# LS150

# EVALUATION DATA

| DWG.No PA579-53-01 | | |
|---|---|---|
| APPD | CHK | DWG |
| 22 May 08 | 22-May-08 | |

**DENSEI-LAMBDA**

# INDEX



Terminology Used

| | Definition | |
|---|---|---|
| Vin | . . . . . | Input voltage |
| Vout | . . . . . | Output Voltage |
| Iin | . . . . . | Input Current |
| Iout | . . . . . | Output Current |
| Ta | . . . . . | Ambient temperature |

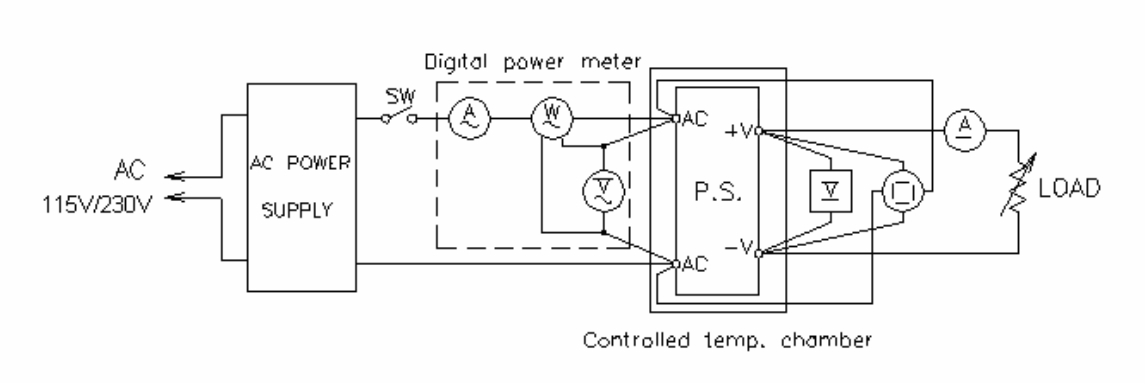
**1-2 List of equipment used**

| | EQUIPMENT USED | MANUFACTURER | MODEL NO. |
|---|---|---|---|
| 1 | DIGITAL STORAGE OSCILLOSCOPE | YOKOGAWA | DL1740/DL1740E |
| 2 | DIGITAL MULTIMETER | FLUKE | 89 VI |
| 3 | DIGITAL POWER METER | YOKOGAWA | WT210 |
| 4 | CURRENT PROBE/AMPLIFIER | TEKTRONIX | TCP404XL/TCPA400 |
| 5 | DYNAMIC DUMMY LOAD | CHROMA | 63030/63201 |
| 6 | DYNAMIC DUMMY LOAD | KIKUSUI | PLZ1004W |
| 7 | CONTROLLED TEMP. CHAMBER | ESPEC | SU-241 |
| 8 | LEAKAGE CURRENT METER | SIMPSON | 228 |
| 9 | AC SOURCE | KIKUSUI | PCR-2000L |
| 10 | AC SOURCE | CHROMA | 6530 |
| 11 | POWER ANALYZER | CHROMA | 6630 |
| 12 | EMI TEST RECEIVER | ROHDE&SCHWARZ | ESCI |
| 13 | EMI TEST RECEIVER | ROHDE&SCHWARZ | ESI26 |
| 14 | LISN | ROHDE&SCHWARZ | ENV216 |
| 15 | ANTENNA | ROHDE&SCHWARZ | HL562 |

## 1. Evaluation Method

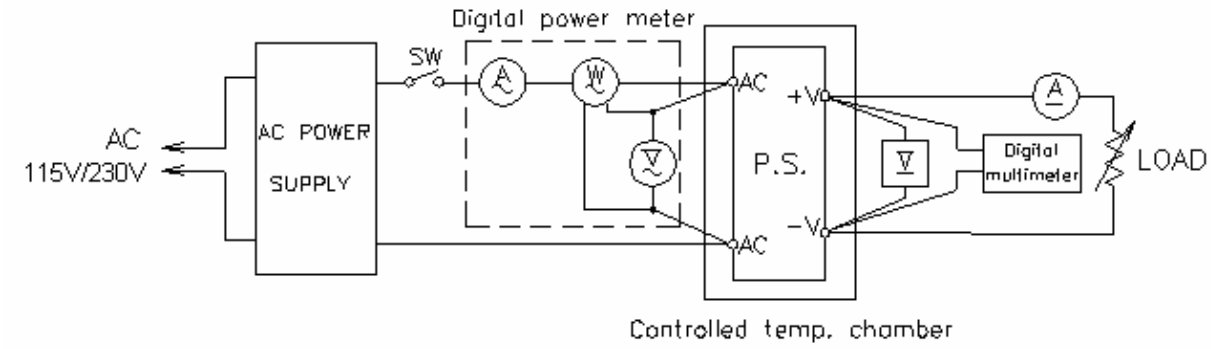
### 1-1 Circuit used for determination

(1) Steady state data



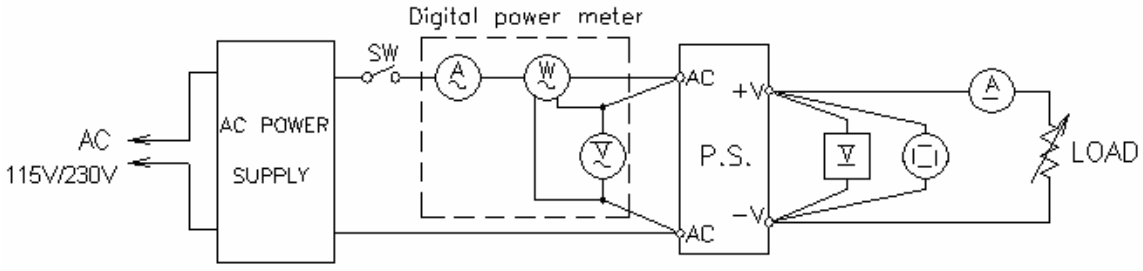

(2) Warm up voltage drift characteristics
Same as Steady state data

(3) Over current protection (OCP) characteristics




(4) Over voltage protection (OVP) characteristics
Same as Steady state data

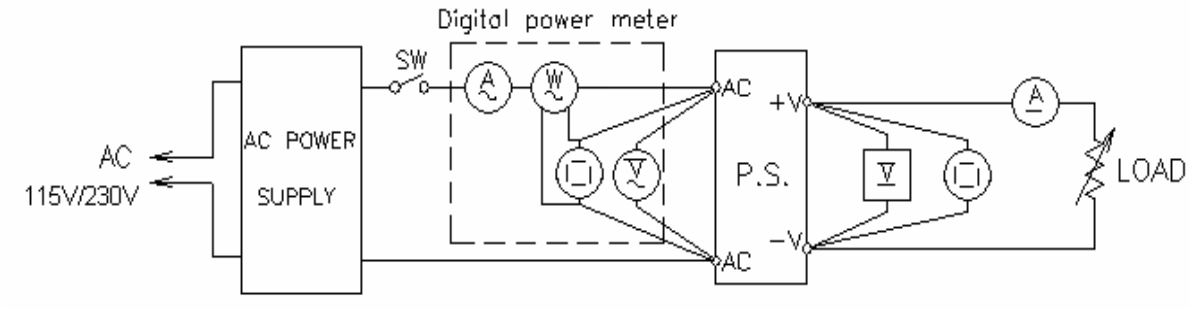
(5) Output rise characteristics



(6) Output fall characteristics

Same as Output rise characteristics

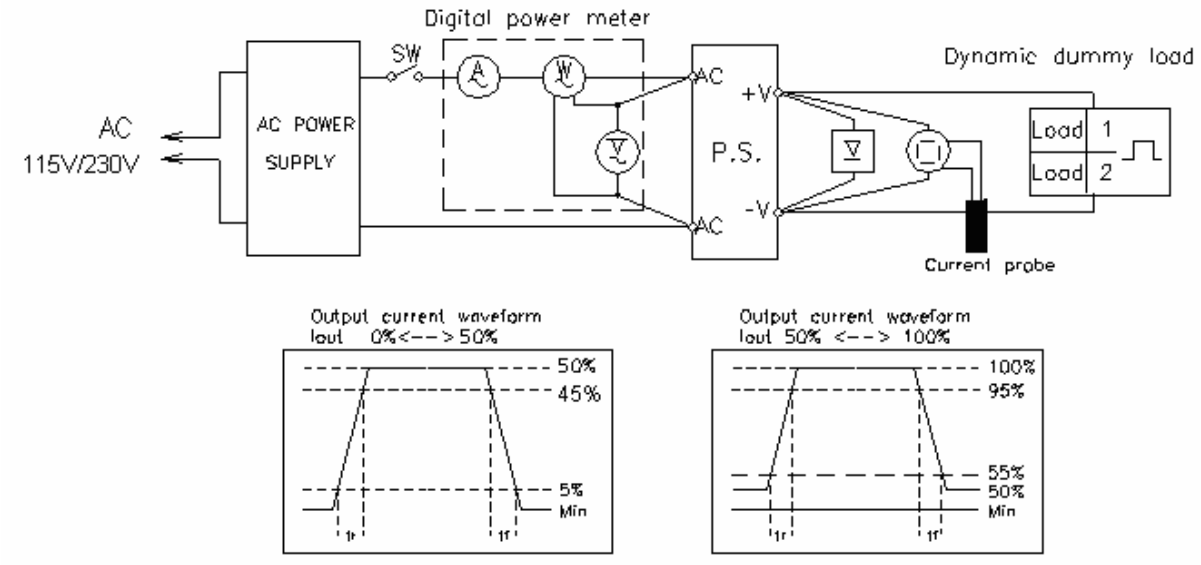
(7) Response to brown out characteristics



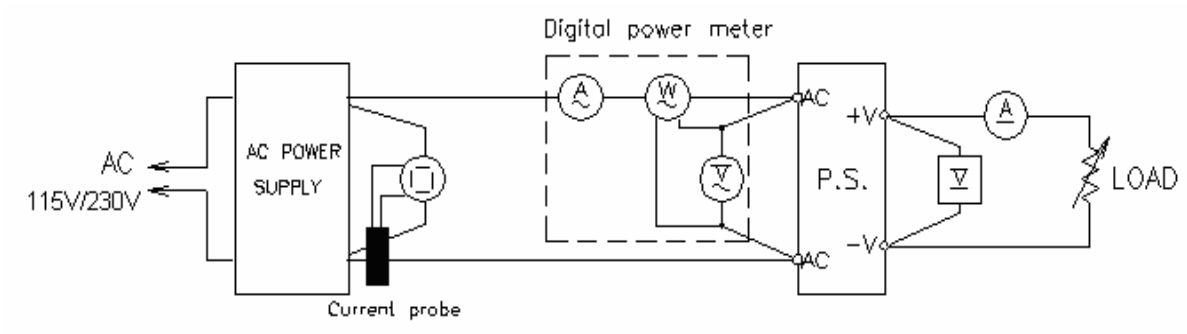

(8) Dynamic line characteristics

Same as Response to brown out characteristics.

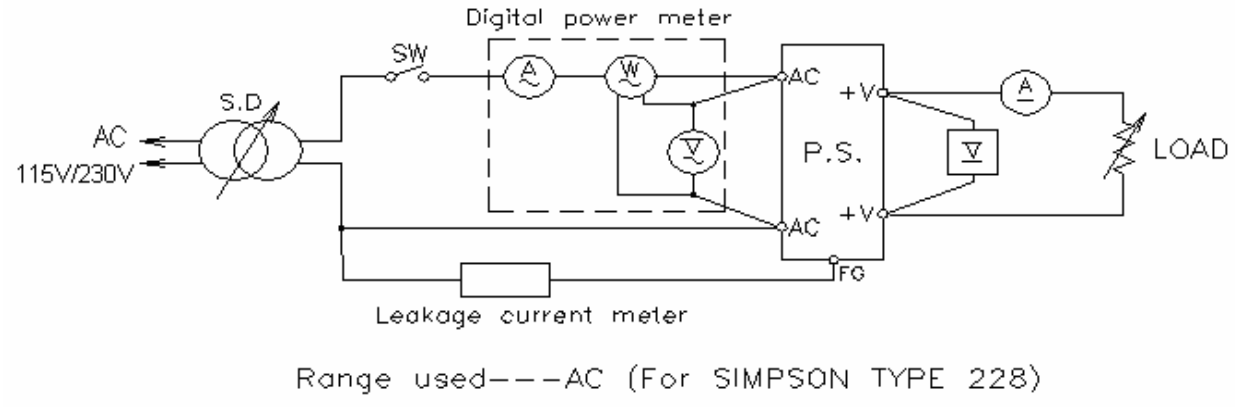
(9) Dynamic load response characteristics



(10) Inrush current characteristics

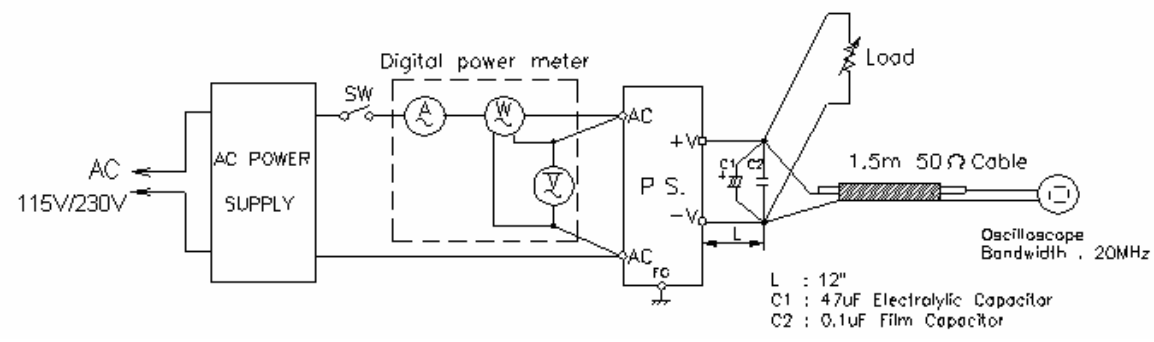



(11) Leakage current characteristics

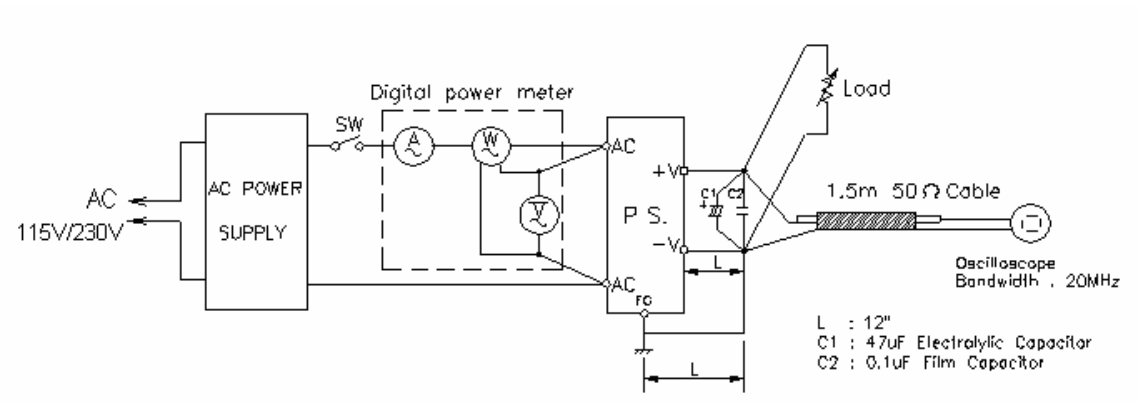



(12) Output ripple and noise waveform

(a) Normal Mode (using a 12" twisted pair terminated with 0.1uF and 47uF capacitor at 20MHz)

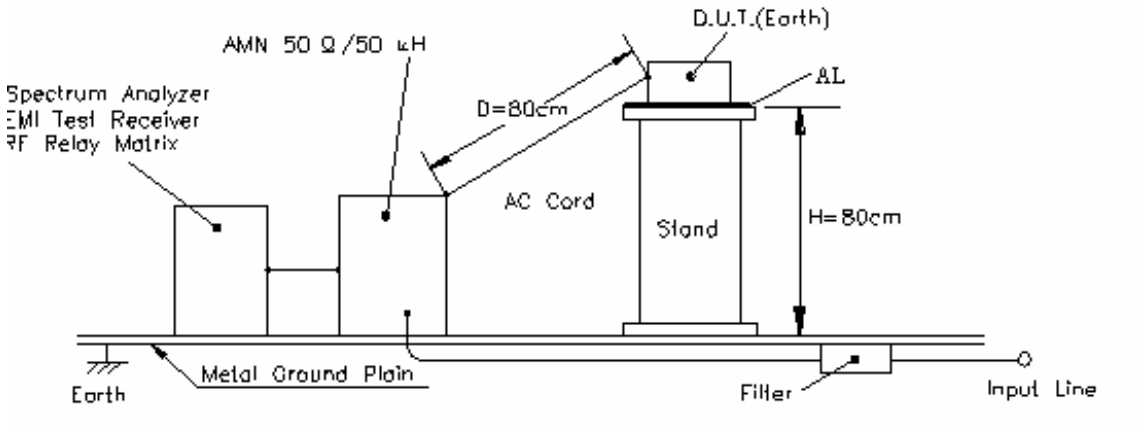


(b) Normal +Common Mode

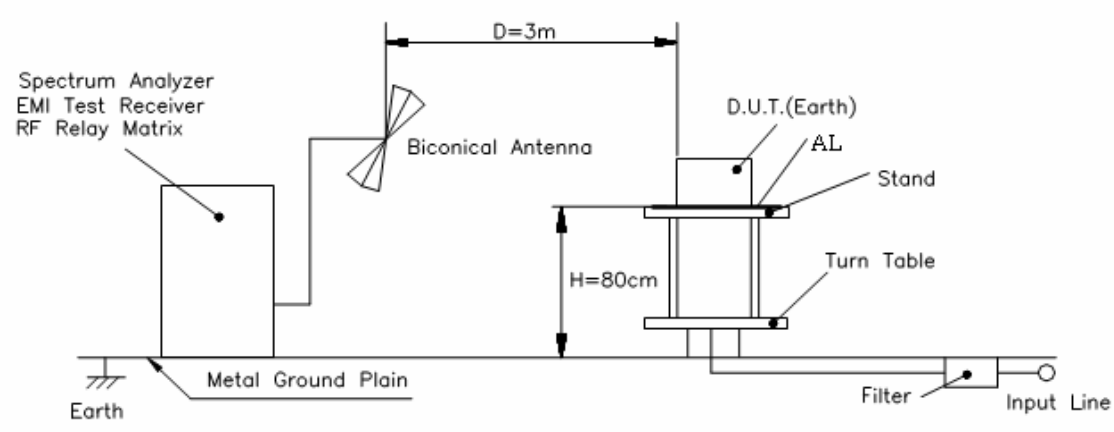



(13) Electro-Magnetic Interference characteristics

(a) Conducted Emission Noise



(b) Radiated Emission Noise



## 2. Characteristics

### 2-1 Steady state data

**(1) Regulation - line and load, Temperature drift**

5V

1. Regulation-line and load — Condition Ta : 25°C

| Iout \ Vin | 88VAC | 115VAC | 230VAC | 264VAC | line regulation | |
|---|---|---|---|---|---|---|
| 0% | 5.023V | 5.023V | 5.027V | 5.027V | 0.004V | 0.080% |
| 50% | 5.013V | 5.013V | 5.019V | 5.018V | 0.006V | 0.120% |
| 100% | 5.001V | 5.002V | 5.010V | 5.011V | 0.010V | 0.200% |
| load | 0.022V | 0.021V | 0.017V | 0.016V | | |
| regulation | 0.440% | 0.420% | 0.340% | 0.320% | | |

2. Temperature drift — Conditions; Vin = 115VAC, Iout =100%

| Ta | -25°C | 25°C | 50°C | temperature stability | |
|---|---|---|---|---|---|
| Vout | 4.985V | 5.002V | 4.999V | 0.017V | 0.34% |

12V

1. Regulation-line and load — Condition Ta : 25°C

| Iout \ Vin | 88VAC | 115VAC | 230VAC | 264VAC | line regulation | |
|---|---|---|---|---|---|---|
| 0% | 12.005 | 12.01 | 12.015 | 12.015 | 0.010V | 0.083% |
| 50% | 12.005 | 12.01 | 12.005 | 12.01 | 0.005V | 0.042% |
| 100% | 11.994 | 11.999 | 11.994 | 11.989 | 0.010V | 0.083% |
| load | 0.011V | 0.011V | 0.021V | 0.026V | | |
| regulation | 0.092% | 0.092% | 0.175% | 0.217% | | |

2. Temperature drift — Conditions; Vin = 115VAC, Iout = 100%

| Ta | -25°C | 25°C | 50°C | temperature stability | |
|---|---|---|---|---|---|
| Vout | 11.973V | 11.999V | 11.985V | 0.026V | 0.22% |

24V

1. Regulation-line and load — Condition Ta : 25°C

| Iout \ Vin | 88VAC | 115VAC | 230VAC | 264VAC | line regulation | |
|---|---|---|---|---|---|---|
| 0% | 24.058 | 24.052 | 24.052 | 24.068 | 0.016V | 0.067% |
| 50% | 24.047 | 24.047 | 24.052 | 24.047 | 0.005V | 0.021% |
| 100% | 24.052 | 24.041 | 24.047 | 24.047 | 0.011V | 0.046% |
| load | 0.011V | 0.011V | 0.005V | 0.021V | | |
| regulation | 0.046% | 0.046% | 0.021% | 0.088% | | |

2. Temperature drift — Conditions; Vin = 115VAC, Iout =100%

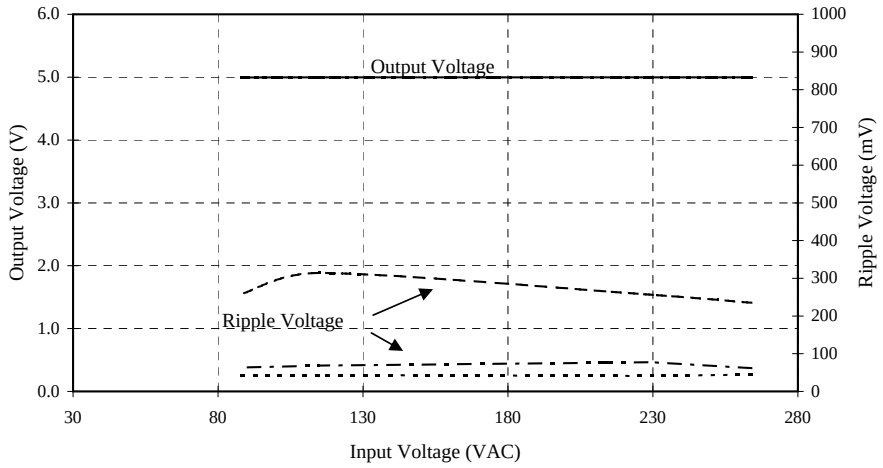
| Ta | -25°C | 25°C | 50°C | temperature stability | |
|---|---|---|---|---|---|
| Vout | 24.084V | 24.041V | 24.009V | 0.075V | 0.312% |

## 2-1 Steady State Data

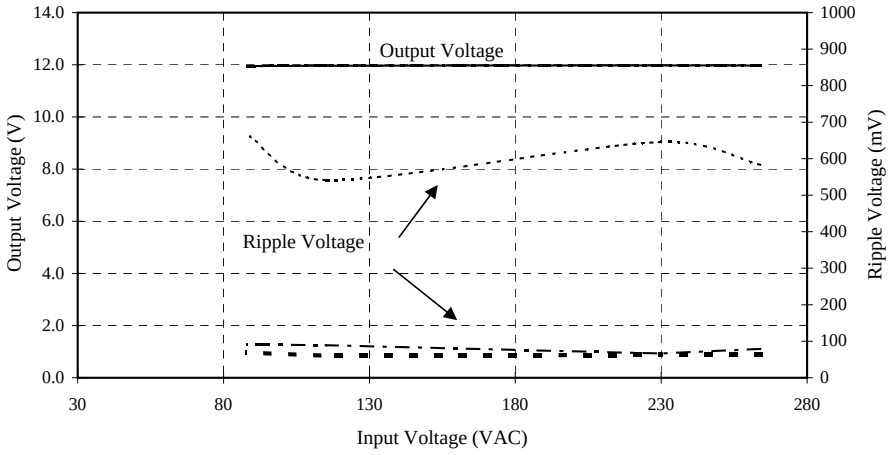
### (2) Output Voltage And Ripple Voltage Vs Input Voltage

Condition : Iout = 100%
Ta = -25°C
= 25°C
= 50°C

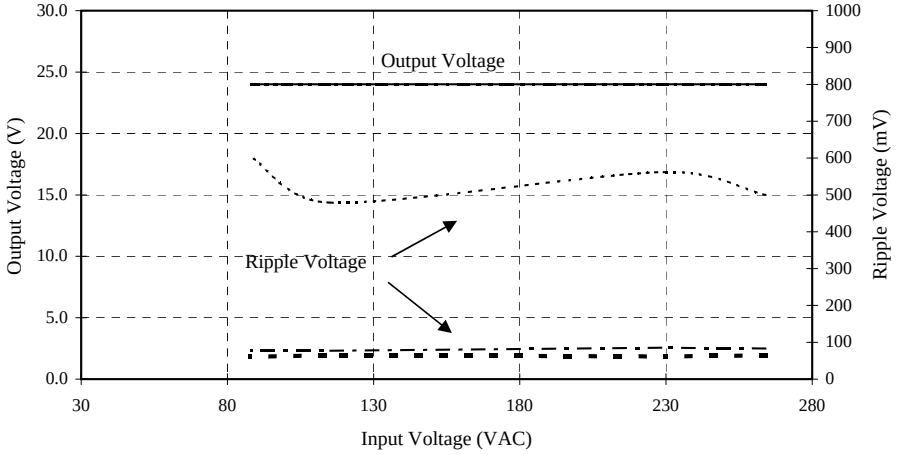
5V




12V




24V

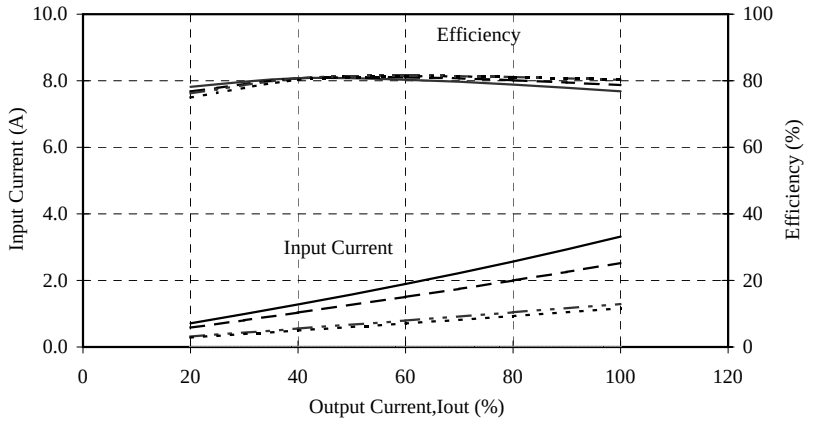


## 2-1 Steady State Data

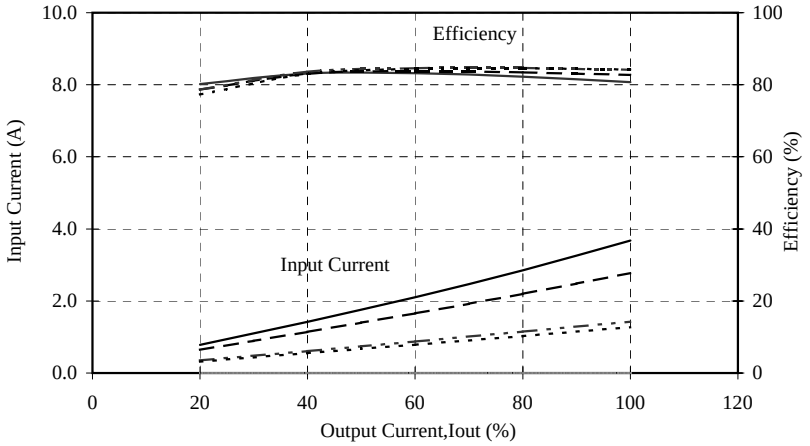
### (3) Efficiency And Input Current Vs Output Current

Conditions: Ta= 25°C
Vin= 88VAC
115VAC
230VAC
264VAC

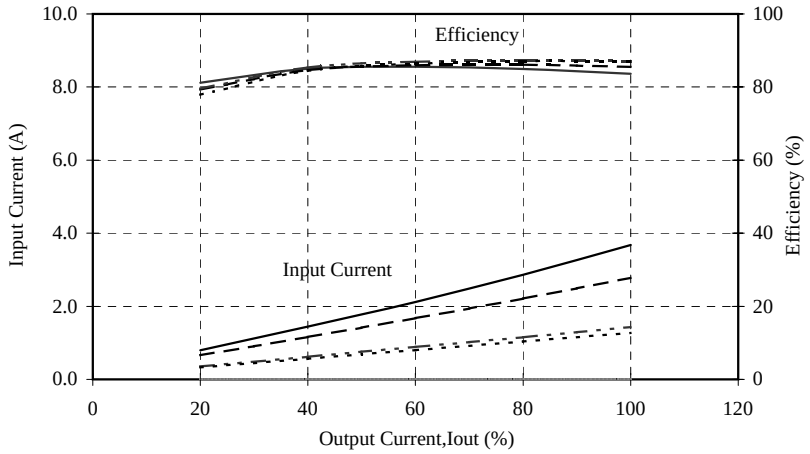
5V




12V



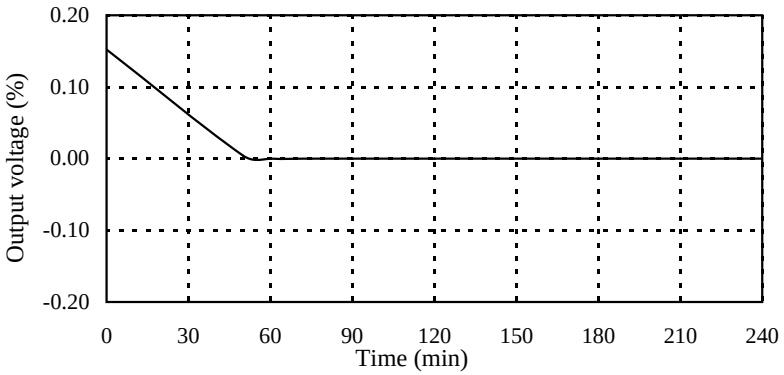

24V



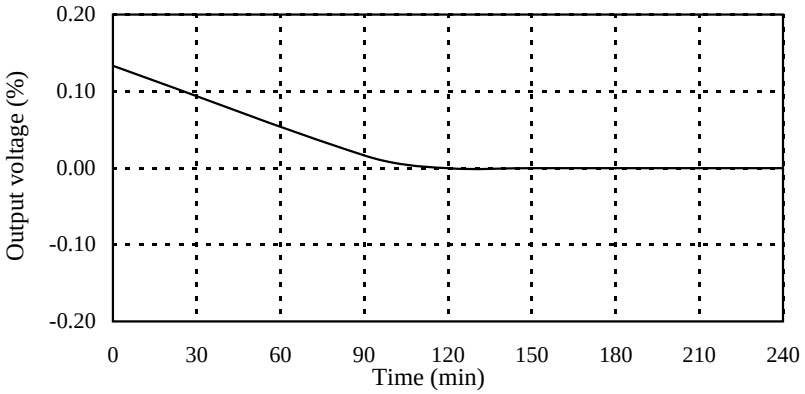
## 2-2 Warm up voltage drift characteristics

Conditions: Vin : 230VAC
Iout : 100%
Ta : 25℃

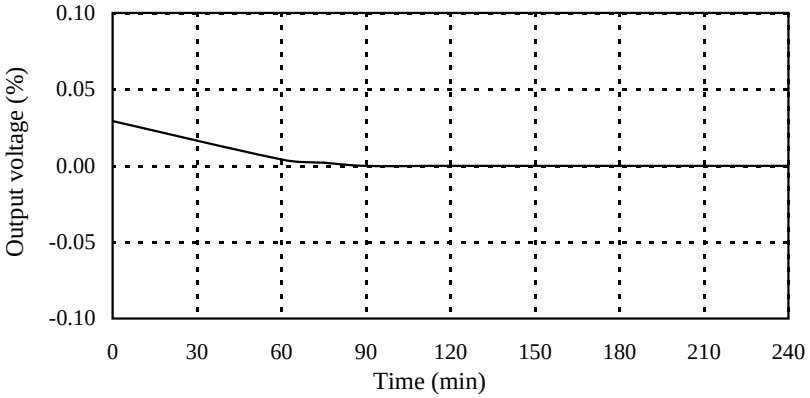
5V




12V



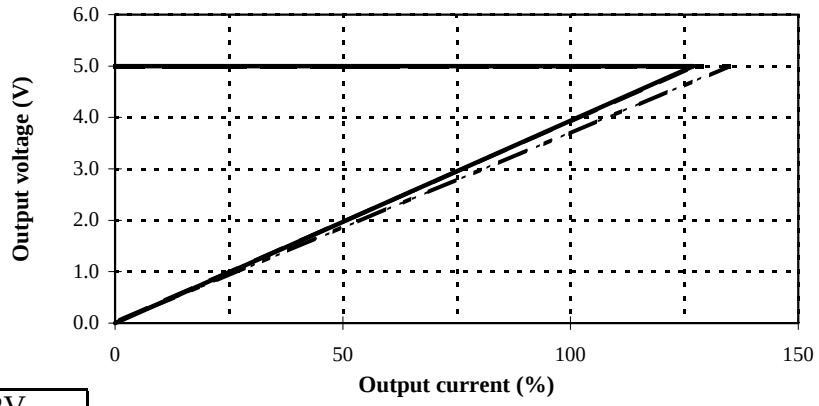

24V



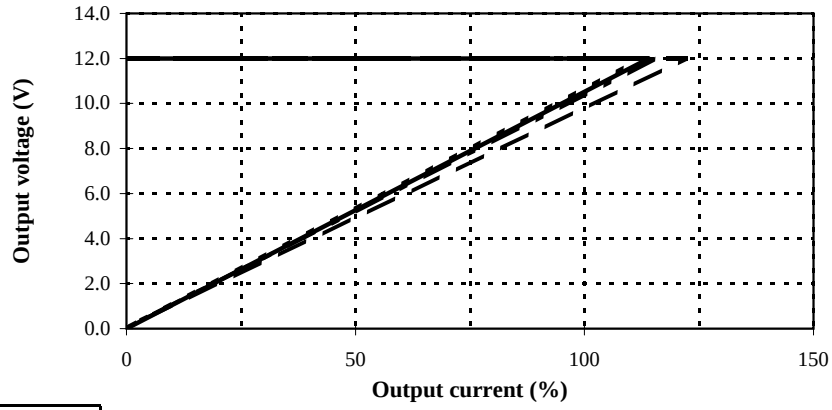
### 2-3 Over current protection (OCP) characteristics

Conditions: Vin : 88 VAC
115 VAC
230 VAC
264 VAC
Ta : 25℃

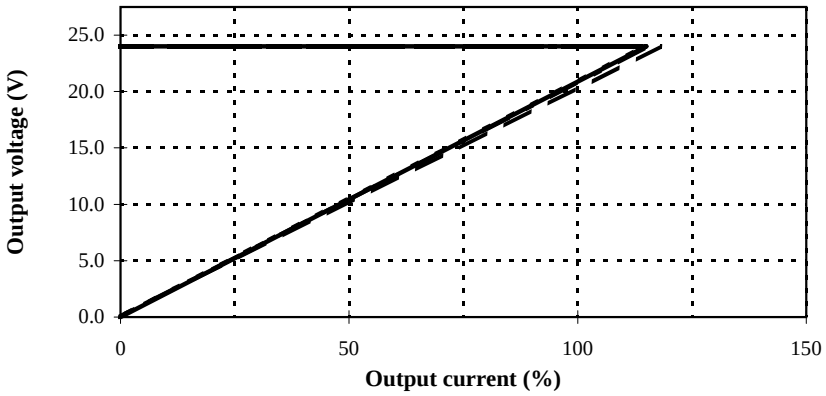
5V




12V



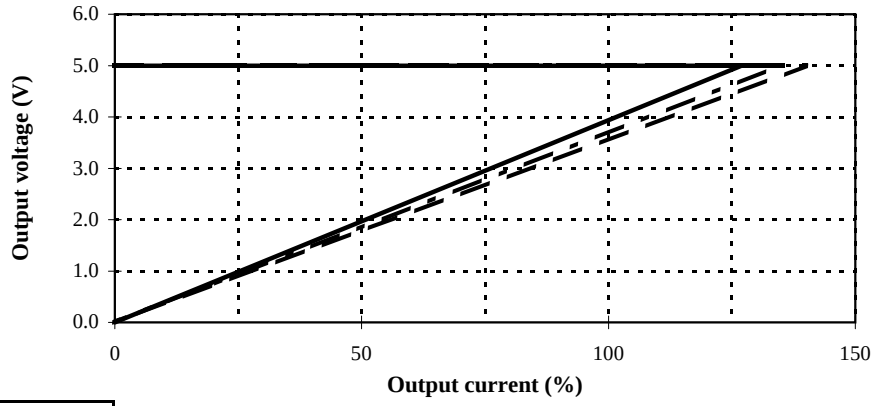

24V



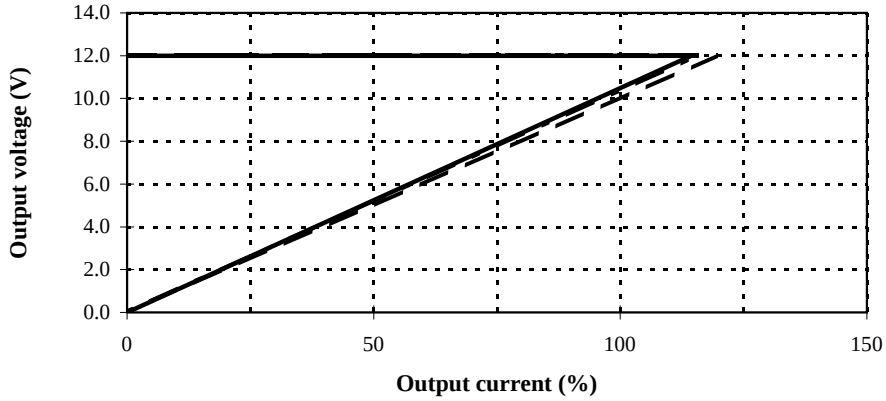
### 2-3 Over current protection (OCP) characteristics

Conditions: Vin : 115VAC
Ta : -25℃ – – – – –
25℃ - · - · - · -
50℃ ———

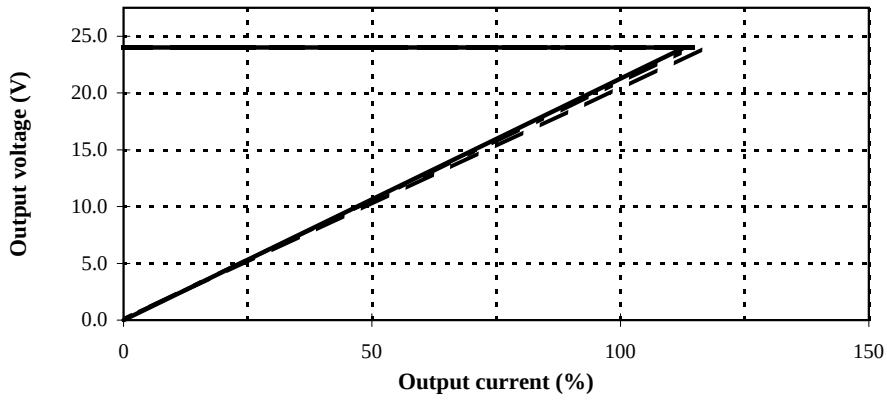
5V




12V



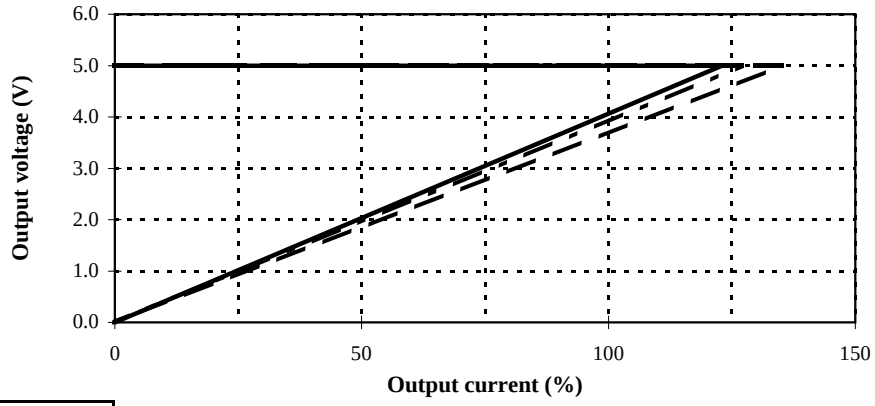

24V



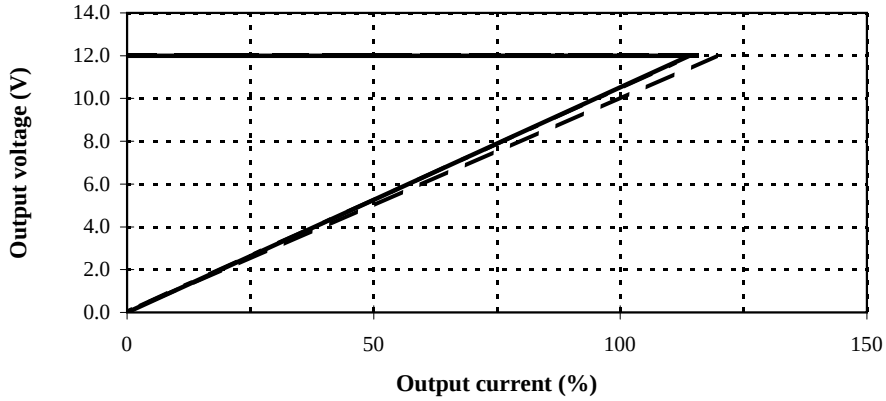
### 2-3 Over current protection (OCP) characteristics

Conditions: Vin : 230VAC
Ta : -25℃ – – – – –
25℃ - · - · - · -
50℃ ———

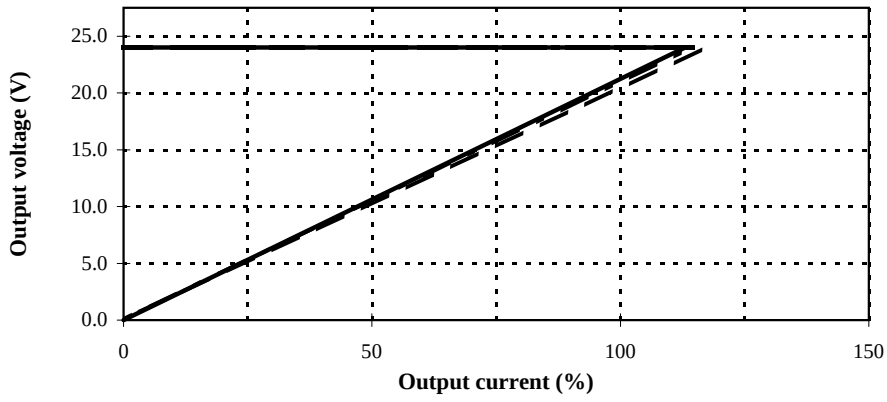
5V




12V



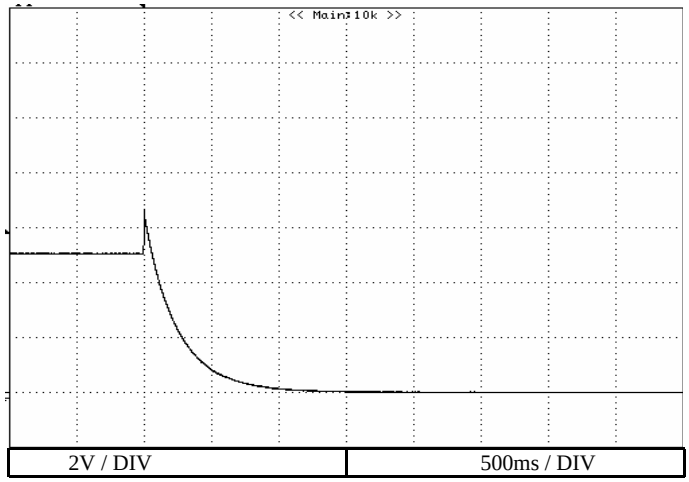

24V



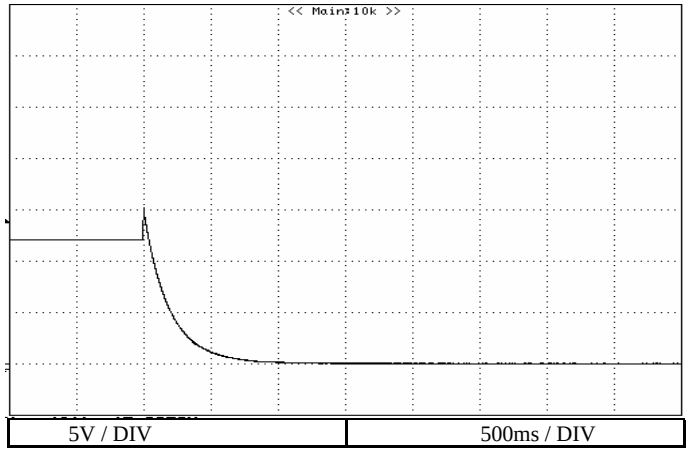
## 2-4 Over voltage protection (OVP) characteristics

Conditions : Ta = 25°C
Vin = 230VAC
Iout = 0%

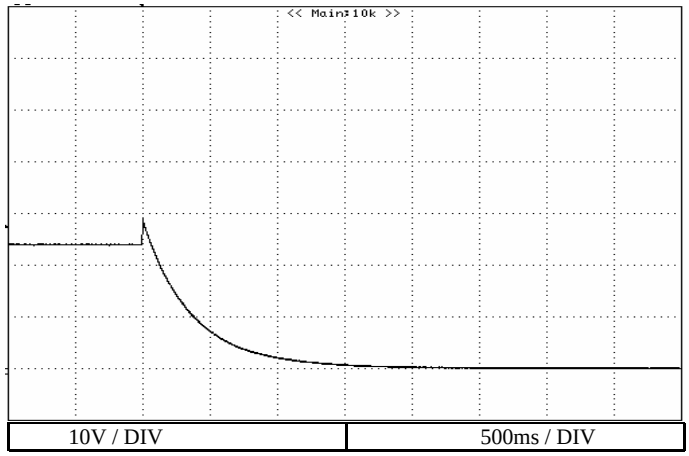
5V




12V



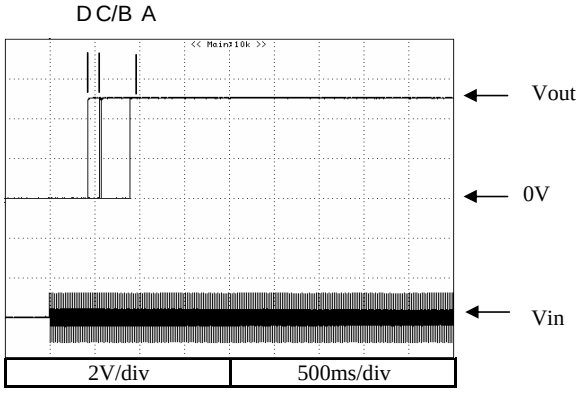

24V



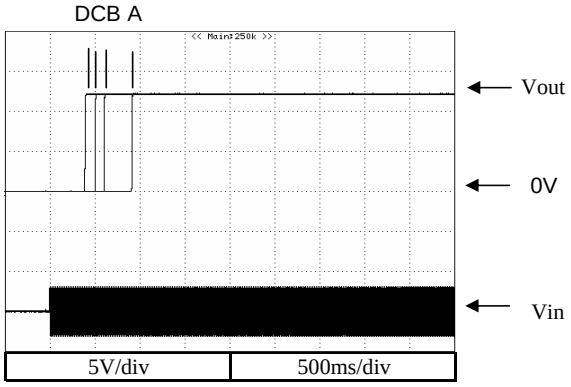
## 2-5 Output Rise Characteristics

Conditions: Vin : 88VAC (A)
: 115VAC (B)
: 230VAC (C)
: 264VAC (D)
Iout : 0%
Ta : 25°C

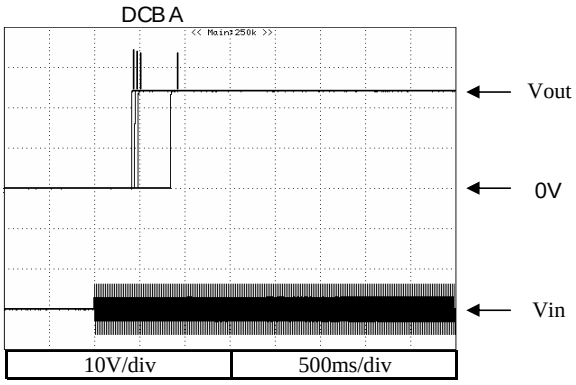
5V




12V



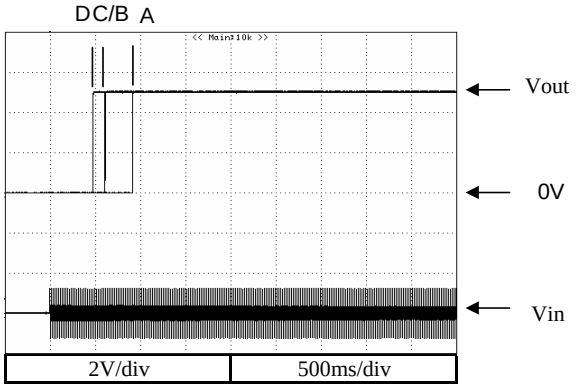

24V



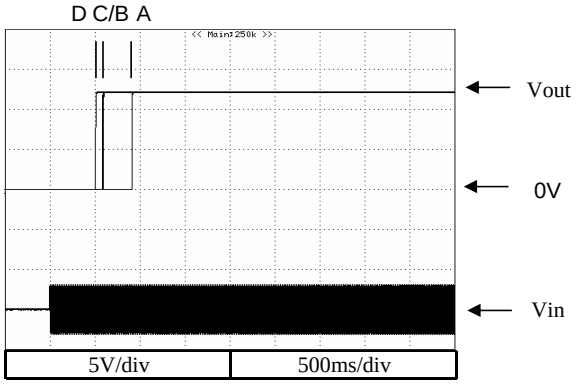
## 2-5 Output Rise Characteristics

Conditions:
Vin : 88VAC (A)
: 115VAC (B)
: 230VAC (C)
: 264VAC (D)
Iout : 100%
Ta : 25°C

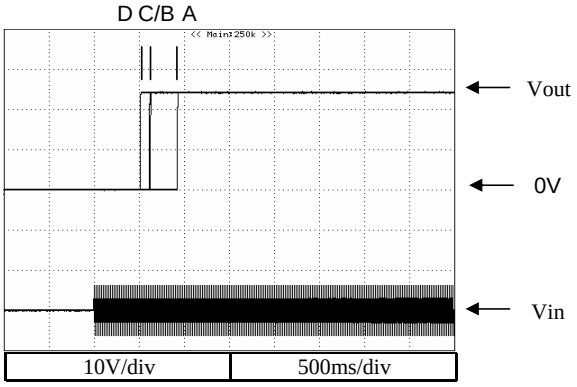
5V




12V



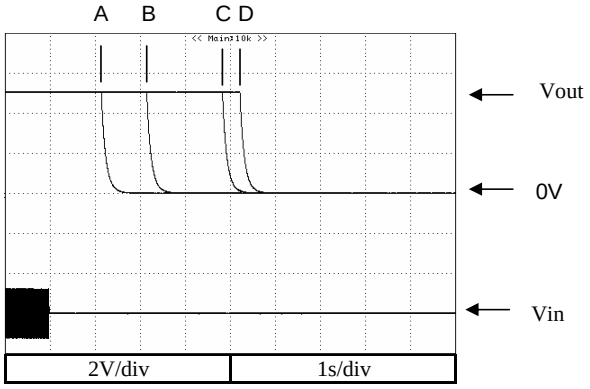

24V



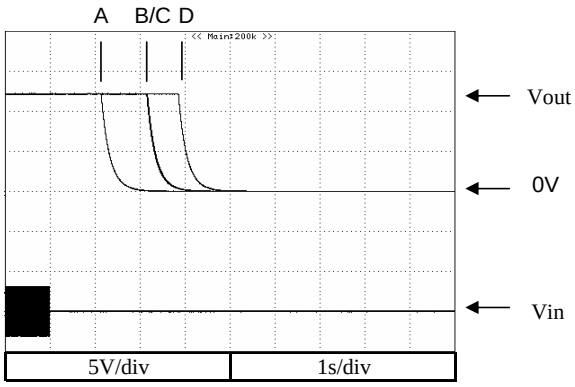
## 2-6 Output Fall Characteristics

Conditions: Vin : 88VAC (A)
: 115VAC (B)
: 230VAC (C)
: 264VAC (D)
Iout : 0%
Ta : 25°C

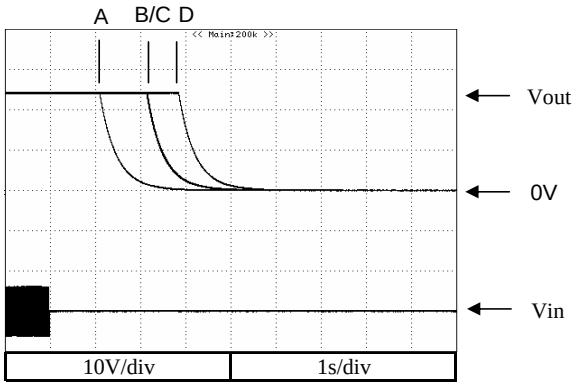
5V




12V



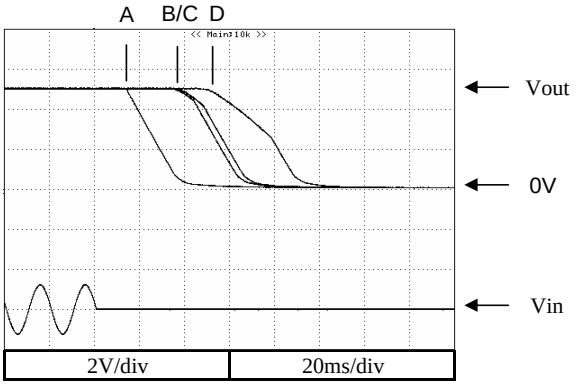

24V



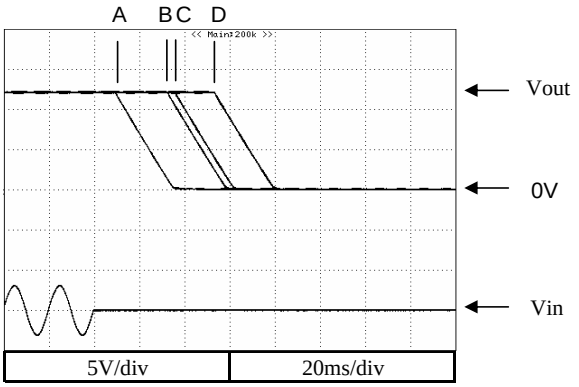
## 2-6 Output Fall Characteristics

Conditions: Vin : 88VAC (A)
: 115VAC (B)
: 230VAC (C)
: 264VAC (D)
Iout : 100%
Ta : 25°C

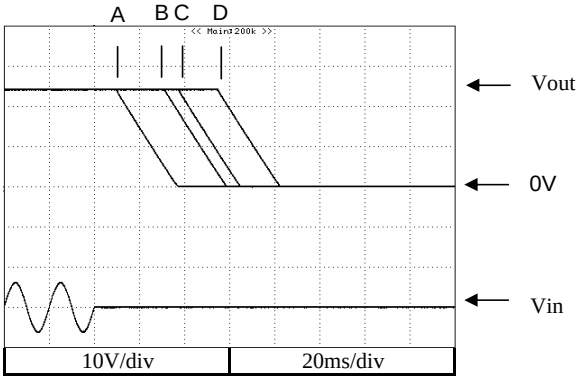
5V




12V



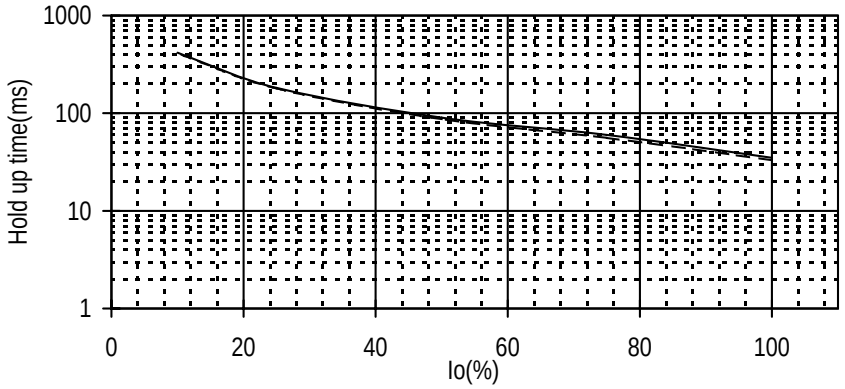

24V



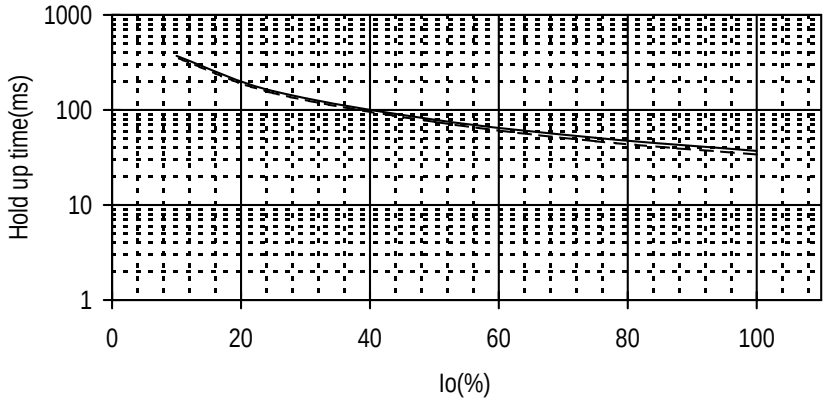
## 2-7 Hold Up Time Characteristics

Conditions Vin: 115VAC - - - - - - - -
230VAC ————
Ta: 25°C

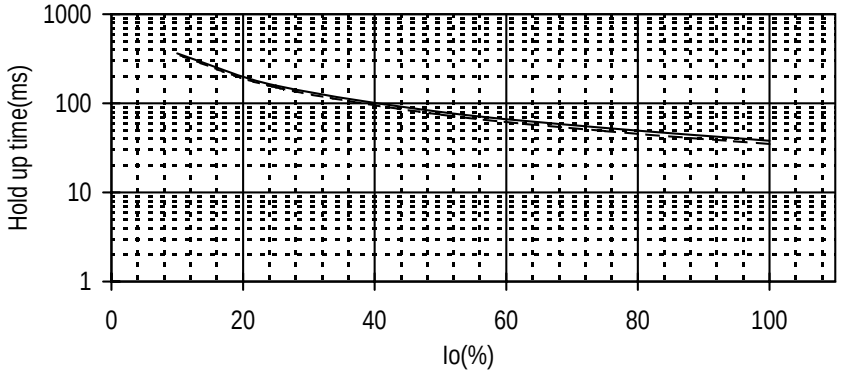
5V




12V



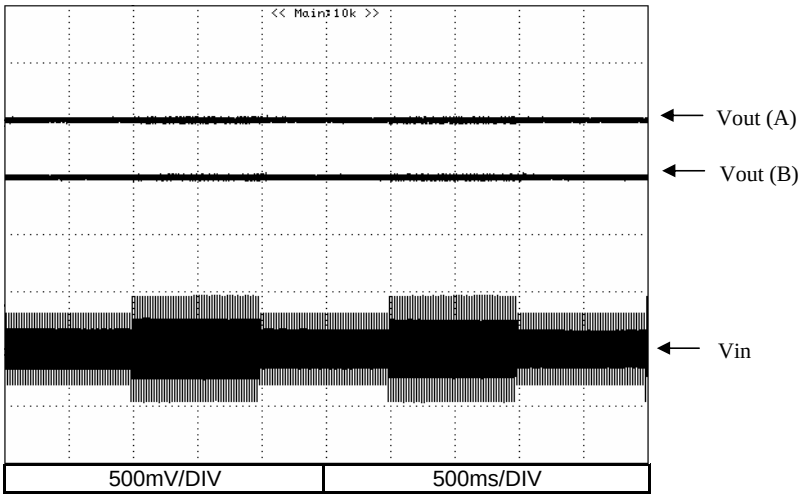

24V



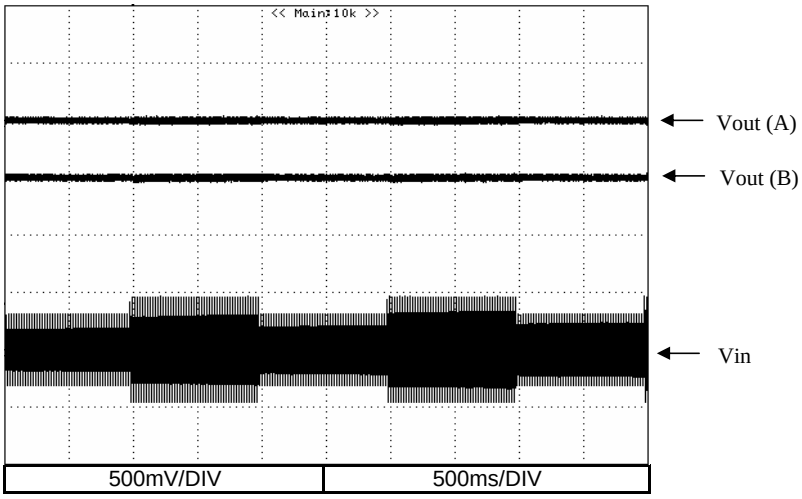
## 2-8 Dynamic Line Response Characteristics

Conditions : Vin = 88 <=>132 VAC (A)
= 170<=>264 VAC (B)
Iout = 100%
Ta = 25°C

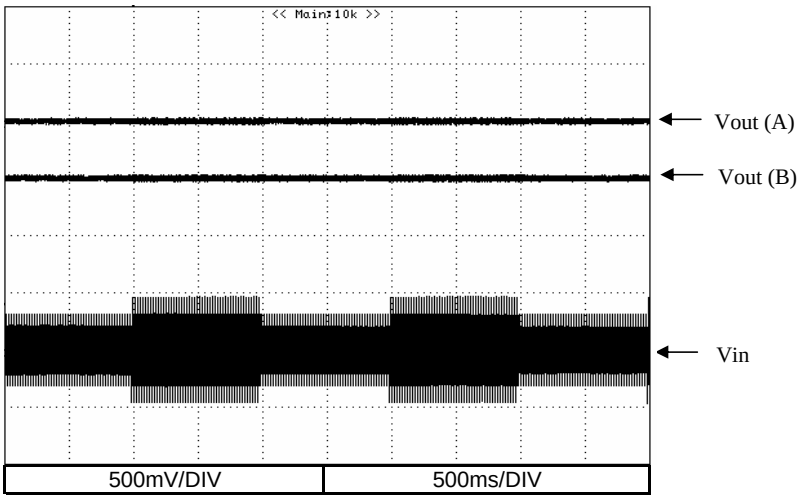
5V




12V




24V

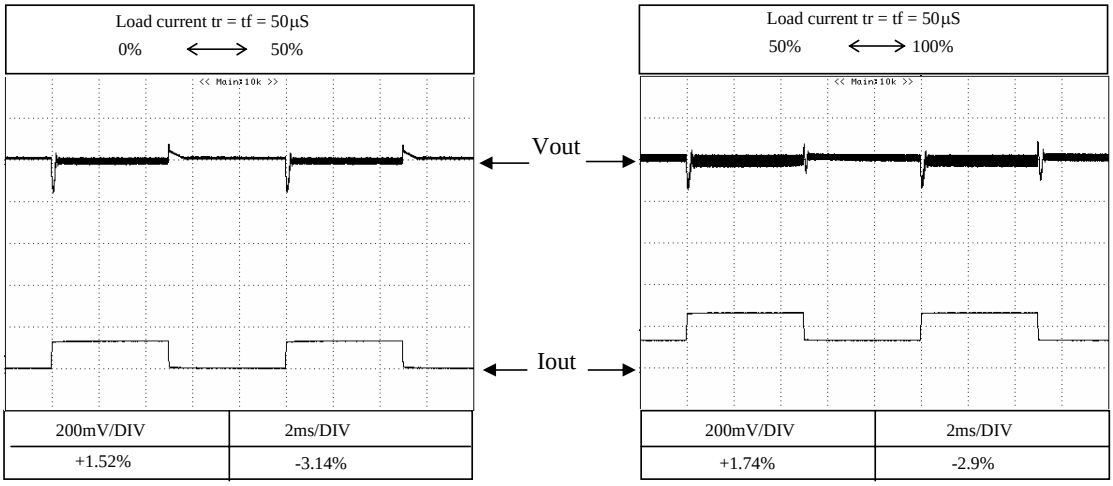


## 2-9 Dynamic Load Response Characteristics

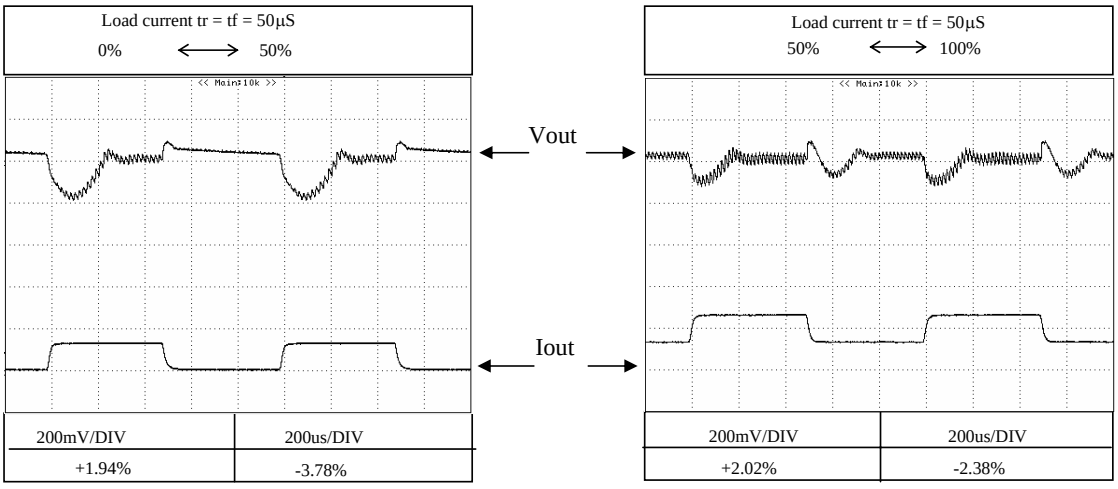
Conditions Vin = 115VAC
Ta = 25°C

5V

f=100Hz




f=1KHz

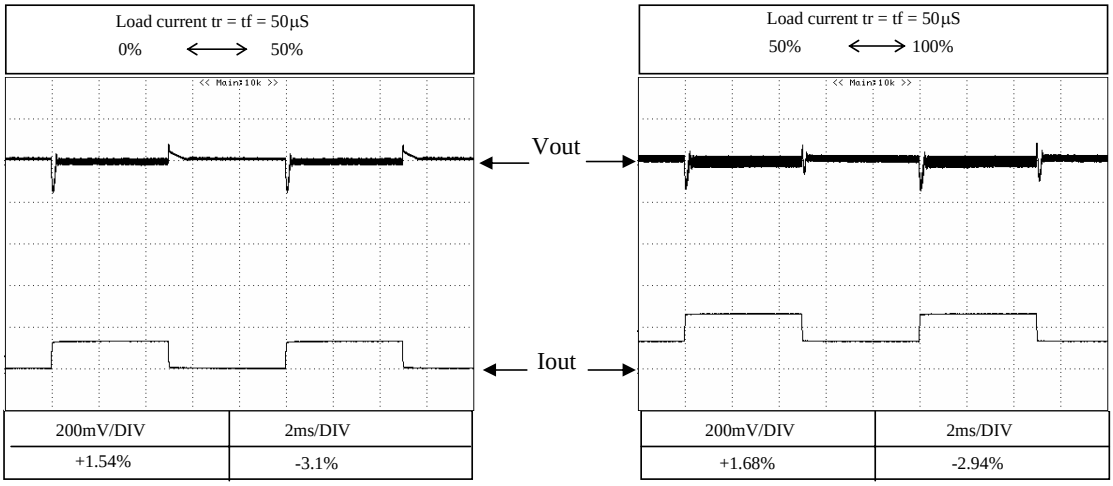


## 2-9 Dynamic Load Response Characteristics

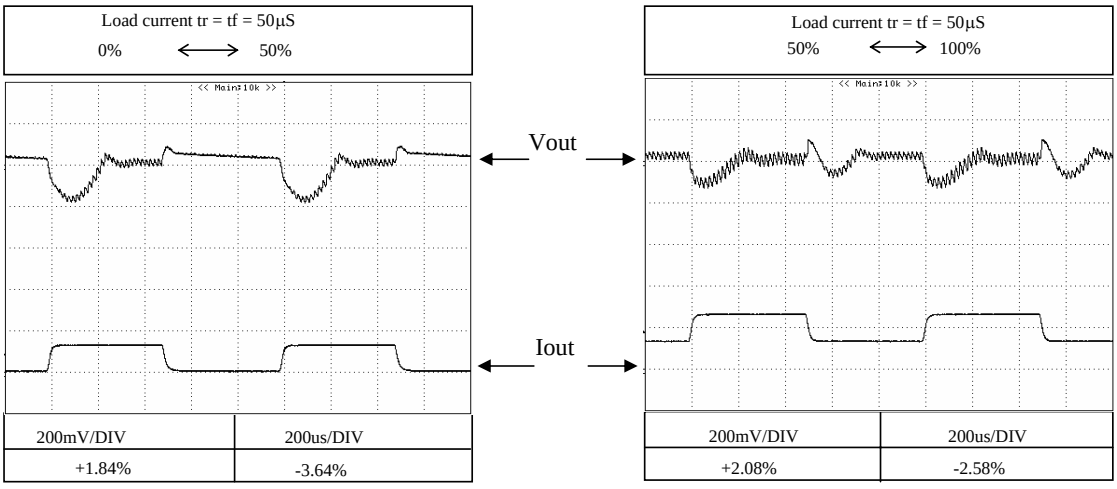
Conditions Vin = 230VAC
Ta = 25°C

5V

f=100Hz




f=1KHz

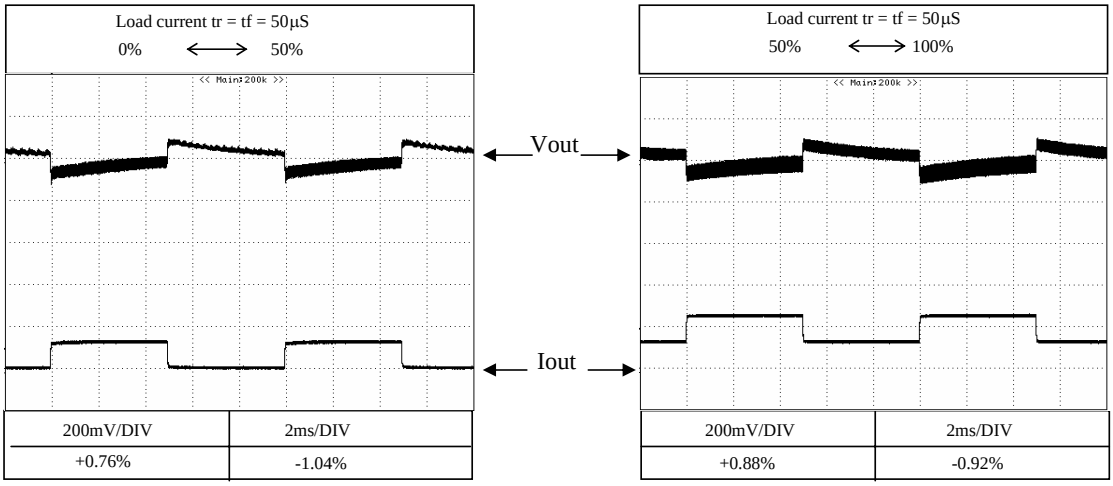


## 2-9 Dynamic Load Response Characteristics

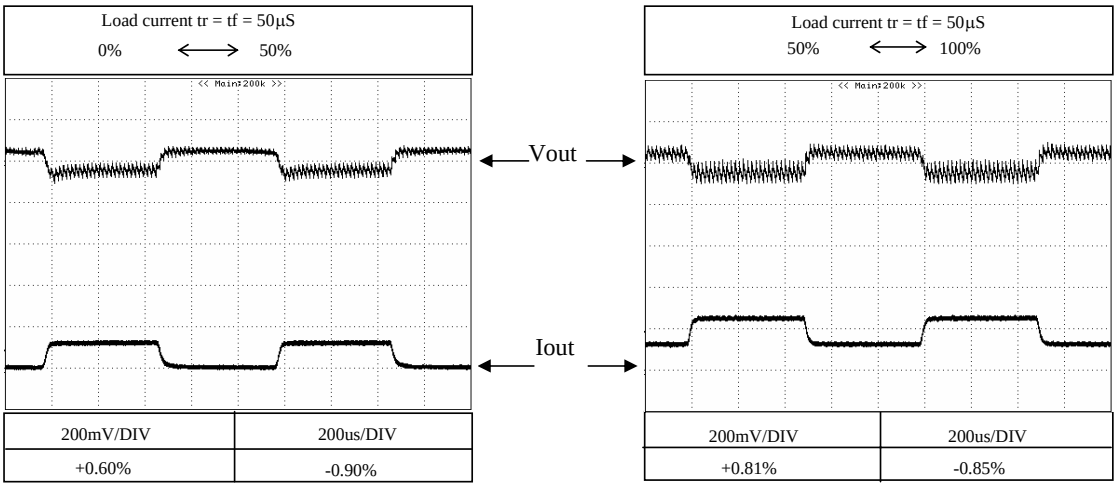
Conditions Vin = 115VAC
Ta = 25°C

12V

f=100Hz




f=1KHz

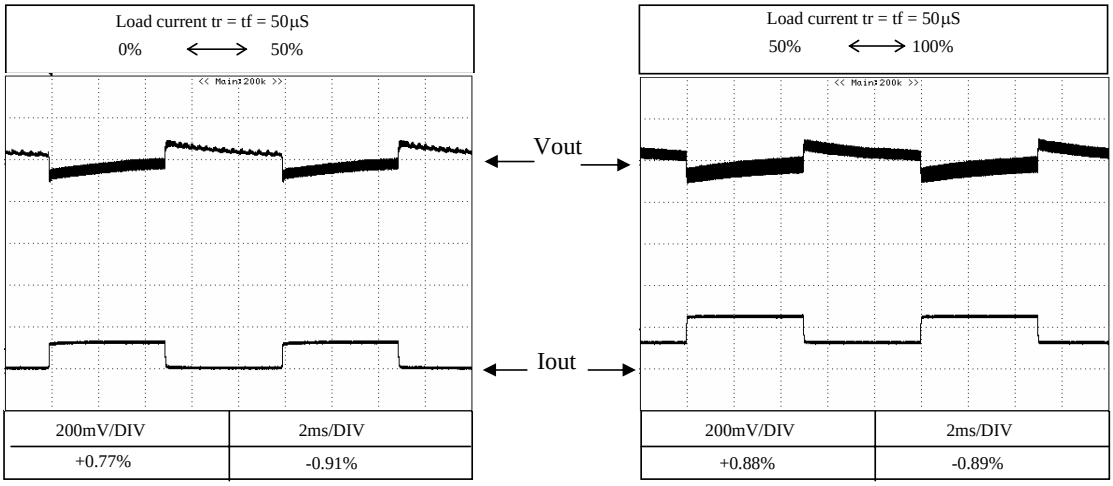


## 2-9 Dynamic Load Response Characteristics

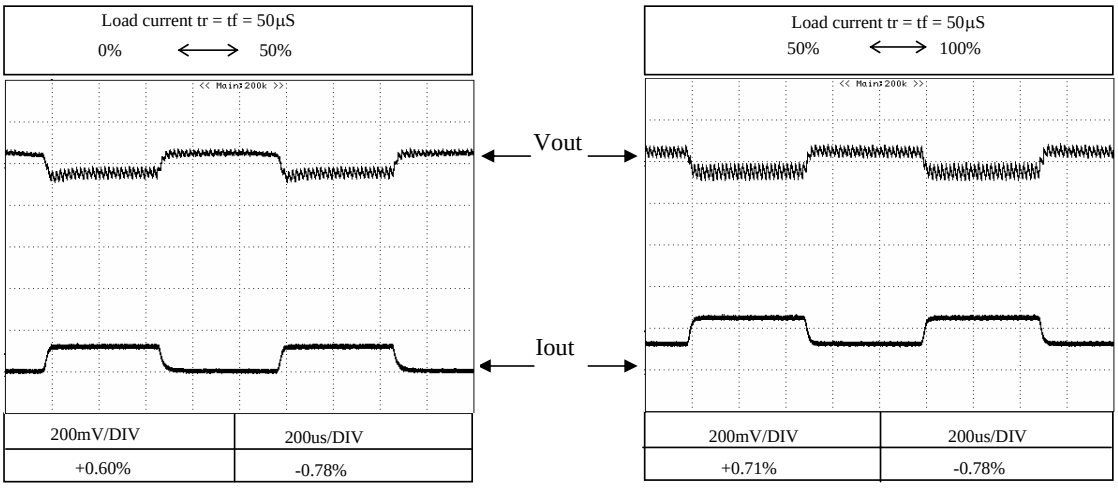
Conditions Vin = 230VAC
Ta = 25°C

12V

f=100Hz




f=1KHz

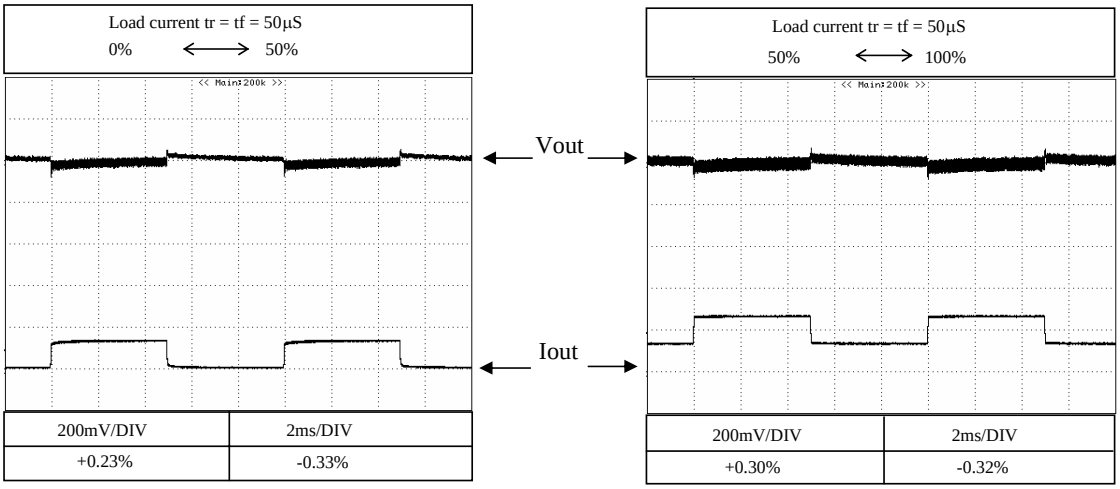


## 2-9 Dynamic Load Response Characteristics

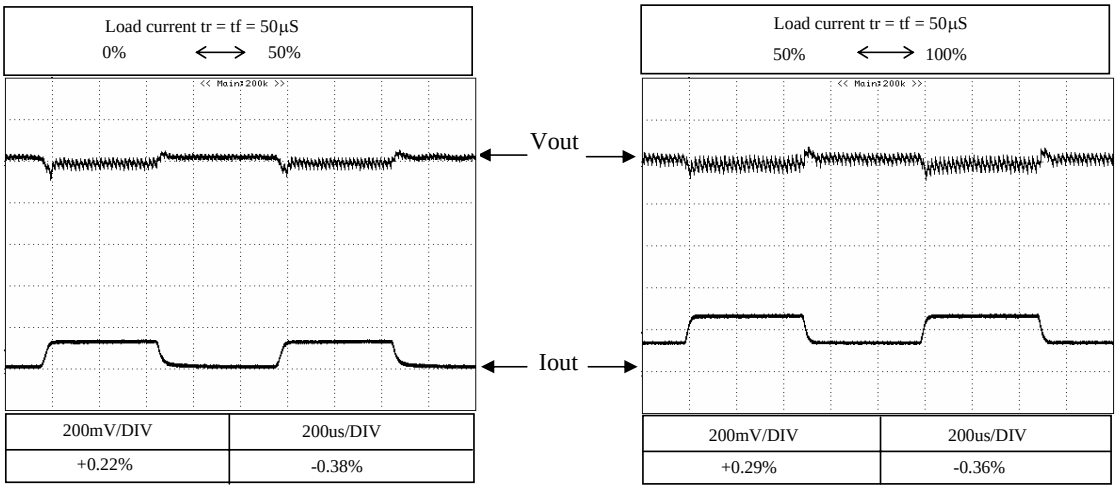
Conditions Vin = 115VAC
Ta = 25°C

24V

f=100Hz




f=1KHz

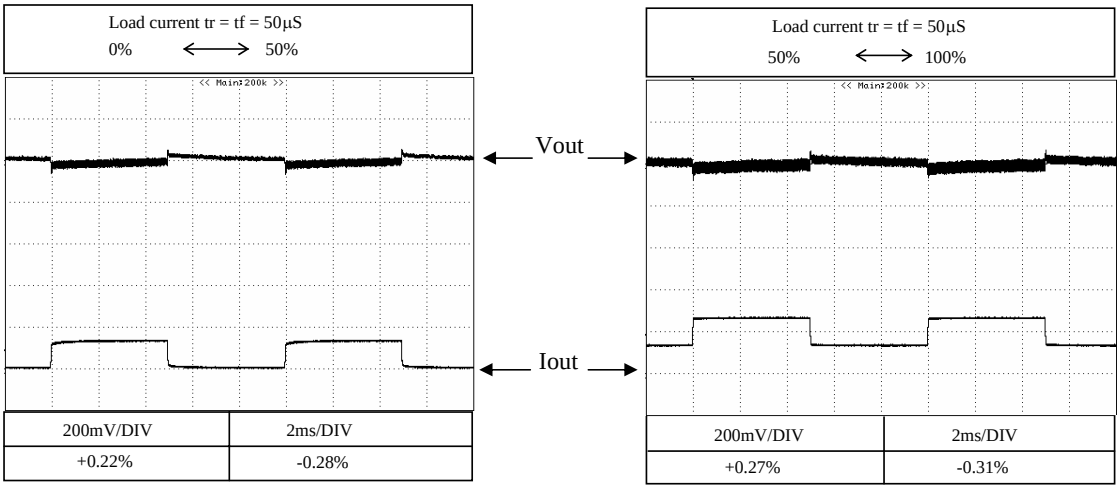


## 2-9 Dynamic Load Response Characteristics

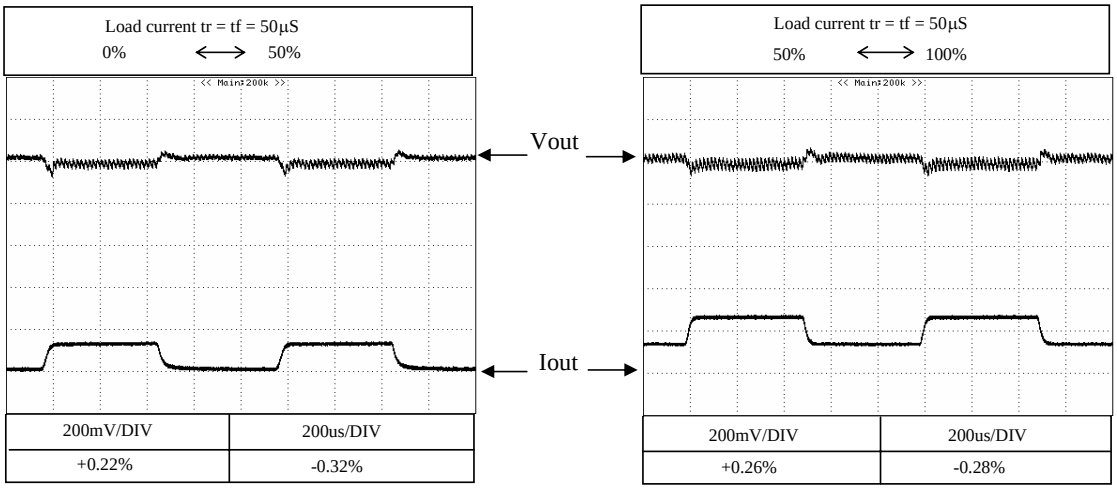
Conditions Vin = 230VAC
Ta = 25°C

24V

f=100Hz




f=1KHz

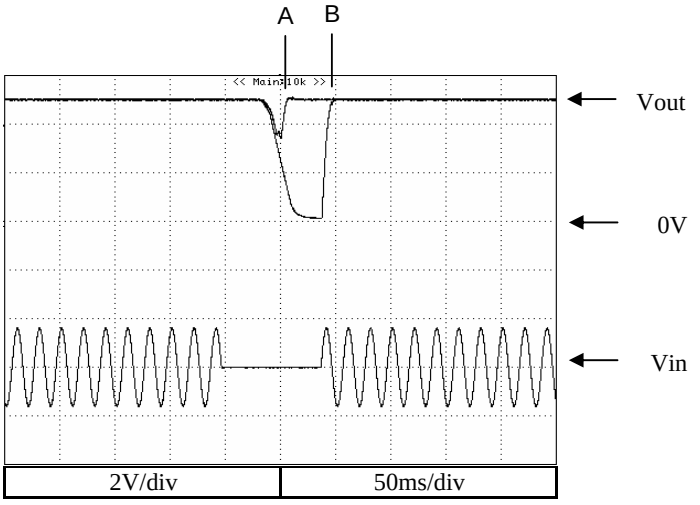


## 2-10 Response to Brown Out Characteristics

Conditions: Vin : 115VAC
Iout : 100%
Ta : 25°C

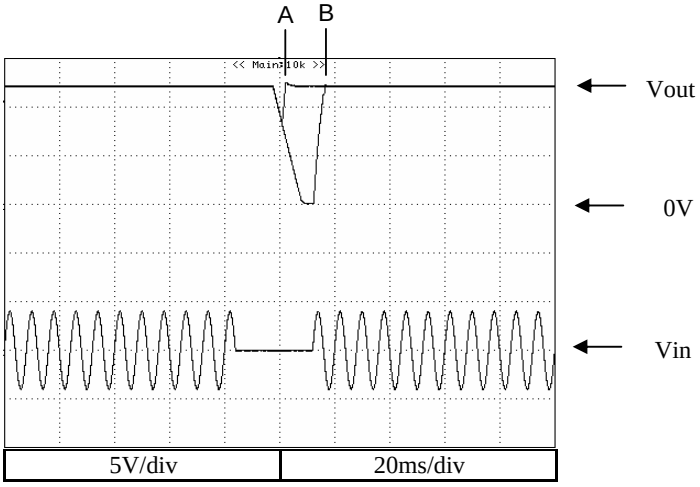
### 5V

A = 20ms
B = 60ms



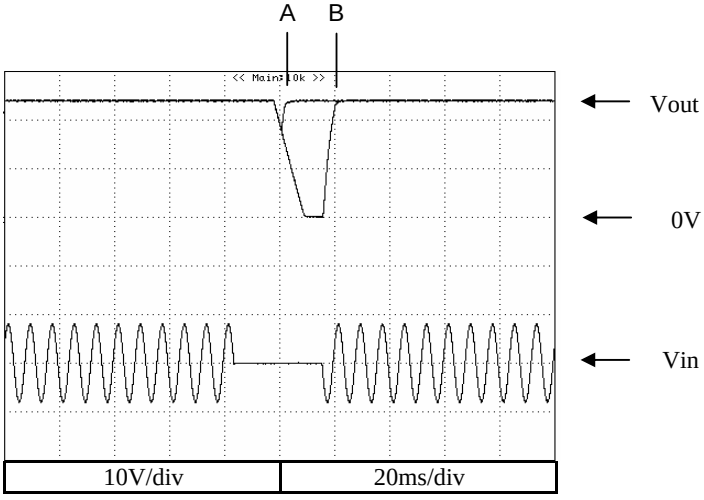

### 12V

A = 51ms
B = 89ms




### 24V

A = 41ms
B = 78ms

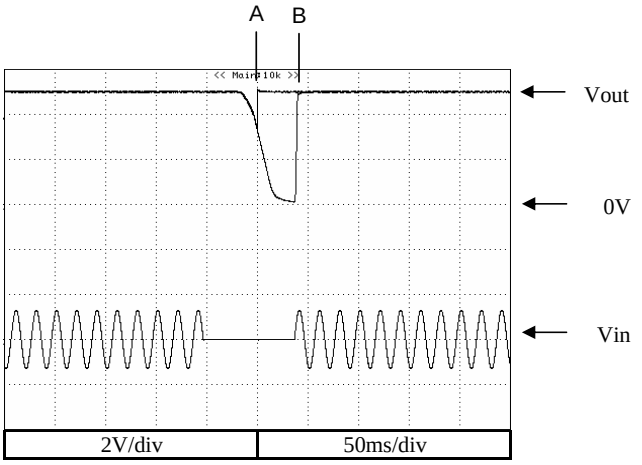


**2-10 Response to Brown Out Characteristics**

Conditions: Vin : 230VAC
Iout : 100%
Ta : 25°C

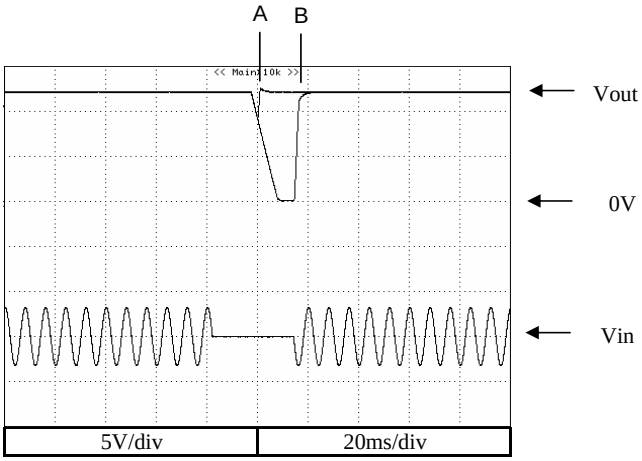
5V

A = 51ms
B = 90ms



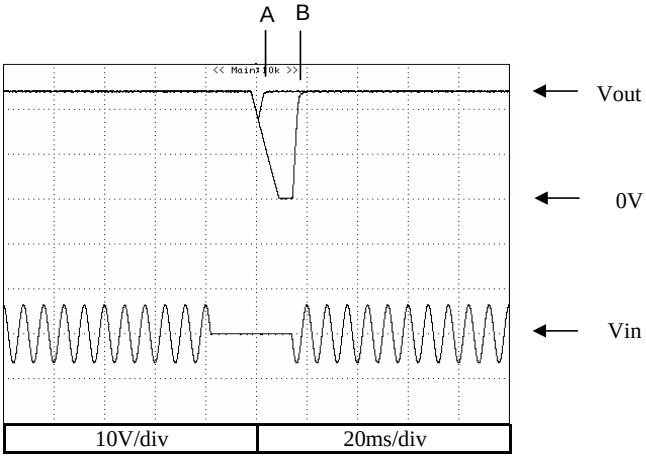

12V

A = 44ms
B = 88ms




24V

A = 46ms
B = 79ms

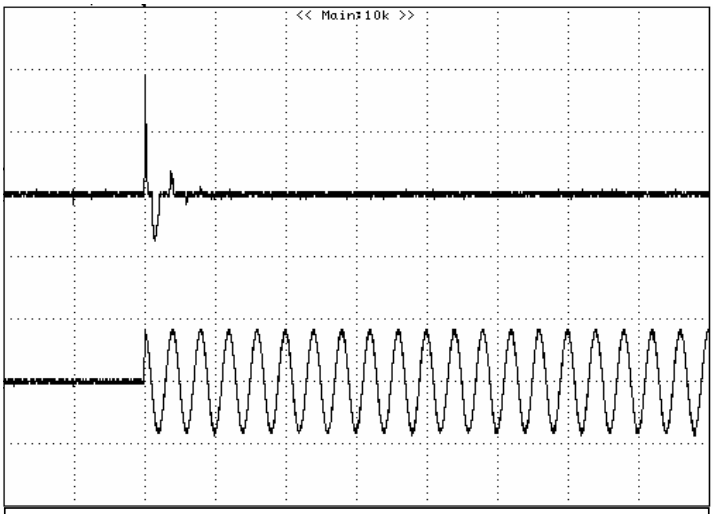


## 2-11 Inrush Current

Conditions : Vin = 115Vac
Iout = 100%
Ta = 25°C

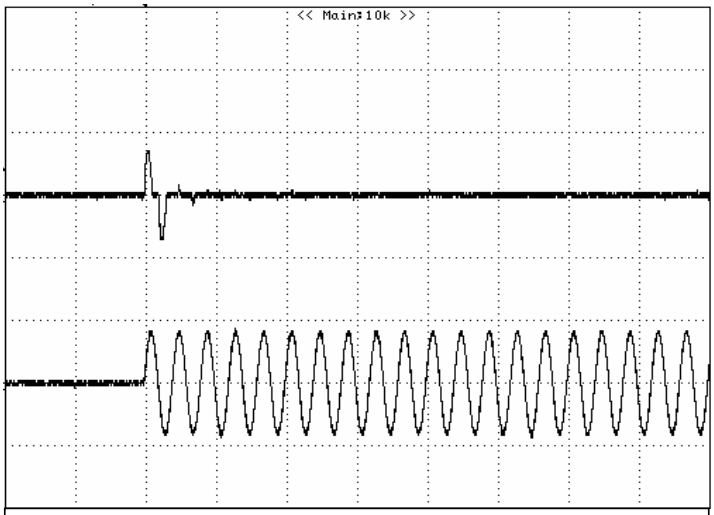
5V

Φ = 90°




| 38.33 A | |
|---|---|
| 20A/DIV | 50mS/DIV |

Φ = 0°



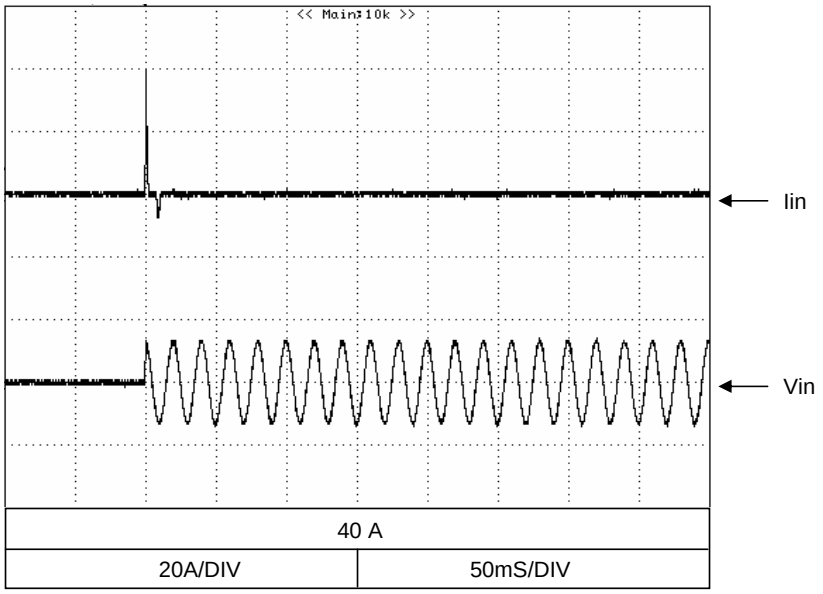

| 14.67 A | |
|---|---|
| 20A/DIV | 50mS/DIV |

## 2-11 Inrush Current

Conditions : Vin = 230Vac
Iout = 100%
Ta = 25°C

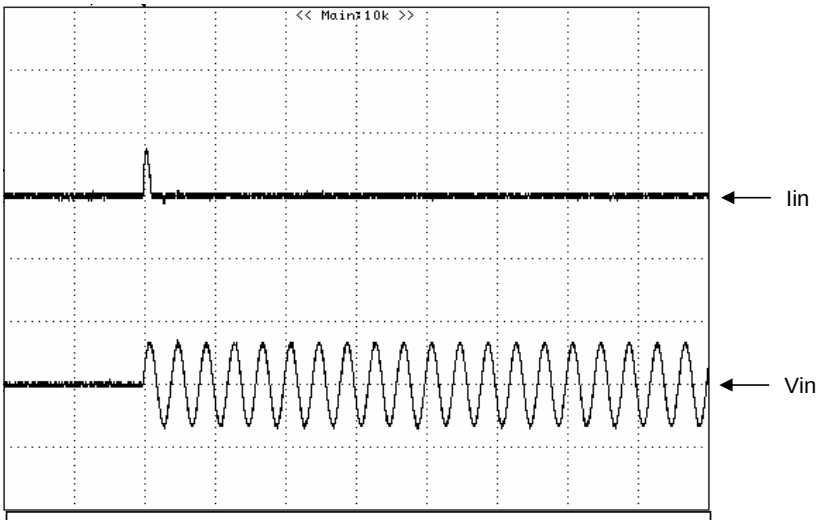
5V

Φ = 90°




| 40 A | |
|---|---|
| 20A/DIV | 50mS/DIV |

Φ = 0°

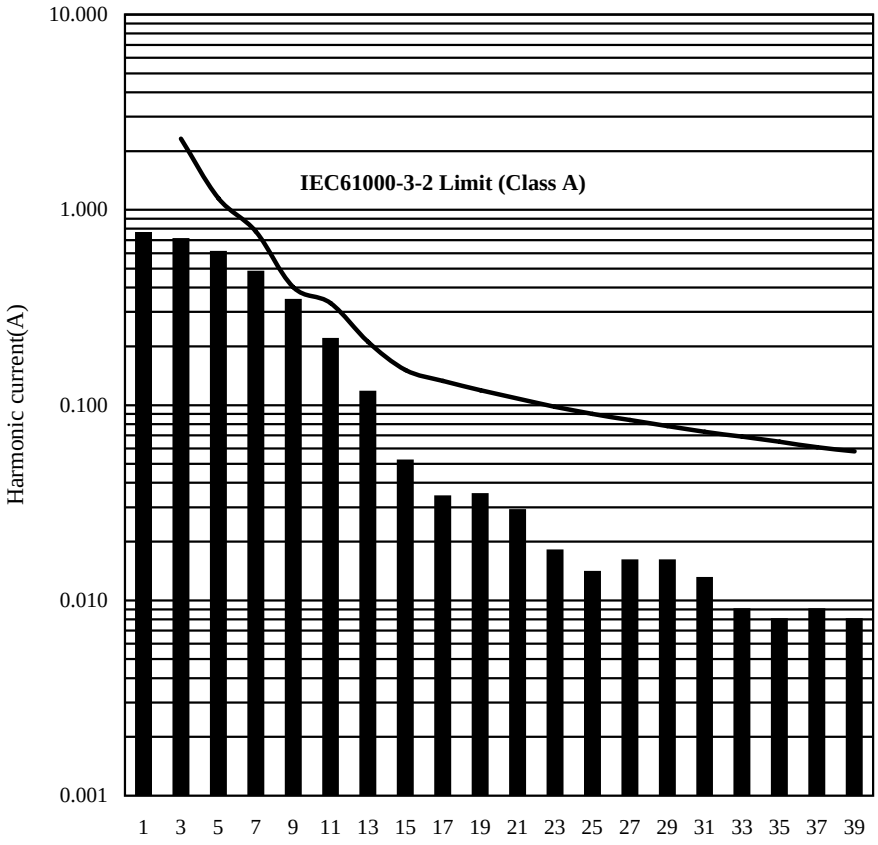



| 15 A | |
|---|---|
| 20A/DIV | 50mS/DIV |

## 2-12 Input Current Harmonics

Conditions : Vin = 230VAC
Iout = 100%
Ta = 25°C
f = 60Hz

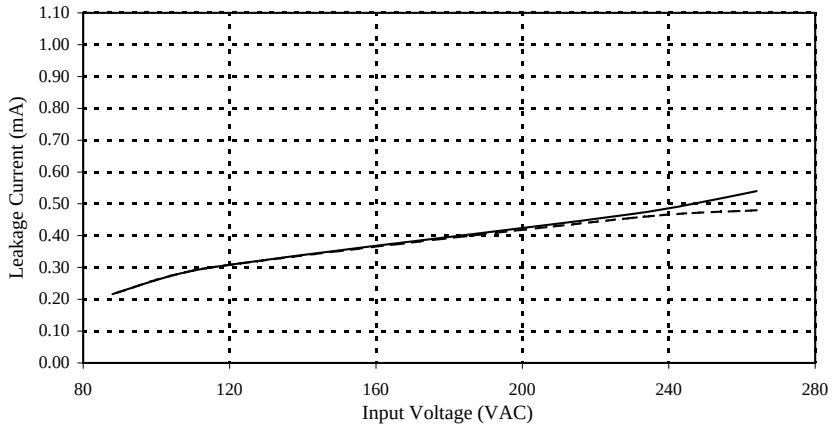
12V



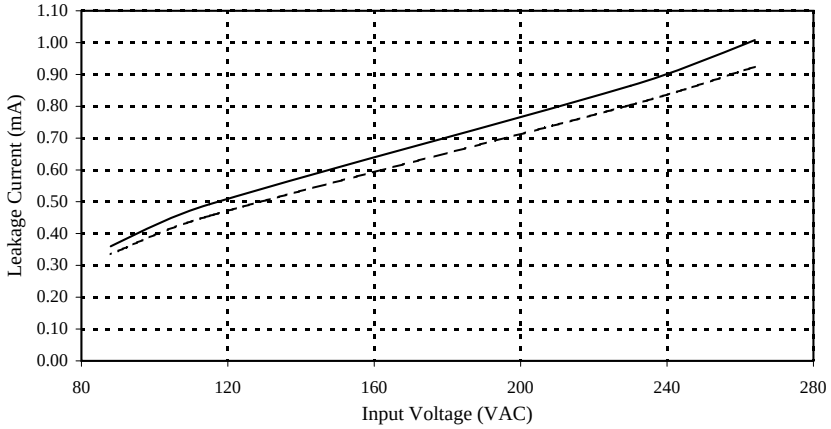
## 2-13 Leakage Current Characteristics

Conditions : Iout = 0% ——
= 100% - - - - - -
Ta = 25°C
f = 50Hz

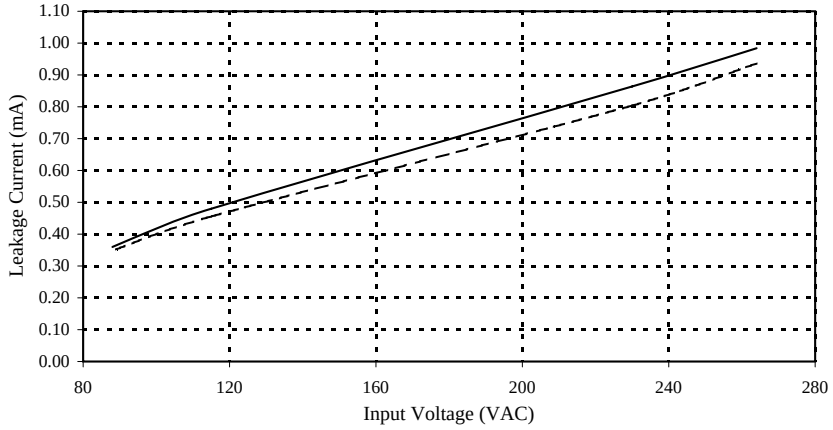
5V




12V




24V

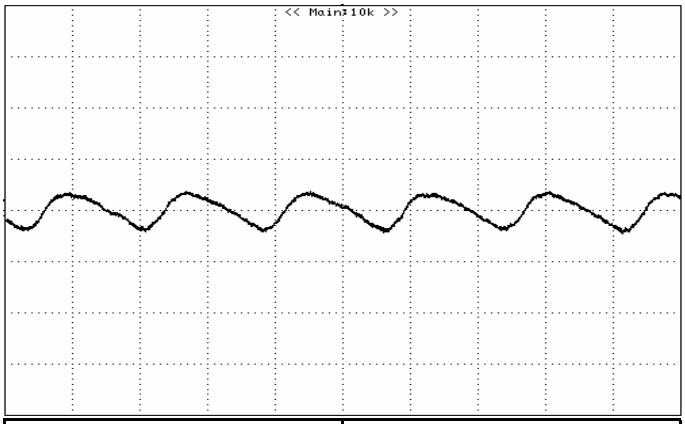


## 2-14 Output Ripple And Noise Waveform

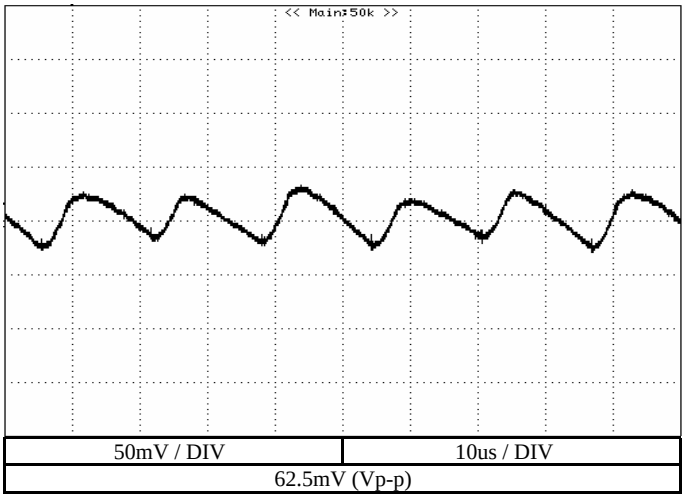
Conditions Vin = 230VAC
Iout = 100%
Ta = 25°C

**NORMAL MODE**

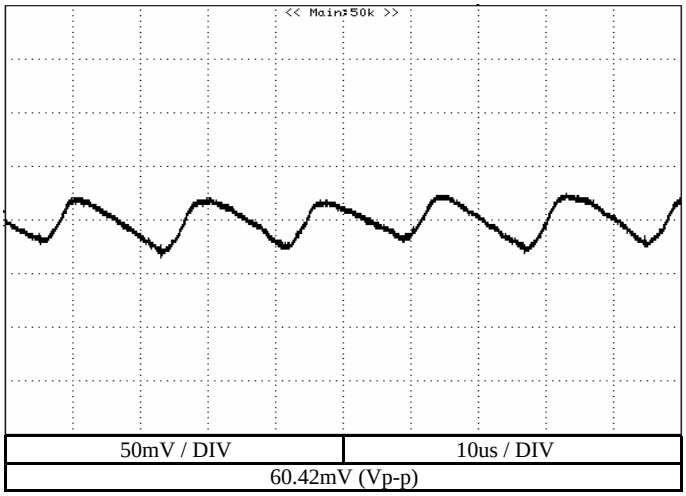
5V




12V




24V

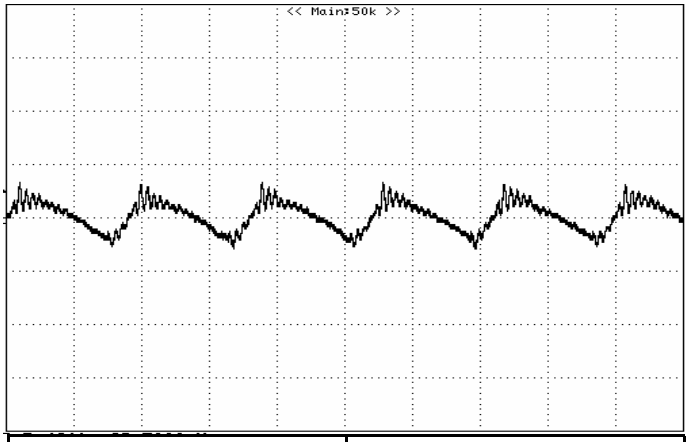


## 2-14 Output Ripple And Noise Waveform

Conditions Vin = 230VAC
Iout = 100%
Ta = 25°C

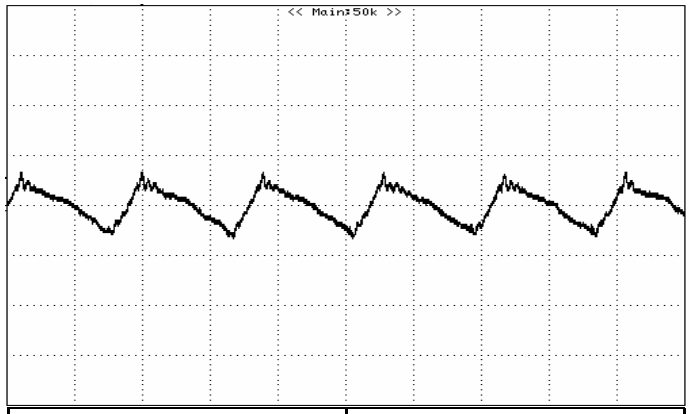
**NORMAL + COMMON MODE**

5V



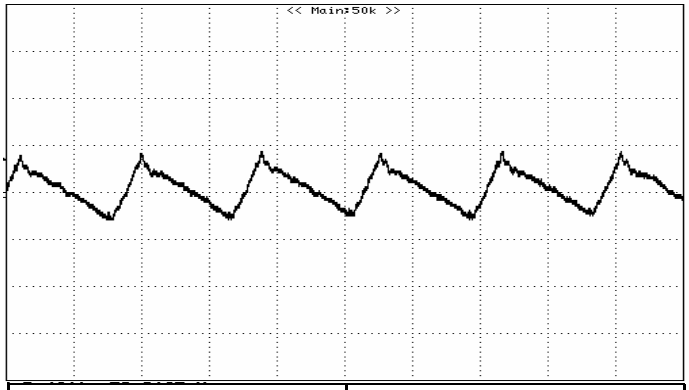

| 50mV / DIV | 10us / DIV |
|---|---|
| 62.5mV (Vp-p) | |

12V




| 50mV / DIV | 10us / DIV |
|---|---|
| 66.67mV (Vp-p) | |

24V




| 50mV / DIV | 10us / DIV |
|---|---|
| 72.92mV (Vp-p) | |

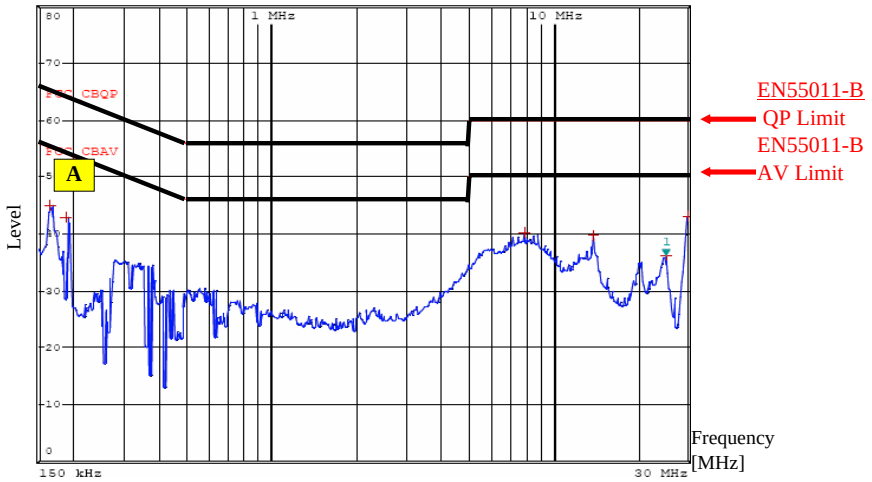
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 115VAC
Iout : 100%

### Conducted Emission

5V

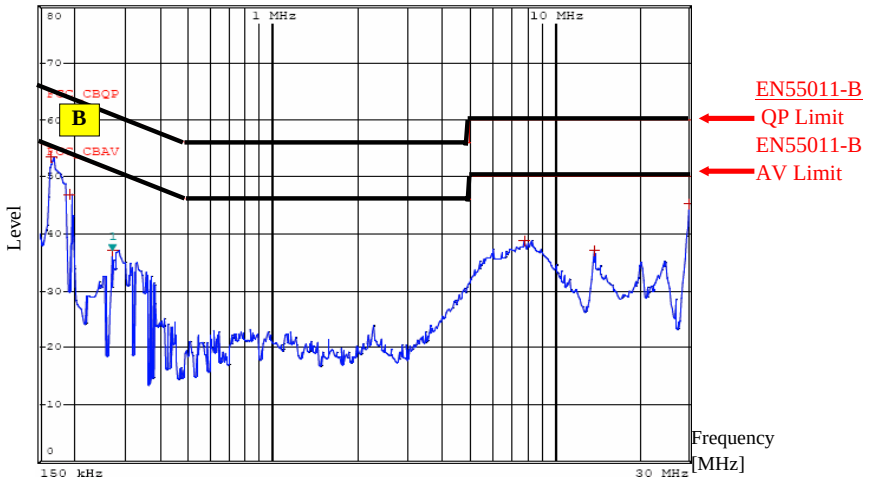
[dB(u V / m)]




Phase : N

| Ref. / Data | Point A (0.166MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 65.16 | 45.26 |
| AV | 55.16 | 39.01 |

[dB(u V / m)]




Phase : L

| Ref. / Data | Point B (0.165MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 65.21 | 52.73 |
| AV | 55.21 | 47.09 |

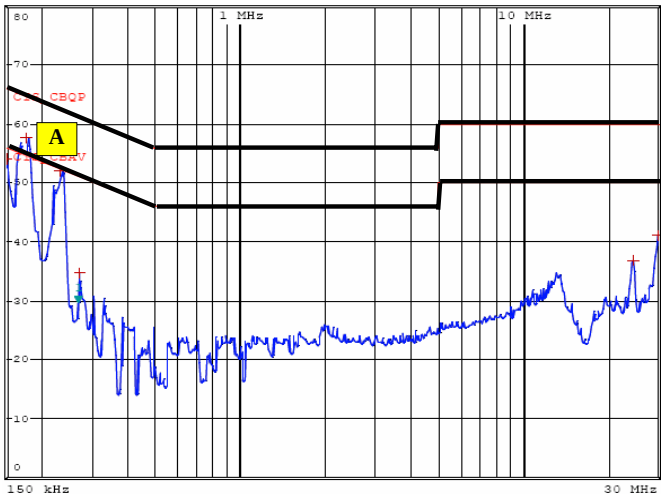
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 230VAC
Iout : 100%

### Conducted Emission

5V

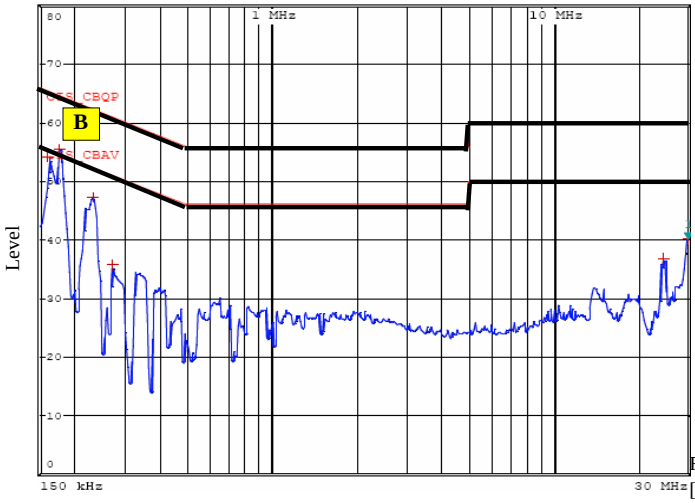
[dB(u V / m)]




Phase : N

| Ref. / Data | Point A (0.178MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.58 | 55.47 |
| AV | 54.58 | 39.36 |

[dB(u V / m)]




Phase : L

| Ref. / Data | Point B (0.163MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 65.31 | 53.62 |
| AV | 55.31 | 39.08 |

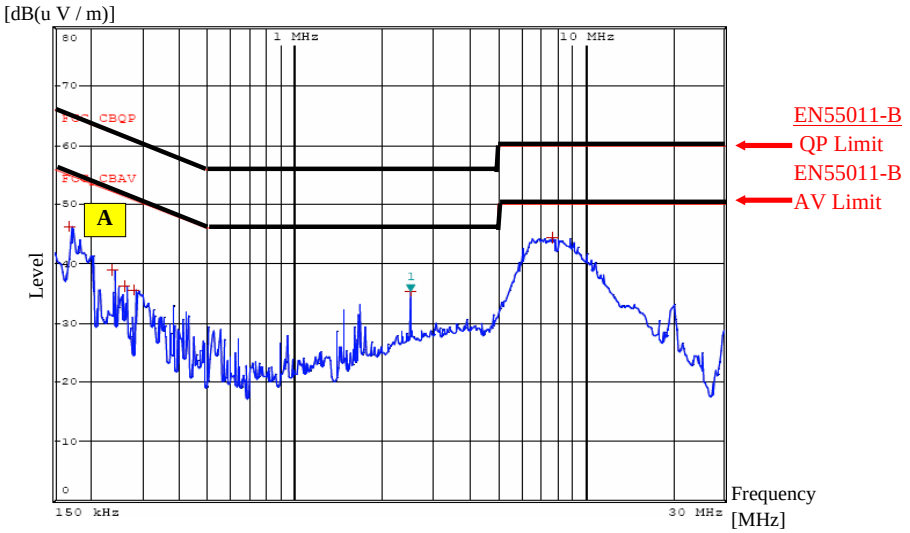
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 115VAC
Iout : 100%

### Conducted Emission

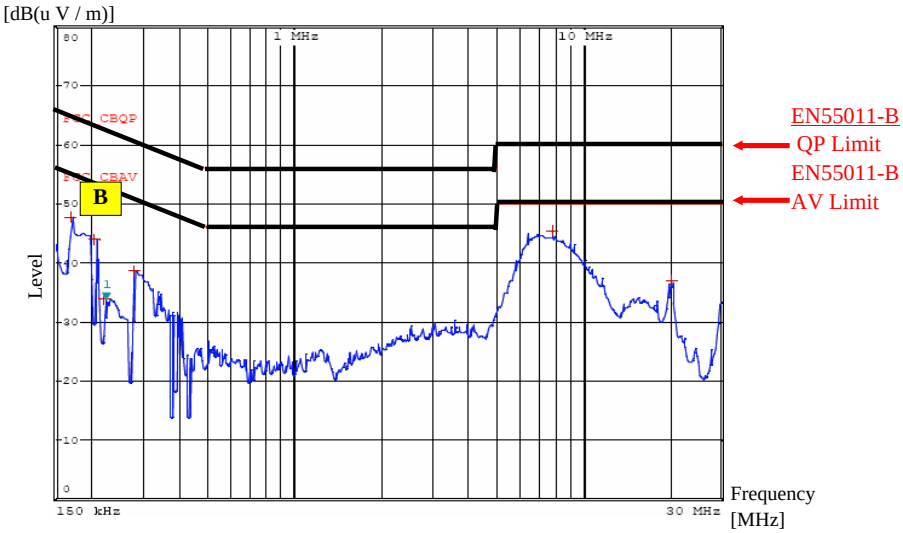
12V

Phase : N




| Ref. Data | Point A (0.17MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.96 | 43.78 |
| AV | 54.96 | 37.49 |

Phase : L




| Ref. Data | Point B (0.173 MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.82 | 46.62 |
| AV | 54.82 | 39.42 |

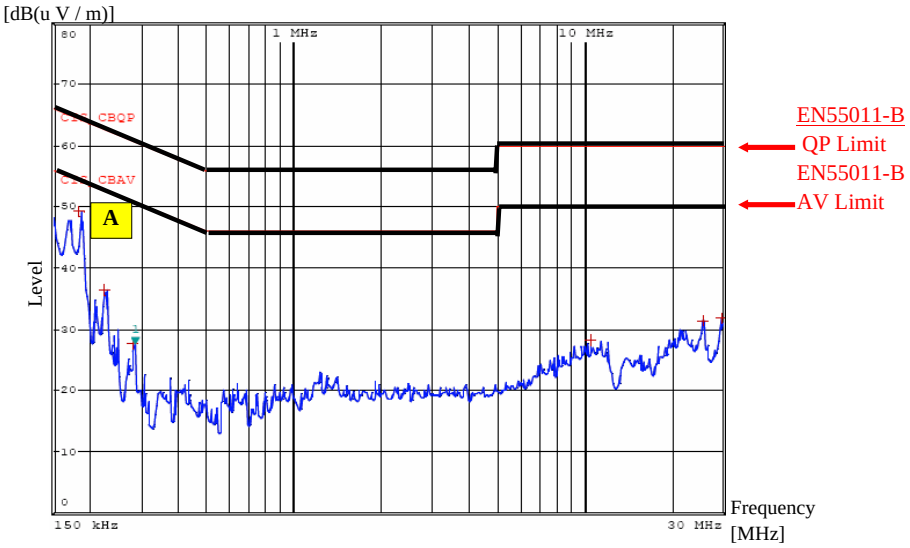
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 230VAC
Iout : 100%

### Conducted Emission

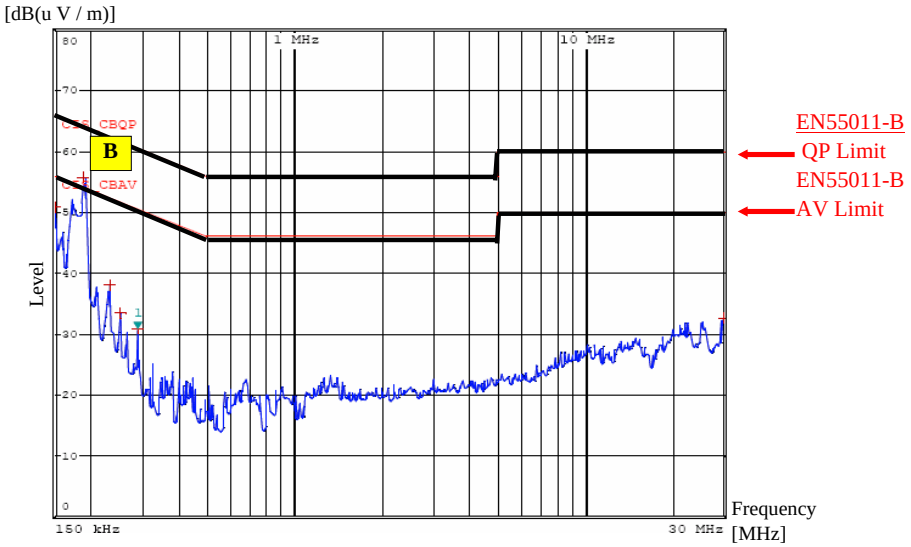
12V

Phase : N




| Ref. / Data | Point A (0.187 MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.17 | 46.24 |
| AV | 54.17 | 29.44 |

Phase : L




| Ref. / Data | Point B (0.189MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.08 | 54.58 |
| AV | 54.08 | 35.35 |

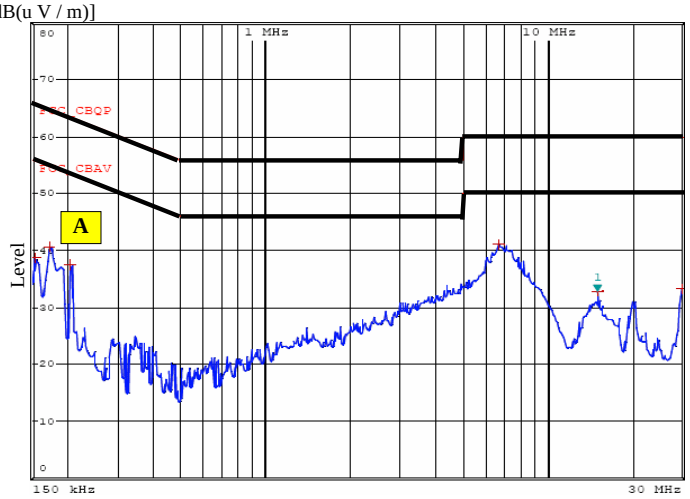
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 115VAC
Iout : 100%

### Conducted Emission

24V

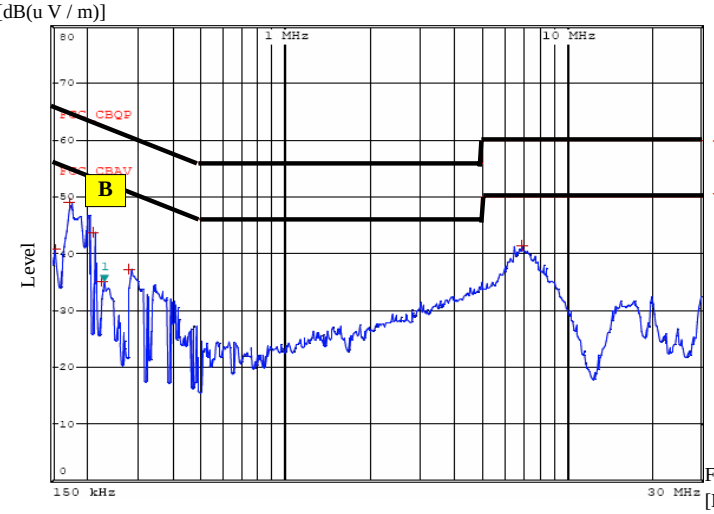
[dB(u V / m)]




Phase : N

| Ref. Data | Point A (0.173 MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.82 | 38.72 |
| AV | 54.82 | 32.79 |

[dB(u V / m)]




Phase : L

| Ref. Data | Point B (0.174 MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.77 | 47.89 |
| AV | 54.77 | 41.09 |

## 2-15 Electro-Magnetic Interference characteristics

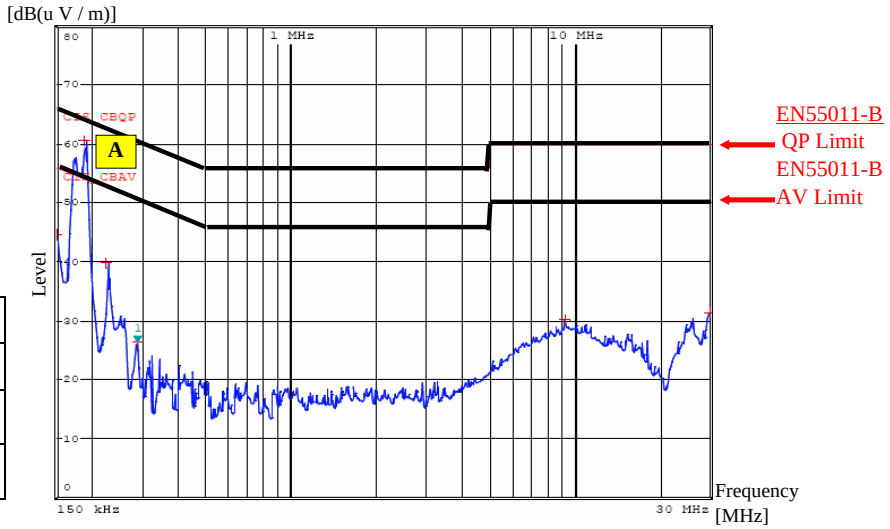
Conditions: Vin : 230VAC
Iout : 100%

### Conducted Emission

24V

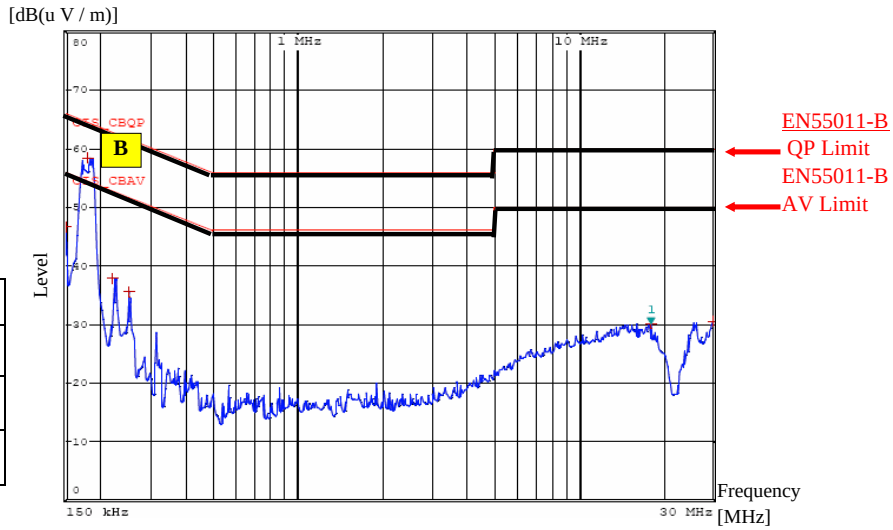
Phase : N

| Ref. / Data | Point A (0.189MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.08 | 58.83 |
| AV | 54.08 | 39.51 |




Phase : L

| Ref. / Data | Point B (0.186MHz) Limit (dBµV) | Measure (dBµV) |
|---|---|---|
| QP | 64.21 | 58.46 |
| AV | 54.21 | 39.35 |



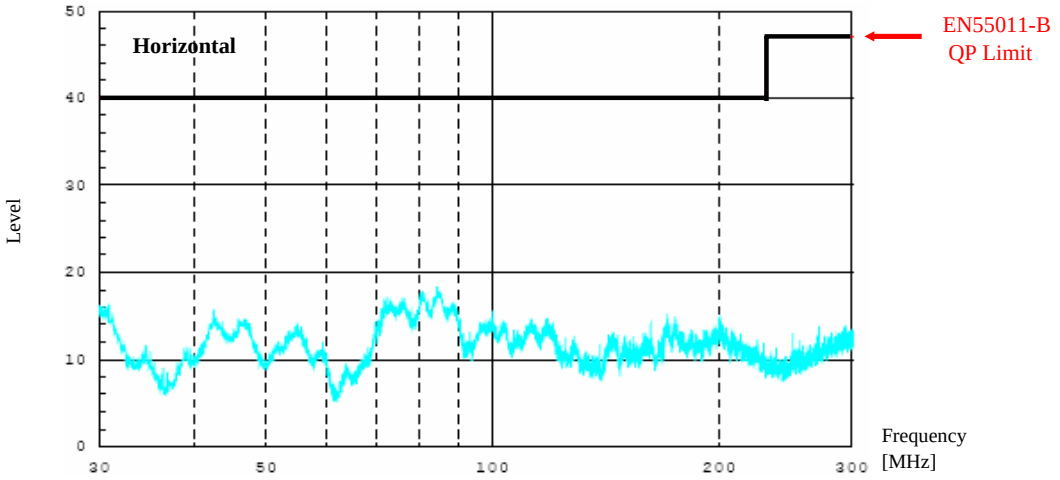
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 115VAC
Iout : 100%

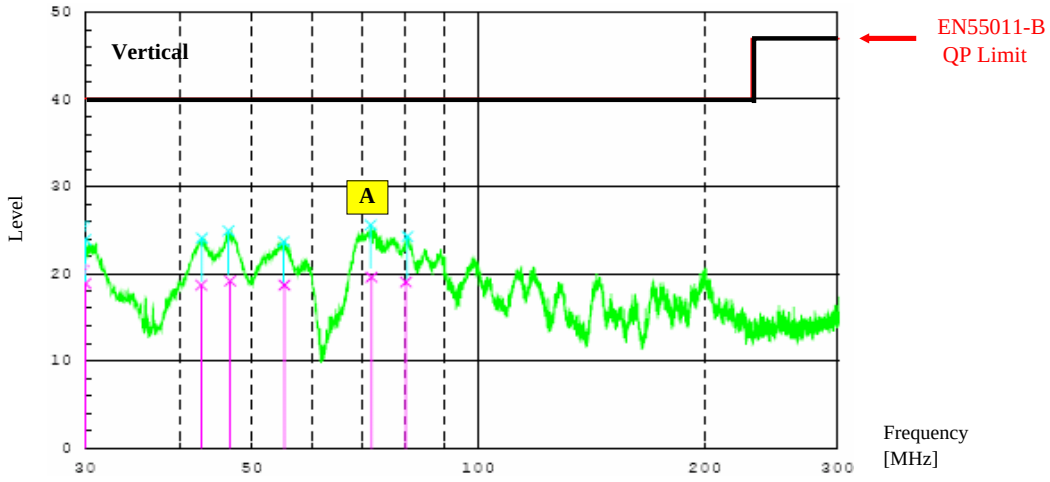
### Radiated Emission

5V

[dB(u V / m)]




[dB(u V / m)]



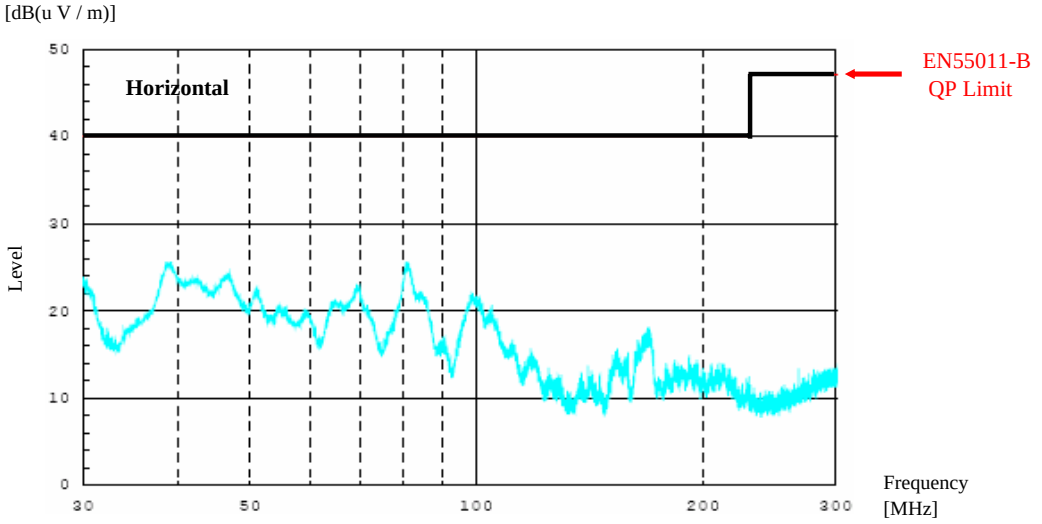

| Point A (72.024MHz) | | |
|---|---|---|
| Limit (dBμV/m) | Measure (dBμV/m) | (P) |
| 40.0 | 19.6 | V |

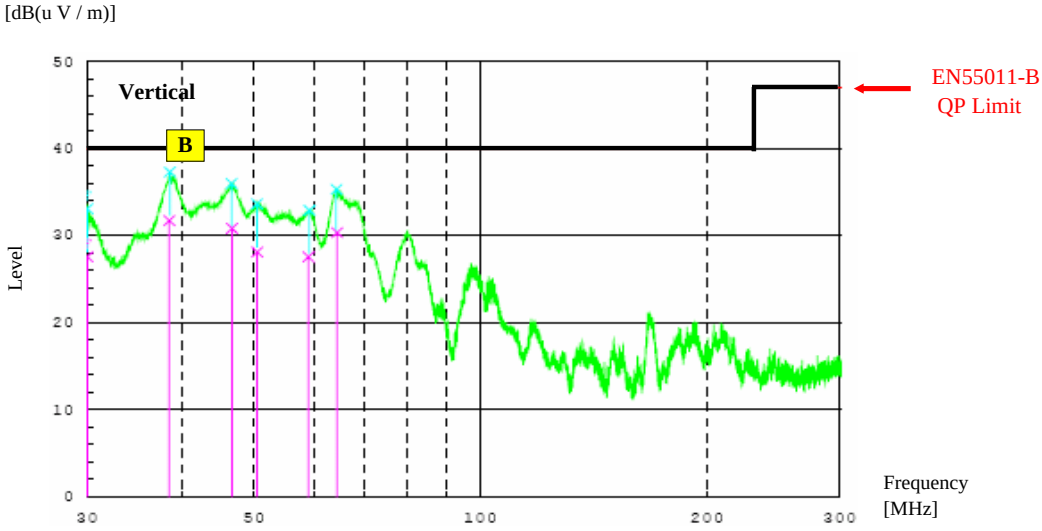
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 230VAC
Iout : 100%

### Radiated Emission

5V




| Point B (38.568MHz) | | |
|---|---|---|
| Limit (dBμV/m) | Measure (dBμV/m) | (P) |
| 40.0 | 31.7 | V |

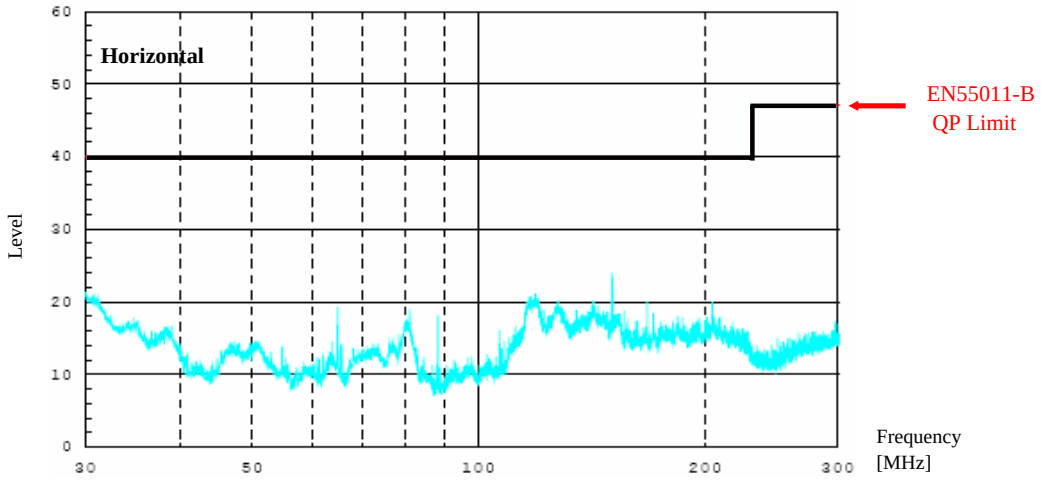
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 115VAC
Iout : 100%

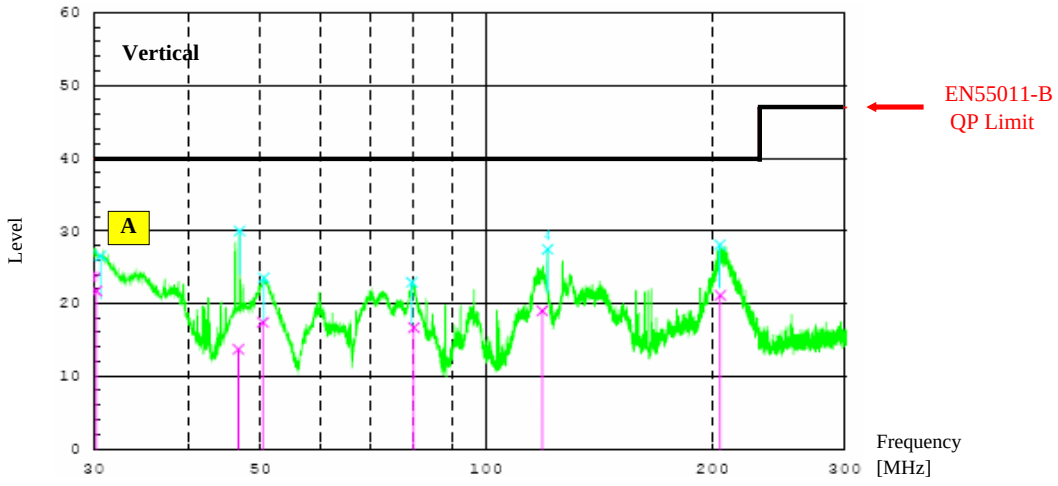
### Radiated Emission

12V

[dB(u V / m)]




[dB(u V / m)]



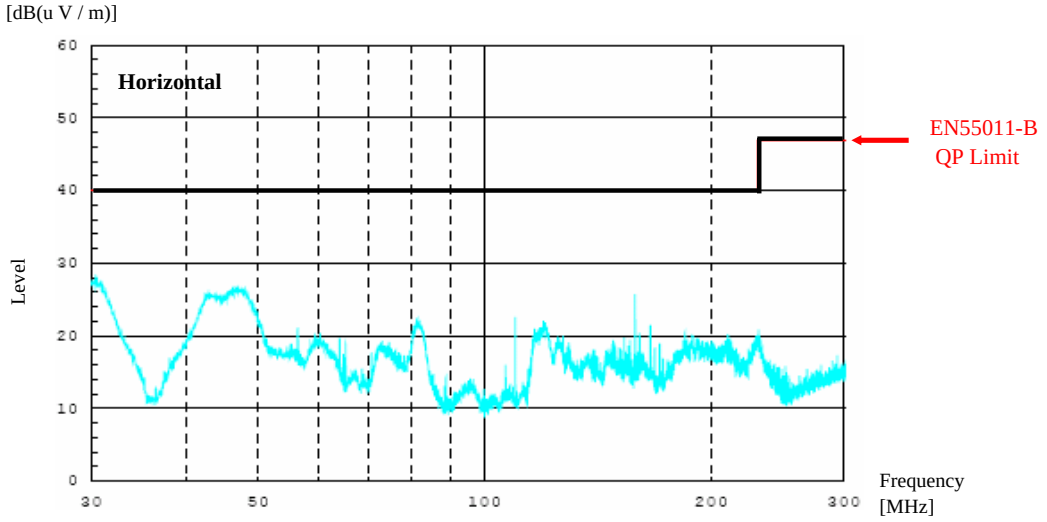

| Point A (30.221MHz) | | |
|---|---|---|
| Limit (dBμV/m) | Measure (dBμV/m) | (P) |
| 40.0 | 21.7 | V |

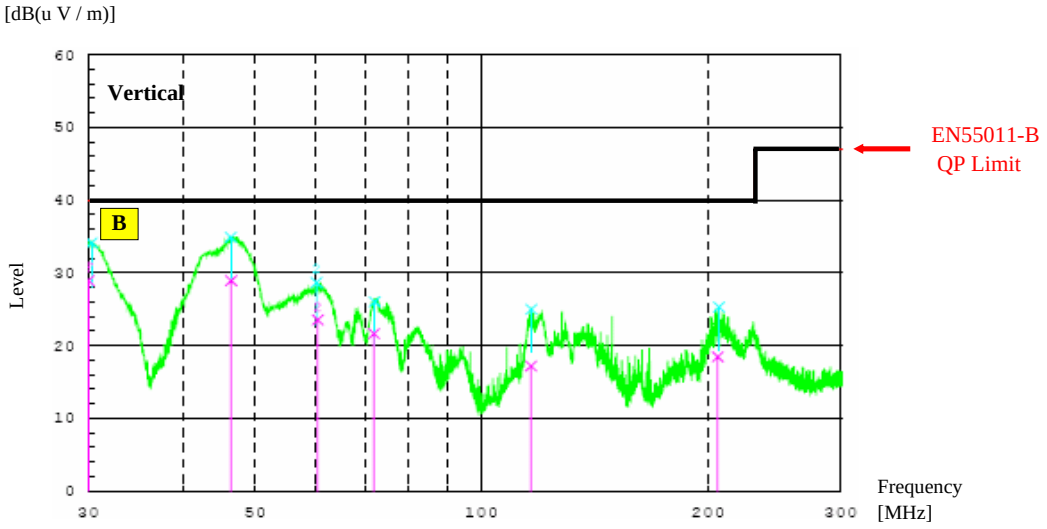
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 230VAC
Iout : 100%

### Radiated Emission

12V




| Point B (30.061MHz) | | |
|---|---|---|
| Limit (dBμV/m) | Measure (dBμV/m) | (P) |
| 40.0 | 28.9 | V |

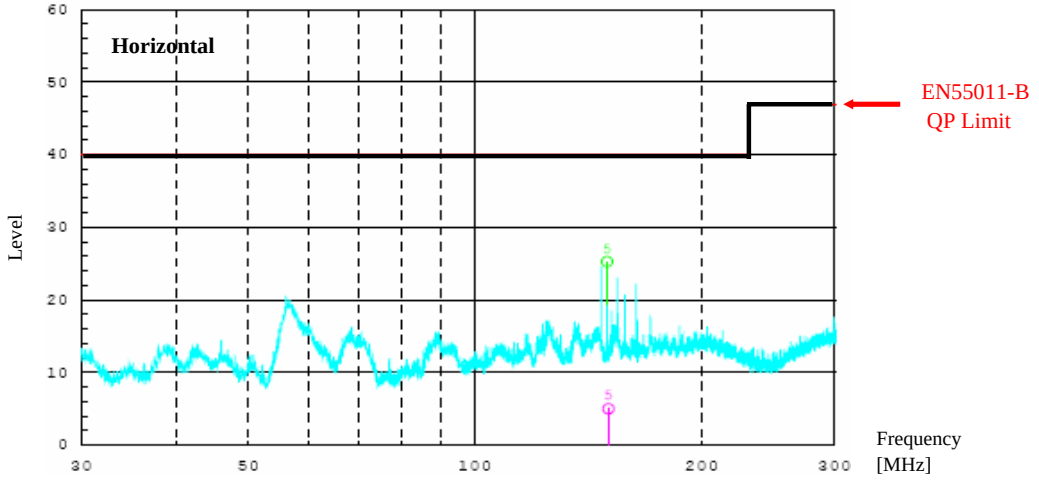
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 115VAC
Iout : 100%

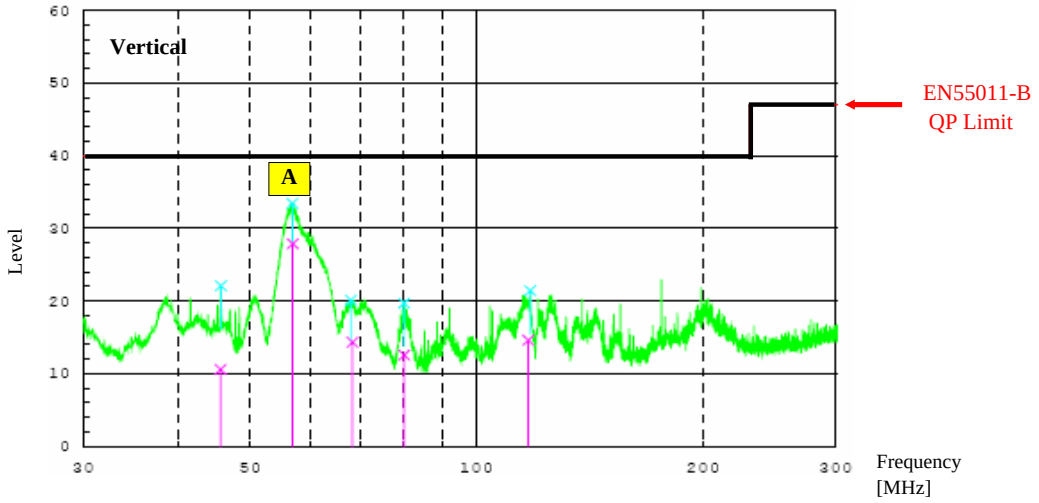
### Radiated Emission

24V

[dB(u V / m)]




[dB(u V / m)]



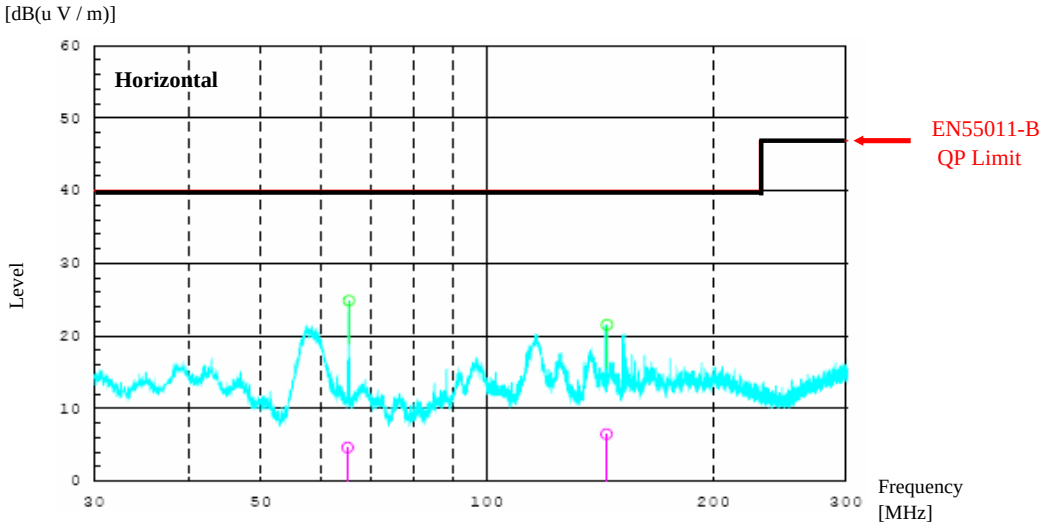

| Point A (56.939MHz) | | |
|---|---|---|
| Limit (dBμV/m) | Measure (dBμV/m) | (P) |
| 40.0 | 27.9 | V |

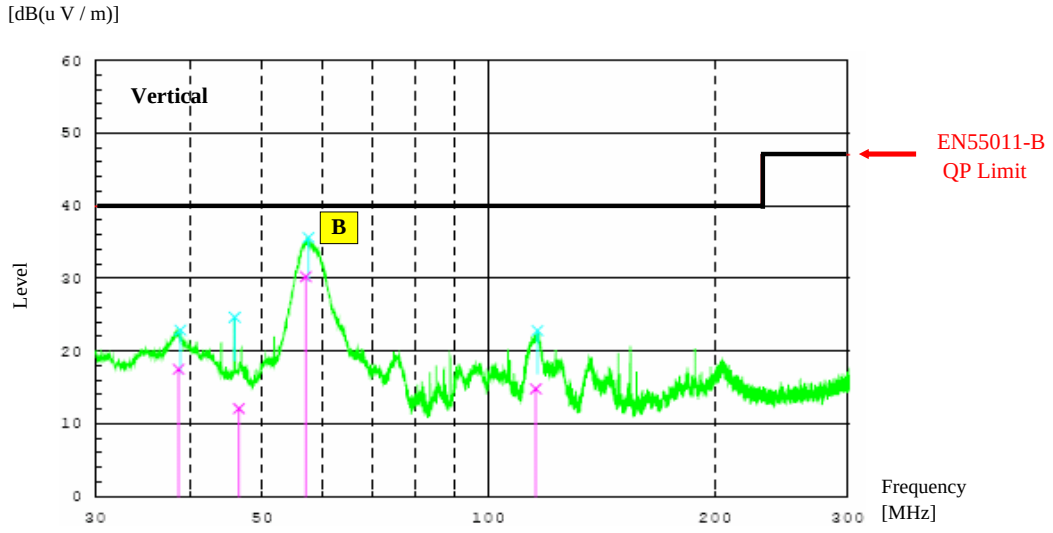
## 2-15 Electro-Magnetic Interference characteristics

Conditions: Vin : 230VAC
Iout : 100%

### Radiated Emission

24V




| Point B (57.103MHz) | | |
|---|---|---|
| Limit (dBμV/m) | Measure (dBμV/m) | (P) |
| 40.0 | 30.2 | V |