

# **CUS350MP-1000**

## **EVALUATION DATA**

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2. Characteristics

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Terminology used

	Definition
V <sub>in</sub>	Input voltage
V <sub>out</sub>	Output voltage
I <sub>in</sub>	Input current
I <sub>out</sub>	Output current
T <sub>a</sub>	Ambient temperature
f	Frequency
V <sub>stb</sub>	STB output voltage
I <sub>stb</sub>	STB output current

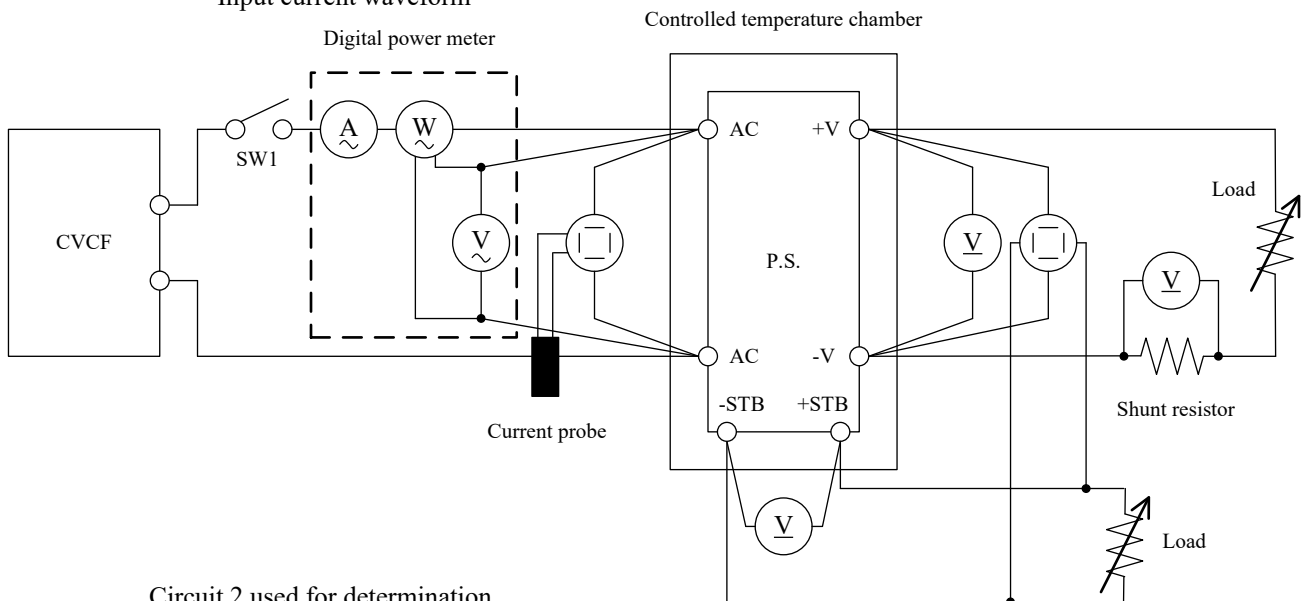
※ Test results are reference data based on our measurement condition.

# 1. Evaluation Method

## 1-1. Circuit used for determination

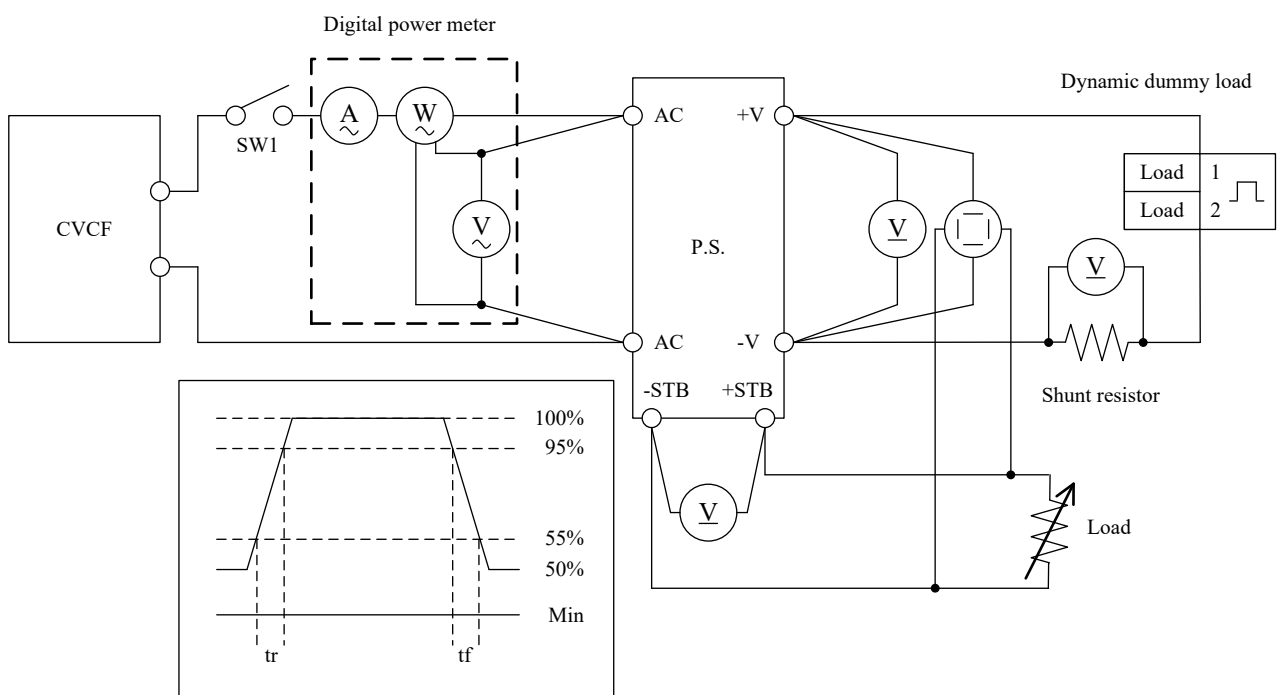
### Circuit 1 used for determination

- 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
- Input current waveform



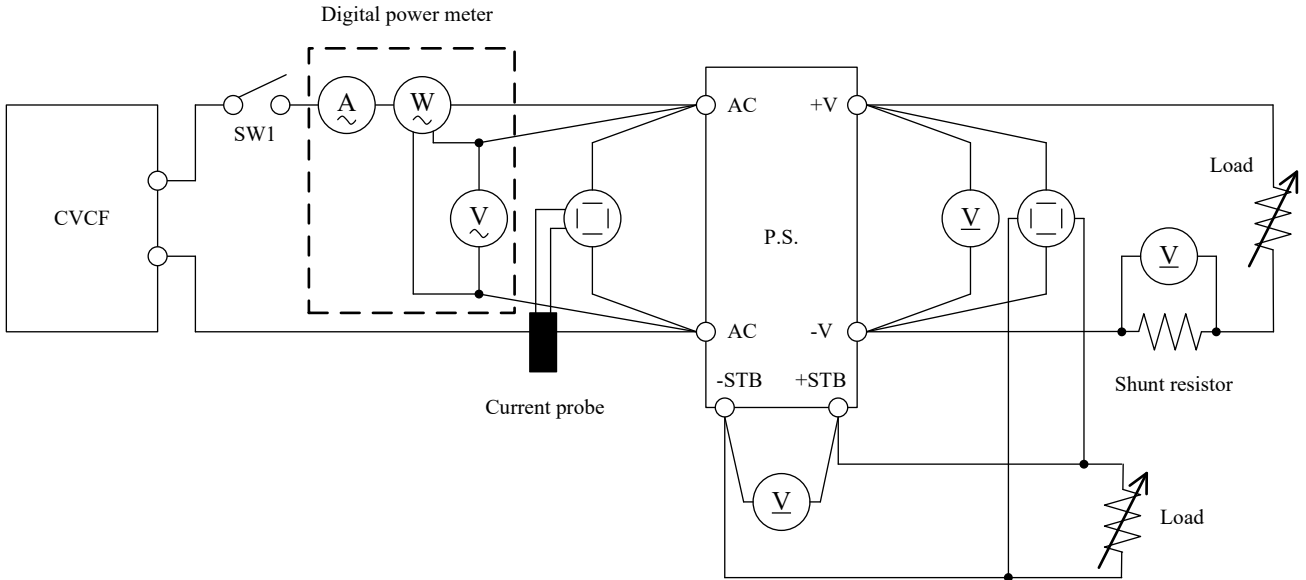
### Circuit 2 used for determination

- Dynamic load response characteristics



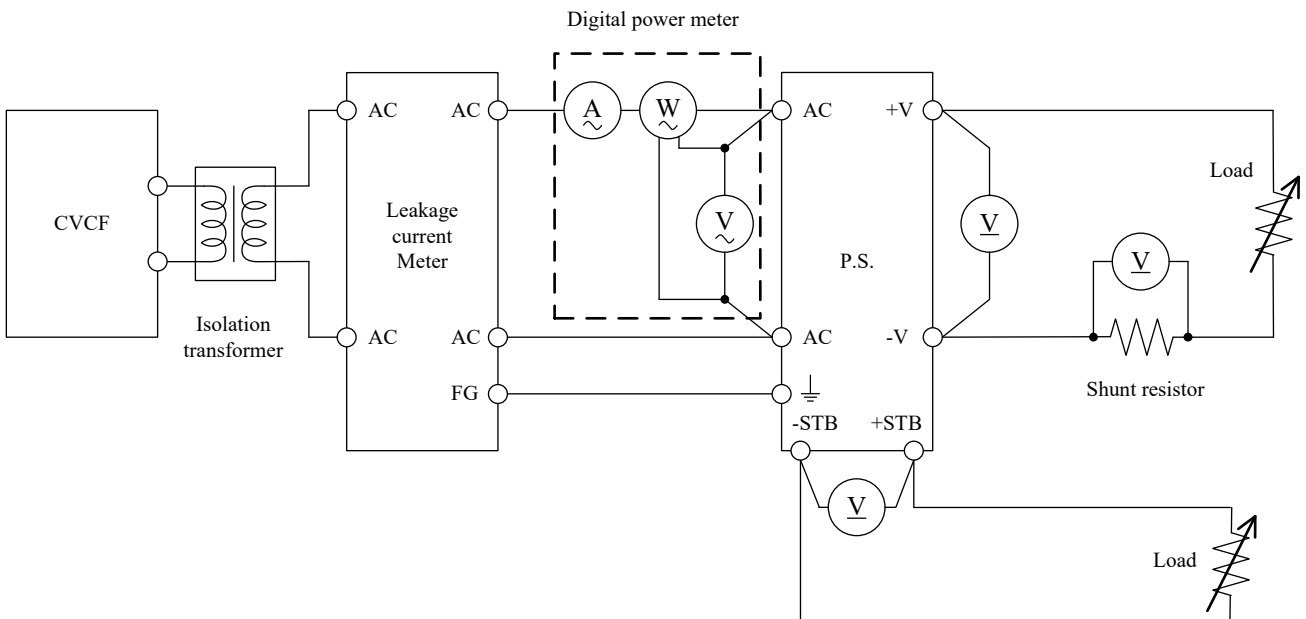
Circuit 3 used for determination

- Inrush current waveform



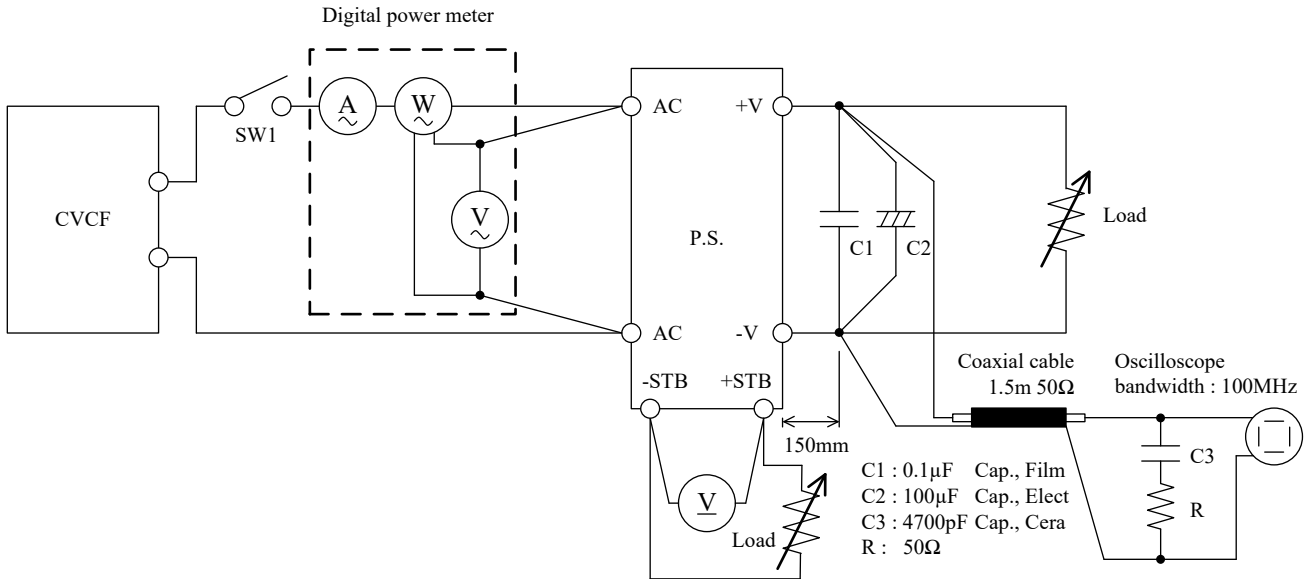
Circuit 4 used for determination

- Leakage current characteristics



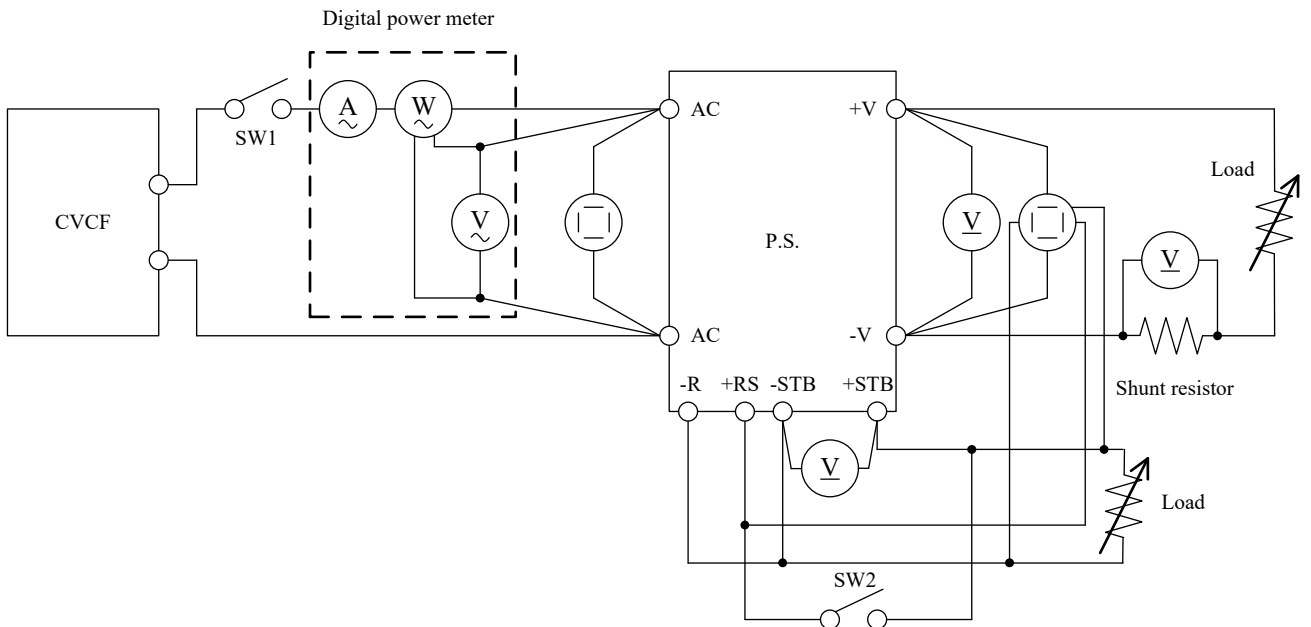
Circuit 5 used for determination

- Output ripple and noise waveform



Circuit 6 used for determination

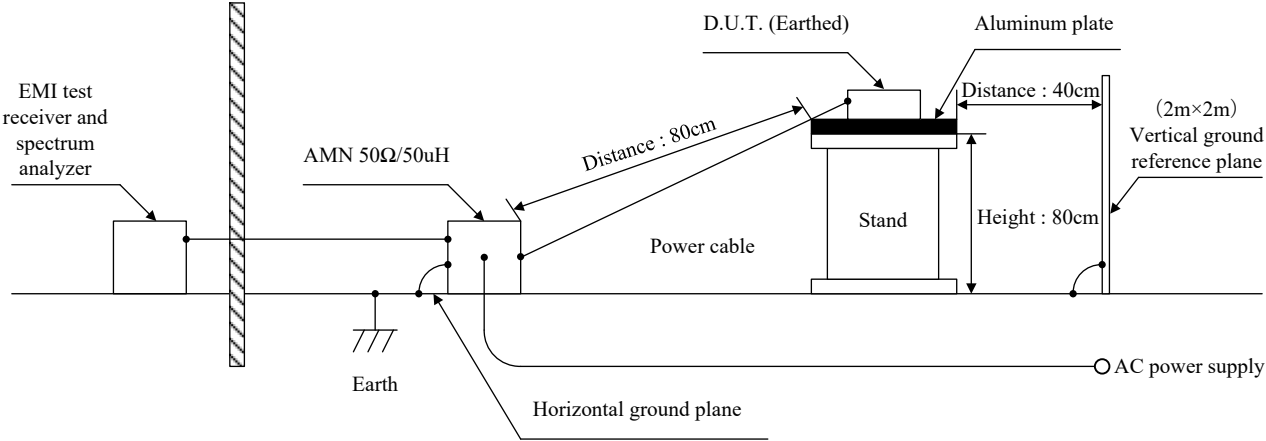
- Output rise and fall characteristics with ON/OFF Control



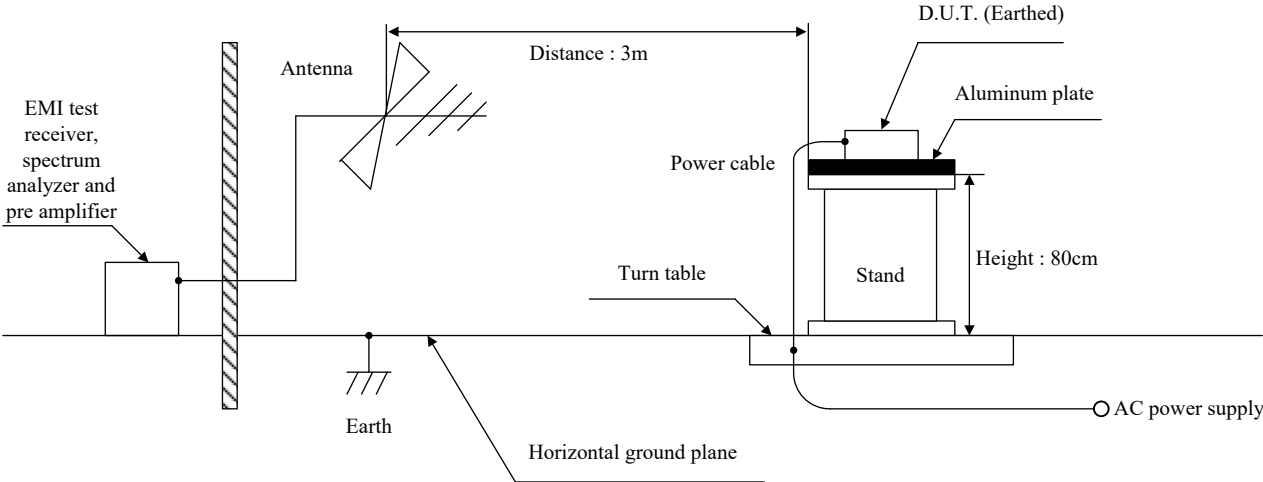
Configuration used for determination

- Electro-Magnetic Interference characteristics

(a) Conducted Emission



(b) Radiated Emission



1-2. List of equipment used

	EQUIPMENT USED	MANUFACTURE	MODEL NO.
1	DIGITAL STORAGE OSCILLOSCOPE	YOKOGAWA ELECT.	DLM2054
2	DIGITAL STORAGE OSCILLOSCOPE	YOKOGAWA ELECT.	DL1740E
3	DIGITAL MULTIMETER	AGILENT	34970A
4	DIGITAL POWER METER	YOKOGAWA ELECT.	WT310E / WT210
5	DIGITAL POWER METER	HIOKI	3333 / PW3337
6	CURRENT PROBE	YOKOGAWA ELECT.	701933 / 701931
7	DYNAMIC DUMMY LOAD	CHROMA	63112A
8	DUMMY LOAD	CHROMA	63106A / 63108A
9	DUMMY LOAD	KIKUSUI	PLZ1205W
10	SLIDE REGULATOR	VOLTAC	SB-102 / 50384
11	CVCF	KIKUSUI	PCR4000LE
12	CVCF	KIKUSUI	PCR12000WE2R
13	CVCF	CHROMA	6520 / 61505
14	CVCF	AGILENT	6813B
15	SHUNT RESISTOR	YOKOGAWA ELECT.	2215
16	LEAKAGE CURRENT METER	SIMPSON	228
17	CONTROLLED TEMP. CHAMBER	ESPEC	SH-662 / SU-241
18	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI
19	EMI TEST SPECTRUM ANALYZER	ROHDE&SCHWARZ	ESCI
20	PRE AMP	SONOMA	310
21	LISN	TOYO TECNICA	NNLK8121
22	ANTENNA	ROHDE&SCHWARZ	CBL6111D
23	DUMMY LOAD	PCN	RHF250 SERIES

1-3. Load condition

Convection cooling

V <sub>in</sub>	I <sub>out</sub>	24V	30V	36V	48V
90VAC - 265VAC	100%	14.6A	11.65A	9.7A	7.3A

Forced air cooling

V <sub>in</sub>	I <sub>out</sub>	24V	30V	36V	48V
90VAC - 265VAC	143%	20.8A	16.6A	13.8A	10.4A

\* V<sub>stb</sub>=5V, I<sub>stb</sub>=0.3A (100%)



2. Characteristics

2-1. Steady state data

(1) Line and load regulation, Temperature drift, Start up voltage and Drop out voltage

Condition Istb : 0%  
Cooling : Forced air cooling

24V

1. Line and load regulation

Condition Ta : 25°C

Iout / Vin	90VAC	100VAC	200VAC	265VAC	Line regulation	
0%	24.014V	24.002V	24.014V	24.016V	14mV	0.058%
50%	24.006V	24.006V	24.004V	24.006V	2mV	0.008%
100%	24.011V	24.010V	24.012V	24.013V	3mV	0.013%
143%	24.013V	24.012V	24.014V	24.015V	3mV	0.013%
Load regulation	8mV	10mV	10mV	10mV		
	0.033%	0.042%	0.042%	0.042%		

2. Temperature drift

Condition Vin : 100VAC  
Iout : 100%

Ta	-20°C	+25°C	+50°C	Temperature stability	
Vout	24.056V	24.010V	23.987V	69mV	0.288%

3. Start up voltage and Shut down voltage

Condition Ta : 25°C  
Iout : 100%

Start up voltage (Vin)	77VAC
Shut down voltage (Vin)	66VAC

30V

1. Line and load regulation

Condition Ta : 25°C

Iout / Vin	90VAC	100VAC	200VAC	265VAC	Line regulation	
0%	29.977V	29.993V	29.992V	29.994V	17mV	0.057%
50%	30.006V	30.006V	30.006V	30.005V	1mV	0.003%
100%	30.013V	30.013V	30.013V	30.014V	1mV	0.003%
143%	30.014V	30.014V	30.016V	30.015V	2mV	0.007%
Load regulation	37mV	21mV	24mV	21mV		
	0.123%	0.070%	0.080%	0.070%		

2. Temperature drift

Condition Vin : 100VAC  
Iout : 100%

Ta	-20°C	+25°C	-50°C	Temperature stability	
Vout	30.047V	30.013V	29.966V	81mV	0.270%

3. Start up voltage and Shut down voltage

Condition Ta : 25°C  
Iout : 100%

Start up voltage (Vin)	77VAC
Shut down voltage (Vin)	66VAC

2. Characteristics

2-1. Steady state data

(1) Line and load regulation, Temperature drift, Start up voltage and Drop out voltage

Condition Istb : 0%  
Cooling : Forced air cooling

36V

1. Line and load regulation

Condition Ta : 25°C

Iout / Vin	90VAC	100VAC	200VAC	265VAC	Line regulation	
0%	35.995V	36.002V	35.996V	36.002V	7mV	0.019%
50%	36.000V	36.000V	36.002V	36.002V	2mV	0.006%
100%	36.006V	36.005V	36.008V	36.007V	3mV	0.008%
143%	36.011V	36.010V	36.013V	36.013V	3mV	0.008%
Load regulation	16mV	10mV	17mV	11mV		
	0.044%	0.028%	0.047%	0.031%		

2. Temperature drift

Condition Vin : 100VAC  
Iout : 100%

Ta	-20°C	+25°C	-50°C	Temperature stability	
Vout	36.017V	36.005V	35.989V	28mV	0.078%

3. Start up voltage and Shut down voltage

Condition Ta : 25°C  
Iout : 100%

Start up voltage (Vin)	77VAC
Shut down voltage (Vin)	66VAC

48V

1. Line and load regulation

Condition Ta : 25°C

Iout / Vin	90VAC	100VAC	200VAC	265VAC	Line regulation	
0%	48.001V	48.006V	48.001V	48.003V	5mV	0.010%
50%	48.004V	48.005V	48.005V	48.003V	2mV	0.004%
100%	48.008V	48.010V	48.009V	48.007V	3mV	0.006%
143%	48.014V	48.015V	48.014V	48.012V	3mV	0.006%
Load regulation	13mV	10mV	13mV	9mV		
	0.027%	0.021%	0.027%	0.019%		

2. Temperature drift

Condition Vin : 100VAC  
Iout : 100%

Ta	-20°C	+25°C	-50°C	Temperature stability	
Vout	47.936V	48.010V	47.986V	74mV	0.154%

3. Start up voltage and Shut down voltage

Condition Ta : 25°C  
Iout : 100%

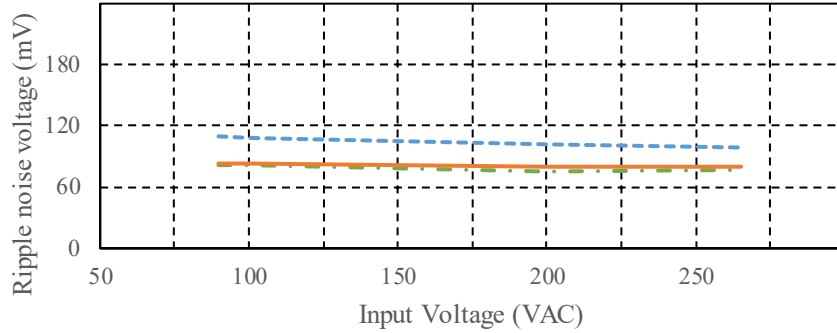
Start up voltage (Vin)	77VAC
Shut down voltage (Vin)	66VAC

(2) Ripple noise voltage vs. Input voltage

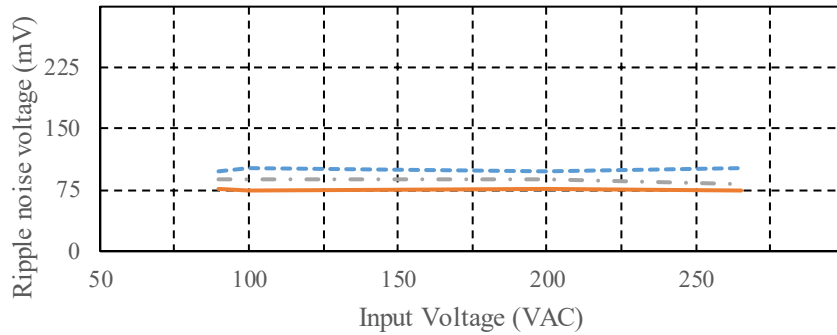
Condition Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling

Ta : -20°C (Blue dashed line)  
 +25°C (Green dash-dot line)  
 +50°C (Orange solid line)

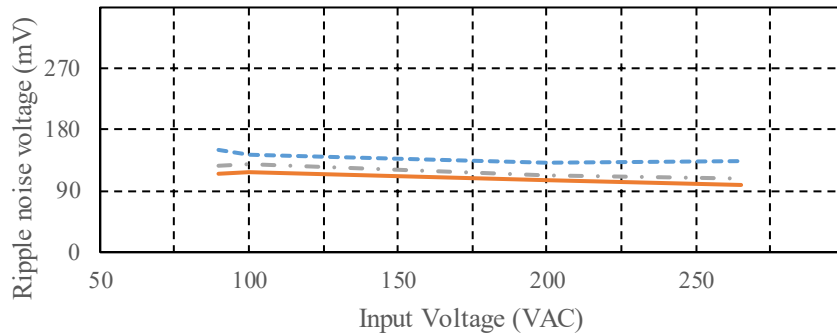
24V



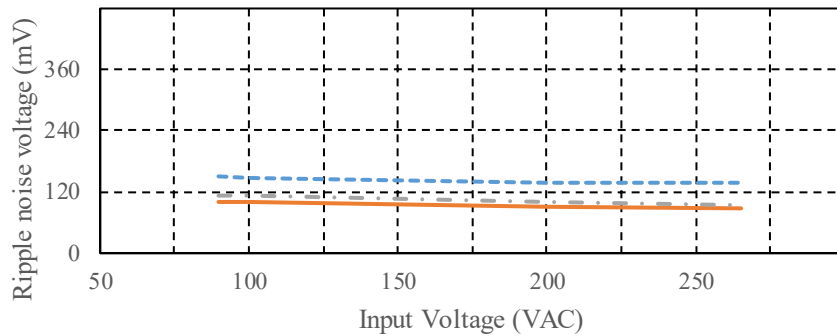
30V



36V



48V

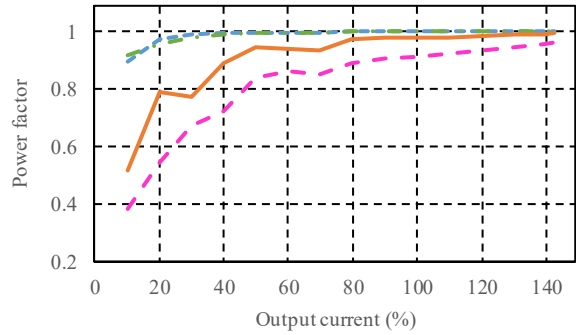
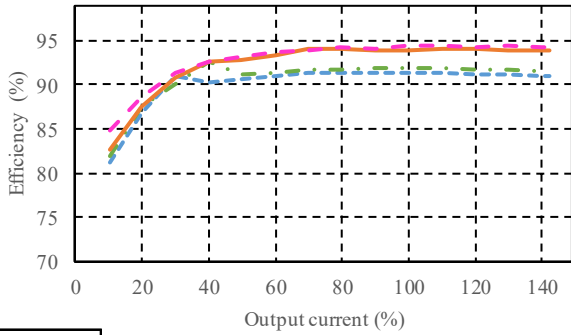


(3) Efficiency and Power factor vs. Output current

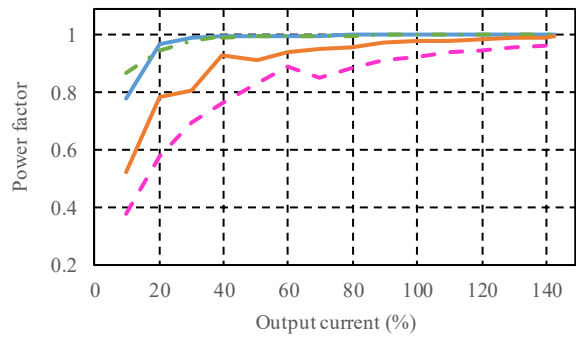
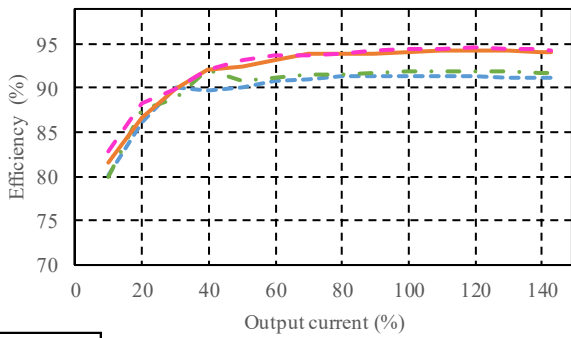
Condition Vin : 90VAC ---  
 100VAC - - -  
 200VAC ———  
 265VAC - · - ·  
 Istb : 0%  
 Cooling : Forced air cooling

Ta : 25°C

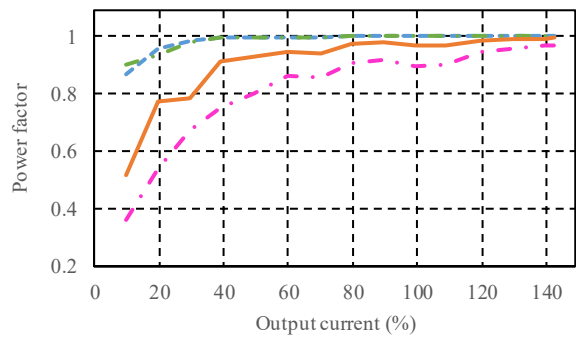
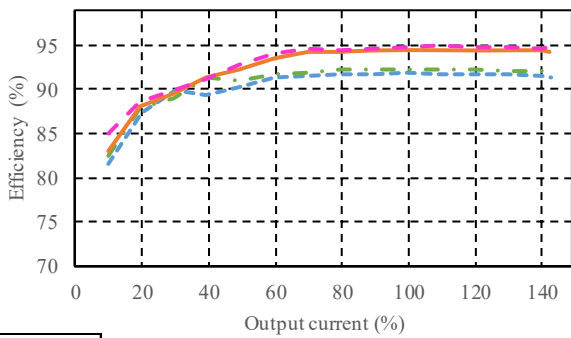
24V



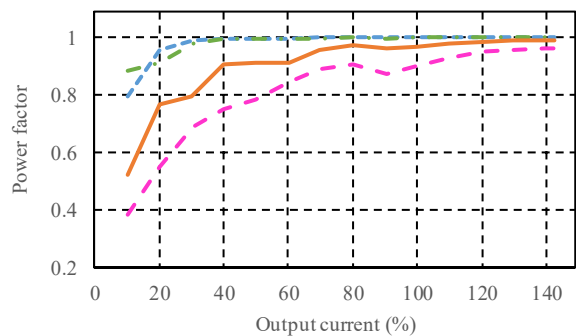
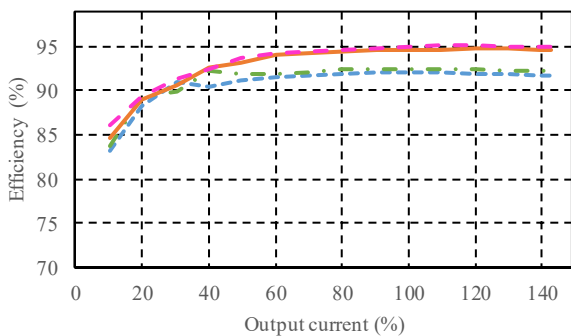
30V



36V



48V

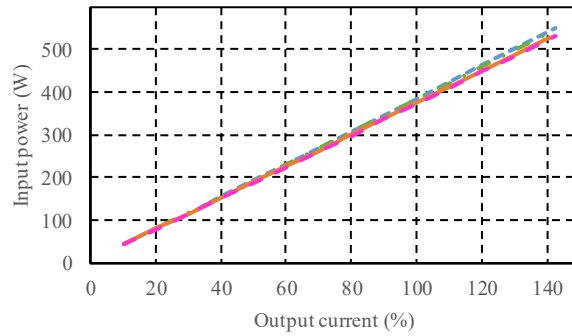


(4) Input power vs. Output current

Condition Vin : 90VAC ---  
 100VAC - - -  
 200VAC ———  
 265VAC - · - ·  
 Istb : 0%  
 Cooling : Forced air cooling  
 Ta : 25°C

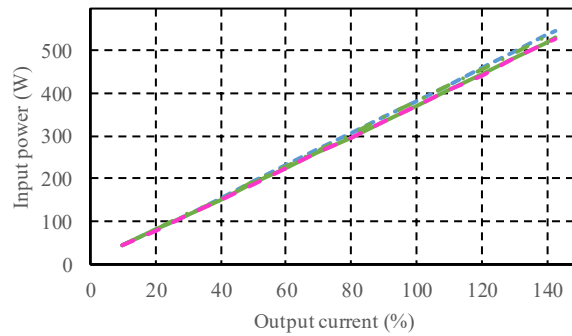
24V

Input Voltage	Input Power	
	Iout : 0%	Control OFF
90VAC	1.8W	0.6W
100VAC	1.6W	0.6W
200VAC	1.4W	0.8W
265VAC	1.4W	1.1W



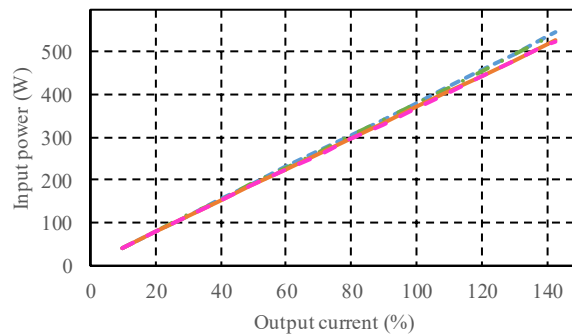
30V

Input Voltage	Input Power	
	Iout : 0%	Control OFF
90VAC	3.3W	0.6W
100VAC	3.4W	0.6W
200VAC	2.6W	0.8W
265VAC	2.4W	1.0W



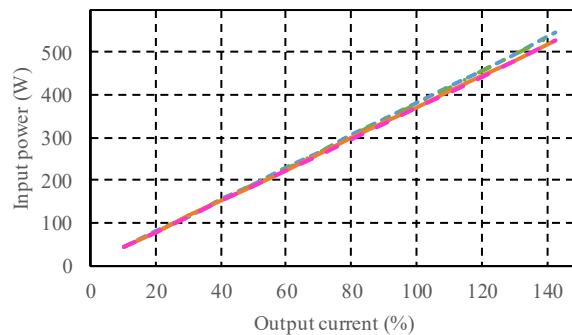
36V

Input Voltage	Input Power	
	Iout : 0%	Control OFF
90VAC	2.1W	0.6W
100VAC	2.0W	0.6W
200VAC	1.6W	0.8W
265VAC	1.6W	1.0W



48V

Input Voltage	Input Power	
	Iout : 0%	Control OFF
90VAC	2.3W	0.6W
100VAC	2.1W	0.6W
200VAC	1.6W	0.8W
265VAC	1.6W	1.1W



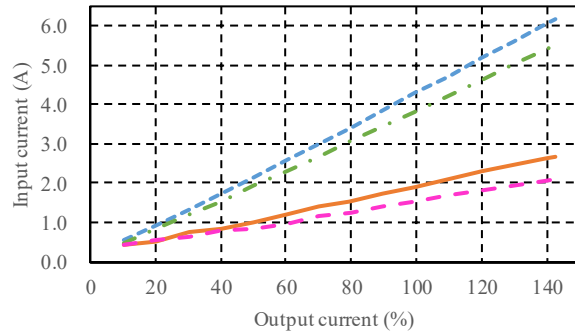
(5) Input current vs. Output current

Condition Vin : 90VAC ---  
 100VAC - - -  
 200VAC ———  
 265VAC - · - ·  
 Istb : 0%  
 Cooling : Forced air cooling

Ta : 25°C

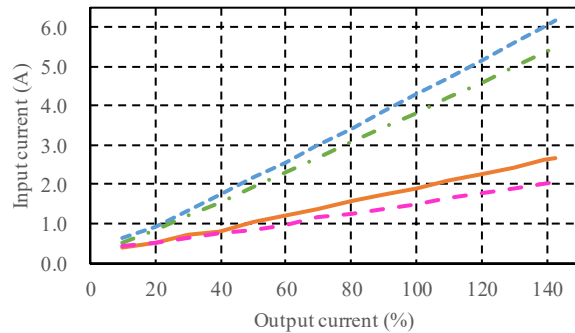
24V

Input Voltage	Input Current	
	Iout : 0%	Control OFF
90VAC	0.09A	0.01A
100VAC	0.10A	0.08A
200VAC	0.17A	0.17A
265VAC	0.23A	0.22A



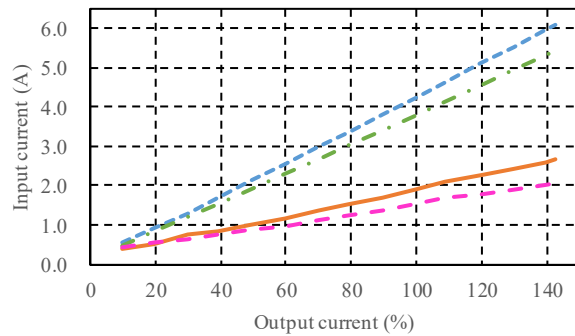
30V

Input Voltage	Input Current	
	Iout : 0%	Control OFF
90VAC	0.11A	0.13A
100VAC	0.11A	0.17A
200VAC	0.18A	0.24A
265VAC	0.23A	0.29A



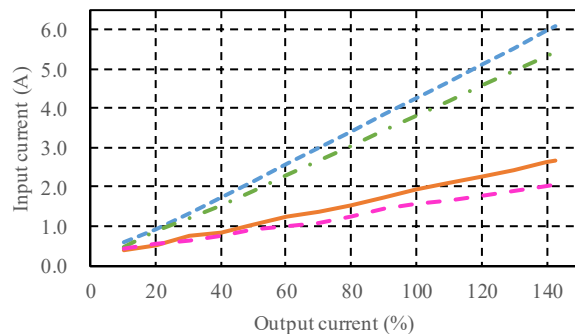
36V

Input Voltage	Input Current	
	Iout : 0%	Control OFF
90VAC	0.10A	0.13A
100VAC	0.10A	0.14A
200VAC	0.17A	0.24A
265VAC	0.23A	0.29A



48V

Input Voltage	Input Current	
	Iout : 0%	Control OFF
90VAC	0.10A	0.07A
100VAC	0.10A	0.08A
200VAC	0.17A	0.17A
265VAC	0.23A	0.22A

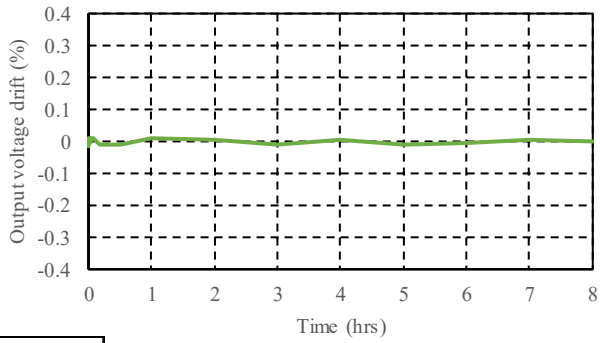


2-2. Warm up voltage drift characteristics

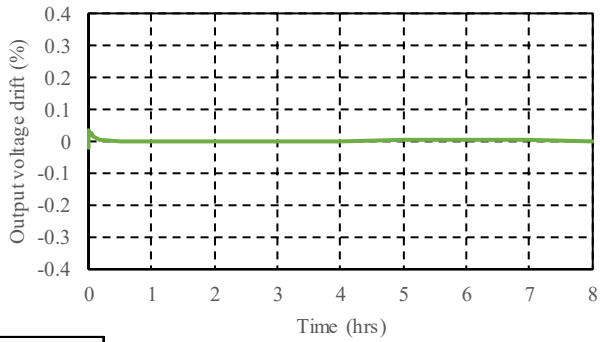
Condition Vin : 100VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling

24V

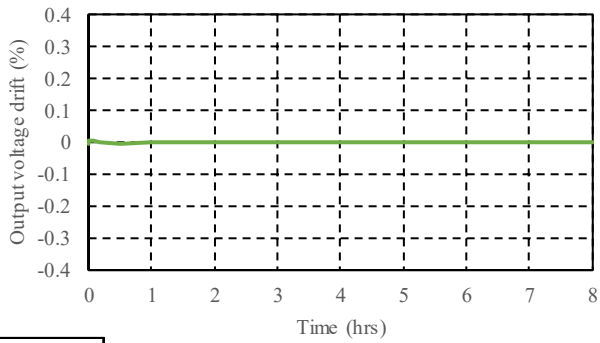
Ta : 25°C



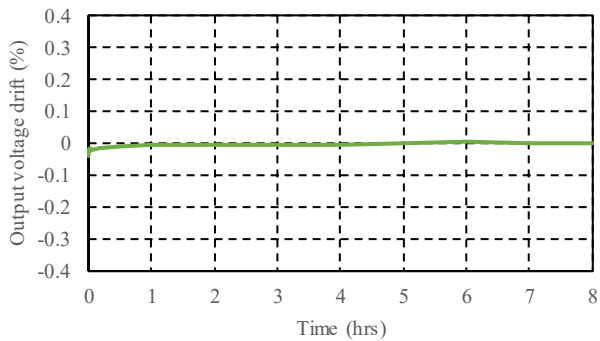
30V



36V



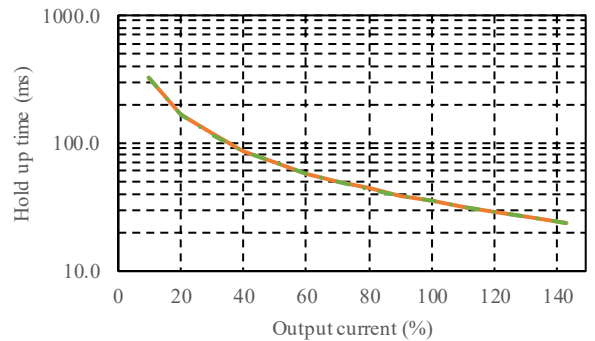
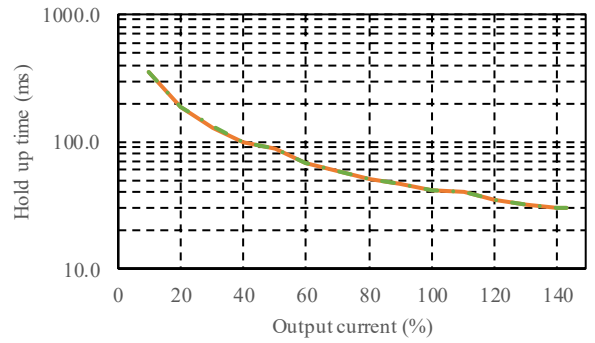
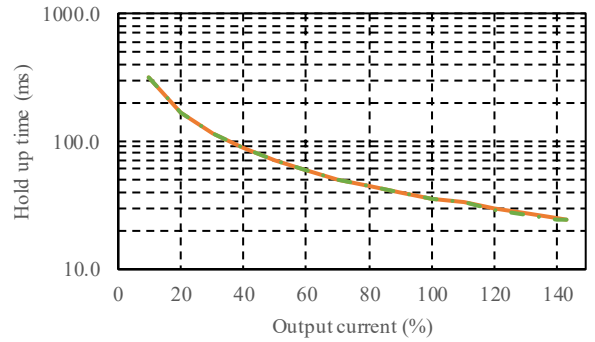
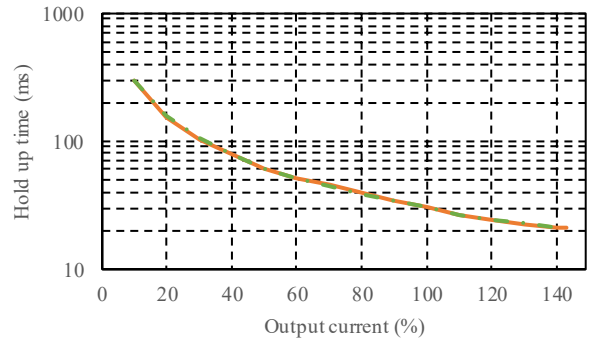
48V



2-3. Hold up time characteristics

Condition Vin : 100VAC  
 200VAC  
 Istb : 100%  
 Cooling : Forced air cooling

Ta : 25°C

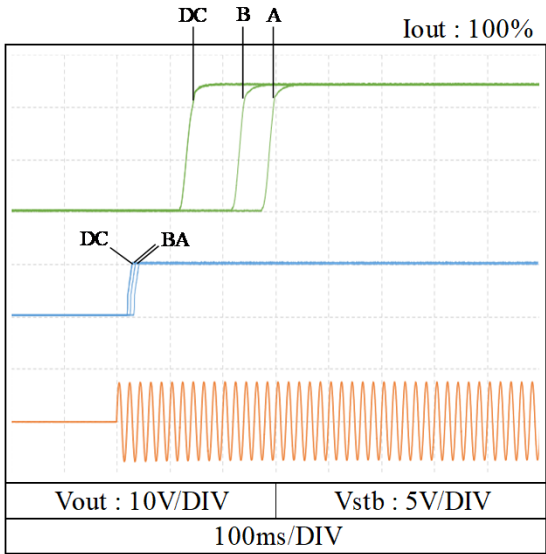
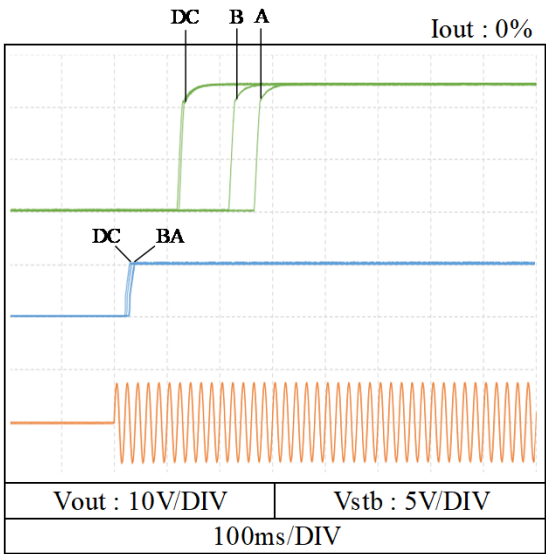


2-4. Output rise characteristics

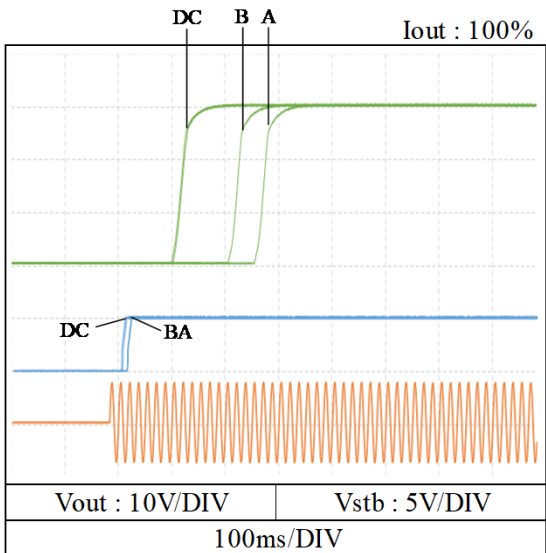
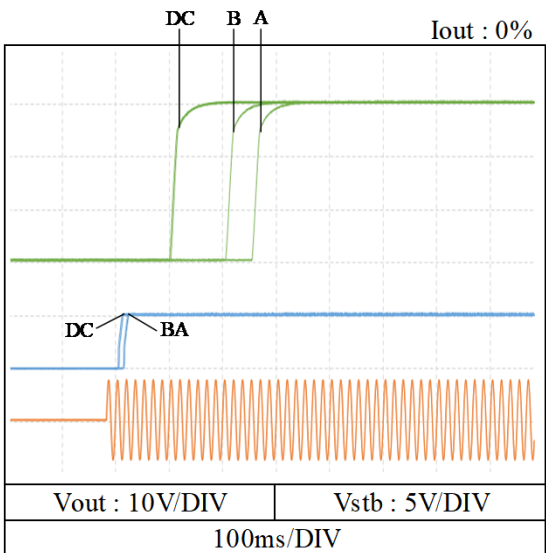
Condition Vin : 90VAC (A)  
100VAC (B)  
200VAC (C)  
265VAC (D)  
Istb : 100%  
Cooling : Convection cooling

Ta : 25°C

24V



30V



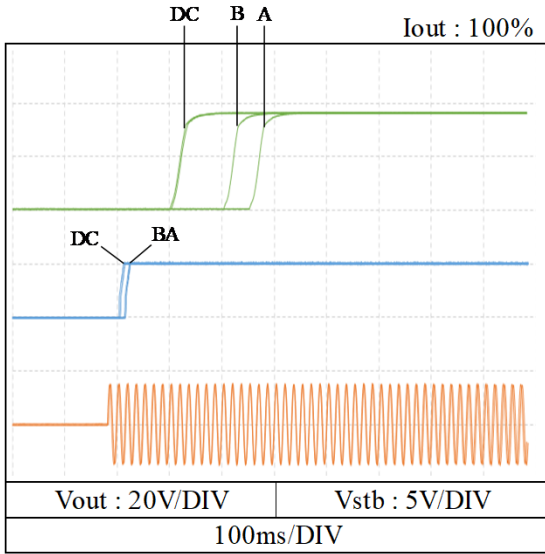
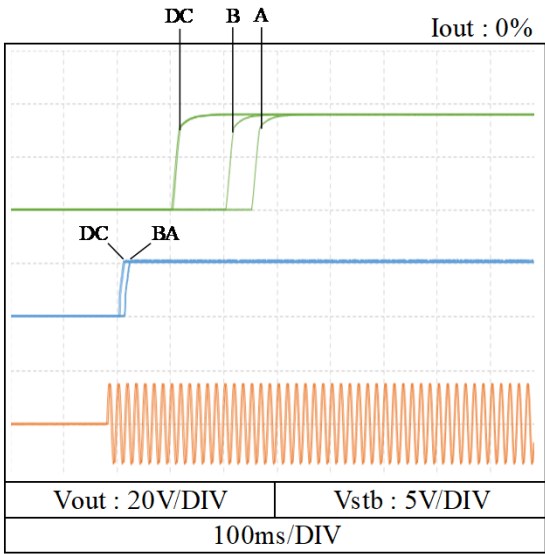


2-4. Output rise characteristics

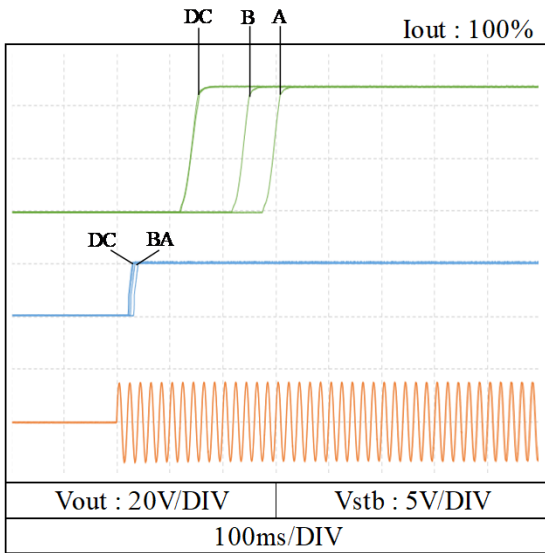
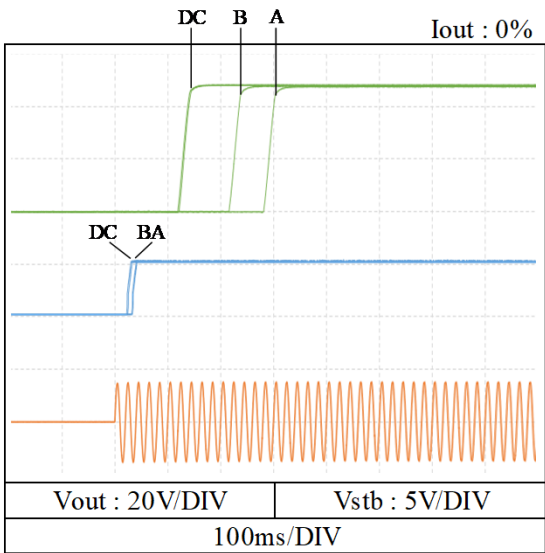
Condition Vin : 90VAC (A)  
100VAC (B)  
200VAC (C)  
265VAC (D)  
Istb : 100%  
Cooling : Convection cooling

Ta : 25°C

36V



48V

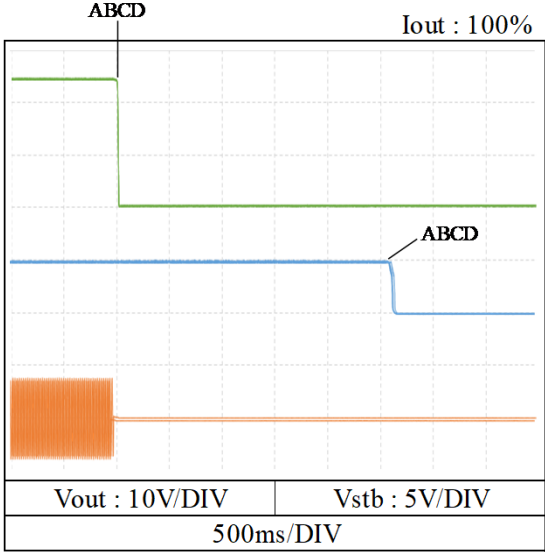
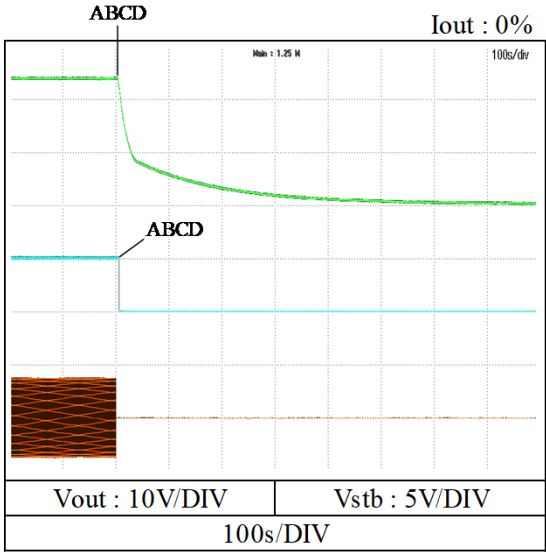


2-5. Output fall characteristics

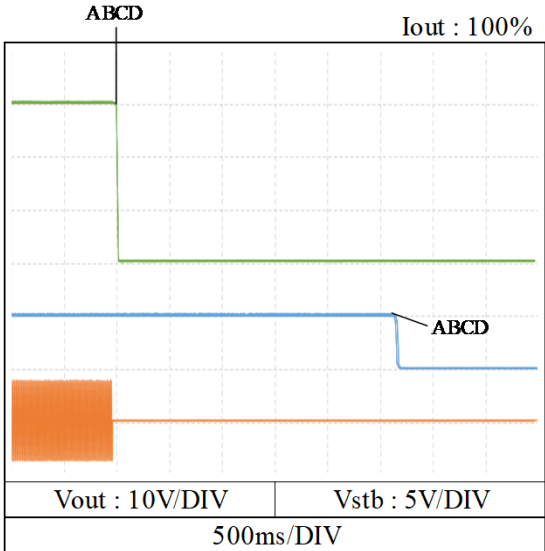
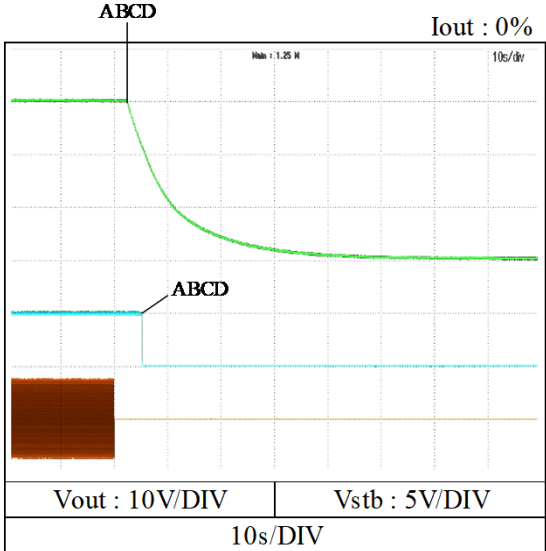
Condition Vin : 90VAC (A)  
 100VAC (B)  
 200VAC (C)  
 265VAC (D)  
 Istb : 100%  
 Cooling : Convection cooling

Ta : 25°C

24V



30V

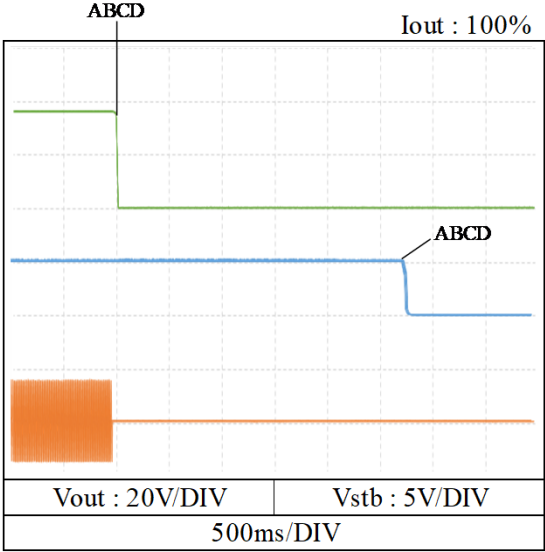
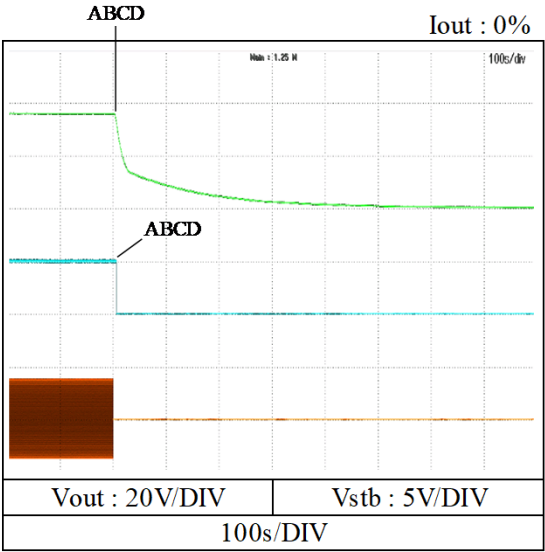


2-5. Output fall characteristics

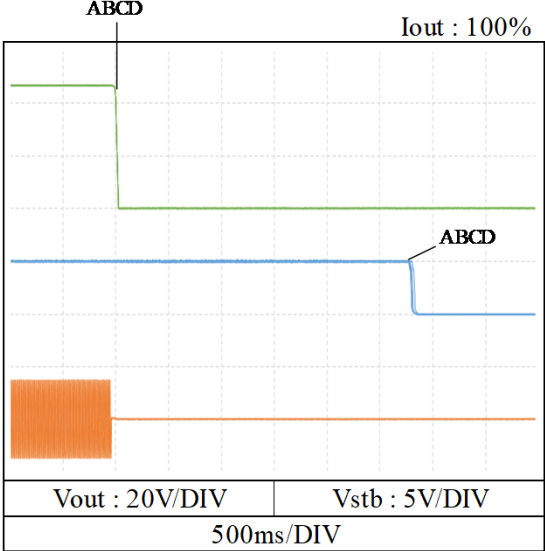
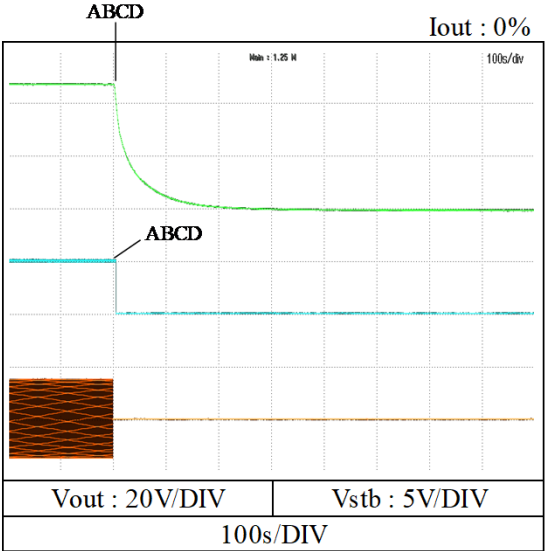
Condition Vin : 90VAC (A)  
 100VAC (B)  
 200VAC (C)  
 265VAC (D)  
 Istb : 100%  
 Cooling : Convection cooling

Ta : 25°C

36V



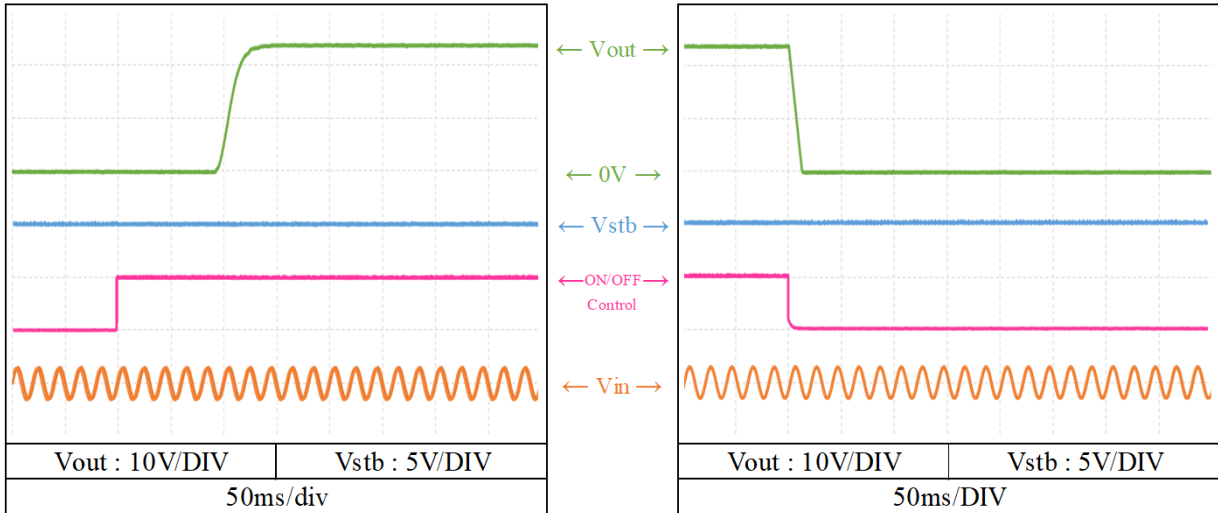
48V



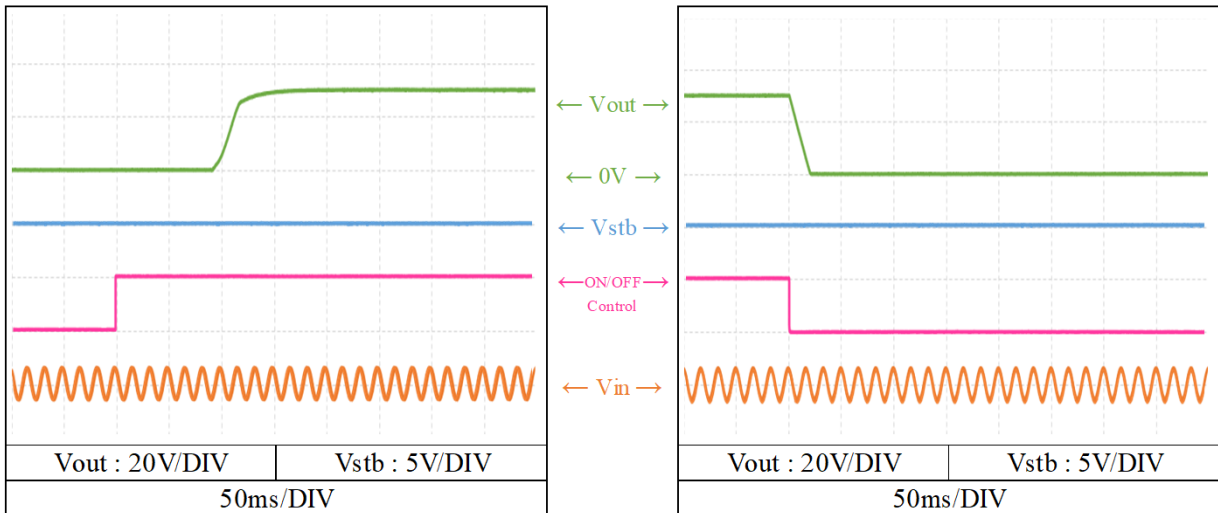
2-6. Output rise and fall characteristics with ON/OFF Control

Condition       $V_{in}$  : 100VAC  
 $I_{out}$  : 100%  
 $I_{stb}$  : 100%  
 Cooling : Forced air cooling  
  
 $T_a$  : 25°C

24V



30V

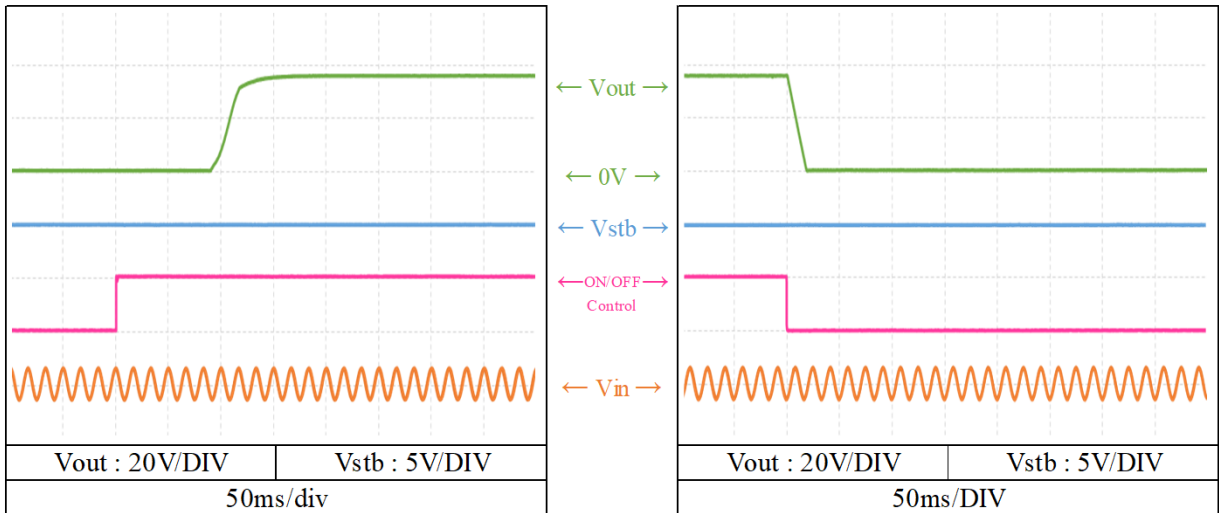


2-6. Output rise and fall characteristics with ON/OFF Control

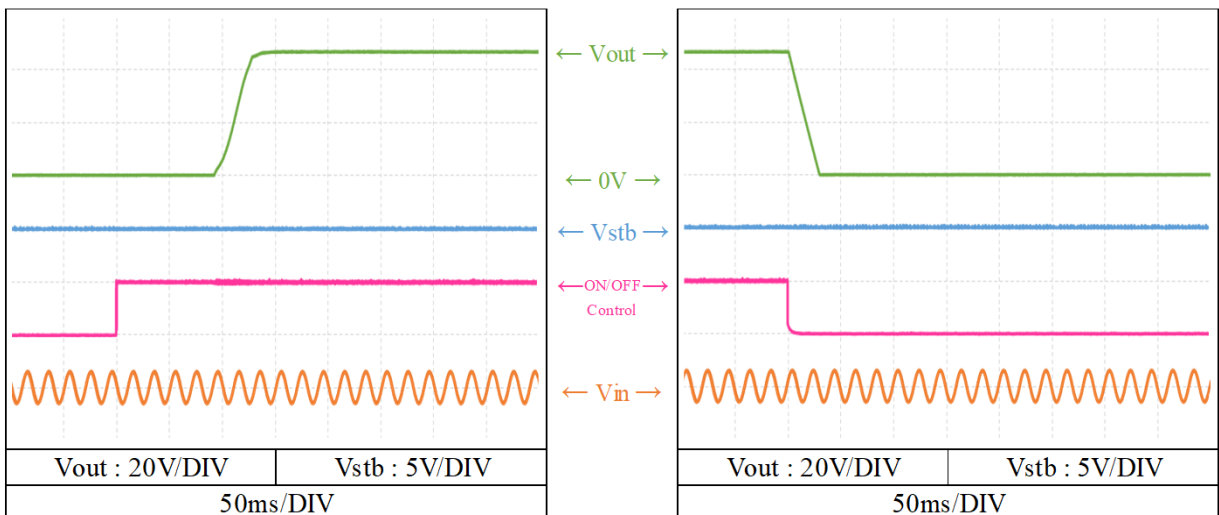
Condition Vin : 100VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Forced air cooling

Ta : 25°C

36V



48V

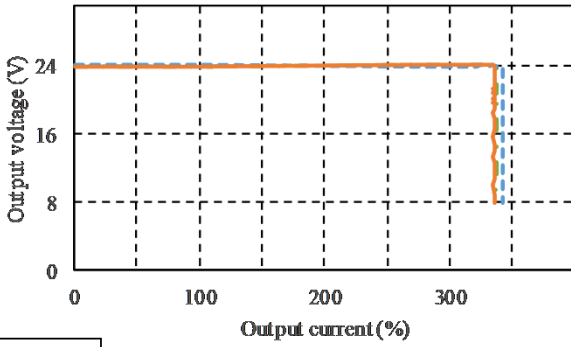


2-7. Over current protection (OCP) characteristics

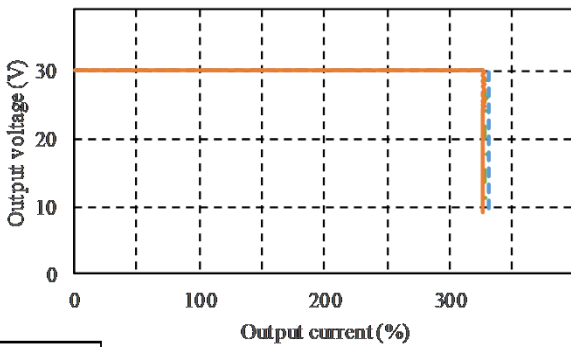
Condition Vin : 100VAC  
 Istb : 100%  
 Cooling : Convection cooling

Ta : -20°C ——— (blue dashed)  
 25°C ——— (green dashed)  
 50°C ——— (orange solid)

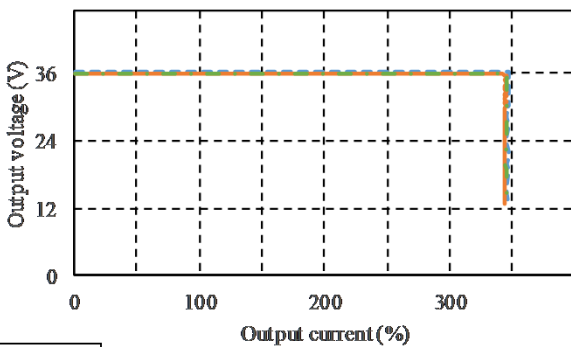
24V



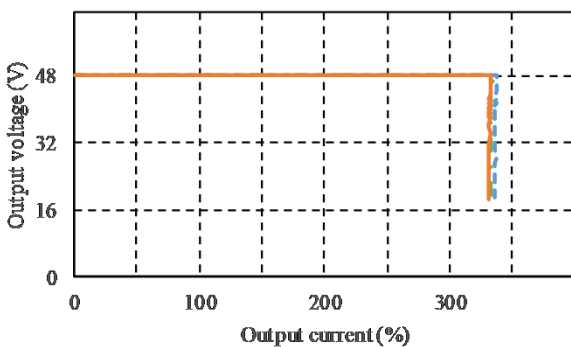
30V



36V



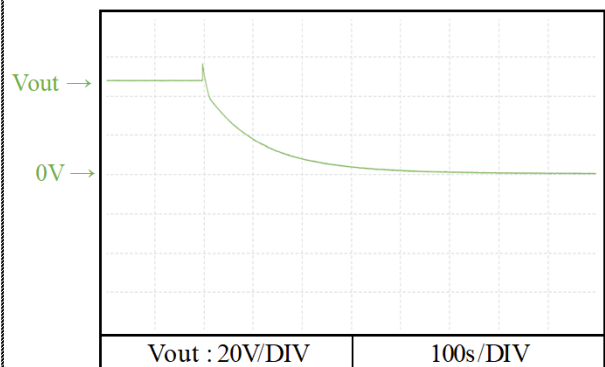
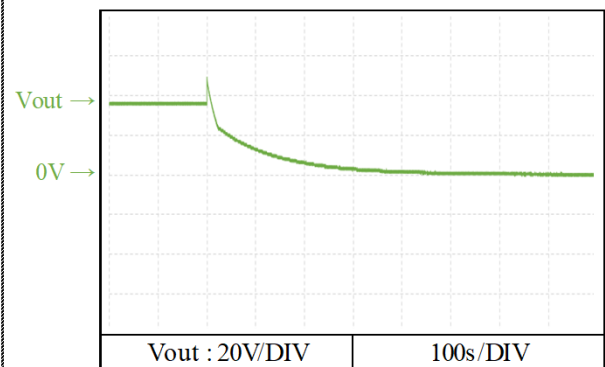
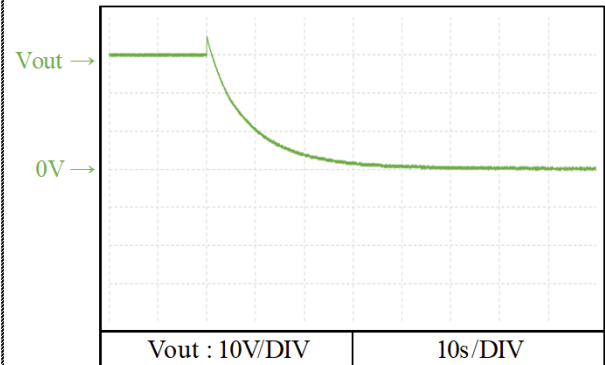
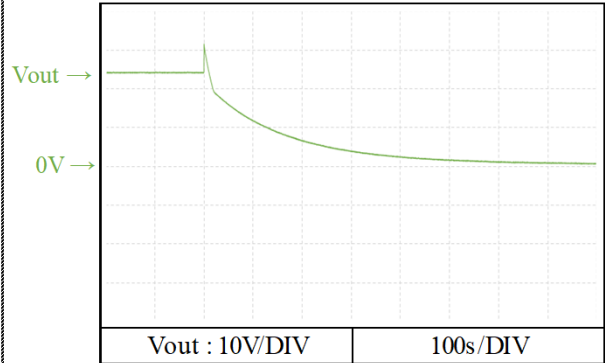
48V



2-8. Over voltage protection (OVP) characteristics

Condition Vin : 100VAC  
 Iout : 0%  
 Cooling : Convection cooling  
 Istb : 0%

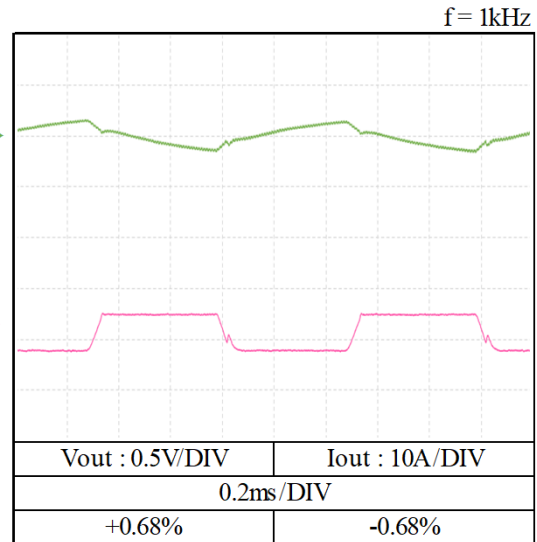
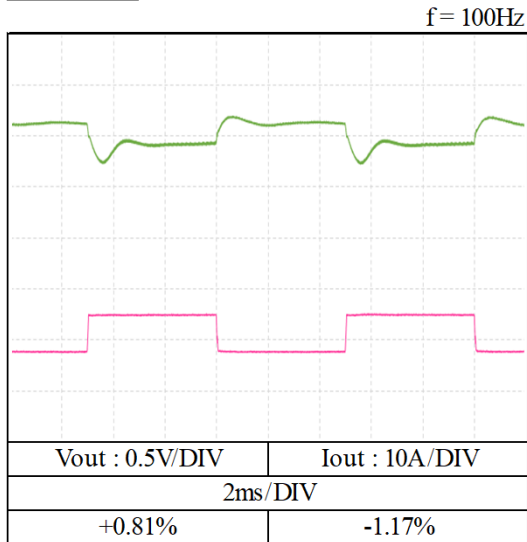
Ta : 25°C



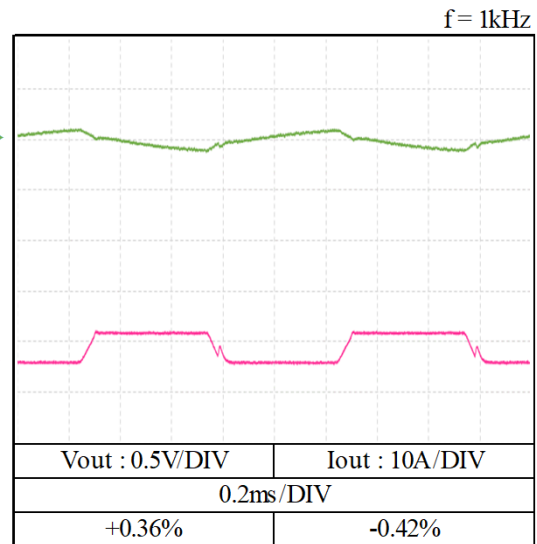
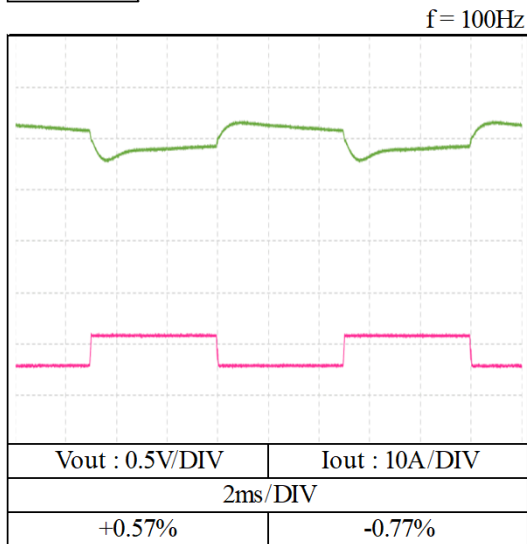
2-9. Dynamic load response characteristics

Condition  $V_{in}$  : 100VAC  
 $I_{out}$  : 50%  $\leftrightarrow$  100%  
 ( $t_r = t_f = 75\mu s$ )  
 $I_{stb}$  : 100%  
 Cooling : Convection cooling  
 $T_a$  : 25°C

24V



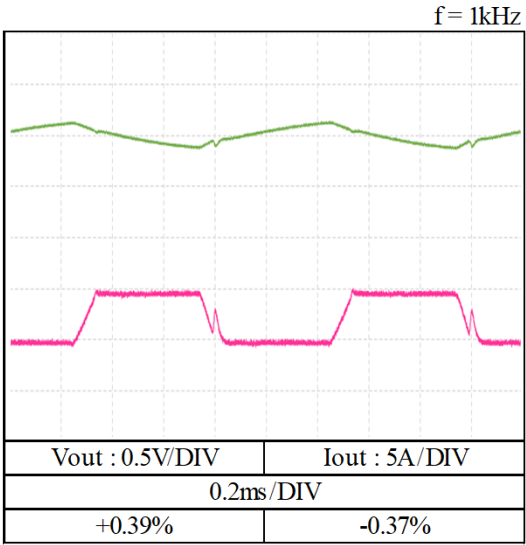
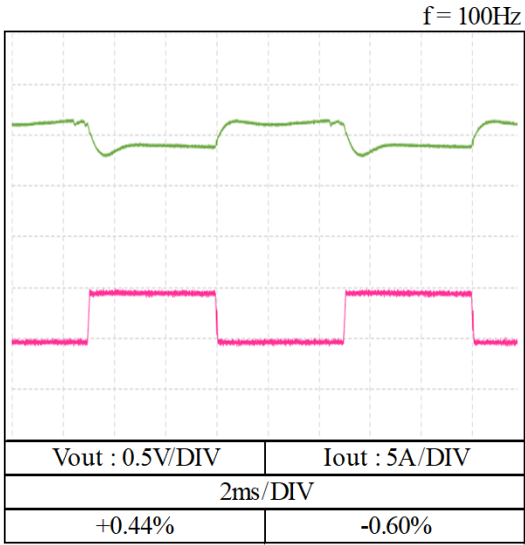
30V



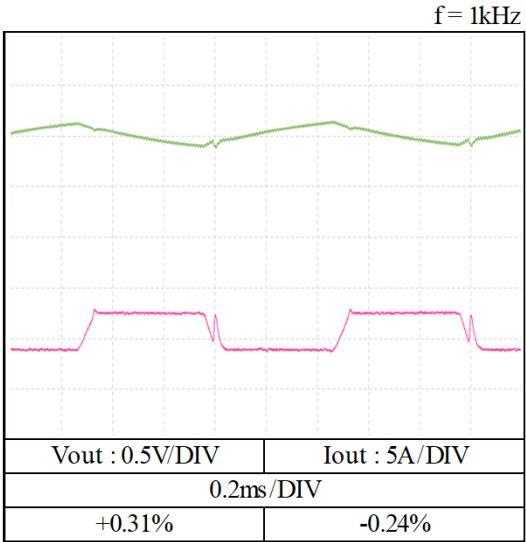
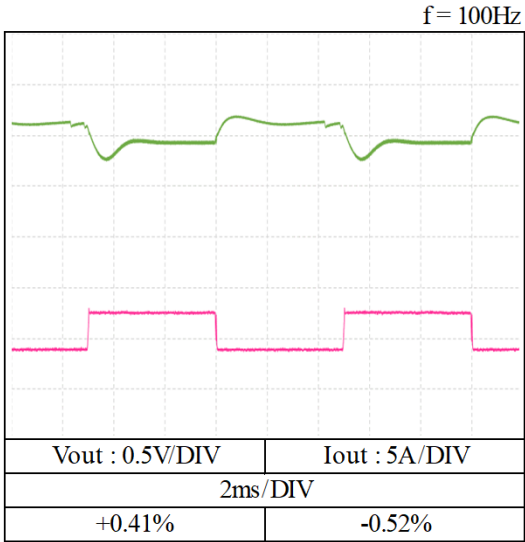
2-9. Dynamic load response characteristics

Condition Vin : 100VAC  
Iout : 50% ↔ 100%  
(tr = tf = 75us)  
Istb : 100%  
Cooling : Convection cooling  
Ta : 25°C

36V



48V



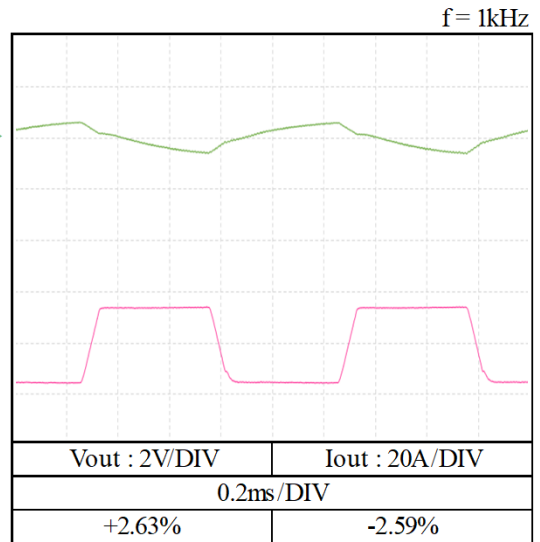
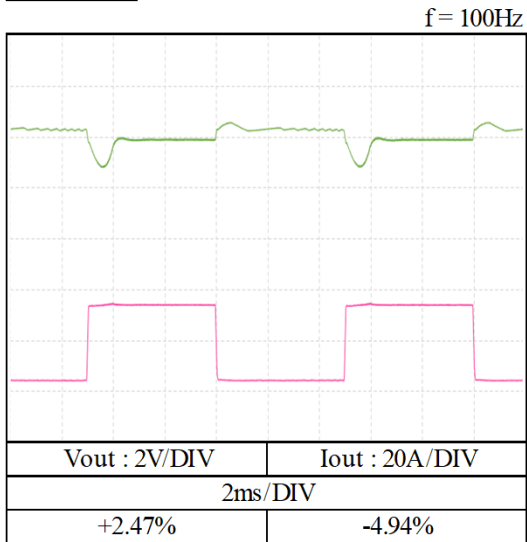


2-9. Dynamic load response characteristics

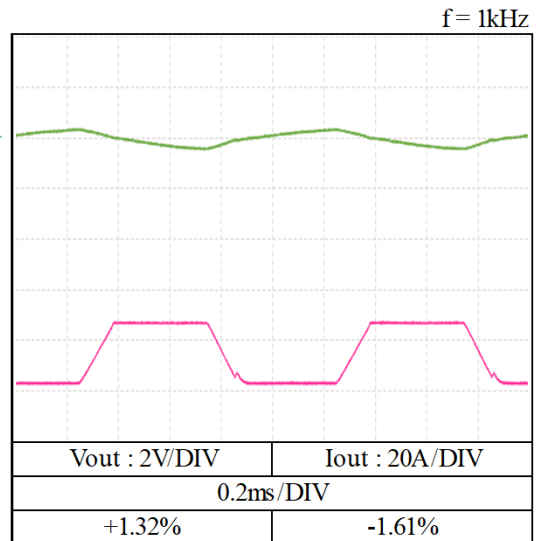
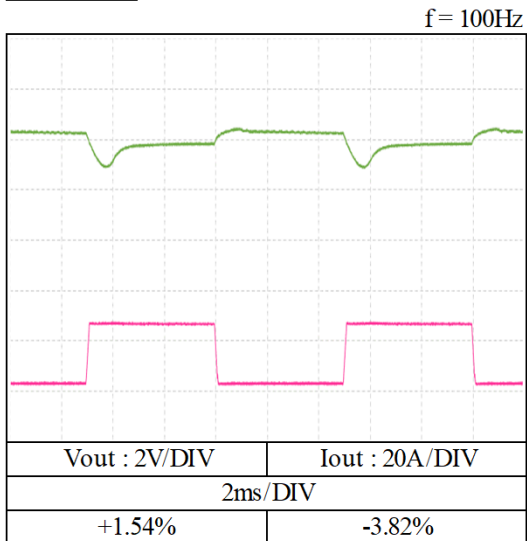
Condition Vin : 100VAC  
 Iout/Pout : 25% ↔ 800W  
 (tr = tf = 75us)  
 Istb : 100%  
 Cooling : Convection cooling

Ta : 25°C

24V



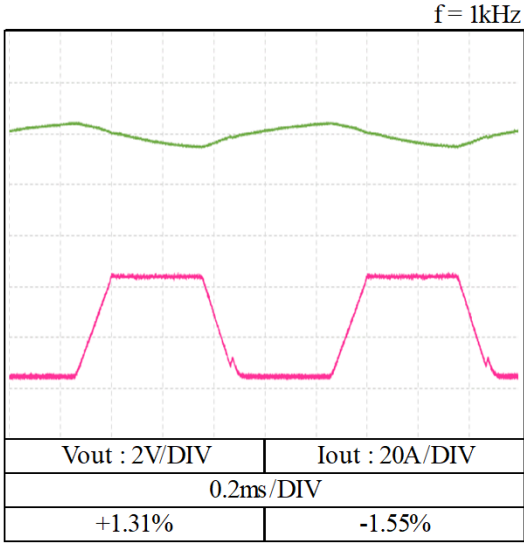
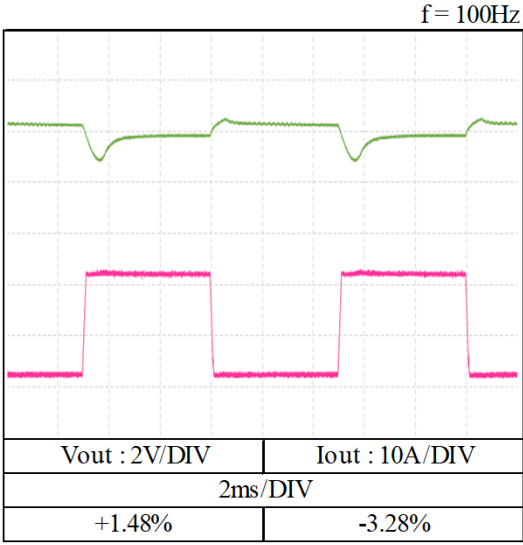
30V



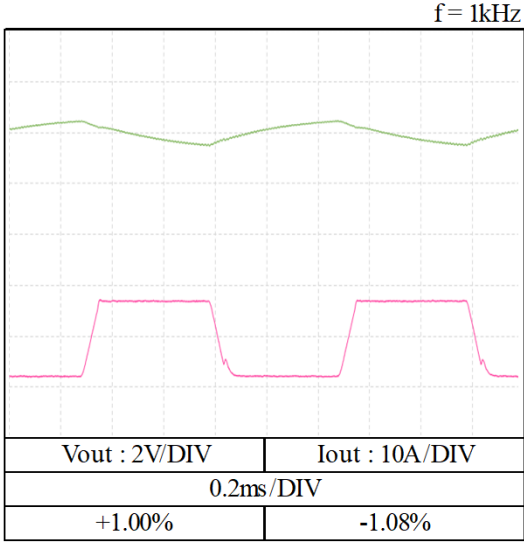
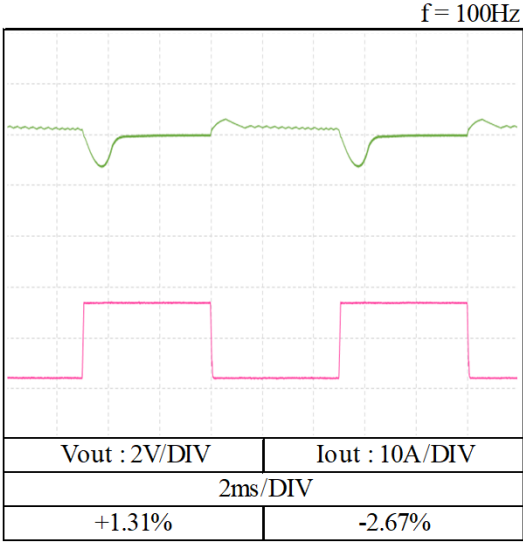
2-9. Dynamic load response characteristics

Condition Vin : 100VAC  
 Iout/Pout : 25% ↔ 800W  
 (tr = tf = 75us)  
 Istb : 100%  
 Cooling : Convection cooling  
 Ta : 25°C

36V



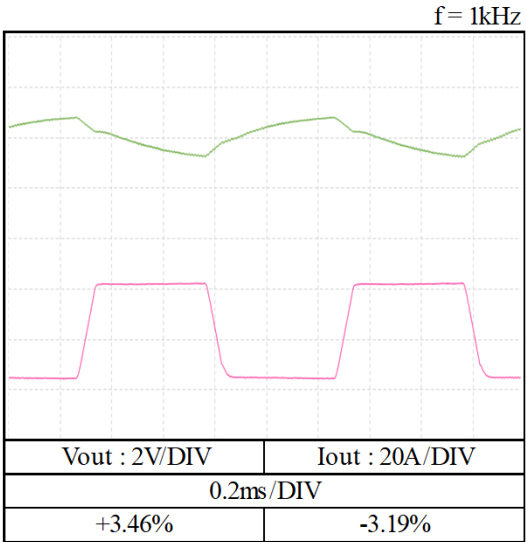
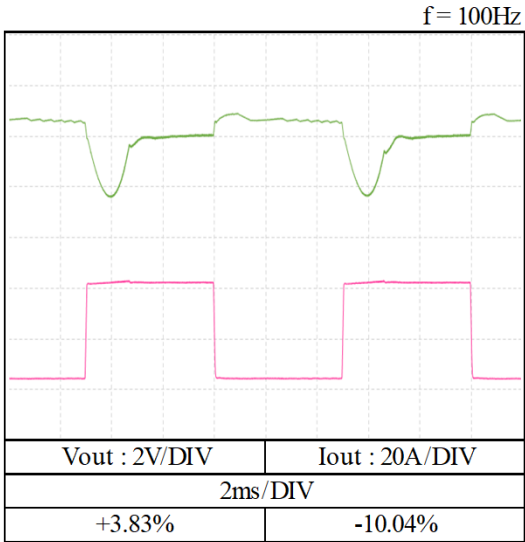
48V



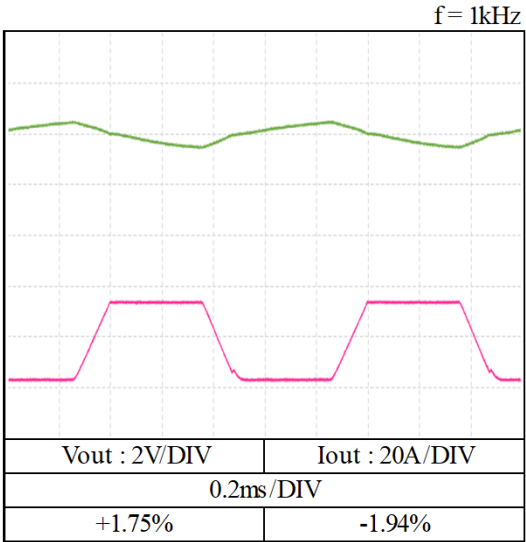
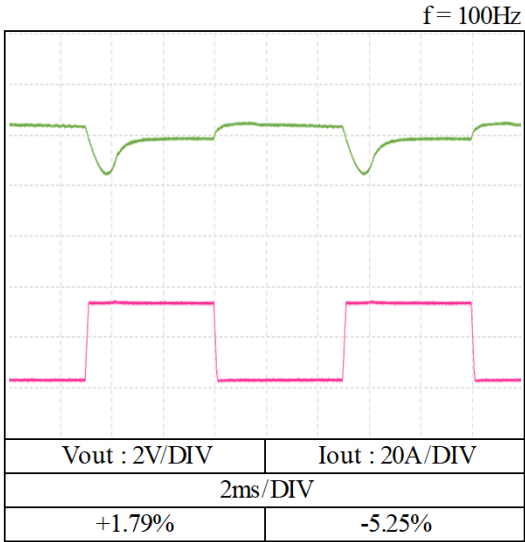
2-9. Dynamic load response characteristics

Condition Vin : 200VAC  
 Iout/Pout : 25% ↔ 1000W  
 (tr = tf = 75us)  
 Istb : 100%  
 Cooling : Convection cooling  
 Ta : 25°C

24V



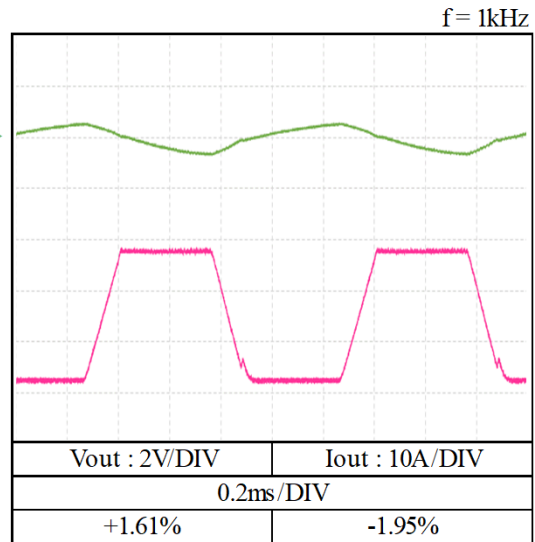
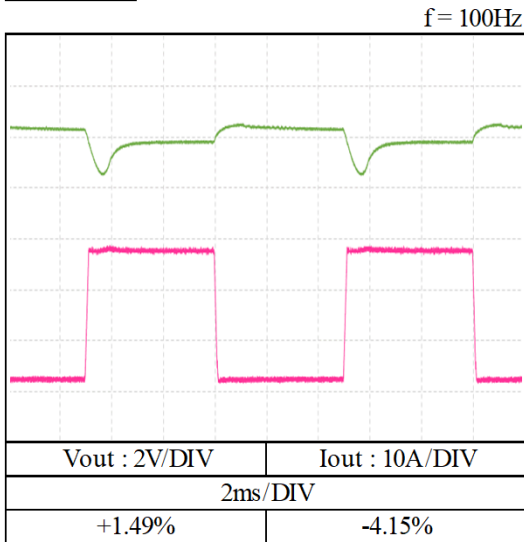
30V



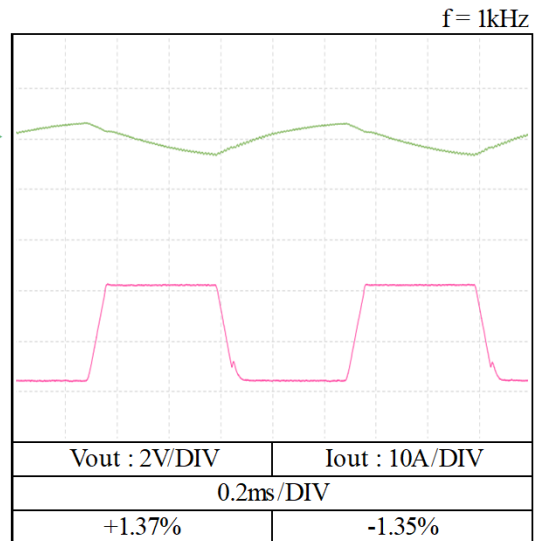
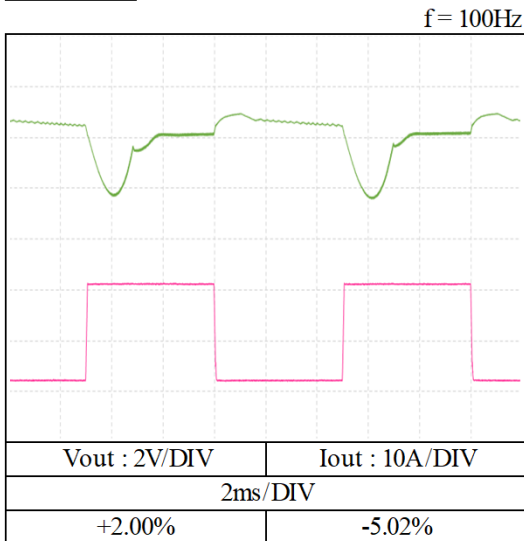
2-9. Dynamic load response characteristics

Condition Vin : 200VAC  
 Iout/Pout : 25% ↔ 1000W  
 (tr = tf = 75us)  
 Istb : 100%  
 Cooling : Convection cooling  
 Ta : 25°C

36V



48V



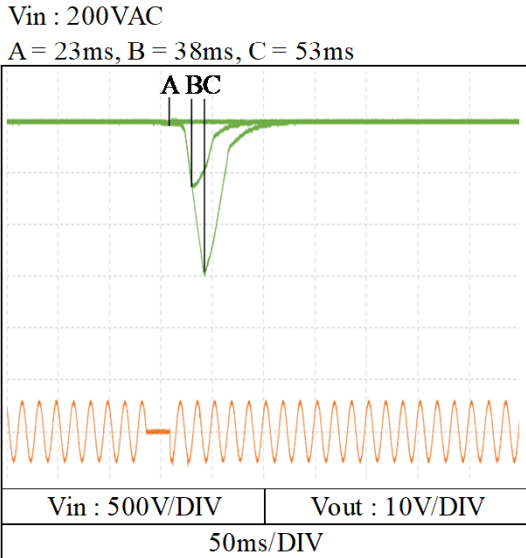
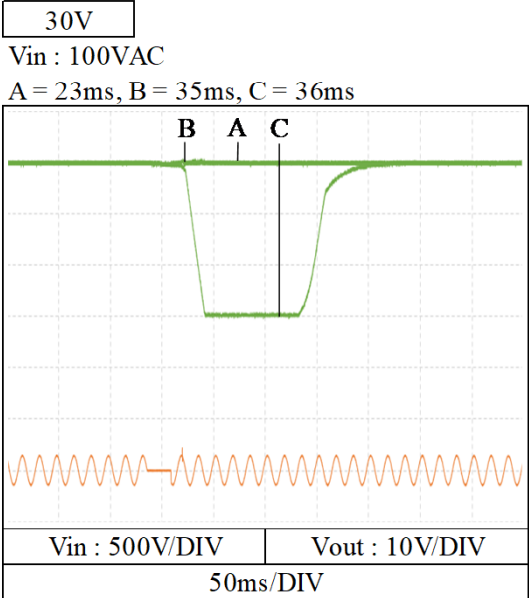
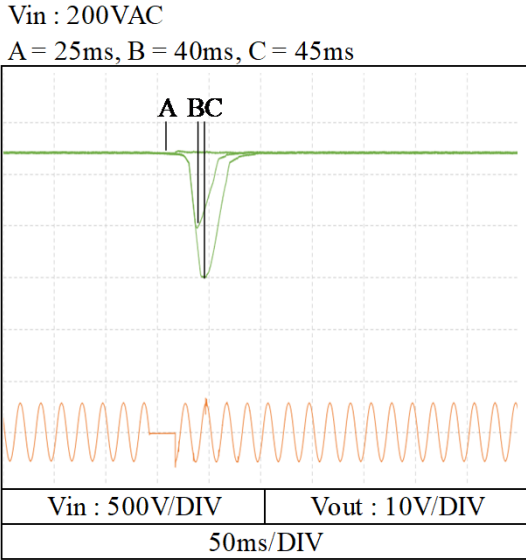
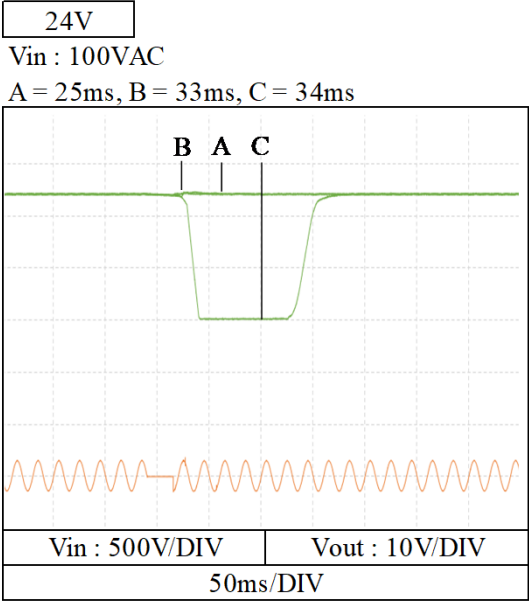
2-10. Response to brown out characteristics

Condition      Iout : 100%  
                  Istb : 100%  
Cooling : Convection cooling

Interruption time

Ta : 25°C

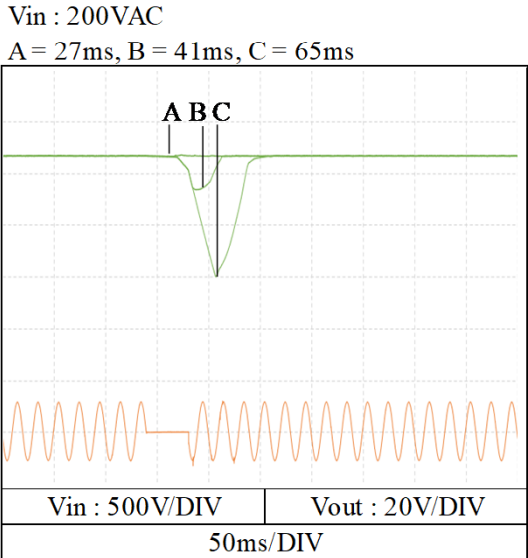
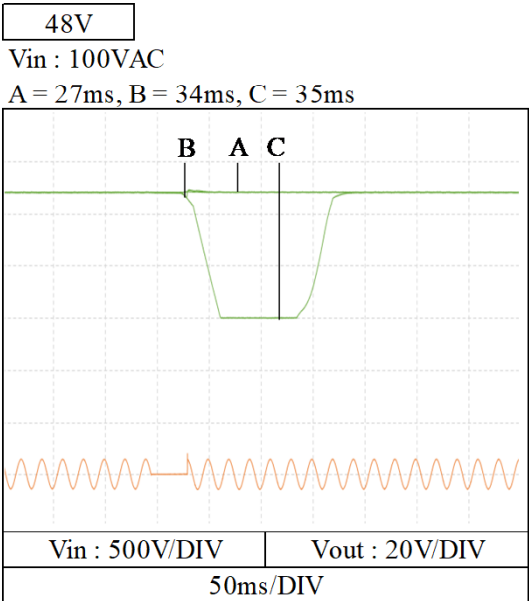
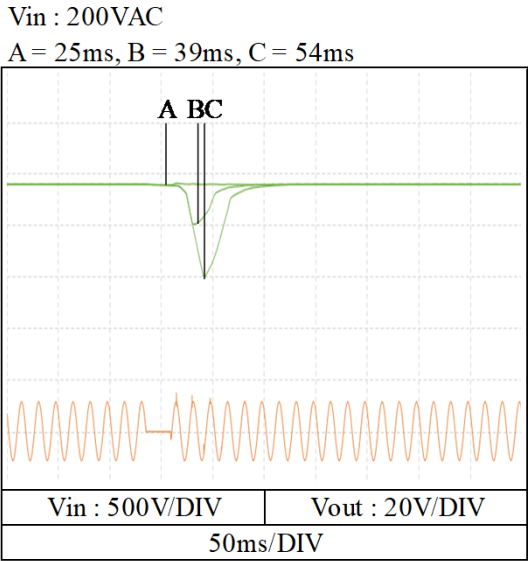
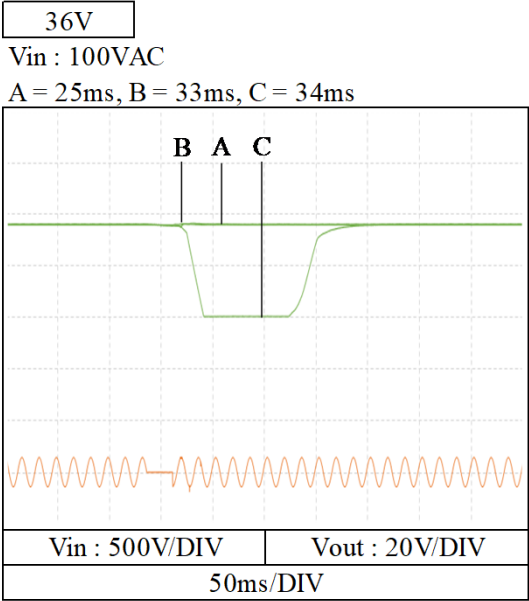
- A : No output voltage drop
- B : No output voltage drop to 0V
- C : Output voltage drops to 0V



2-10. Response to brown out characteristics

Condition      Iout : 100%  
                  Istb : 100%  
Cooling : Convection cooling  
  
                  Ta : 25°C

Interruption time  
A : No output voltage drop  
B : No output voltage drop to 0V  
C : Output voltage drops to 0V



2-11. Inrush current waveform

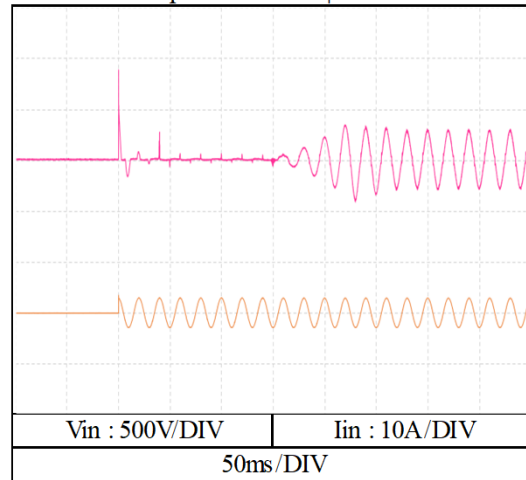
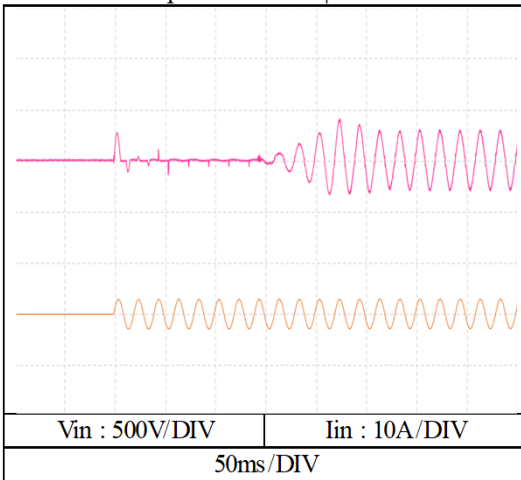
Condition Vin : 100VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling

Ta : 25°C

24V

Input tum on at  $\phi = 0^\circ$

Input tum on at  $\phi = 90^\circ$

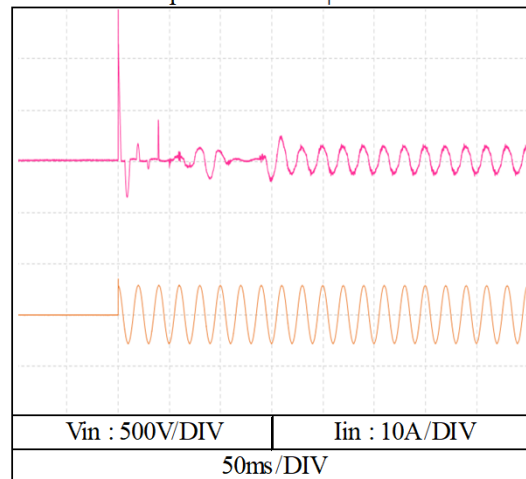
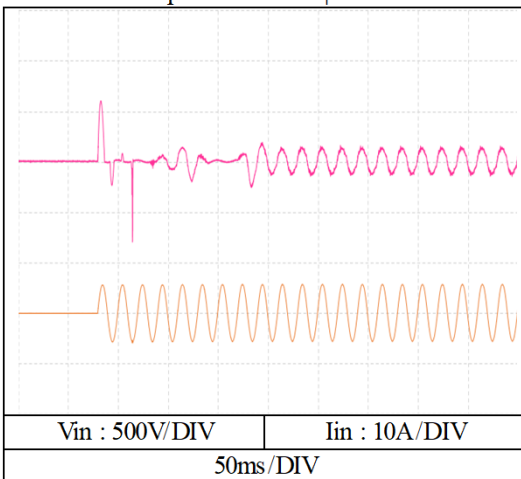


Condition Vin : 200VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling

Ta : 25°C

Input tum on at  $\phi = 0^\circ$

Input tum on at  $\phi = 90^\circ$



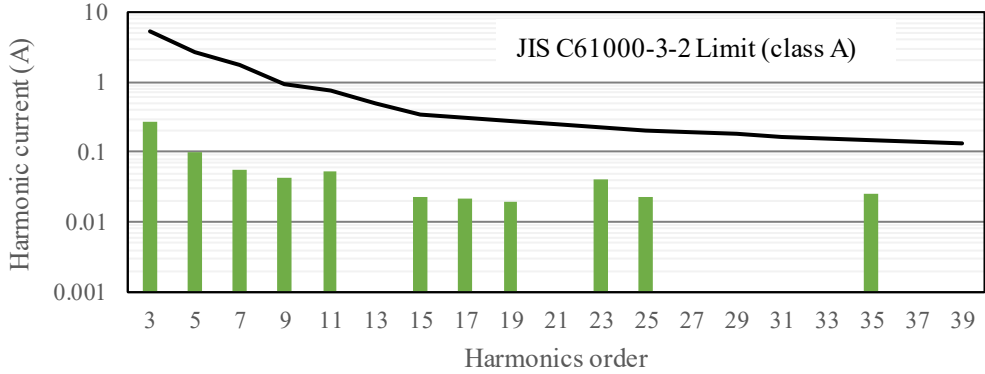
2-12. Input current harmonics

Condition Iout : 100%  
Istb : 100%  
Cooling : Convection cooling

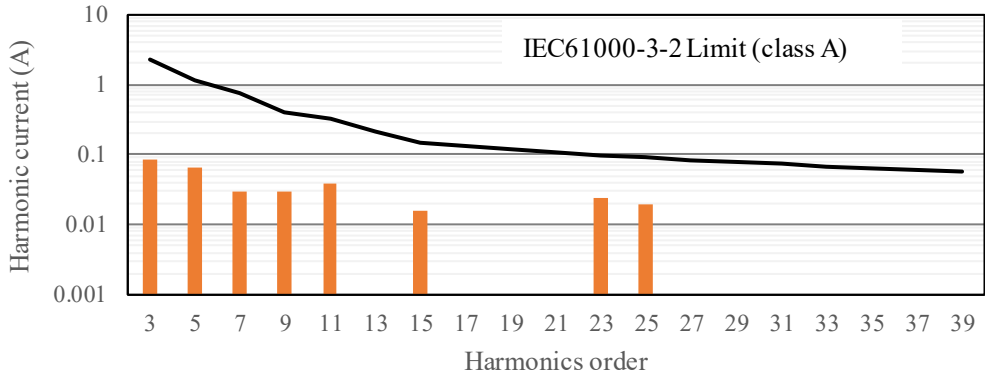
Ta : 25°C

24V

Vin : 100VAC



Vin : 230VAC



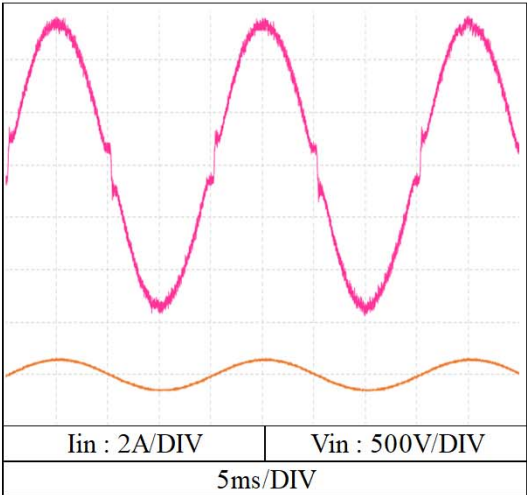
2-13. Input current waveform

Condition Iout : 100%  
Istb : 100%  
Cooling : Convection cooling

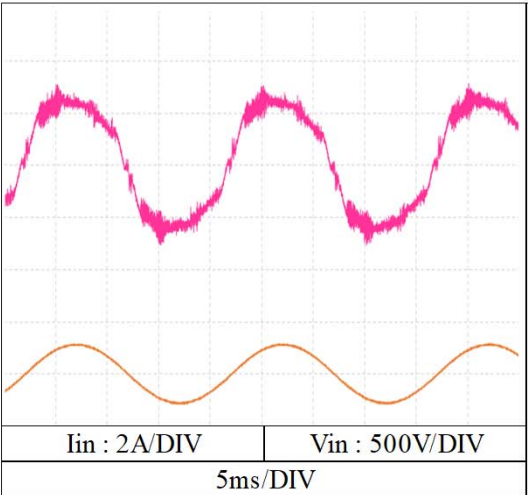
Ta : 25°C

24V

Vin : 100VAC



Vin : 200VAC





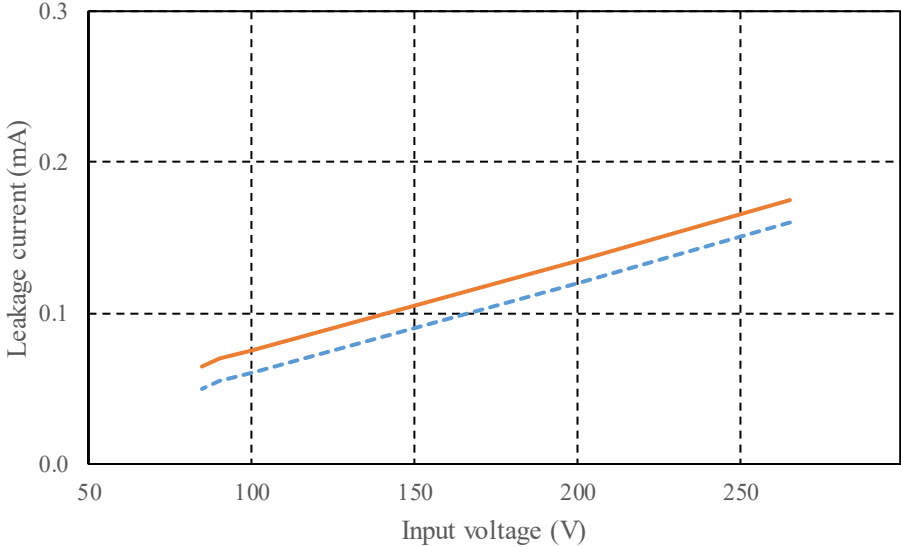
2-14. Leakage current characteristics

Condition Iout : 0% ---  
                  100% —  
                  Istb : 100%  
                  Cooling : Convection cooling

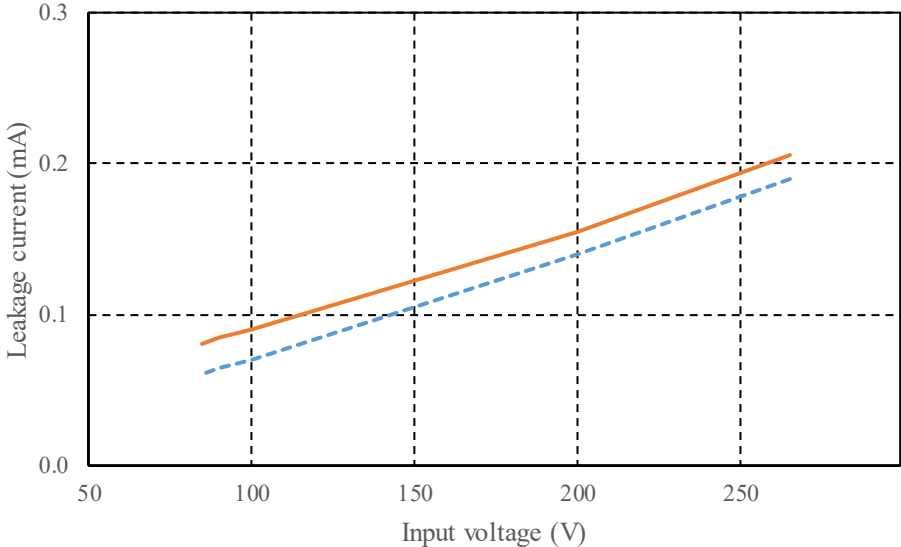
Ta : 25°C

24V

f = 50Hz



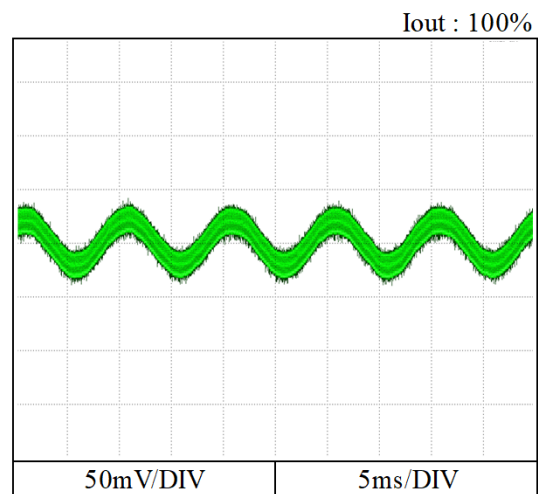
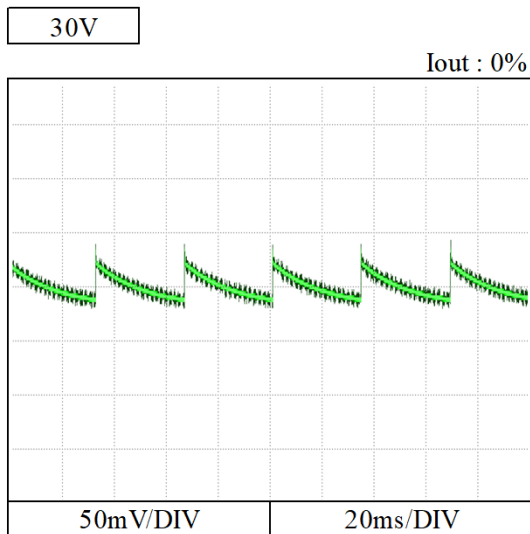
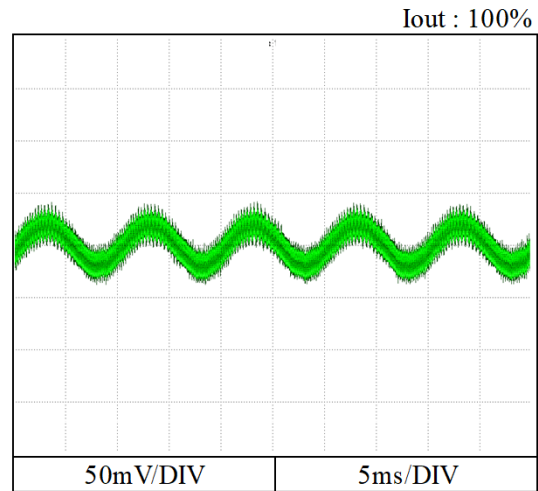
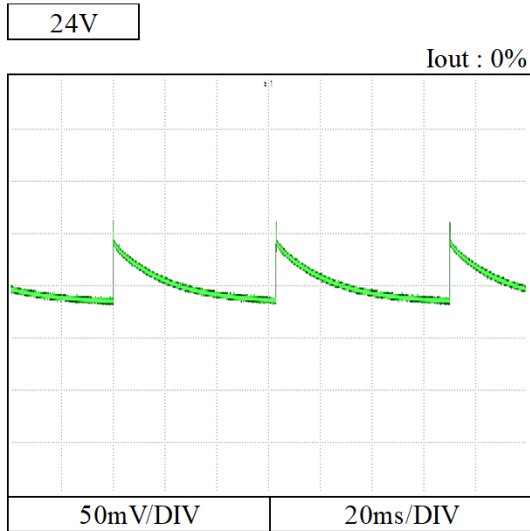
f = 60Hz



2-15. Output ripple and noise waveform

Condition Vin : 100VAC  
Iout : 100%  
Istb : 100%  
Cooling : Convection cooling

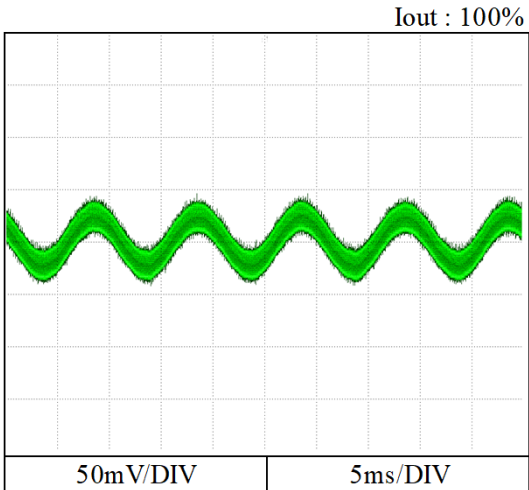
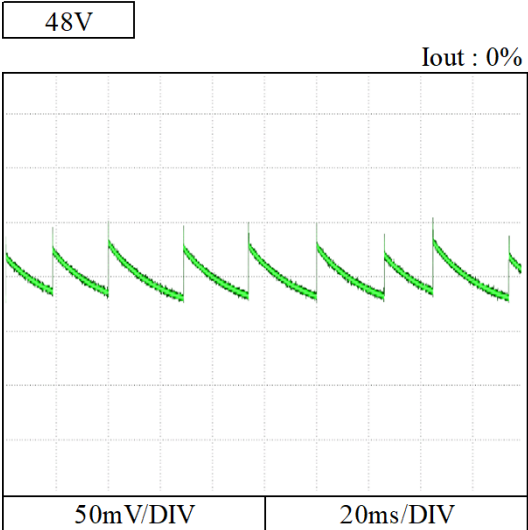
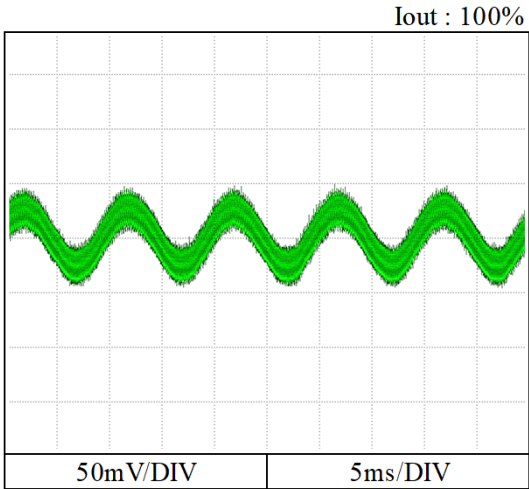
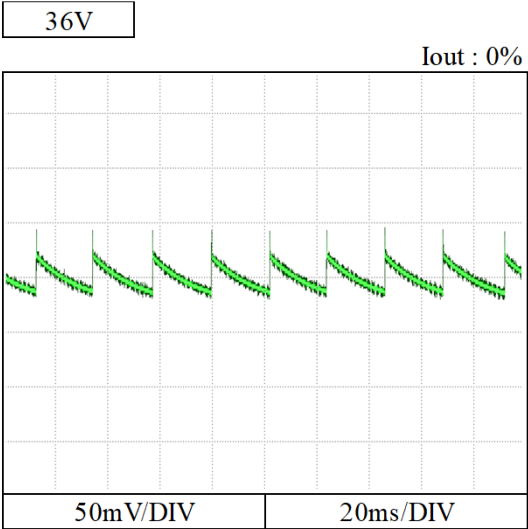
Ta : 25°C



2-15. Output ripple and noise waveform

Condition Vin : 100VAC  
Iout : 100%  
Istb : 100%  
Cooling : Convection cooling

Ta : 25°C



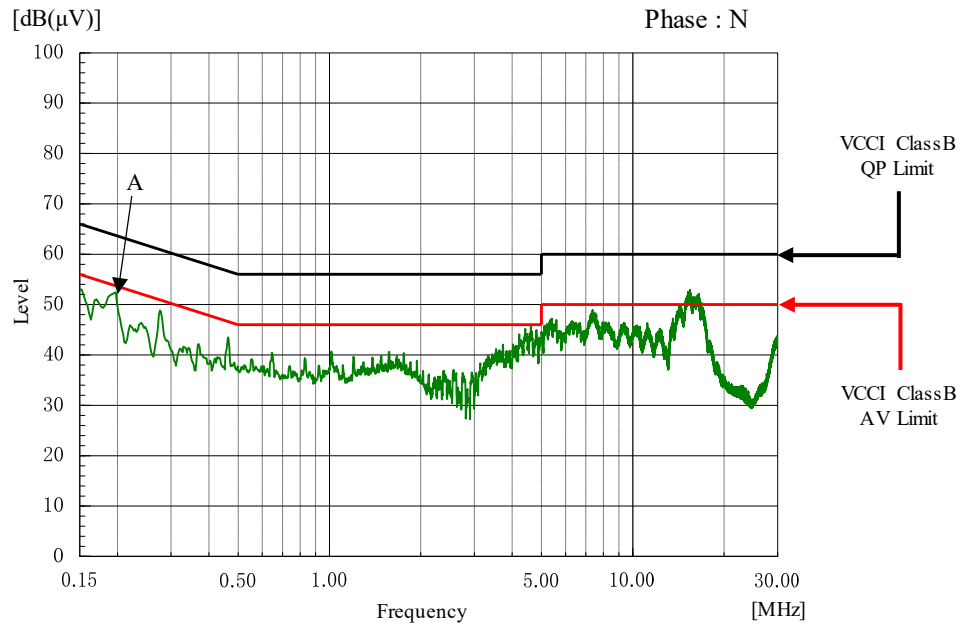
2-16. Electro-Magnetic Interference characteristics  
 Conducted Emission

Condition Vin : 230VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling

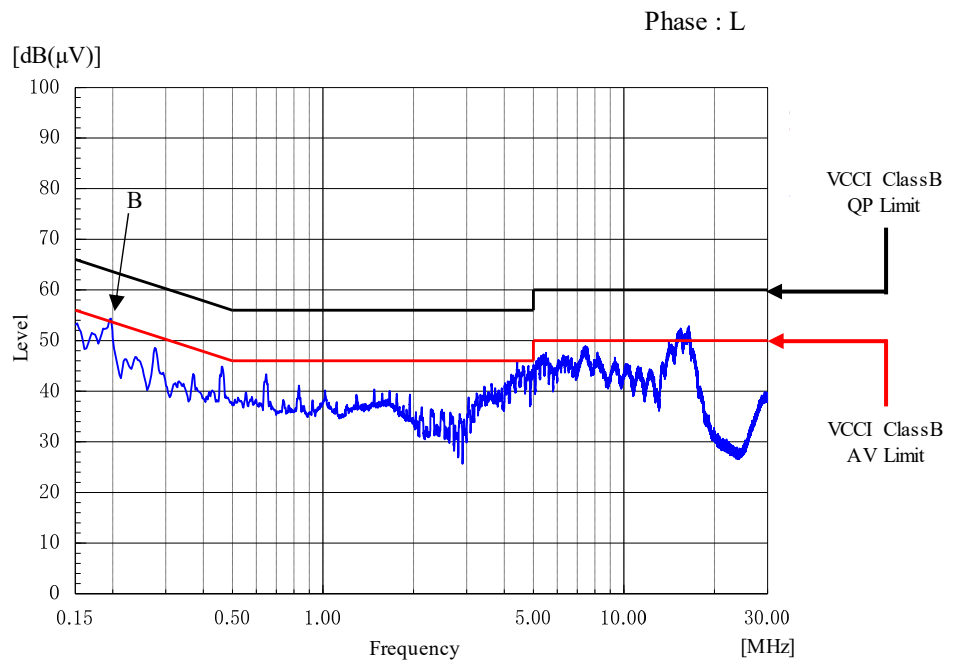
24V

Ta : 25°C

Ref. Data	Point A (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	51.2
AV	53.7	49.1



Ref. Data	Point B (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	53.1
AV	53.7	49.3



Limit of EN55011-B,EN55032-B,FCC-B are same as its VCCI class B.

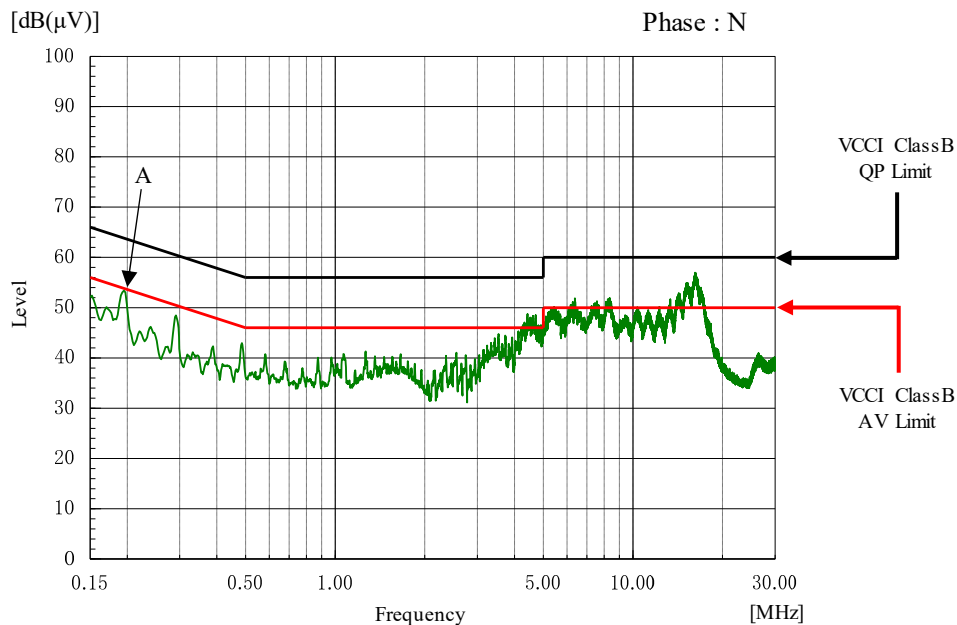
2-16. Electro-Magnetic Interference characteristics  
 Conducted Emission

Condition Vin : 230VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling

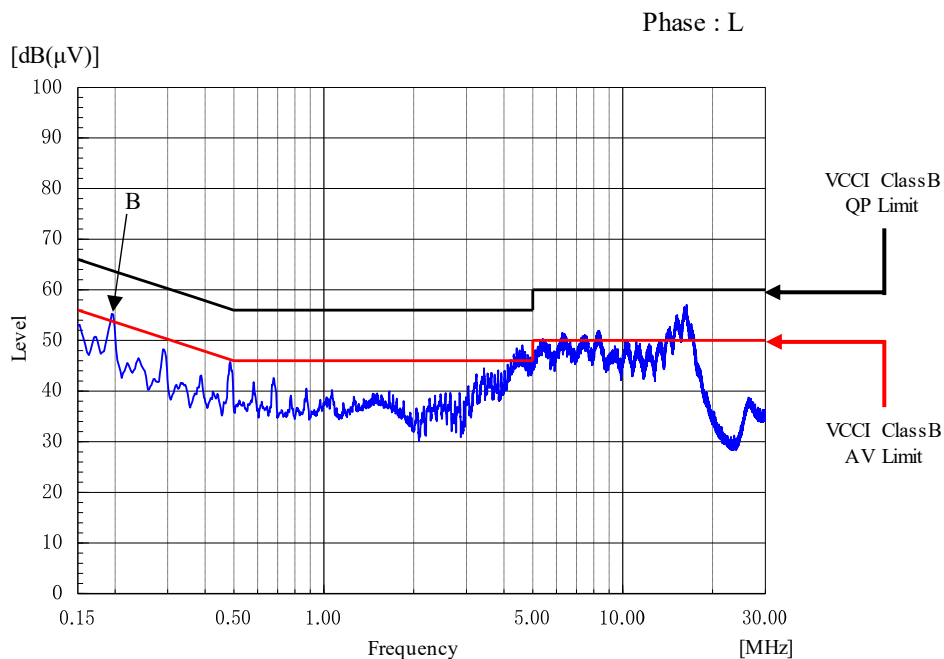
30V

Ta : 25°C

Ref. Data	Point A (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	51.5
AV	53.7	48.4



Ref. Data	Point B (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	52.9
AV	53.7	48.7



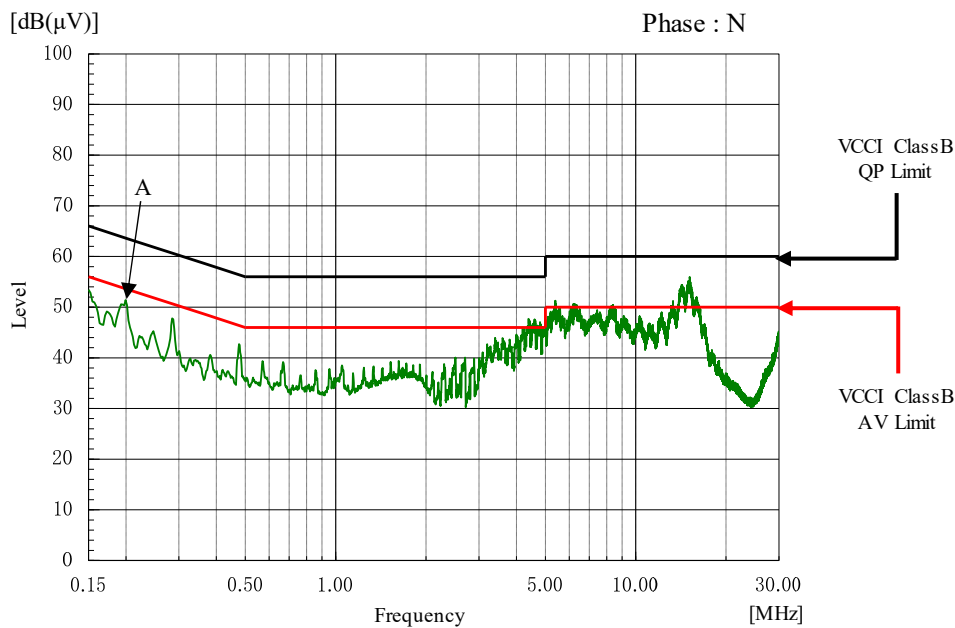
Limit of EN55011-B,EN55032-B,FCC-B are same as its VCCI class B.

2-16. Electro-Magnetic Interference characteristics  
 Conducted Emission

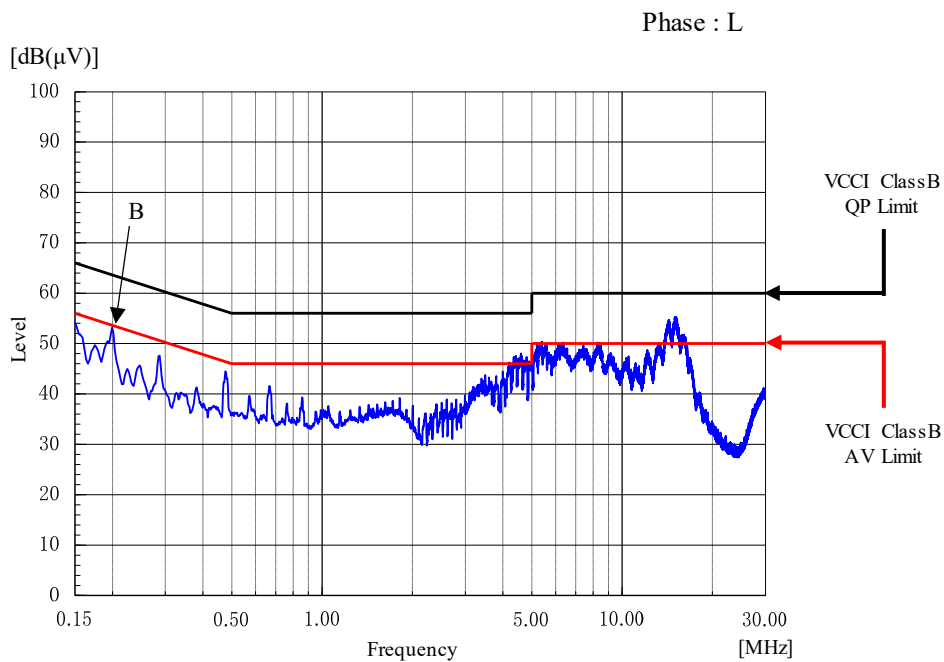
Condition Vin : 230VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling  
 Ta : 25°C

36V

Ref. Data	Point A (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	50.1
AV	53.7	47.8



Ref. Data	Point B (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	51.7
AV	53.7	48.1



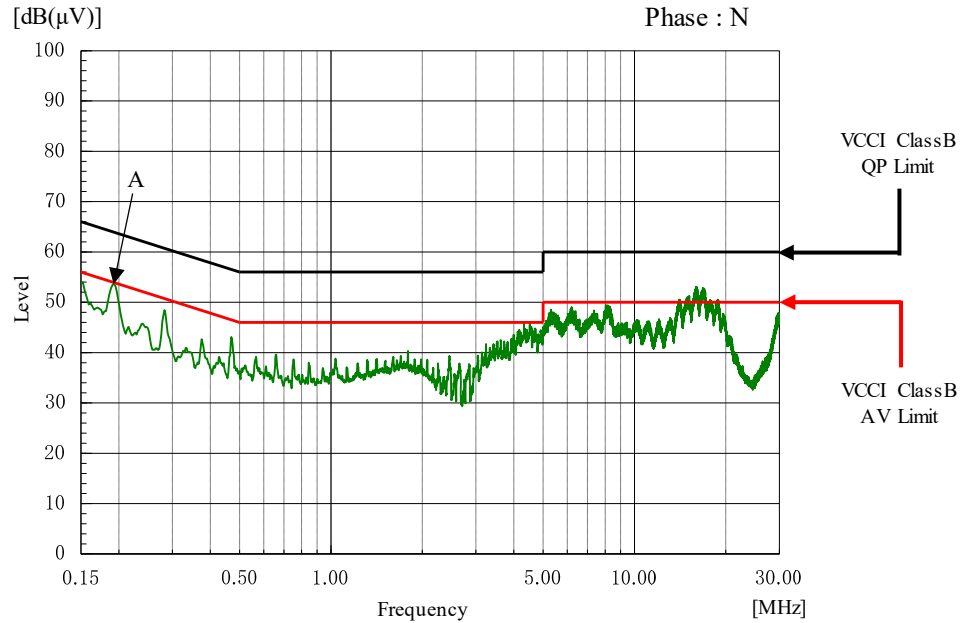
Limit of EN55011-B,EN55032-B,FCC-B are same as its VCCI class B.

2-16. Electro-Magnetic Interference characteristics  
 Conducted Emission

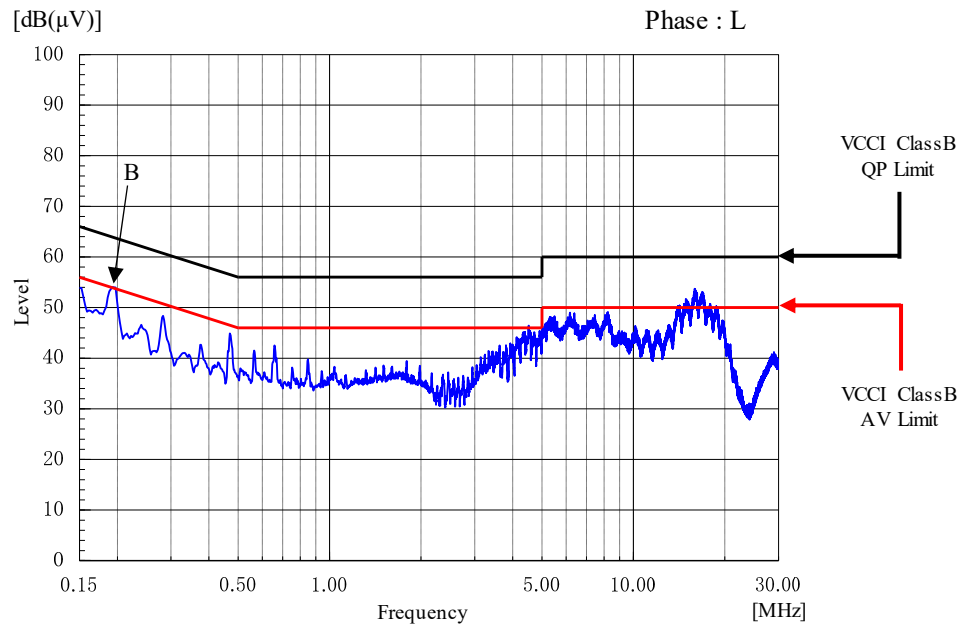
Condition Vin : 230VAC  
 Iout : 100%  
 Istb : 100%  
 Cooling : Convection cooling  
 Ta : 25°C

48V

Ref. Data	Point A (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	50.6
AV	53.7	48.5



Ref. Data	Point B (0.2MHz)	
	Limit (dB)	Measure (dB)
QP	63.7	52.5
AV	53.7	48.7



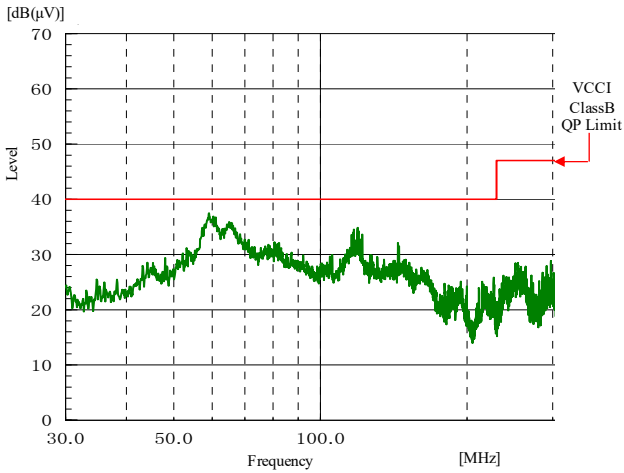
Limit of EN55011-B,EN55032-B,FCC-B are same as its VCCI class B.

Radiated Emission

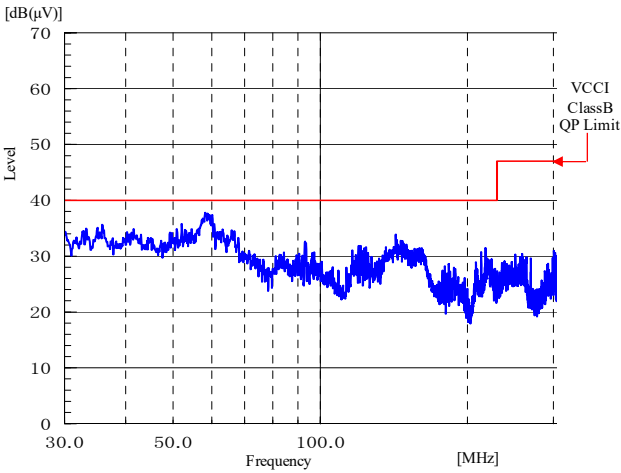
Condition Vin : 230VAC  
Iout : 100%  
Istb : 100%  
Cooling : Convection cooling  
Ta : 25°C

24V

Horizontal

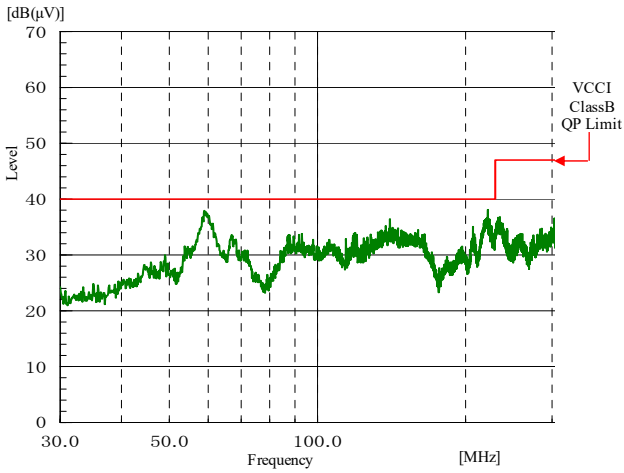


Vertical

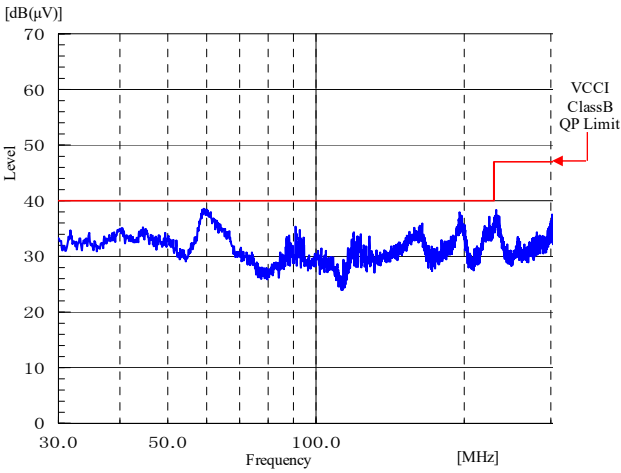


30V

Horizontal



Vertical



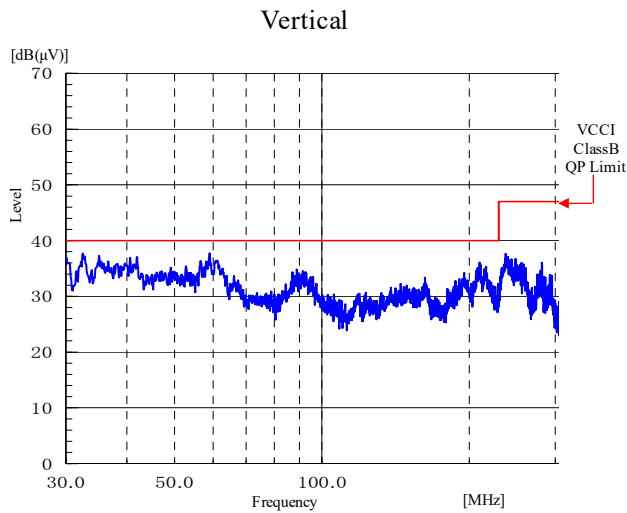
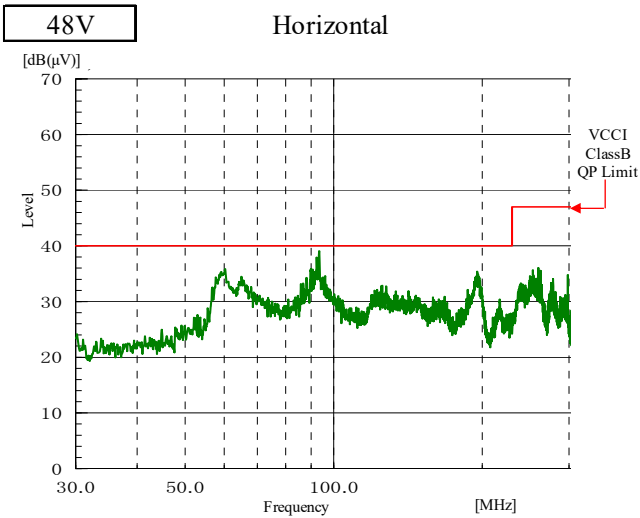
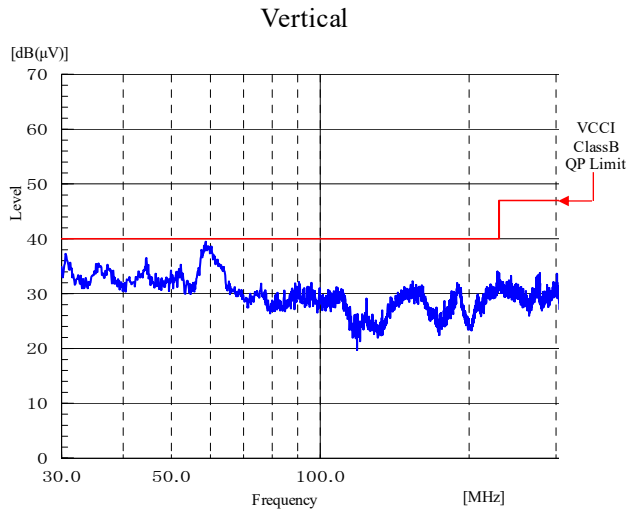
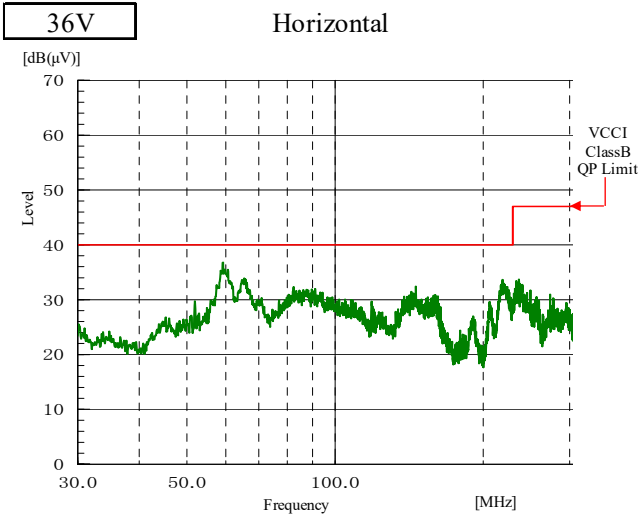
Limit of EN55011-B,EN55032-B are same as its VCCI class B.

Indication is peak values.



Radiated Emission

Condition Vin : 230VAC  
Iout : 100%  
Istb : 100%  
Cooling : Convection cooling  
Ta : 25°C



Limit of EN55011-B,EN55032-B are same as its VCCI class B.

Indication is peak values.