PAH150S48-*

QUALITY
TEST DATA

POWER MODULE

DRAWING NO. : PA548-53-01		
NLS R&D		
PREPARED	CHECKED	APPROVED
8/9/99	8/9/99	8/9/99
DATE ISSUE :	8 Sept 99	

NEMIC-LAMBDA (S) PTE LTD

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2. Characteristics

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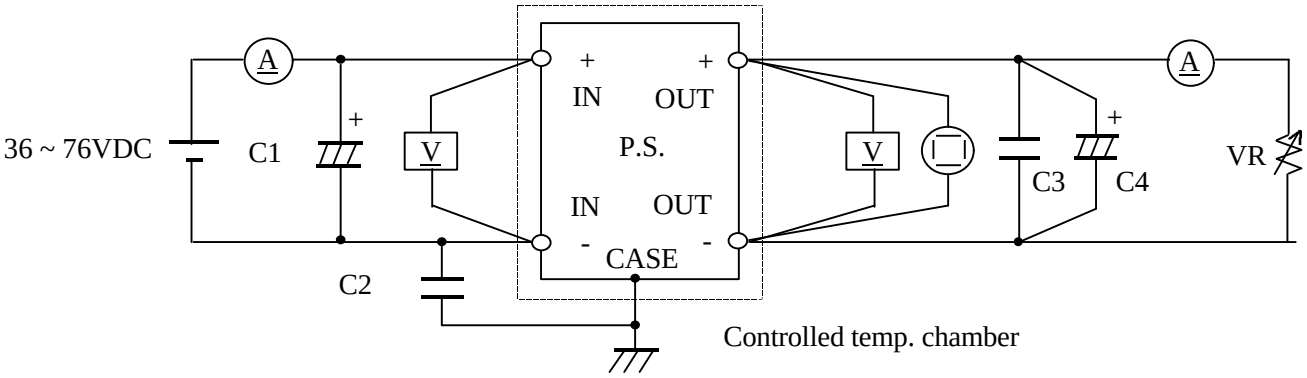
Terminology used

Vin -	Input Voltage	Iout -	Output Current
Vout -	Output Voltage	Tp -	Base-Plate Temperature
Iin -	Input Current	Tr -	Load Rise-Time
		Tf -	Load Fall-Time

1. EVALUATION METHOD

1 - 1 Circuit used for determination

(1) Steady state data



(i) Tp = -20°C ~ 100°C

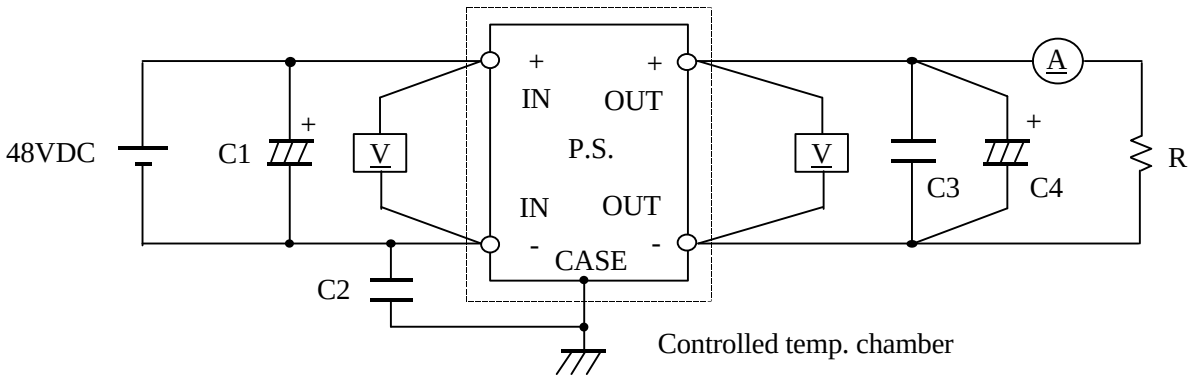
C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor

C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(ii) Tp = -40°C ~ 100°C

C1 : 33µF Ceramic Capacitor or equivalent capacitor such as 100V 6.8µF x 5 pcs
C4 : 2 pieces of the above recommended value

(2) Warm up voltage drift characteristics



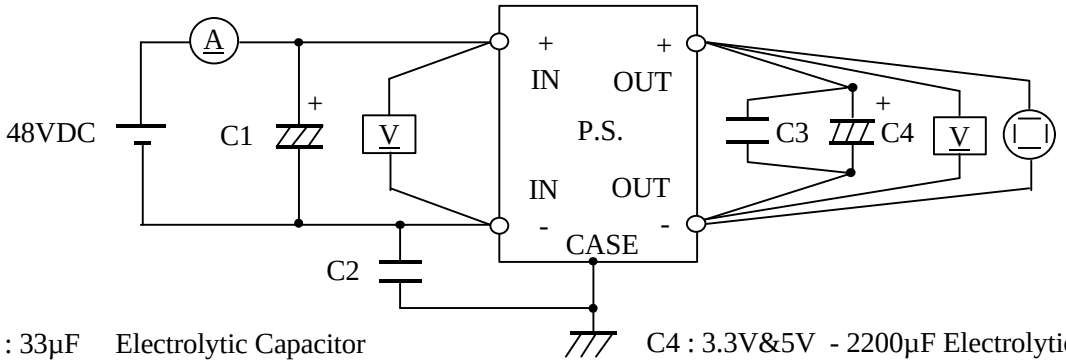
C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor

C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(3) Over current protection (O.C.P.) characteristics

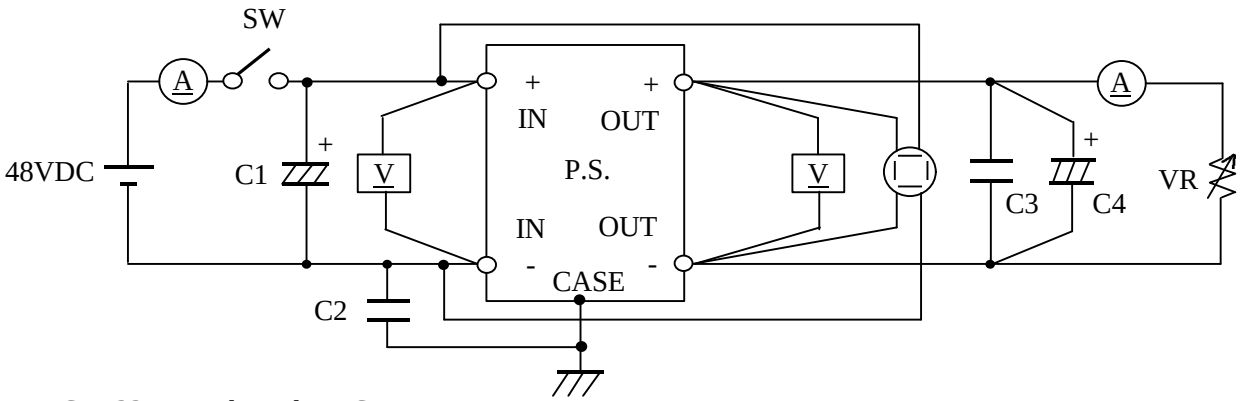
Same as steady state data

(4) Over voltage protection (O.V.P.) characteristics



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1uF Ceramic Capacitor
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

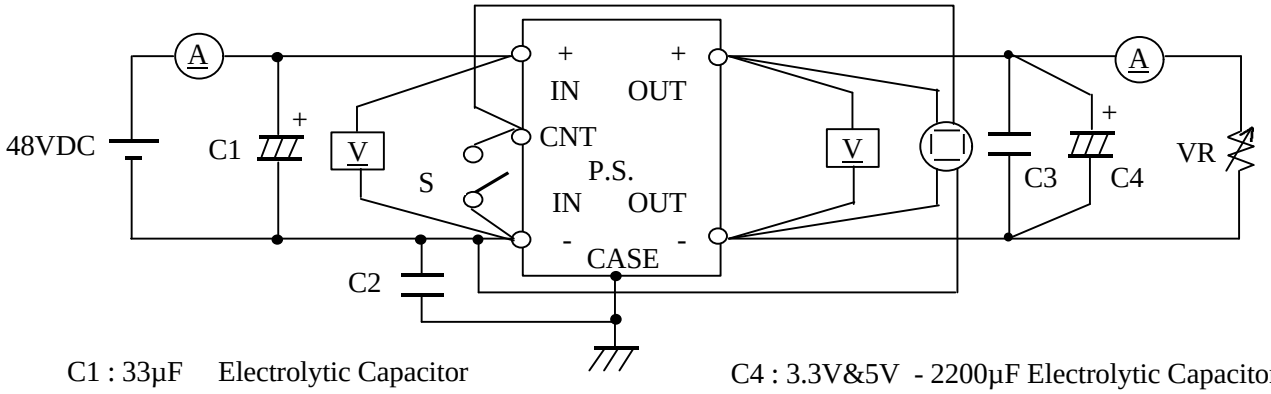
(5) Output rise characteristics



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(6) Output fall characteristics
Same as Output rise characteristics

(7) Output rise characteristics with on/off control

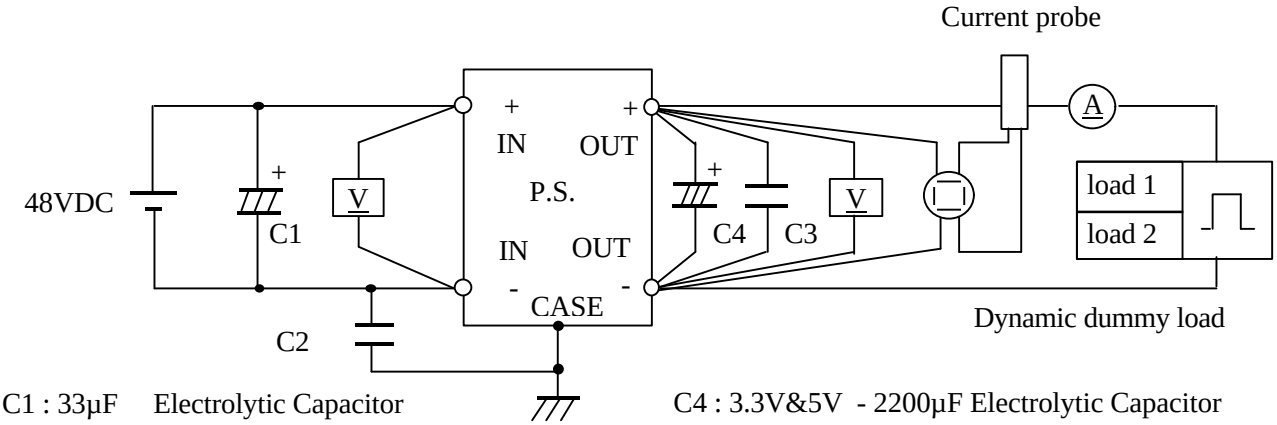


C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1uF Ceramic Capacitor
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(8) Output fall characteristics with on/off control

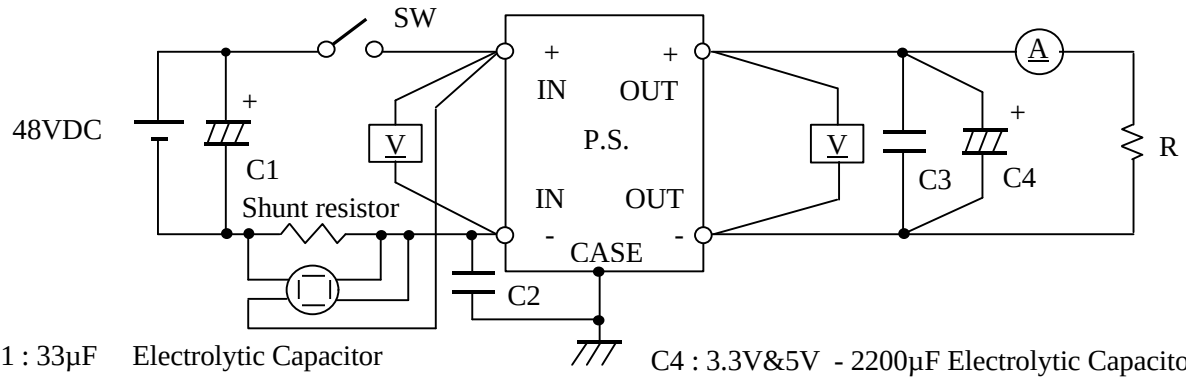
Same as Output rise characteristics with on/off control

(9) Dynamic load response characteristics



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

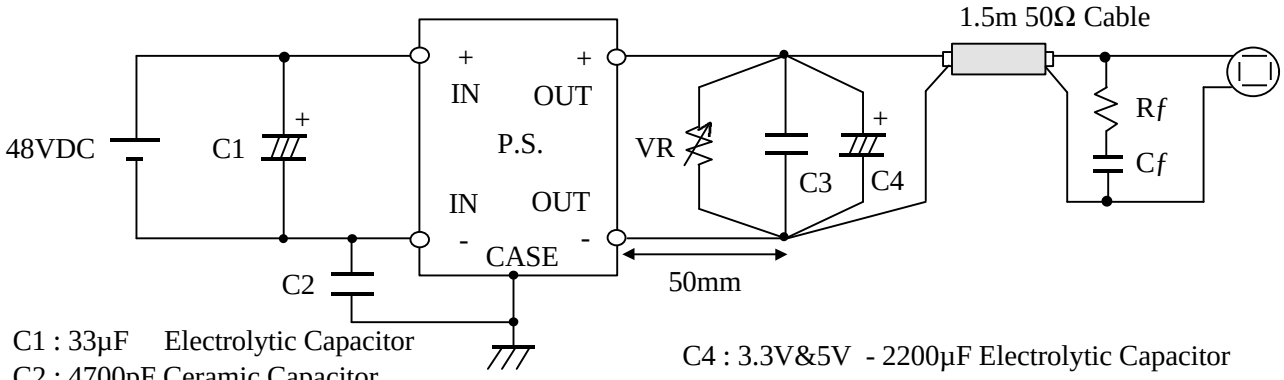
(10) Inrush current waveform



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(11) Output-ripple , noise waveform

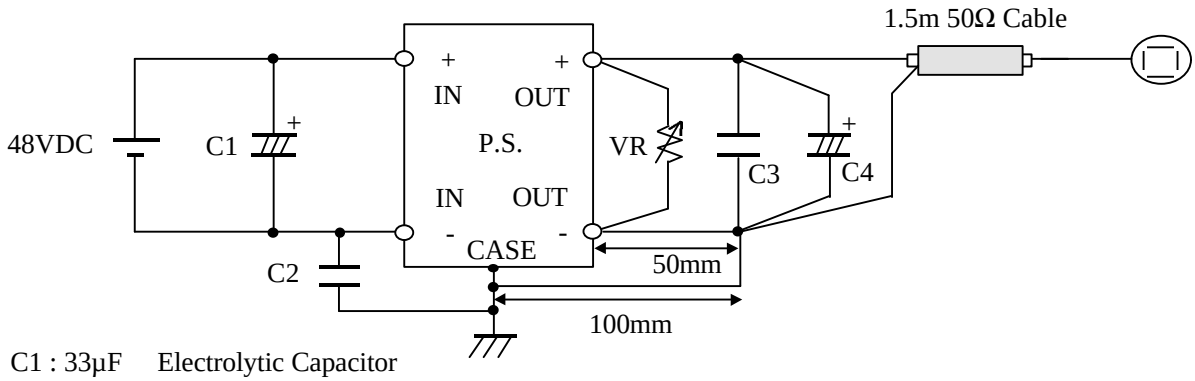
NORMAL MODE (EIAJ Standard RC-9002A)



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor
Rf : 50Ω
Cf : 4700pF
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(11) Output-ripple , noise waveform

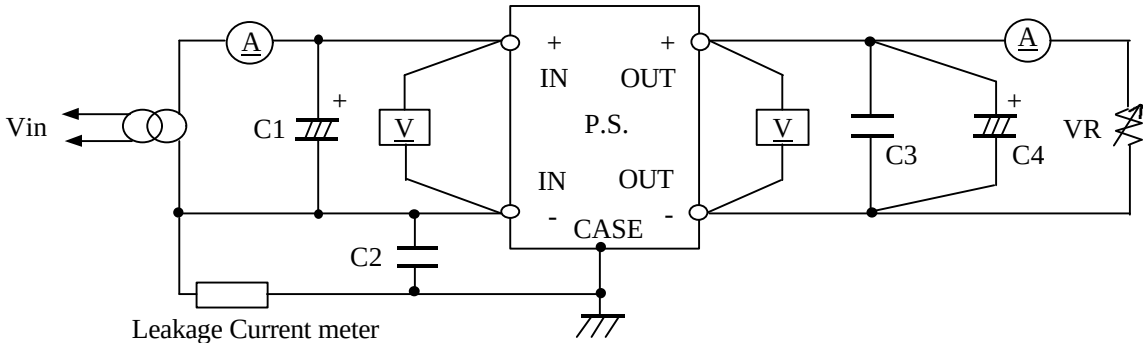
NORMAL + COMMON MODE



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor

C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

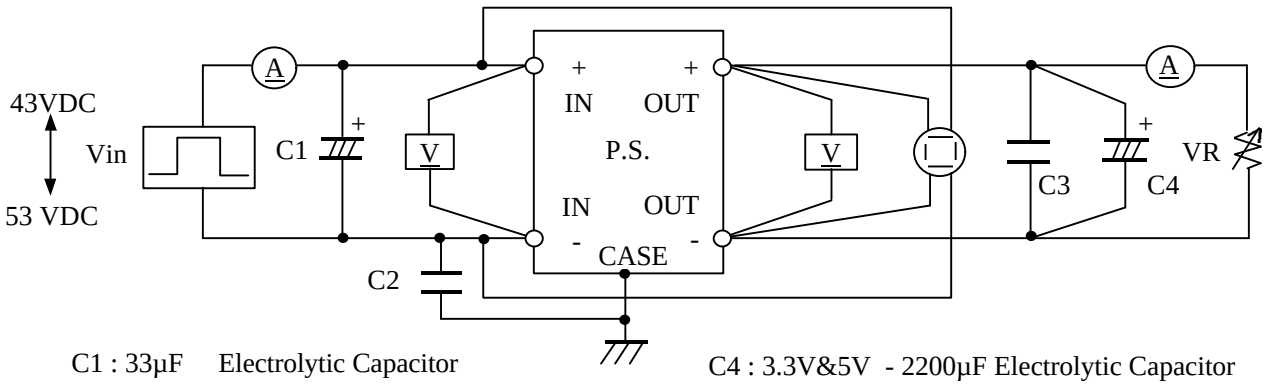
(12) Leakage current characteristics



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor

C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

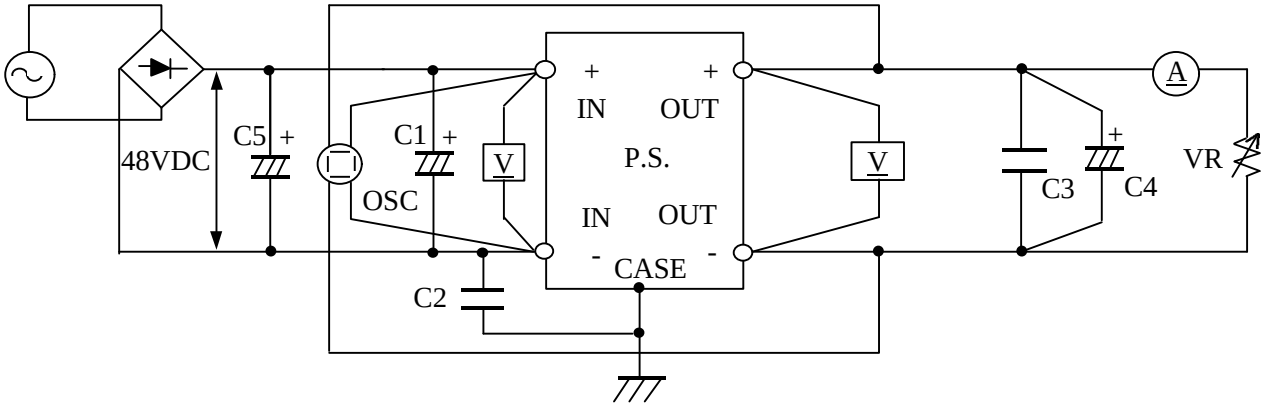
(13) Dynamic line characteristics



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor

C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

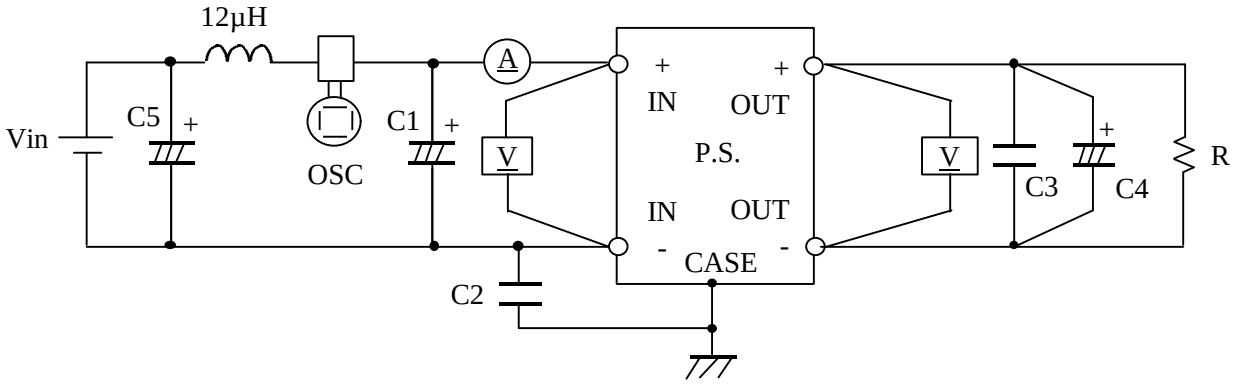
(14) AC input response characteristics



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor
C5 : 560µF Electrolytics Capacitor

C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(15) Input Reflected current characteristics



C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor
C5 : 220µF Elerctrolytic Capacitor

C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

1-2 List of equipment used

No	Description	Manufacturer	Model No.
1	Oscilloscope	TEKTRONIX	2465B
2		HITACHI	V-1050F
3	Digital oscilloscope	YEW	DL2140
4		HITACHI	VC-6041
5	Digital volt meter	IWATSU	VDAC 7411
6	DC ampere meter	YOKOGAWA ELEC.	2051
7	Dynamic dummy load	TAKAMIZAWA	PSA-150D
8	Variable resistive load	MATSUNAGA	44/11Ω
9	Variable resistive load	MATSUNAGA	2.4/0.6Ω
10	Controlled temp . chamber	TABAI	PL-2GM
11	Shunt resistor	KUWANO	100mV , 1A
12	Current probe amplifier	TEKTRONIX	TM503
13	Current probe	TEKTRONIX	A6303
14	AC power source / Analyzer	HEWLETT PACKARD	6813A
15	Leakage current tester	SIMPSON	229-2

2. CHARACTERISTICS

2-1 Steady State Data

(1) Regulation - Line and Load, Temperature Drift

5 V

Regulation - Line and Load Tp = 25°C

Iout \ Vin	36 VDC	48 VDC	76 VDC	Line Regulation	
0%	5.019 V	5.019 V	5.019 V	0 mV	0.00%
50%	5.016 V	5.016 V	5.017 V	1 mV	0.02%
100%	5.014 V	5.015 V	5.016 V	2 mV	0.04%
Load Regulation	5 mV	4 mV	3 mV		
	0.10%	0.08%	0.06%		

Temperature Drift Vin = 48VDC
Iout = 100%

Tp	-40°C	25°C	100°C	Temp. Stability	
Vout	4.996 V	5.015 V	4.985 V	30 mV	0.60%

12 V

Regulation - Line and Load Tp = 25°C

Iout \ Vin	36 VDC	48 VDC	76 VDC	Line Regulation	
0%	12.022 V	12.017 V	12.018 V	5 mV	0.04%
50%	12.027 V	12.026 V	12.028 V	2 mV	0.02%
100%	12.029 V	12.029 V	12.029 V	0 mV	0.00%
Load Regulation	7 mV	12 mV	11 mV		
	0.06%	0.10%	0.09%		

Temperature Drift Vin = 48VDC
Iout = 100%

Tp	-40°C	25°C	100°C	Temp. Stability	
Vout	12.060 V	12.029 V	11.961 V	99 mV	0.83%

24 V

Regulation - Line and Load Tp = 25°C

Iout \ Vin	36 VDC	48 VDC	76 VDC	Line Regulation	
0%	24.068 V	24.046 V	24.041 V	27 mV	0.11%
50%	24.081 V	24.081 V	24.068 V	13 mV	0.05%
100%	24.087 V	24.084 V	24.069 V	18 mV	0.08%
Load Regulation	19 mV	38 mV	28 mV		
	0.08%	0.16%	0.12%		

Temperature Drift Vin = 48VDC
Iout = 100%

Tp	-40°C	25°C	100°C	Temp. Stability	
Vout	24.128 V	24.084 V	24.005 V	0.123 V	0.51%

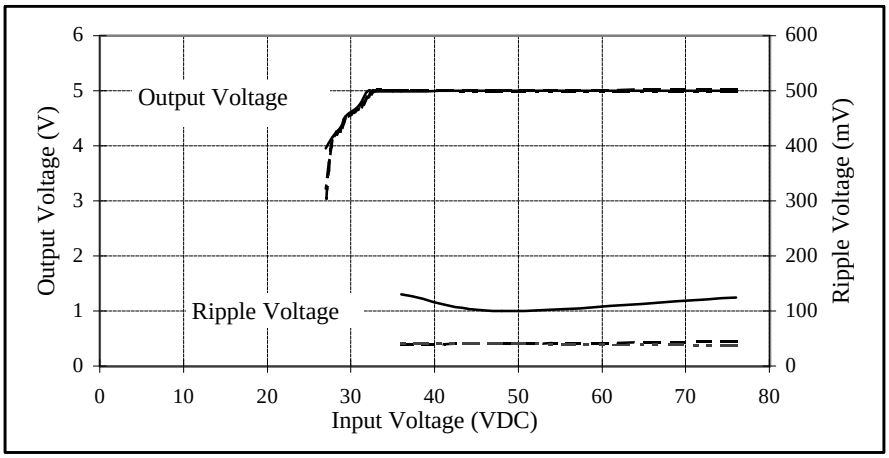
2. CHARACTERISTICS

2-1 Steady State Data

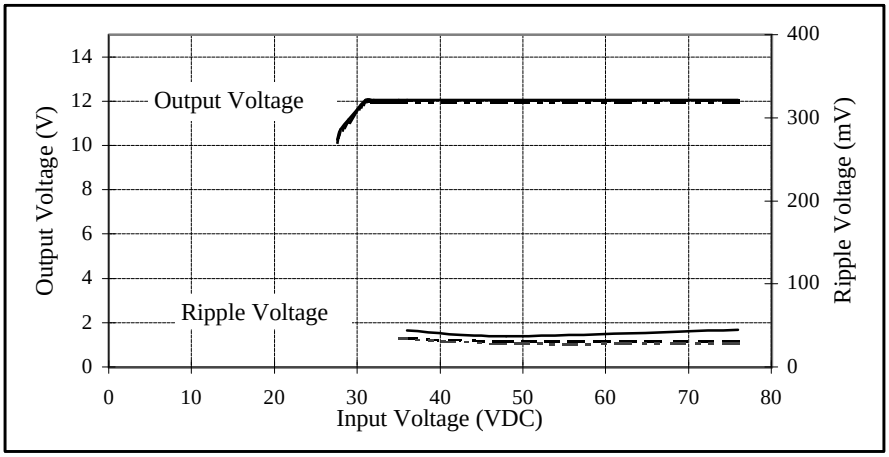
(2) Output Voltage And Ripple Voltage V.S. Input Voltage

Condition : Iout = 100%
Tp = -40°C ————
Tp = 25°C – – – – –
Tp = 100°C —·—·—·—

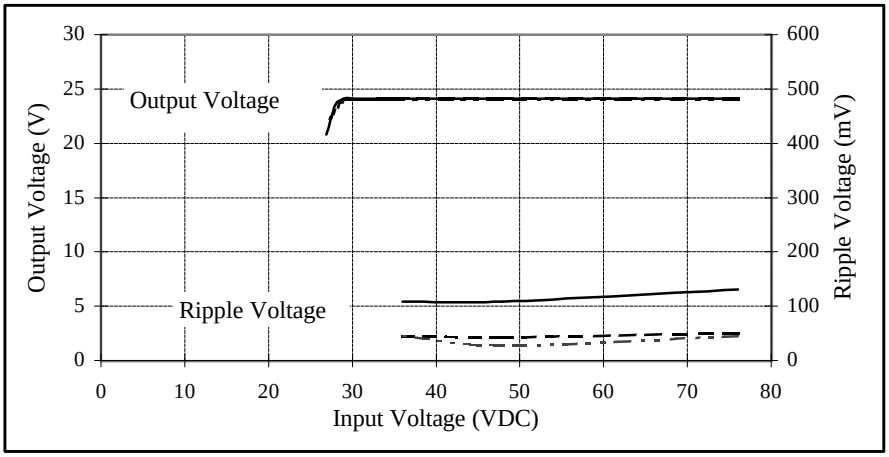
5 V



12 V



24 V

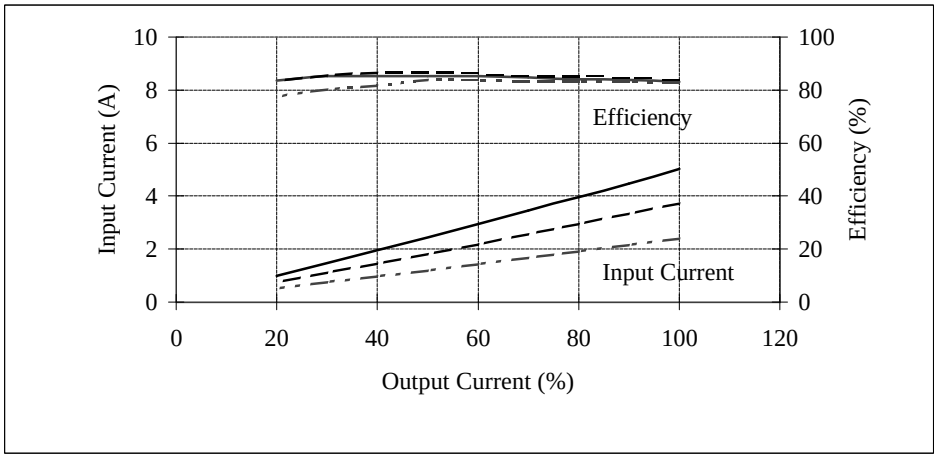


2. CHARACTERISTICS
2-1 Steady State Data

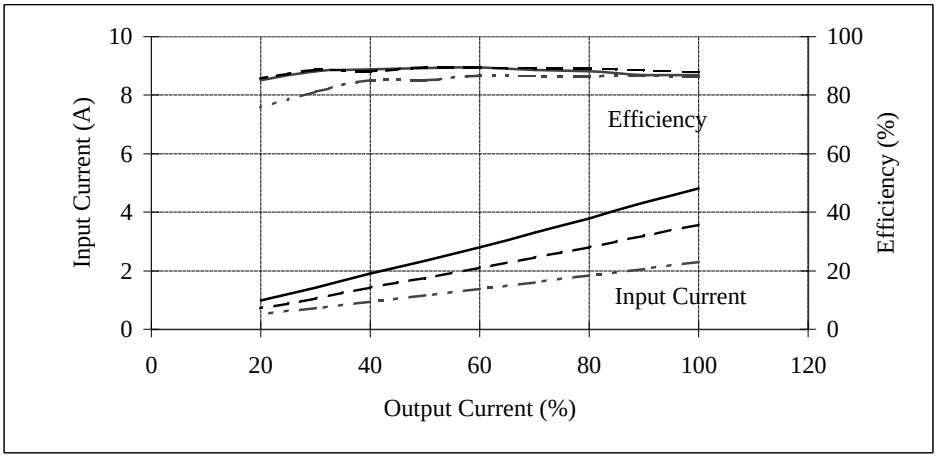
(3) Efficiency And Input Current V.S. Output Current

Condition : Vin = 36 VDC ———
= 48VDC – – – –
= 76VDC –·–·–
Tp = 25°C

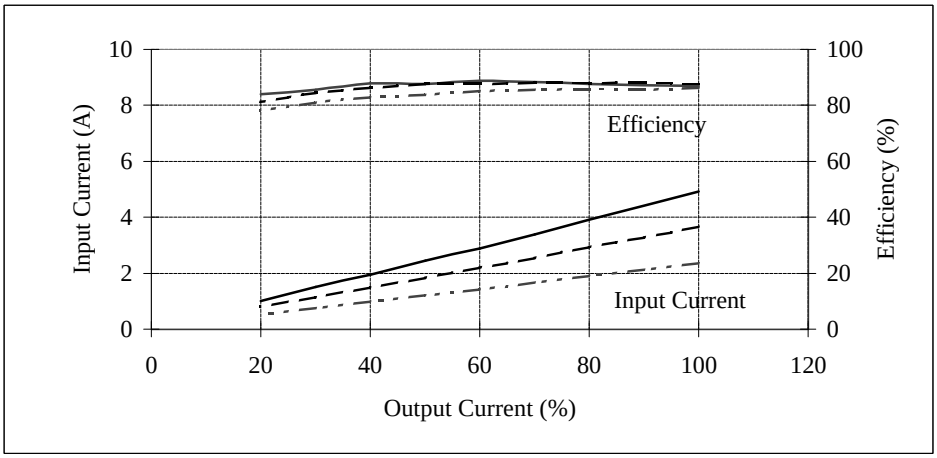
5 V



12 V



24 V



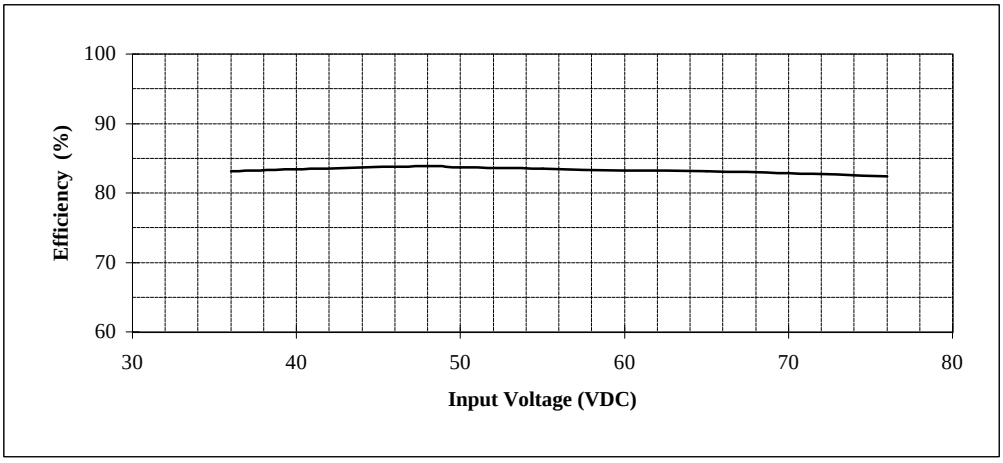
2. CHARACTERISTICS

2-1 Steady State Data

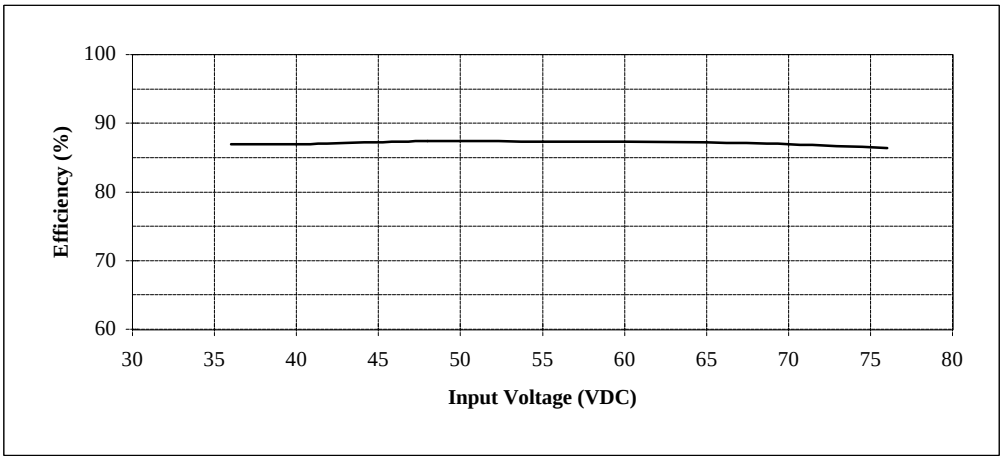
(4) Efficiency v.s. Input Voltage

Condition : Iout = 100%
Tp = 25°C

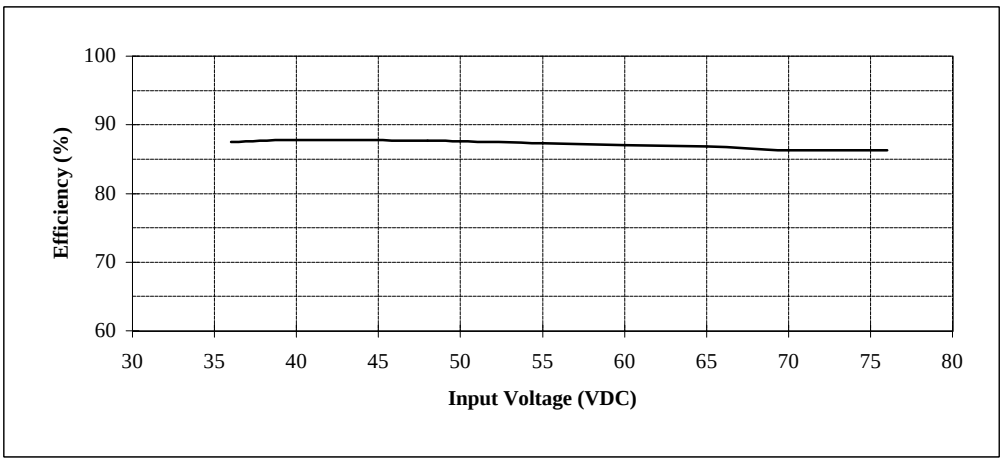
5 V



12 V



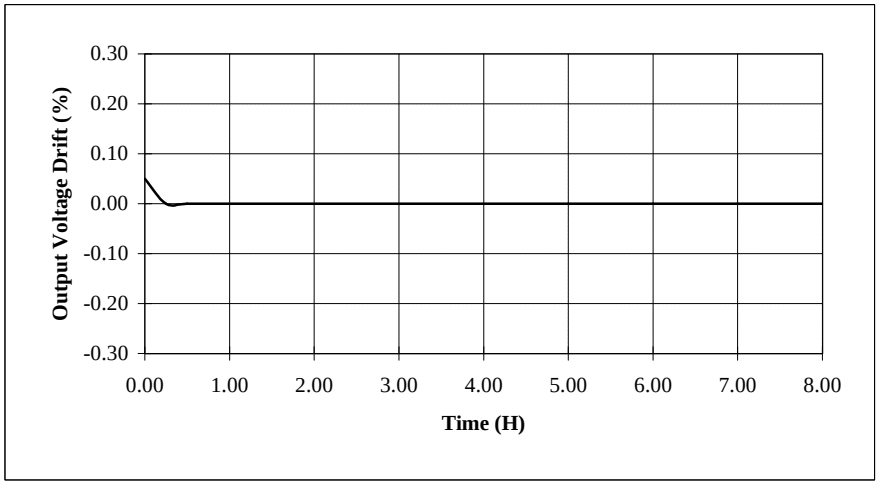
24 V



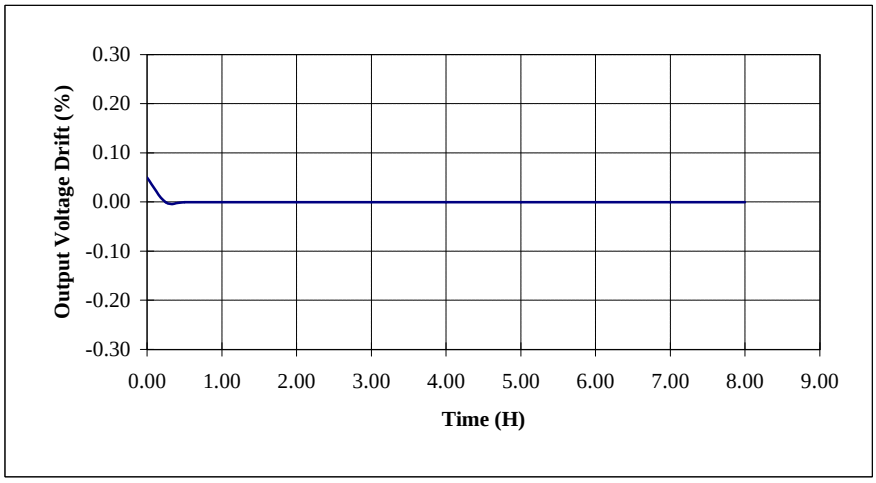
2-2 Warm Up Voltage Drift Characteristics

Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C

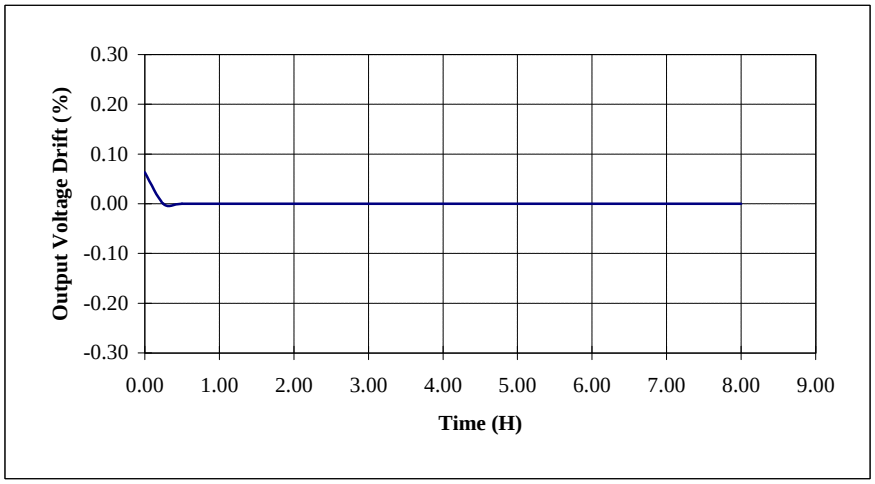
5 V



12 V



24 V

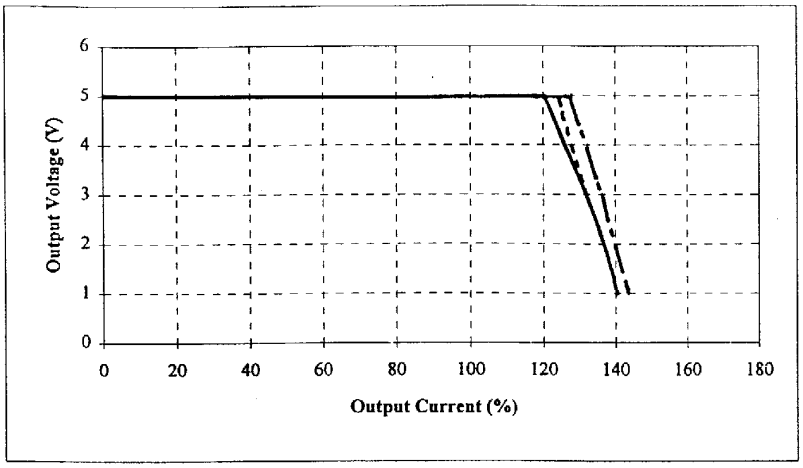


2-3 O.C.P. Charateristics

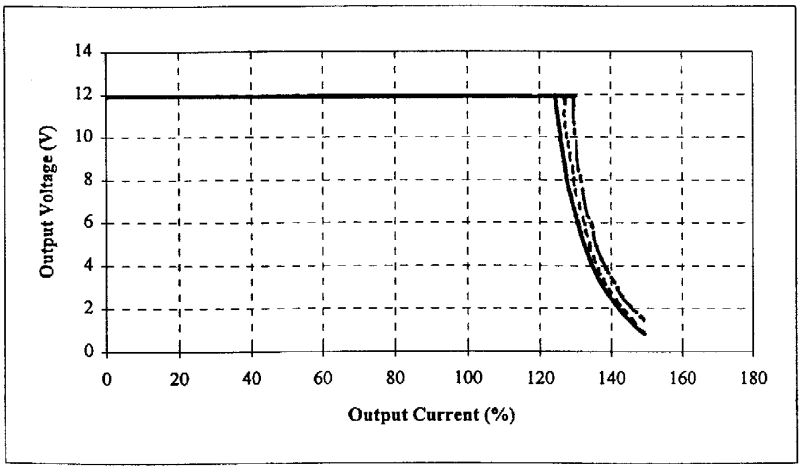
PAH150S48-*

Condition : Vin = 36 VDC ————
Vin = 48 VDC ---------
Vin = 76 VDC —·—·—·—
Tp = 25°C

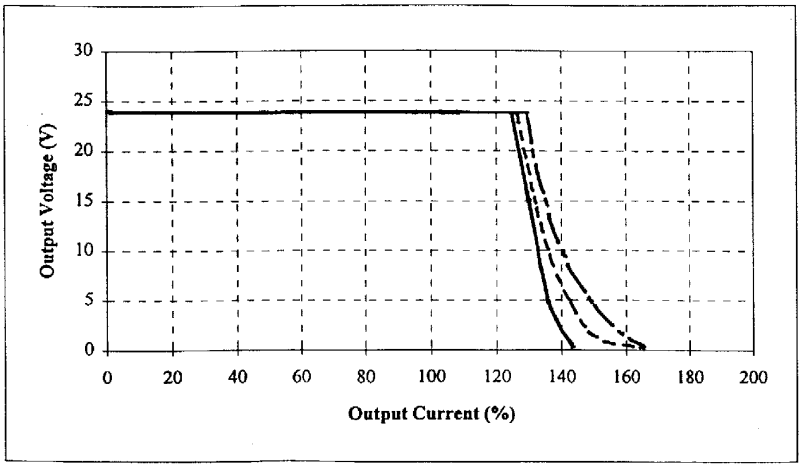
5 V



12 V



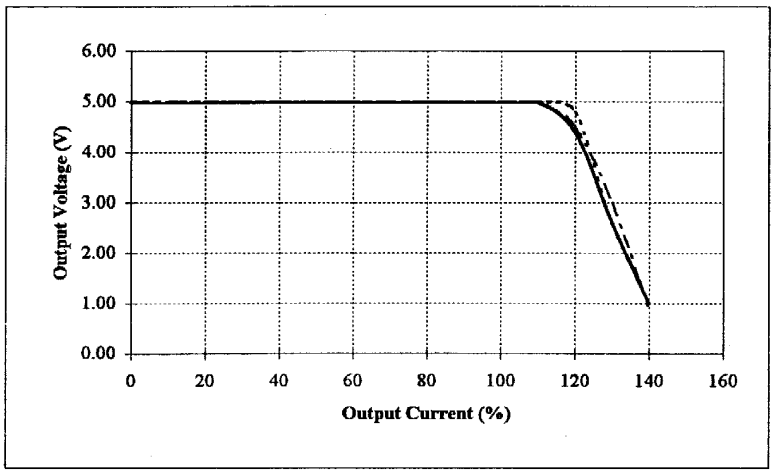
24 V



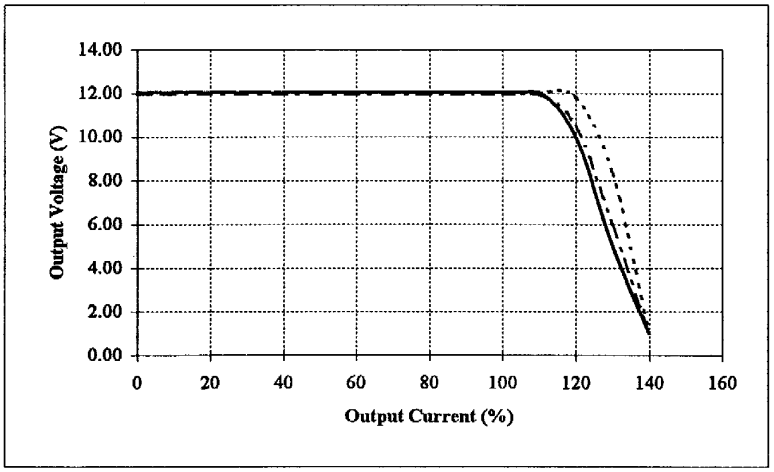
O.C.P. Charateristics

Condition : Tp = -40°C ——————
Tp = 25°C . . . . . .
Tp = 100°C — . — . — .
Vin = 48 VDC

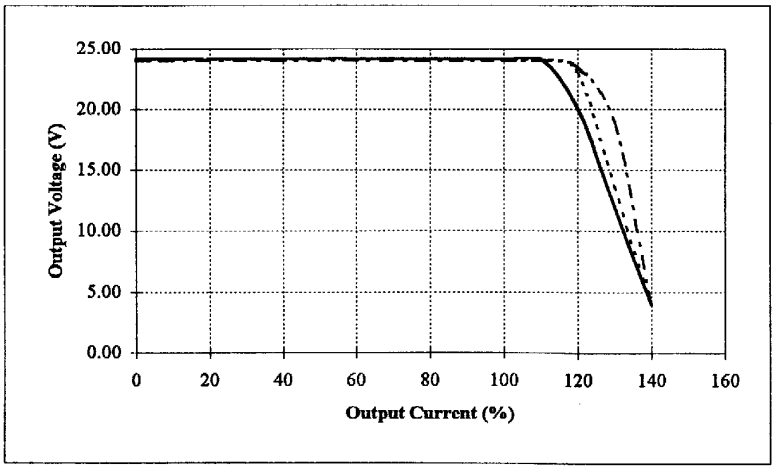
5 V



12 V



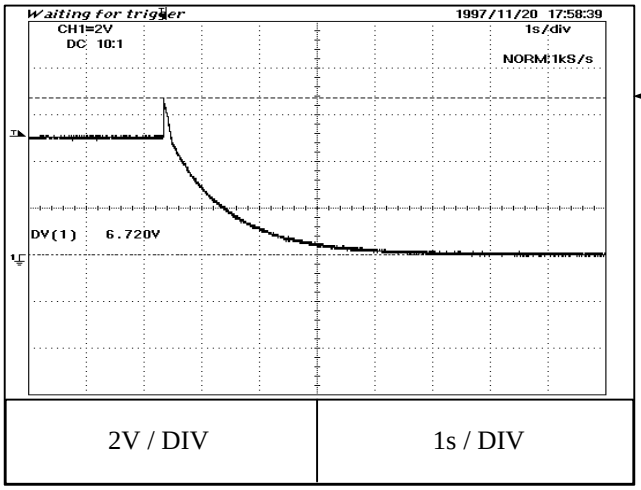
24 V



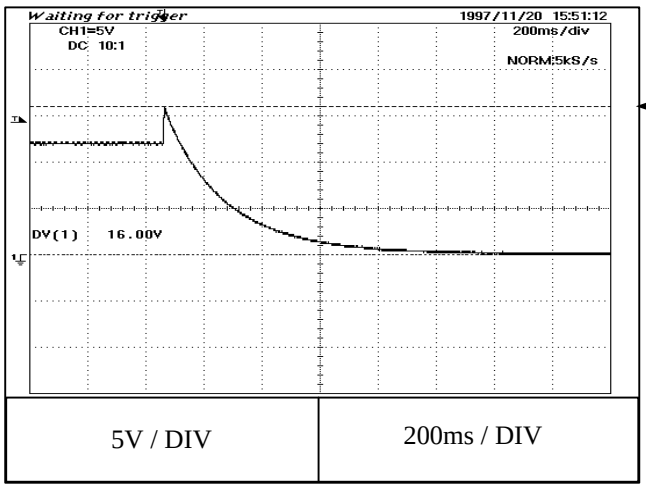
2-4 O.V.P. Characteristics

Condition : Vin = 48 V DC
Iout = 0 %
Tp = 25°C

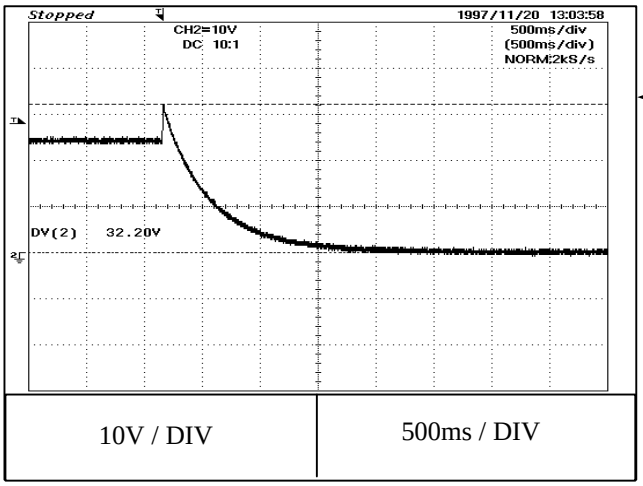
5 V



12 V



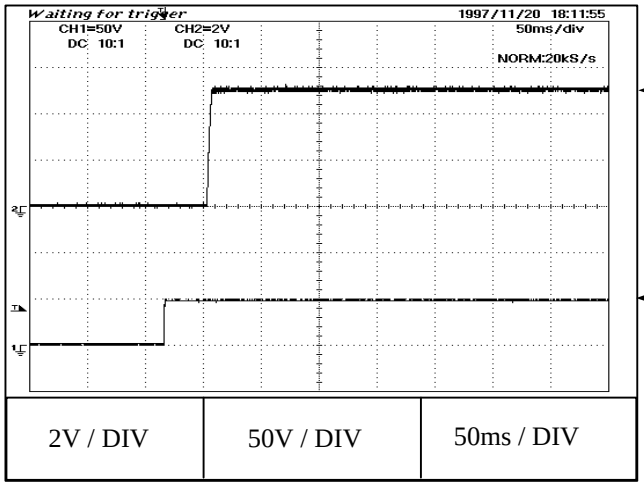
24 V



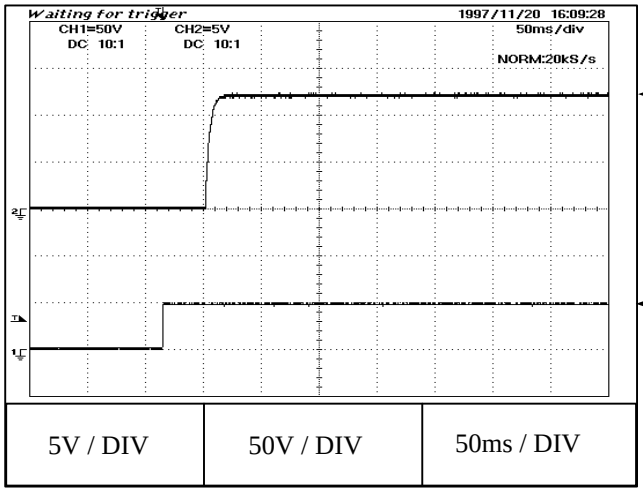
2-5 Output Rise Characteristics

Condition : Vin = 48 V DC
Iout = 0 %
Tp = 25°C

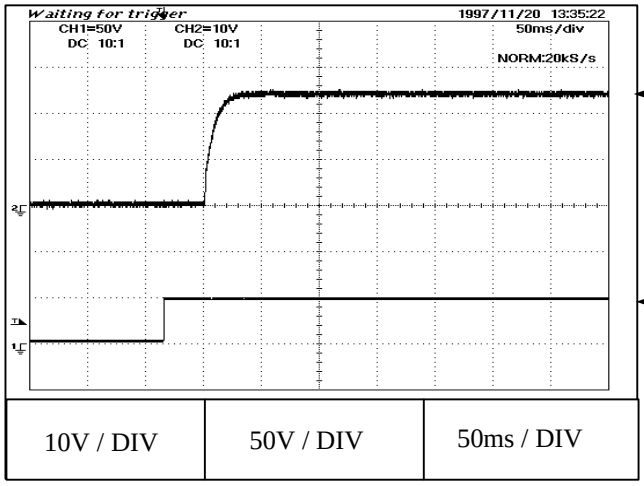
5 V



12 V



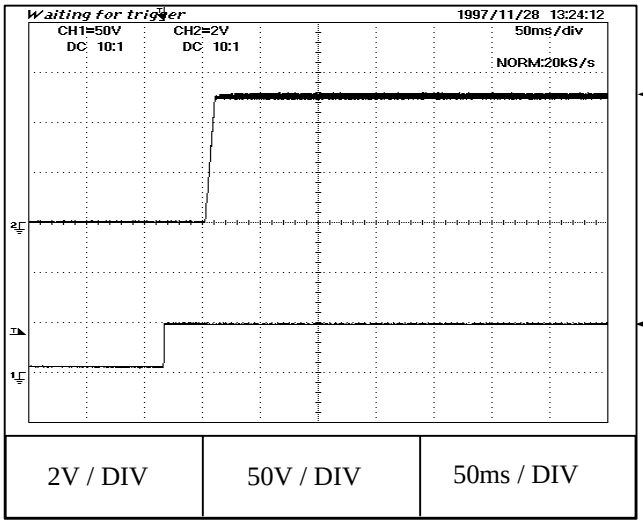
24 V



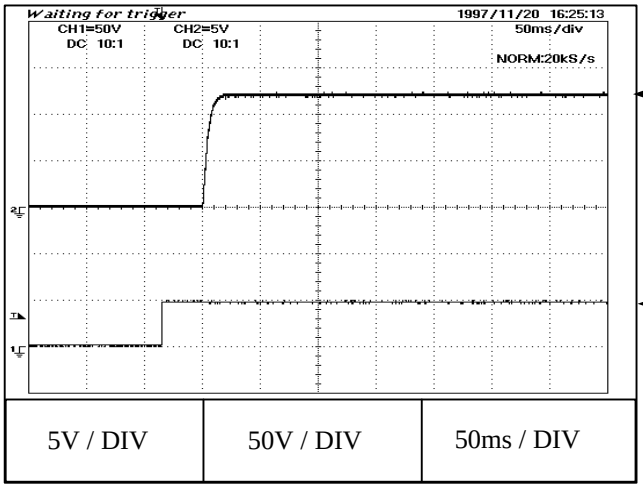
Output Rise Characteristics

Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C

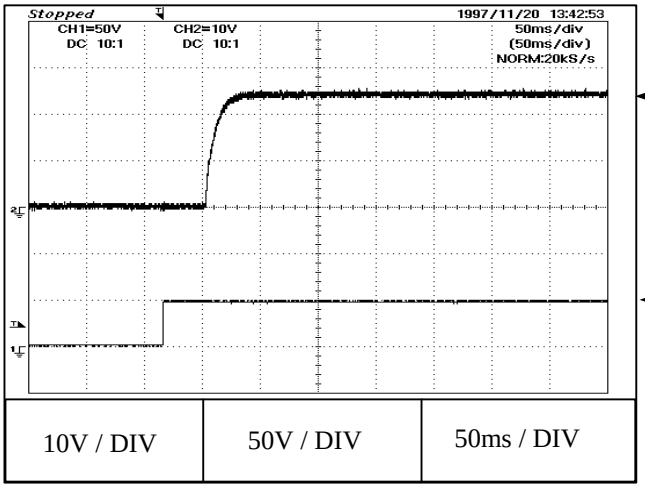
5 V



12 V



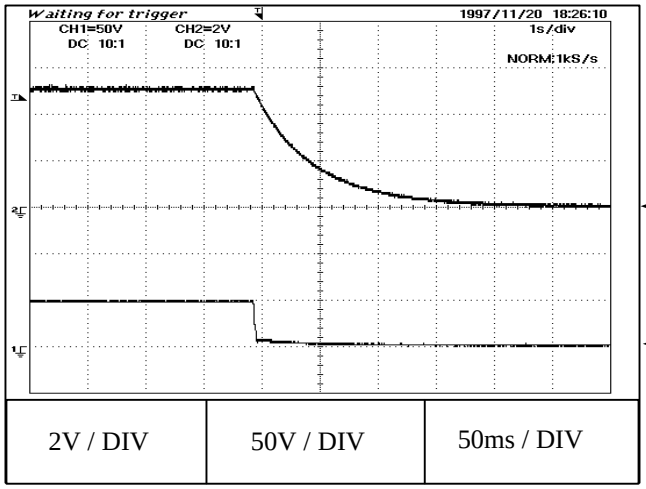
24 V



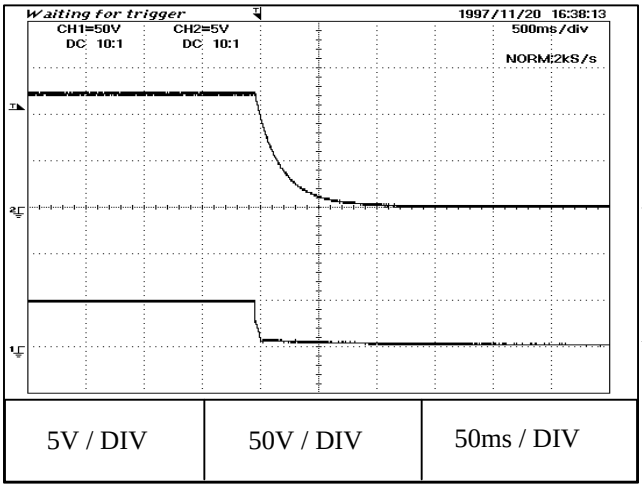
2-6 Output Fall Characteristics

Condition : Vin = 48 V DC
Iout = 0 %
Tp = 25°C

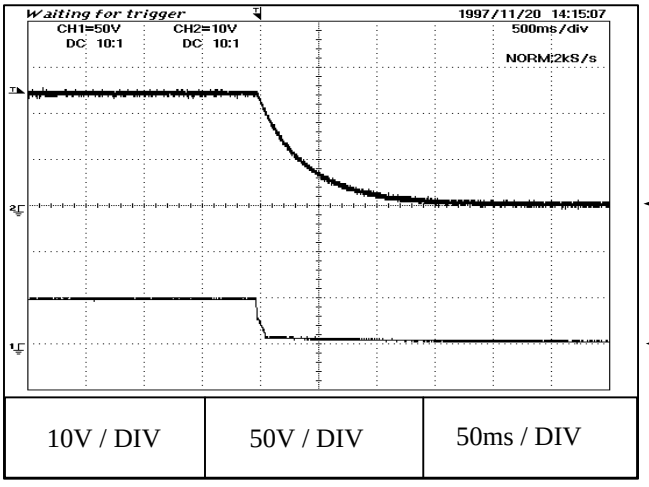
5 V



12 V



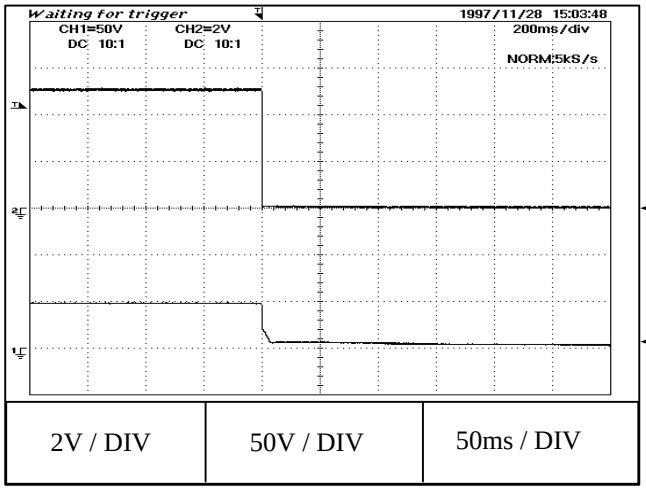
24 V



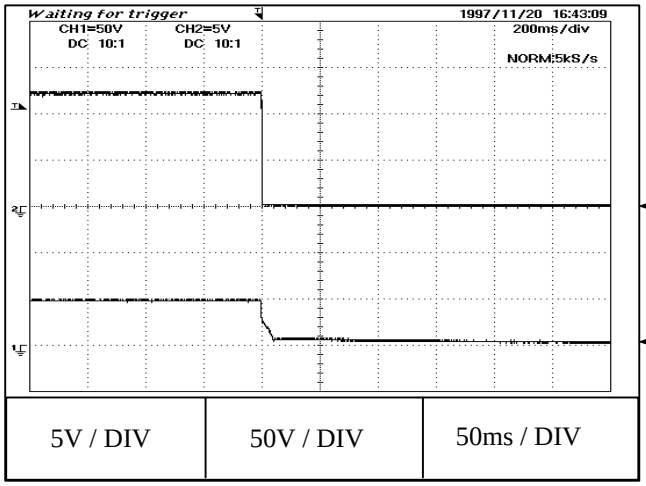
Output Fall Characteristics

Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C

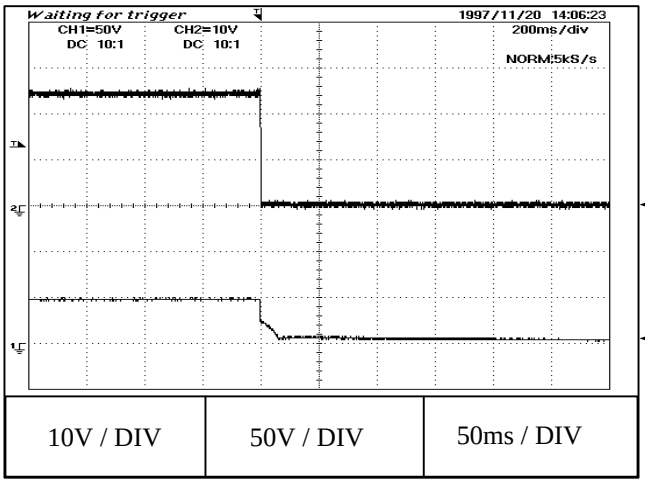
5 V



12 V



24 V

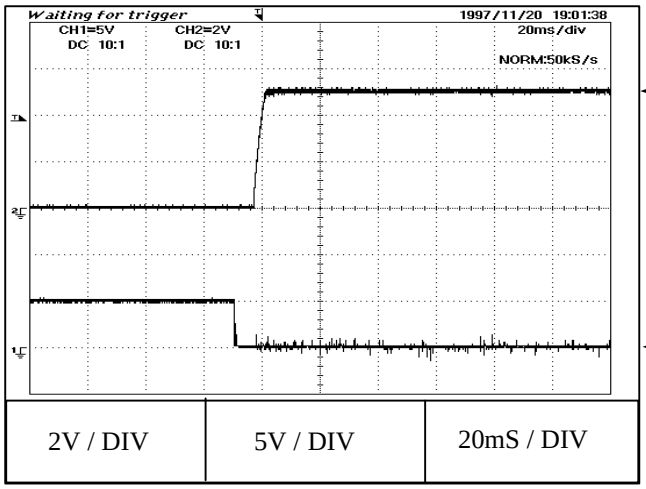


2-7 Output Rise With On/Off Characteristics

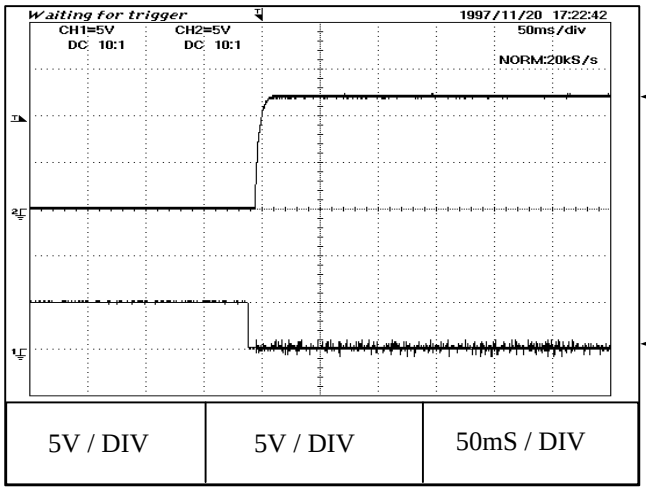
(Negative logic)

Condition : Vin = 48 V DC
Iout = 0 %
Tp = 25°C

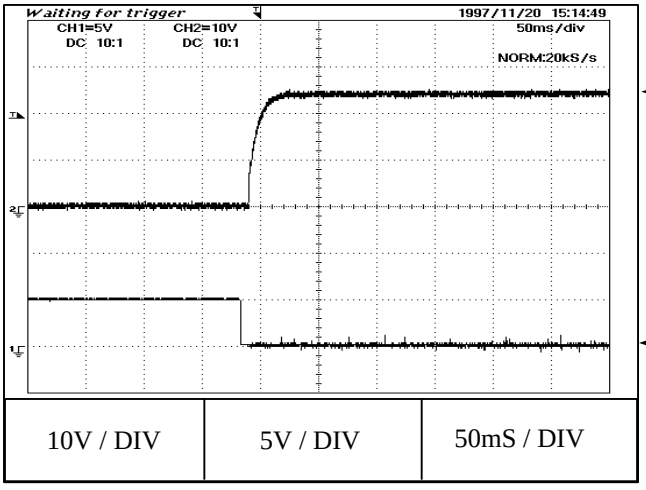
5 V



12 V



24 V

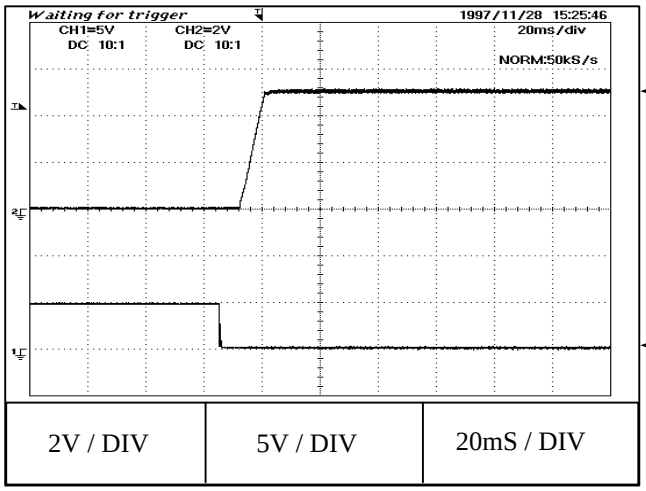


Output Rise With On/Off Characteristics

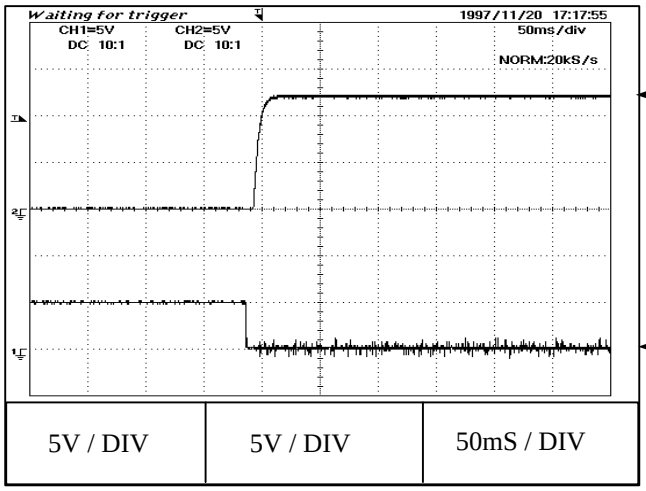
(Negative logic)

Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C

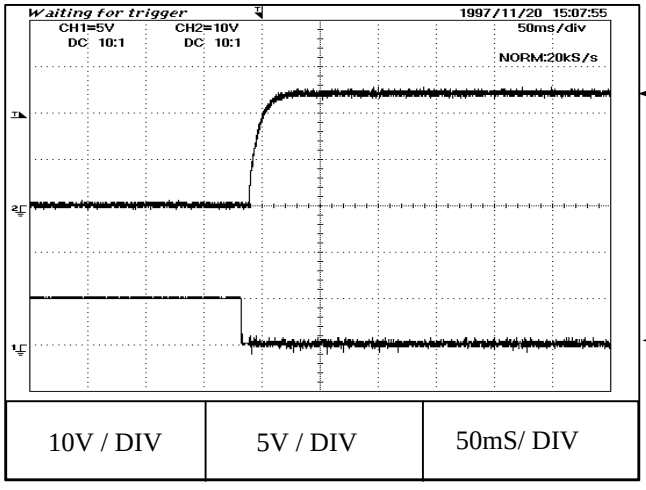
5 V



12 V



24 V

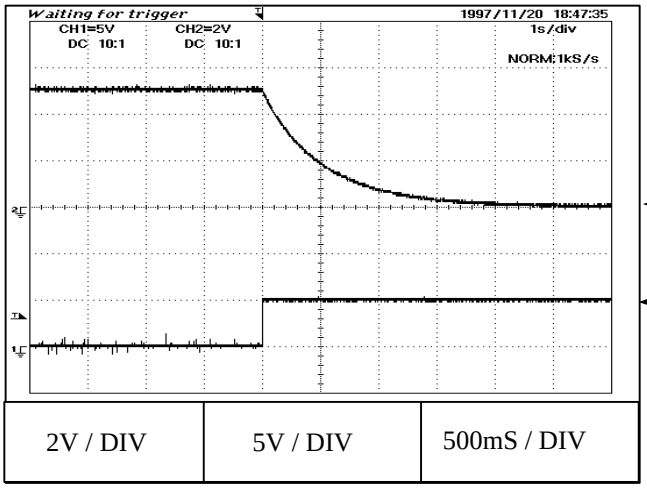


2-8 Output Fall With On/Off Characteristics

(Negative logic)

Condition : Vin = 48 V DC
Iout = 0 %
Tp = 25°C

5 V

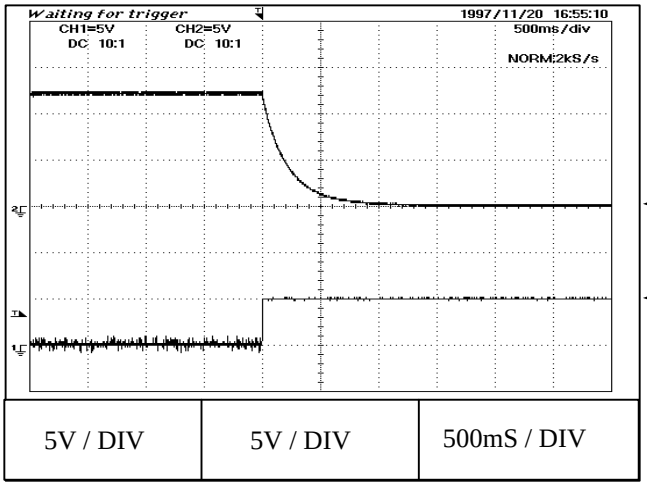


Vout

On/Off Control

2V / DIV	5V / DIV	500mS / DIV

12 V

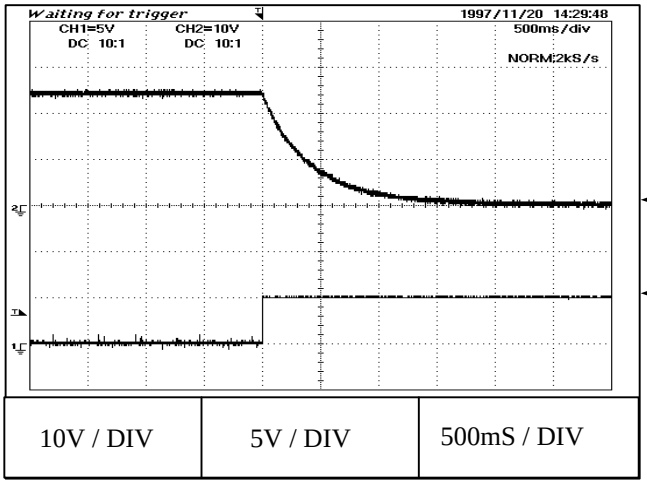


Vout

On/Off Control

5V / DIV	5V / DIV	500mS / DIV

24 V



Vout

On/Off Control

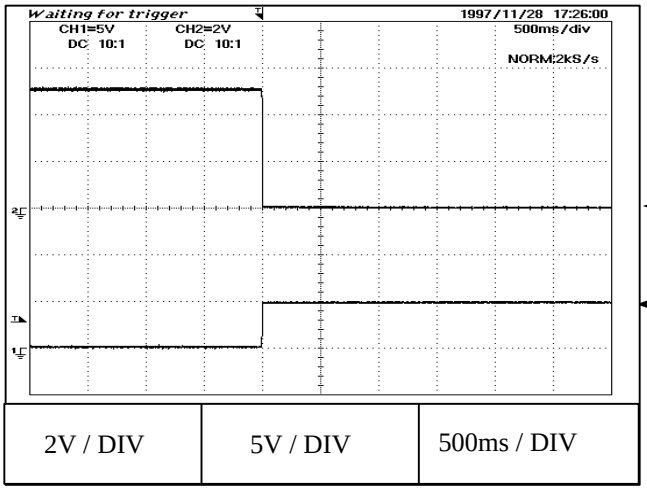
10V / DIV	5V / DIV	500mS / DIV

Output Fall With On/Off Characteristics

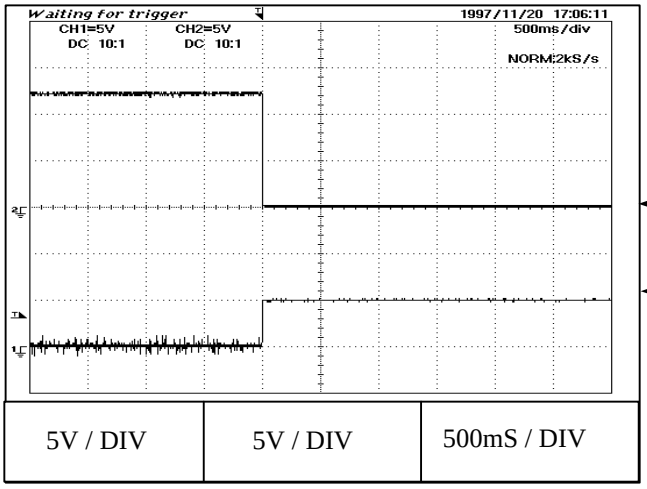
(Negative logic)

Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C

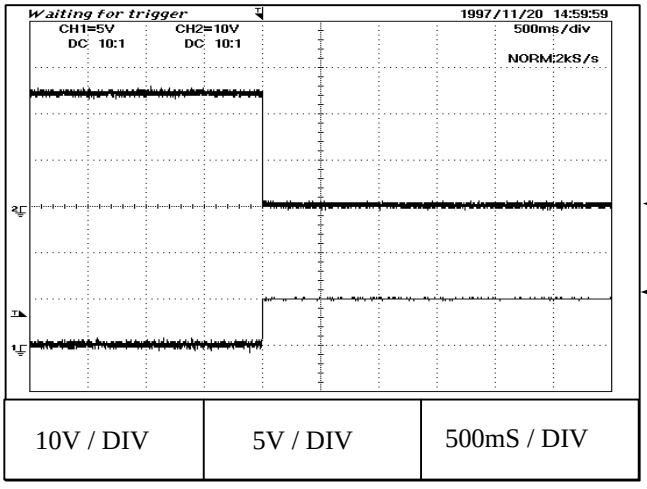
5 V



12 V



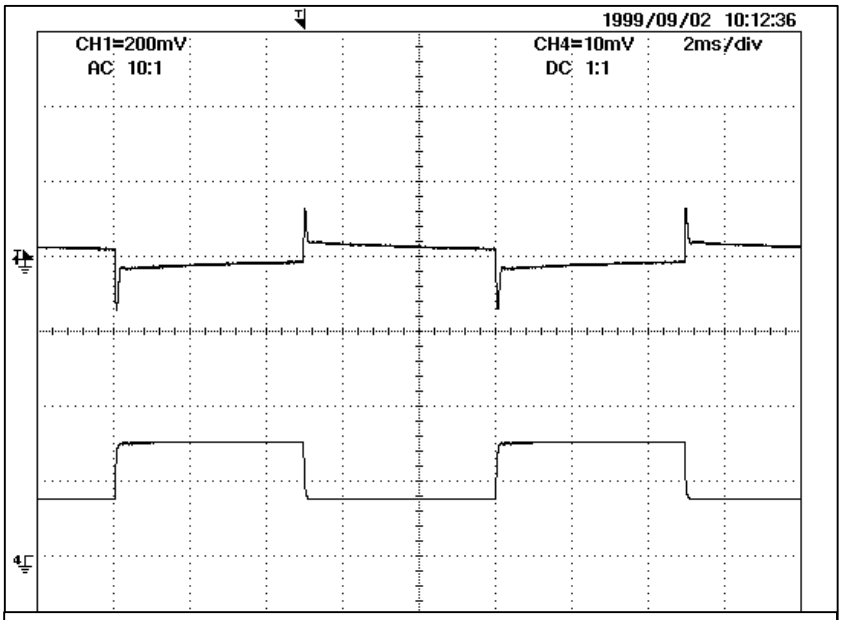
24 V



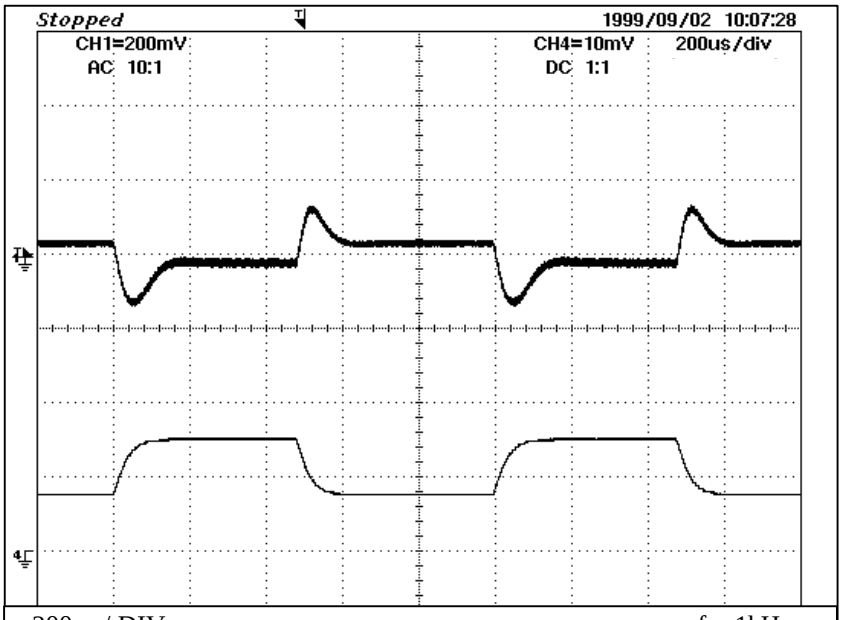
2-9 Dynamic Load Response Characteristics

Condition : Vin = 48 VDC
Tp = 25°C

5 V



2ms / DIV	f = 100Hz
Iout (20A / DIV)	Vout (0.2V / DIV)
50% ⇄ 100% (Tr = 75us, Tf = 75us)	+2.56% , -2.88%

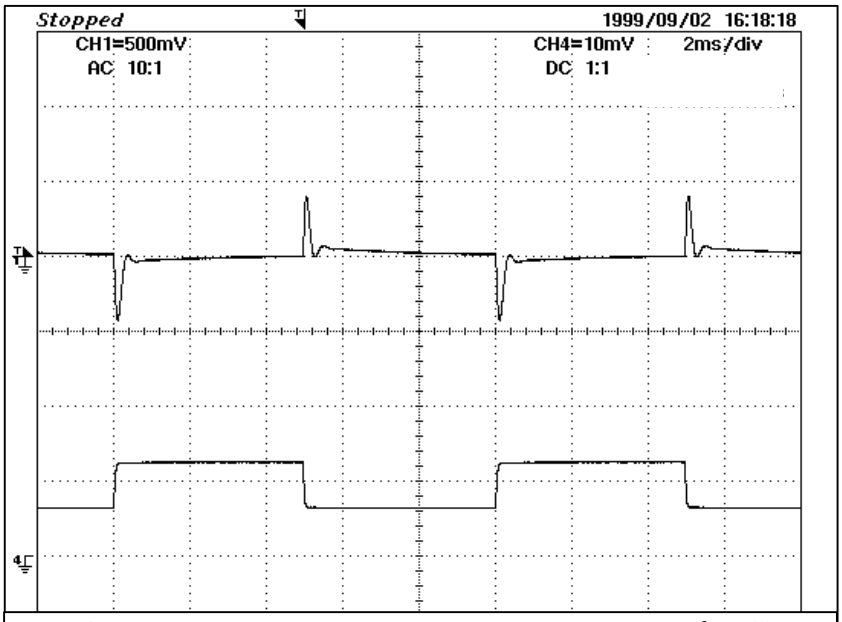


200us / DIV	f = 1kHz
Iout (20A / DIV)	Vout (0.2V / DIV)
50% ⇄ 100% (Tr = 75us, Tf = 75us)	+2.56% , -2.72%

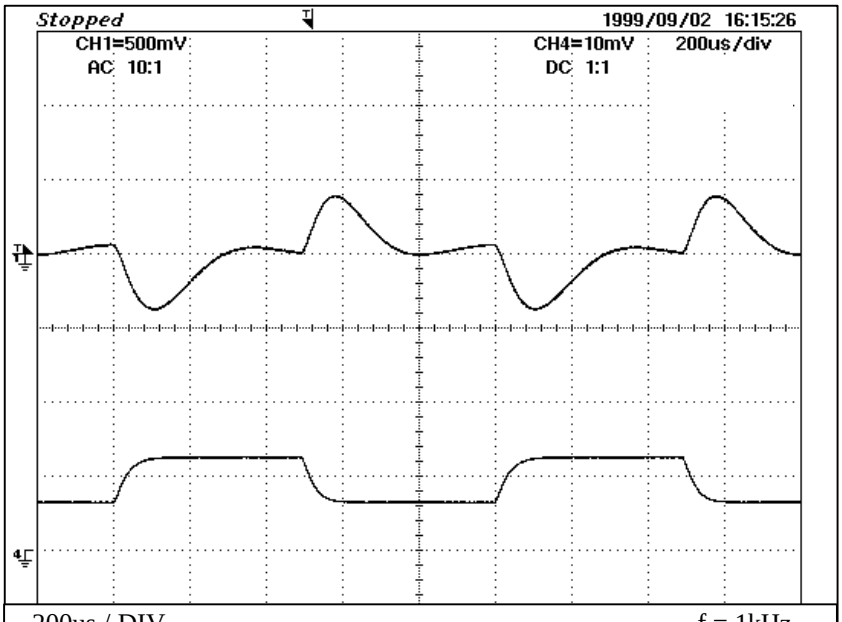
Dynamic Load Response Characteristics

Condition : Vin = 48 VDC
Tp = 25°C

12 V



2ms / DIV	f = 100Hz
Iout (10A / DIV)	Vout (0.5V / DIV)
50% ⇄ 100% (Tr = 75us, Tf = 75us)	+3.33% , -3.5%

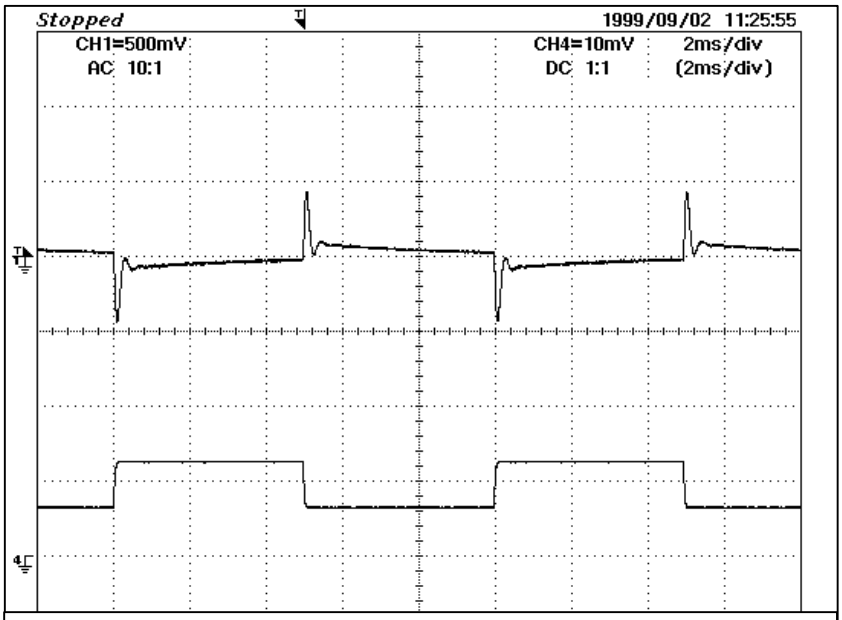


200us / DIV	f = 1kHz
Iout (10A / DIV)	Vout (0.5V / DIV)
50% ⇄ 100% (Tr = 75us, Tf = 75us)	+3.33% , -3.167%

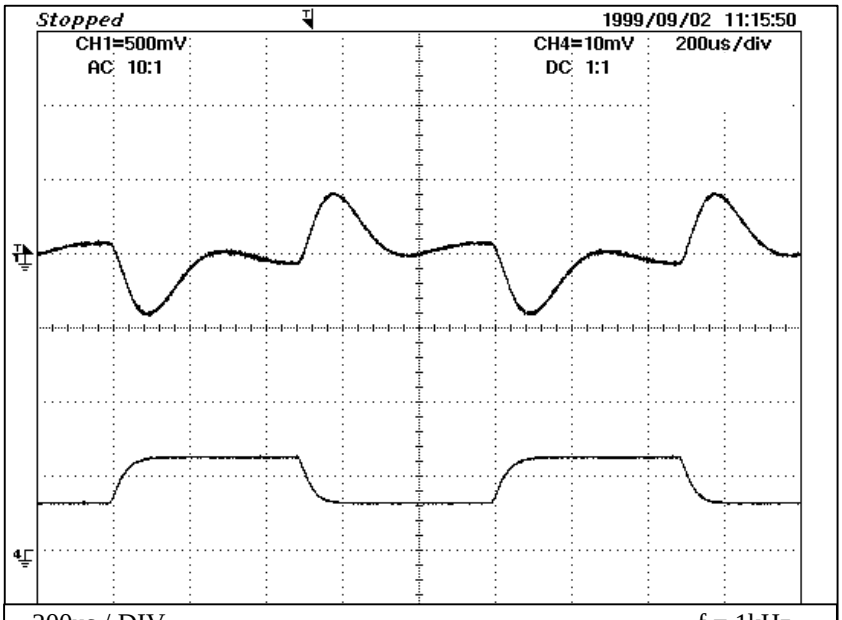
Dynamic Load Response Characteristics

Condition : Vin = 48 VDC
Tp = 25°C

24 V



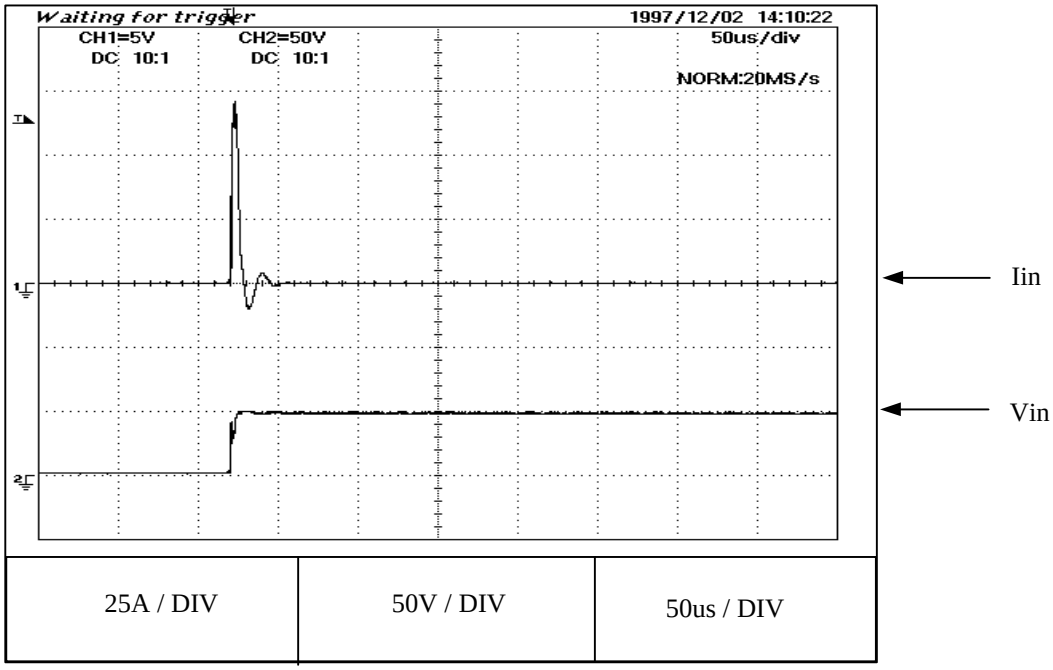
2ms / DIV	f = 100Hz
Iout (5A / DIV)	Vout (0.5V / DIV)
50% ⇄ 100% (Tr = 75us, Tf = 75us)	+1.83% , -1.83%



200us / DIV	f = 1kHz
Iout (5A / DIV)	Vout (0.5V / DIV)
50% ⇄ 100% (Tr = 75us, Tf = 75us)	+1.75% , -1.75%

2-10 Inrush Current Waveform

Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C



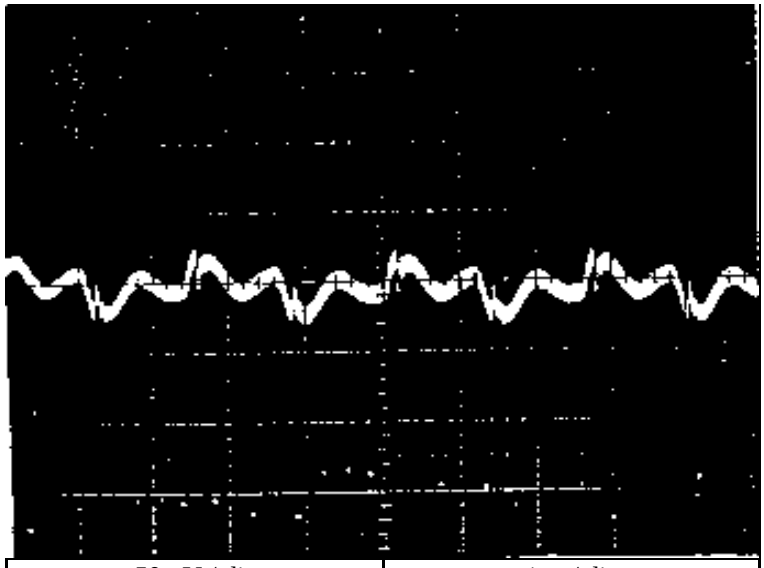
25A / DIV	50V / DIV	50us / DIV

2-11 Output - Ripple & Noise Waveform

Condition : Vin = 48V DC
Iout = 100%
Tp = 25°C

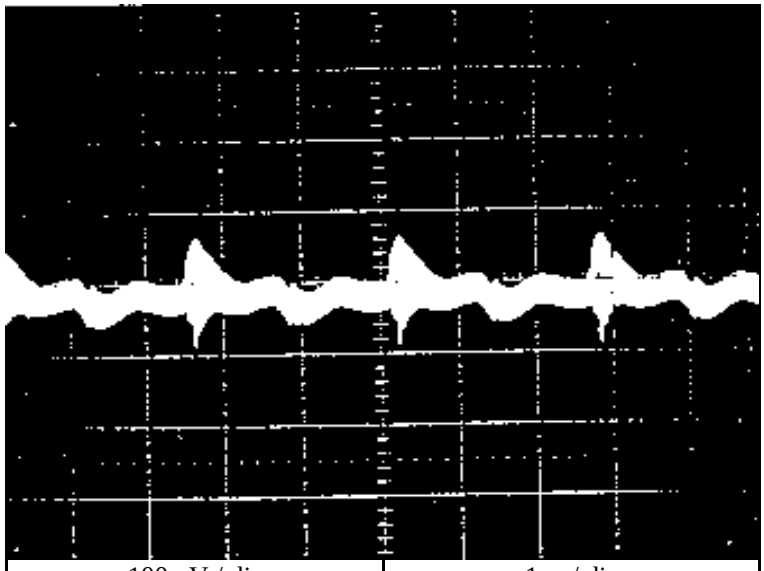
5 V

NORMAL MODE



50mV / div	1µs / div
58 mV (Vp-p)	

NORMAL + COMMON MODE



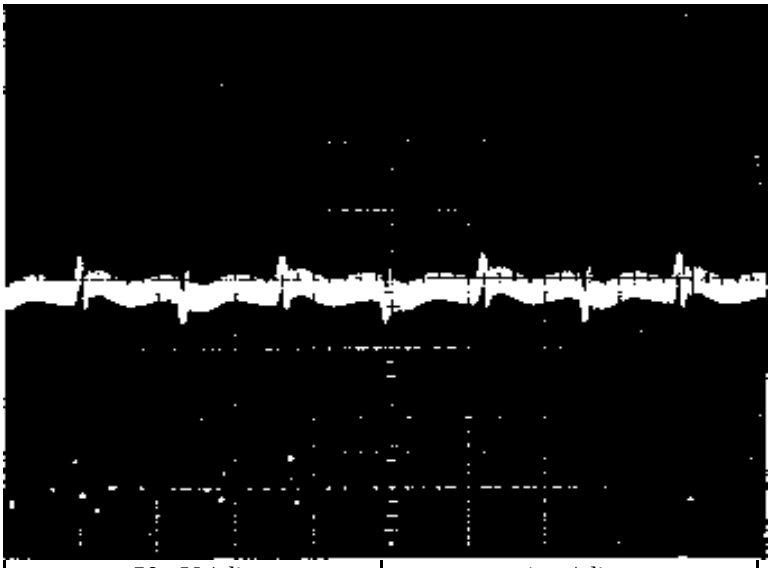
100mV / div	1µs / div
148 mV (Vp-p)	

Output - Ripple & Noise Waveform

Condition : Vin = 48V DC
Iout = 100%
Tp = 25°C

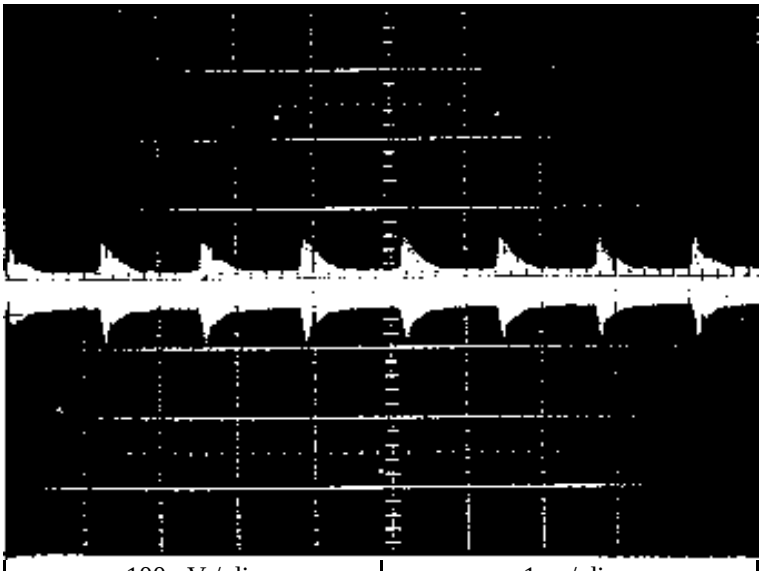
12 V

NORMAL MODE



50mV / div	1µs / div
50 mV (Vp-p)	

NORMAL + COMMON MODE



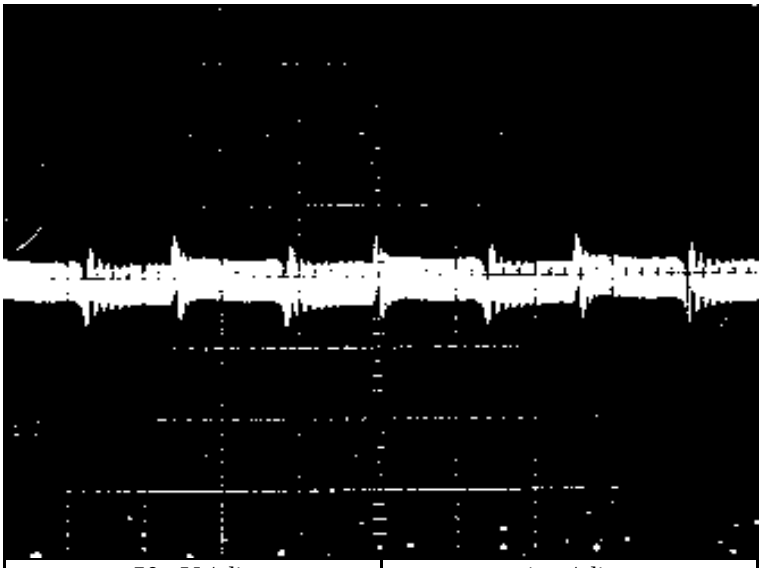
100mV / div	1µs / div
150 mV (Vp-p)	

Output - Ripple & Noise Waveform

Condition : Vin = 48V DC
Iout = 100%
Tp = 25°C

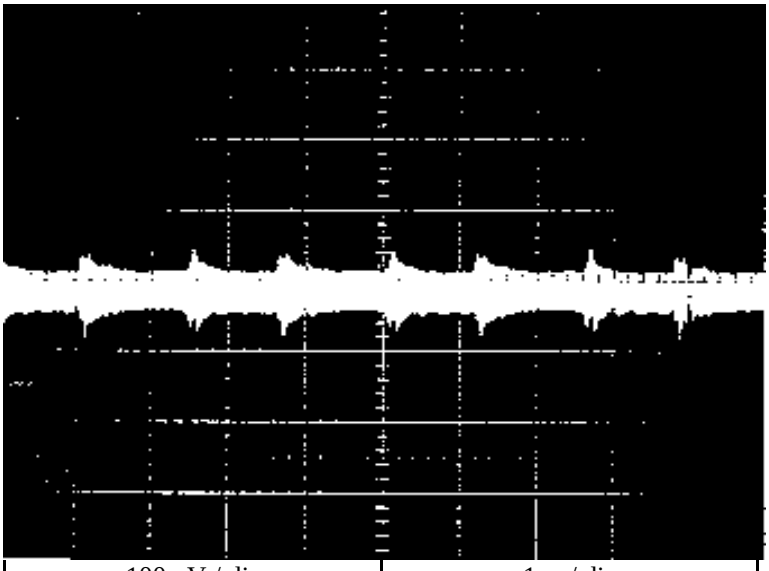
24 V

NORMAL MODE



50mV / div	1µs / div
80 mV (Vp-p)	

NORMAL + COMMON MODE

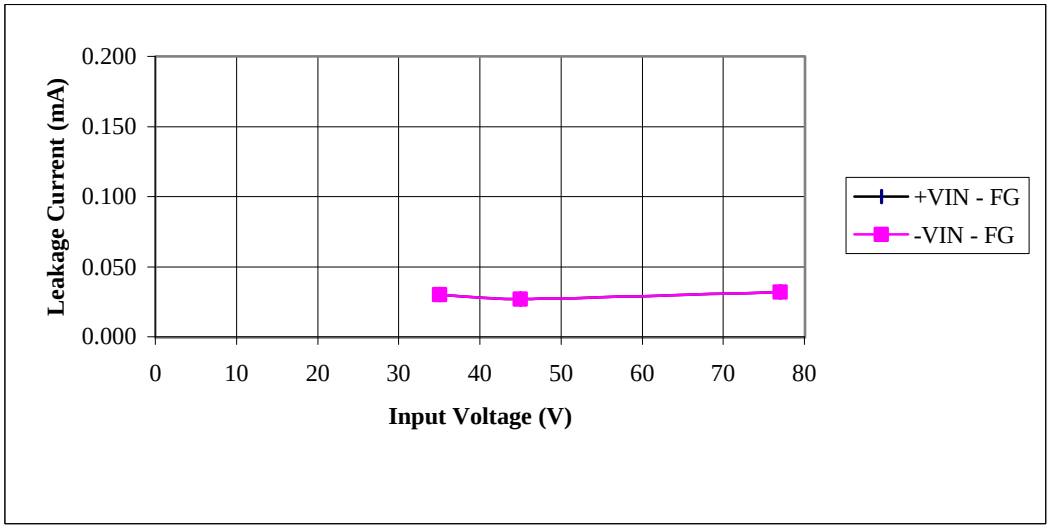


100mV / div	1µs / div
132 mV (Vp-p)	

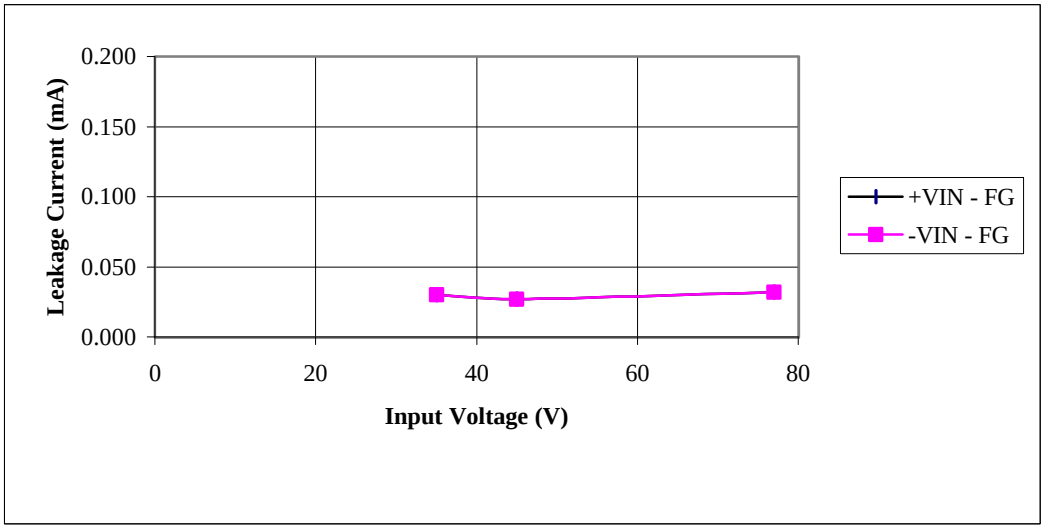
2-12 Leakage Current Characteristics

Condition : Iout = 100%
Tp= 25°C

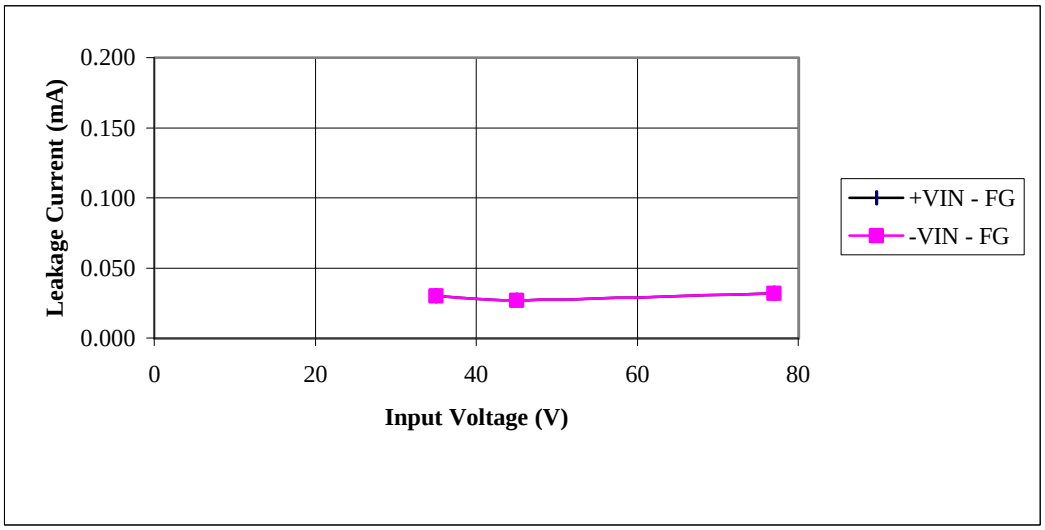
5V



12V



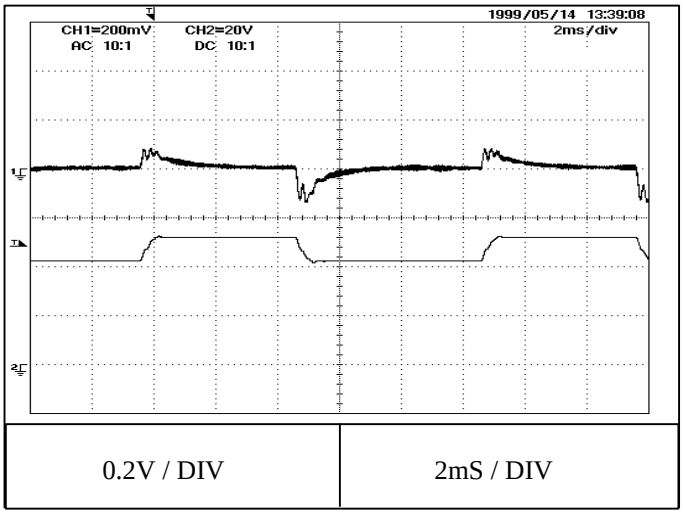
24V



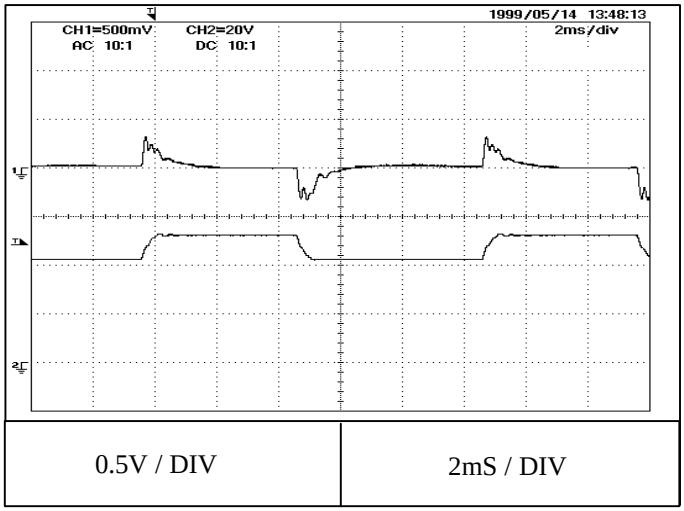
2-13 Dynamic Line Response Characteristics

Condition : Vin = 43 <=> 53VDC
Iout = 100%
Tp= 25°C

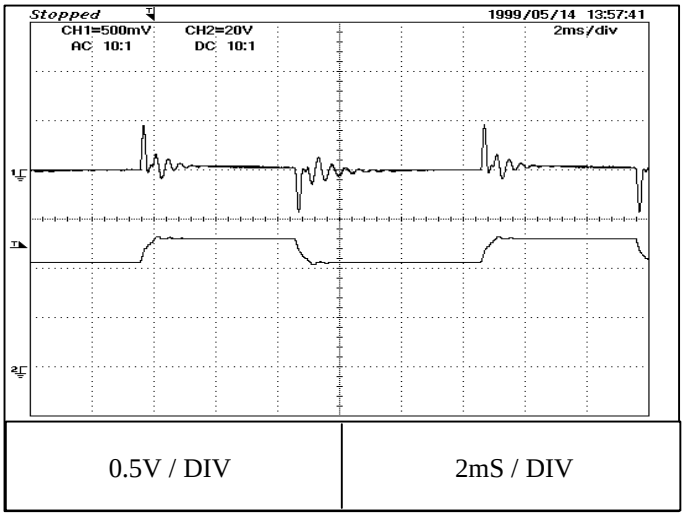
5 V



12 V



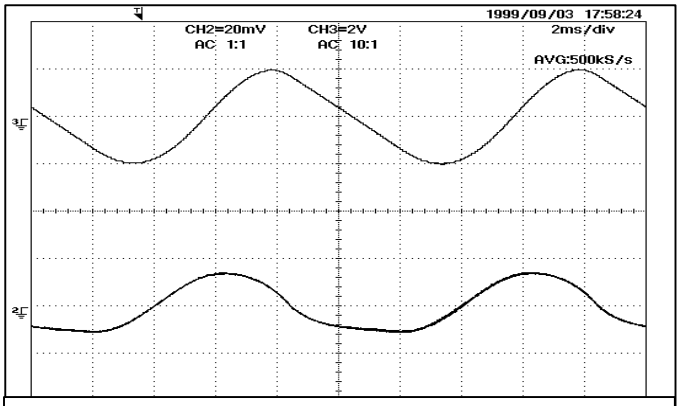
24 V



2-14 AC Input Response

Condition : Vin = 48 VDC
Iout = 100%
Tp= 25°C

5V

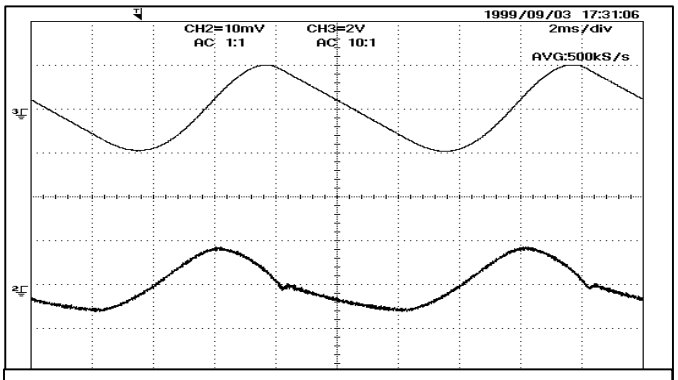


Input Waveform

Output Waveform

AC Input Ripple Voltage = 4V
Output Ripple Voltage = 24 mV

12V

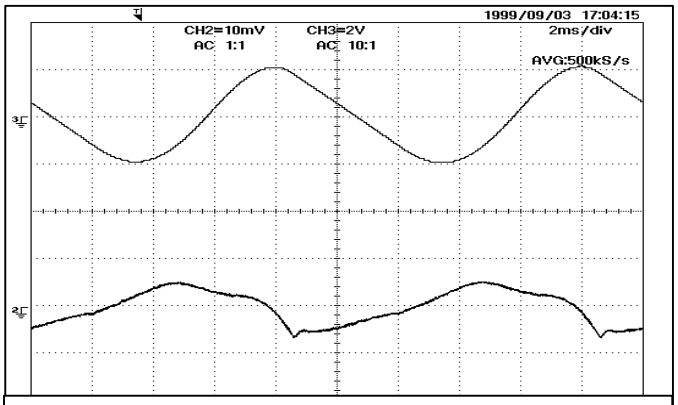


Input Waveform

Output Waveform

AC Input Ripple Voltage = 4V
Output Ripple Voltage = 16 mV

24V



Input Waveform

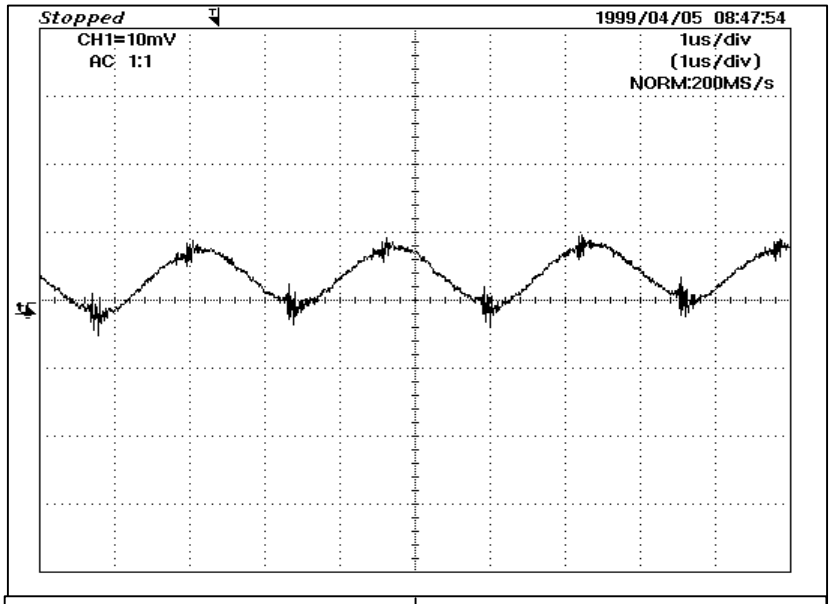
Output Waveform

AC Input Ripple Voltage = 4V
Output Ripple Voltage = 18 mV

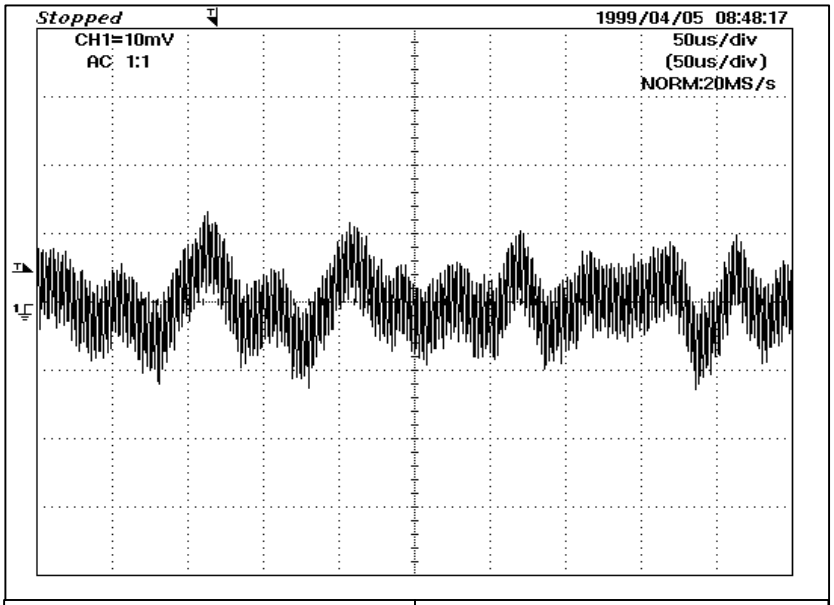
2-15 INPUT REFLECTED CURRENT

Condition : Vin = 48 VDC
Iout = 100%
Tp= 25°C

5 V



10mA / DIV	1uS / DIV

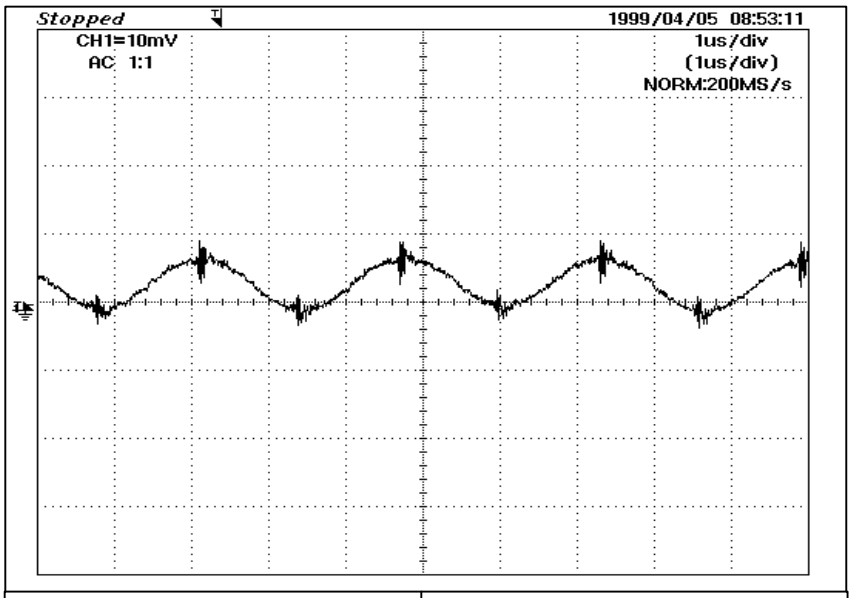


10mA / DIV	50uS / DIV

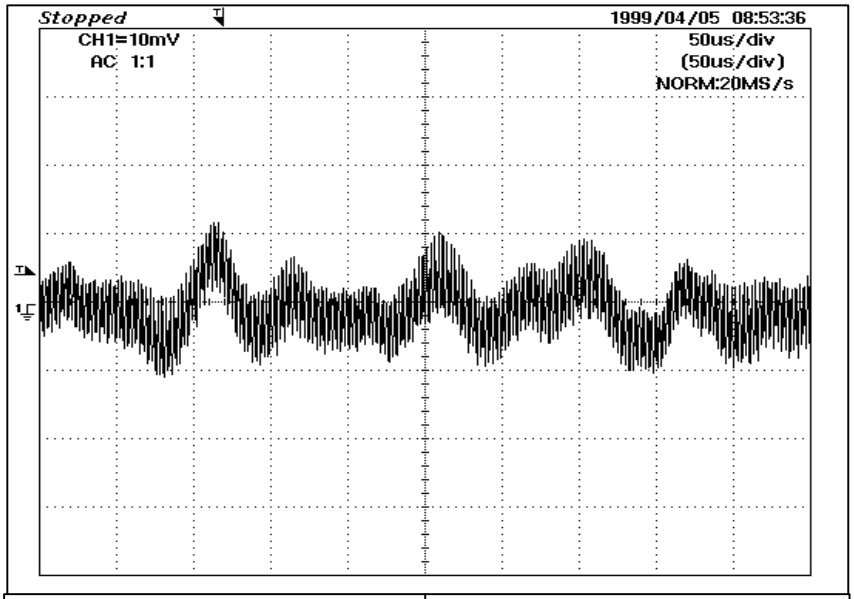
2-15 INPUT REFLECTED CURRENT

Condition : Vin = 48 VDC
Iout = 100%
Tp= 25°C

12 V



10mA / DIV	1uS / DIV

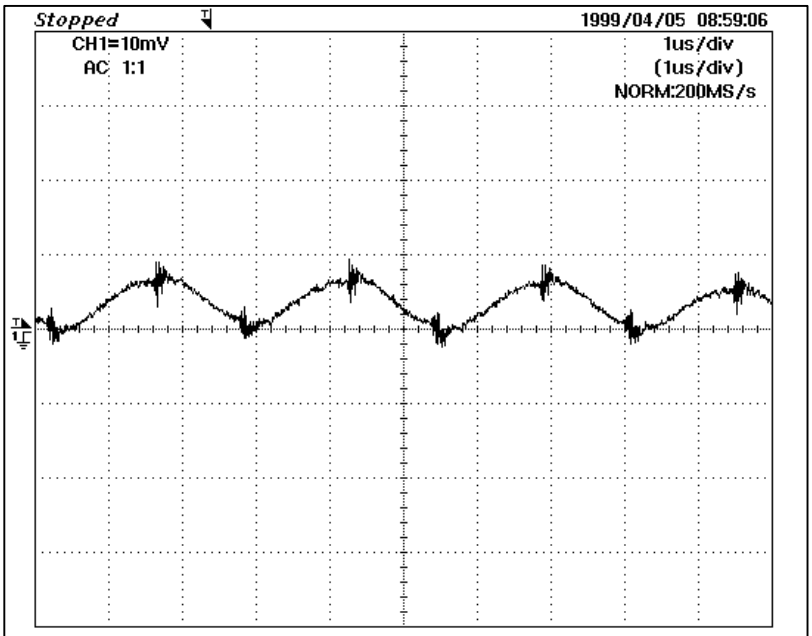


10mA / DIV	50uS / DIV

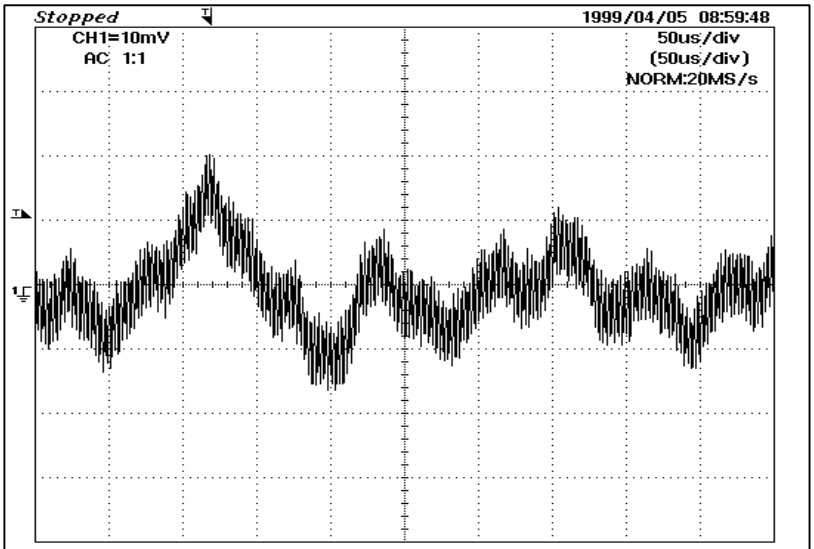
2-15 INPUT REFLECTED CURRENT

Condition Vin = 48 VDC
Iout = 100%
Tp= 25°C

24 V



10mA / DIV	1uS / DIV



10mA / DIV	50uS / DIV