172.0 kHz	Spectrum         Spectrum           Ref Level 57.00 dbµV         Att         0 db s           PIPk Max         0 db s         9           S0 dbµV         0 db s         9           40 dbµV         0 db s         9           30 dbµV         10 dbµV         10 dbµV           10 dbµV         10 dbµV         10 dbµV           -30 dbµV         -30 dbµV         -30 dbµV           -30 dbµV         -30 dbµV         -30 dbµV           -40 dbµV         -40 dbµV         -40 dbµV	rum 2 ③	Here KHZ KHZ Mode Auto FF M3[1] M3[1] Low note on State Lon Low note on State Long Low note on State Low note on State Long Lo	FT	5.91 da 172.0 k	
Spectrum         Spectrum         2           Ref Level         57.00 dbµV         0 db         SWT 2.1           Att         0 db         SWT 2.1         0 db W           10 dbµV         0 dbµV         0 dbµV         0 dbµV           10 dbµV         0 dbµV         0 dbµV         0 dbµV           10 dbµV         0 dbµV         0 dbµV         0 dbµV           20 dbµV         10 dbµV         10 dbµV         10 dbµV           20 dbµV         10 dbµV         10 dbµV         10 dbµV           10 dbµV         10 dbµV         10 dbµV         10 dbµV	Image: Second	nde Auto FFT	Stop 30.0 MHz	Spectrum         Spectrum           Ref Level 57.00 dbµ/ Att         0 db s           0 1Pk Max         0 db s           1Pk Max         0 db s           50 dbµ/ 40 dbµ/         0 db s           30 dbµ/ 20 dbµ/         0 db s           10 dbµ/ -0 dbµ/         0 db s           -30 dbµ/ -30 dbµ/         0 db s/ -30 dbµ/           -30 dbµ/ -40 dbµ/         0 db s/ -30 dbµ/           -30 dbµ/ -40 dbµ/         0 db s/ -30 dby/	rum 2 ③	Here Node Auto FI	FT	5.91 dB 172.0 k	

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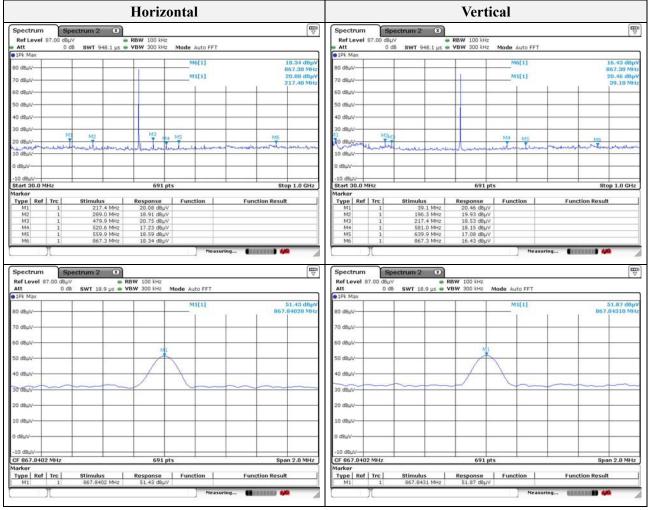
#### Test results (Below 1 000 Mz)

Mode: FSK

Distance of measurement: 3 meter Channel: 1

Frequency (Mat)	Level (dBµV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBµN/m)	Limit (dBµN/m)	Margin (dB)
39.10	20.46	Peak	V	12.64	-	33.10	40.00	6.90
217.40	20.08	Peak	Н	12.53	-	32.61	46.00	13.39
479.90	20.75	Peak	Н	18.15	-	38.90	46.00	7.10
599.90	18.50	Peak	Н	20.81	-	39.31	46.00	6.69
867.84	51.43	Peak	Н	-7.88	-	45.35	80.83	35.48
867.84	51.87	Peak	V	-7.88	-	45.79	80.83	35.04

#### Test plots (Below 1 000 Mz)



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#### Test results (Above 1 000 Mz)

Mode: FSK

Distance of measurement: 3 meter Channel: 1

Frequency (Mz)	Level (dBµV)	Detect mode	Ant. Pol. (H/V)	CF (dB)	DCF (dB)	Field strength (dBµN/m)	Limit (dBµV/m)	Margin (dB)
*1 303.90	57.88	Peak	Н	-7.91	-	49.97	74.00	24.03
*1 303.90	58.47	Peak	V	-7.91	-	50.56	74.00	23.44
1 738.10	46.55	Peak	Н	-4.79	-	41.76	80.83	39.07
1 738.10	51.34	Peak	V	-4.79	-	46.55	80.83	34.28
2 172.20	38.33	Peak	Н	-1.49	-	36.84	80.83	43.99
2 172.20	40.85	Peak	V	-1.49	-	39.36	80.83	41.47
2 606.40	42.34	Peak	Н	0.74	-	43.08	80.83	37.75
2 606.40	41.24	Peak	V	0.74	-	41.98	80.83	38.85
3 040.50	40.45	Peak	Н	2.39	-	42.84	80.83	37.99
3 040.50	42.03	Peak	V	2.39	-	44.42	80.83	36.41
3 468.90	49.09	Peak	Н	2.17	-	51.26	80.83	29.57
3 468.90	47.75	Peak	V	2.17	-	49.92	80.83	30.91
*3 908.80	36.67	Peak	Н	4.17	-	40.84	74.00	33.16
*3 908.80	42.54	Peak	V	4.17	-	46.71	74.00	27.29
4 337.19	41.09	Peak	Н	5.46	-	46.55	80.83	34.28
4 337.19	37.58	Peak	V	5.46	-	43.04	80.83	37.79

#### Note.

- 3m PeakLimit(dBµN/m) = 20log[41.6667(F(Mk)-7083.3333) = 80.83 3m Average Limit(dBµN/m) = Peak limit - 20 = 60.83 Average Field strength = Peak Field strength + Duty Cycle Correction Factor
- 2. Correction Factors = Antenna Factor + Cable Loss + Amp.Gain
- 3. "\*"means the restricted band.
- 4. Average test would not be applied if the peak results were lower than the average limit.
- 5. Duty Cycle Correction Factor : 20log(Ton / 100 ms) = 20log(8.986 / 100) = -20.93 Tx on time = 8.986 ms

Tx  $_{on+off} \ge 100 \text{ ms}$  (pulse train is 100 ms)



Test report No.: KES-RF-16T0094-R1 Page (15 ) of (22)

### Test plots (Above 1 000 Mz)

			Horizo	ntal			Vertical							
Spectrum	Spe	ectrum 2 🛞					Spectrum	Spe	ectrum 2 🛞					
Ref Level 81	7.00 dBuV	· RB	W 1 MHz				Ref Level 87	.00 dBuV	· RB	W 1 MHz				
Att	0 dB	SWT 4 ms . VB	W 3 MHz Mode	Auto Sweep			Att	0 dB	SWT 4 ms . VB	W 3 MHz Mode	Auto Sweep			
1Pk Max							1Pk Max							
80 dBuV				M8[1]		V48b 90.1	BO dBuV				M8[1]			37.58 dBµ
						3719 GHz								4.33719 GH
70 dBuV				M1[1]		0390 GHz	70 dBµV				M1[1]			58.47 dBp
60 dBuV		-			1.3	0390 GHZ	60 dBuV			-		1	1	1.30390 CH
	N/2			M6				M2			MG			
50 dBµV	V A		M4 Ar	1	MB		50 dBµV		Ma	M4 M5	T	M7	-	
souther		Dun M3	T T				1 Sort Sale me	annul l		¥ 7		T	MB	
to uppe		manna	requiredes	mahre	margh burgers & hours	whitewas		0.000	monturno	mannen	undre	mandrene	and a second	a men s
30 dBµV							30 dBµV							
20 dBuV							20 dBµV							
10 dBµV							10 dBµV						-	
0 dBuV							0 dBuV							
													1	
-10 d8µV			-				-10 d8µV					_	1	-
Start 1.0 GH	2		691 pts		Stop	5.0 GHz	Start 1.0 GH;	2		691 pt	5		St	top 5.0 GHz
Marker		5000000000 gr					Marker							
Type   Ref		Stimulus	Response	Function	Function Result		Type   Ref	Trc	Stimulus	Response	Function	Fur	ction Resu	lt
M1	1	1.3039 GHz	57.88 dBµV				M1	1	1.3039 GHz	58.47 dBµV				
M2 M3	1	1.7381 GHz 2.1722 GHz	46.55 dBµV 38.33 dBµV				M2 M3	1	1.7381 GHz 2.1722 GHz	51.34 dBµV 40.85 dBµV				
M3 M4	1	2.1722 GH2 2.6064 GHz	42.34 dBµV				M3 M4	1	2.1722 GH2 2.6064 GHz	40.85 dBµV 41.24 dBµV				
MS	1	3.0405 GHz	40.45 dBµV				MS	1	3.0405 GHz	42.03 dBµV				
M6	1	3.4689 GHz	49.09 dBuV				M6	1	3.4689 GHz	47.75 dBµV				
M7	1	3.9088 GHz	36.67 dBµV				M7	1	3.9088 GHz	42.54 dBµV				
MB	1	4.33719 GHz	41.09 dBµV				MB	1	4.33719 GHz	37.58 dBµV				
	1	the second se	and the second					-	the second se	arrive weeks				
				Mea	asuring 📲 📰 📲 🗰	1		1			Mea	suring 🔳	REFERENCE 4	



#### **3.2.** Bandwidth of operation frequency

Test setup



#### **Test procedure**

1. Use the following spectrum analyzer setting

- 2. RBW = 10 kHz
- 3. VBW = 30 kHz ( $\geq$  RBW)
- 4. Span = 1 MHz
- 5. Detector function = peak
- 6. Trace = max hold

#### Limit

The bandwidth of the emissions shall be no wider than 0.25 % of the center frequency for devices operating above 70 Mz and below 900 Mz. Bandwidth is determined at the points 20 dB down from the modulated carrier.

#### **Test results**

Frequency(Mz)	Bandwidth( <sup>kHz</sup> )	Limit ( <sup>kHz</sup> )
433.92	189.6	1 084.80

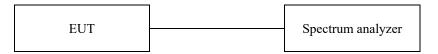


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#### **3.3.** Transmission time

Test setup



#### **Test procedure**

- 1. Place the EUT on the table and set it in transmitting mode.
- 2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- 3. Set center frequency of spectrum analyzer = operating frequency.
- 4. Set the spectrum analyzer as RBW=100 kHz, VBW=100 kHz, Span=0 Hz.

#### Limit

A transmitter activated automatically shall cease transmission within 5 seconds after activation.

#### **Test results**

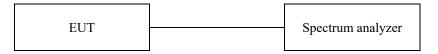
Frequency(Mz)	Transmission time (ms)	Limit (s)
433.92	8.696	Same or less than 5

Offset 10.80 dB ● RBW 100 k SWT 500 ms ● VBW 100 k			Ref Level 20.00 dBm Offs Att 25 dB · SWT	t 10.83 dB • RBW 1 MHz 6 s • VBW 1 MHz		
			SGL	OF THE		
			9 1Pk Clrw			
M1 D2	D2[1] 	-1,00 dB 8,696 ms 8,62 dBm 181,159 ms	0 dBm-		02[1] M1[1]	-56.22 5.0000 10.04 di 243.48
			-10 dBm			
			-20 dBm			
			-30 dBm			
			-40 d8m			D2 .
			-50 dBm	and the second of the second o	na sa	Service and the service of the servi
whether when we have a service of the service of th	the manufacture and a brought the start	www.matabanagadalaiga	-60 dBm			
			-70 d8m			
691		50.0 ms/	CF 433.92 MHz	691 pts		600.0 m
		691 pts	691 pts 50.0 ms/	0 dbn           -10 dbn	0 dbm       0 dbm <t< td=""><td>0     0     0     0     0     0     0     0       1     1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       20     28m     3     3     3     1     1     1       20     28m     1     1     1     1</td></t<>	0     0     0     0     0     0     0     0       1     1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       1     1     1     1     1     1     1     1       20     28m     3     3     3     1     1     1       20     28m     1     1     1     1



#### **3.4.** Duty cycle correction factor

Test setup



#### **Test procedure**

1. The transmitter output is connected to the spectrum analyzer.

- 2. Set center frequency of spectrum analyzer = operating frequency.
- 3. Set the spectrum analyzer as RBW=100 kHz, VBW=100 kHz, Span=0 Hz and Sweep time =100 ms.

#### Limit

None (No dedicated Limit specified in the Rules)

#### **Test results**

Duty Cycle Correction Factor :  $20\log(Ton / 100 \text{ ms}) = 20\log(8.986 / 100) = -20.93$ 

Tx <sub>on time</sub> = 8.986 ms

Tx  $_{on+off} \ge 100 \text{ ms}$  (pulse train is 100 ms)

1Pk Clrw								
10 dBm			M1	D2[ D2 M1[				-1.03 dE 8.986 m 8.62 dBn 45.942 m
0 dBm								
-10 dBm			_					
-20 dBm	-							
-30 dBm			_					
-40 dBm								
-50 dBm								
ogelpane uterfolge	An Marthallower	Monteration	www	Hilen/o	white the	Happle Harber	Han adalation	hand balanda
-70 dBm						1991		

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#### 3.5. AC conducted emissions

#### Limit

According to 15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50uH/50 ohm line impedance stabilization network (LISN). Compliance with the provision of this paragraph shall on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower applies at the boundary between the frequencies ranges.

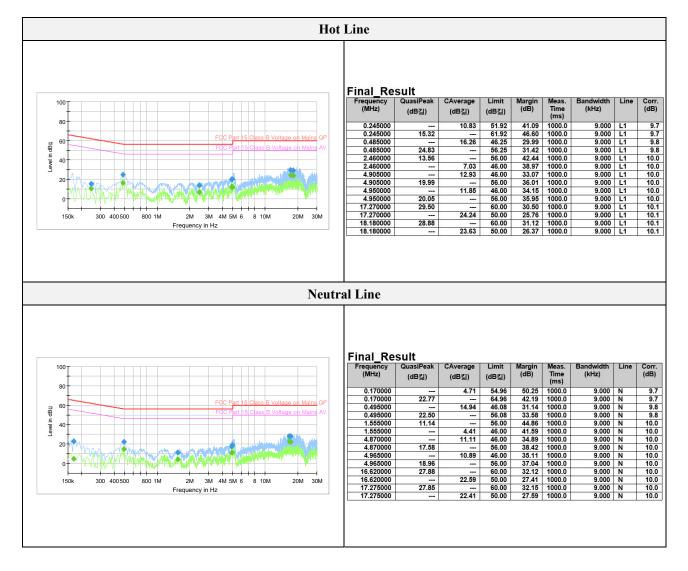
Enguara of Emission (Mg)	Conducted limit (dBµN/m)				
Frequency of Emission (Mz)	Quasi-peak	Average			
0.15 - 0.50	66 - 56*	56 - 46*			
0.50 - 5.00	56	46			
5.00 - 30.0	60	50			

#### Note.

- 1. All AC line conducted spurious emission are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and the appropriate frequencies. All data rates and modes were investigated for conducted spurious emission. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section.
- 3. Both Cable loss and LISN factor are included in measurement level.(QP Level or AV Level).



#### Test results





Equipment	Manufacturer	Model	Serial No.	Calibration interval	Calibration due
Spectrum Analyzer	R&S	FSV30	10076	1 year	2017.07.06
8360B Series Swept Signal Generator	HP	83630B	3844A00786	1 year	2017.01.25
PSG Analog Signal Generator	AGILENT	E8257C	US42340237	1 year	2017.07.05
DC Power Supply	HP	6674A	US36370369	1 year	2017.07.04
Attenuator	Agilent	8493C	51401	1 year	2017.07.05
Loop Antenna	R&S	HFH2- Z2.335.4711.52	826532	2 years	2017.03.03
Trilog-broadband antenna	SCHWARZBECK	VULB 9163	9168-713	2 years	2017.05.15
Horn Antenna	A.H.	SAS-571	781	2 years	2017.05.07
High Pass Filter	WAINWRIGHT INSTRUMENT	WHJS3000-10TT	1	1 year	2017.07.04
Low Pass Filter	WEINSCHEL	WLK1.0/18G-10TT	1	1 year	2017.07.04
Preamplifier	SCHWARZBECK	BBV-9718	9718-246	1 year	2016.10.23
EMI Test Receiver	R&S	ESR3	101781	1 year	2017.05.03
EMI Test Receiver	R&S	ESU26	100552	1 year	2017.04.24
EMI Test Receiver	R&S	ESR3	101783	1 year	2017.05.03
LISN	R&S	ENV216	101137	1 year	2017.02.04

#### Appendix A. Measurement equipment

#### **Peripheral devices**

Device	Manufacturer	Model No.	Serial No.
Notebook	SAMSUNG	NT-R519-BA24J	ZKPA93ES900086Z