

## REFLED002-EVK-001 EMC test report

This document consists of following chapters.

### Table of Contents

1.	Evaluation Summary.....	2
1.1.	Objective .....	2
1.2.	Evaluation target.....	2
1.3.	Evaluation items .....	2
1.4.	Equipment .....	2
1.5.	Test composition .....	3
1.6.	Reference design overview .....	5
1.7.	Reference design overview .....	5
1.8.	The Image of Reference design .....	8
1.9.	The PCB layout of reference design.....	8
2.	Measurement results .....	11
2.1.	Conducted noise measurement .....	11
2.2.	Radiated noise measurements .....	12
2.2.1.	30MHz to 300MHz, Antenna in horizontal .....	12
2.2.2.	30MHz to 300MHz, Antenna in vertical .....	13
2.2.3.	300MHz to 1GHz, Antenna in horizontal.....	14
2.2.4.	300MHz to 1GHz, Antenna in vertical .....	15

## 1. Evaluation Summary

### 1.1. Objective

About the reference design (REFLED002-EVK-001) with backlight LED driver IC BD83A04EFV-M on board, the measurement results in accordance with CISPR25 are shown.

### 1.2. Evaluation target

Reference design REFLED002-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	Vertical/Horizontal
	300MHz to 1GHz	Vertical/Horizontal

### 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

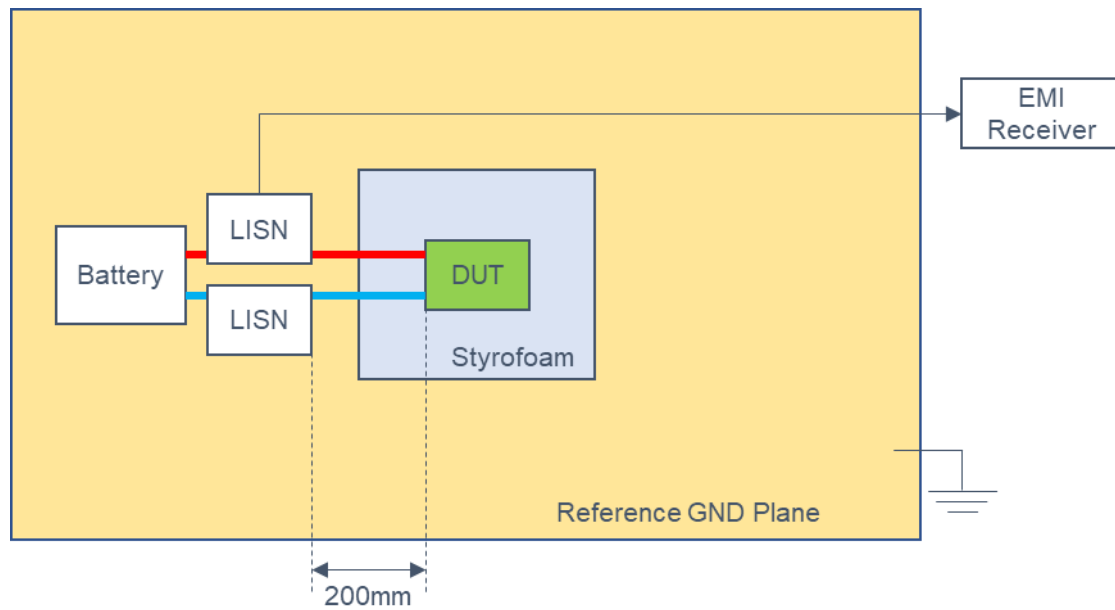


Figure 1. Top view of conducted noise measurement setup

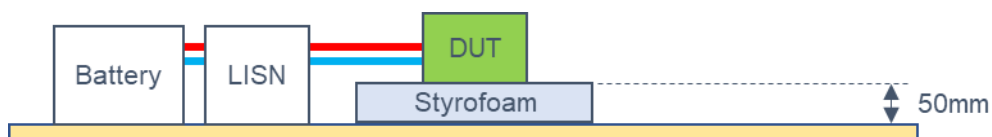


Figure 2. Side view of conducted noise measurement setup

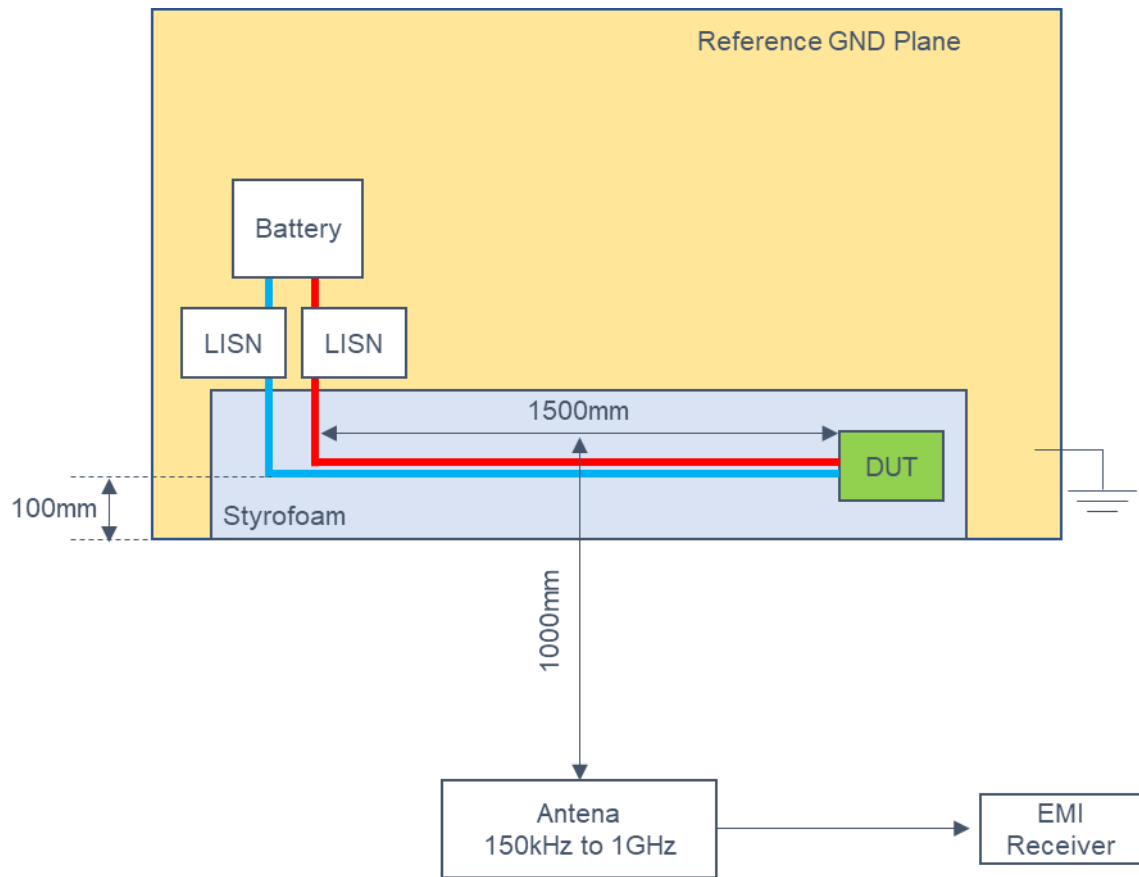


Figure 3. Top view of radiated noise measurement setup

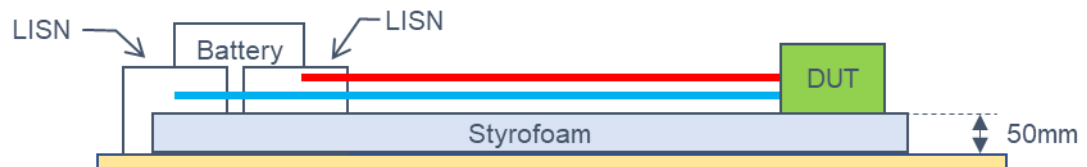


Figure 4. Side view of radiated noise measurement setup

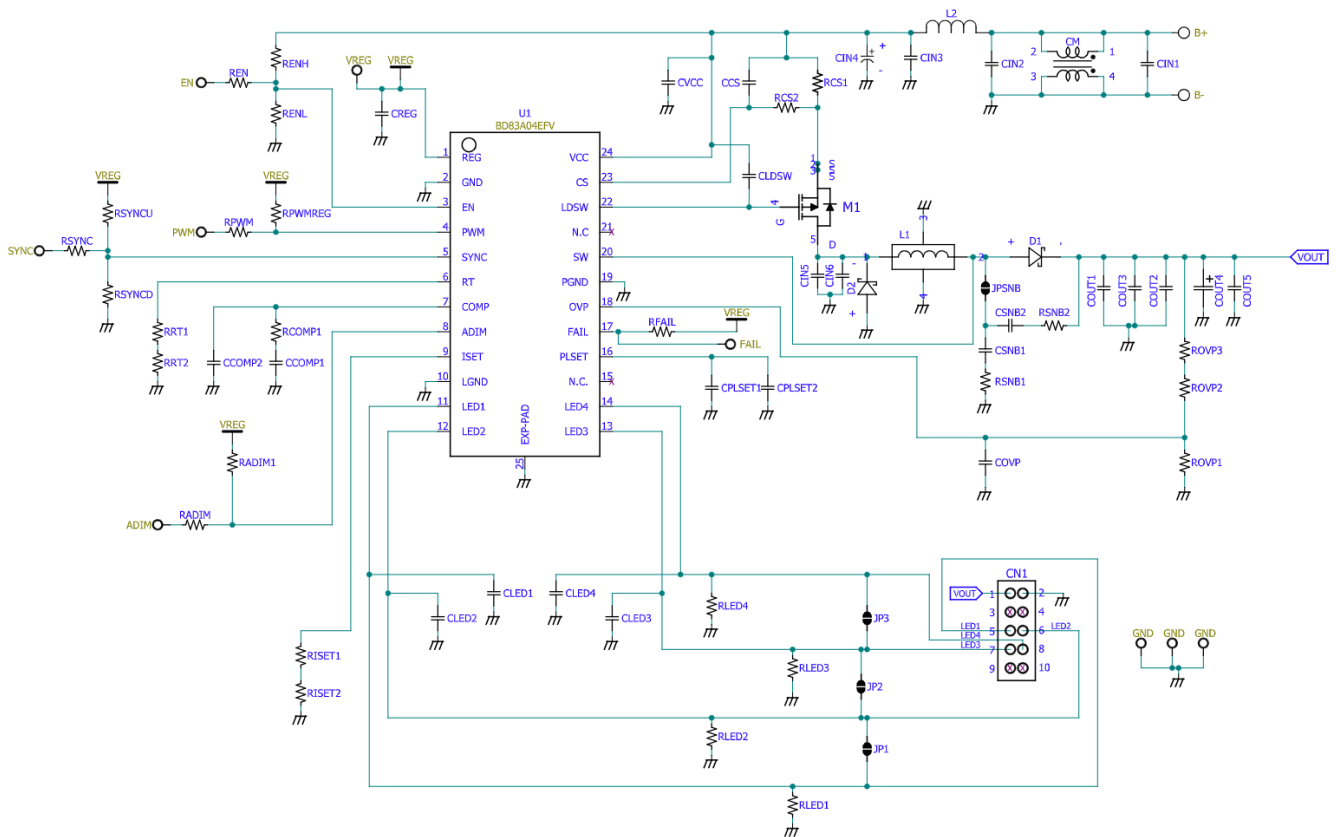
## 1.6. Measurement condition

**Table 3. Measurement condition**

Item	Condition
Ambient Temperature (Ta)	Room temperature(Ta = 27°C)
Input voltage (VBAT)	12V
Output voltage (VOUT)	28.7V
Switching Frequency (fosc)	415kHz
Output condition	80.7mA/ch x 4ch 9 LEDs per column

## 1.7. Reference design overview

The schematic and parts list of reference design is shown in figure 5 and Table 4.



**Figure 5. The schematic of REFLED002-EVK-001**

Table 4. Parts list

No	Package	Parameters	Part name(series)	Type	Manufacturer
CCOMP1	2012	1 $\mu$ F, X7S, 50V	GCM21BR71H105KA01	Ceramic	Murata
CCOMP2	-	Open	-	-	-
CCS	1608	100pF	GCM1882C1H101JA01	Ceramic	Murata
CIN1	-	Open	-	-	-
CIN2	3225	10 $\mu$ F, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
CIN3	1608	0.01 $\mu$ F, R, 50V	GCM188R11H103KA01	Ceramic	Murata
CIN4	$\phi$ 8 x L10mm	220 $\mu$ F/35V	UCD1V221MNL1GS	Electrolytic	Nichicon
CIN5	1005	0.1 $\mu$ F, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
CIN6	3225	10 $\mu$ F, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
CLDSW	1608	100pF	GCM1882C1H101JA01	Ceramic	Murata
CLED1	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED2	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED3	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CLED4	1005	470pF, R, 50V	GCM155R11H471KA01	Ceramic	Murata
CM	-	Open	-	-	-
COUT1	1005	0.01 $\mu$ F, R, 50V	GCM155R11H103KA40	Ceramic	Murata
COUT2	1005	0.1 $\mu$ F, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
COUT3	3225	10 $\mu$ F, X7S, 50V	GCM32EC71H106KA01	Ceramic	Murata
COUT4	$\phi$ 6.3 x L7.7mm	33 $\mu$ F/50V	50HVPF33M	Hybrid	SunCon
COUT5	1005	0.1 $\mu$ F, X7S, 50V	GCM155R71H104KE37	Ceramic	Murata
COVP	-	Open	-	-	-
CPLSET1	-	Open	-	-	-
CPLSET2	1005	1500pF, R, 50V	GCM155R11H152KA01	Ceramic	Murata
CREG	1608	2.2 $\mu$ F, X7R, 6.3V	GCM188R70J225KE21	Ceramic	Murata
CSNB1	-	Open	-	-	-
CSNB2	-	Open	-	-	-
CVCC	2012	1 $\mu$ F, X7S, 50V	GCM21BR71H105KA01	Ceramic	Murata
D1	W4.7xL2.5xH0.95mm	60V/5A	RB088LAM-60	SBD	ROHM
D2	W4.7xL2.5xH0.95mm	60V/3A	RB058LAM-60	SBD	ROHM
JP1	-	Open	-	-	-
JP2	-	Open	-	-	-
JP3	-	Open	-	-	-
JPSNB	-	Open	-	-	-
L1	W7.0xL7.4xH4.5mm	22 $\mu$ H	SPM7054VT-220M	Inductor	TDK
L2	W6.3xL6.0xH4.5mm	3.3 $\mu$ H	CLF6045NIT-3R3N-D	Inductor	TDK
M1 *1	W3.3xL3.3xH0.8mm	-40V/-27A	RQ3G270BJ	MOSFET	Rohm
RADIM	-	Open	-	-	-
RADIM1	-	Short	-	-	-
RCOMP1	1608	100 $\Omega$	MCR03 series	Resistor	ROHM
RCS1	1632	15m $\Omega$	LTR18	Resistor	ROHM
RCS2	1608	100 $\Omega$	MCR03 series	Resistor	ROHM
REN	-	Open	-	-	-
RENH	1005	120k $\Omega$ , 1/16W	MCR01 series	Resistor	ROHM

Table 4. Parts list- continued

No	Package	Parameters	Part name(series)	Type	Manufacturer
RENL	1005	39kΩ, 1/16W	MCR01 series	Resistor	ROHM
RFAIL	1608	100kΩ, 1/10W	MCR03 series	Resistor	ROHM
RISSET1	1608	15kΩ, 1/10W	MCR03 series	Resistor	ROHM
RISSET2	-	Short	-	-	-
RLED1	-	Open	-	-	-
RLED2	-	Open	-	-	-
RLED3	-	Open	-	-	-
RLED4	-	Open	-	-	-
ROVP1	1608	10kΩ, 1/10W	MCR03 series	Resistor	ROHM
ROVP2	-	Short	-	-	-
ROVP3	1608	330kΩ, 1/10W	MCR03 series	Resistor	ROHM
RPWM	-	Open	-	-	-
RPWMREG	-	Short	-	-	-
RRT1	1608	27kΩ, 1/10W	MCR03 series	Resistor	ROHM
RRT2	-	Open	-	-	-
RSNB1	-	Open	-	-	-
RSNB2	-	Open	-	-	-
RSYNC	-	Open	-	-	-
RSYNCD	-	Open	-	-	-
RSYNCU	-	Short	-	-	-
U1	HTSSOP-B24	-	BD83A04EFV-M	IC	ROHM

\*1 The land pattern of M1 is SOT-669 (5mm x 6mm).

## 1.8. The Image of Reference design

The image of reference design is shown in figure 6.



Figure 6. The image of reference design

## 1.9. The PCB layout of reference design

PCB Structure and layer specification is in Table 5.

Table 5. PCB structure and layer specification

Material	FR-4 High TG
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	0.3mm



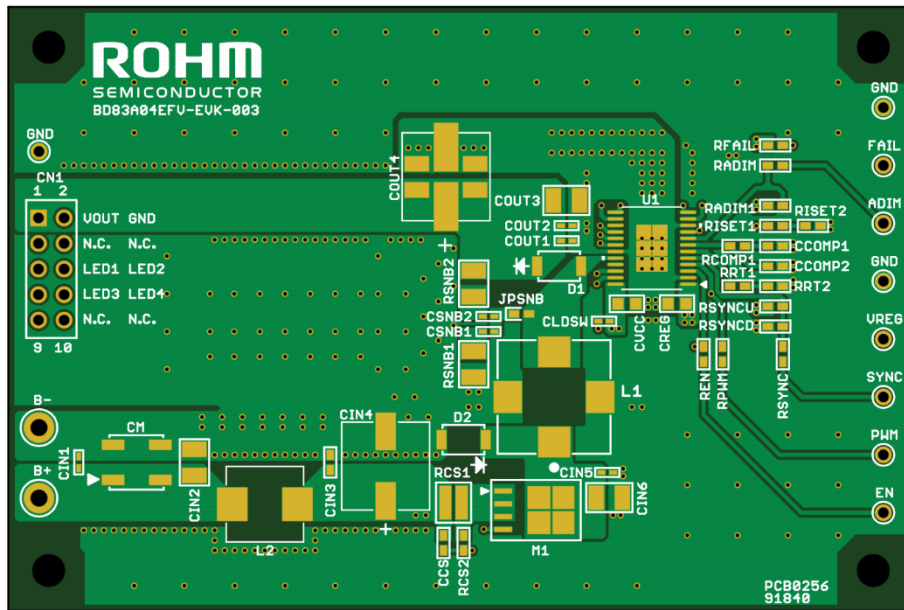


Figure 7. Top metal and silk layer

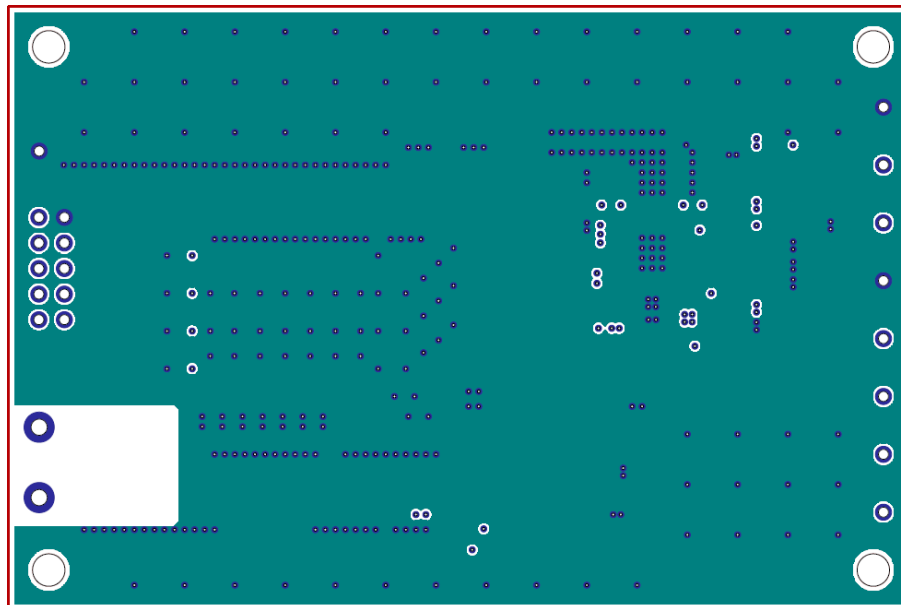


Figure 8. Inner layer1

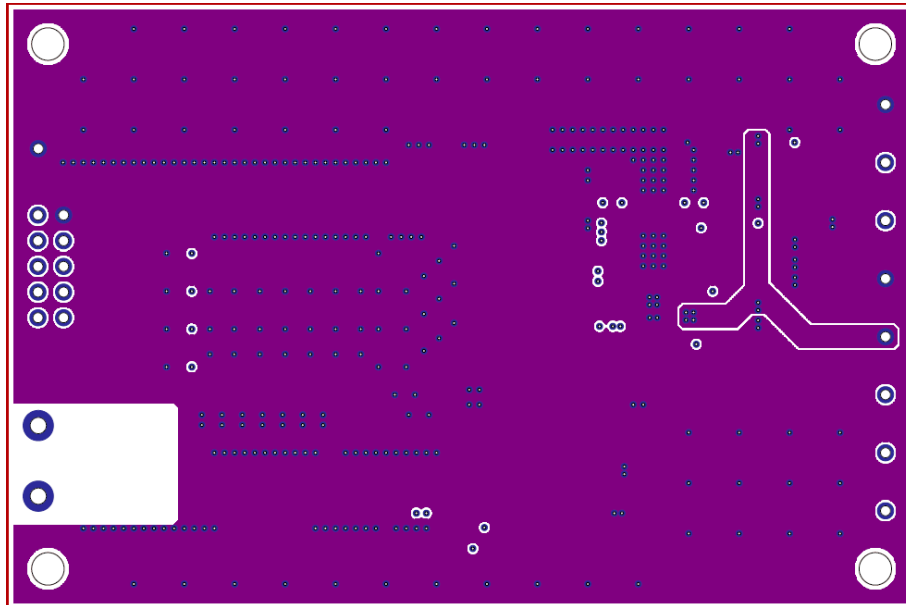


Figure 9. Inner layer2

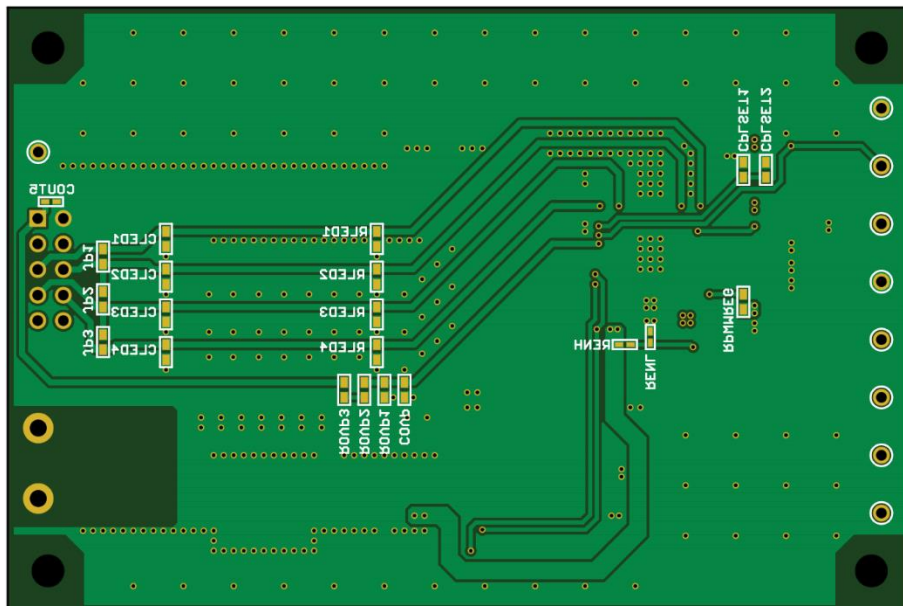


Figure 10. Bottom metal and silk layer

## 2. Measurement results

### 2.1. Conducted noise measurement

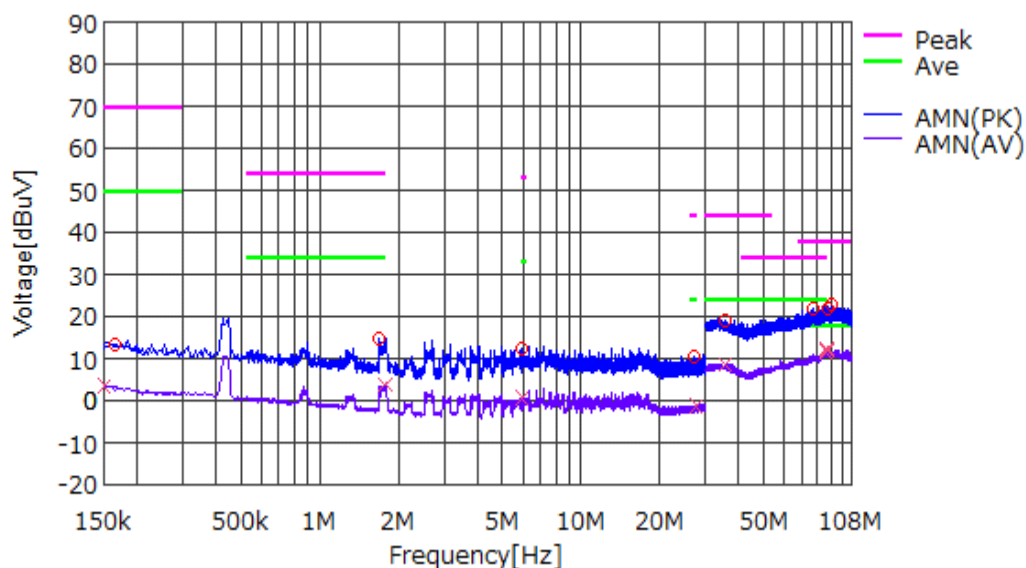


Figure 11. Measurement result

(Note 1) Pin 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	0.155	AMN	17.75	-	-	70.0	-	-	52.25	-	-	OK
LW	0.155	AMN	-	5.60	-	-	50.0	-	-	44.40	-	OK
MW	1.695	AMN	16.99	-	-	54.0	-	-	37.01	-	-	OK
MW	1.790	AMN	-	6.53	-	-	34.0	-	-	27.47	-	OK
SW	5.920	AMN	12.28	-	-	53.0	-	-	40.72	-	-	OK
SW	5.965	AMN	-	1.14	-	-	33.0	-	-	31.86	-	OK
FM	81.600	AMN	25.49	-	-	38.0	-	-	12.51	-	-	OK
FM	87.050	AMN	-	15.82	-	-	18.0	-	-	2.18	-	OK
TV I	84.750	AMN	-	15.84	-	-	24.0	-	-	8.16	-	OK
TV I	85.750	AMN	25.73	-	-	34.0	-	-	8.27	-	-	OK
CB	27.820	AMN	-	2.02	-	-	24.0	-	-	21.98	-	OK
CB	27.125	AMN	12.77	-	-	44.0	-	-	31.23	-	-	OK
VHF	33.000	AMN	-	15.44	-	-	24.0	-	-	8.56	-	OK
VHF	34.350	AMN	25.86	-	-	44.0	-	-	18.14	-	-	OK
VHF	83.400	AMN	25.49	-	-	38.0	-	-	12.51	-	-	OK
VHF	86.300	AMN	-	15.68	-	-	18.0	-	-	2.32	-	OK

## 2.2. Radiated noise measurements

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

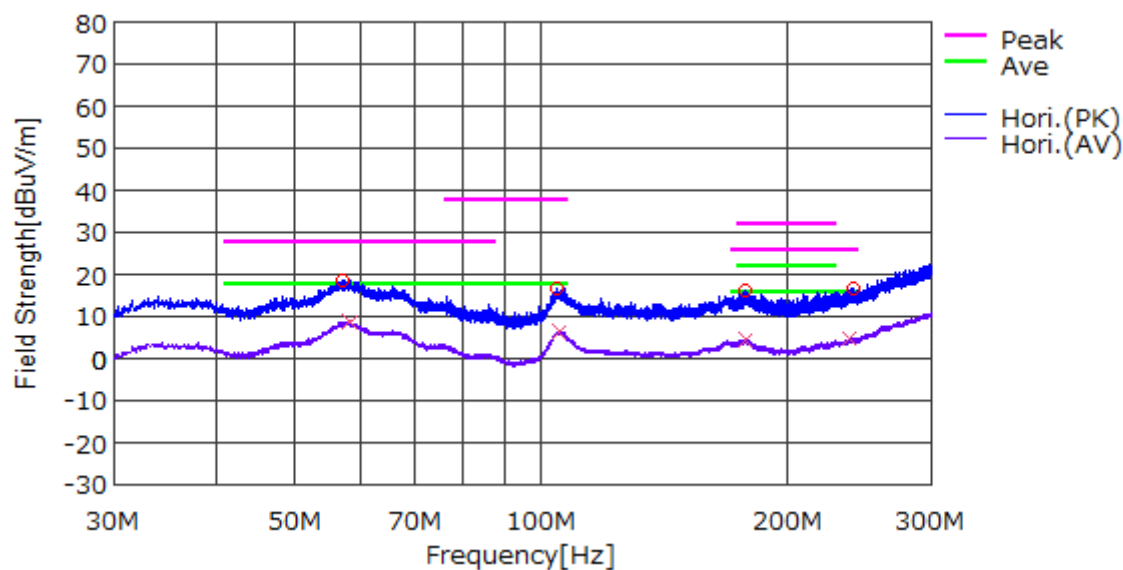


Figure 12. Measurement result

(Note 1) Pin 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	104.300	Hori.	14.79	-	-	38.0	-	-	23.21	-	-	OK
FM	104.500	Hori.	-	4.89	-	-	18.0	-	-	13.11	-	OK
TV I	58.500	Hori.	-	4.57	-	-	18.0	-	-	13.43	-	OK
TV I	58.700	Hori.	14.09	-	-	28.0	-	-	13.91	-	-	OK
TV III	228.350	Hori.	15.25	-	-	32.0	-	-	16.75	-	-	OK
TV III	228.850	Hori.	-	4.14	-	-	22.0	-	-	17.86	-	OK
DAB III	240.700	Hori.	-	5.18	-	-	16.0	-	-	10.82	-	OK
DAB III	244.000	Hori.	16.21	-	-	26.0	-	-	9.79	-	-	OK

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

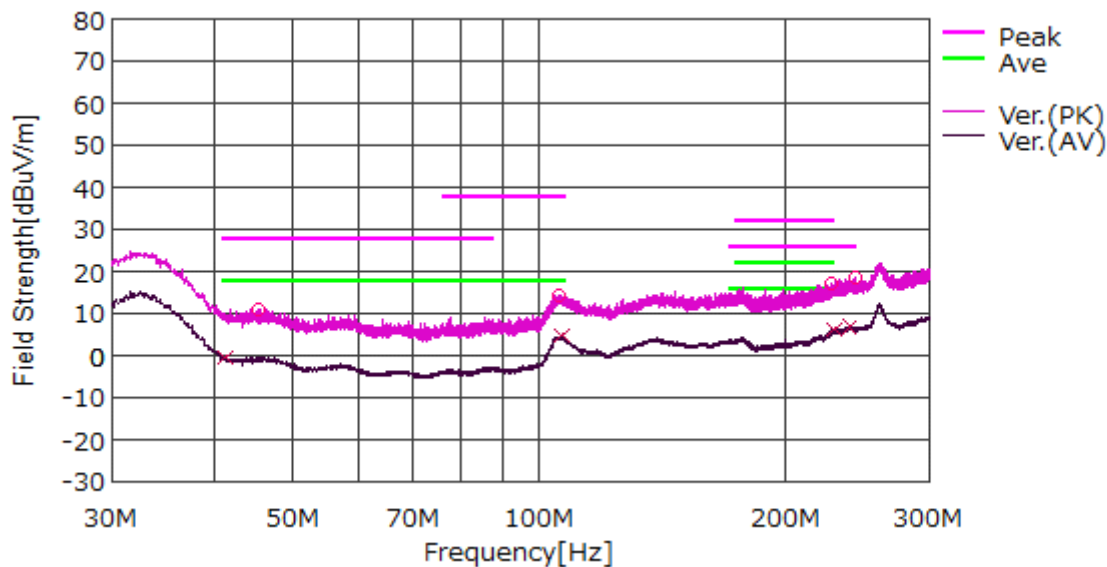


Figure 13. Measurement result

(Note 1) Pin 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]	
LW	0.150	Ver.	28.16	-	-	46.0	-	-	17.84	-	-	OK
LW	0.150	Ver.	-	10.92	-	-	26.0	-	-	15.08	-	OK
MW	0.900	Ver.	20.69	-	-	40.0	-	-	19.31	-	-	OK
MW	0.900	Ver.	-	9.83	-	-	20.0	-	-	10.17	-	OK
SW	5.905	Ver.	13.36	-	-	40.0	-	-	26.64	-	-	OK
SW	5.915	Ver.	-	2.00	-	-	20.0	-	-	18.00	-	OK
FM	104.300	Ver.	-	5.79	-	-	18.0	-	-	12.21	-	OK
FM	104.600	Ver.	14.69	-	-	38.0	-	-	23.31	-	-	OK
TV I	41.050	Ver.	-	-0.06	-	-	18.0	-	-	18.06	-	OK
TV I	41.200	Ver.	11.67	-	-	28.0	-	-	16.33	-	-	OK
TV III	178.500	Ver.	-	6.09	-	-	22.0	-	-	15.91	-	OK
TV III	227.900	Ver.	16.98	-	-	32.0	-	-	15.02	-	-	OK
DAB III	239.800	Ver.	-	6.23	-	-	16.0	-	-	9.77	-	OK
DAB III	240.750	Ver.	17.87	-	-	26.0	-	-	8.13	-	-	OK

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

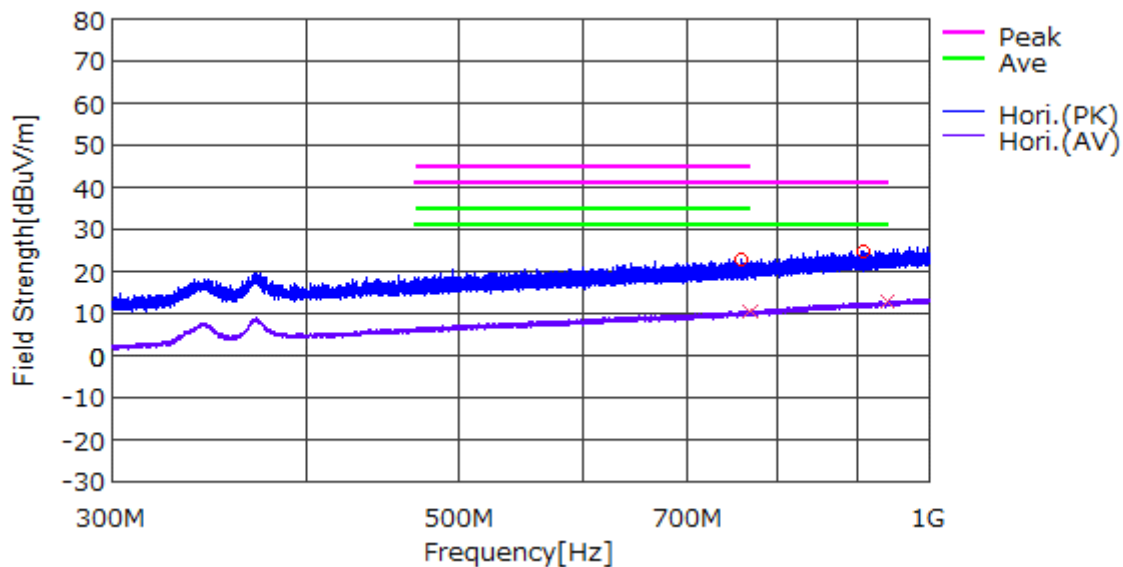


Figure 14. Measurement result

(Note 1) Pin 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	920.950	Hori.	24.56	-	-	41.0	-	-	16.44	-	-	OK
TV IV	940.800	Hori.	-	12.81	-	-	31.0	-	-	18.19	-	OK
DTTV	765.550	Hori.	-	10.69	-	-	35.0	-	-	24.31	-	OK
DTTV	766.100	Hori.	22.66	-	-	45.0	-	-	22.34	-	-	OK

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

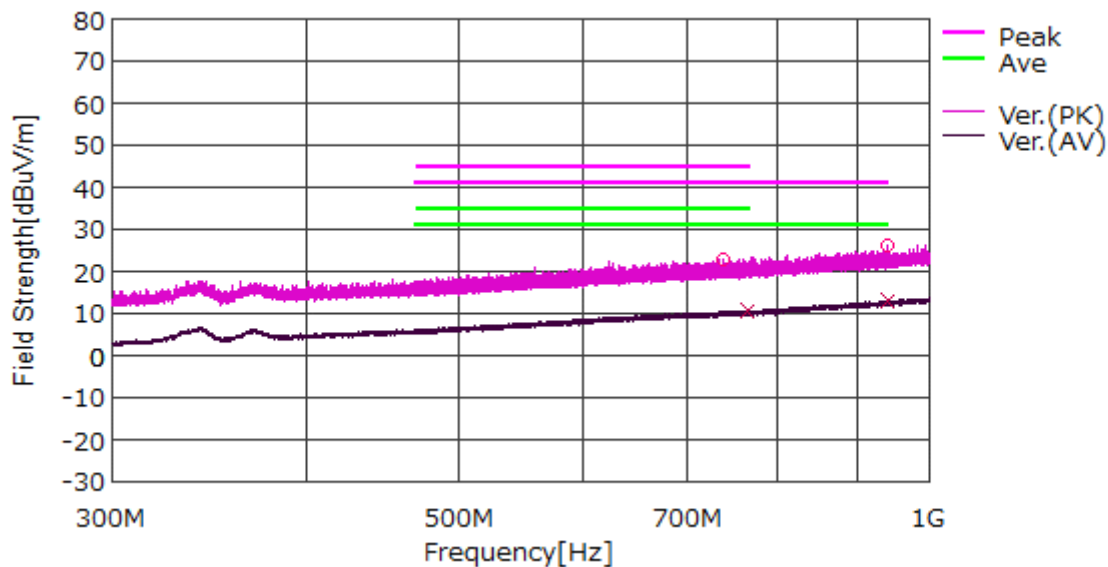


Figure 15. Measurement result

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

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

Table 10. 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	936.700	Ver.	24.85	-	-	41.0	-	-	16.15	-	-	OK
TV IV	939.450	Ver.	-	13.08	-	-	31.0	-	-	17.92	-	OK
DTTV	758.800	Ver.	23.03	-	-	45.0	-	-	21.97	-	-	OK
DTTV	768.550	Ver.	-	10.44	-	-	35.0	-	-	24.56	-	OK

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