

ANNEX A_EMI TEST RESULT

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1. GENERAL INFORMATION

1.1 Details of Support Equipment

All equipment descriptions used in the tested system (including inserted cards) are:

Device Type	Model Name	Manufacturer	Tech. Information
EUT	SM-A202F/DS	SAMSUNG	-
Battery	EB-BA202ABU	BYD	-
TA	EP-TA200	SOLUM	Input: AC 100~240 V, 50~60 Hz, 0.5 A Output: DC 9.0 V, 1.67 A or DC 5.0 V, 2.0 A
Data Cable	EP-DR140AWE	KSD	-
Ear-jack	EHS61ASFWE	CRESYN	-

1.2. Test Facility

Test site is located at 74, SEOICHEON-RO, 578BEON-GIL, MAJANG-MYEON, ICHEON-SI, GYEONGGI-DO, SOUTH KOREA. Those measurement facilities are constructed in conformance with the requirements of ANSI C63.4-2014. The Normalized site attenuations (30 MHz to 1 GHz) and Site validation (1 GHz to 18 GHz) were performed in accordance with the standard in ANSI C63.4-2014

Measurement Facilities	Registration Number
Radiated Field strength measurement facility 3 m Semi Anechoic chamber	90661
Radiated Field strength measurement facility 10 m Semi Anechoic chamber	

1.3 Calibration of Measuring Instrument

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturers recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2006).

1.4 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014.

All measurement uncertainty values are shown with a coverage factor of $k = 2$ to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (dB)
Conducted Emission (0.15 MHz to 30 MHz)	1.82 dB
Radiated Emissions (30 MHz to 1 GHz)	5.20 dB
Radiated Emissions (1 GHz to 18 GHz)	5.24 dB
Radiated Emissions (18 GHz to 40 GHz)	5.40 dB

2. LIST OF TEST EQUIPMENT

Type	Manufacturer	Model Name	Serial Number	Calibration Cycle	CAL Date
<u>Conducted Emission</u>					
☒ EMI Test Receiver	Rohde & Schwarz	ESCI	100033	1 year	06.27.2018
☒ LISN	Rohde & Schwarz	ENV216	102245	1 year	12.12.2018
☐ LISN	Rohde & Schwarz	ENV216	100073	1 year	05.03.2018
☒ Radio communication analyzer	ANRITSU	MT8820C	6201138643	1 year	08.21.2018
☒ Antenna (for Communication)	Schwarzbeck	USLP9142	VSLP 9142-200	-	-
☒ Software	Rohde & Schwarz	EMC32 VER8.54.0	-	-	-
<u>Radiated Emission</u>					
-For measurement below 1 GHz					
☒ EMI Test Receiver	Rohde & Schwarz	ESU40	100524	1 year	07.27.2018
☒ Trilog Antenna	Schwarzbeck	VULB 9168	760	2 year	03.22.2019
☒ Antenna master	INNCO Systems	MA4640-XP-ET	-	N/A	-
☒ Antenna master controller	INNCO Systems	CO 3000	CO3000/870/ 35990515/L	N/A	-
☒ Turn Table	INNCO Systems	1060	-	N/A	-
☒ Turn Table controller	INNCO Systems	CO2000	CO2000/095/ 7590304/L	N/A	-
☒ Radio communication analyzer	ANRITSU	MT8820C	6201138643	1 year	08.21.2018
☒ Antenna (for Communication)	Schwarzbeck	USLP9142	VSLP 9142-200	-	-
☒ Software	Rohde & Schwarz	EMC32 VER8.40.0	-	-	-
-For measurement above 1 GHz					
☒ EMI Test Receiver	Rohde & Schwarz	ESU40	100524	1 year	07.27.2018
☒ Antenna master	INNCO Systems	MA4640-XP-ET	-	N/A	-
☒ Antenna master controller	INNCO Systems	CO3000	CO3000/870/ 35990515/L	N/A	-
☒ Turn Table	INNCO Systems	1060	-	N/A	-
☒ Turn Table controller	INNCO Systems	CO2000	CO2000/095/ 7590304/L	N/A	-
☒ Horn Antenna	Schwarzbeck	BBHA 9120D	01836	2 year	07.20.2018
☒ Low Noise Amplifier	TESTEK	TK-PA18H	170034-L	1 year	03.04.2019
☐ Power Amplifier	TESTEK	TK-PA1840H	170030-L	1 year	12.17.2018
☐ Horn Antenna	Schwarzbeck	BBHA 9170	BBHA9170#786	2 year	12.05.2017
☒ Radio communication analyzer	ANRITSU	MT8820C	6201138643	1 year	08.21.2018
☒ Antenna (for Communication)	Schwarzbeck	USLP9142	VSLP 9142-200	-	-
☐ Highpass Filter	Wainwright Instruments	WHKX1.0/15G-12SS	42	1 year	08.02.2018
☒ Software	Rohde & Schwarz	EMC32 VER8.40.0	-	-	-

3. DESCRIPTION OF MEASUREMENTS

3.1 Measurement of Conducted Emission

The test procedure was in accordance with ANSI C63.4-2014, Clause 7.3

- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN).

If the EUT is connected to the PC through USB, the AC power-line adapter of the PC is directly connected to a line impedance stabilization network (LISN).

Other support units were connected to the power mains through another LISN. The two LISNs provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

- b. Both conducted lines are measured in Quasi-Peak and Average mode, including the worst-case data points for each tested configuration.
- c. The frequency range from 150 kHz to 30 MHz was searched.

[Conducted Emission Limits]

Frequency (MHz)	Resolution Bandwidth (kHz)	Quasi-Peak (dB(μV))	Average (dB(μV))
0.15 to 0.5	9	66 to 56*	56 to 46*
0.5 to 5	9	56	46
5 to 30	9	60	50

**Decreases with the logarithm of the frequency.*

3.2 Measurement of Radiated Emission

The test procedure was in accordance with ANSI C63.4-2014, Clause 8.3

- The EUT was placed on the top of a turn table 0.8 meters above the ground at a semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- The EUT was set 3 m away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- The antenna height is varied from 1 m to 4 m above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 m to 4 m and the turn table was turned from 0 degrees to 360 degrees to find the maximum reading.
- The test-receiver system was set to Quasi-Peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- The test-receiver system was set to Peak and Average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz.
- Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response.(1 GHz to 40 GHz)

[Radiated Emission Limits]

Frequency (MHz)	Antenna Distance (m)	Field Strength ($\mu\text{V}/\text{m}$)	Quasi-Peak ($\text{dB}(\mu\text{V})/\text{m}$)
30 to 88	3	100	40.0
88 to 216	3	150	43.5
216 to 960	3	200	46.0
Above 960	3	500	54.0
Frequency (MHz)	Antenna Distance (m)	Peak ($\text{dB}(\mu\text{V})/\text{m}$)	Average ($\text{dB}(\mu\text{V})/\text{m}$)
Above 1 000	3	74	54

3.2.1 Frequency Range of Radiated Measurements

An unintentional radiator, including a digital device, the spectrum shall be investigated from the lowest radio frequency signal generated or used in the device, without going below the lowest frequency for which a Radiated Emission limit is specified, up to the frequency shown in the following table

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705 to 108	1 000
108 to 500	2 000
500 to 1 000	5 000
Above 1 000	5 th harmonic of the highest frequency or 40 GHz, whichever is lower

4. PRELIMINARY TEST

During preliminary tests, the following operating mode was investigated.

GSM 850 Idle
WCDMA Idle
LTE B5 Idle

NOTE.

1. The worst band is tested.

4.1 Conducted Emission

It was tested the following operating mode, after connecting all peripheral devices.

Operating Modes:

LTE B5 Idle (Low CH)
LTE B5 Idle (Middle CH)
LTE B5 Idle (High CH)

NOTE.

1. The worst case of operating mode is reported.

4.2 Radiated Emission

It was tested the following operating mode, after connecting all peripheral devices.

Operating Modes:

LTE B5 Idle (Low CH)
LTE B5 Idle (Middle CH)
LTE B5 Idle (High CH)

NOTE.

1. Three orientations have been investigated and the worst case orientation is reported.
2. The worst case of operating mode is reported.

5. CONDUCTED AND RADIATED EMISSION TEST SUMMARY

5.1 Conducted Emission

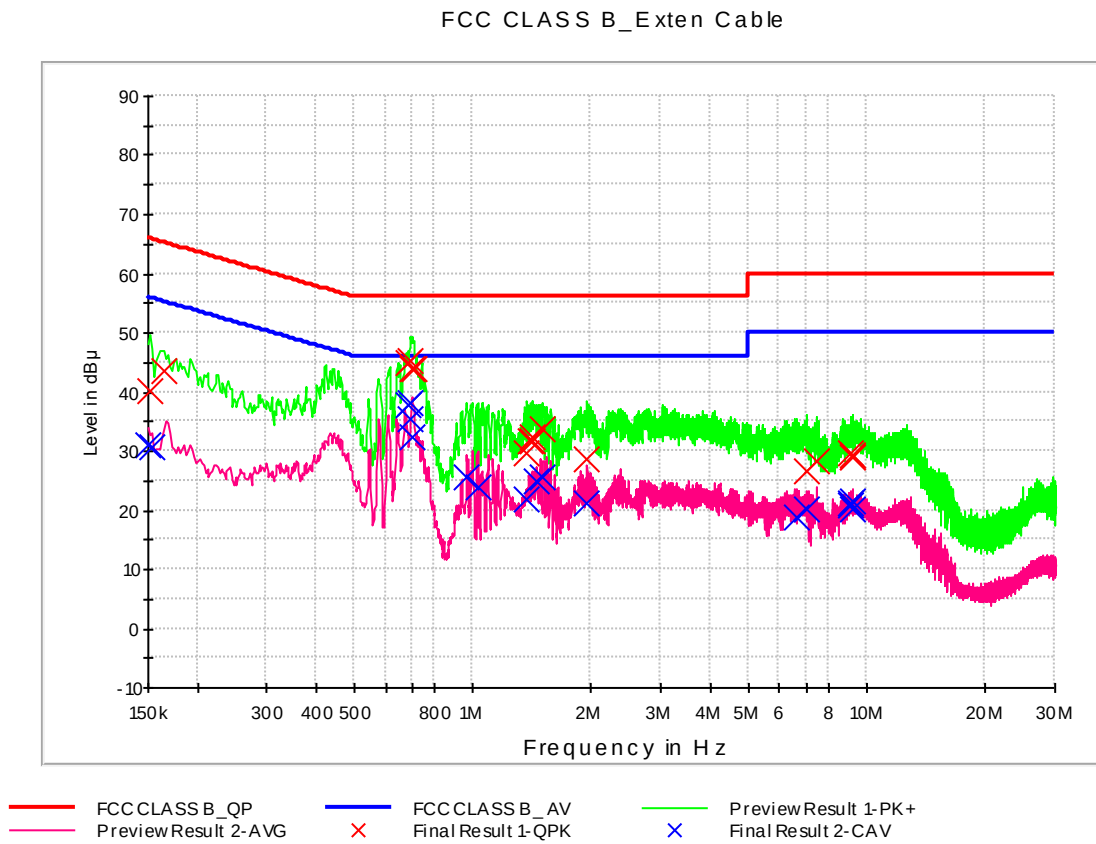
The test results of conducted emission at mains ports provide the following information:

Applicable Standards	FCC PART 15 Subpart B Class B ANSI C63.4-2014
Detector	Quasi-Peak, CISPR-Average
Bandwidth	9 kHz (6 dB)
Worst Case of Operating Mode	LTE B5 Low CH Idle
Kind of Test Site	Shielded Room
Temperature	21.5 °C
Relative Humidity	42.6 %
Test Date	March 27, 2019

- Calculation Formula:

1. Conductor L1 = Hot, Conductor N = Neutral
2. Corr. = LISN Factor + Cable Loss
3. QuasiPeak or CAverage= Receiver Reading + Corr.
4. Margin = Limit – QuasiPeak or CAverage

Figure 1: Conducted Emission, LTE B5 Low CH Idle, Line (L1)



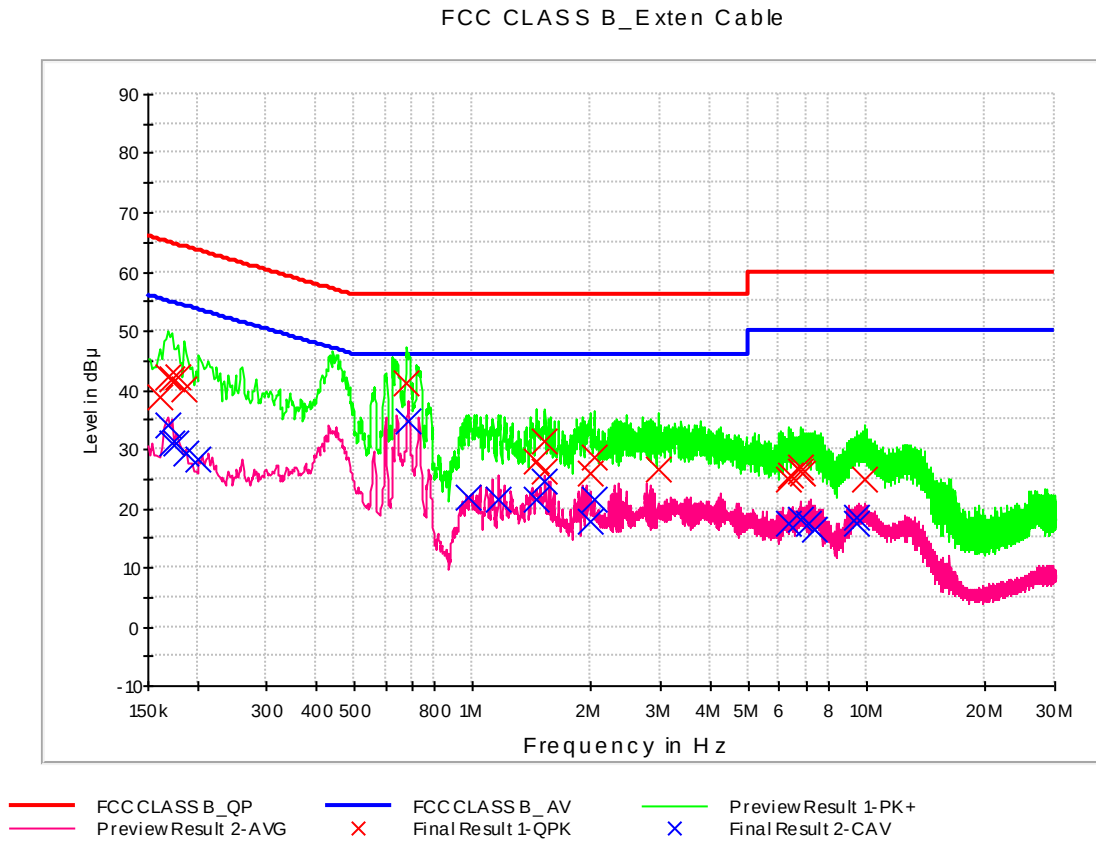
QuasiPeak Final Result, Line (L1)

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.152000	40.3	9.000	L1	9.7	25.6	65.9
0.164000	43.4	9.000	L1	9.7	21.8	65.3
0.686000	45.0	9.000	L1	9.8	11.0	56.0
0.696000	45.2	9.000	L1	9.8	10.8	56.0
0.704000	43.9	9.000	L1	9.8	12.1	56.0
0.708000	43.9	9.000	L1	9.8	12.1	56.0
1.374000	29.7	9.000	L1	9.9	26.3	56.0
1.408000	31.6	9.000	L1	9.9	24.4	56.0
1.418000	31.7	9.000	L1	9.9	24.3	56.0
1.422000	32.4	9.000	L1	9.9	23.6	56.0
1.506000	33.7	9.000	L1	9.9	22.3	56.0
1.954000	28.6	9.000	L1	9.8	27.4	56.0
7.062000	26.7	9.000	L1	10.1	33.3	60.0
7.488000	28.4	9.000	L1	10.1	31.6	60.0
9.134000	29.7	9.000	L1	10.2	30.3	60.0
9.164000	29.1	9.000	L1	10.2	30.9	60.0
9.186000	28.9	9.000	L1	10.2	31.1	60.0
9.230000	29.3	9.000	L1	10.2	30.7	60.0

CAverage Final Result, Line (L1)

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.150000	31.0	9.000	L1	9.7	25.0	56.0
0.154000	30.8	9.000	L1	9.7	25.0	55.8
0.686000	38.0	9.000	L1	9.8	8.0	46.0
0.692000	38.3	9.000	L1	9.8	7.7	46.0
0.696000	35.5	9.000	L1	9.8	10.5	46.0
0.700000	32.5	9.000	L1	9.8	13.5	46.0
0.966000	25.6	9.000	L1	9.8	20.4	46.0
1.028000	23.9	9.000	L1	9.8	22.1	46.0
1.374000	22.0	9.000	L1	9.9	24.0	46.0
1.452000	24.9	9.000	L1	9.9	21.1	46.0
1.506000	25.5	9.000	L1	9.9	20.5	46.0
1.954000	21.2	9.000	L1	9.8	24.8	46.0
6.650000	19.0	9.000	L1	10.1	31.0	50.0
7.060000	20.1	9.000	L1	10.1	29.9	50.0
9.116000	21.3	9.000	L1	10.2	28.7	50.0
9.134000	20.9	9.000	L1	10.2	29.1	50.0
9.164000	20.2	9.000	L1	10.2	29.8	50.0
9.168000	21.6	9.000	L1	10.2	28.4	50.0

Figure 2: Conducted Emission, LTE B5 Low CH Idle, Line (N)



QuasiPeak Final Result, Line (N)

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.160000	38.9	9.000	N	9.8	26.6	65.5
0.168000	42.3	9.000	N	9.8	22.7	65.1
0.172000	41.8	9.000	N	9.8	23.1	64.9
0.178000	42.1	9.000	N	9.8	22.5	64.6
0.186000	40.1	9.000	N	9.8	24.1	64.2
0.682000	41.2	9.000	N	9.9	14.8	56.0
1.448000	27.8	9.000	N	10.1	28.2	56.0
1.518000	26.4	9.000	N	10.1	29.6	56.0
1.528000	31.4	9.000	N	10.1	24.6	56.0
1.980000	25.8	9.000	N	10.0	30.2	56.0
2.036000	28.8	9.000	N	10.0	27.2	56.0
2.962000	26.6	9.000	N	10.1	29.4	56.0
6.364000	24.9	9.000	N	10.3	35.1	60.0
6.412000	25.7	9.000	N	10.3	34.3	60.0
6.818000	26.4	9.000	N	10.3	33.6	60.0
6.824000	26.9	9.000	N	10.3	33.1	60.0
6.864000	25.8	9.000	N	10.3	34.2	60.0
9.842000	25.0	9.000	N	10.4	35.0	60.0

CAverage Final Result, Line (N)

Frequency (MHz)	CAverage (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.168000	34.0	9.000	N	9.8	21.1	55.1
0.172000	30.9	9.000	N	9.8	24.0	54.9
0.176000	31.0	9.000	N	9.8	23.7	54.7
0.188000	29.2	9.000	N	9.8	24.9	54.1
0.202000	28.3	9.000	N	9.9	25.2	53.5
0.686000	34.9	9.000	N	9.9	11.1	46.0
0.978000	21.8	9.000	N	10.0	24.2	46.0
1.166000	21.5	9.000	N	10.0	24.5	46.0
1.448000	21.5	9.000	N	10.1	24.5	46.0
1.528000	24.6	9.000	N	10.1	21.4	46.0
1.980000	17.9	9.000	N	10.0	28.1	46.0
2.036000	21.5	9.000	N	10.0	24.5	46.0
6.364000	17.5	9.000	N	10.3	32.5	50.0
6.818000	18.2	9.000	N	10.3	31.8	50.0
7.106000	17.4	9.000	N	10.3	32.6	50.0
7.354000	16.5	9.000	N	10.4	33.5	50.0
9.388000	18.5	9.000	N	10.4	31.5	50.0
9.416000	17.6	9.000	N	10.4	32.4	50.0

5.2 Radiated Emission

The test results of radiated emission provide the following information:

-For Measurement Below 1 GHz

Applicable Standards	FCC PART 15 Subpart B Class B ANSI C63.4-2014
Detector	Quasi-Peak
Bandwidth	120 kHz (6 dB)
Worst Case of Operating Mode	LTE B5 Low CH Idle
Kind of Test Site	3 m semi anechoic chamber
Temperature	23.5 °C
Relative Humidity	42.9 %
Test Date	March 26, 2019

Frequency (MHz)	Quasi Peak (dBμV/m)	Antenna Height (cm)	POL. (H/V)	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
40.314400	37.0	100.0	V	52.0	19.6	3.0	40.0
42.164000	35.5	100.0	V	145.0	19.7	4.5	40.0
60.025600	27.0	100.0	V	30.0	19.7	13.0	40.0
93.728000	28.1	225.2	H	0.0	14.8	15.4	43.5
143.352000	30.0	193.7	H	194.0	19.6	13.5	43.5
269.911200	18.2	100.0	V	320.0	19.6	27.8	46.0

- Calculation Formula:

1. POL. H = Horizontal, POL. V = Vertical
2. QuasiPeak = Reading (Receiver Reading) + Corr.
3. Corr. (Correction Factor) = Antenna Factor + Cable Loss
4. Margin = Limit - QuasiPeak

-For Measurement Above 1 GHz

Applicable Standards	FCC PART 15 Subpart B Class B ANSI C63.4-2014
Detector	Peak mode: Peak (RBW: 1 MHz, VBW: 3 MHz) CISPR-Average mode: Peak (RBW: 1 MHz, VBW: 10 Hz)
Worst Case of Operating Mode	LTE B5 Low CH Idle
Kind of Test Site	3 m semi anechoic chamber
Temperature	24.5 °C
Relative Humidity	43.9 %
Test Date	March 27, 2019

Frequency (MHz)	Peak (dBμV/m)	Antenna Height (cm)	POL. (H/V)	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
3026.915000	35.9	100.0	V	150.0	-21.1	38.1	74.0
5562.445000	39.1	149.5	V	303.0	-15.3	34.9	74.0
7251.325000	43.1	276.4	H	177.0	-10.2	30.9	74.0
9636.265000	48.4	204.6	V	123.0	-5.4	25.6	74.0
10572.355000	48.7	125.8	V	50.0	-3.4	25.3	74.0
14746.430000	49.0	189.4	V	16.0	0.8	25.0	74.0

Frequency (MHz)	CAverage (dBμV/m)	Antenna Height (cm)	POL. (H/V)	Azimuth (deg)	Corr. (dB)	Margin (dB)	Limit (dBμV/m)
3026.915000	22.6	100.0	V	150.0	-21.1	31.4	54.0
5562.445000	26.2	149.5	V	303.0	-15.3	27.8	54.0
7251.325000	30.9	276.4	H	177.0	-10.2	23.1	54.0
9636.265000	35.8	204.6	V	123.0	-5.4	18.2	54.0
10572.355000	36.1	125.8	V	50.0	-3.4	17.9	54.0
14746.430000	36.0	189.4	V	16.0	0.8	18.0	54.0

- Calculation Formula:

1. POL. H = Horizontal, POL. V = Vertical
2. Peak or CAverage = Reading (Receiver Reading) + Corr.
3. Corr. (Correction Factor) = Antenna Factor+ Cable Loss –Amplifier Gain
4. Margin = Limit - Peak or CAverage