PAH50S48-*

QUALITY TEST DATA

POWER MODULE

DRAWING NO. : PA552-53-01		
NLS R&D		
PREPARED	CHECKED	APPROVED
3/9/99	3/9/99	3/9/99
DATE ISSUE :	3/9/99	

NEMIC-LAMBDA (S) PTE LTD

INDEX

PAH50S48-*

1. Evaluation Method **PAGE**

1 - 1 Circuit used for determination T - 1
(1) Steady state data
(2) Warm up voltage drift characteristics
(3) Over current protection (O.C.P.) characteristics
(4) Over voltage protection (O.V.P.) characteristics
(5) Output rise characteristics
(6) Output fall characteristics
(7) Output rise characteristics with ON / OFF control (negative logic)
(8) Output fall characteristics with ON / OFF control (negative logic)
(9) Dynamic load response characteristics
(10) Inrush current waveform
(11) Output-ripple , noise waveform
(12) Leakage current characteristics
(13) Dynamic line response characteristics
(14) AC input response
(15) Input reflected current

1 - 2 List of equipment used T - 6

2. Characteristics

2 - 1 Steady state data T - 7
(1) Regulation - line and load , temp. drift
(2) Output voltage and ripple voltage v.s. input voltage
(3) Efficiency and input current v.s.output current
(4) Efficiency v.s. input voltage
2 - 2 Warm up voltage drift characteristics T - 11
2 - 3 Over current protection (O.C.P.) characteristics T - 12
2 - 4 Over voltage protection (O.V.P.) characteristics T - 14
2 - 5 Output rise characteristics T - 15
2 - 6 Output fall characteristics T - 17
2 - 7 Output rise characteristics with ON / OFF control (negative logic) T - 19
2 - 8 Output fall characteristics with ON / OFF control (negative logic) T - 21
2 - 9 Dynamic load response characteristics T - 23
2 - 10 Inrush current waveform T - 26
2 - 11 Output-ripple , noise waveform T - 27
2 - 12 Leakage current characteristics T - 30
2 - 13 Dynamic line response characteristics T - 31
2 - 14 AC input response T - 32
2 - 15 Input reflected current T - 33

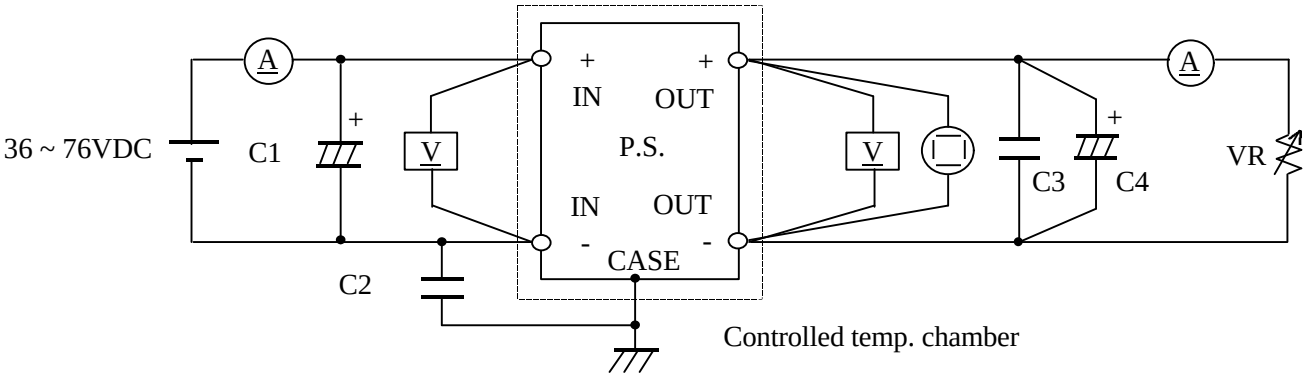
Terminology used

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



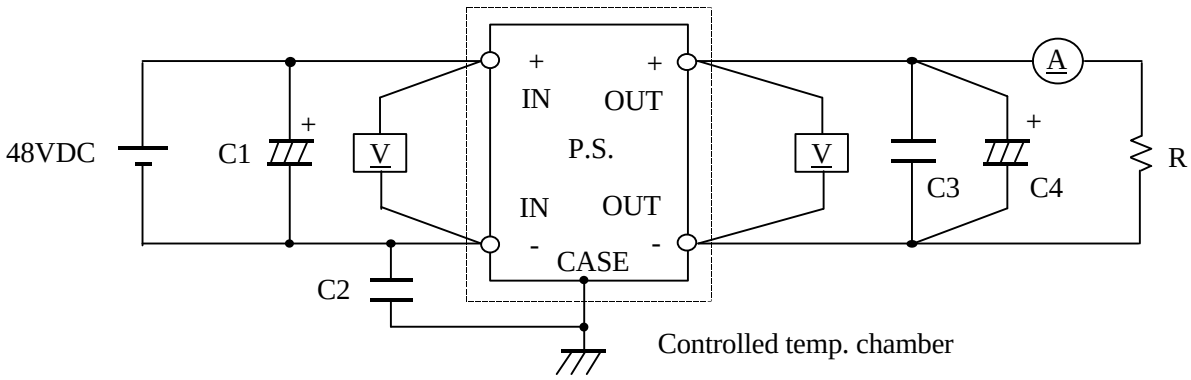
(i) Tp = -20°C ~ 100°C

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

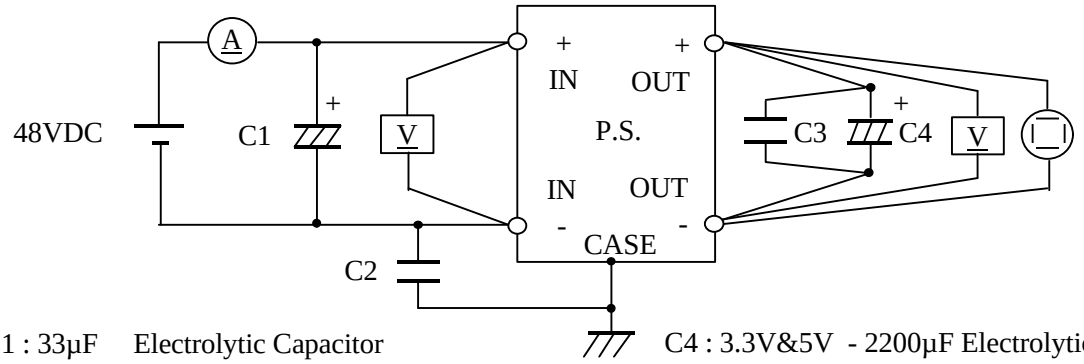


C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1µF Ceramic Capacitor
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

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

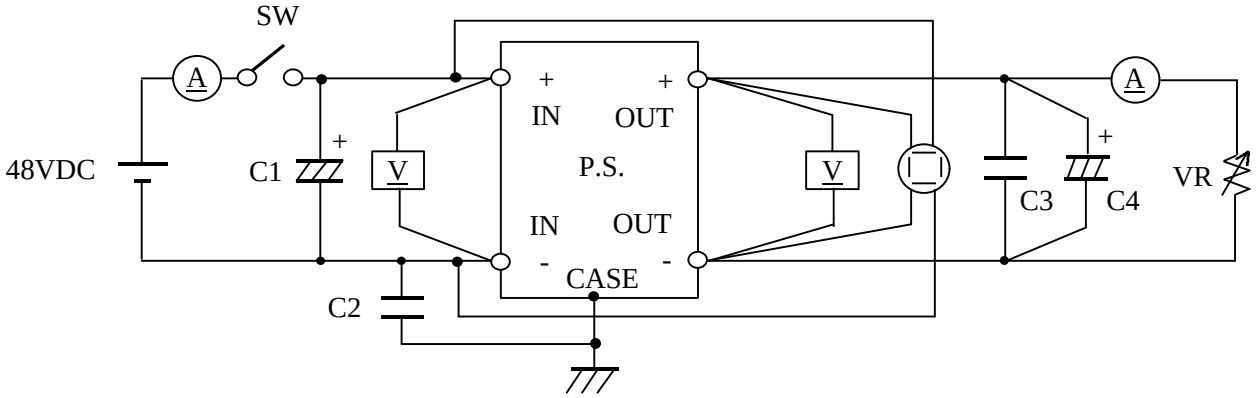
Same as steady state data

(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

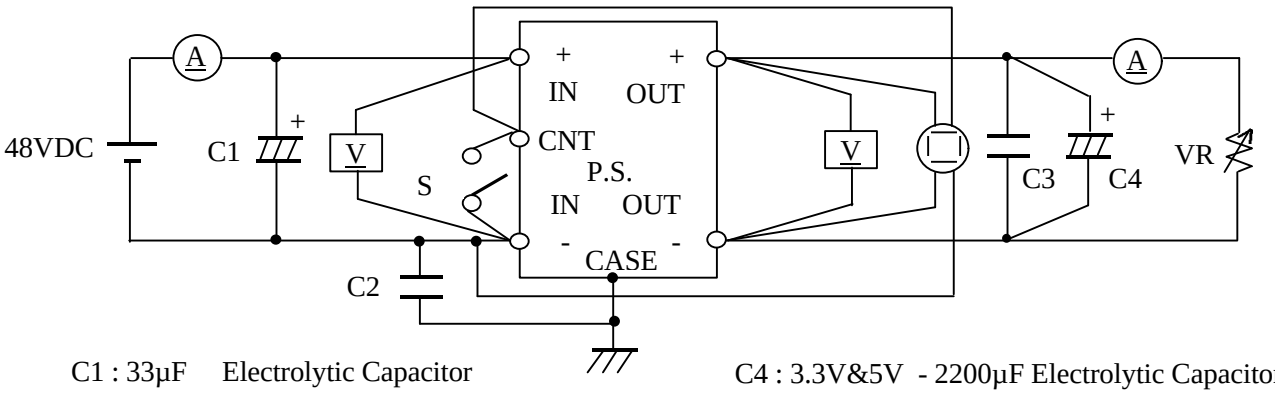
(5) Output rise characteristics



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

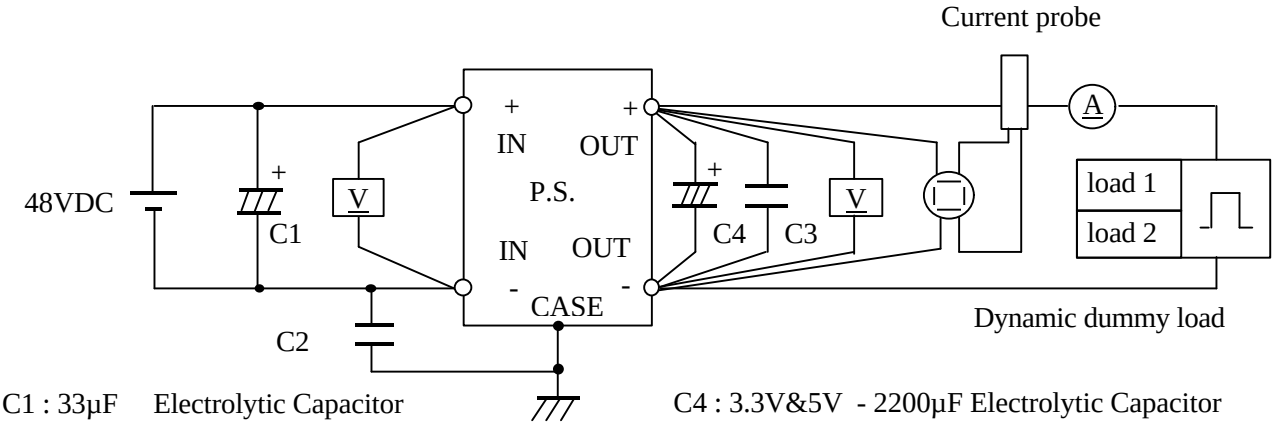


C1 : 33µF Electrolytic Capacitor
C2 : 4700pF Ceramic Capacitor
C3 : 1uF Ceramic Capacitor
C4 : 3.3V&5V - 2200µF Electrolytic Capacitor
12V&15V - 470µF Electrolytic Capacitor
24V&28V - 220µF Electrolytic Capacitor

(8) Output fall characteristics with on/off control

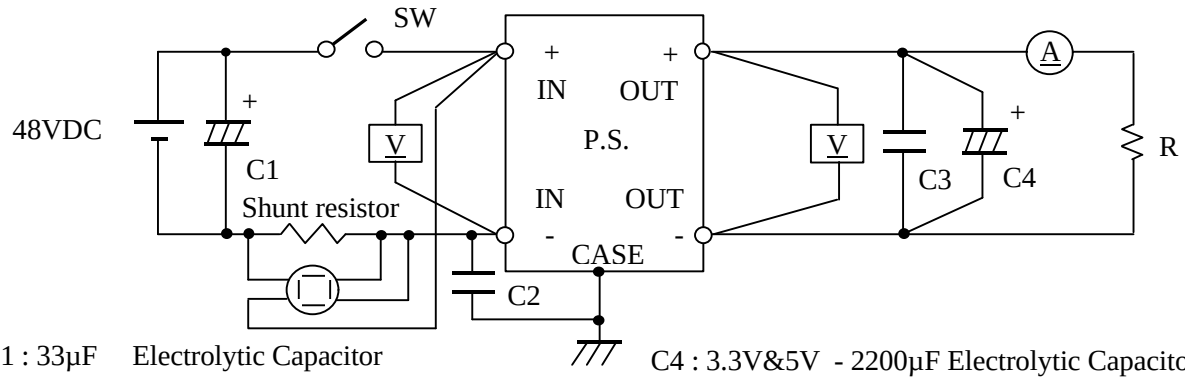
Same as Output rise characteristics with on/off control

(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

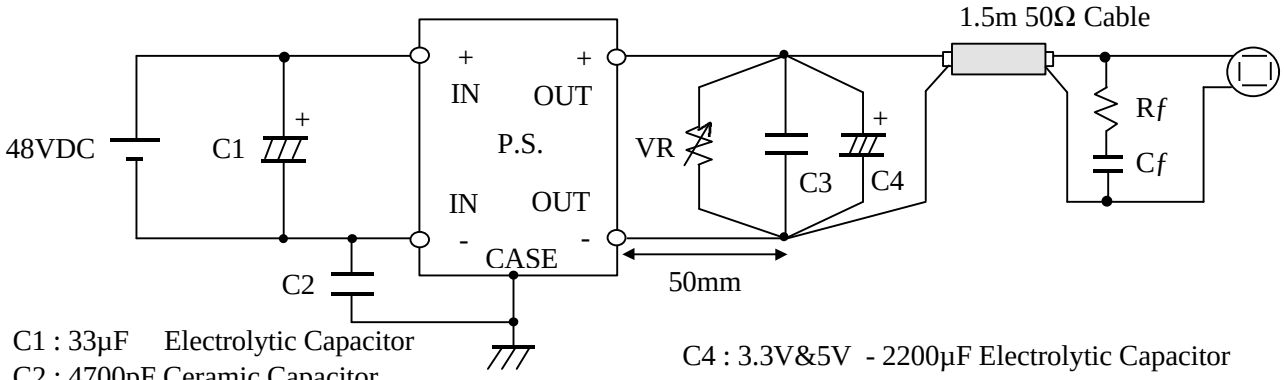
(10) Inrush current waveform



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

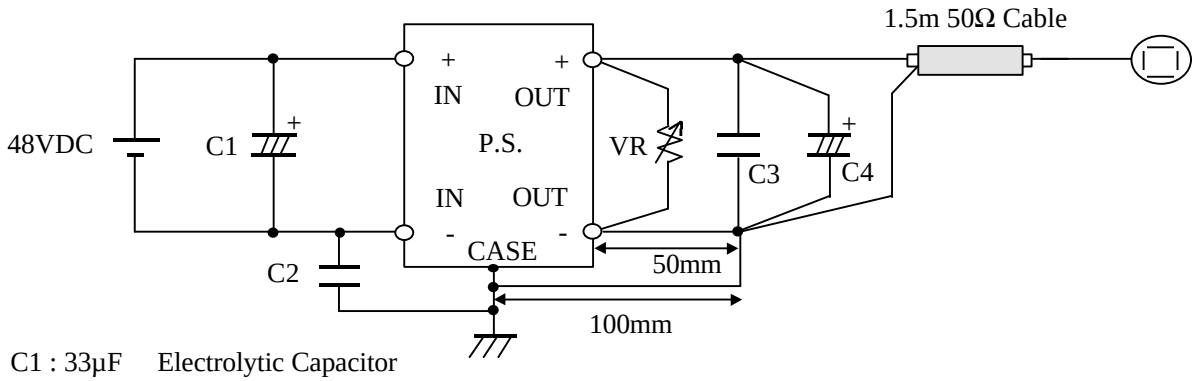
NORMAL MODE (EIAJ Standard RC-9002A)



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

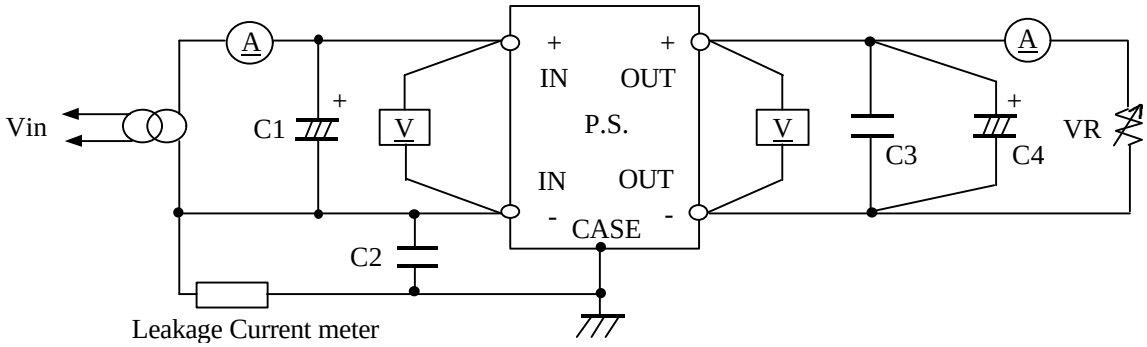
NORMAL + COMMON MODE



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

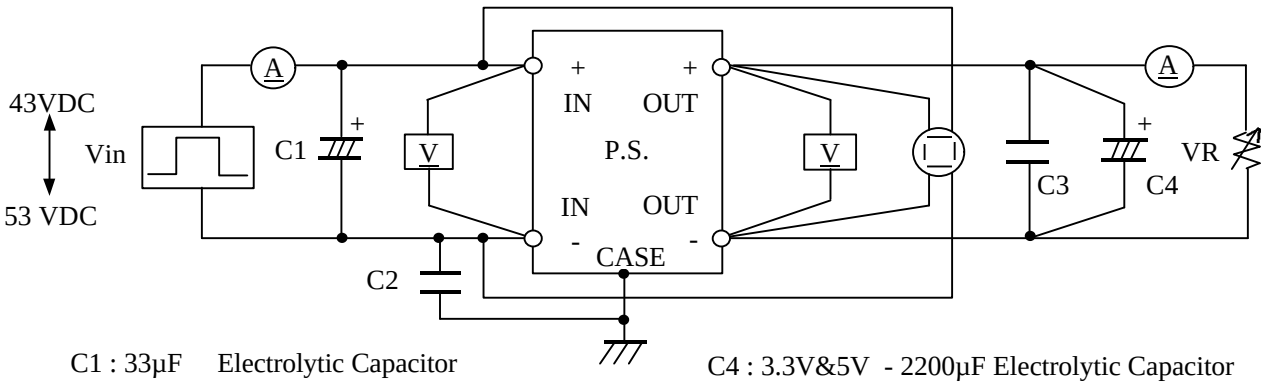
(12) Leakage current characteristics



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

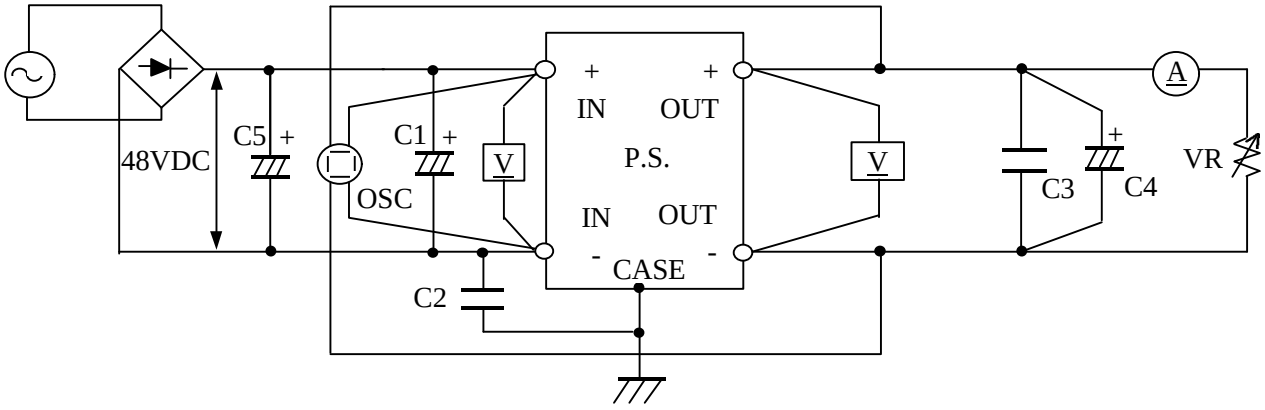
(13) Dynamic line characteristics



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

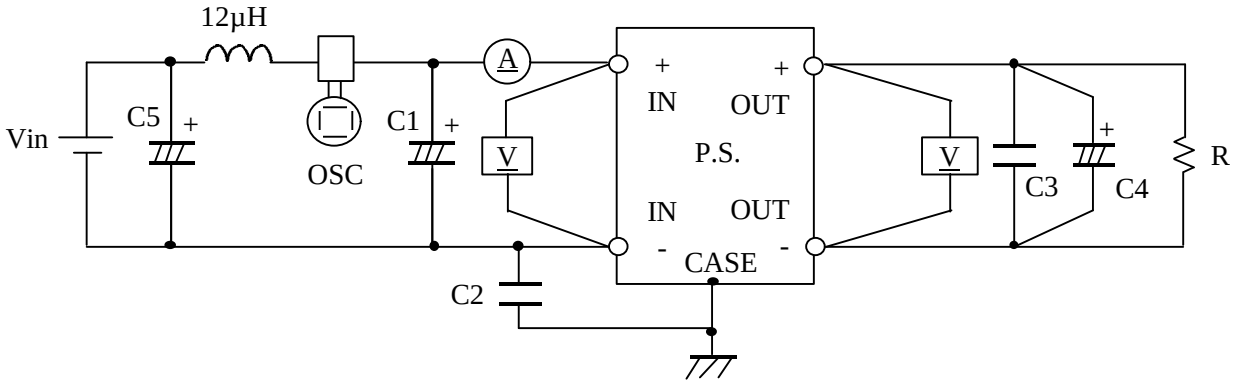
(14) AC input response characteristics



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%	5.051V	5.051V	5.051V	0 mV	0.00%
50%	5.050V	5.050V	5.050V	0 mV	0.00%
100%	5.049V	5.049V	5.049V	0 mV	0.00%
Load Regulation	2 mV	2 mV	2 mV		
	0.04%	0.04%	0.04%		

Temperature Drift — Vin = 48VDC, Iout = 100%

Tp	-40°C	25°C	100°C	Temp. Stability	
Vout	5.039V	5.056V	5.054V	17 mV	0.34%

12 V

Regulation - Line and Load — Tp = 25°C

Iout \ Vin	36 VDC	48 VDC	76 VDC	Line Regulation	
0%	12.024V	12.020V	12.019V	5 mV	0.042%
50%	12.026V	12.025V	12.024V	2 mV	0.017%
100%	12.026V	12.025V	12.025V	1 mV	0.008%
Load Regulation	2 mV	5 mV	6 mV		
	0.017%	0.042%	0.050%		

Temperature Drift — Vin = 48VDC, Iout = 100%

Tp	-40°C	25°C	100°C	Temp. Stability	
Vout	12.002V	12.030V	12.010V	28 mV	0.23%

24 V

Regulation - Line and Load — Tp = 25°C

Iout \ Vin	36 VDC	48 VDC	76 VDC	Line Regulation	
0%	24.009V	24.007V	24.005V	4 mV	0.017%
50%	24.011V	24.011V	24.009V	2 mV	0.008%
100%	24.011V	24.012V	24.011V	1 mV	0.004%
Load Regulation	2 mV	5 mV	6 mV		
	0.008%	0.021%	0.025%		

Temperature Drift — Vin = 48VDC, Iout = 100%

Tp	-40°C	25°C	100°C	Temp. Stability	
Vout	23.958V	24.029V	23.926V	103 mV	0.43%

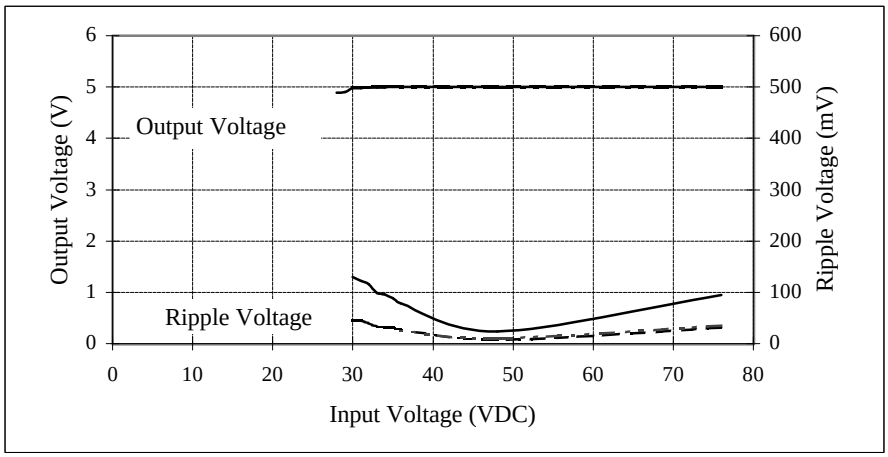
2. CHARACTERISTICS

2-1 Steady State Data

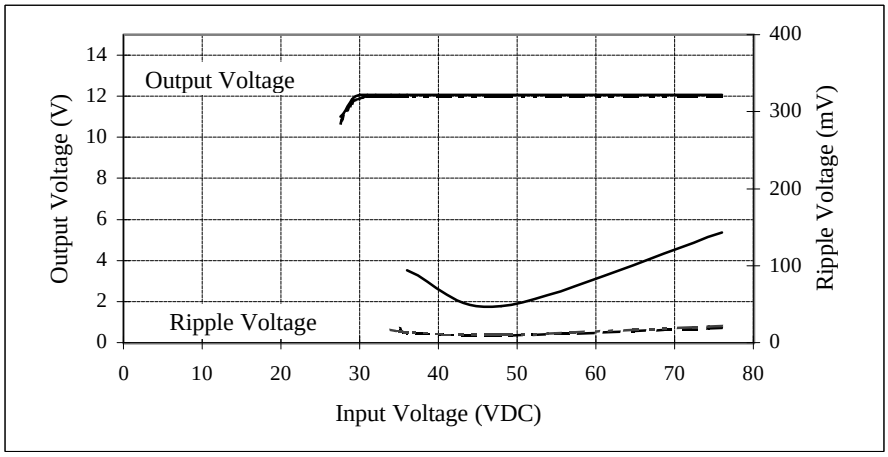
(2) Output Voltage And Ripple Voltage V.S. Input Voltage

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

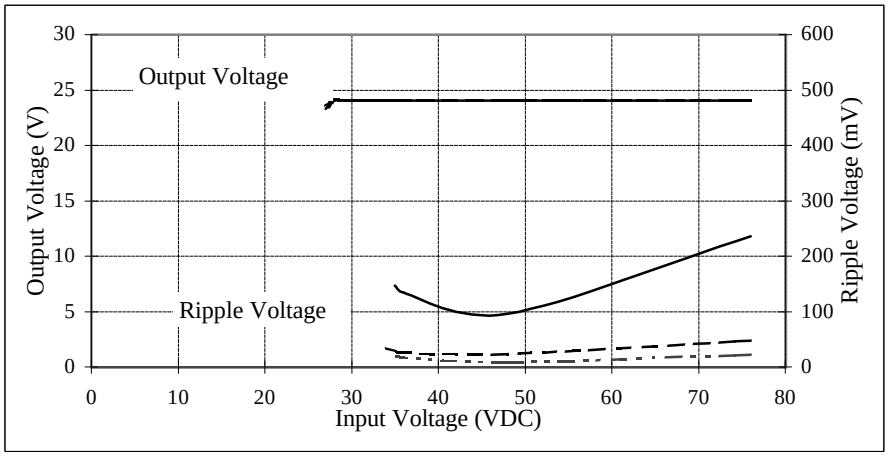
5 V



12 V



24 V



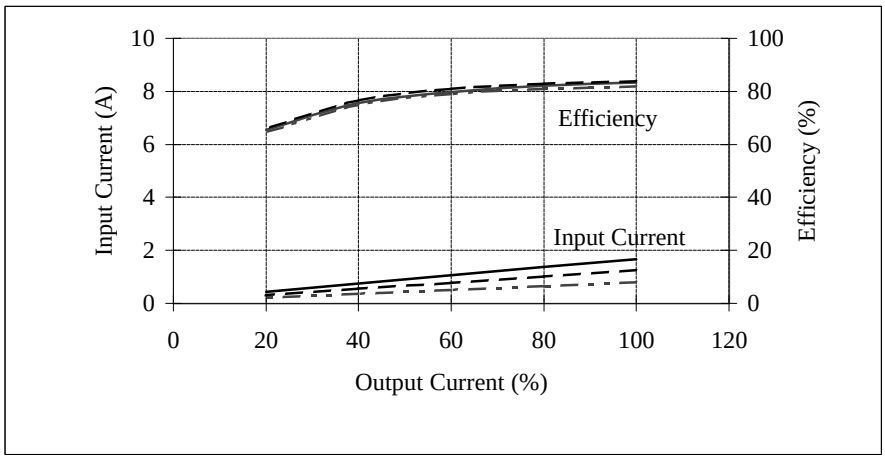
2. CHARACTERISTICS

2-1 Steady State Data

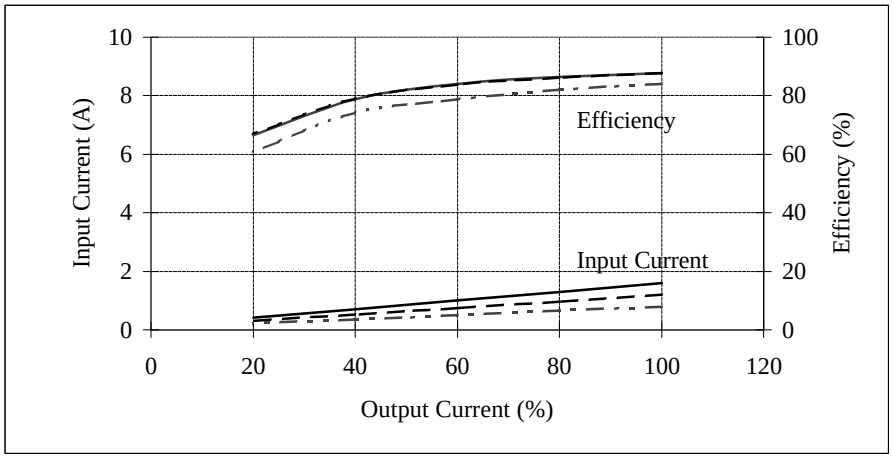
(3) Efficiency And Input Current V.S. Output Current

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

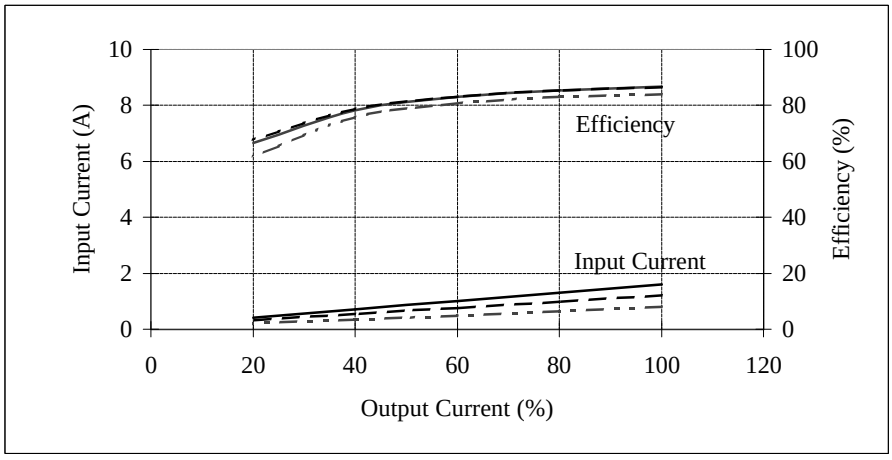
5 V



12 V



24 V



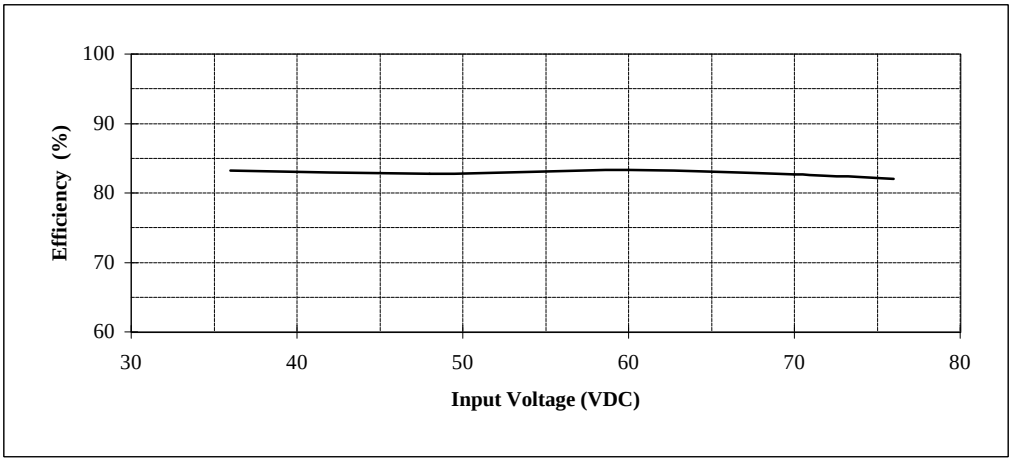
2. CHARACTERISTICS

2-1 Steady State Data

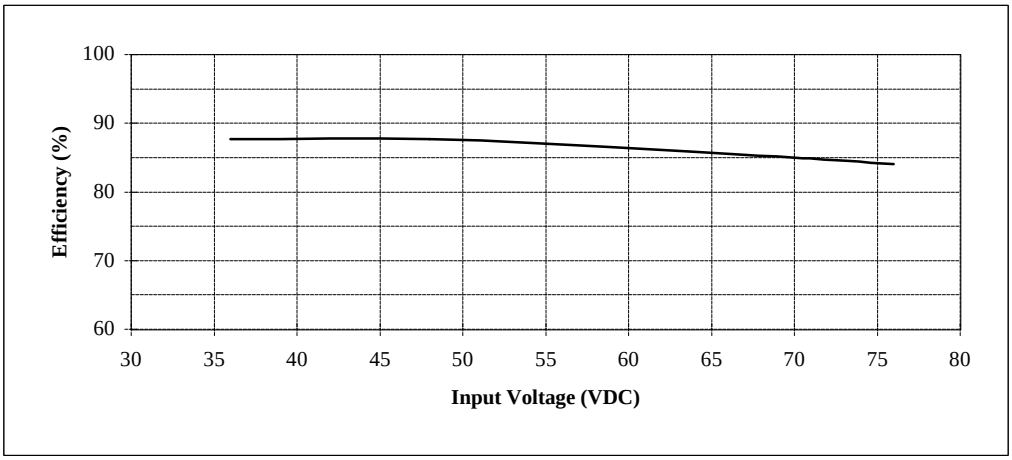
(4) Efficiency v.s. Input Voltage

Condition : Iout = 100%
Tp = 25°C

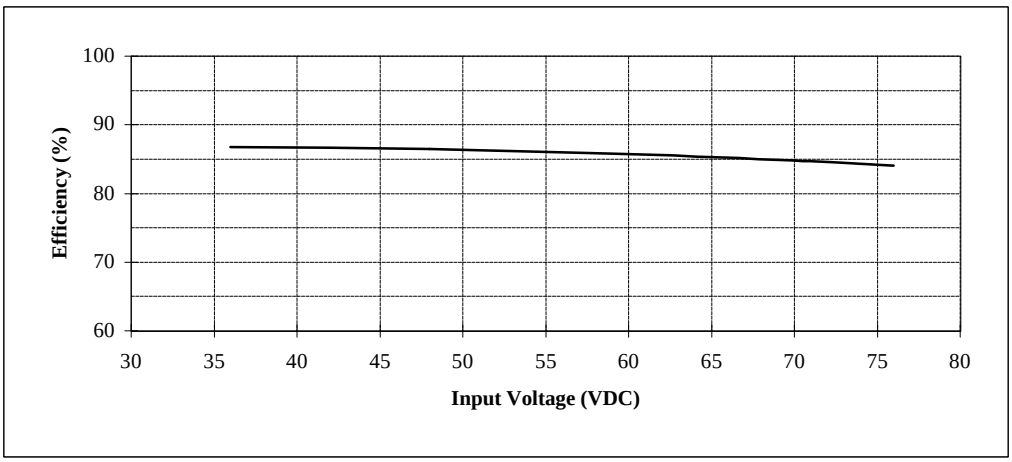
5 V



12 V



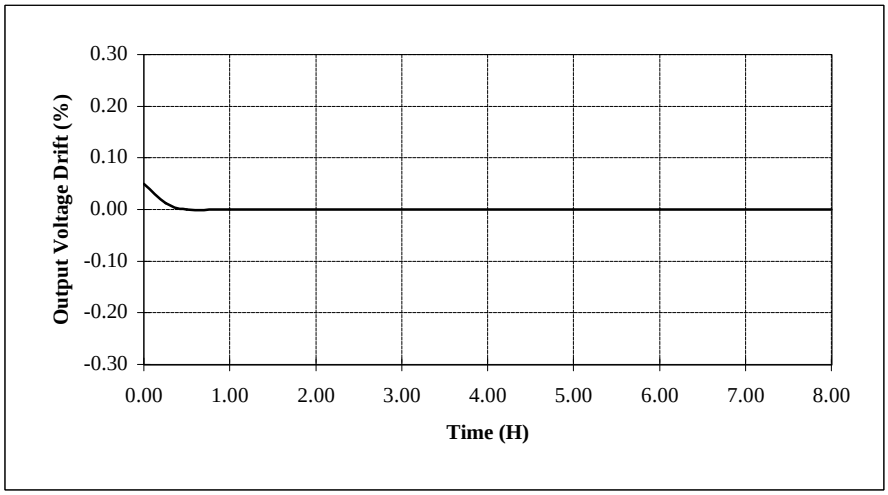
24 V



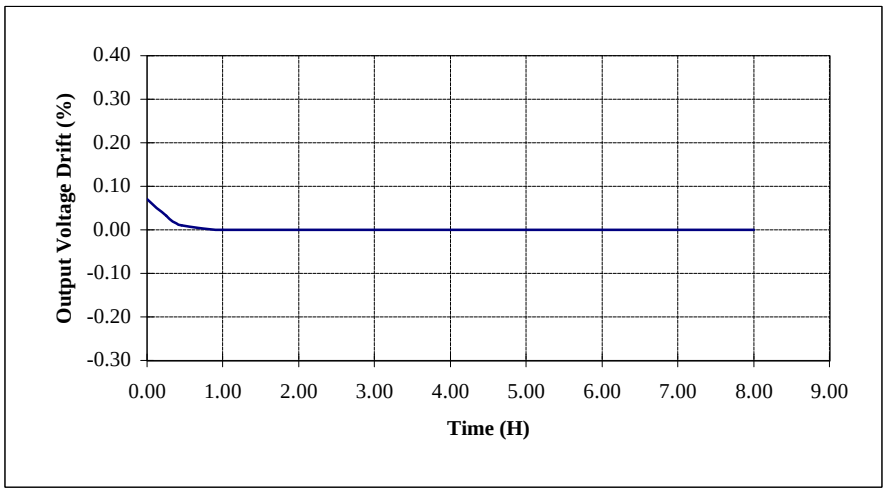
2-2 Warm Up Voltage Drift Characteristics

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

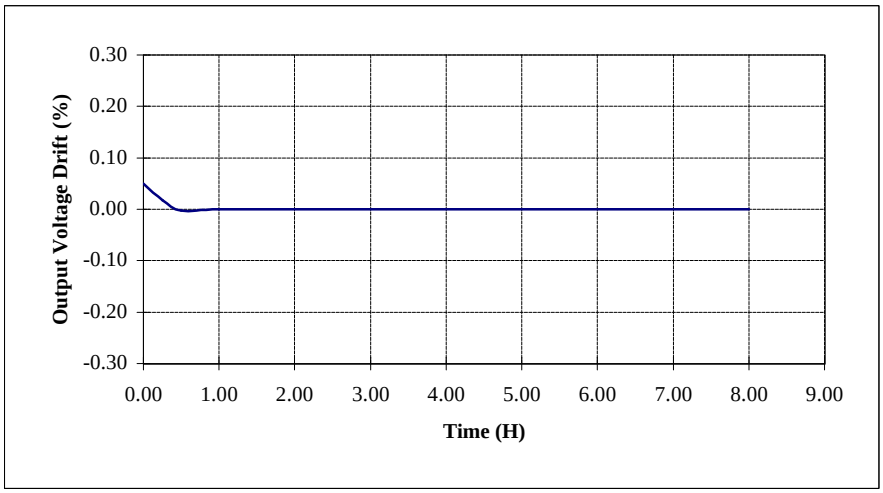
5 V



12 V



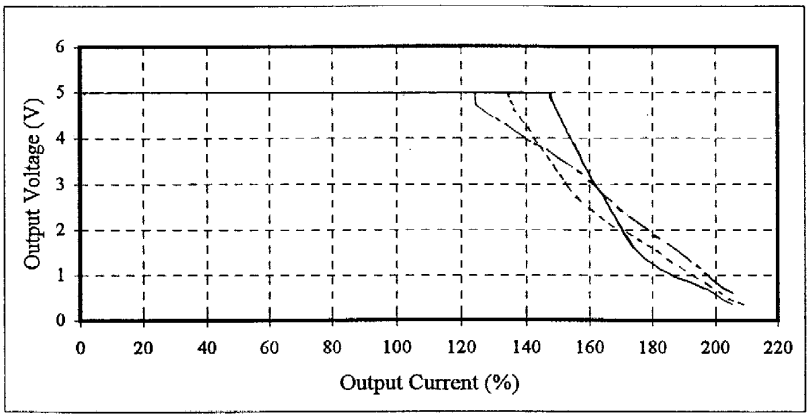
24 V



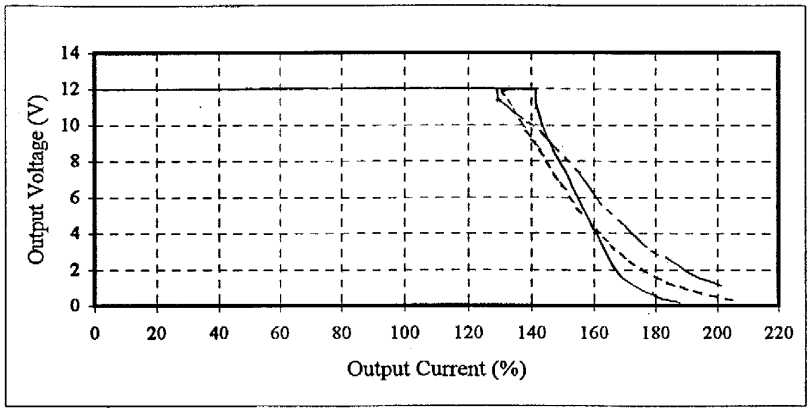
2-3 O.C.P. Charateristics

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

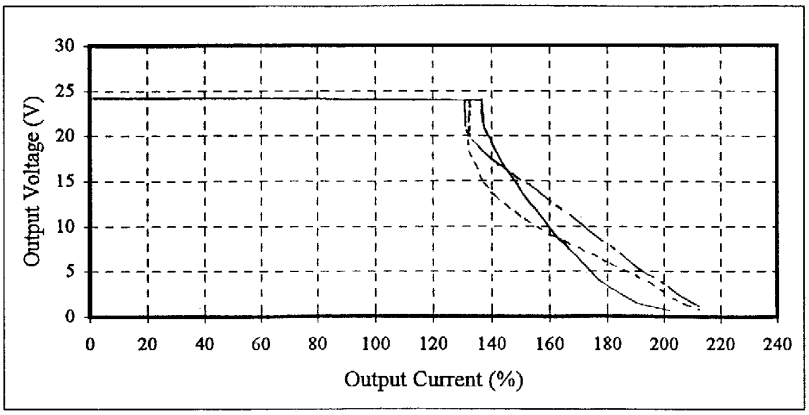
5 V



12 V



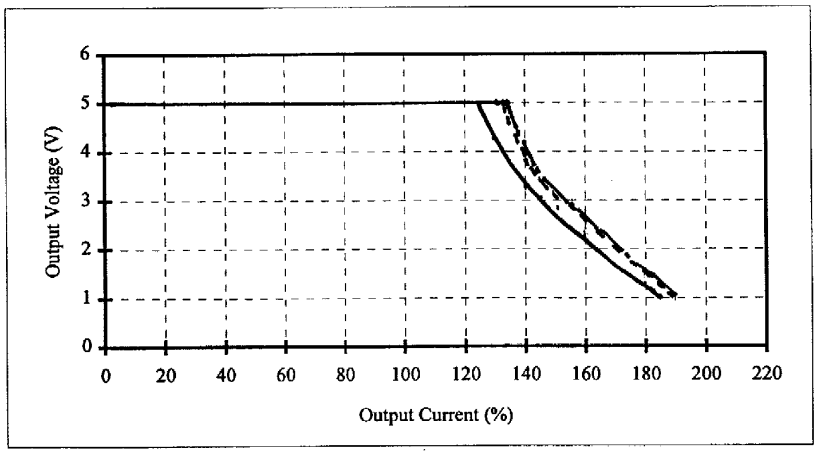
24 V



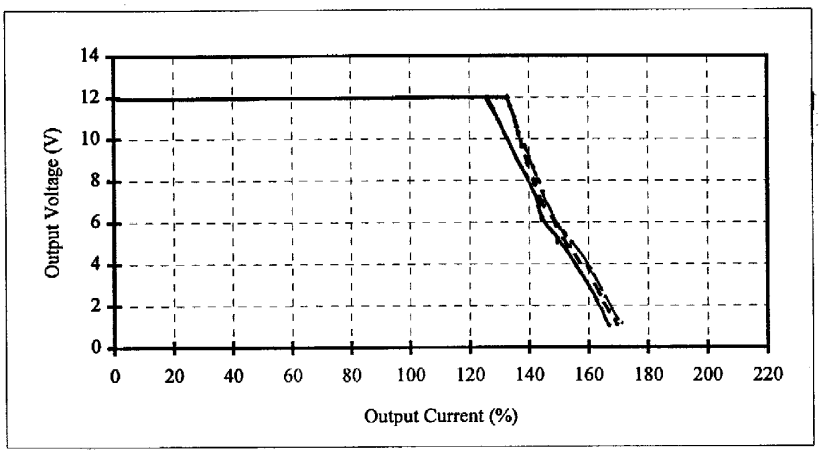
O.C.P. Charateristics

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

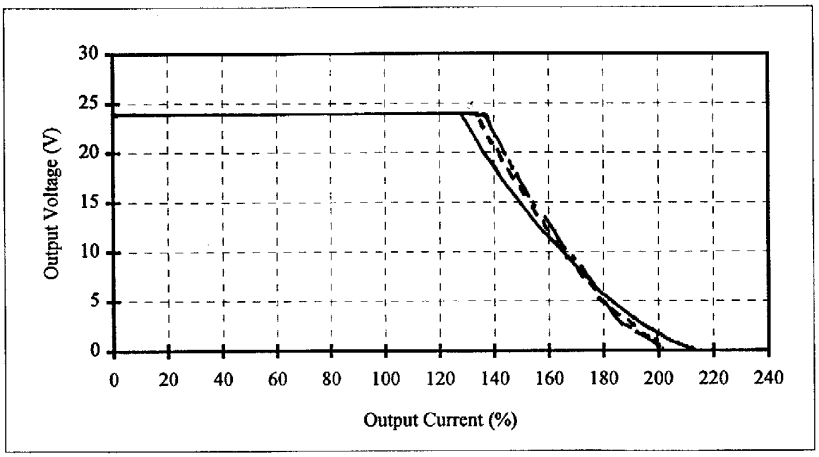
5 V



12 V



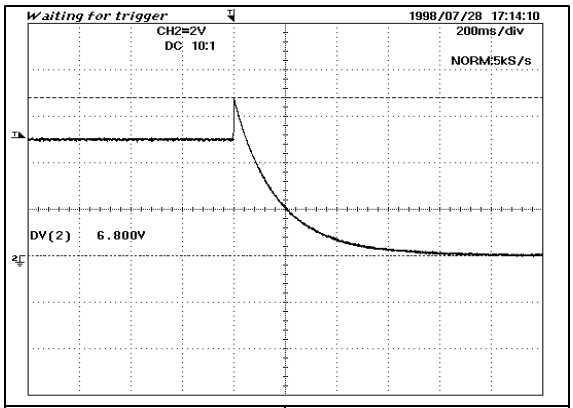
24 V



2-4 O.V.P. Characteristics

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

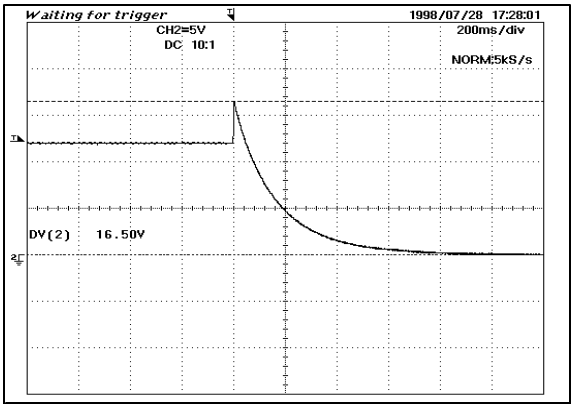
5 V



2V / DIV	200 ms / DIV

← OVP Trip Point

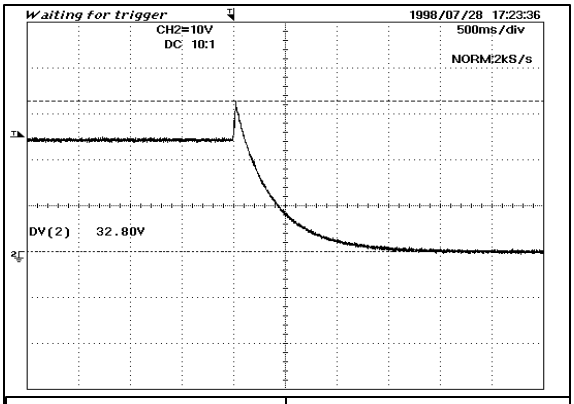
12 V



5V / DIV	200ms / DIV

← OVP Trip Point

24 V



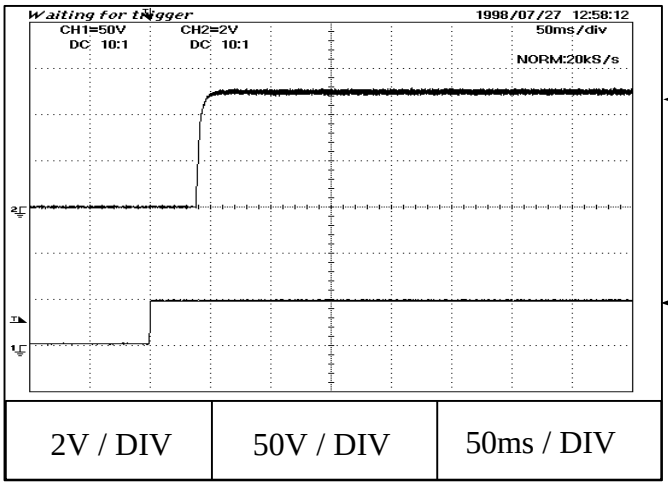
10V / DIV	500ms / DIV

← OVP Trip Point

2-5 Output Rise Characteristics

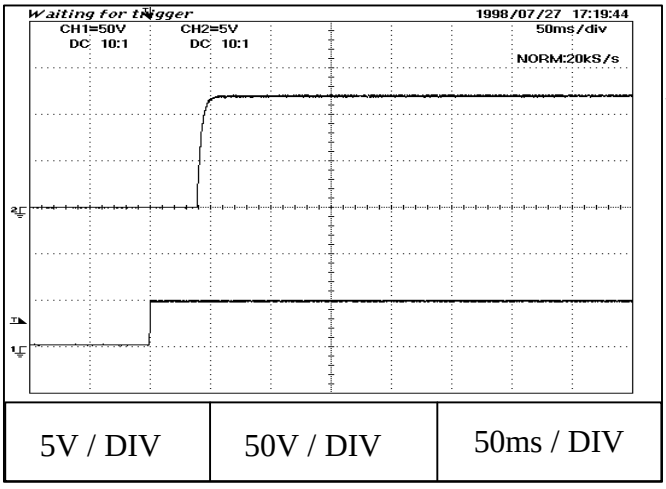
Condition : Vin = 48 V DC
Iout = 0 %
Tp = 25°C

5 V



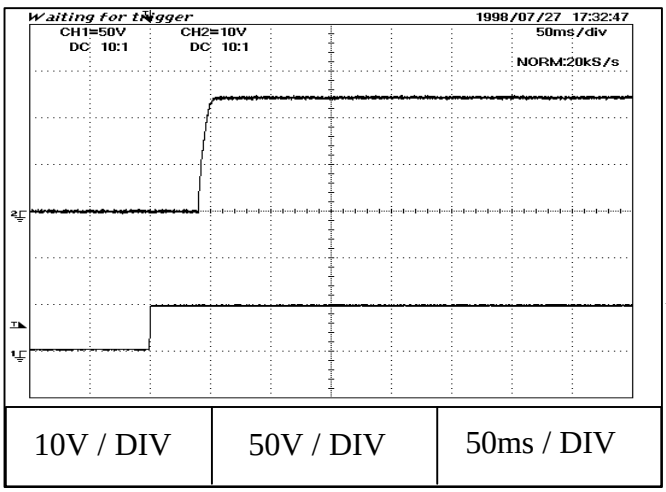
2V / DIV	50V / DIV	50ms / DIV

12 V



5V / DIV	50V / DIV	50ms / DIV

24 V

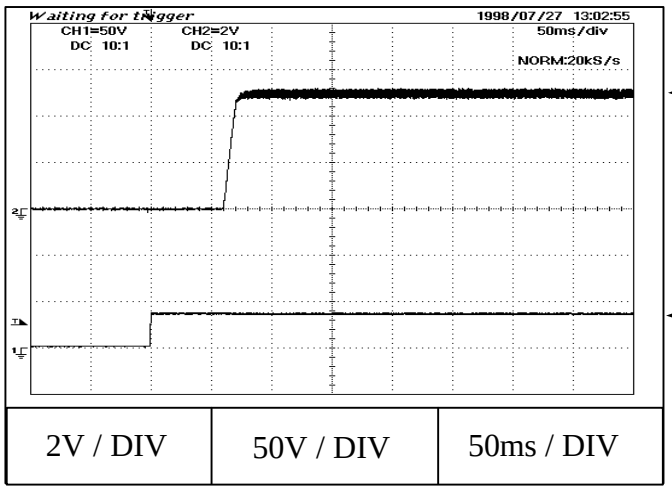


10V / DIV	50V / DIV	50ms / DIV

Output Rise Characteristics

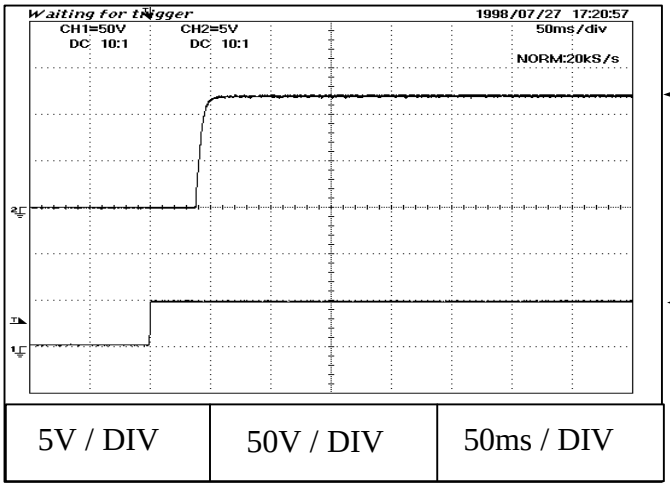
Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C

5 V



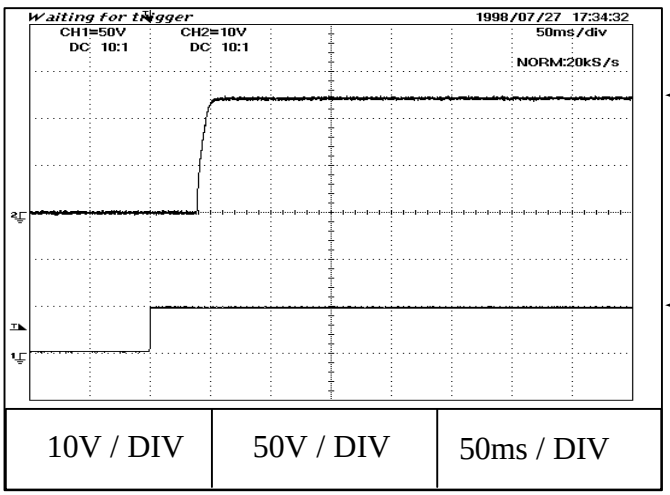
2V / DIV	50V / DIV	50ms / DIV

12 V



5V / DIV	50V / DIV	50ms / DIV

24 V

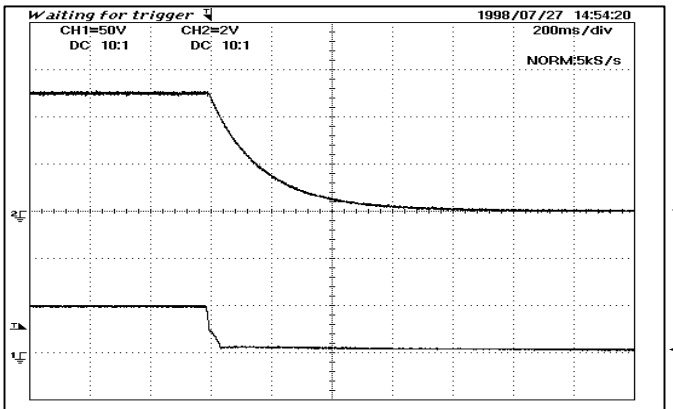


10V / DIV	50V / DIV	50ms / DIV

2-6 Output Fall Characteristics

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

5 V

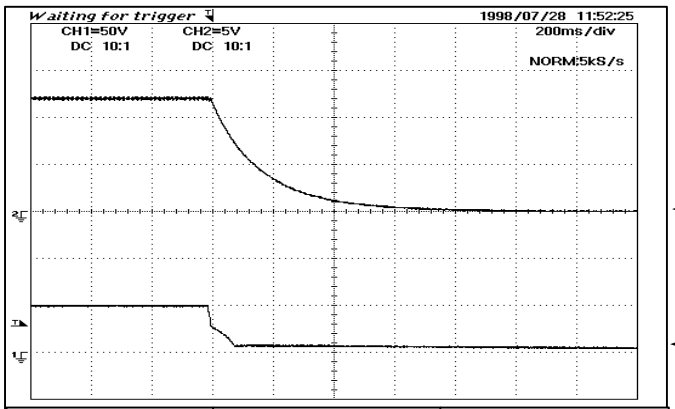


Vout

Vin

2V / DIV	50V / DIV	200ms / DIV

12 V

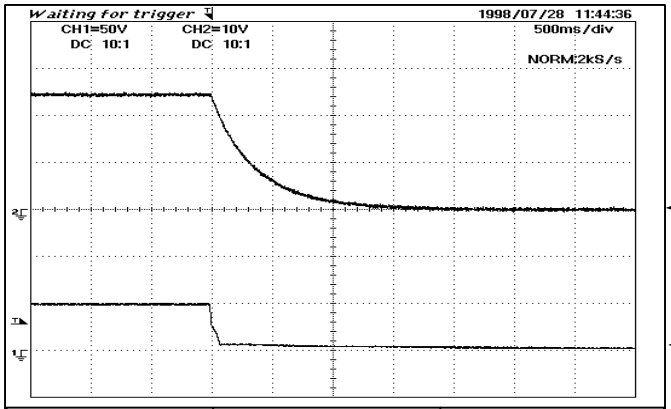


Vout

Vin

5V /	50V / DIV	200ms / DIV

24 V



Vout

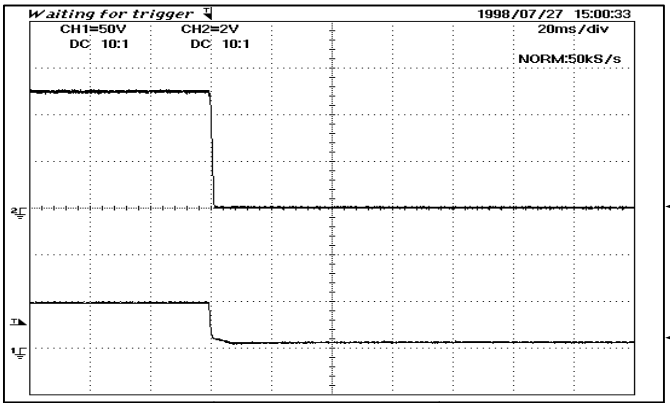
Vin

10V / DIV	50V / DIV	500ms / DIV

Output Fall Characteristics

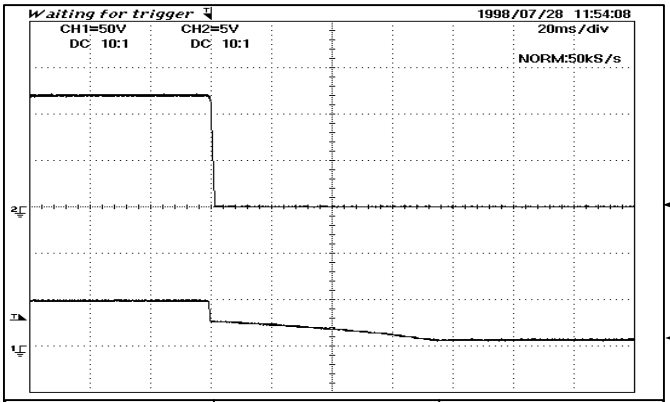
Condition : Vin = 48 V DC
Iout = 100 %
Tp = 25°C

5 V



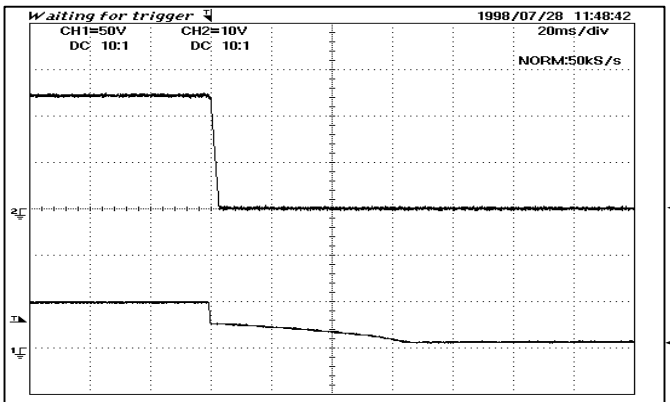
2V / DIV	50V / DIV	20ms / DIV

12 V



5V / DIV	50V / DIV	20ms / DIV

24 V



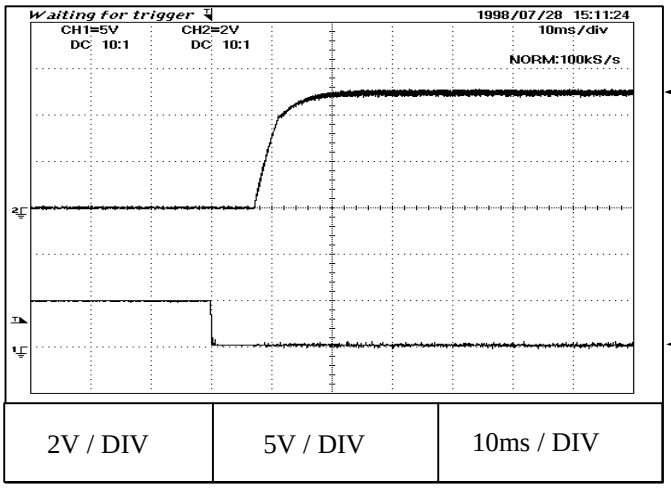
10V / DIV	50V / DIV	20ms / DIV

2-7 Output Rise With On/Off Characteristics

(Negative logic)

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

5 V

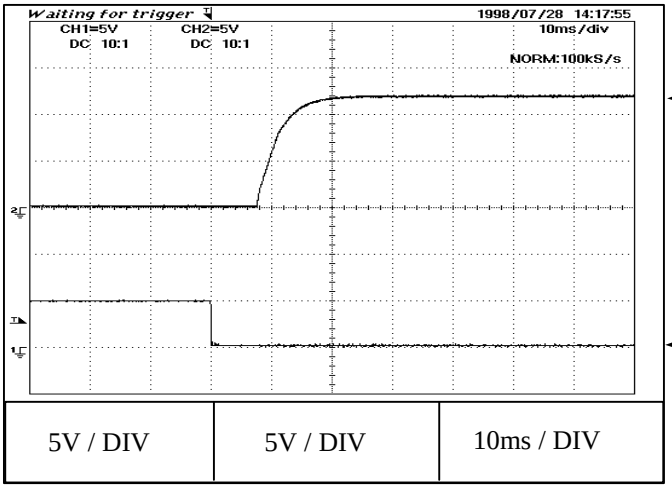


Vout

On/Off Control

2V / DIV	5V / DIV	10ms / DIV

12 V

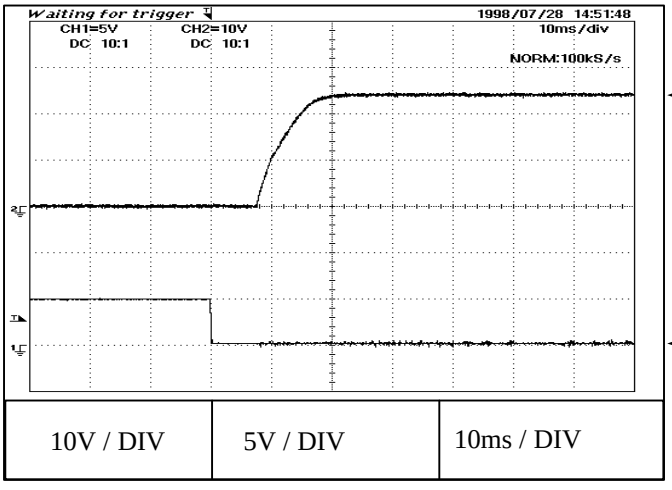


Vout

On/Off Control

5V / DIV	5V / DIV	10ms / DIV

24 V



Vout

On/Off Control

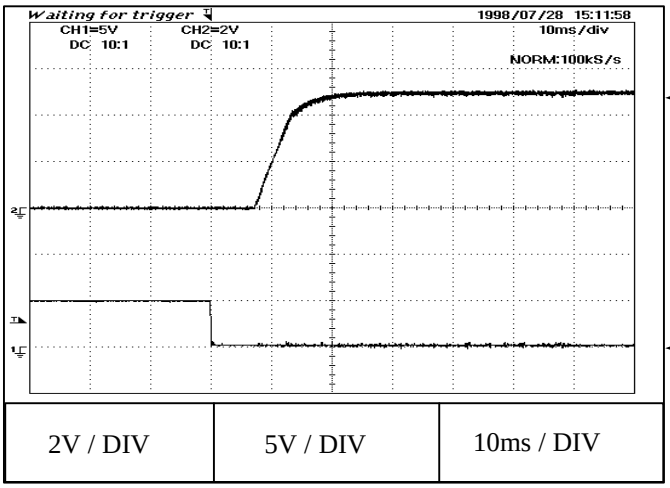
10V / DIV	5V / DIV	10ms / DIV

Output Rise With On/Off Characteristics

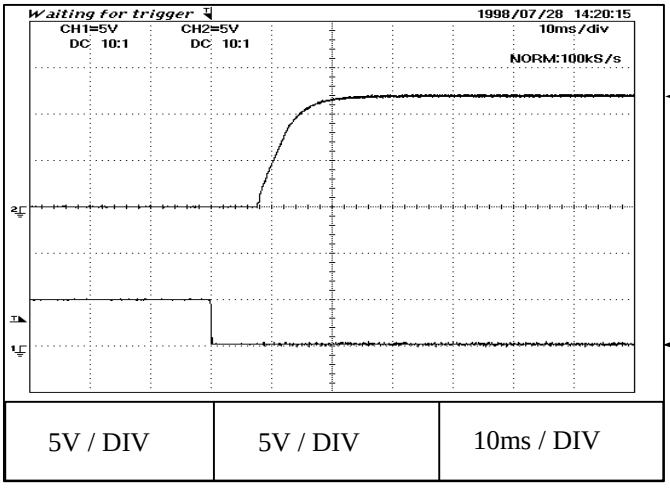
(Negative logic)

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

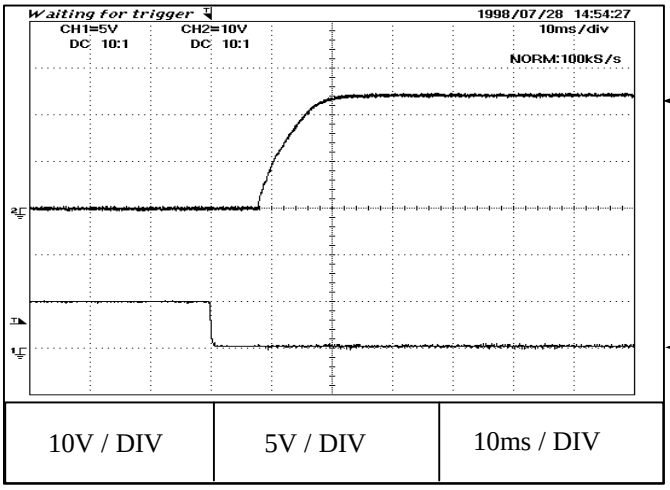
5 V



12 V



24 V

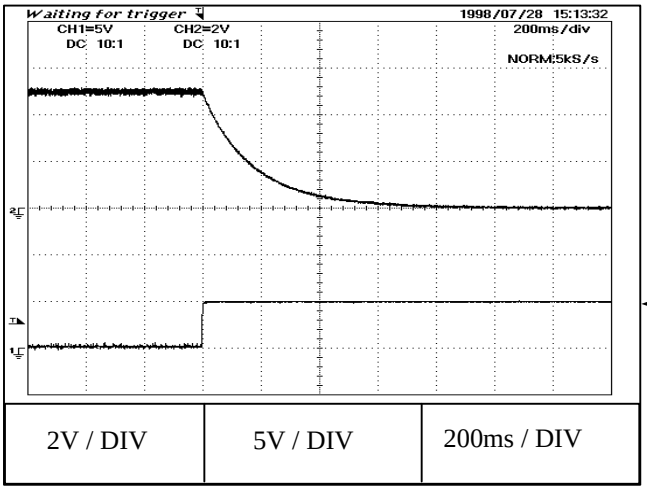


2-8 Output Fall With On/Off Characteristics

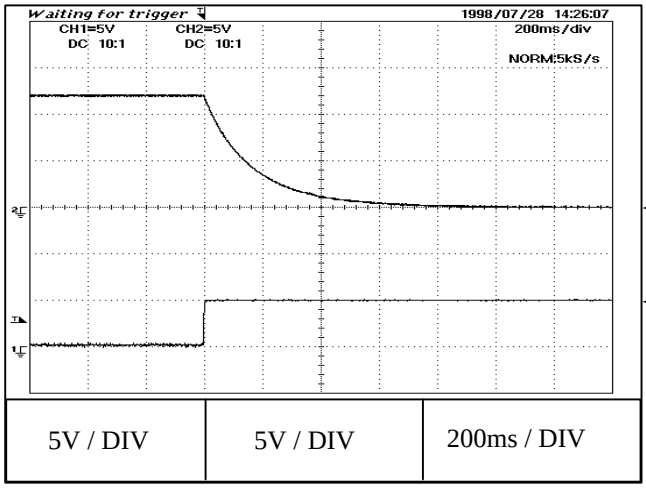
(Negative logic)

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

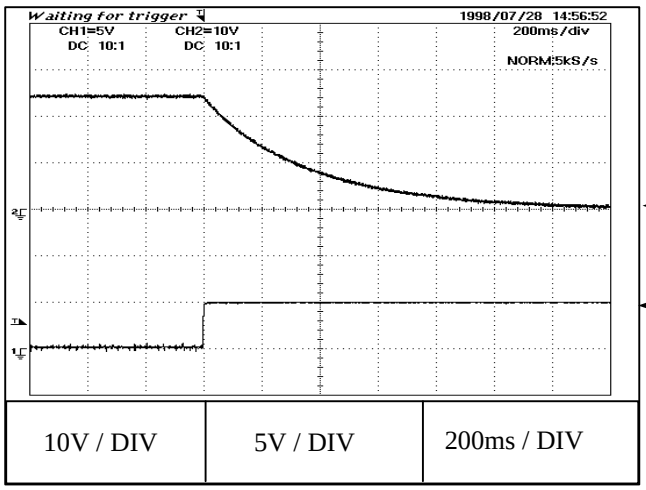
5 V



12 V



24 V

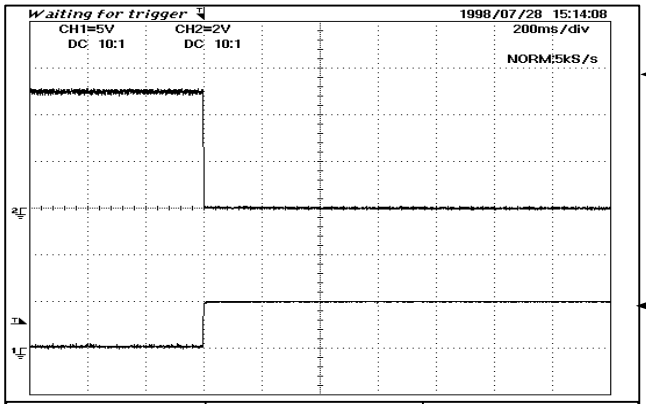


Output Fall With On/Off Characteristics

(Negative logic)

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

5 V

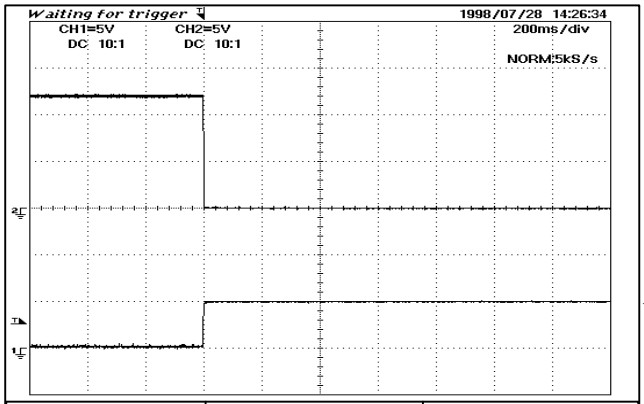


Vout

On/Off Control

2V / DIV	5V / DIV	200ms / DIV

12 V

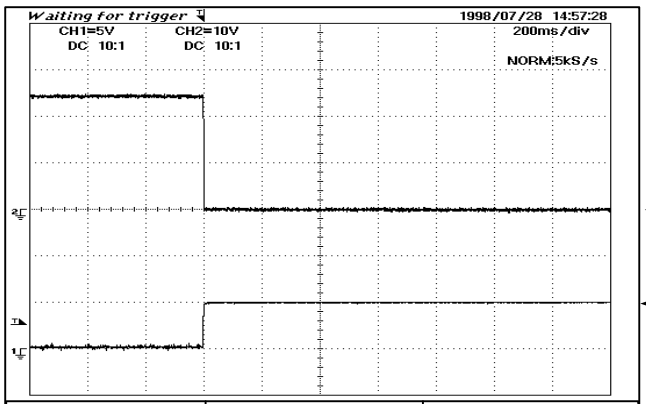


Vout

On/Off Control

5V / DIV	5V / DIV	200ms / DIV

24 V



Vout

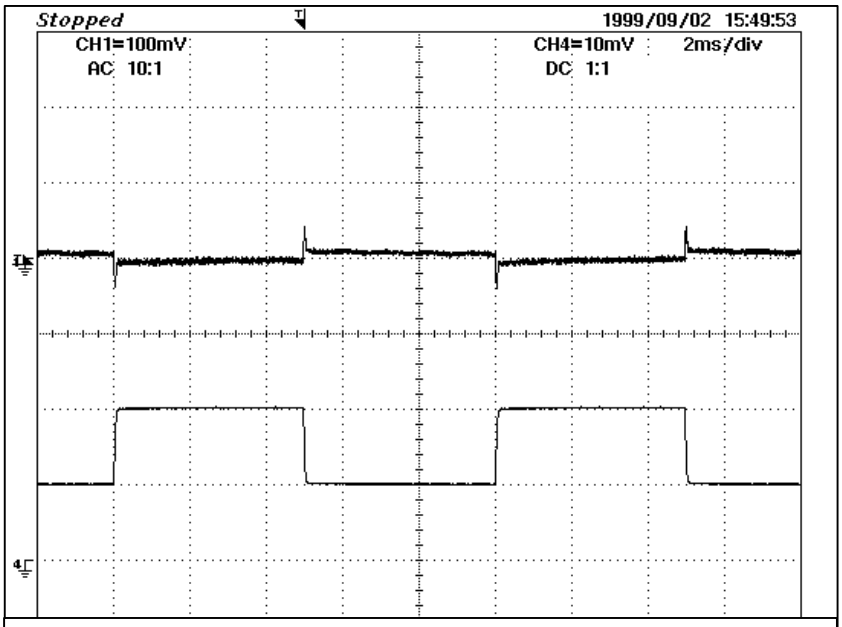
On/Off Control

10V / DIV	5V / DIV	200ms / DIV

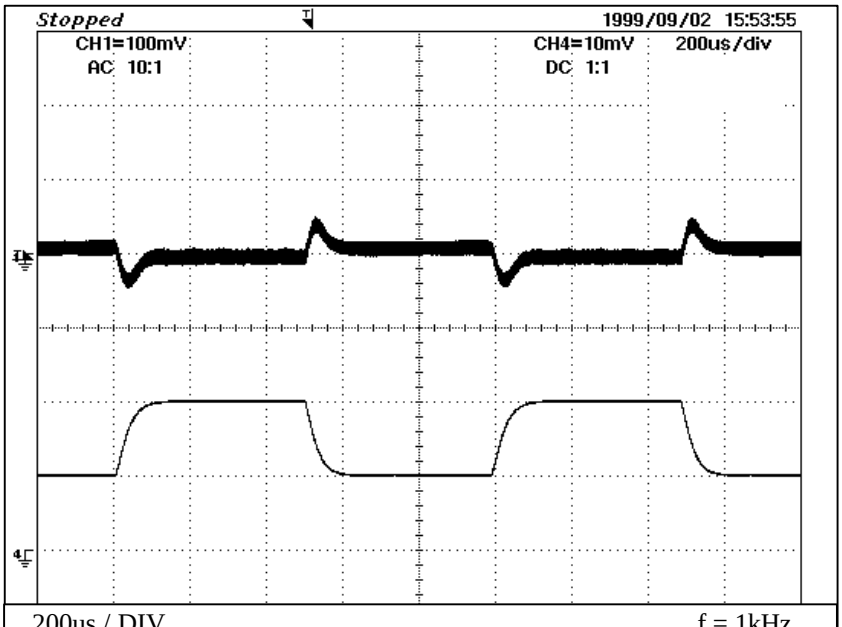
2-9 Dynamic Load Response Characteristics

Condition : Vin = 48 VDC
Tp = 25°C

5 V



2ms / DIV	f = 100Hz
Iout (5A / DIV)	Vout (0.1V / DIV)
50% Tr = 75us / Tf = 75us 100%	+0.88% , -0.8%

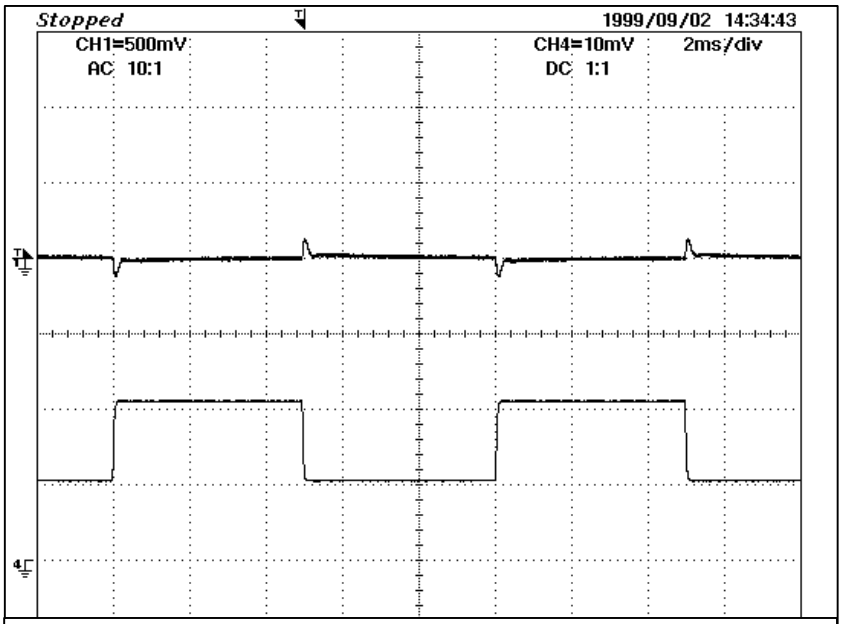


200us / DIV	f = 1kHz
Iout (5A / DIV)	Vout (0.1V / DIV)
50% Tr = 75us / Tf = 75us 100%	+0.96% , -0.88%

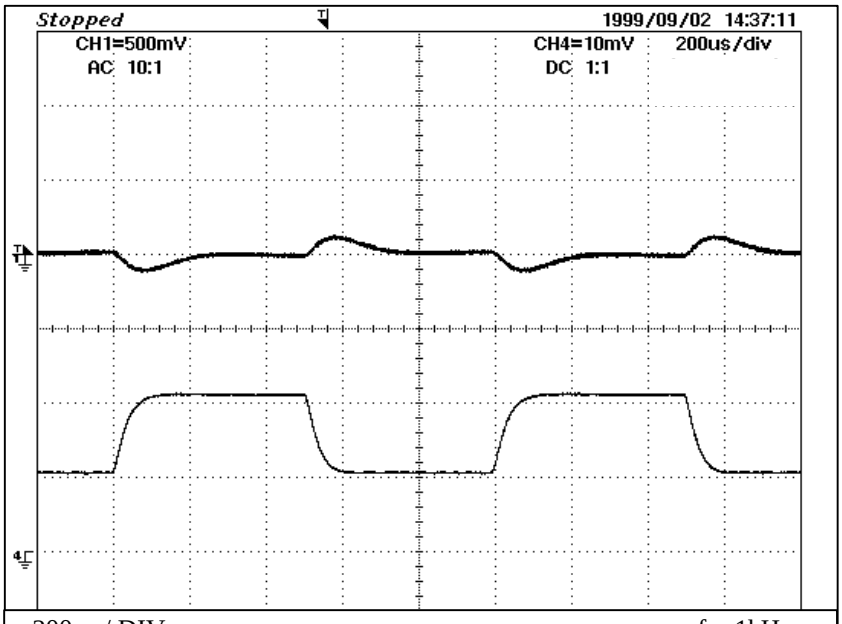
Dynamic Load Response Characteristics

Condition : Vin = 48 VDC
Tp = 25°C

12 V



2ms / DIV	f = 100Hz
Iout (2A / DIV)	Vout (0.5V / DIV)
50% Tr = 75us / Tf = 75us 100%	+1.167% , -1.167%

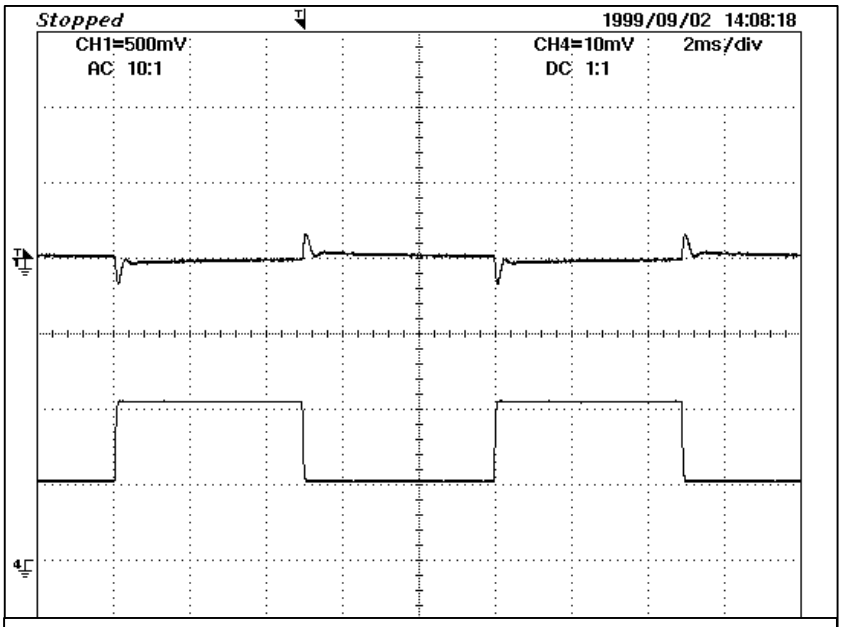


200us / DIV	f = 1kHz
Iout (2A / DIV)	Vout (0.5V / DIV)
50% Tr = 75us / Tf = 75us 100%	+1% , -1%

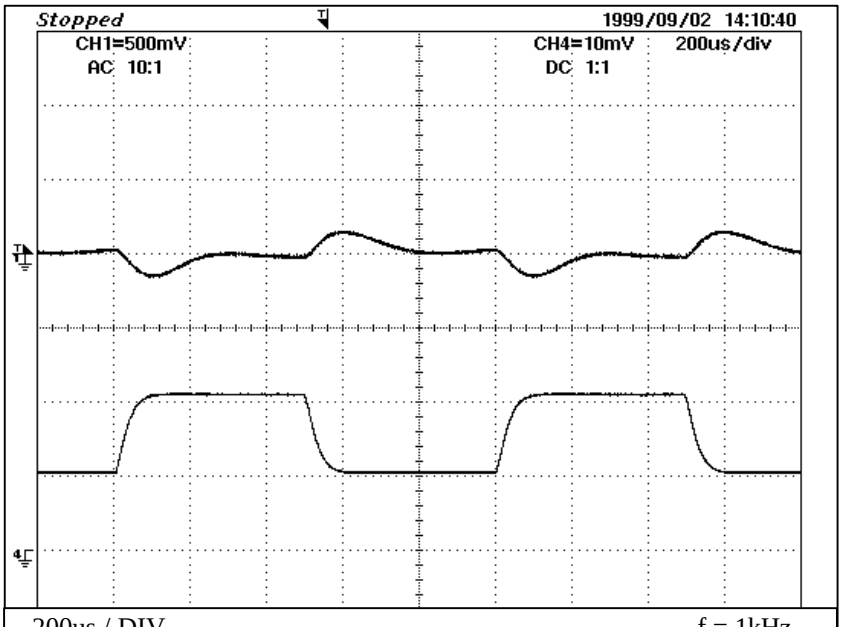
Dynamic Load Response Characteristics

Condition : Vin = 48 VDC
Tp = 25°C

24 V



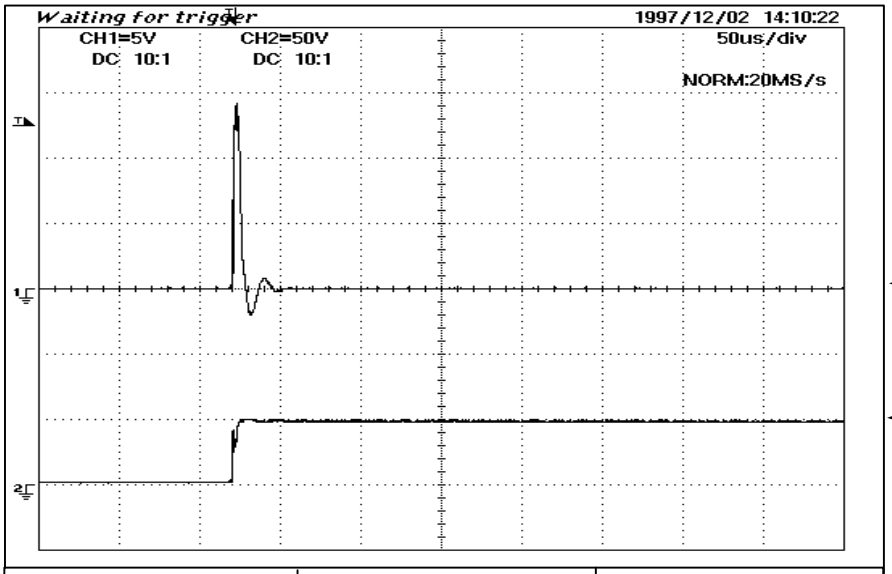
2ms / DIV	f = 100Hz
Iout (1A / DIV)	Vout (0.5V / DIV)
50% Tr = 75us, Tf = 75us 100%	+0.667% , -0.75%



200us / DIV	f = 1kHz
Iout (1A / DIV)	Vout (0.5V / DIV)
50% Tr = 75us, Tf = 75us 100%	+0.667% , -0.667%

2-10 Inrush Current Waveform

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



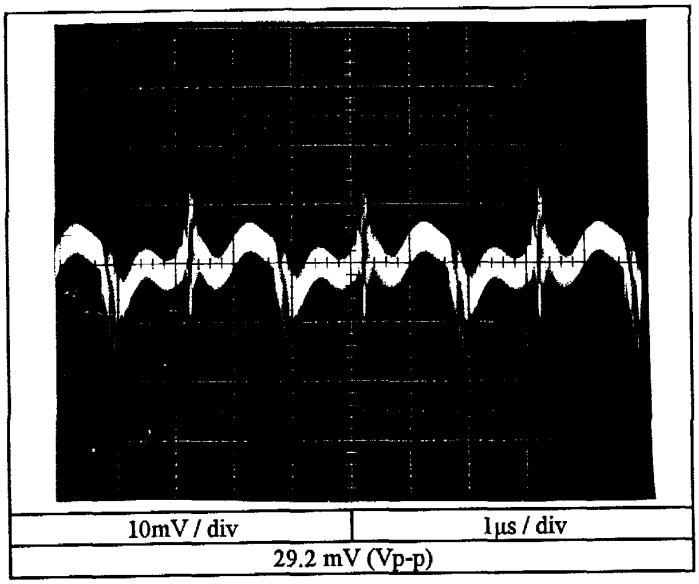
25A / DIV	50V / DIV	50us / DIV

2-11 Output - Ripple & Noise Waveform

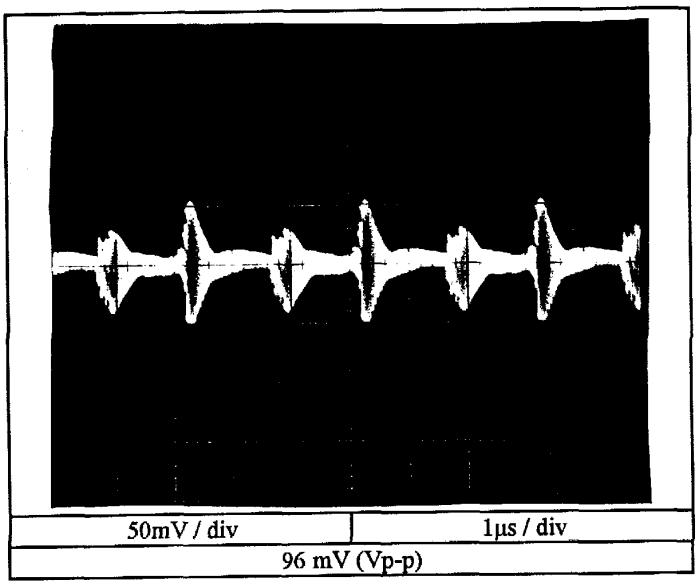
Condition : Vin = 48V DC
Iout = 100%
Tp = 25°C

5 V

NORMAL MODE



NORMAL + COMMON MODE

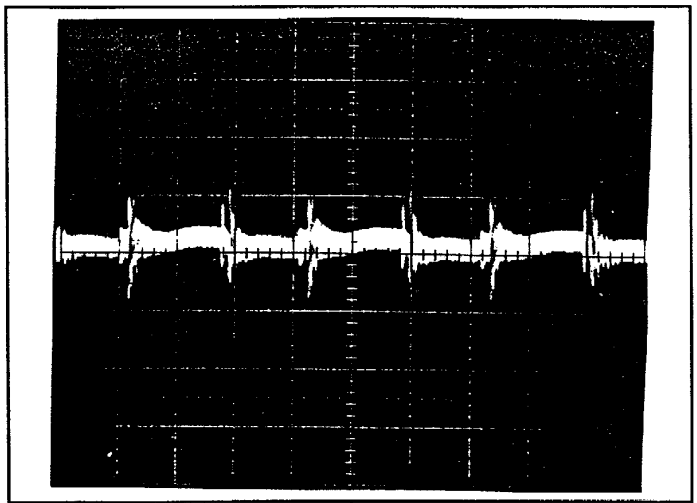


Output - Ripple & Noise Waveform

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

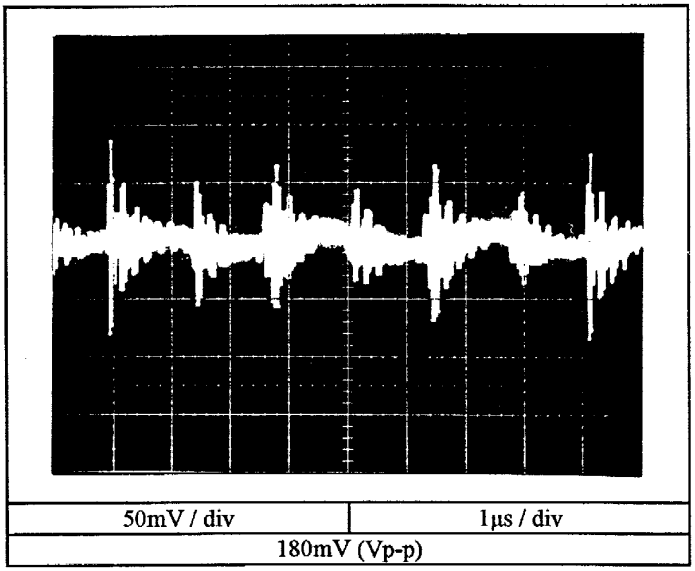
12 V

NORMAL MODE



20mV / div	1μs / div
43 mV (Vp-p)	

NORMAL + COMMON MODE



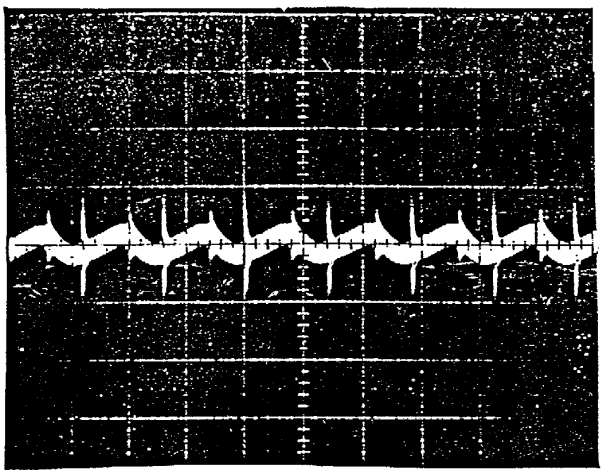
50mV / div	1μs / div
180mV (Vp-p)	

Output - Ripple & Noise Waveform

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

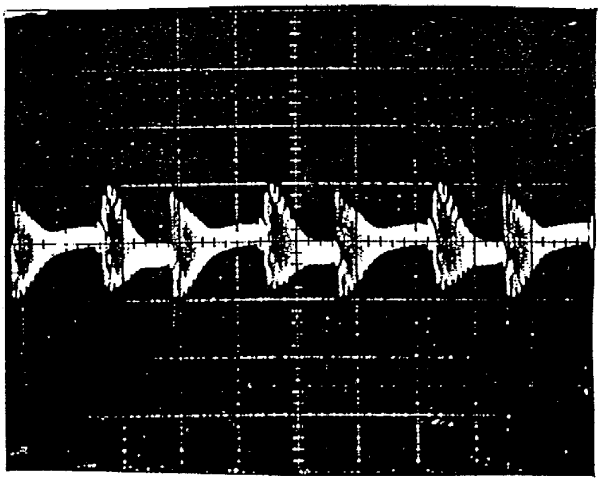
24 V

NORMAL MODE



20mV / div	1μs / div
38mV (Vp-p)	

NORMAL + COMMON MODE

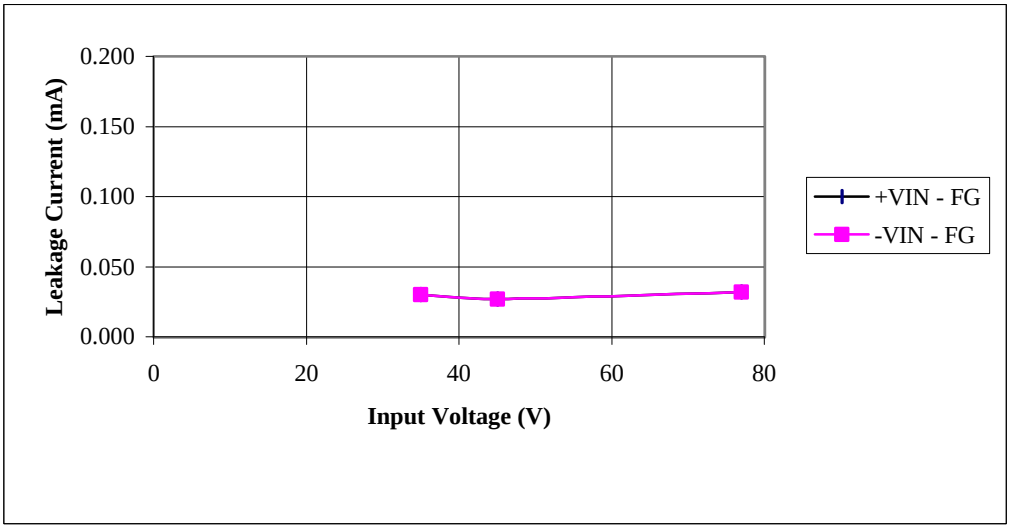


100mV / div	1μs / div
185 mV (Vp-p)	

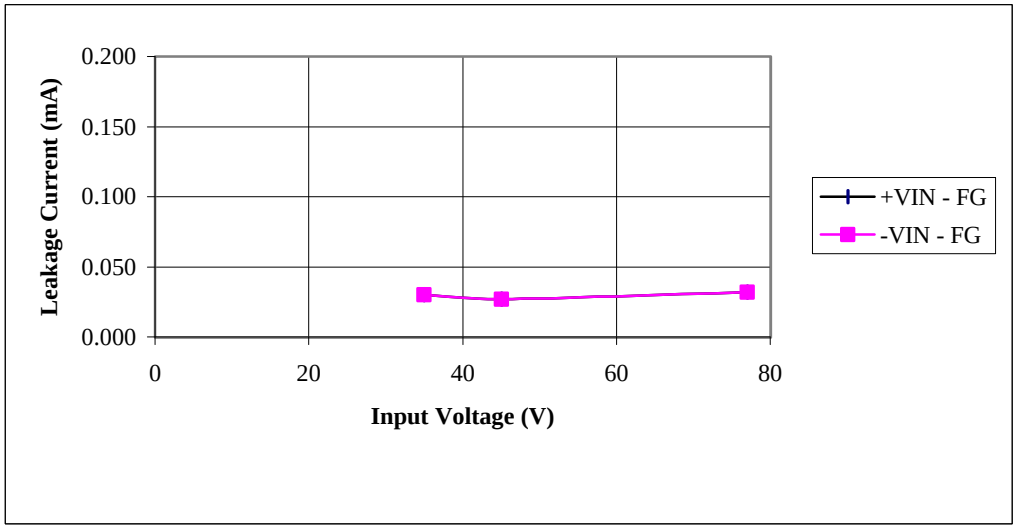
2-12 Leakage Current Characteristics

Condition : Iout = 100%
Tp= 25°C

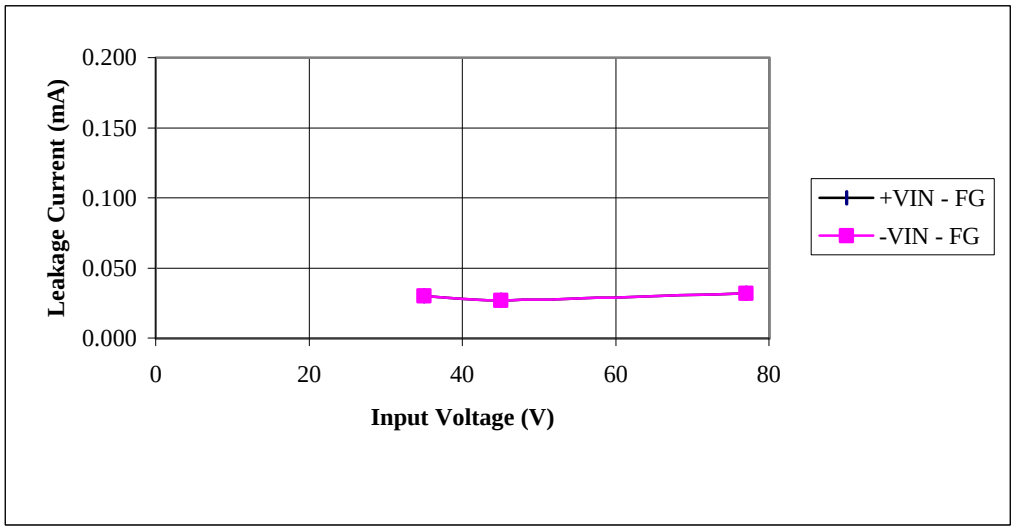
5V



12V



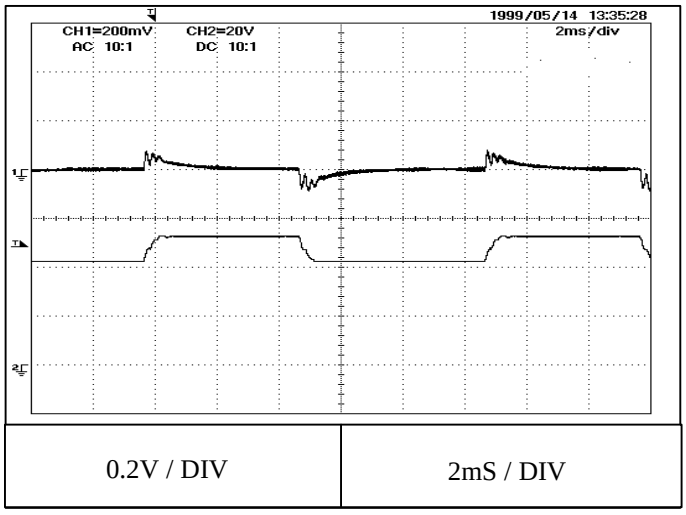
24V



2-13 Dynamic Line Response Characteristics

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

5 V

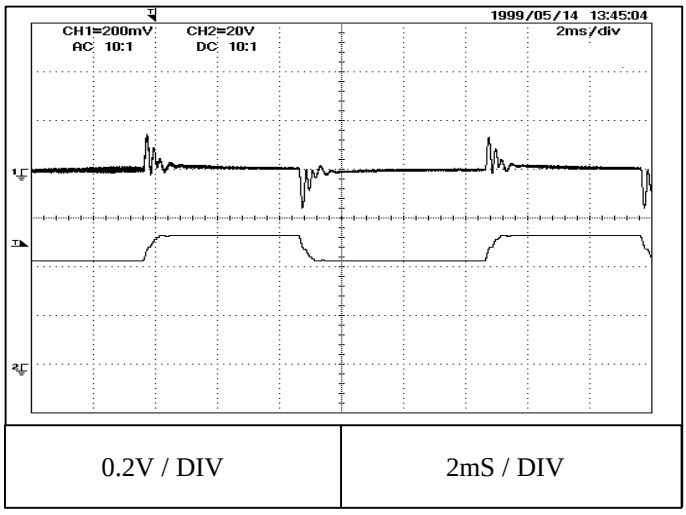


Vout

Vin

0.2V / DIV	2mS / DIV

12 V

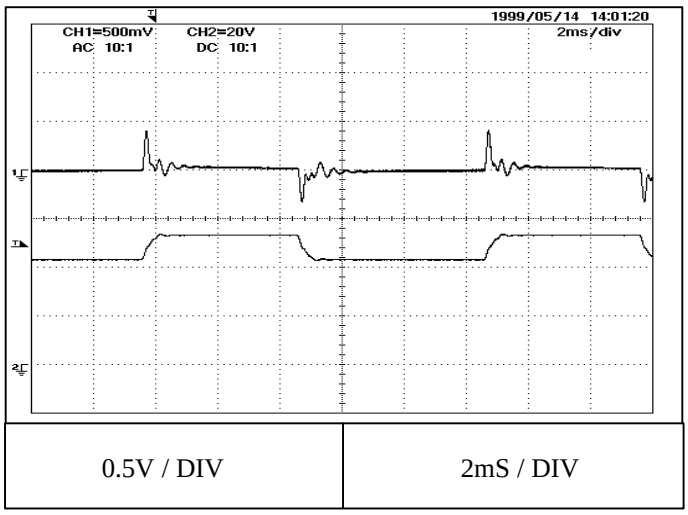


Vout

Vin

0.2V / DIV	2mS / DIV

24 V



Vout

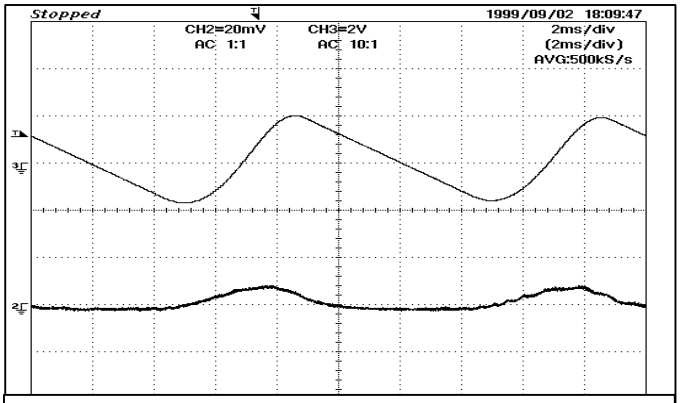
Vin

0.5V / DIV	2mS / DIV

2-14 AC Input Response

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

5V

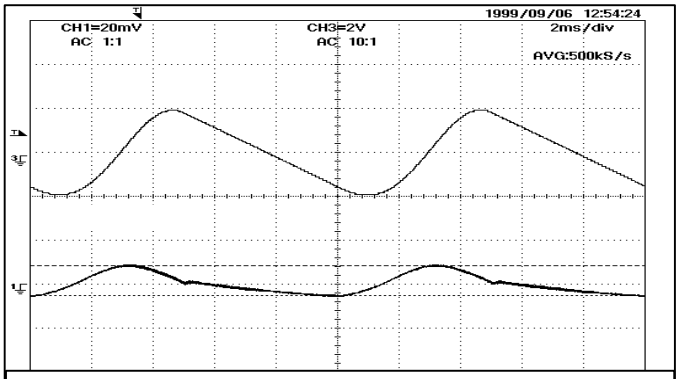


Input Waveform

Output Waveform

AC Input Ripple Voltage = 4V
Output Ripple Voltage = 9.8 mV

12V

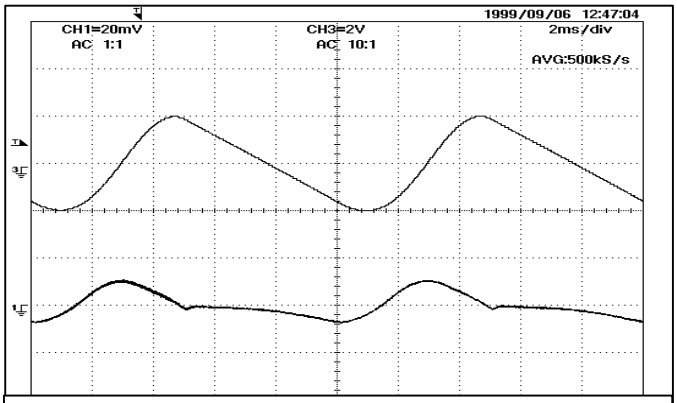


Input Waveform

Output Waveform

AC Input Ripple Voltage = 4V
Output Ripple Voltage = 13.6mV

24V



Input Waveform

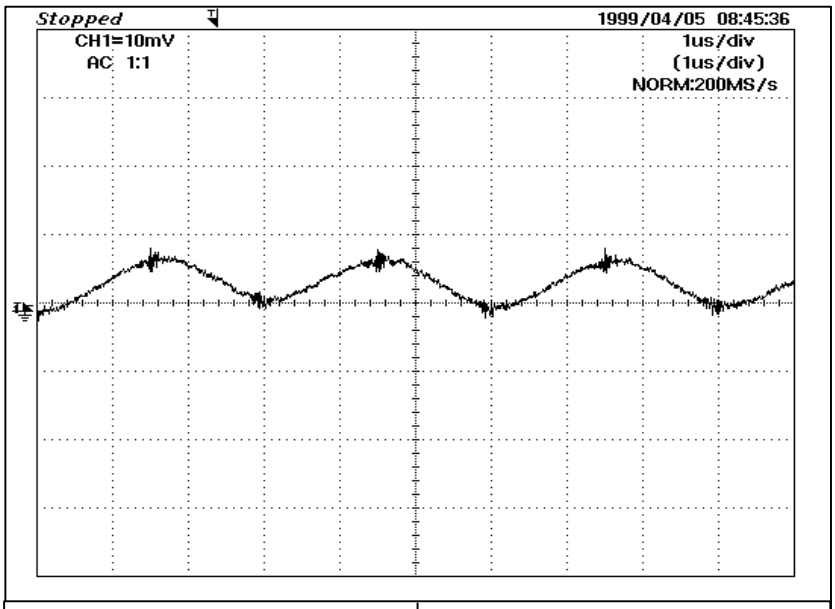
Output Waveform

AC Input Ripple Voltage = 4V
Output Ripple Voltage = 20.6 mV

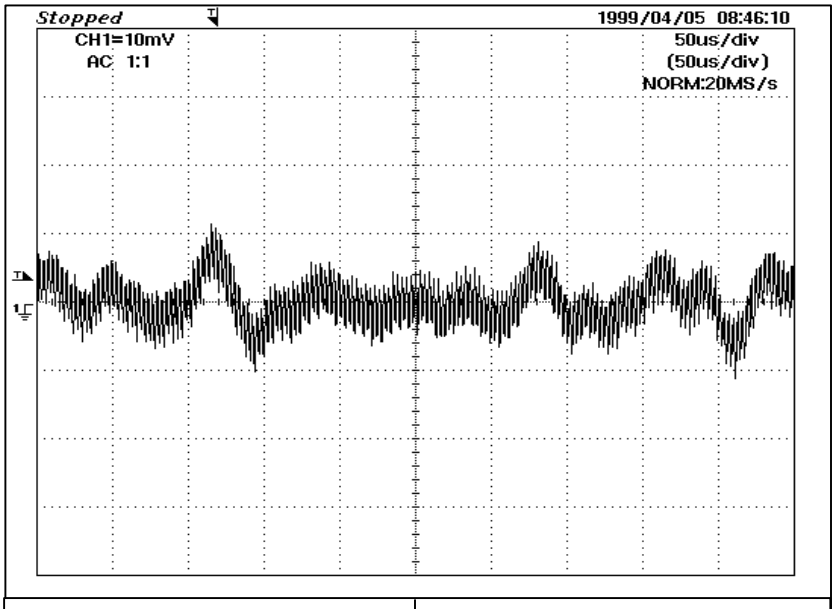
2-15 INPUT REFLECTED CURRENT

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

5 V



10mA / DIV	1uS / DIV

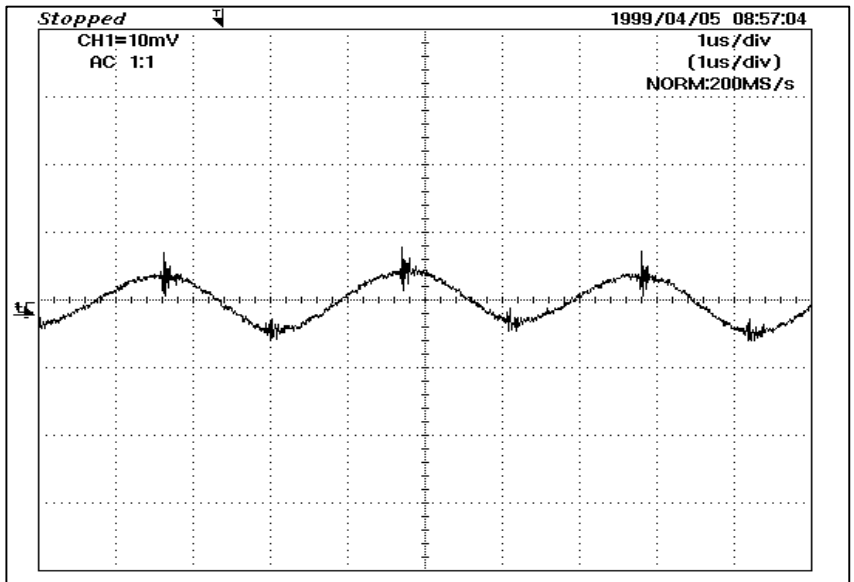


10mA / DIV	50uS / DIV

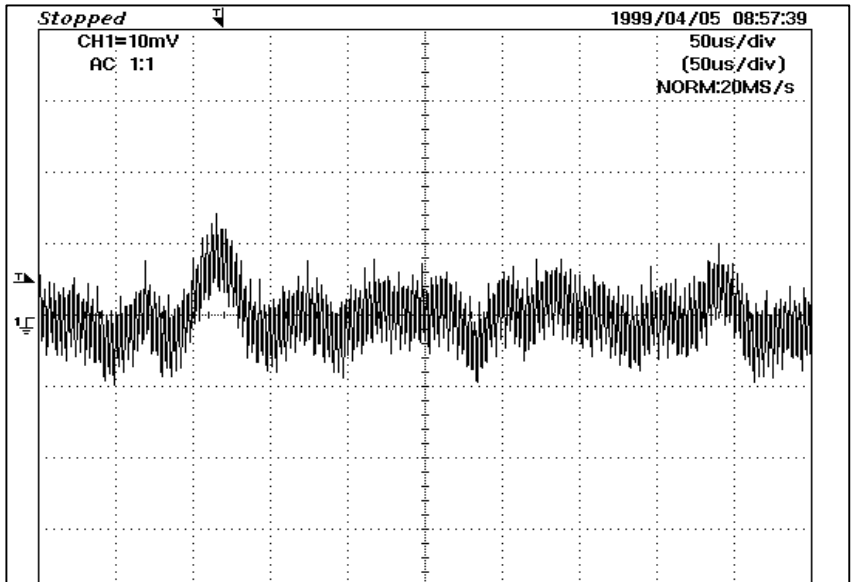
2-15 INPUT REFLECTED CURRENT

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

12 V



10mA / DIV	1uS / DIV

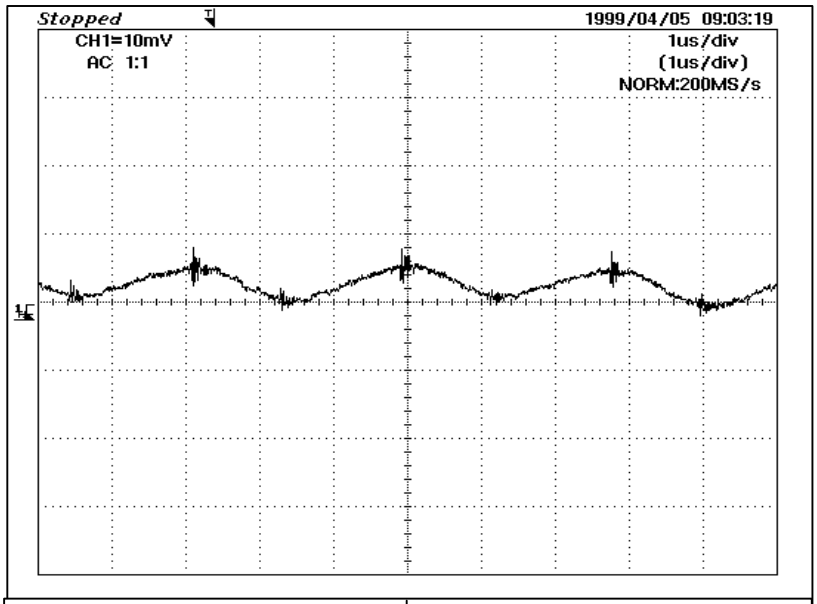


10mA / DIV	50uS / DIV

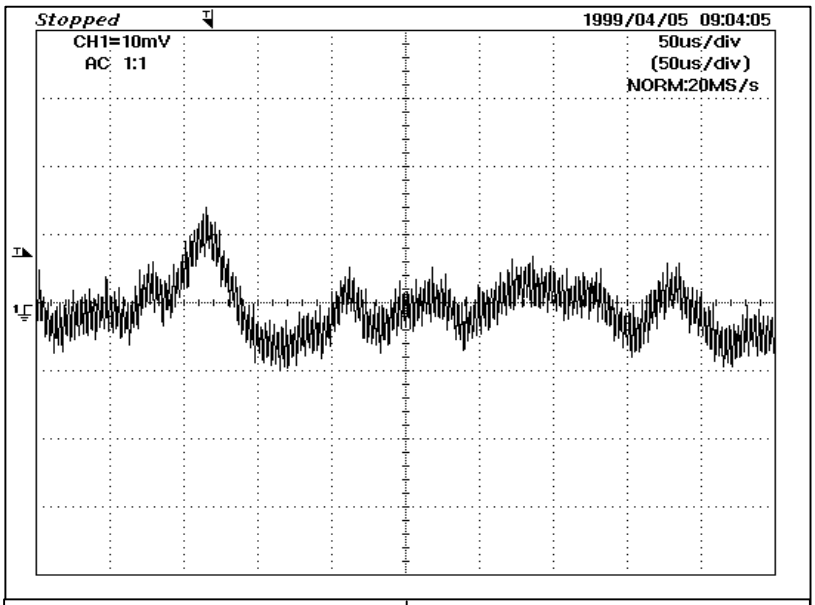
2-15 INPUT REFLECTED CURRENT

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

24 V



10mA / DIV	1uS / DIV



10mA / DIV	50uS / DIV