

CUS600M1

EVALUATION DATA

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Terminology used

	Definition
V_{in} Input voltage
V_{out} Output voltage
I_{in} Input current
I_{out} Output current
T_a Ambient temperature

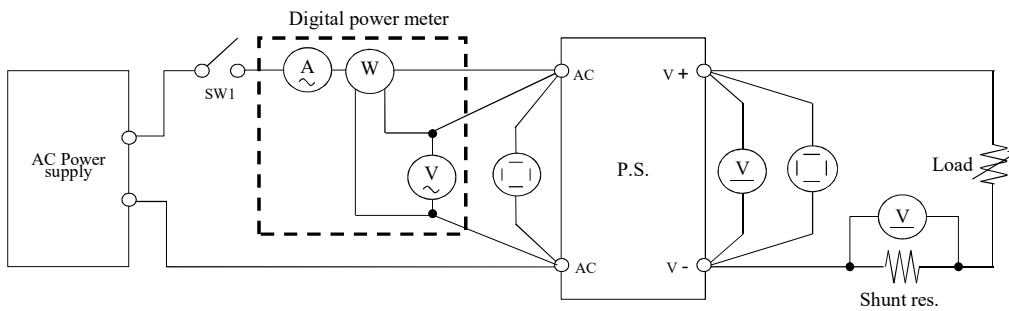
※ Test results are reference data based on our measurement condition.

1. Evaluation Method

1-1. Circuit used for determination

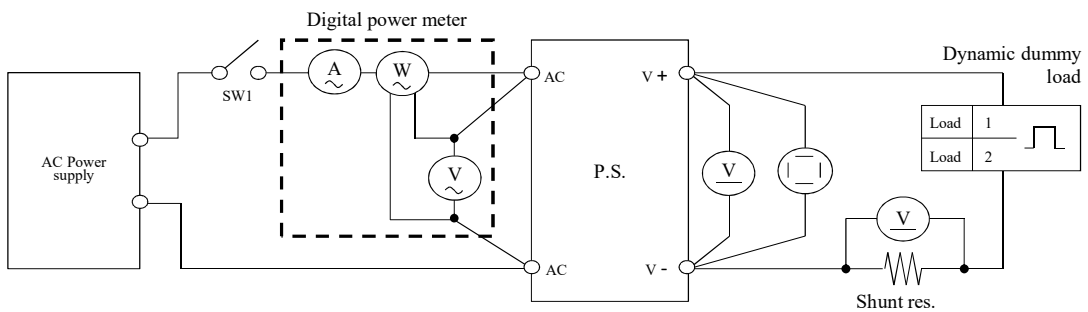
Circuit 1 used for determination

- Steady state data
- Warm up voltage drift characteristics
- Hold up time characteristics
- Output rise characteristics
- Output fall characteristics
- Over current protection (OCP) characteristics
- Over voltage protection (OVP) characteristics
- Response to brown out characteristics

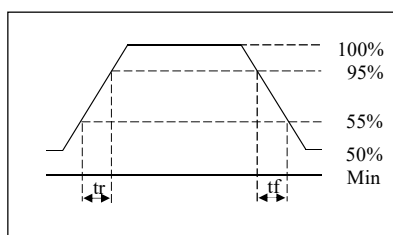


Circuit 2 used for determination

- Dynamic load response characteristics

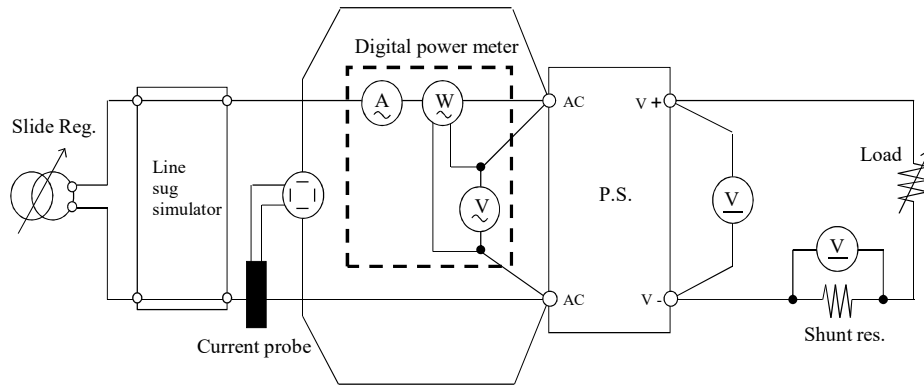


Output current waveform
Iout 50% <=> 100%



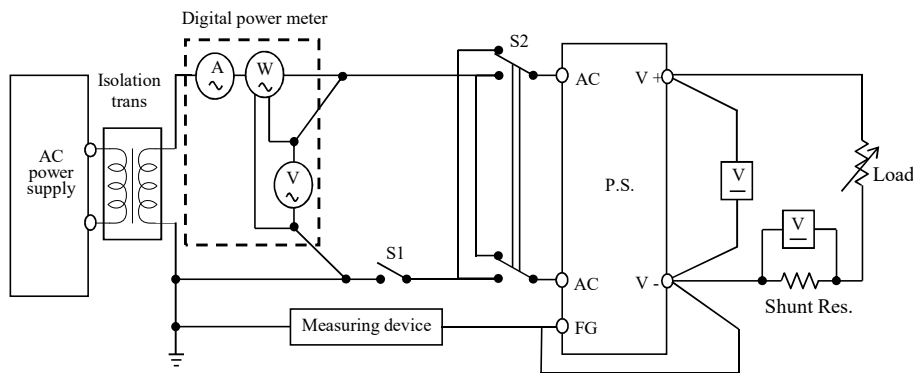
Circuit 3 used for determination

- Inrush current waveform



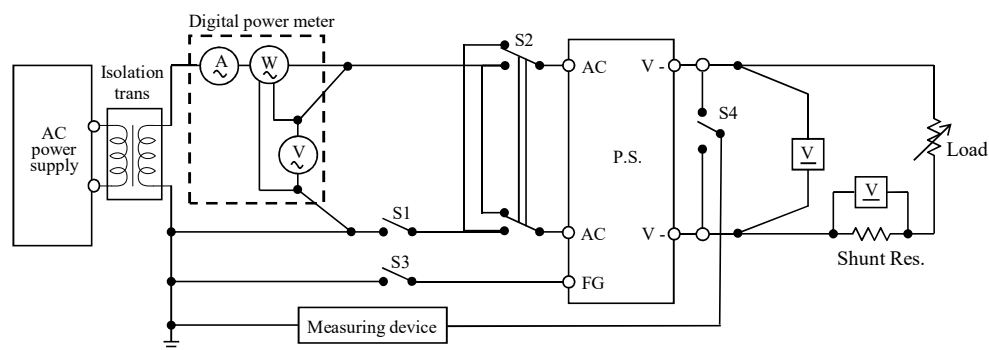
Circuit 4 used for determination

- Earth leakage current characteristics



Measure in all possible combination of position of S2 with :
S1 closed (normal condition), and S1 open (single fault condition)

- Patient leakage current



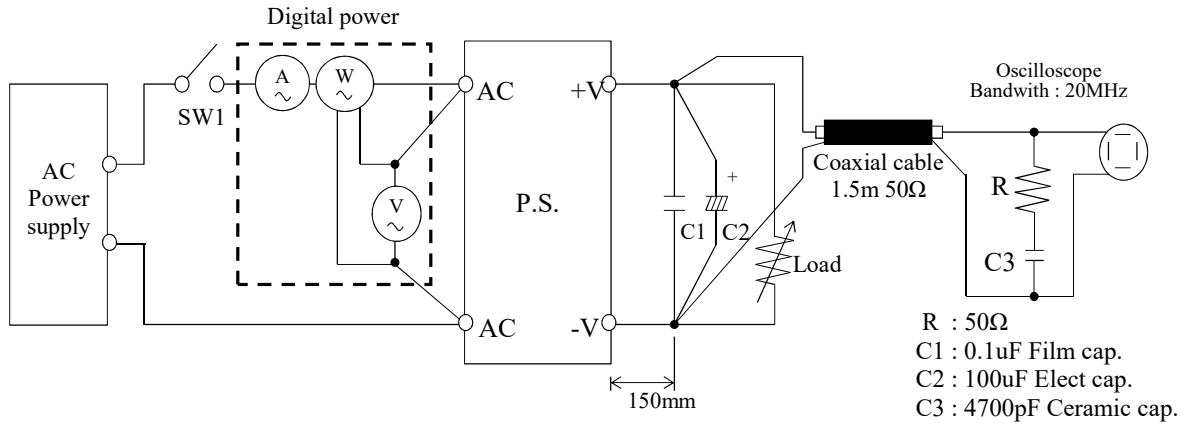
CLASS I equipment:

S1, S3 closed, measure under all possible position of S2 & S4.

Single fault condition: S1 open with S3 close or S1 close with S3 open.

Circuit 5 used for determination

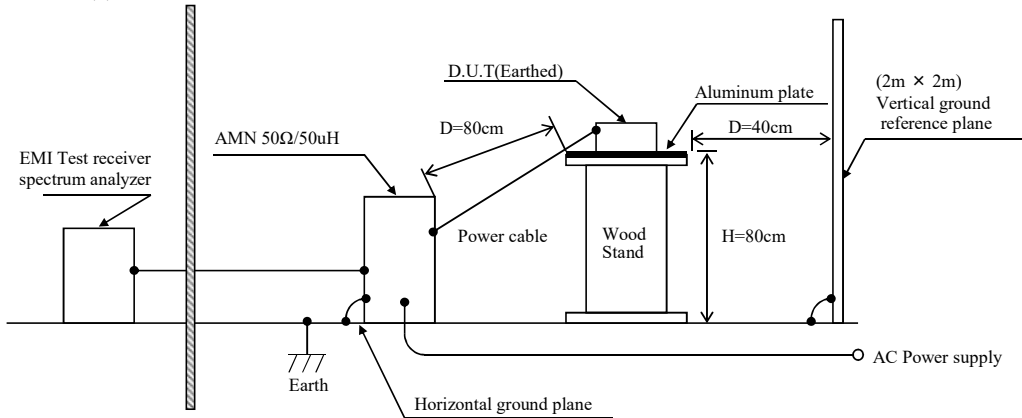
- Output ripple and noise waveform



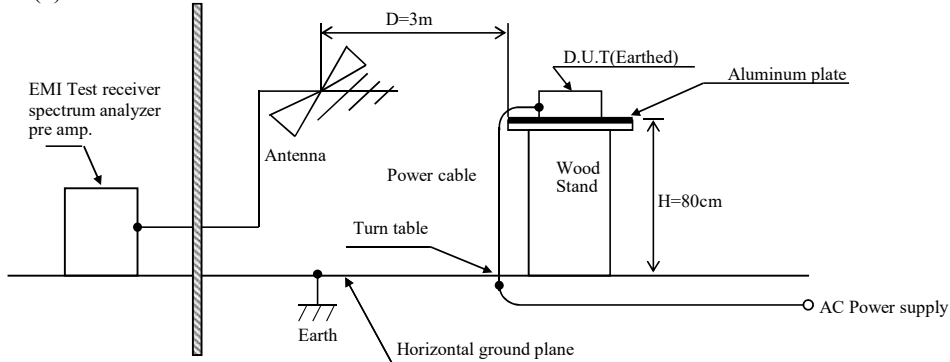
Configuration used for determination

- Electro-Magnetic Interference characteristics

(a) Conducted Emission



(b) Radiated Emission



1-2. List of equipment used

	EQUIPMENT USED	MANUFACTURER	MODEL NO.
1	DIGITAL STORAGE OSCILLOSCOPE	YOKOGAWA ELECT.	DL2054
2	DIGITAL MULTIMETER	AGILENT	34970A
3	DIGITAL POWER METER	YOKOGAWA ELECT.	WT310E
4	CURRENT PROBE	YOKOGAWA ELECT.	701930
5	DC AMPERE METER	TEKTRONIX	P5100
6	DYNAMIC DUMMY LOAD	CHROMA	63030/63610/63640
7	AC SOURCE	KIKUSUI	PCR2000LE
8	EARTH LEAKAGE CURRENT METER	SIMPSON	228
9	PATIENT LEAKAGE CURRENT METER	SIQ	SIQ16042
10	CONTROLLED TEMP. CHAMBER	TABAI-ESPEC	SU-661
11	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESCI-03
12	LISN	ROHDE & SCHWARZ	ENV216
13	BROADBAND ANTENNA	SCHWARZBECK	VULB9168
14	LINE SUG SIMULATOR	TAKAMISAWA	PSA-210

2. Characteristics

2-1. Steady state data

(1) Regulation - line and load, Temperature drift / Start up voltage and Drop out voltage

12V 1. Regulation - line and load Condition Ta : 25 °C
Iout : 100 % (50A)
Cooling : Forced Air

Iout \ Vin	85VAC	115VAC	230VAC	265VAC	Line regulation	
0%	12.015V	12.016V	12.015V	12.016V	1mV	0.008%
50%	12.006V	12.006V	12.006V	12.006V	0mV	0.000%
100%	-	12.009V	12.009V	12.009V	0mV	0.000%
Load regulation	9mV	10mV	9mV	10mV		
	0.075%	0.083%	0.075%	0.083%		

2. Temperature drift Condition Vin : 115 VAC
Iout : 100 % (50A)
Cooling : Forced Air

Ta	-20°C	+25°C	+55°C	Temperature stability	
Vout	11.973V	12.009V	12.017V	44mV	0.367%

3. Start up voltage and Drop out voltage Condition Ta : 25 °C
Iout : 80 % (40A)
Cooling : Forced Air

Start up voltage (Vin)	77.8VAC
Drop out voltage (Vin)	76.7VAC

24V 1. Regulation - line and load Condition Ta : 25 °C
Iout : 100 % (25A)
Cooling : Forced Air

Iout \ Vin	85VAC	115VAC	230VAC	265VAC	Line regulation	
0%	23.966V	23.965V	23.966V	23.966V	1mV	0.004%
50%	23.956V	23.956V	23.957V	23.957V	1mV	0.004%
100%	-	23.956V	23.956V	23.956V	0mV	0.000%
Load regulation	10mV	9mV	10mV	10mV		
	0.042%	0.038%	0.042%	0.042%		

2. Temperature drift Condition Vin : 115 VAC
Iout : 100 % (25A)
Cooling : Forced Air

Ta	-20°C	+25°C	+55°C	Temperature stability	
Vout	23.910V	23.956V	23.953V	46mV	0.192%

3. Start up voltage and Drop out voltage Condition Ta : 25 °C
Iout : 80 % (20A)
Cooling : Forced Air

Start up voltage (Vin)	77.8VAC
Drop out voltage (Vin)	76.7VAC

48V 1. Regulation - line and load Condition Ta : 25 °C
Iout : 100 % (12.6A)
Cooling : Forced Air

Iout \ Vin	85VAC	115VAC	230VAC	265VAC	Line regulation	
0%	48.015V	48.016V	48.016V	48.017V	2mV	0.004%
50%	48.003V	48.003V	48.003V	48.003V	0mV	0.000%
100%	-	48.003V	48.003V	48.003V	0mV	0.000%
Load regulation	12mV	13mV	13mV	14mV		
	0.025%	0.027%	0.027%	0.029%		

2. Temperature drift Condition Vin : 115 VAC
Iout : 100 % (12.6A)
Cooling : Forced Air

Ta	-20°C	+25°C	+55°C	Temperature stability	
Vout	47.922V	48.004V	48.003V	82mV	0.171%

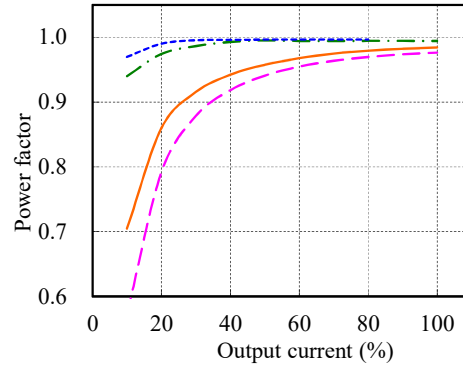
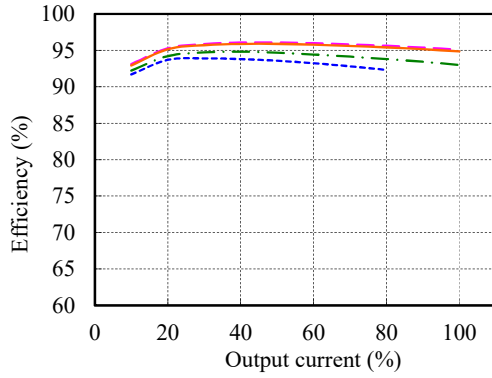
3. Start up voltage and Drop out voltage Condition Ta : 25 °C
Iout : 80 % (10.1A)
Cooling : Forced Air

Start up voltage (Vin)	77.8VAC
Drop out voltage (Vin)	76.7VAC

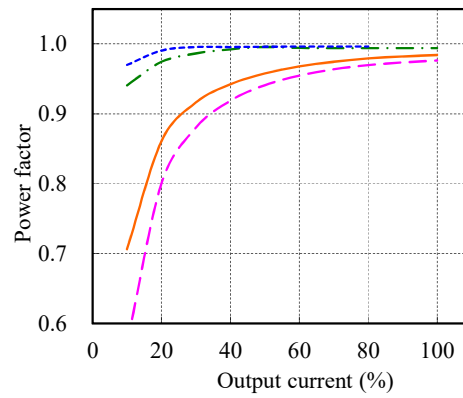
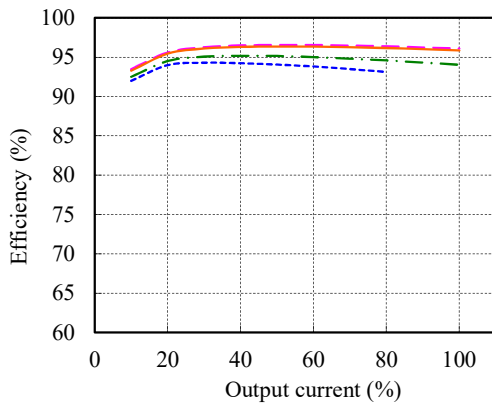
(2) Efficiency and Power factor vs. Output current

Conditions Vin : 85 VAC ---
 115 VAC -.-
 230 VAC —
 265 VAC -.-
 Ta : 25 °C
 Cooling : Forced air

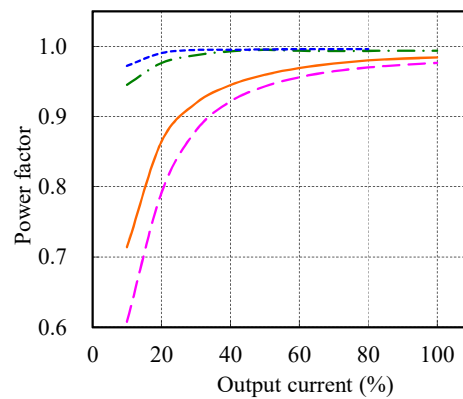
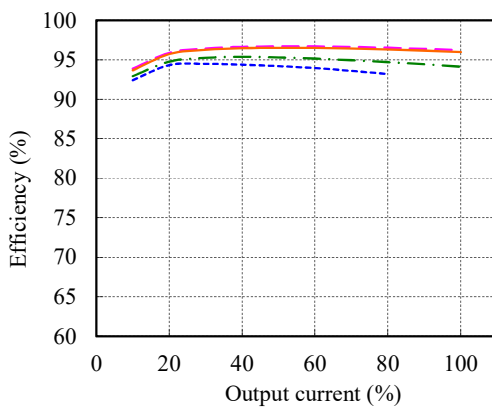
12V



24V



48V

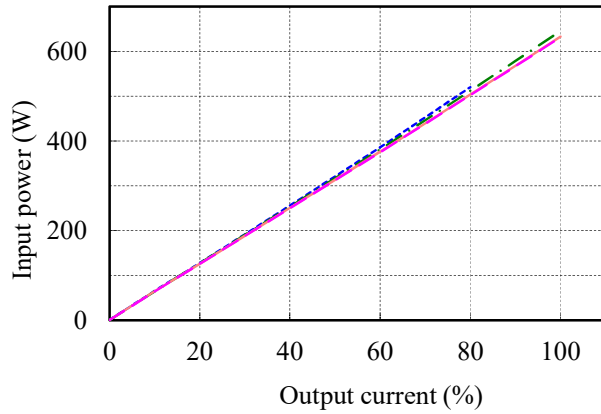


(3) Input power vs. Output current

Conditions Vin : 85 VAC ---
 115 VAC - - -
 230 VAC ———
 265 VAC - · - ·
 Ta : 25 °C
 Cooling : Forced air

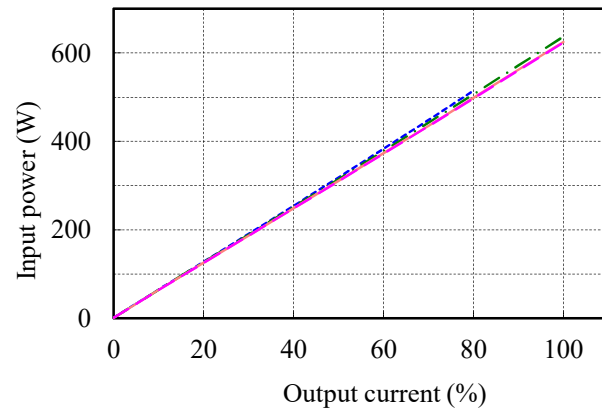
12V

Vin	Input power
	Iout : 0%
85VAC	1.0W
115VAC	0.8W
230VAC	0.8W
265VAC	0.9W



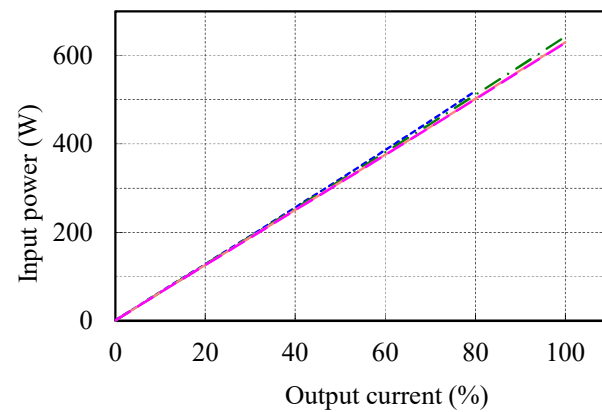
24V

Vin	Input power
	Iout : 0%
85VAC	1.2W
115VAC	1.0W
230VAC	1.0W
265VAC	1.0W



48V

Vin	Input power
	Iout : 0%
85VAC	1.3W
115VAC	1.0W
230VAC	1.0W
265VAC	1.1W

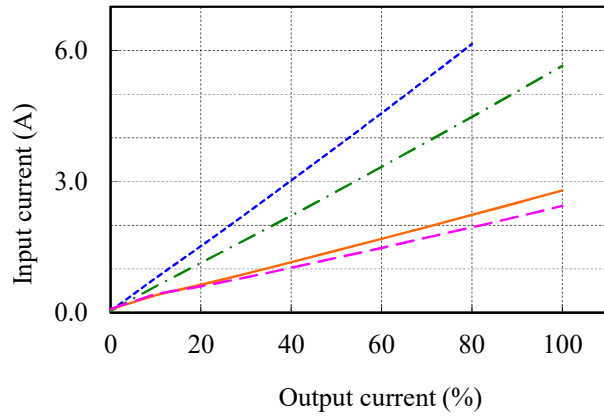


(4) Input current vs. Output current

Conditions Vin : 85 VAC ---
 115 VAC -.-
 230 VAC —
 265 VAC -.-
 Ta : 25 °C
 Cooling : Forced air

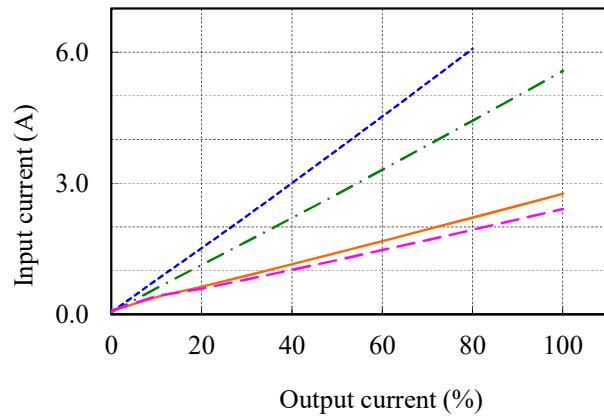
12V

Vin	Input current
	Iout : 0%
85VAC	0.04A
115VAC	0.04A
230VAC	0.07A
265VAC	0.08A



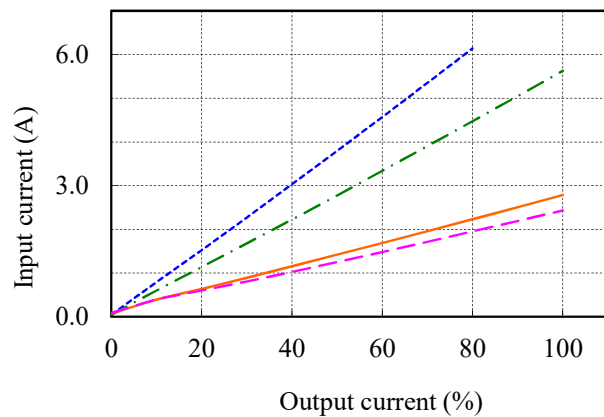
24V

Vin	Input current
	Iout : 0%
85VAC	0.04A
115VAC	0.04A
230VAC	0.07A
265VAC	0.08A



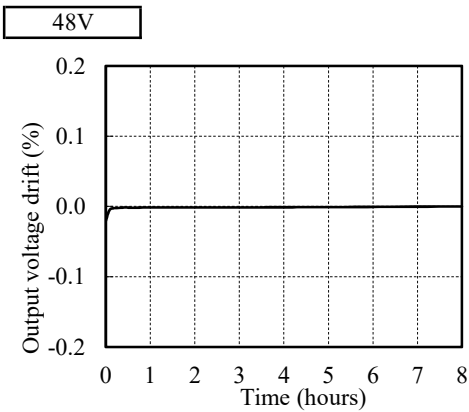
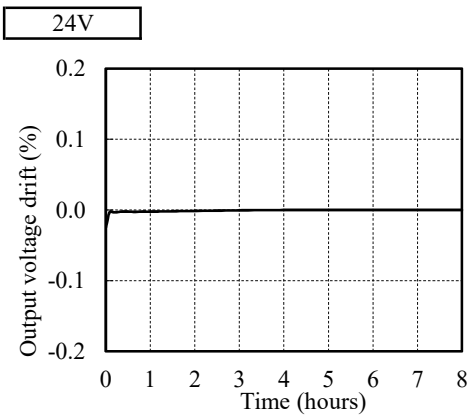
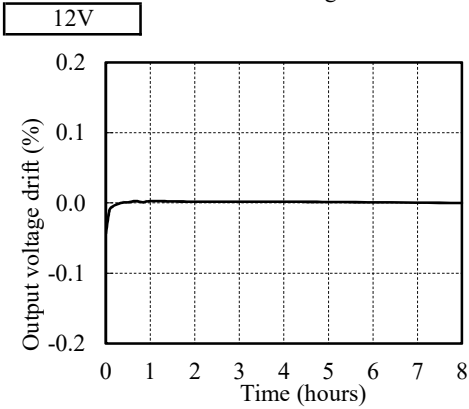
48V

Vin	Input current
	Iout : 0%
85VAC	0.04A
115VAC	0.04A
230VAC	0.07A
265VAC	0.08A



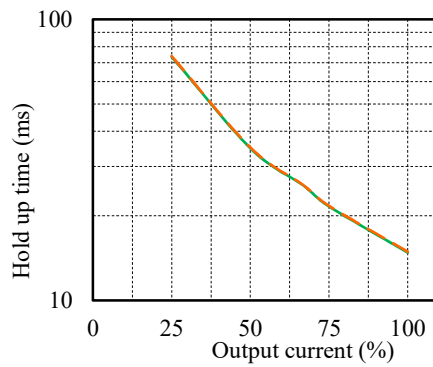
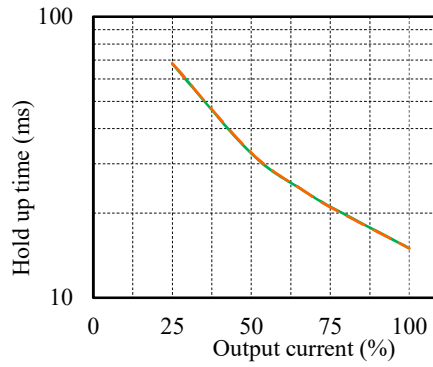
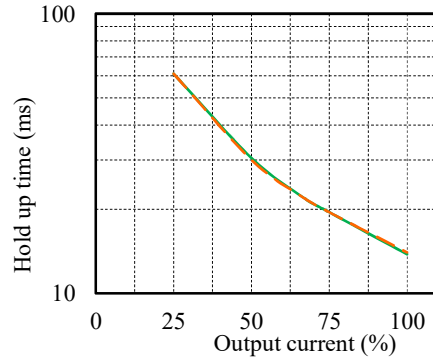
2-2. Warm up voltage drift characteristics

Conditions V_{in} : 115 VAC
 I_{out} : 100 %
 T_a : 25 °C
 Cooling : Forced Air



2-3. Hold up time characteristics

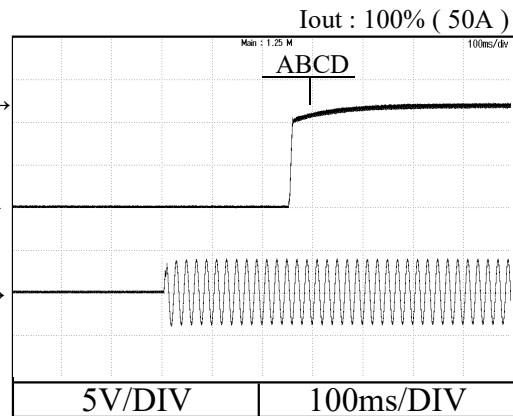
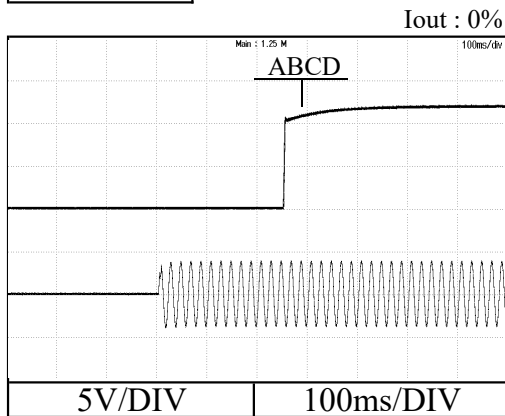
Conditions V_{in} : 115 VAC ———
 230 VAC - - - -
 T_a : 25 °C
 Cooling : Forced Air



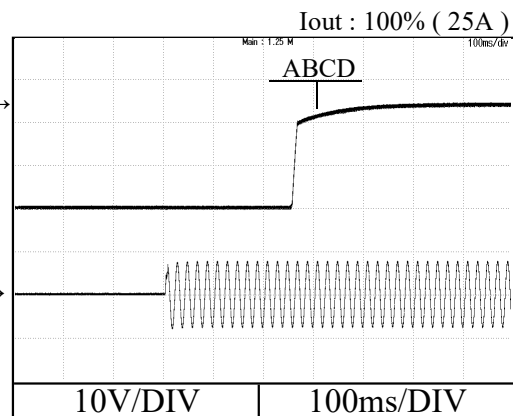
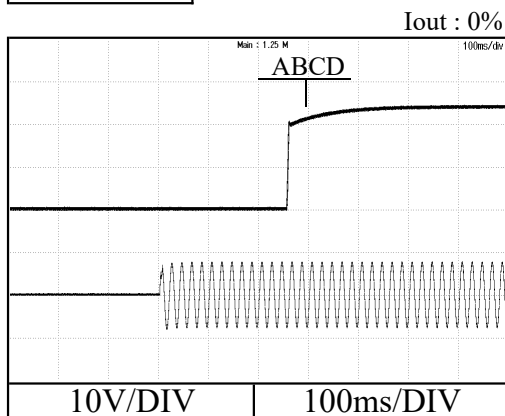
2-4. Output rise characteristics

Conditions Vin : 85 VAC (A)
 115 VAC (B)
 230 VAC (C)
 265 VAC (D)
 Ta : 25 °C
 Cooling : Forced Air

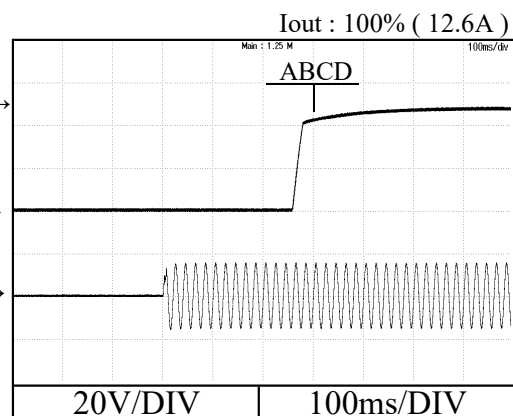
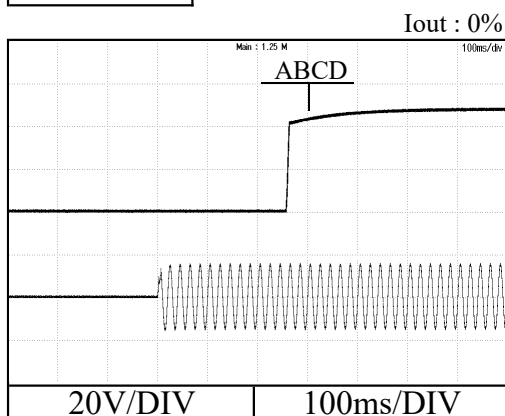
12V



24V

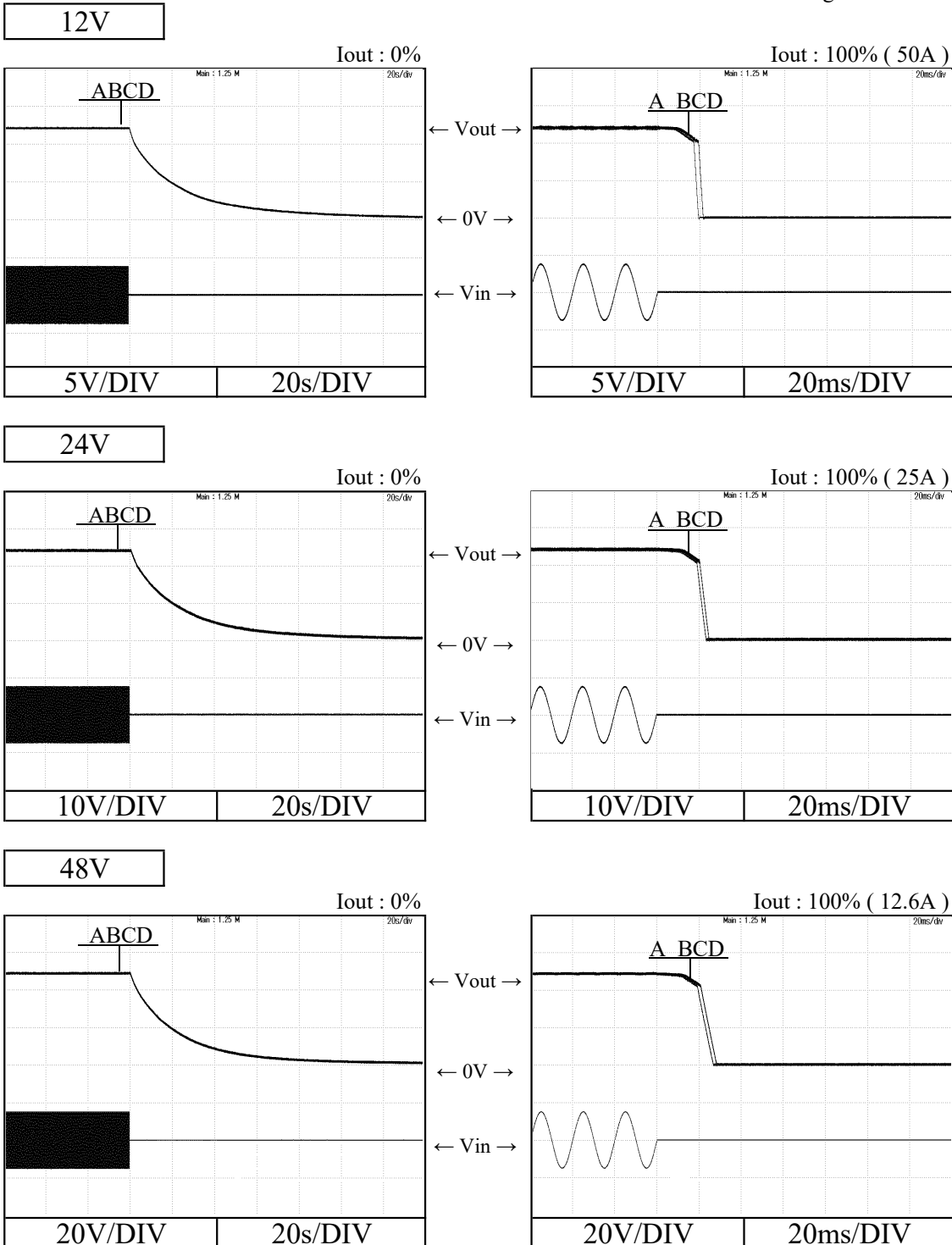


48V



2-5. Output fall characteristics

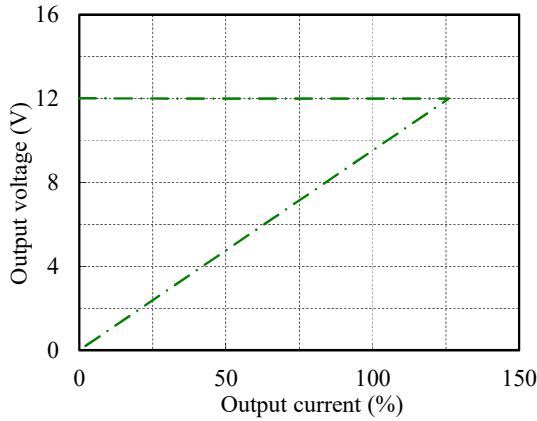
Conditions Vin : 85 VAC (A)
 115 VAC (B)
 230 VAC (C)
 265 VAC (D)
 Ta : 25 °C
 Cooling : Forced Air



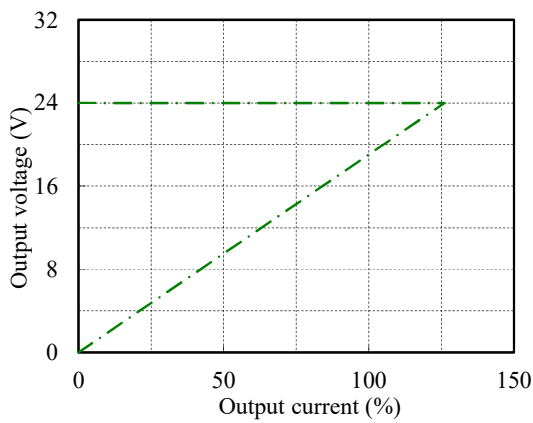
2-6. Over current protection (OCP) characteristics

Conditions Vin : 115 VAC
 Ta : 25 °C
 Cooling : Forced Air

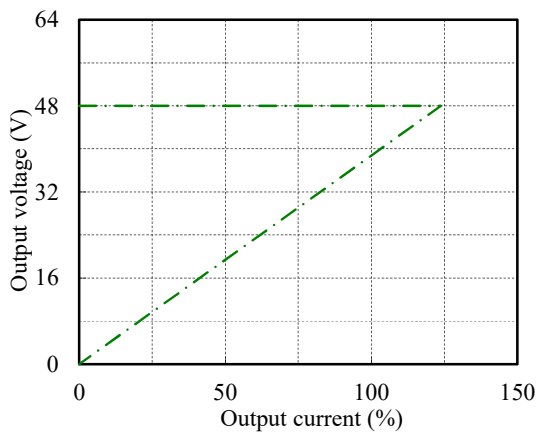
12V



24V



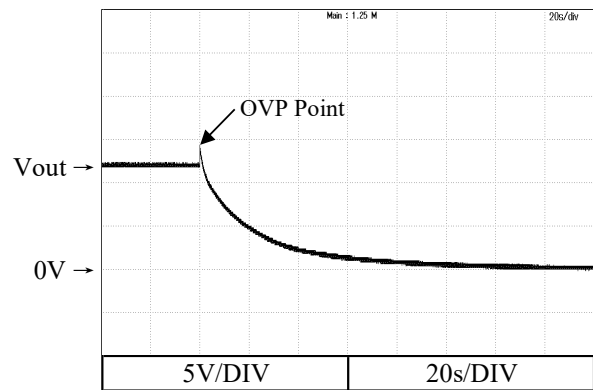
48V



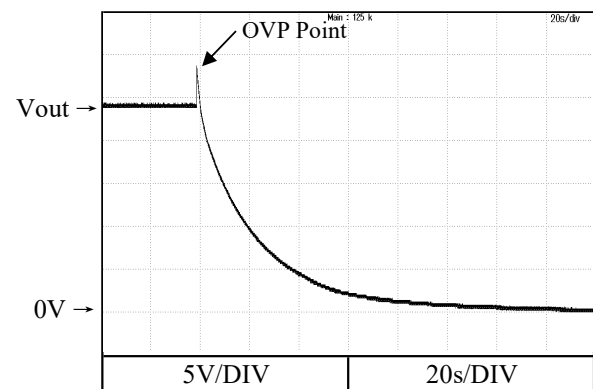
2-7. Over voltage protection (OVP) characteristics

Conditions Vin : 115 VAC
 Iout : 0 %
 Ta : 25 °C

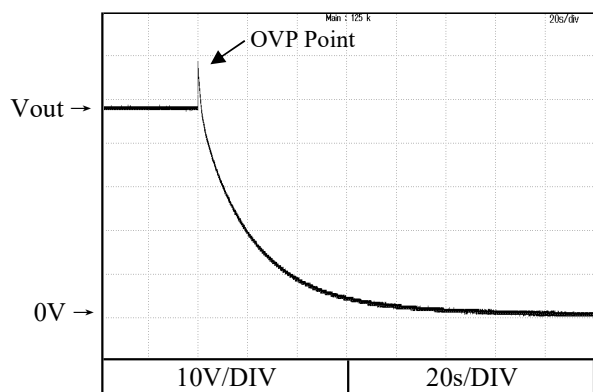
12V



24V



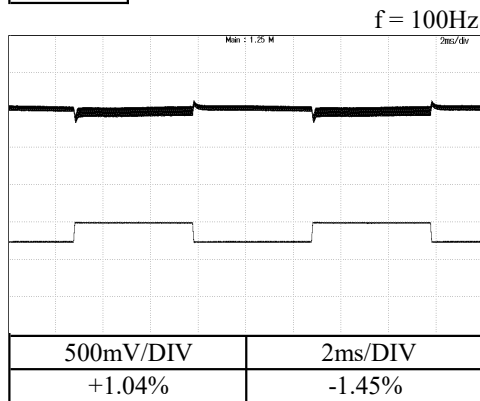
48V



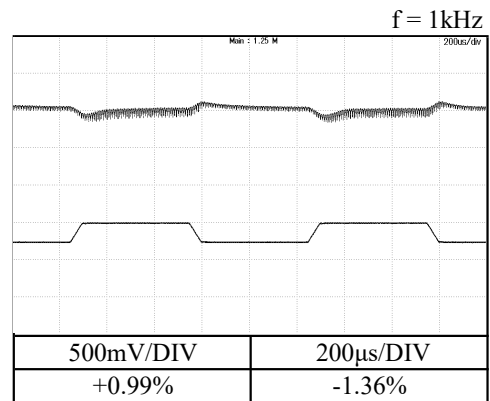
2-8. Dynamic load response characteristics

Conditions Vin : 115 VAC
 Iout : 50 % ↔ 100 %
 (tr = tf = 50us)
 Ta : 25 °C
 Cooling : Forced Air

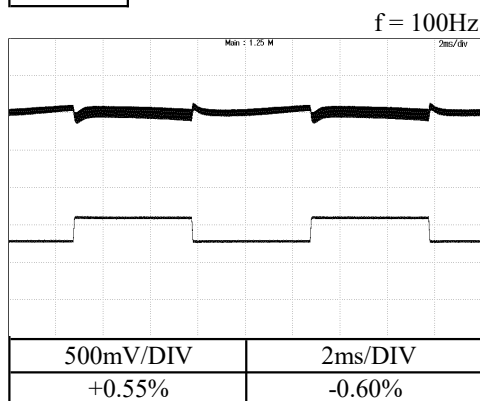
12V



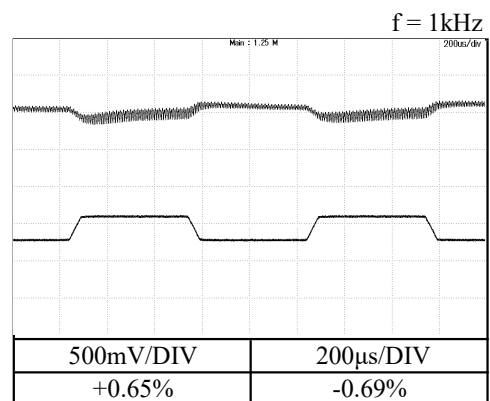
← Vout →
 ← Iout →
 ← Iout:0% →



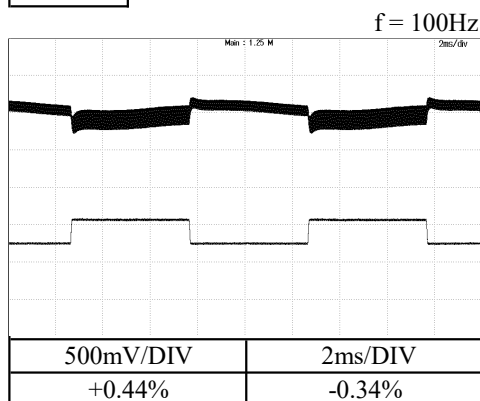
24V



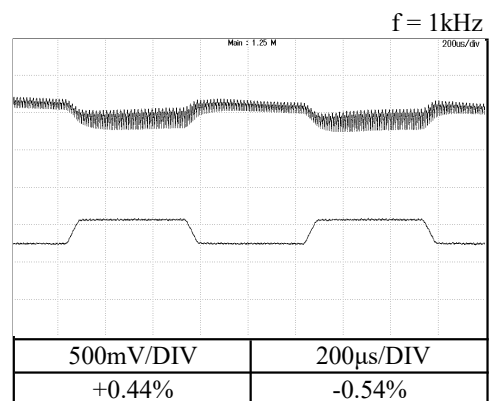
← Vout →
 ← Iout →
 ← Iout:0% →



48V



← Vout →
 ← Iout →
 ← Iout:0% →



2-9. Response to brown out characteristics

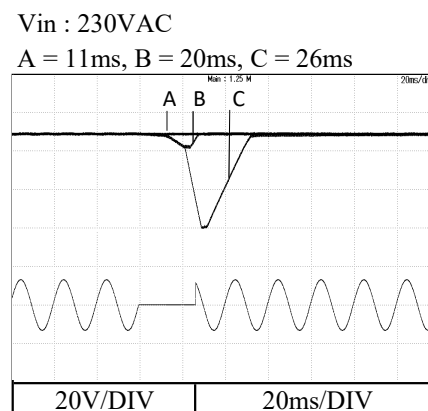
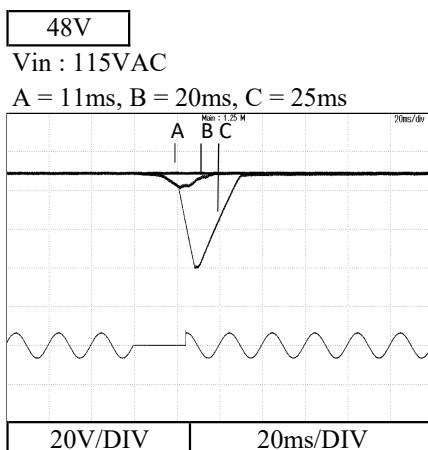
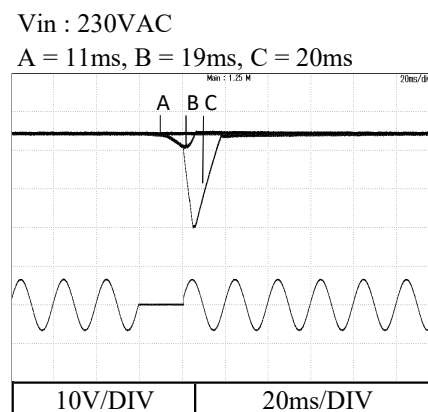
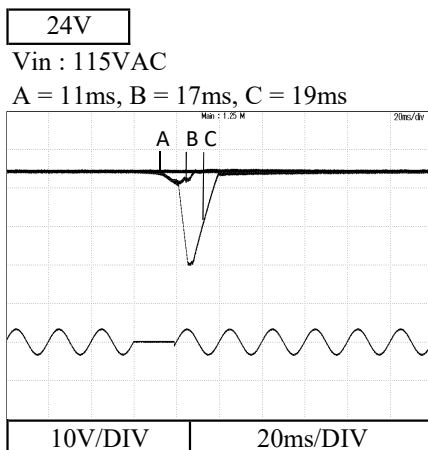
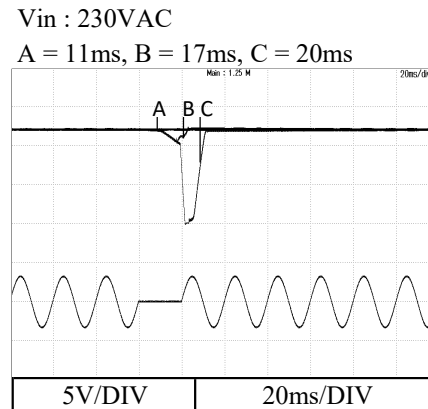
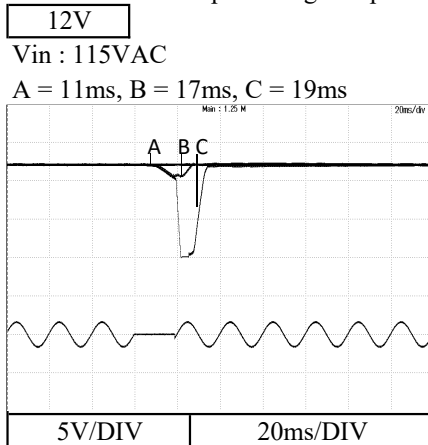
Conditions Iout : 100 %
 Ta : 25 °C
 Cooling : Forced Air

Interruption time

A : Output voltage does not drop.

B : Output voltage drop down to 20~40% of the nominal output voltage.

C : Output voltage drops until 0V.

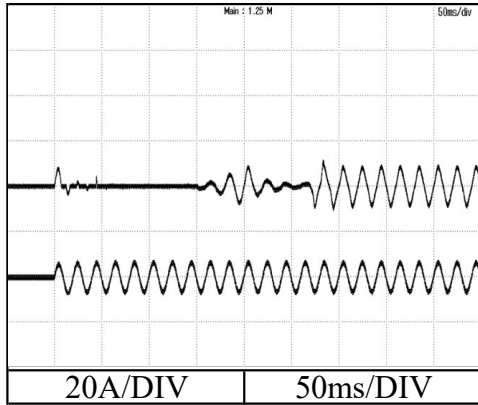


2-10. Inrush current waveform

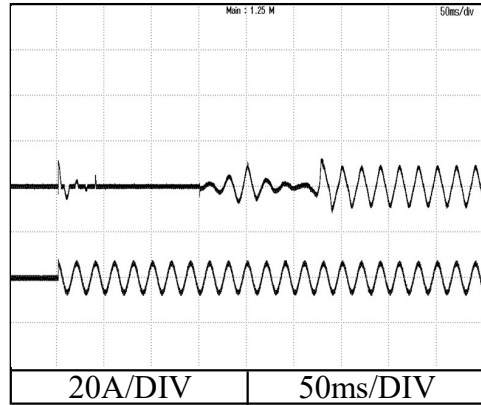
Conditions V_{in} : 115 VAC
 I_{out} : 12.6A (100%)
 T_a : 25 °C
 Cooling : Forced Air

48V

Switch on phase angle of input AC voltage
 $\phi = 0^\circ$

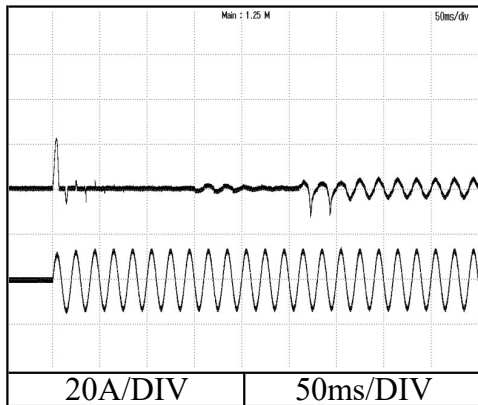


Switch on phase angle of input AC voltage
 $\phi = 90^\circ$

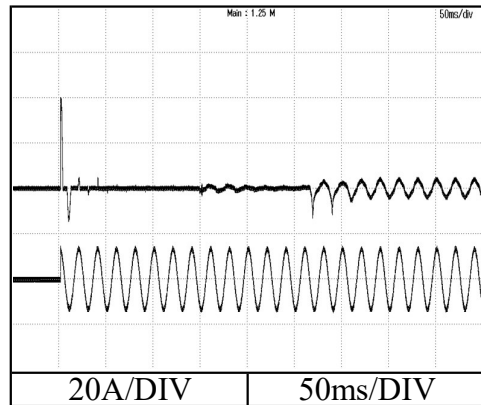


Conditions V_{in} : 230 VAC
 I_{out} : 12.6A (100%)
 T_a : 25 °C
 Cooling : Forced Air

Switch on phase angle of input AC voltage
 $\phi = 0^\circ$



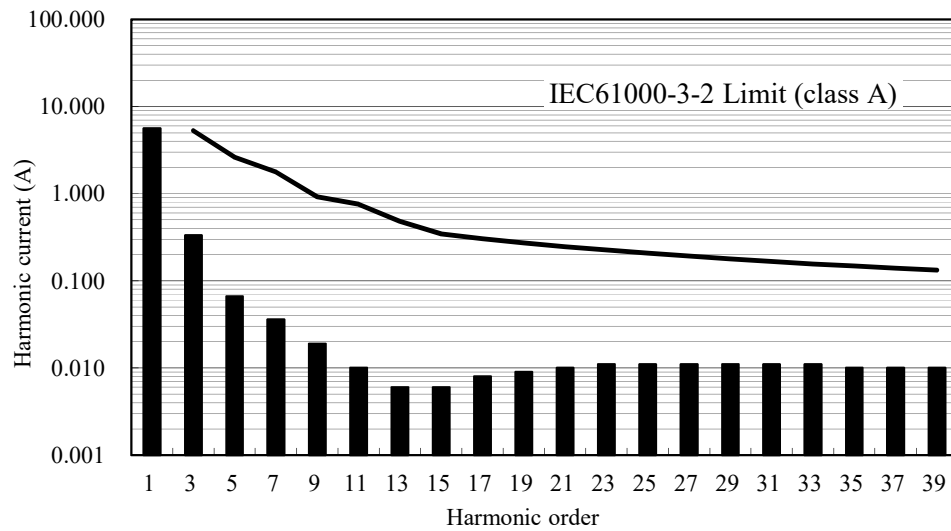
Switch on phase angle of input AC voltage
 $\phi = 90^\circ$



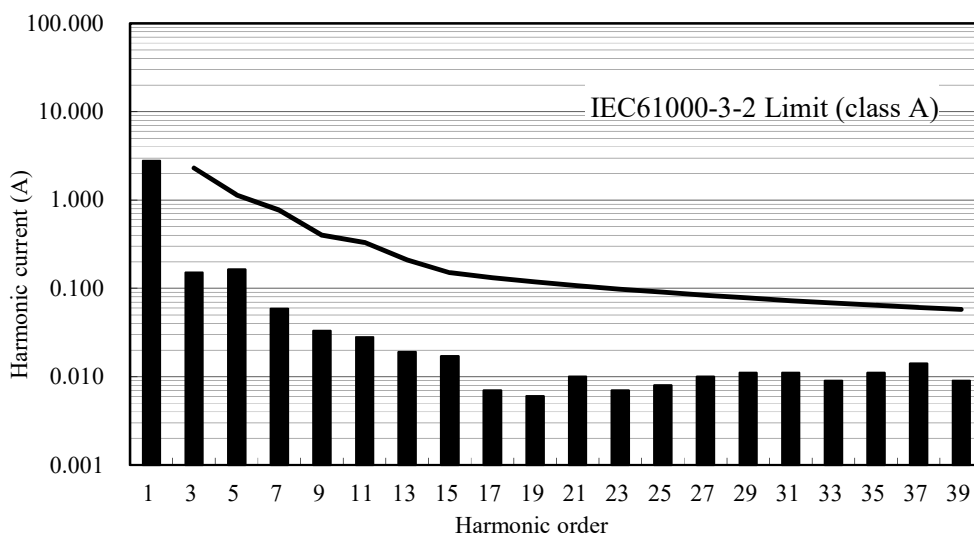
2-11. Input current harmonics

Conditions Vin : 115 VAC
 Iout : 12.6A (100%)
 Ta : 25 °C
 Cooling : Forced Air

48V



Conditions Vin : 230 VAC
 Iout : 12.6A (100%)
 Ta : 25 °C
 Cooling : Forced Air

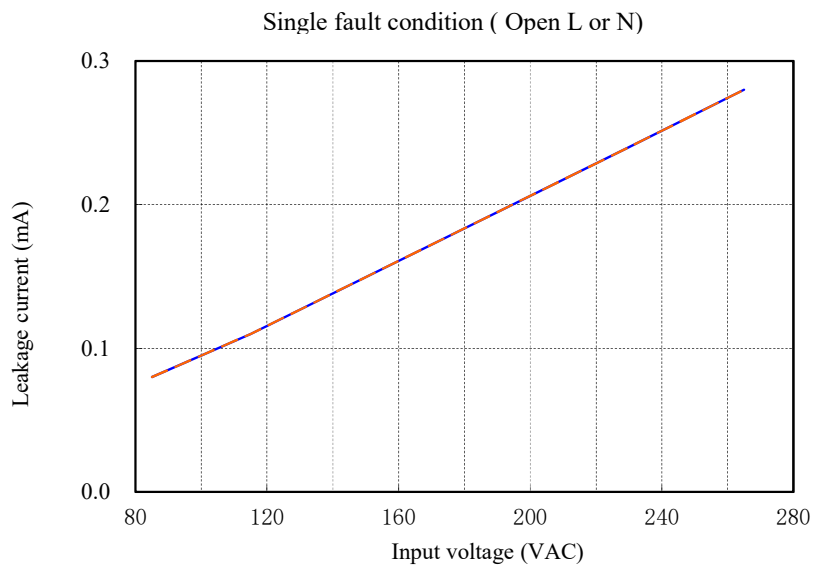
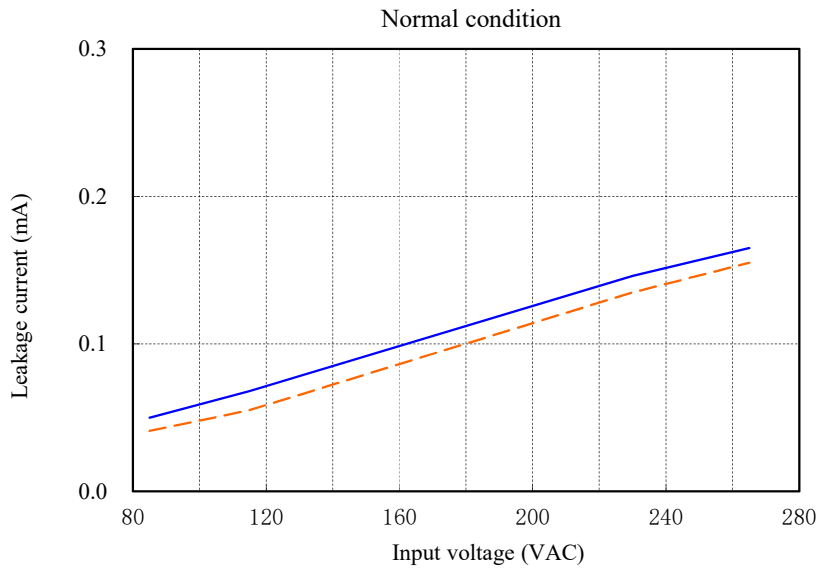


2-12. Leakage current characteristics

Earth leakage current of CLASS I equipment

Conditions Iout : 0 % ———
 100 % - - - -
 Ta : 25 °C
 f : 60 Hz
 Cooling : Forced Air

48V

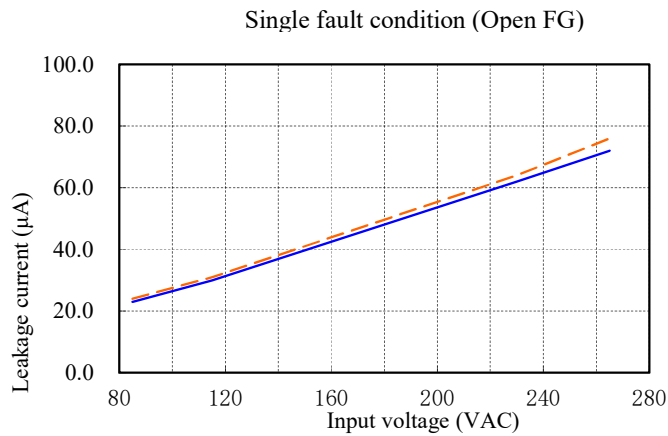
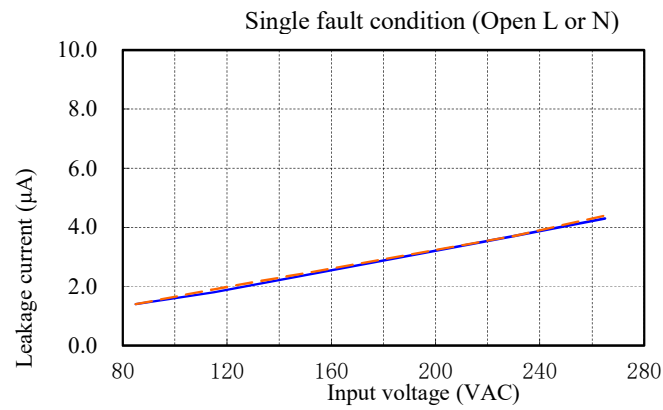
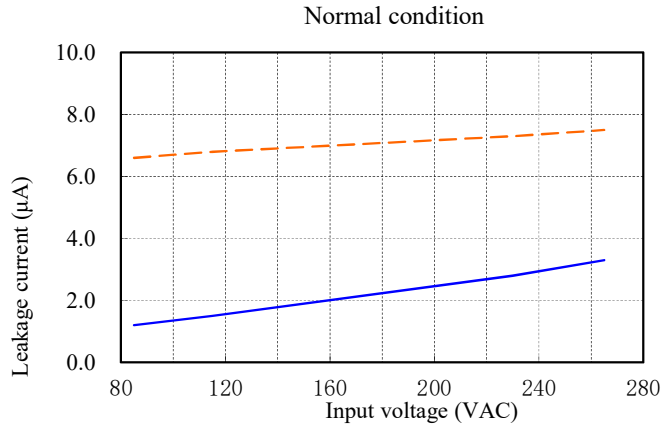


2-12. Leakage current characteristics

Patient leakage current of CLASS I equipment

Conditions Iout : 0 % ———
 100 % - - - -
 Ta : 25 °C
 f : 60 Hz
 Cooling : Forced Air

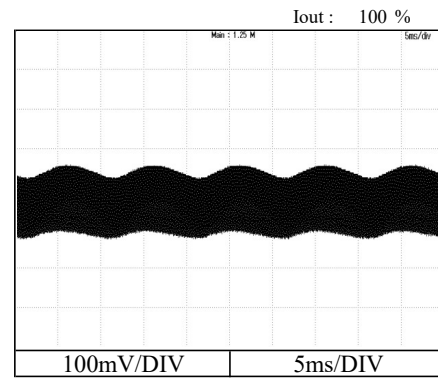
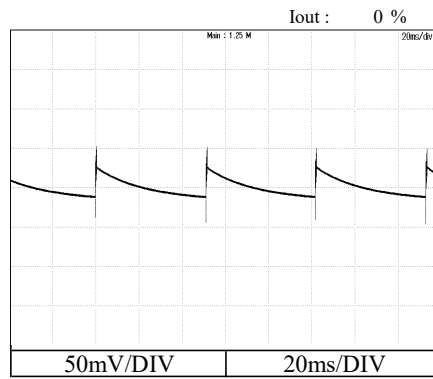
48V



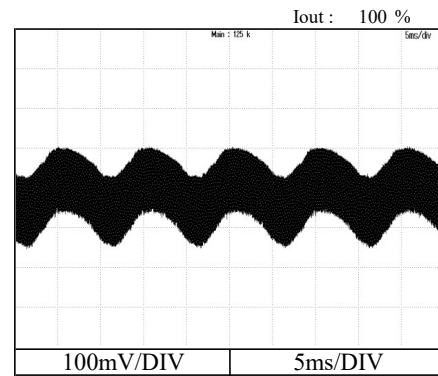
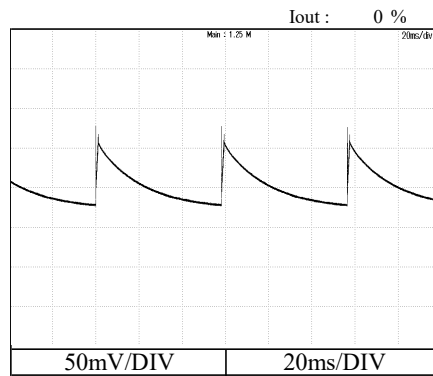
2-13. Output ripple and noise waveform

Conditions Vin : 115 VAC
 Ta : 25 °C
 Cooling : Forced Air

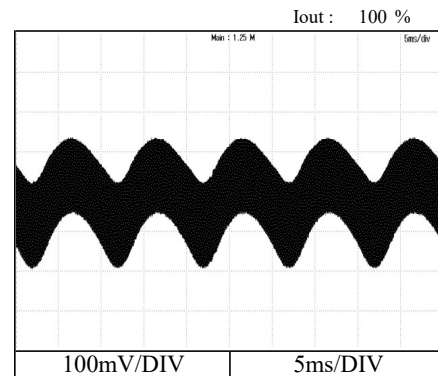
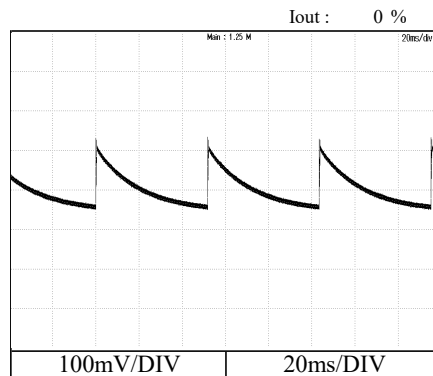
12V



24V



48V



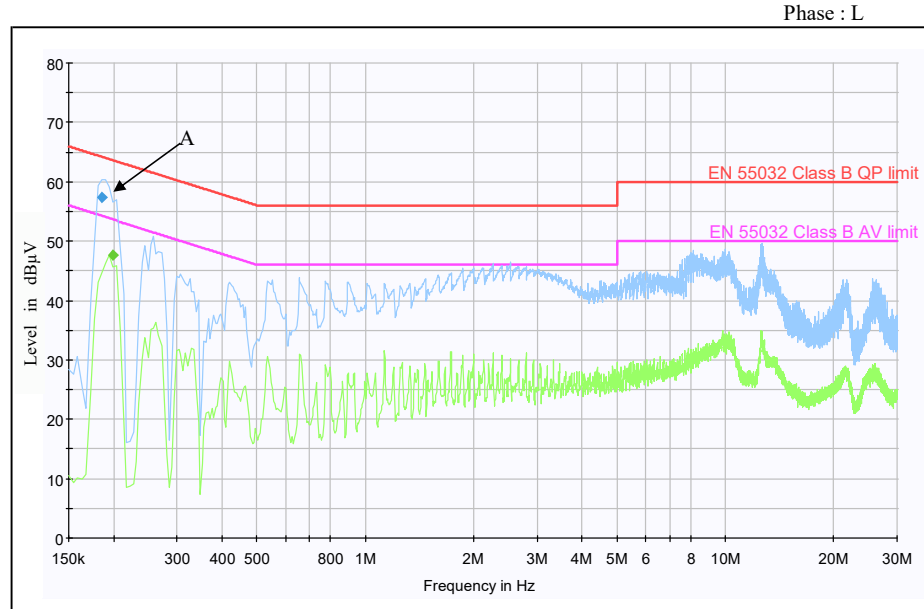
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 115 VAC
 Iout : 50 A (100%)
 Ta : 25 °C
 Cooling : Forced Air

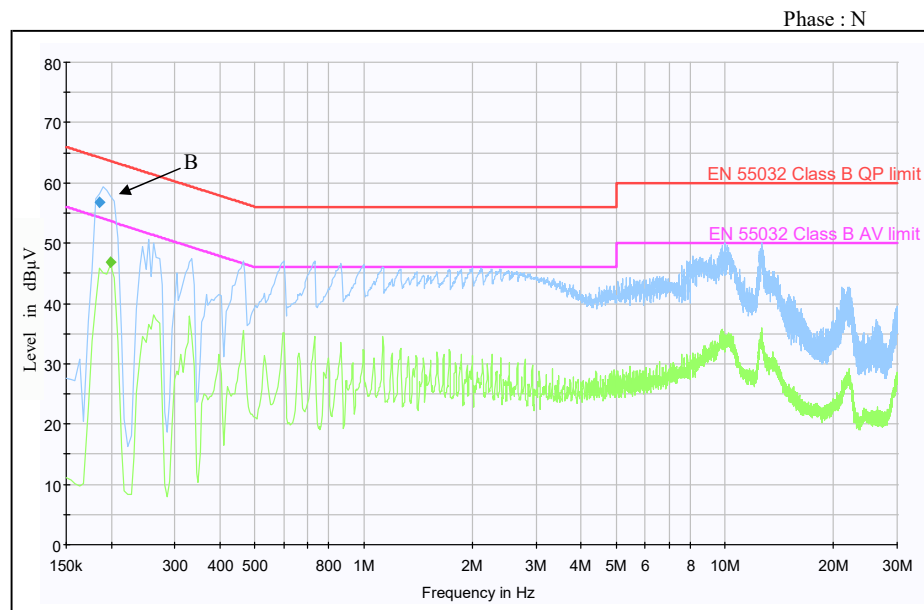
Conducted Emission

12V

Point A (190kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	64.0	57.5
AV	53.6	47.7



Point B (190kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	64.0	56.8
AV	53.6	46.8



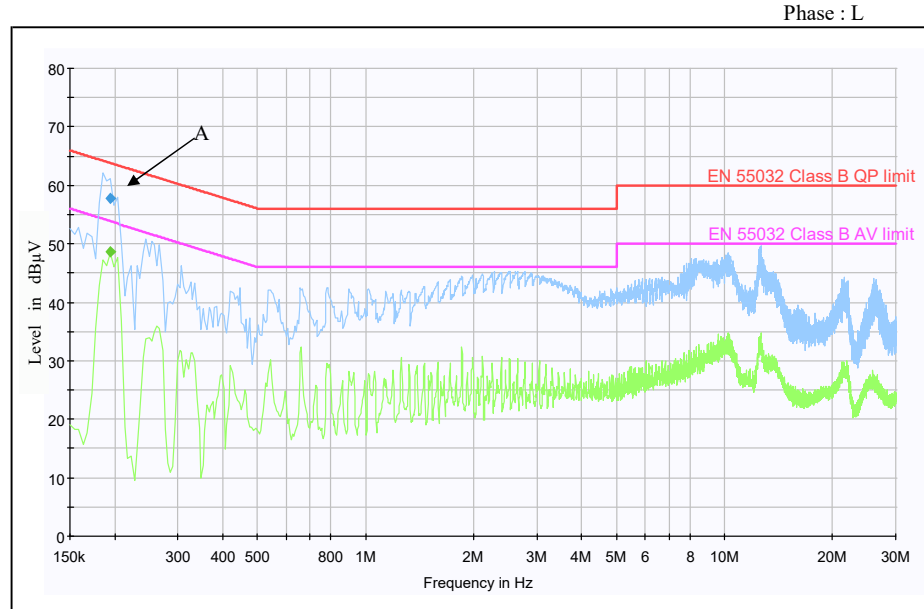
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 230 VAC
 Iout : 50 A (100%)
 Ta : 25 °C
 Cooling : Forced Air

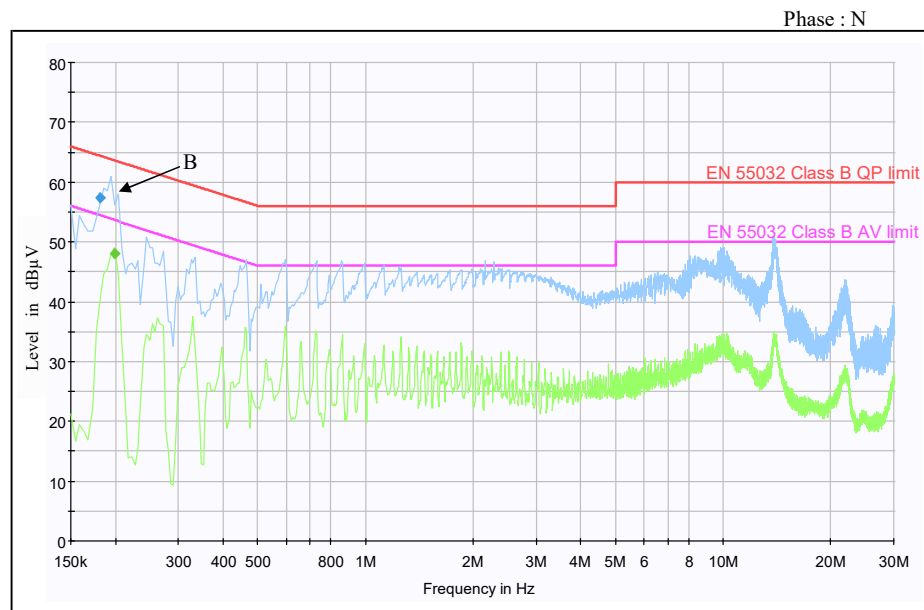
Conducted Emission

12V

Point A (195kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	63.8	57.8
AV	53.8	48.6



Point B (185kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	64.2	57.4
AV	53.6	48.1



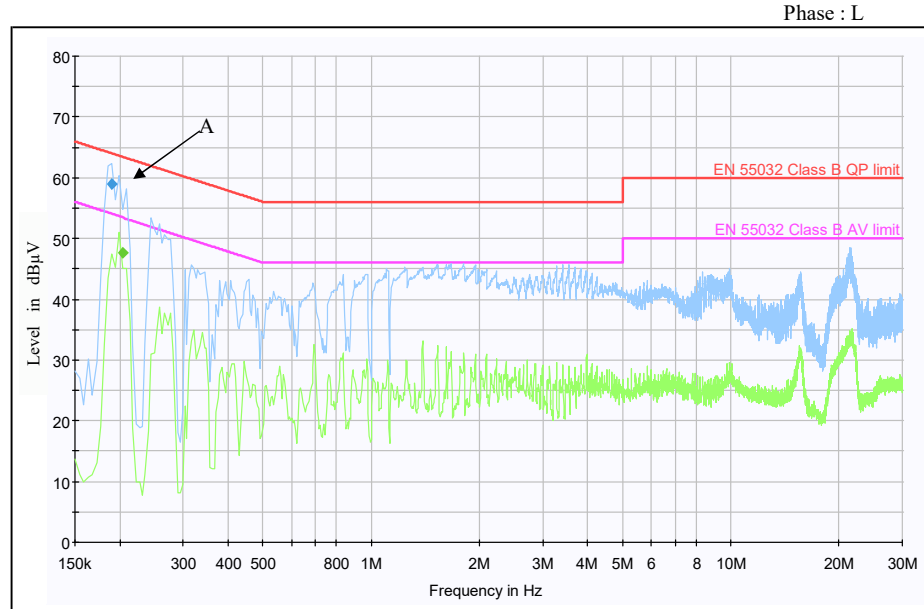
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 115 VAC
 Iout : 25 A (100%)
 Ta : 25 °C
 Cooling : Forced Air

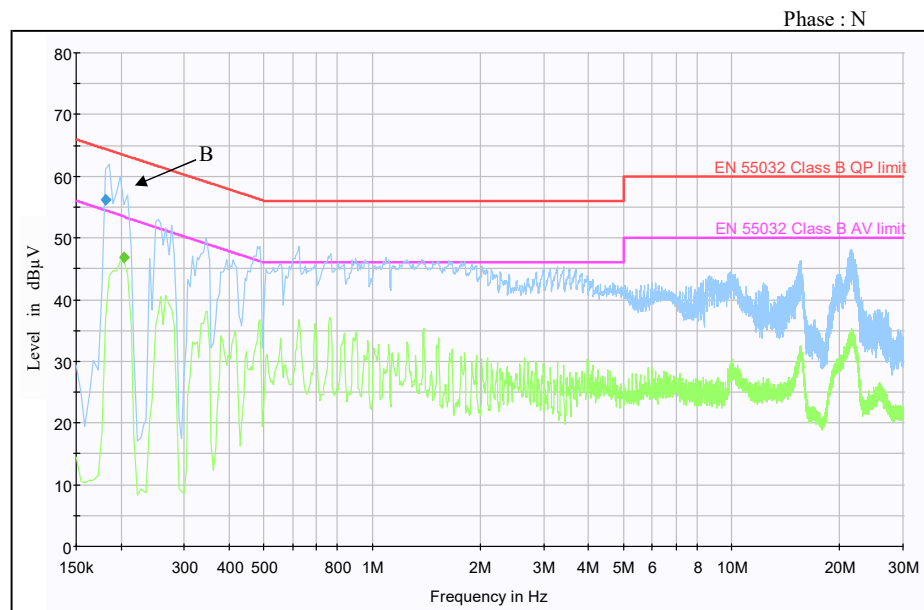
Conducted Emission

24V

Ref. Data	Point A (190kHz)	
	Limit (dB)	Measure (dB)
QP	64.0	59.0
AV	53.4	47.6



Ref. Data	Point B (185kHz)	
	Limit (dB)	Measure (dB)
QP	64.4	56.2
AV	53.4	46.9



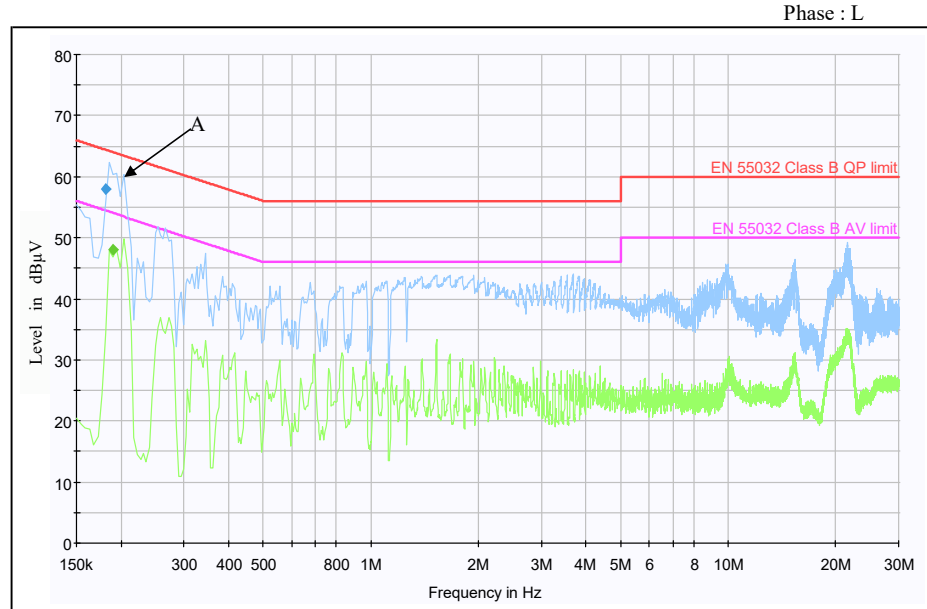
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 230 VAC
 Iout : 25 A (100%)
 Ta : 25 °C
 Cooling : Forced Air

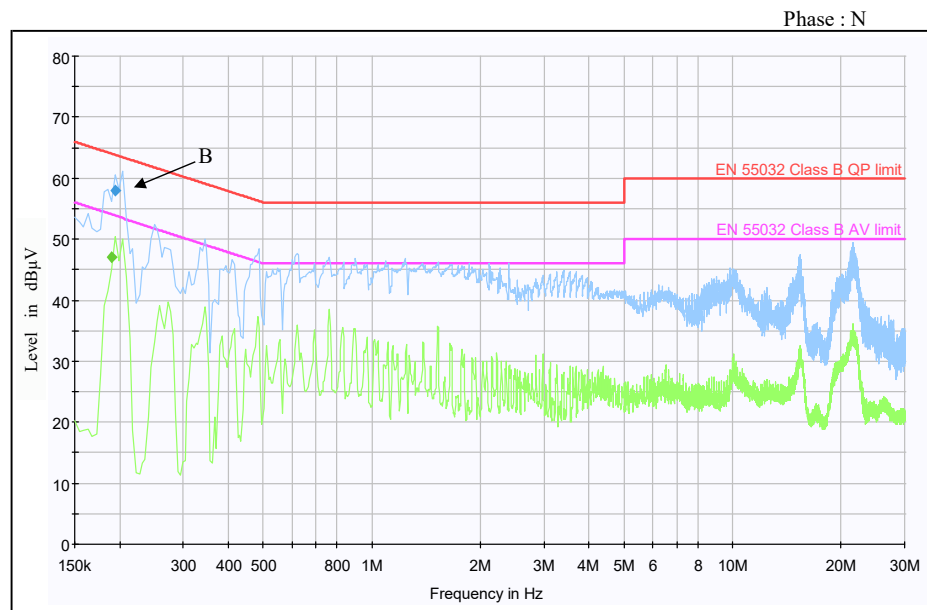
Conducted Emission

24V

Point A (185kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	64.4	57.9
AV	54.0	47.9



Point B (195kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	63.8	57.9
AV	54.0	47.1



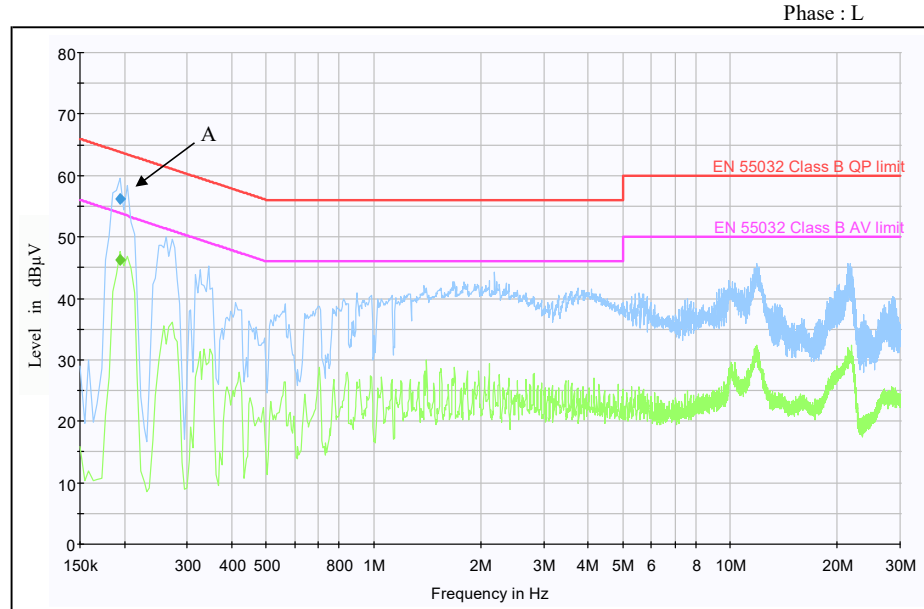
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 115 VAC
 Iout : 12.6 A (100%)
 Ta : 25 °C
 Cooling : Forced Air

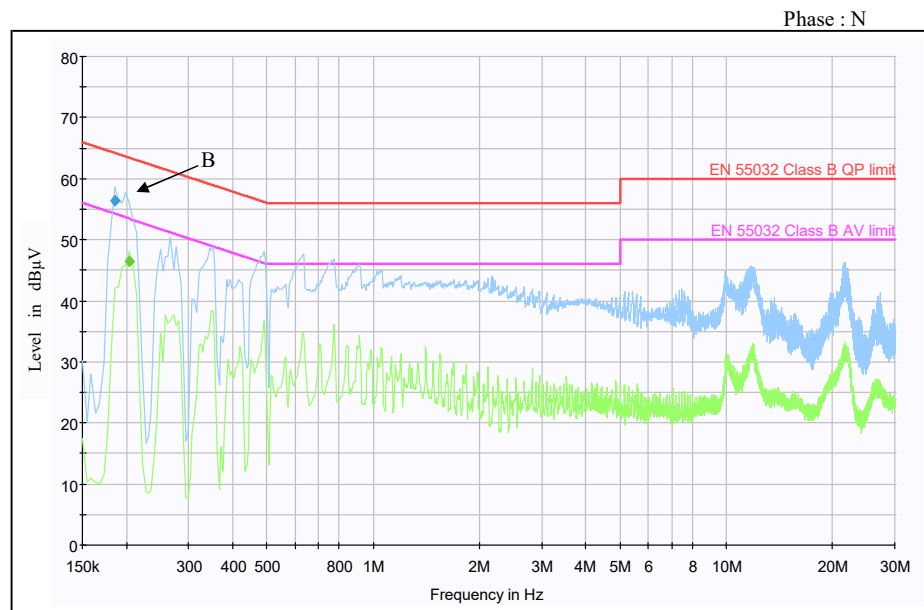
Conducted Emission

48V

Point A (195kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	63.8	56.3
AV	53.8	46.2



Point B (185kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	64.2	56.5
AV	53.4	46.5



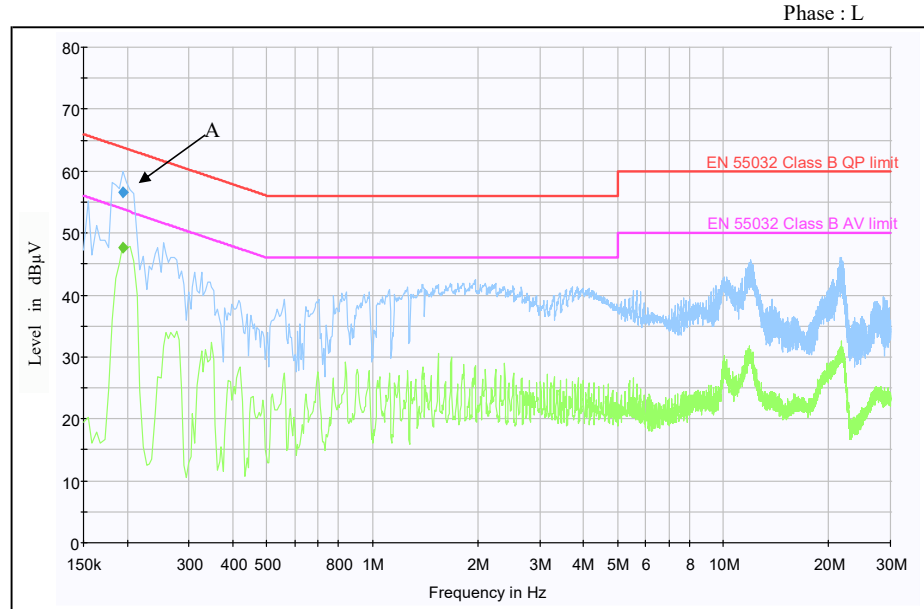
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 230 VAC
 Iout : 12.6 A (100%)
 Ta : 25 °C
 Cooling : Forced Air

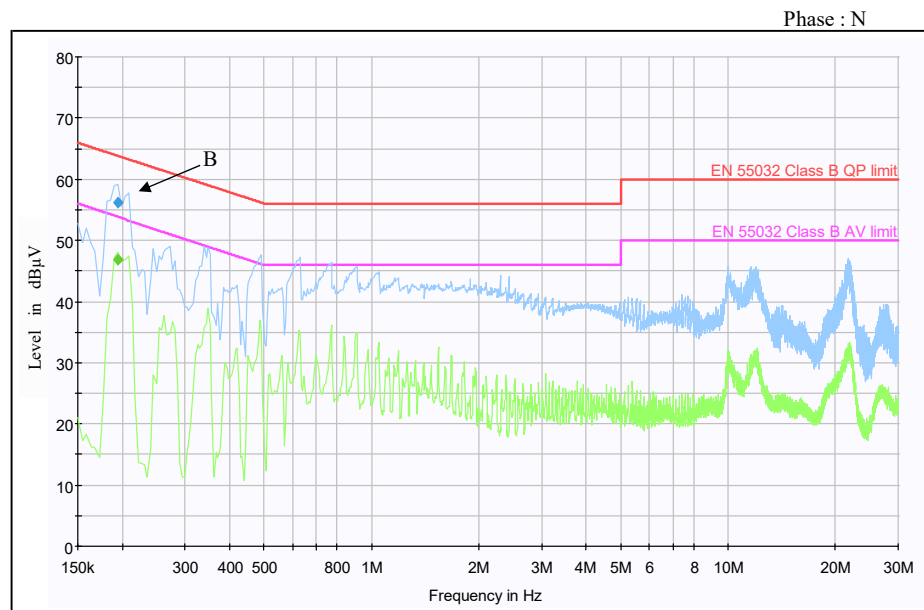
Conducted Emission

48V

Point A (195kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	63.8	56.7
AV	53.8	47.6



Point B (195kHz)		
Ref. Data	Limit (dB)	Measure (dB)
QP	63.8	56.1
AV	53.8	46.9



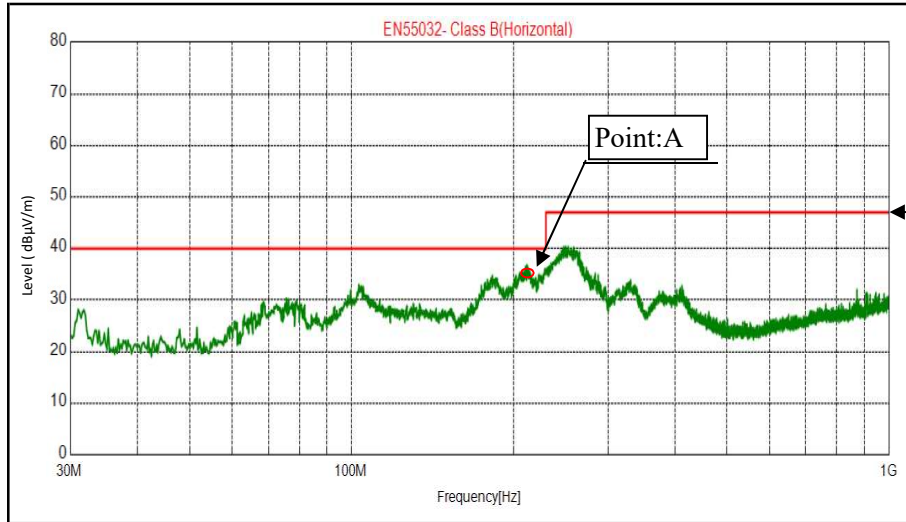
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 115 VAC
 Iout : 50A (100%)
 Ta : 25 °C
 Cooling : Forced Air

Radiated Emission

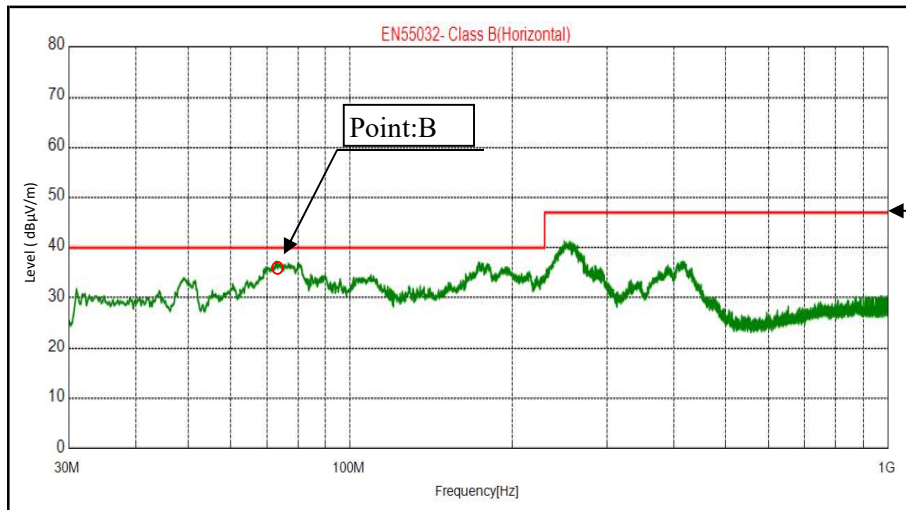
12V

HORIZONTAL



Point A (211MHz)		
Ref.	Data	Measure
QP	Limit (dBuV)	40.0
		35.0

VERTICAL



Point B (73MHz)		
Ref.	Data	Measure
QP	Limit (dBuV)	40.0
		34.8

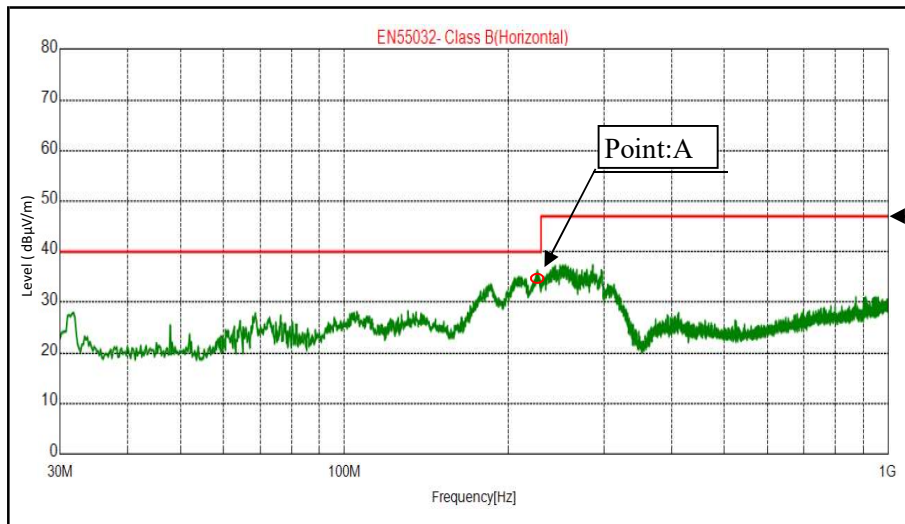
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 230 VAC
 Iout : 50A (100%)
 Ta : 25 °C
 Cooling : Forced Air

Radiated Emission

12V

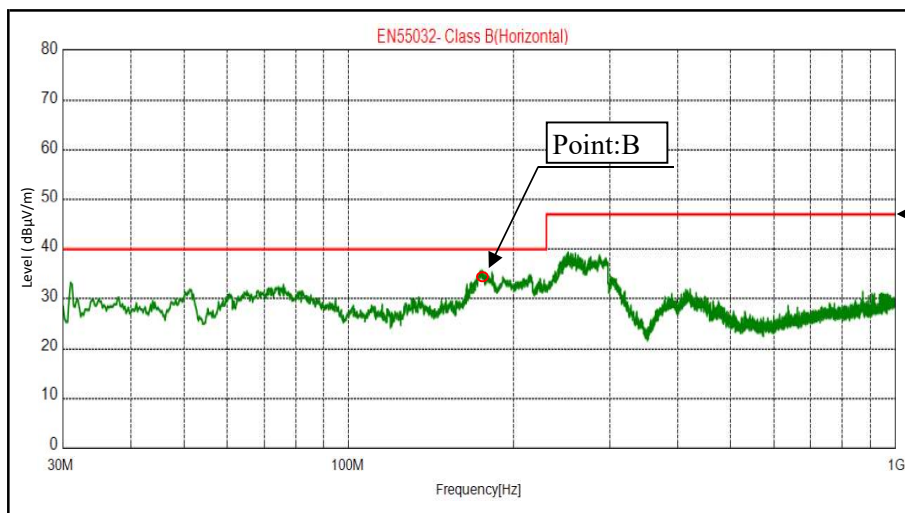
HORIZONTAL



EN55032
 Class B
 QP Limit

Point A (228MHz)		
Ref.	Limit	Measure
Data	(dBuV)	(dBuV)
QP	40.0	35.3

VERTICAL



EN55032
 Class B
 QP Limit

Point B (173MHz)		
Ref.	Limit	Measure
Data	(dBuV)	(dBuV)
QP	40.0	34.7

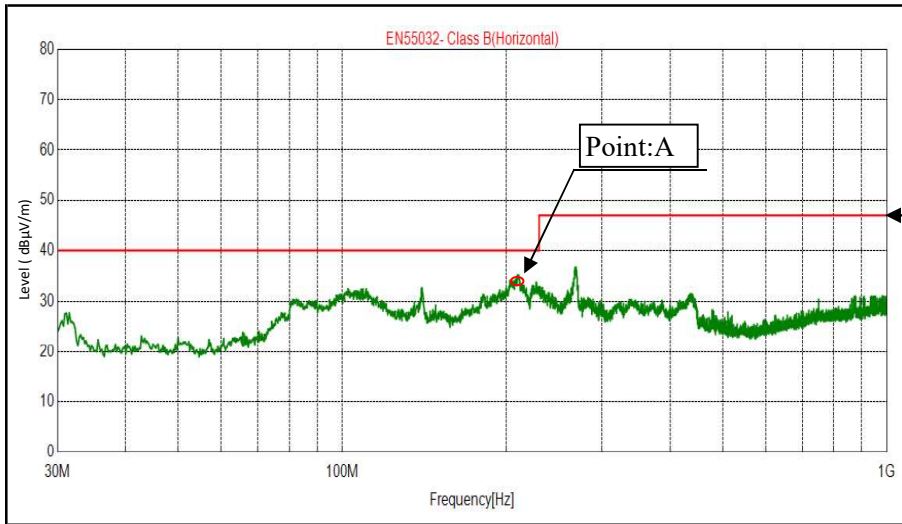
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 115 VAC
 Iout : 25A (100%)
 Ta : 25 °C
 Cooling : Forced Air

Radiated Emission

24V

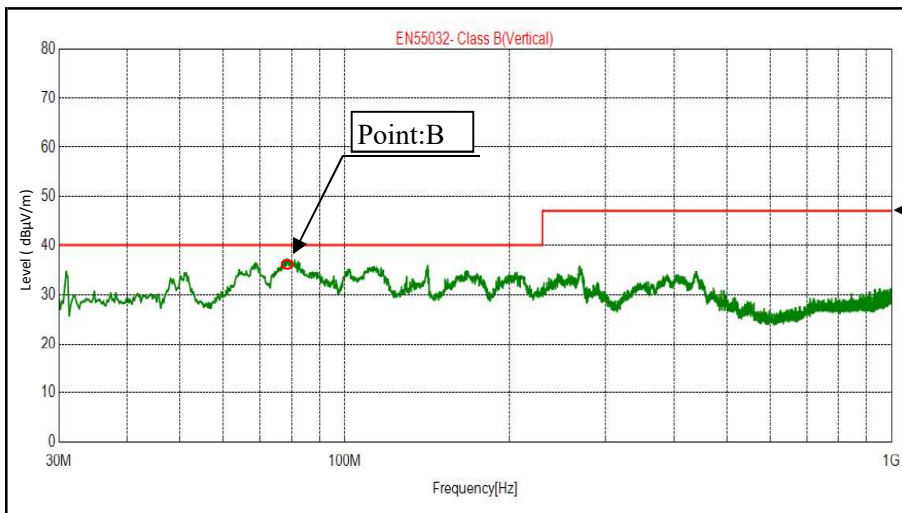
HORIZONTAL



EN55032
 Class B
 QP Limit

Point A (211MHz)		
Ref. Data	Limit (dBµV)	Measure (dBµV)
QP	40.0	34.5

VERTICAL



EN55032
 Class B
 QP Limit

Point B (77MHz)		
Ref. Data	Limit (dBµV)	Measure (dBµV)
QP	40.0	35.1

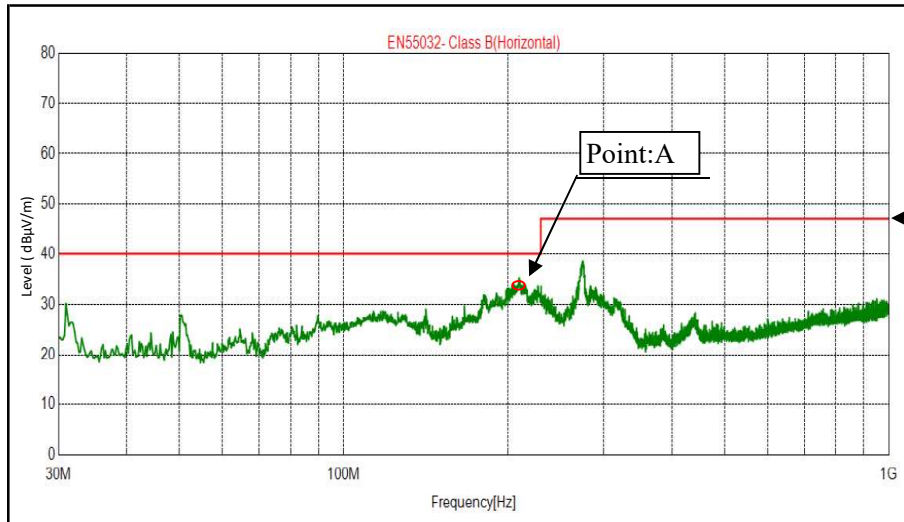
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 230 VAC
 Iout : 25A (100%)
 Ta : 25 °C
 Cooling : Forced Air

Radiated Emission

24V

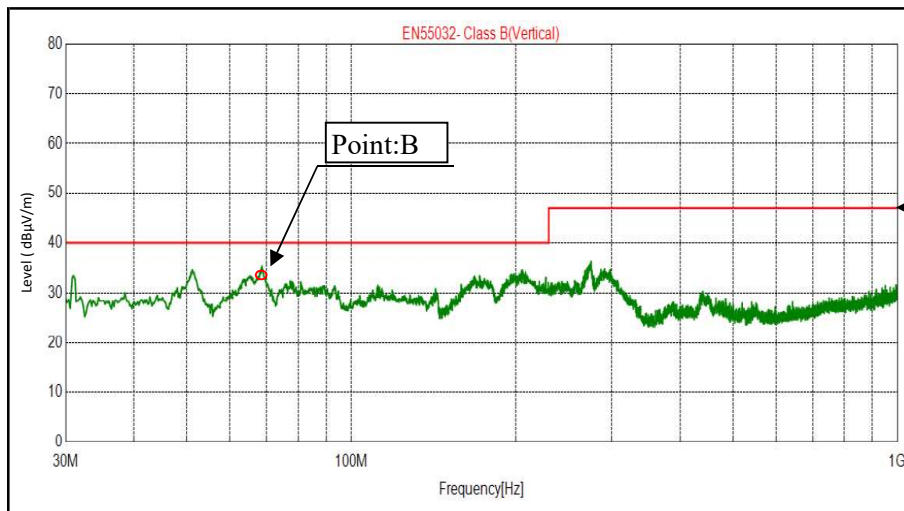
HORIZONTAL



EN55032
Class B
QP Limit

Point A (210MHz)		
Ref.	Data	Measure
QP	40.0	34.0

VERTICAL



EN55032
Class B
QP Limit

Point B (69MHz)		
Ref.	Data	Measure
QP	40.0	33.5

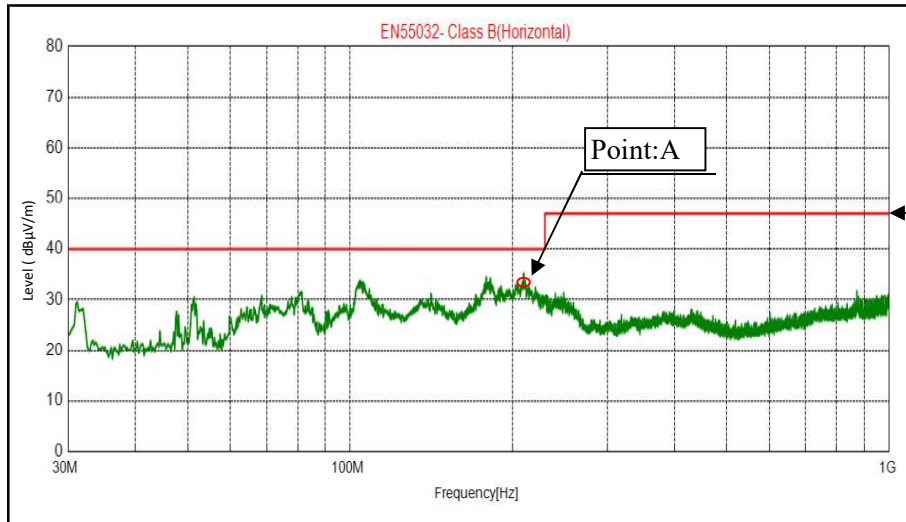
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 115 VAC
 Iout : 12.6A (100%)
 Ta : 25 °C
 Cooling : Forced Air

Radiated Emission

48V

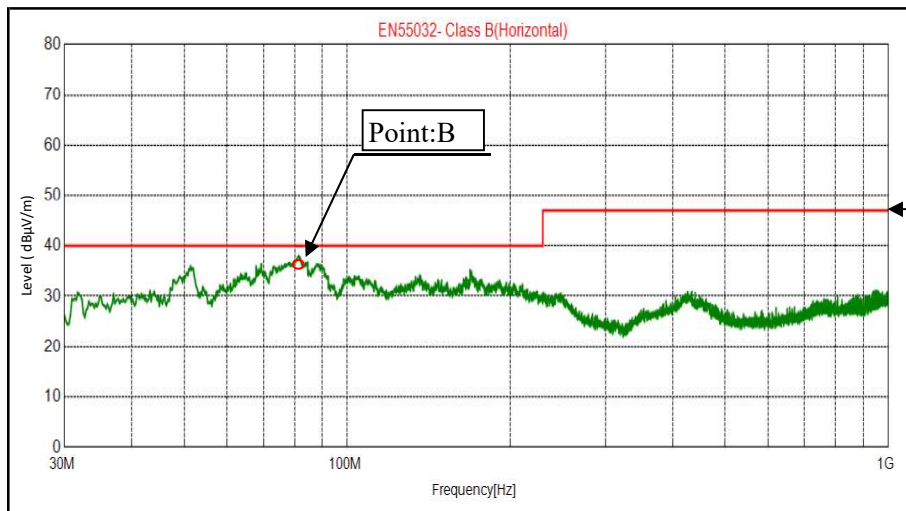
HORIZONTAL



EN55032
 Class B
 QP Limit

Point A (210MHz)		
Ref. Data	Limit (dBuV)	Measure (dBuV)
QP	40.0	33.0

VERTICAL



EN55032
 Class B
 QP Limit

Point B (81MHz)		
Ref. Data	Limit (dBuV)	Measure (dBuV)
QP	40.0	35.5

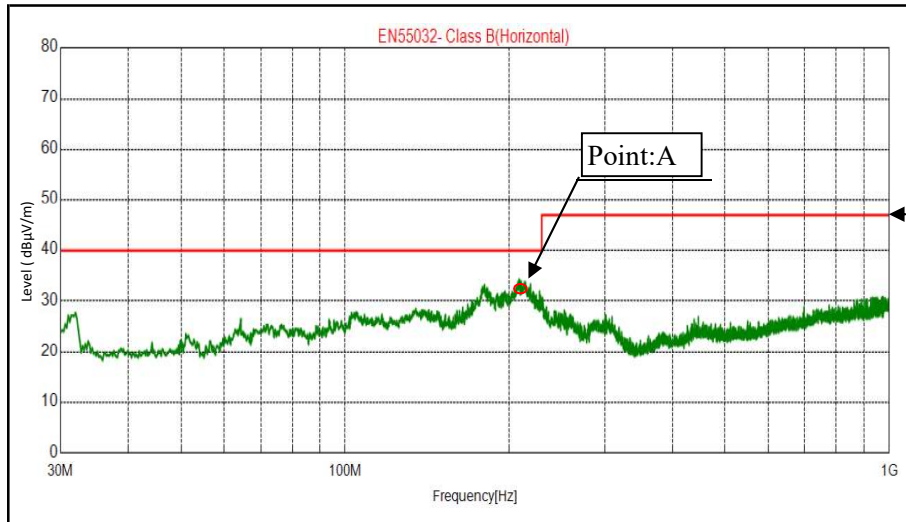
2-14. Electro-Magnetic Interference characteristics

Conditions Vin : 230 VAC
 Iout : 12.6A (100%)
 Ta : 25 °C
 Cooling : Forced Air

Radiated Emission

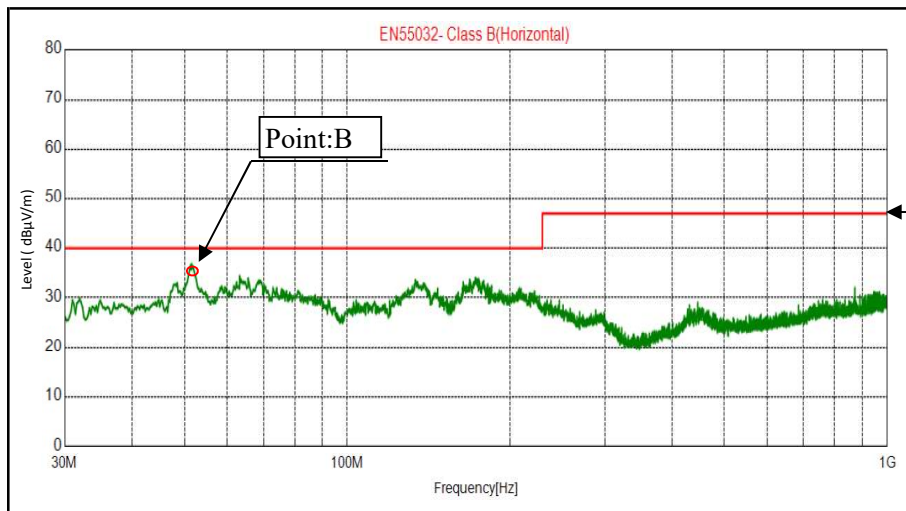
48V

HORIZONTAL



Point A (209MHz)		
Ref.	Data	Measure
QP	40.0	32.8

VERTICAL



Point B (52MHz)		
Ref.	Data	Measure
QP	40.0	36.0