

## REFLED004-EVK-001 EMC test report

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## 1. Evaluation Summary

### 1.1. Objective

Regarding the reference design(REFLED004-EVK-001)with backlight LED driver IC BD83A14EFV-M on board, the measurement results in accordance with CISPR25 Class5 are shown.

### 1.2. Evaluation target

Reference design REFLED004-EVK-001

(Here in after DUT)

### 1.3. Evaluation items

**Table 1. Evaluation items**

Evaluation items	Frequency	Antenna
Conducted noise measurement	150kHz to 108MHz	-
Radiated noise measurement	30MHz to 300MHz	Horizontal/Vertical
	300MHz to 1GHz	Horizontal/Vertical

### 1.4. Equipment

**Table 2. Equipment list**

Equipment	Vendor	Type	Serial No.
Power supply	KIKUSUI	PMC18-3A	FA004529
LISN	SCHWARZBECK	NNBM8125	8125638 8125639
EMI Receiver	ROHDE & SCHWARZ	ESU26	ESU26
Antenna(30MHz to 300MHz)	ETS-LINDGREN	3110B	3376
Antenna(300MHz to 1GHz)	SCHWARZBECK	9118A	784

## 1.5. Test composition

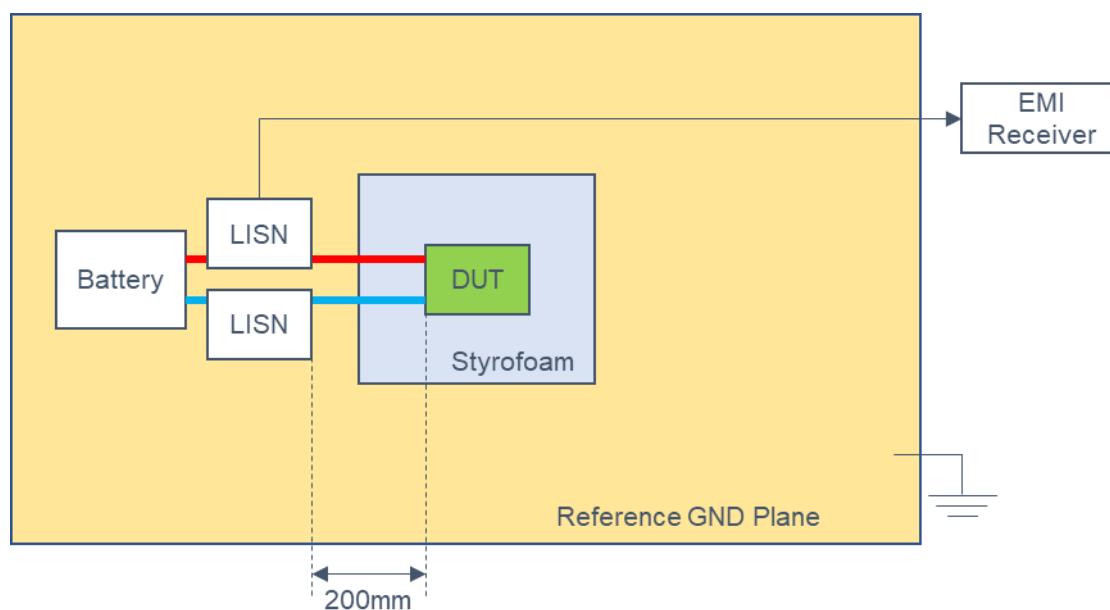


Figure 1. Top view of conducted noise measurement setup

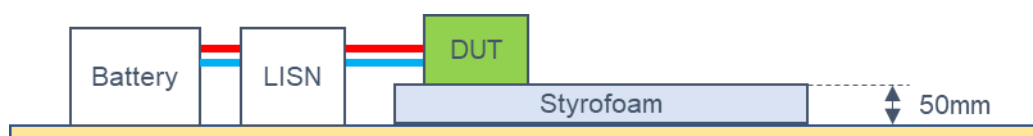


Figure 2. Side view of conducted noise measurement setup

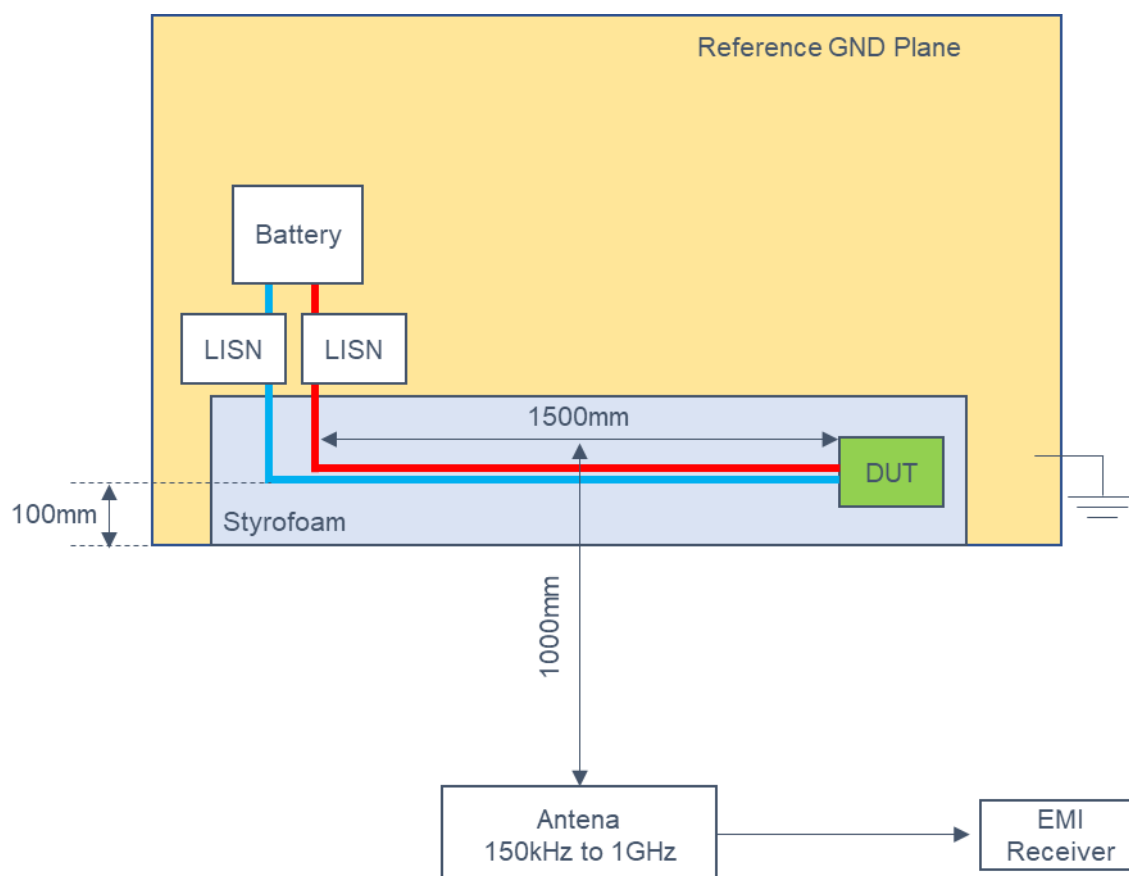


Figure 3. Top view of radiated noise measurement setup

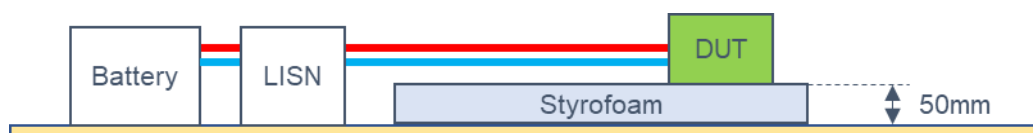


Figure 4. Side view of radiated noise measurement setup

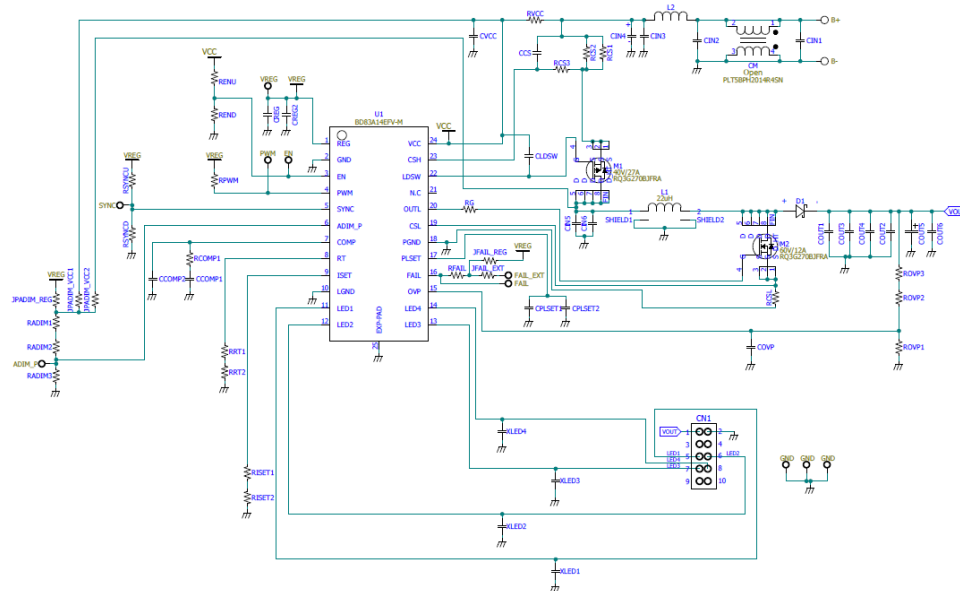
## 1.6. Measurement condition

Table 3. Measurement condition

Item	Condition
Ambient Temperature (Ta)	Room temperature (Ta = 27°C)
Input voltage (VBAT)	12V
Output voltage (VOUT)	34V
Switching Frequency ( $f_{osc}$ )	400kHz
Output condition	100mA/ch x 4ch 12LEDs per column

### 1.7. Reference design of overview

The schematic and parts list of reference design is shown in Figure 5.



**Figure 5. The schematic of REFLED004-EVK-001**

Table 4 Parts list

No	Package	Parameters	Part name(series)	Type	Manufacturer
CIN1	-	Open	-	-	-
CIN2	3225	10 $\mu$ F,X7S,50V	GCM32EC71H106KA01	Ceramic	Murata
CIN3	3225	10 $\mu$ F,X7S,50V	GCM32EC71H106KA01	Ceramic	Murata
CIN4	$\phi$ 10 x L10mm	220 $\mu$ F/50V	UCD1H221MNL1GS	Electrolytic	Nichicon
CIN5	1005	0.1 $\mu$ F,X7S,50V	GCM155R71H104KE02	Ceramic	Murata
CIN6	3225	10 $\mu$ F,X7S,50V	GCM32EC71H106KA01	Ceramic	Murata
CVCC	2012	1 $\mu$ F,X7S,50V	GCM21BR71H105KA01	Ceramic	Murata
CM	-	-	-	-	-
RCSH1	1632	12m $\Omega$	LTR18 series	Resistor	Rohm
RCSH2	-	Open	-	-	-
RCSH3	1608	100 $\Omega$	MCR03 series	Resistor	Rohm
CCSH	-	Open	-	-	-
CLDSW	-	Open	-	-	-
RCOMP1	1608	200 $\Omega$	MCR03 series	Resistor	Rohm
CCOMP1	1005	0.47 $\mu$ F,X7S,10V	GCM155C71A474KE36	Ceramic	Murata
CCOMP2	-	Open	-	-	-
RRT1	1608	13k $\Omega$	MCR03 series	Resistor	Rohm
RRT2	1608	12k $\Omega$	MCR03 series	Resistor	Rohm
RFAIL	1608	100k $\Omega$	MCR03 series	Resistor	Rohm
CREG	2012	2.2 $\mu$ F/16V	GCM21BR71C205KA49	Ceramic	Murata
CREG2	-	Open	-	-	-
M1	HSMT8AG	-40V/-27A	RQ3G270BJFRA	MOSFET	Rohm
M2	HSMT8AG	60V/12A	RQ3L120BKFRA	MOSFET	Rohm
L1	7.5mmx7.0mmx5.4mm	22 $\mu$ H	SPM7054VT-220M-D	Inductor	TDK
L2	7.4mmx7.0mmx4.5mm	4.7 $\mu$ H	CLF7045NIT-4R7N-D	Inductor	TDK
D1	SOD-128_PMDTM	60V/5A	RB088LAM-60TF	SBD	Rohm
COUT1	1005	0.01 $\mu$ F,X7S,50V	GCM155R71H103KA55	Ceramic	Murata
COUT2	1005	0.1 $\mu$ F,X7S,50V	GCM155R71H104KE02	Ceramic	Murata
COUT3	3225	10 $\mu$ F,X7S,50V	GCM32EC71H106KA01	Ceramic	Murata
COUT4	3225	10 $\mu$ F,X7S,50V	GCM32EC71H106KA01	Ceramic	Murata
COUT5	$\phi$ 6.3 x L7,7mm	33 $\mu$ F/63V	HHXC500ARA330MF80G	Hybrid	Nippon Chemi-Con
COUT6	1005	0.1 $\mu$ F,X7S,50V	GCM155R71H104KE02	Ceramic	Murata
ROVP1	1608	10k $\Omega$	MCR03 series	Resistor	Rohm
ROVP2	1608	360k $\Omega$	MCR03 series	Resistor	Rohm
ROVP3	1608	10k $\Omega$	MCR03 series	Resistor	Rohm
RISET1	1608	10k $\Omega$	MCR03 series	Resistor	Rohm
RISET2	1608	0 $\Omega$	-	Resistor	-

Table 4 Parts list - continued

No	Package	Parameters	Part name(series)	Type	Manufacturer
CPLSET1	1005	1500pF,X7S,50V	GCM155R71H222KA37	Ceramic	Murata
CPLSET2	-	Open	-	-	-
RCSL	1220	56mΩ	LTR10L series	Resistor	Rohm
COVP	1005	1000pF,X7S,50V	GCM155R71H102KA37	Ceramic	Murata
XLED1	1005	470pF,X7S,50V	GCM1555C1H471JA16	Ceramic	Murata
XLED2	1005	470pF,X7S,50V	GCM1555C1H471JA16	Ceramic	Murata
XLED3	1005	470pF,X7S,50V	GCM1555C1H471JA16	Ceramic	Murata
XLED4	1005	470pF,X7S,50V	GCM1555C1H471JA16	Ceramic	Murata
RADIM1	-	Open	-	-	-
RADIM2	-	Open	-	-	-
RADIM3	-	Open	-	-	-
REND	-	Open	-	-	-
RENU	-	Open	-	-	-
RSYNCD	-	Open	-	-	-
RVCC	1608	0Ω	-	Resistor	-
RG	1608	0Ω	-	Resistor	-
RSYNCU	1608	0Ω	-	Resistor	-
RPWM	1608	0Ω	-	Resistor	-
JFAIL_EXT	-	Open	-	-	-
JPADIM_VCC1	-	Open	-	-	-
JPADIM_VCC2	-	Open	-	-	-
JFAIL_REG	1608	0Ω	-	Resistor	-
JPADIM_REG	1608	0Ω	-	Resistor	-
U1	HTSSOP-B24	-	BD83A14EFV-M	LED Dr	Rohm

### 1.8. The image of reference design

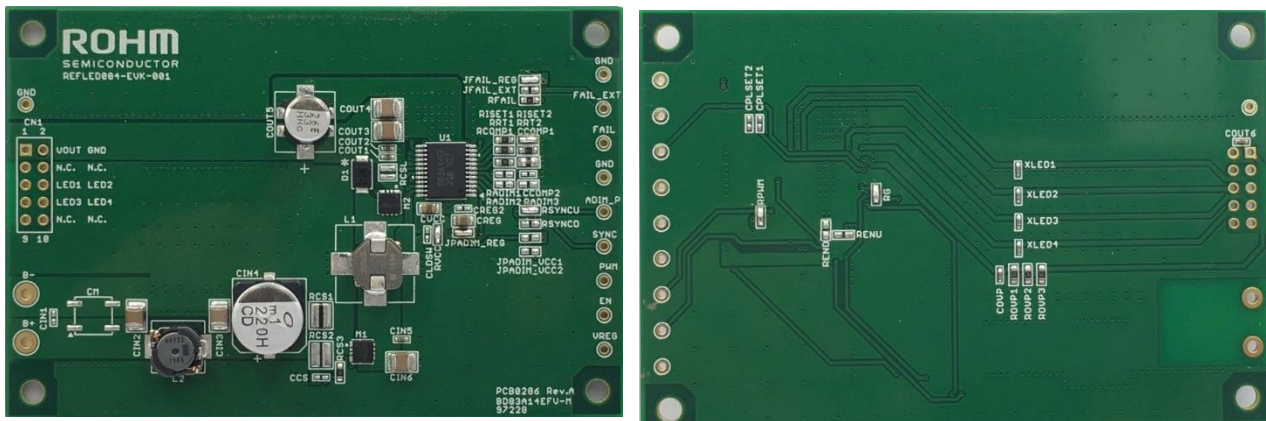


Figure 6. The image of reference design



# 1.9. The PCB layout of reference design

PCB Structure and layer specification is in Table 4.

Table 5. PCB structure and layer specification

Material	FR-4
Board Thickness	1.6mm
Copper Thickness	1oz
Number of Layers	4
Board Size	60mm x 90mm
Minimum Copper Width	0.15mm
Minimum Air Gap	0.15mm
Minimum Hole Size	0.30mm

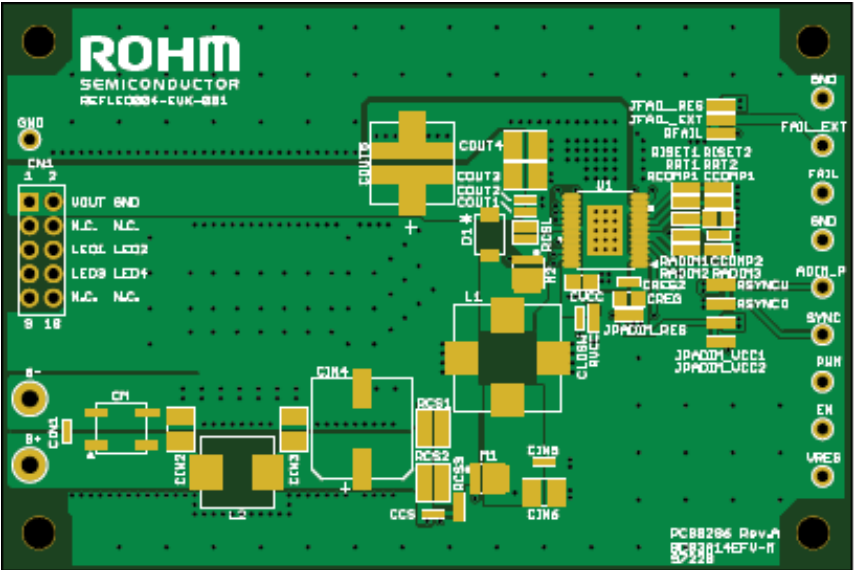


Figure 7. Top metal and silk layer

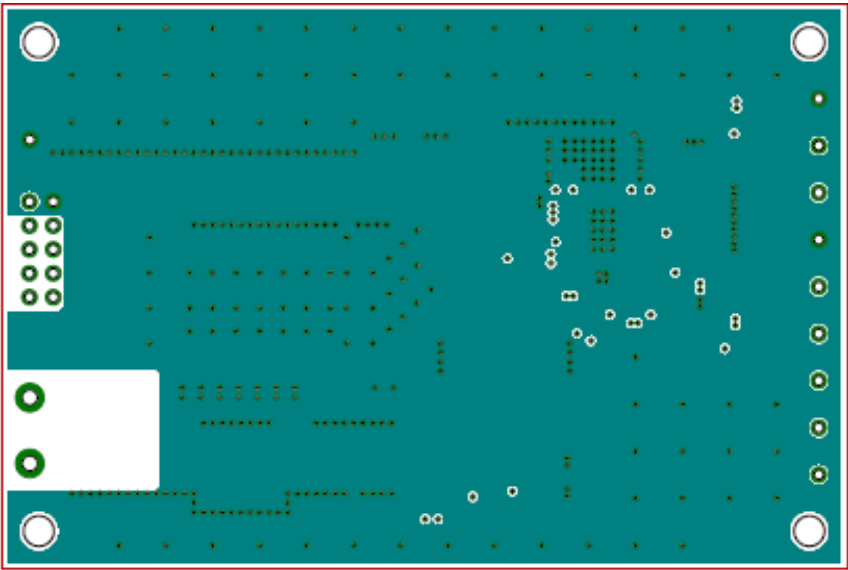


Figure 8. Middle layer1

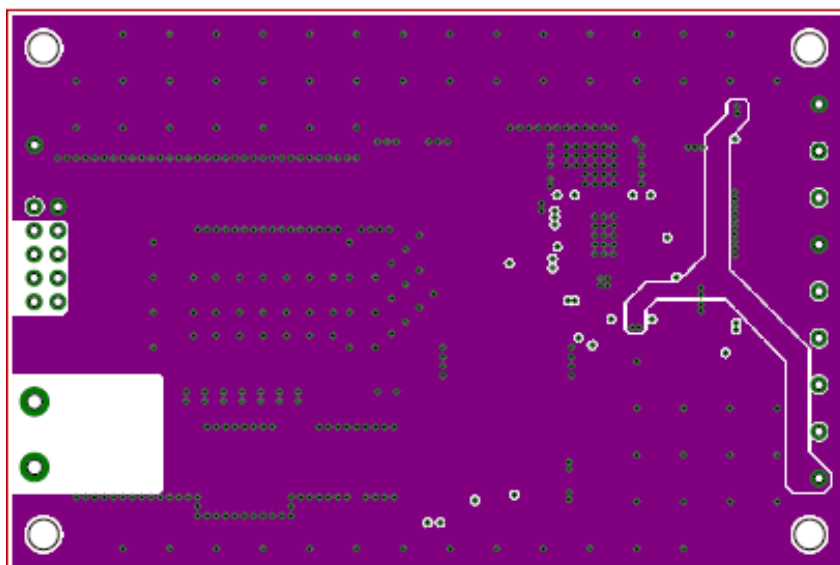


Figure 9. Middle layer2

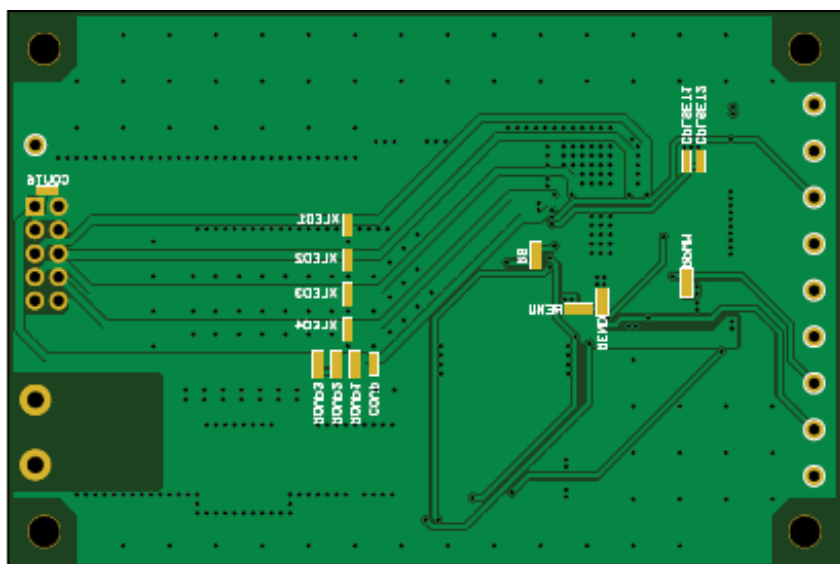
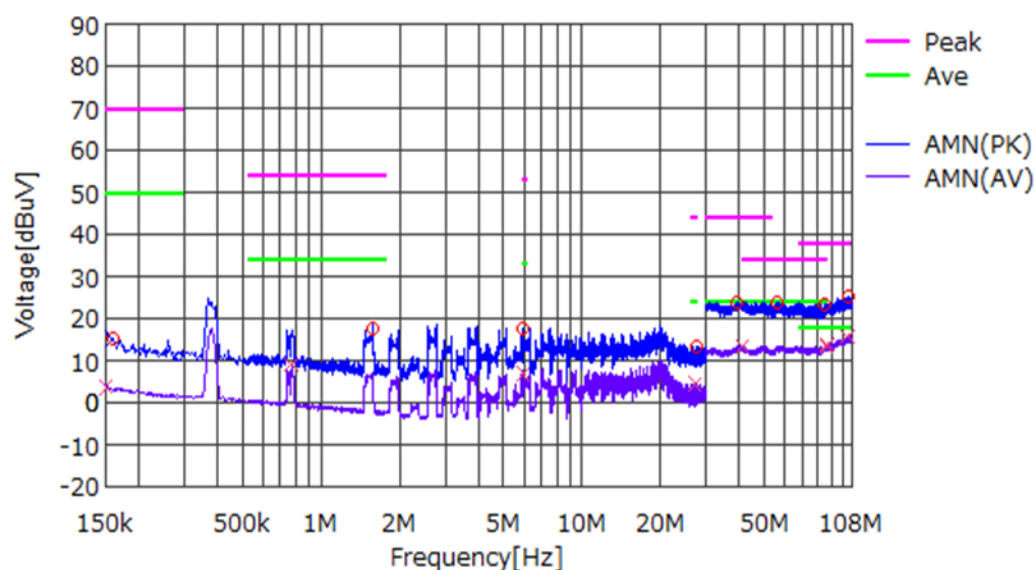


Figure 10. Bottom metal layer

## 2. Measurement results

### 2.1. Conducted noise measurement



**Figure 11. Measurement result**

(Note 1) Pink colored line indicates Peak limit value of CISPR25 Class5.

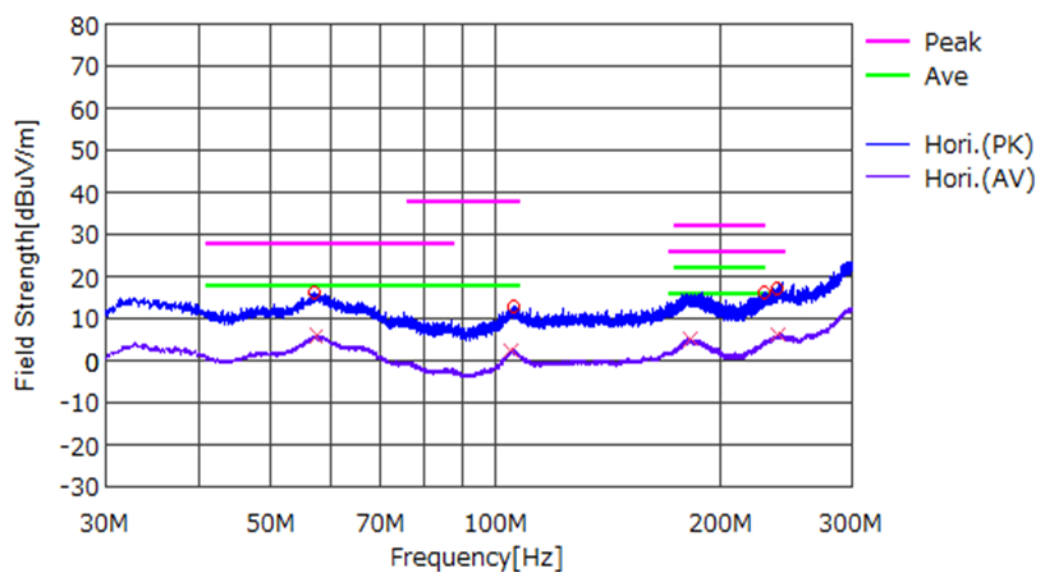
(Note 2) Green colored line indicates Average limit value of CISPR25 Class5.

**Table 6. Measurement result**

Band ID	Freq. [MHz]	Pol	Result			Limit			Margin			Judge
			PK	AV	QP	PK	AV	QP	PK [dB]	AV [dB]	QP [dB]	
LW	0.150	AMN	---	3.63	---	---	50.0	---	---	46.37	---	OK
LW	0.160	AMN	15.14	---	---	70.0	---	---	54.86	---	---	OK
MW	0.775	AMN	---	8.98	---	---	34.0	---	---	25.02	---	OK
MW	1.580	AMN	17.85	---	---	54.0	---	---	36.15	---	---	OK
SW	5.900	AMN	17.63	---	---	53.0	---	---	35.37	---	---	OK
SW	5.930	AMN	---	6.75	---	---	33.0	---	---	26.25	---	OK
FM	104.050	AMN	---	15.70	---	---	18.0	---	---	2.30	---	OK
FM	104.500	AMN	25.02	---	---	38.0	---	---	12.98	---	---	OK
TV I	55.600	AMN	24.03	---	---	34.0	---	---	9.97	---	---	OK
TV I	87.500	AMN	---	13.76	---	---	24.0	---	---	10.24	---	OK
CB	27.225	AMN	---	4.49	---	---	24.0	---	---	19.51	---	OK
CB	27.690	AMN	13.46	---	---	44.0	---	---	30.54	---	---	OK
VHF	41.250	AMN	---	13.38	---	---	24.0	---	---	10.62	---	OK
VHF	39.200	AMN	24.03	---	---	44.0	---	---	19.97	---	---	OK
VHF	86.950	AMN	---	13.33	---	---	18.0	---	---	4.67	---	OK
VHF	85.050	AMN	23.40	---	---	38.0	---	---	14.60	---	---	OK

## 2.2. Radiated noise measurements

### 2.2.1. 30MHz to 300MHz, Antenna in horizontal



**Figure 12. Measurement result**

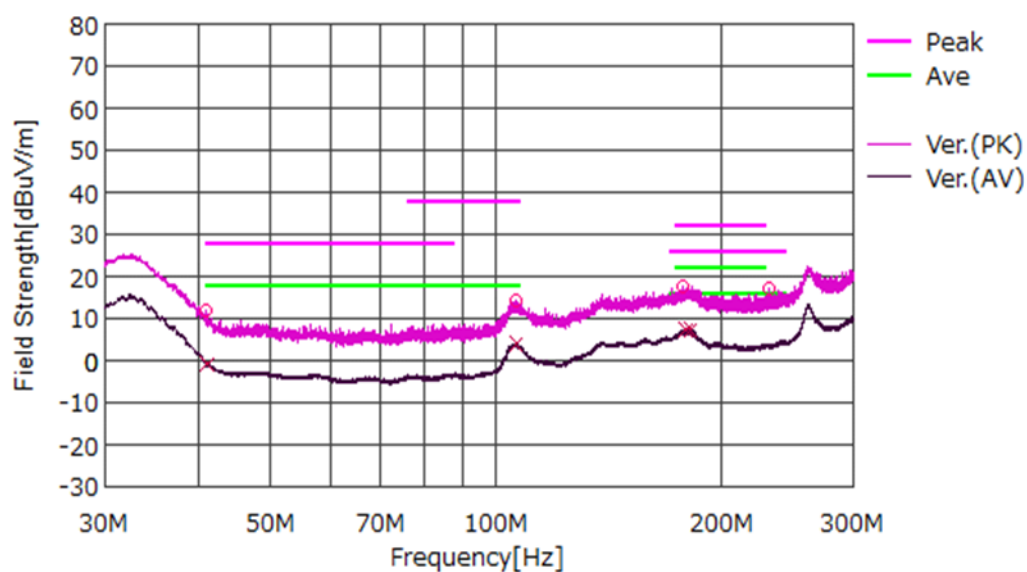
(Note 1) Pink colored line indicates Peak limit value of CISPR25 Class5.

(Note 2) Green colored line indicates Average limit value of CISPR25 Class5.

**Table 7. Measurement result**

Band ID	Freq. [MHz]	Pol	Result			Limit			Margin			Judge
			PK	AV	QP	PK	AV	QP	PK [dB]	AV [dB]	QP [dB]	
FM	104.850	Hori.	---	2.35	---	---	18.0	---	---	15.65	---	OK
FM	105.800	Hori.	12.76	---	---	38.0	---	---	25.24	---	---	OK
TV I	57.150	Hori.	16.09	---	---	28.0	---	---	11.91	---	---	OK
TV I	57.450	Hori.	---	5.81	---	---	18.0	---	---	12.19	---	OK
TV III	182.450	Hori.	---	5.06	---	---	22.0	---	---	16.94	---	OK
TV III	229.400	Hori.	16.07	---	---	32.0	---	---	15.93	---	---	OK
DAB III	237.650	Hori.	17.35	---	---	26.0	---	---	8.65	---	---	OK
DAB III	239.050	Hori.	---	6.19	---	---	16.0	---	---	9.81	---	OK

## 2.2.2. 30MHz to 300MHz, Antenna in vertical



**Figure 13. Measurement result**

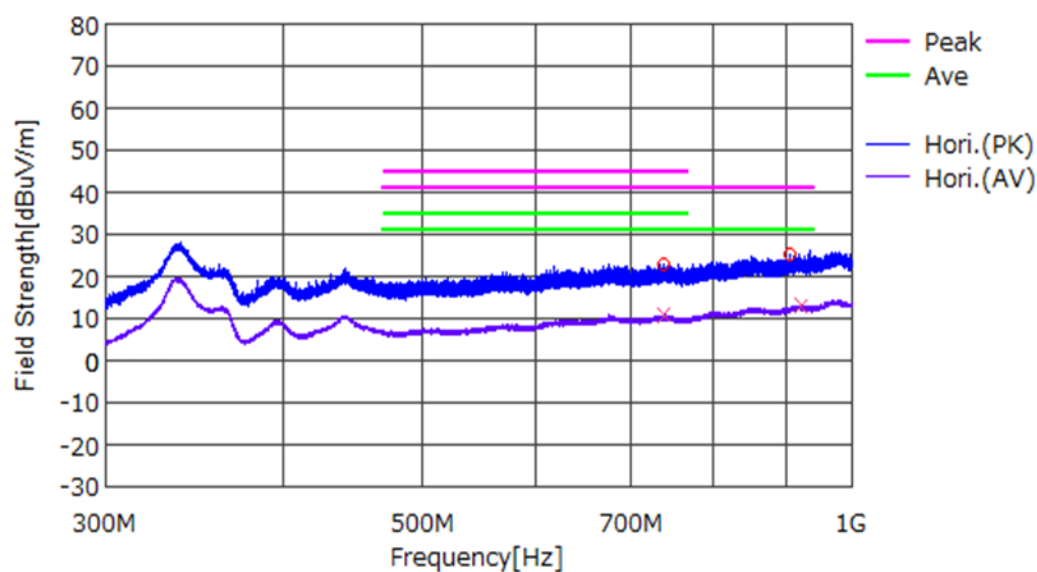
(Note 1) Pink colored line indicates Peak limit value of CISPR25 Class5.

(Note 2) Green colored line indicates Average limit value of CISPR25 Class5.

**Table 8. Measurement result**

Band ID	Freq. [MHz]	Pol	Result			Limit			Margin			Judge
			PK	AV	QP	PK	AV	QP	PK [dB]	AV [dB]	QP [dB]	
FM	106.300	Ver.	---	3.93	---	---	18.0	---	---	14.07	---	OK
FM	106.300	Ver.	14.47	---	---	38.0	---	---	23.53	---	---	OK
TV I	41.000	Ver.	11.79	---	---	28.0	---	---	16.21	---	---	OK
TV I	41.050	Ver.	---	-0.80	---	---	18.0	---	---	18.80	---	OK
TV III	177.900	Ver.	17.62	---	---	32.0	---	---	14.38	---	---	OK
TV III	182.050	Ver.	---	7.27	---	---	22.0	---	---	14.73	---	OK
DAB III	179.350	Ver.	---	7.37	---	---	16.0	---	---	8.63	---	OK
DAB III	232.050	Ver.	17.25	---	---	26.0	---	---	8.75	---	---	OK

### 2.2.3. 300MHz to 1GHz, Antenna in horizontal



**Figure 14. Measurement result**

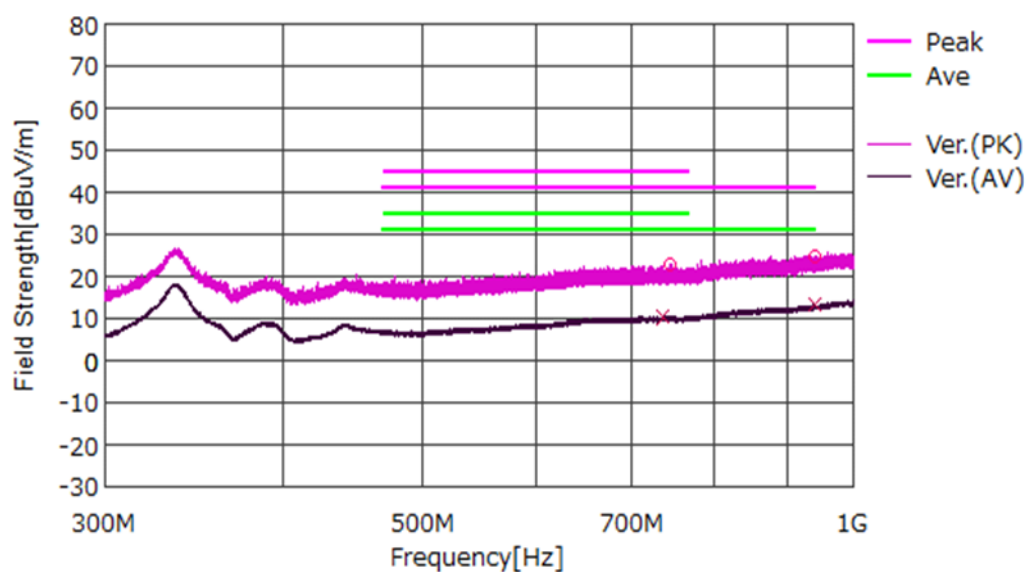
(Note 1) Pink colored line indicates Peak limit value of CISPR25 Class5.

(Note 2) Green colored line indicates Average limit value of CISPR25 Class5.

**Table 9. Measurement result**

Band ID	Freq. [MHz]	Pol	Result			Limit			Margin			Judge
			PK	AV	QP	PK	AV	QP	PK [dB]	AV [dB]	QP [dB]	
TV IV	905.200	Hori.	25.04	---	---	41.0	---	---	15.96	---	---	OK
TV IV	921.550	Hori.	---	13.01	---	---	31.0	---	---	17.99	---	OK
DTTV	738.250	Hori.	---	10.75	---	---	35.0	---	---	24.25	---	OK
DTTV	738.950	Hori.	22.97	---	---	45.0	---	---	22.03	---	---	OK

## 2.2.4. 300MHz to 1GHz, Antenna in vertical



**Figure 15. Measurement result**

(Note 1) Pink colored line indicates Peak limit value of CISPR25 Class5.

(Note 2) Green colored line indicates Average limit value of CISPR25 Class5.

**Table 5. Measurement result**

Band ID	Freq. [MHz]	Pol	Result			Limit			Margin			Judge
			PK	AV	QP	PK	AV	QP	PK [dB]	AV [dB]	QP [dB]	
TV IV	939.750	Ver.	24.95	---	---	41.0	---	---	16.05	---	---	OK
TV IV	939.900	Ver.	---	13.26	---	---	31.0	---	---	17.74	---	OK
DTTV	736.750	Ver.	---	10.39	---	---	35.0	---	---	24.61	---	OK
DTTV	744.350	Ver.	22.71	---	---	45.0	---	---	22.29	---	---	OK

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