

# P R B X

POWERBOX Industrial Line  
 PHB100 Series  
 50-100W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

## Features

50-100W isolated output

Half brick package

Regulated outputs

Efficiency to 85%

500KHz switching frequency

Five-sided shield metal case

Continuous short circuit protection

RoHS compliant



Model Number	Input Voltage	Output Voltage	Output Current	Input Current		Efficiency	Case
				No Load	Full Load		
PHB100-24S33	18-36 VDC	3.3 VDC	20 A	50 mA	3480 mA	79%	HB
PHB100-24S05	18-36 VDC	5.0 VDC	20 A	50mA	5020 mA	83%	HB
PHB100-24S12	18-36 VDC	12.0 VDC	8.3 A	50 mA	4880 mA	85%	HB
PHB100-24S15	18-36 VDC	15.0 VDC	6.7 A	50 mA	4925 mA	85%	HB
PHB100-24S24	18-36 VDC	24.0 VDC	4.17 A	50mA	4905 mA	86%	HB
PHB100-48S33	36-75 VDC	3.3 VDC	20 A	50 mA	1720 mA	80%	HB
PHB100-48S05	36-75 VDC	5.0 VDC	20 A	50 mA	2480 mA	84%	HB
PHB100-48S12	36-75 VDC	12.0 VDC	8.3 A	50 mA	2442 mA	85%	HB
PHB100-48S15	36-75 VDC	15.0 VDC	6.7 A	50 mA	2463 mA	85%	HB
PHB100-48S24	36-75 VDC	24.0 VDC	4.17 A	50 mA	2463 mA	85%	HB

## Notes :

1. Nominal input voltage 24 or 48 VDC

2. All specifications typical at nominal line , full load and 25oC unless otherwise notes.

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Specifications

**Input Specifications**

Parameters	Min	Nominal	Max	Unit	Note
Input voltage range	18	24	36	VDC	
Input voltage range	36	48	75	VDC	
Input filter					Pi-filter
Under-voltage lockout			24V <sub>in</sub> power up 17V 24V <sub>in</sub> power down 16V 48V <sub>in</sub> power up 34V 48V <sub>in</sub> power down 32.5V		

**Positive logic remote On/OFF**

Logic compatibility					Open collector referenced to -input Model ON Open circuit Model OFF <0.8V <sub>dc</sub>
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Suffix "N" to the model number with Negative logic remote on/off

**Output Specifications**

Parameters	Max	Unit	Note
Voltage accuracy	1.0	%	
Transient response	500	usec.	25%step load change
External adjustment range	10	%	
Ripple and noise 20MHz BW.	40	mVrms.	2.5V & 3.3V & 5V output
	100	mVp-p	
	60	mVrms.	12V & 15V output
	150	mVp-p	
	100	mVrms.	24V output
	240	mVp-p	
Temperature coefficient	0.03	%/ oC	
Line regulation	0.2	%	From high line to low line
Load regulation	0.2	%	From full load to zero load
Short circuit protection			Continuous
Over voltage protection trip range	115-140	%	Vo nominal
Current limit	110-140	%	nominal output

**General Specifications**

Parameters	Min	Max	Unit	Note
Isolation resistance	10 <sup>7</sup>		Ohms	
Switching frequency			KHz	500KHz typical
Operating temperature range	-40	+100	oC	
Case temperature thermal shutdown		+100	oC	
Storage temperature range	-40	+105	oC	
Case material		Aluminum		
Case dimensions		2.28 x 2.40 x 0.50 inches ( 57.9 x 61.0 x 12.7 mm)		

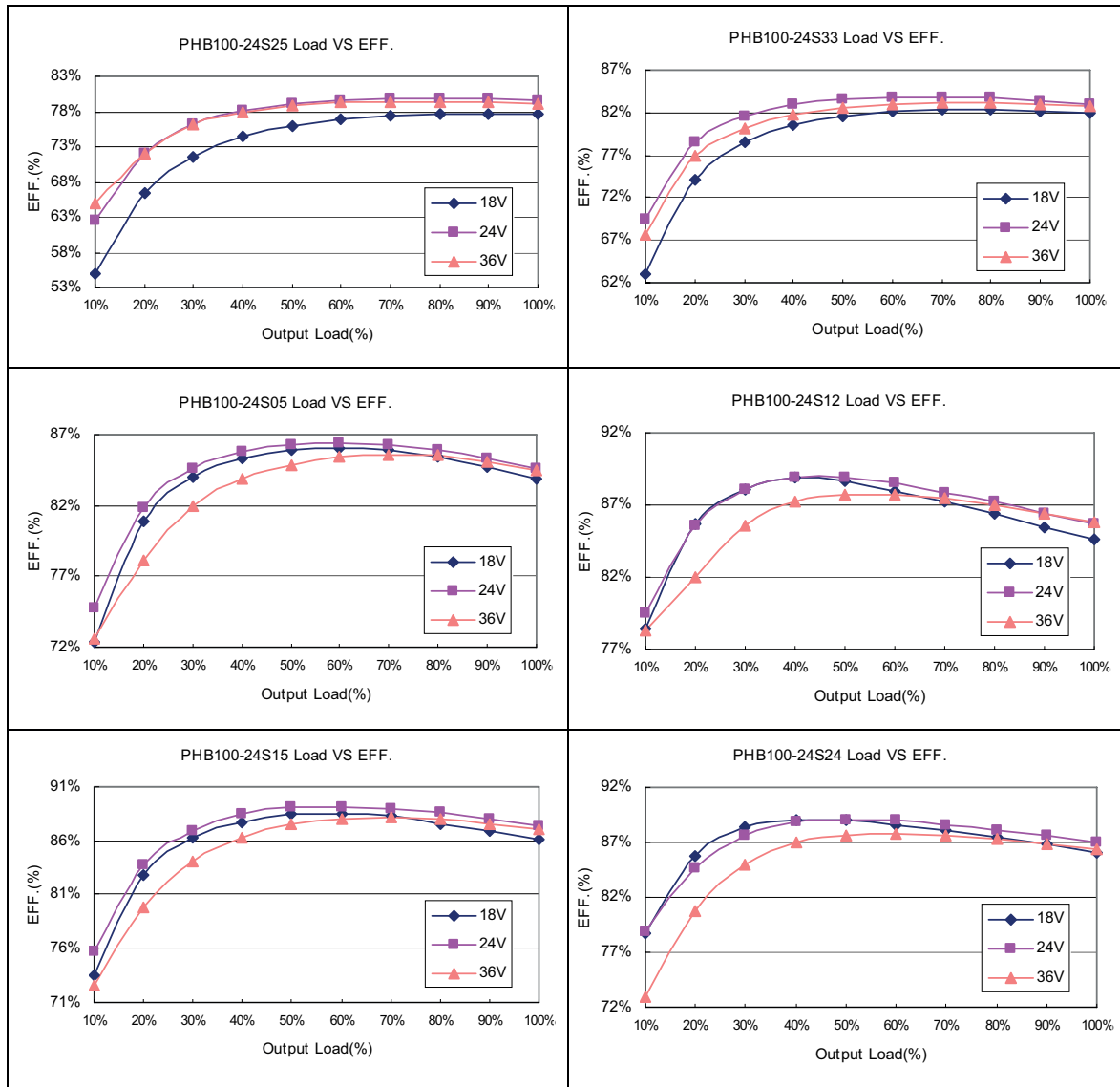
**Isolation Voltage**

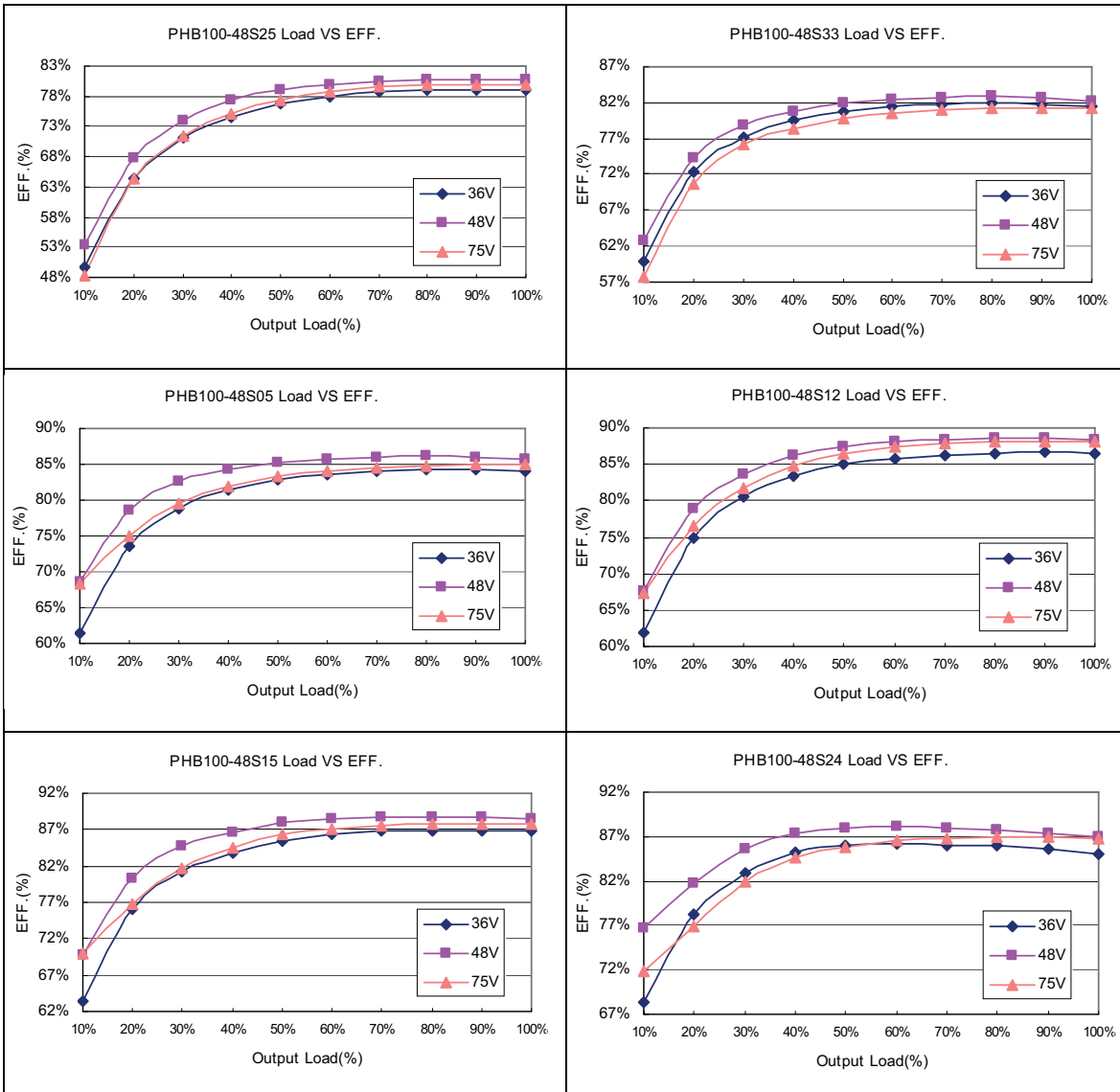
Parameters	Min	Unit	Note
Input to output isolation voltage	1500	VDC	
Input to case isolation voltage	1500	VDC	
Output to case isolation voltage	1500	VDC	

General Information

The PHB100 unit has many operational characterized aspects, including efficiency, input current ripple, start up delay time, overshoot, output ripple & noise, dynamic response to load.

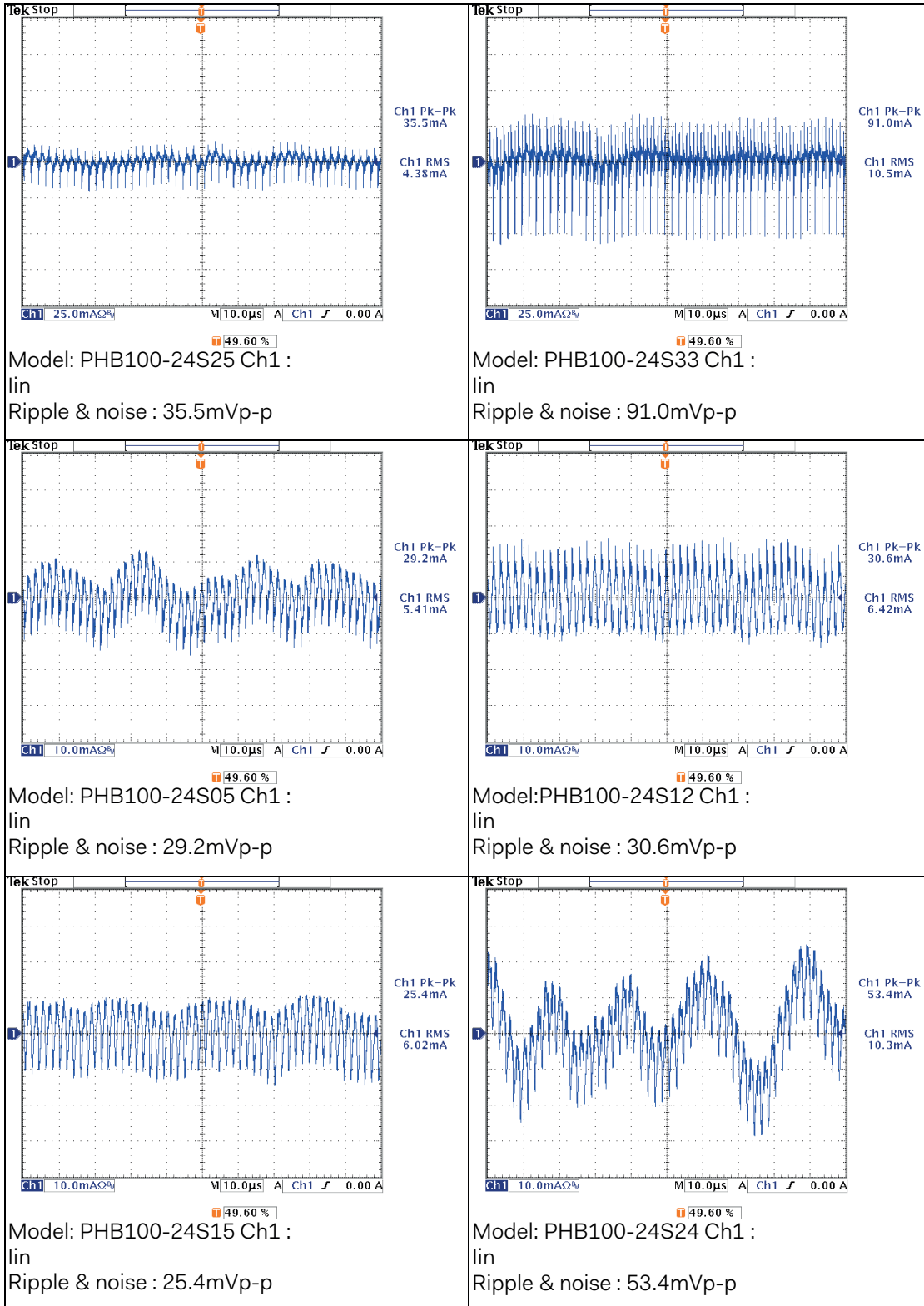
Efficiency

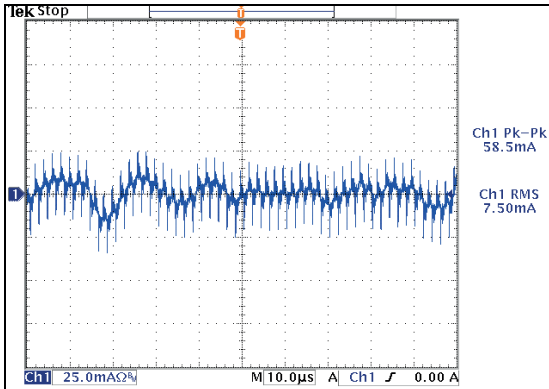




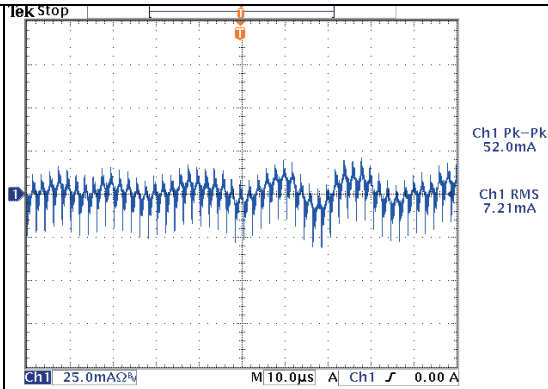
Input Current Ripple

Measuring input current ripple waveform peak to peak. Measure mane bandwidth 20MHz. At nominal input, maximum lout.

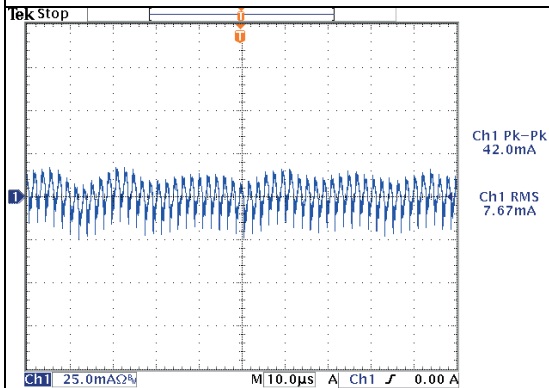




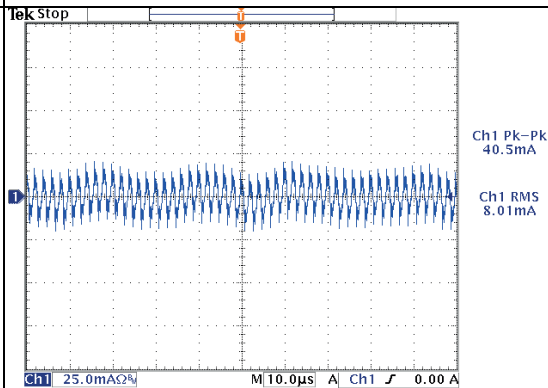
Model: PHB100-48S25 Ch1 :  
 lin  
 Ripple & noise : 58.5mVp-p



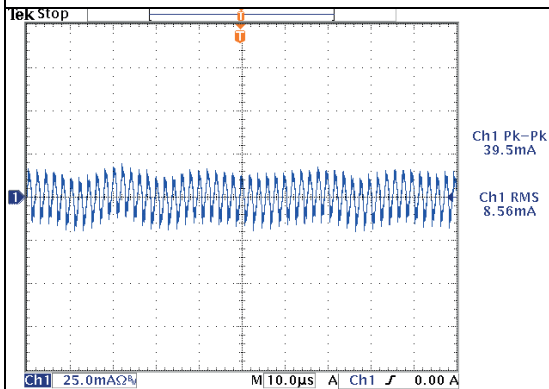
Model: PHB100-48S33 Ch1 :  
 lin  
 Ripple & noise : 52.0mVp-p



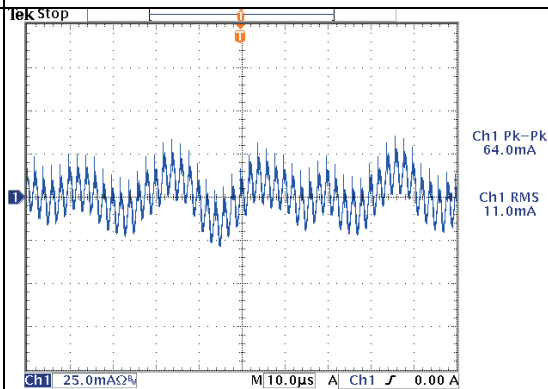
Model: PHB100-48S05 Ch1 :  
 lin  
 Ripple & noise : 42.0mVp-p



Model: PHB100-48S12 Ch1 :  
 lin  
 Ripple & noise : 40.5mVp-p



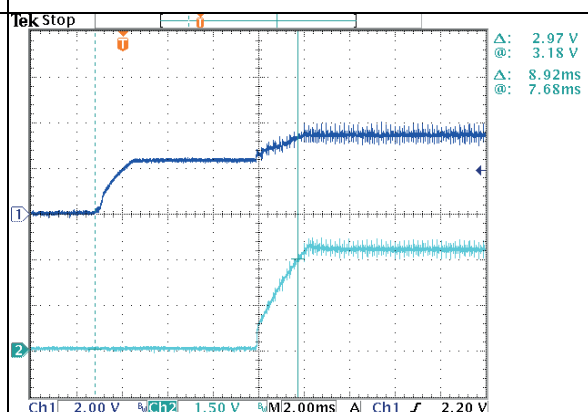
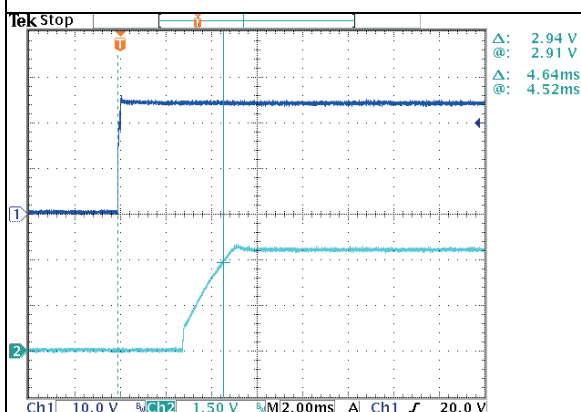
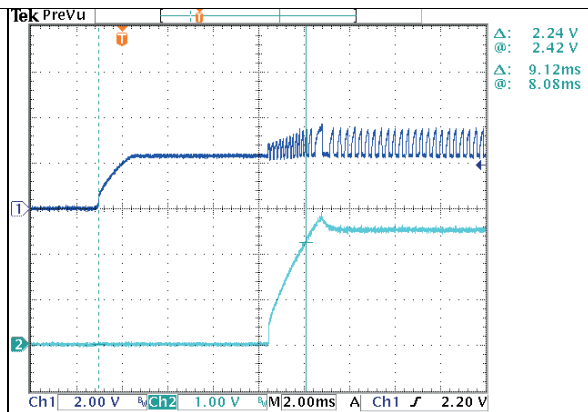
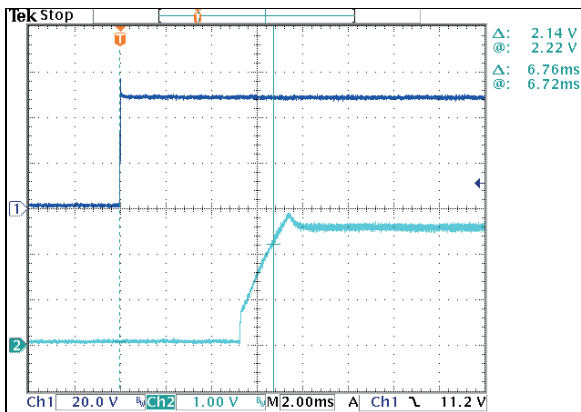
Model: PHB100-48S15 Ch1 :  
 lin  
 Ripple & noise : 39.5mVp-p

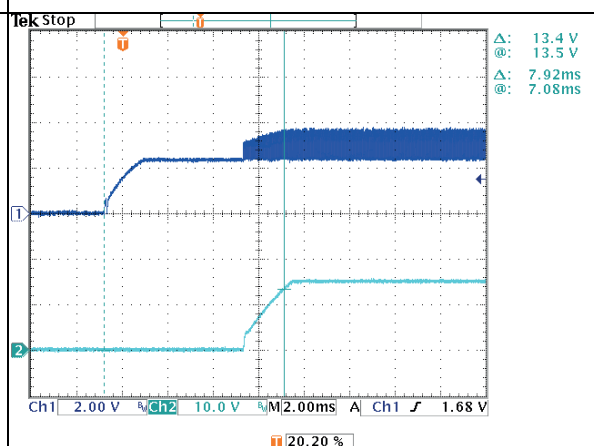
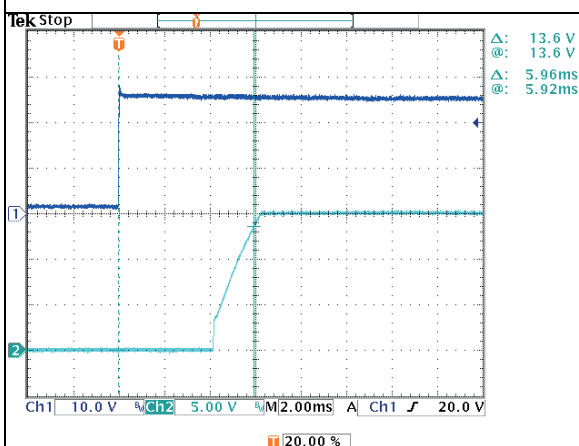
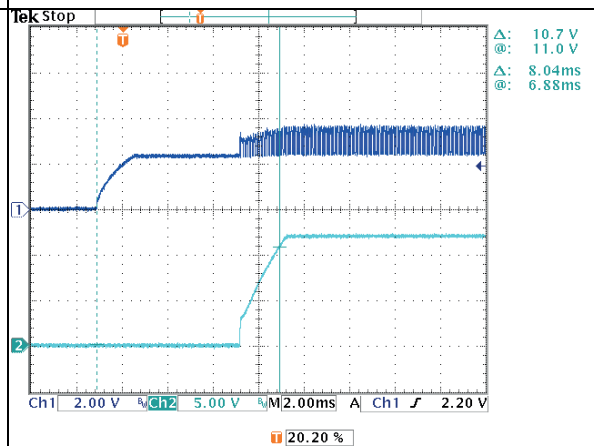
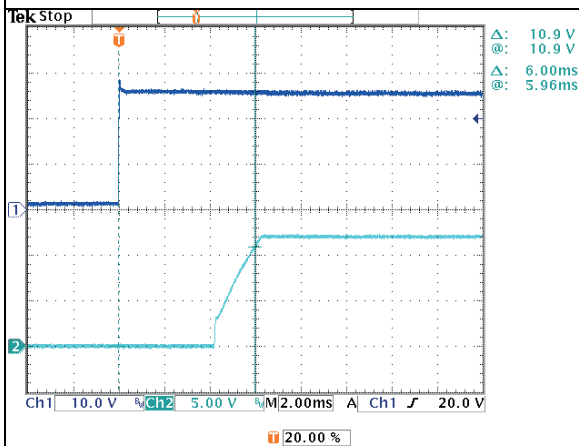
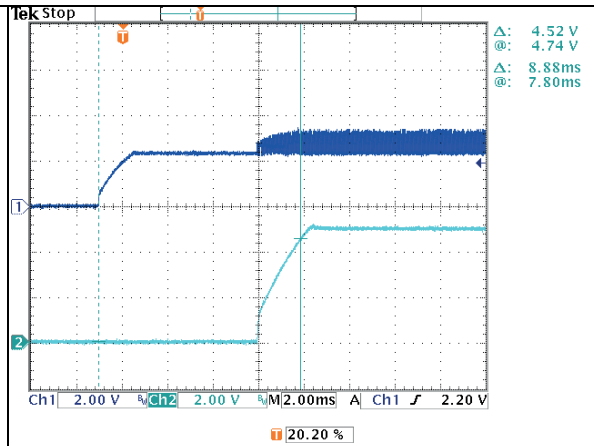
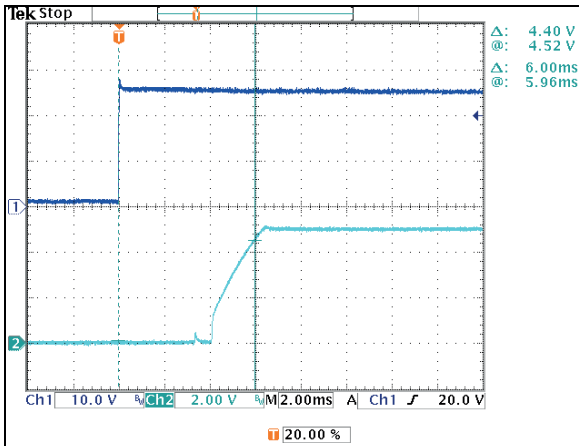


Model: PHB100-48S24 Ch1 :  
 lin  
 Ripple & noise : 64.0mVp-p

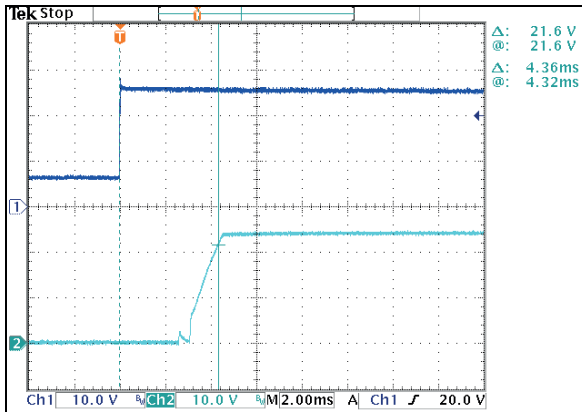
### Start Up Delay Time

1. Start up input power, measuring the time between input power is turn on and output voltage go within 90% Vout. At nominal input and maximum load.
2. Start up use remote on/off , measuring the time between remote is turn on and output voltage go within 90% Vout. At nominal input and maximum load.

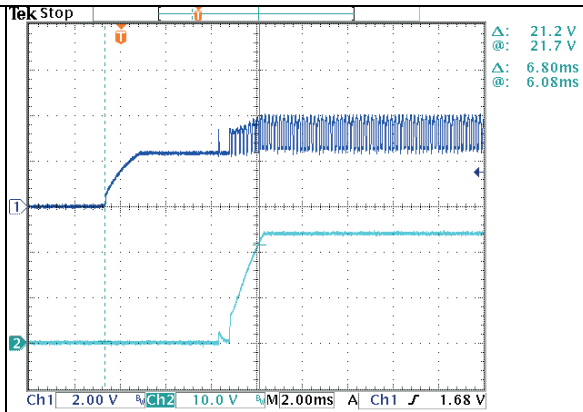




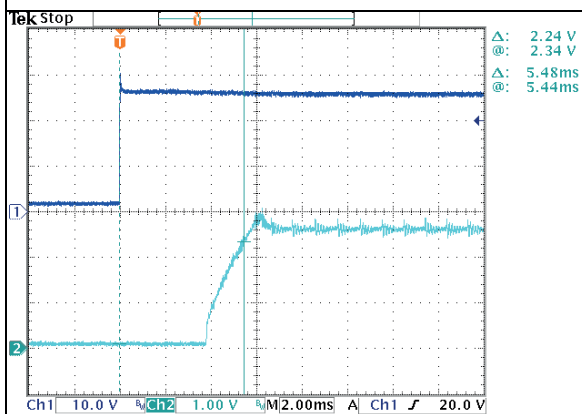




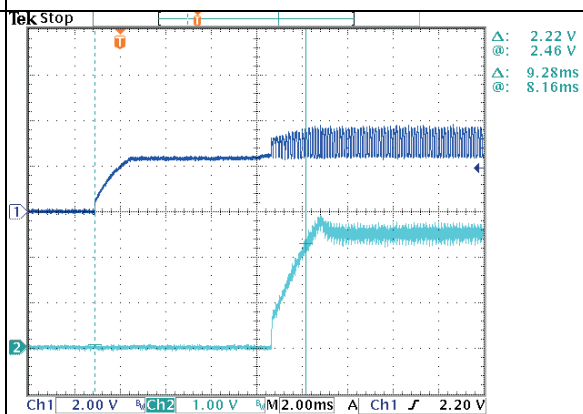
Model : PHB100-24S24  
 Ch1 : Vin Ch2 : Vout Delay  
 time : 4.36ms



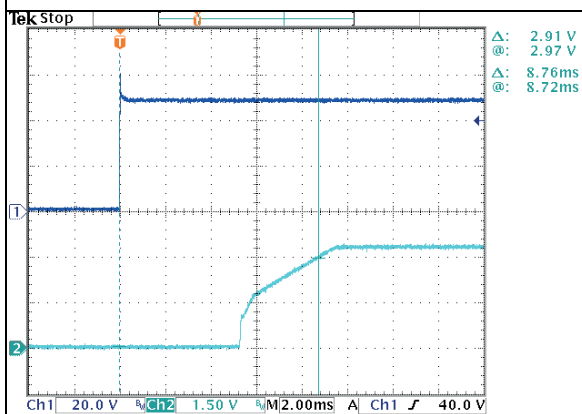
Model : PHB100-24S24 Ch1 :  
 Remote Ch2 : Vout Delay  
 time : 6.80ms



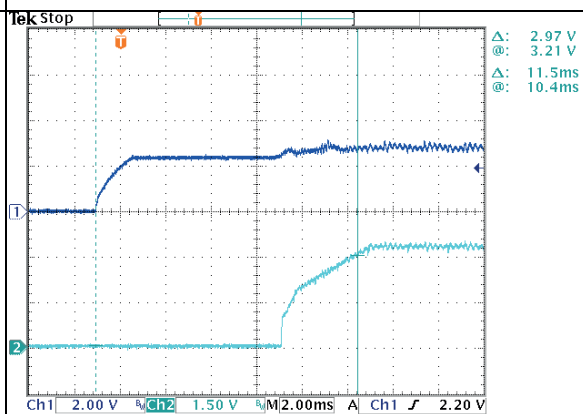
Model : PHB100-48S25  
 Ch1 : Vin Ch2 : Vout Delay  
 time : 5.48ms



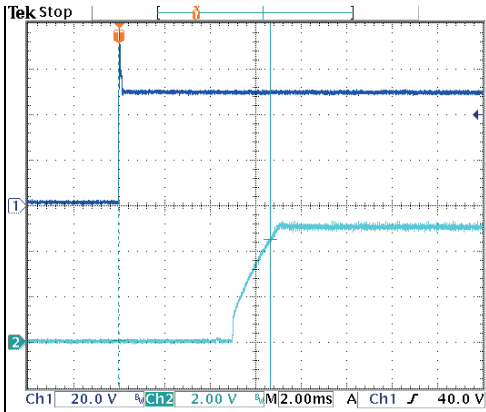
Model : PHB100-48S25 Ch1 :  
 Remote Ch2 : Vout Delay  
 time : 9.28ms



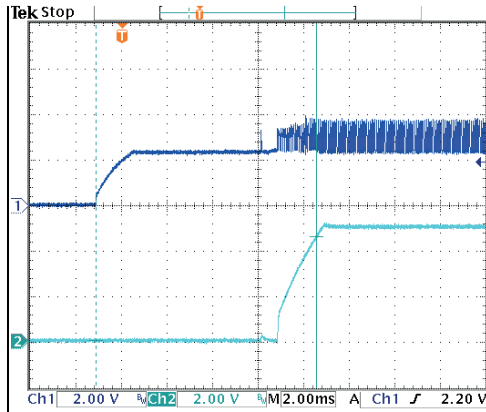
Model : PHB100-48S33  
 Ch1 : Vin Ch2 : Vout Delay  
 time : 8.76ms



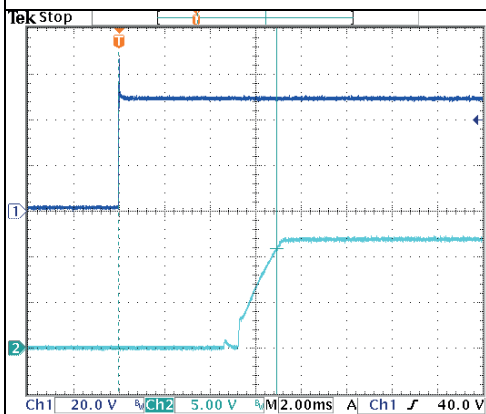
Model : PHB100-48S33 Ch1 :  
 Remote Ch2 : Vout Delay  
 time : 11.5ms



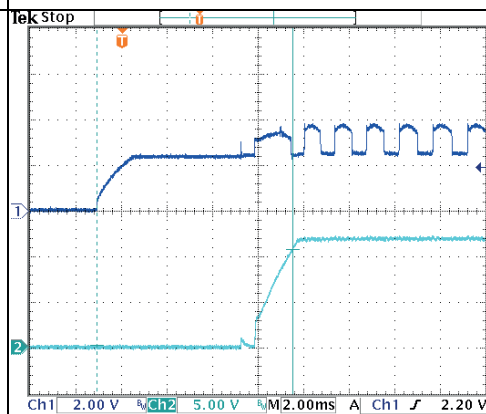
Model : PHB100-48S05  
 Ch1 : Vin Ch2 : Vout Delay  
 time : 6.68ms



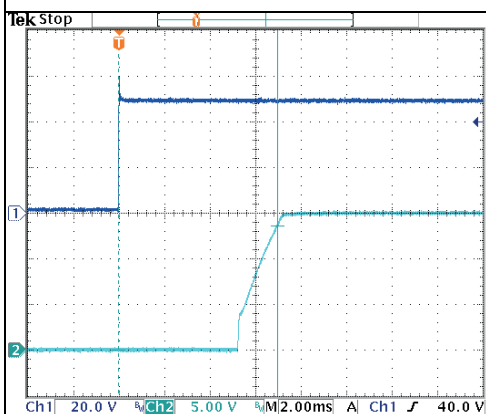
Model : PHB100-48S05 Ch1 :  
 Remote Ch2 : Vout Delay  
 time : 9.68ms



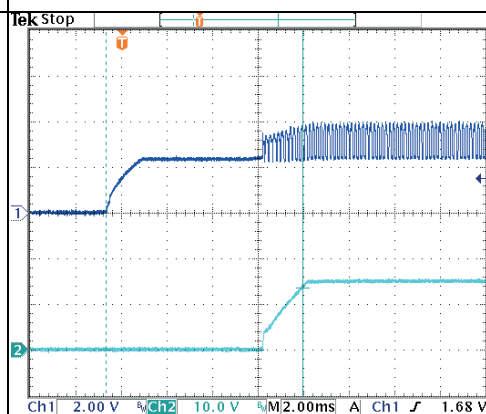
Model : PHB100-48S12  
 Ch1 : Vin Ch2 : Vout Delay  
 time : 6.96ms



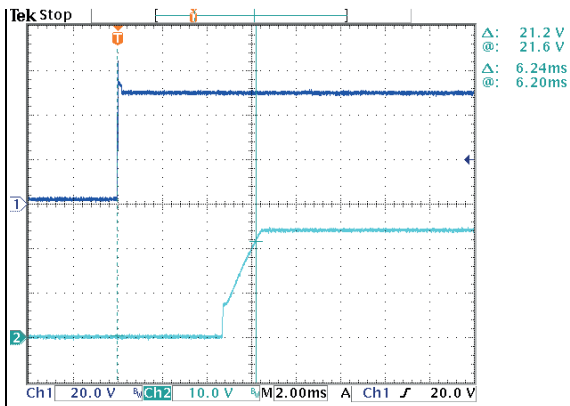
Model : PHB100-48S12 Ch1 :  
 Remote Ch2 : Vout Delay  
 time : 8.60ms



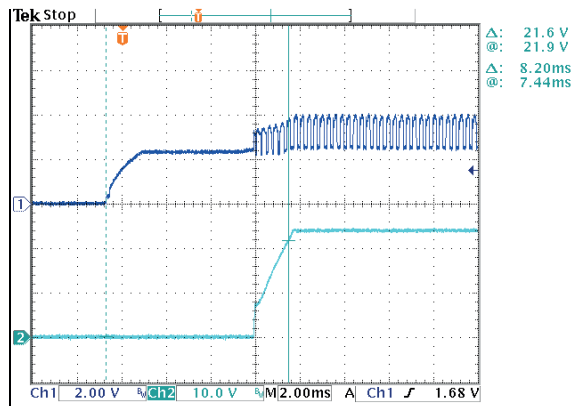
Model : PHB100-48S15  
 Ch1 : Vin Ch2 : Vout Delay  
 time : 7.00ms



Model : PHB100-48S15 Ch1 :  
 Remote Ch2 : Vout Delay  
 time : 8.64ms



Model : PHB100-48S24  
 Ch1 : Vin Ch2 : Vout Delay  
 time : 6.24ms



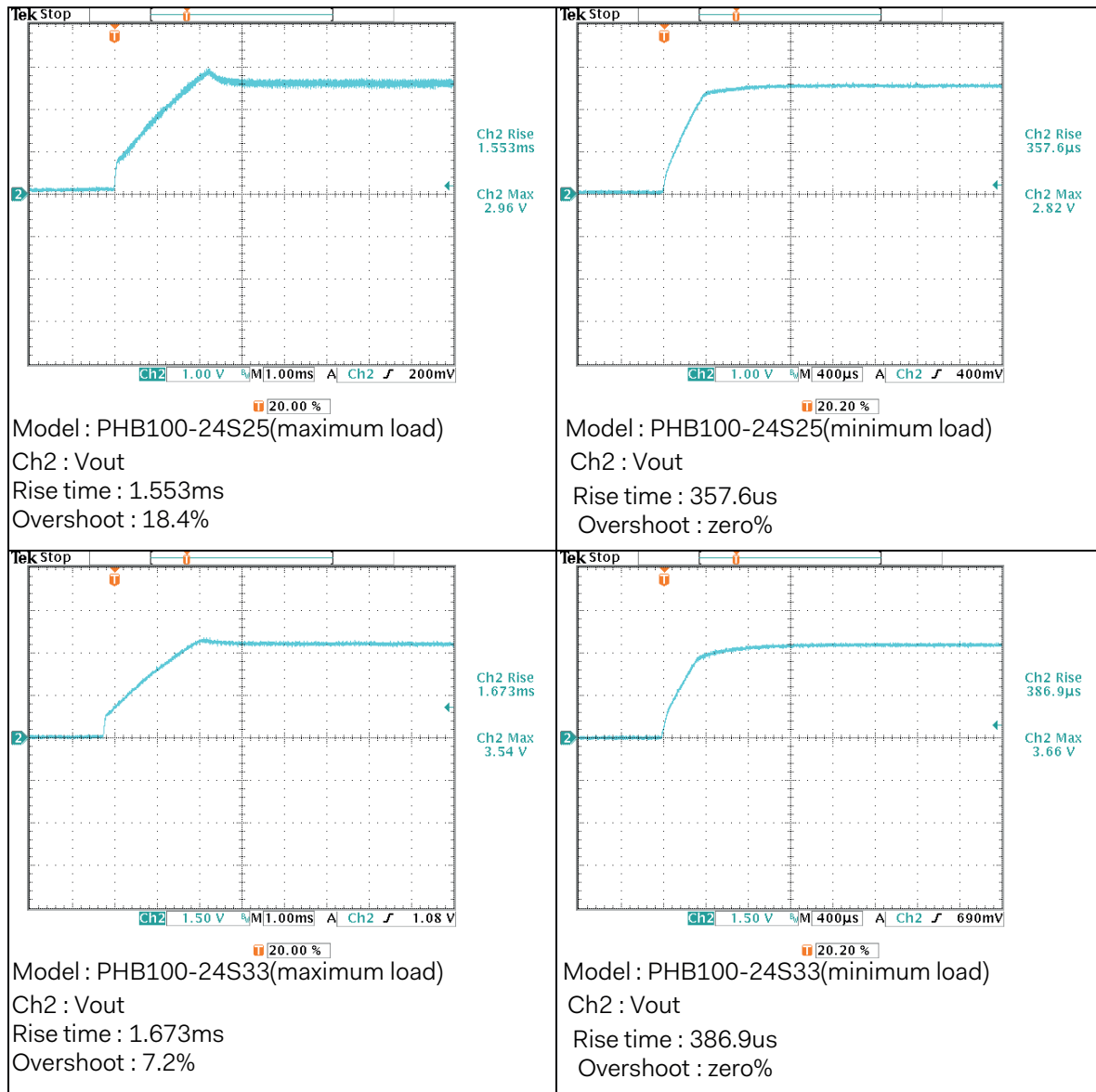
Model : PHB100-48S24 Ch1 :  
 Remote Ch2 : Vout Delay  
 time : 8.20ms

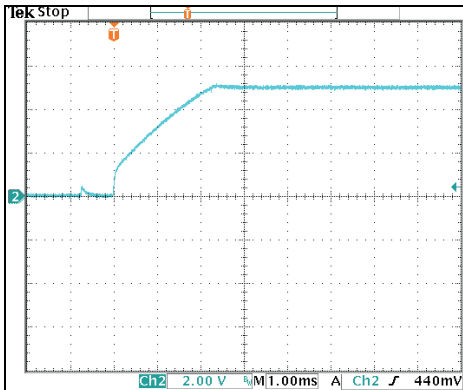
Overshoot

Start up input power, measuring the deviation which over the output. At nominal input , minimum load and maximum load.

Rise Time

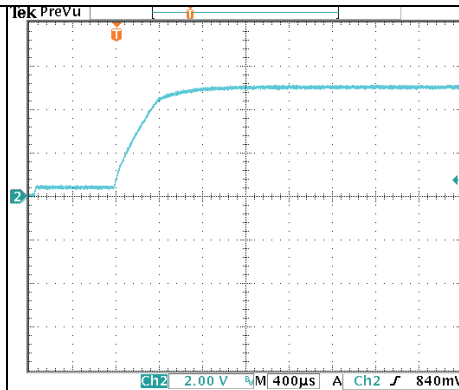
Measuring the time between 10%-Vout to 90%-Vout. At nominal input , minimum load and maximum load.





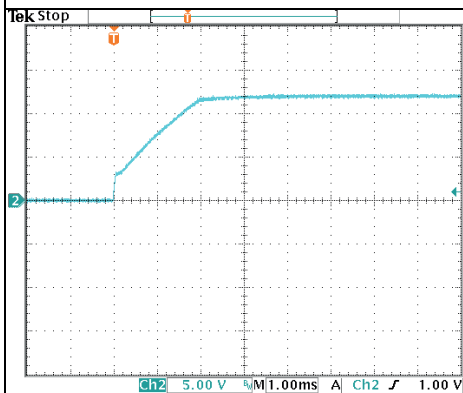
Ch2 Rise  
1.832ms  
Ch2 Max  
5.20 V

Model : PHB100-24S05(maximum load)  
 Ch2 : Vout  
 Rise time : 1.832ms  
 Overshoot : 4%



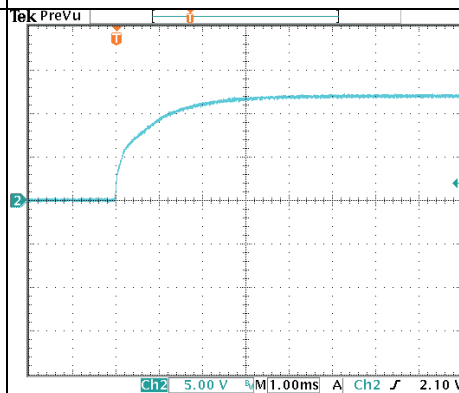
Ch2 Rise  
423.6µs  
Ch2 Max  
5.20 V

Model : PHB100-24S05(minimum load)  
 Ch2 : Vout  
 Rise time : 423.6µs  
 Overshoot : zero%



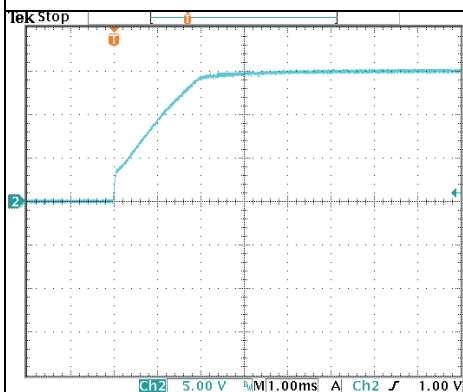
Ch2 Rise  
1.708ms  
Ch2 Max  
12.3 V

Model : PHB100-24S12(maximum load)  
 Ch2 : Vout  
 Rise time : 1.708ms  
 Overshoot : zero%



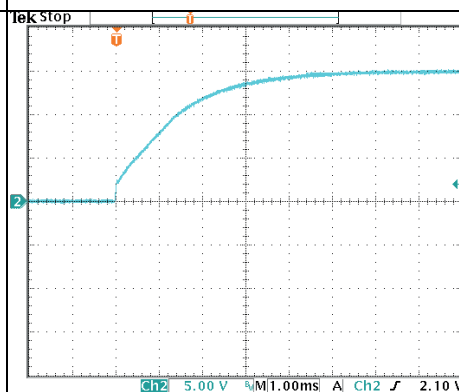
Ch2 Rise  
1.703ms  
Ch2 Max  
12.4 V

Model : PHB100-24S12(minimum load)  
 Ch2 : Vout  
 Rise time : 1.703ms  
 Overshoot : zero%



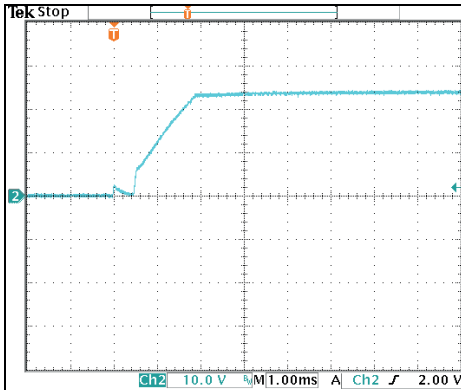
Ch2 Rise  
1.803ms  
Ch2 Max  
15.3 V

Model : PHB100-24S15(maximum load)  
 Ch2 : Vout  
 Rise time : 1.803ms  
 Overshoot : zero%

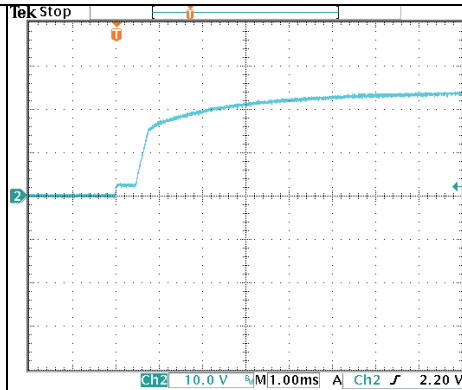


Ch2 Rise  
2.741ms  
Ch2 Max  
15.3 V

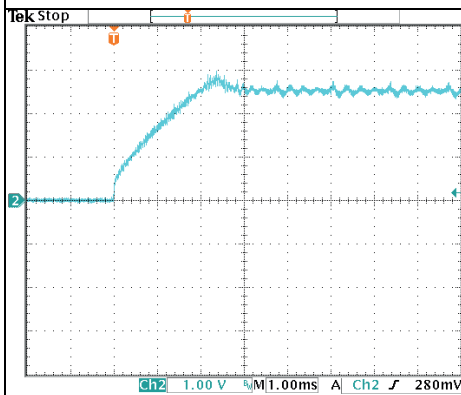
Model : PHB100-24S15(minimum load)  
 Ch2 : Vout  
 Rise time : 2.741ms  
 Overshoot : zero%



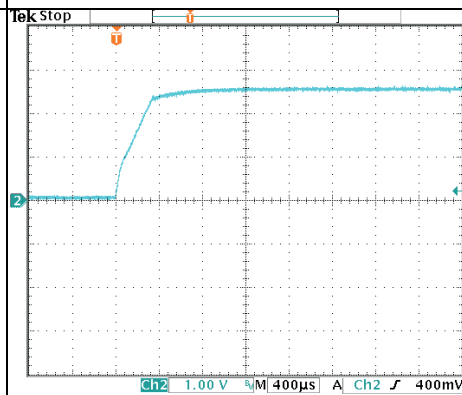
Model : PHB100-24S24(maximum load)  
 Ch2 : Vout  
 Rise time : 1.223ms  
 Overshoot : zero%



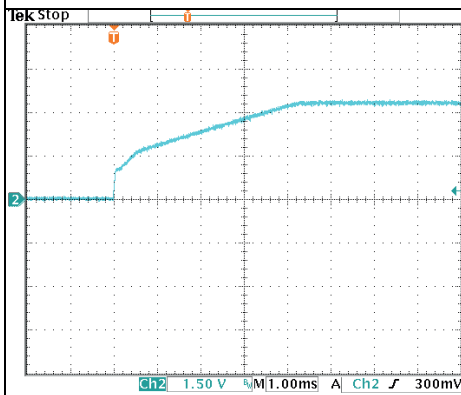
Model : PHB100-24S24(minimum load)  
 Ch2 : Vout  
 Rise time : 2.366ms  
 Overshoot : zero%



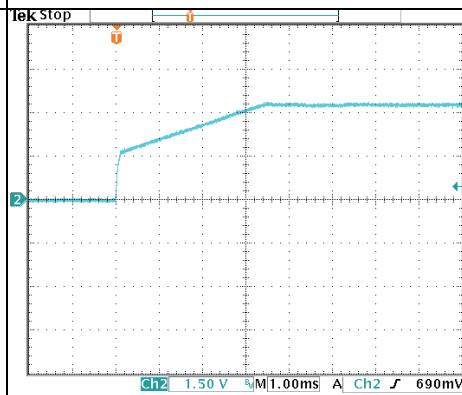
Model : PHB100-48S25(maximum load)  
 Ch2 : Vout  
 Rise time : 1.625ms  
 Overshoot : 23.2%



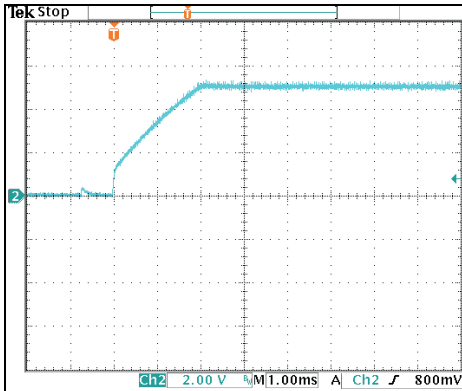
Model : PHB100-48S25(minimum load)  
 Ch2 : Vout  
 Rise time : 317.6µs  
 Overshoot : zero%



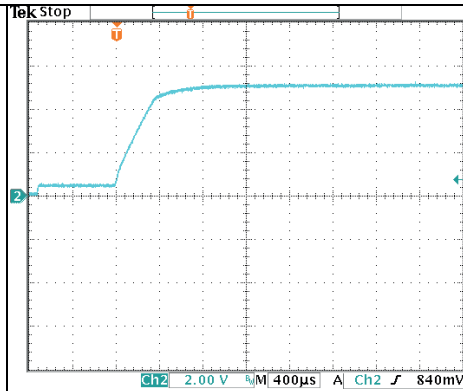
Model : PHB100-48S33(maximum load)  
 Ch2 : Vout  
 Rise time : 3.364ms  
 Overshoot : zero%



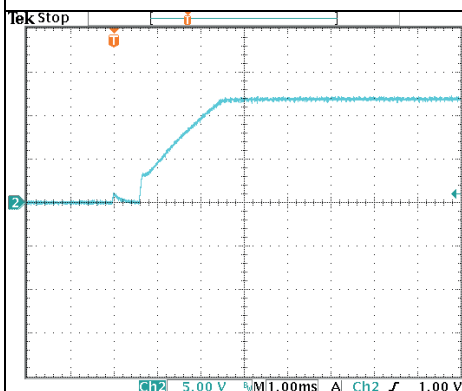
Model : PHB100-48S33(minimum load)  
 Ch2 : Vout  
 Rise time : 2.564ms  
 Overshoot : zero%



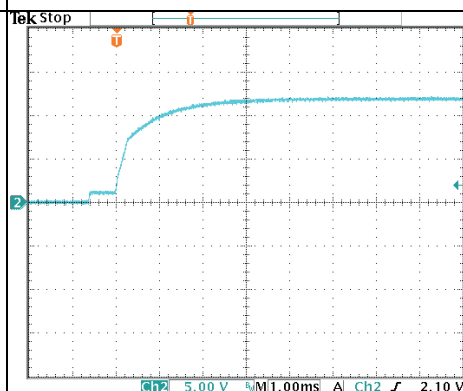
Model : PHB100-48S05(maximum load)  
 Ch2 : Vout  
 Rise time : 1.629ms  
 Overshoot : zero%



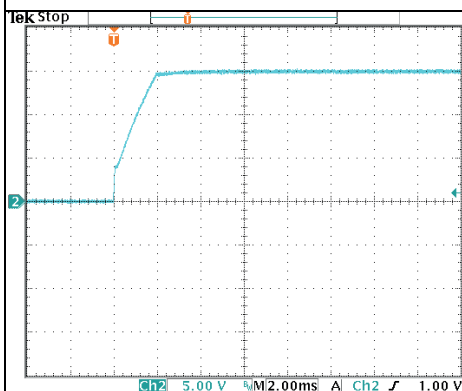
Model : PHB100-48S05(minimum load)  
 Ch2 : Vout  
 Rise time : 386.0µs  
 Overshoot : zero%



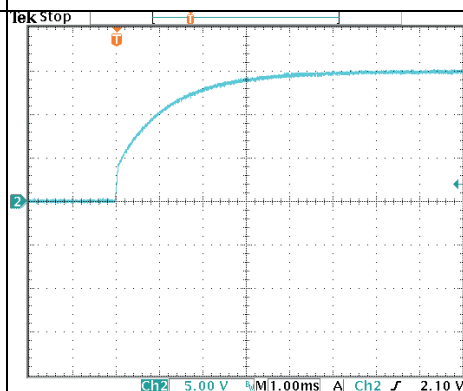
Model : PHB100-48S12(maximum load)  
 Ch2 : Vout  
 Rise time : 1.577ms  
 Overshoot : zero%



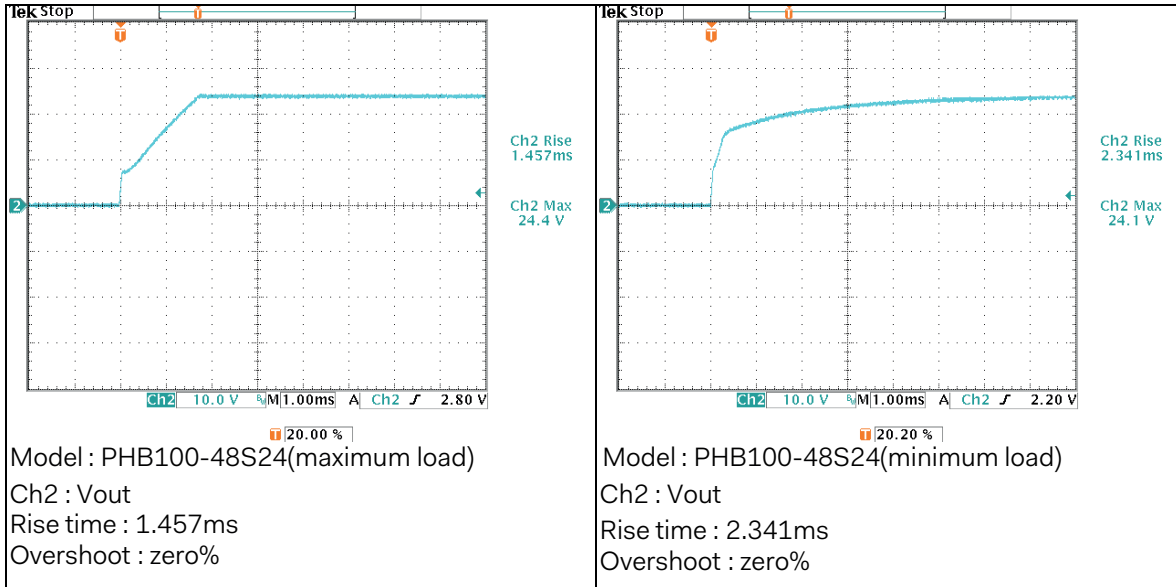
Model : PHB100-48S12(minimum load)  
 Ch2 : Vout  
 Rise time : 1.435ms  
 Overshoot : zero%



Model : PHB100-48S15(maximum load)  
 Ch2 : Vout  
 Rise time : 1.694ms  
 Overshoot : zero%



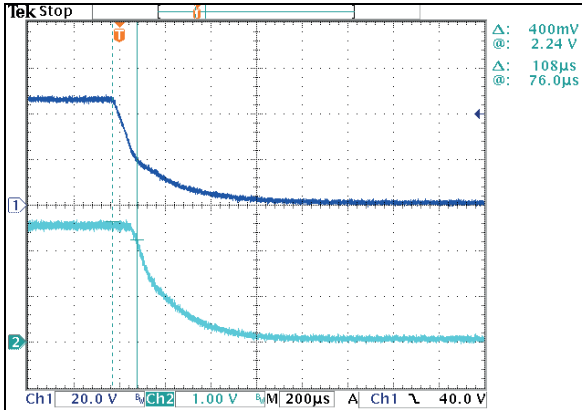
Model : PHB100-48S15(minimum load)  
 Ch2 : Vout  
 Rise time : 2.229ms  
 Overshoot : zero%



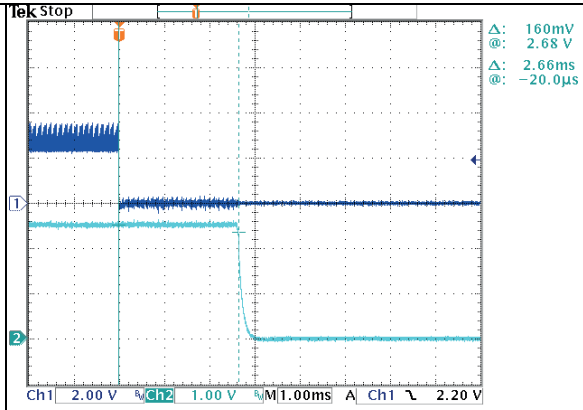


Hold Time

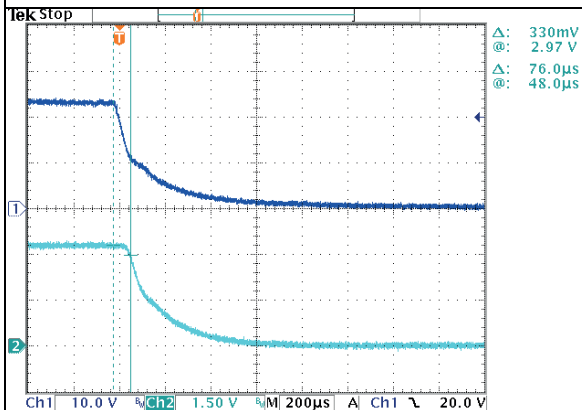
1. Measure from the power supply end to when Vout drop down to 90% output. At nominal input and maximum load.
2. Measure from the remote control end to when Vout drop down to 90% output. At nominal input and maximum load



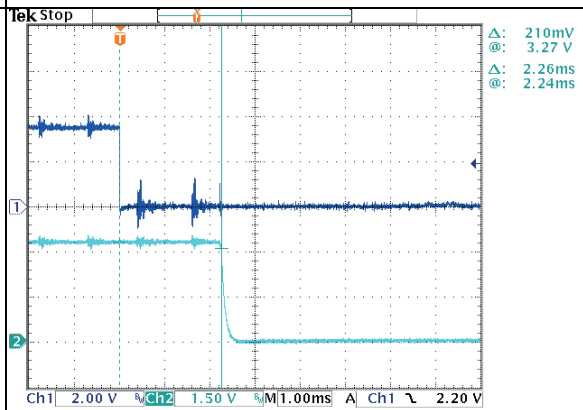
Model : PHB100-24S25  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 108us



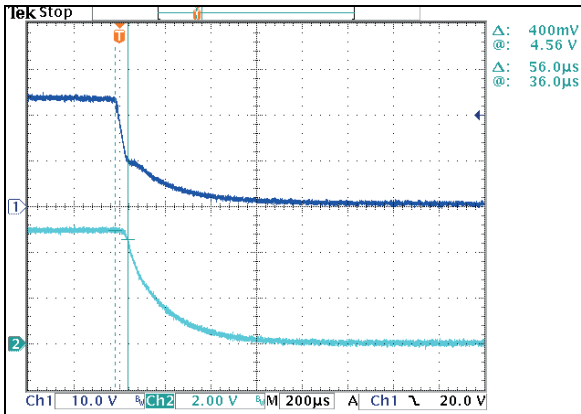
Model : PHB100-24S25 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.66ms



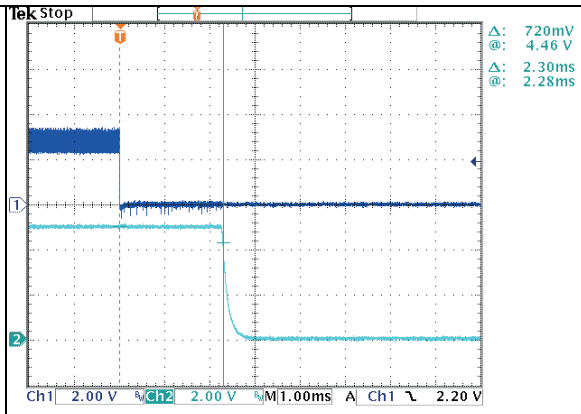
Model : PHB100-24S33  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 76.0us



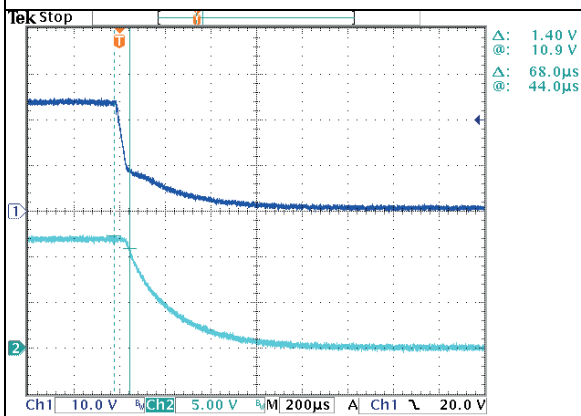
Model : PHB100-24S33 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.26ms



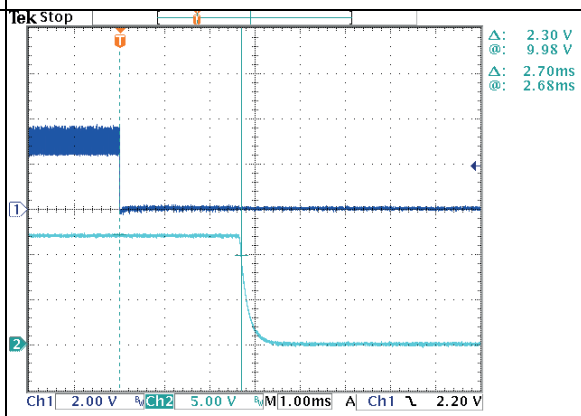
Model : PHB100-24S05  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 56.0us



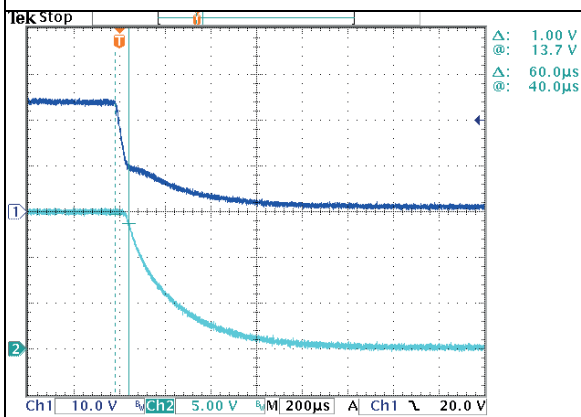
Model : PHB100-24S05 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.30m



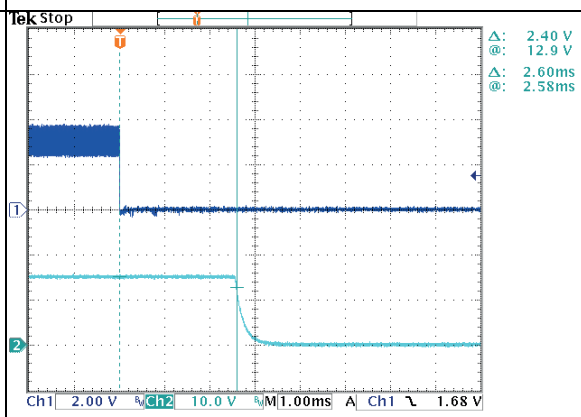
Model : PHB100-24S12  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 68.0us



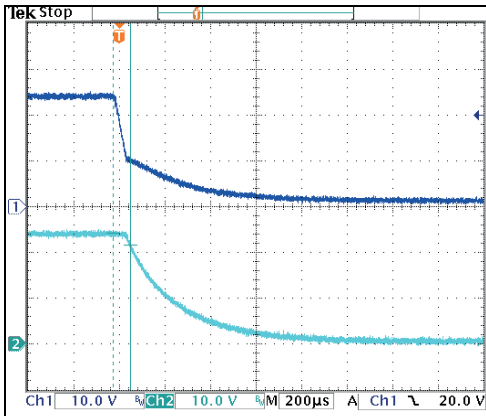
Model : PHB100-24S12 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.70ms



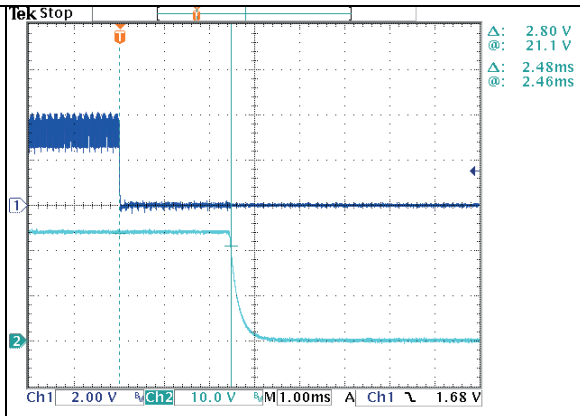
Model : PHB100-24S15  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 60.0us



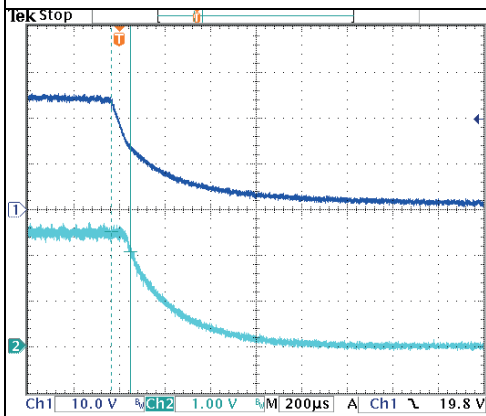
Model : PHB100-24S15 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.60ms



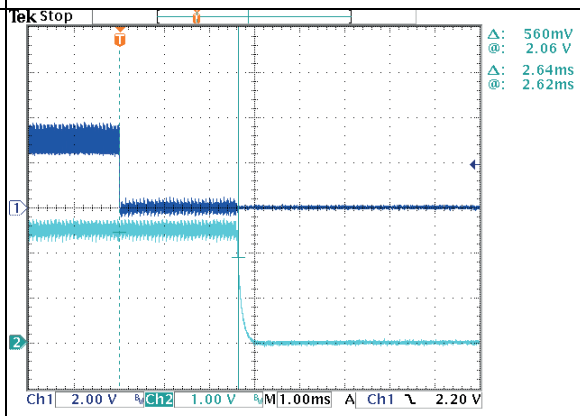
Model : PHB100-24S24  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 76.0us



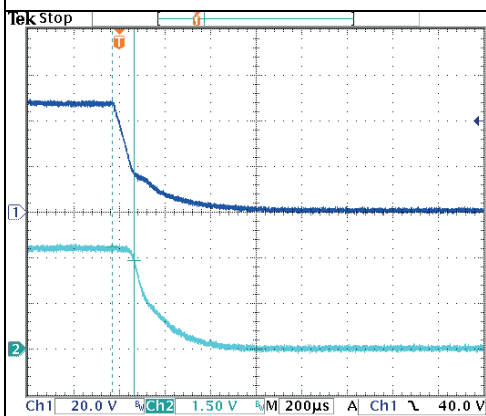
Model : PHB100-24S24 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.48ms



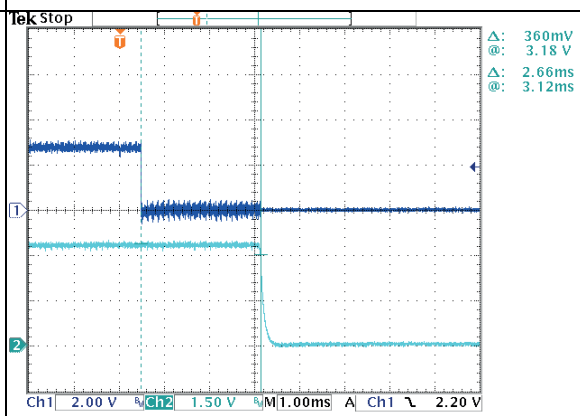
Model : PHB100-48S25  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 84.0us



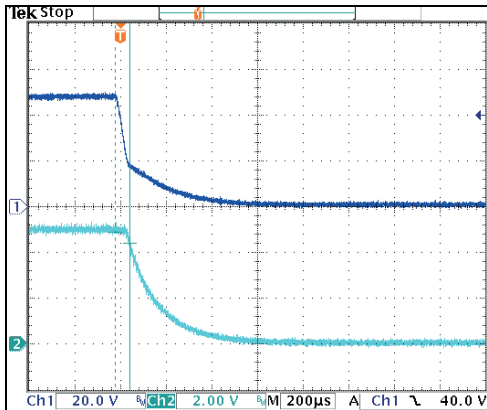
Model : PHB100-48S25 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.64ms



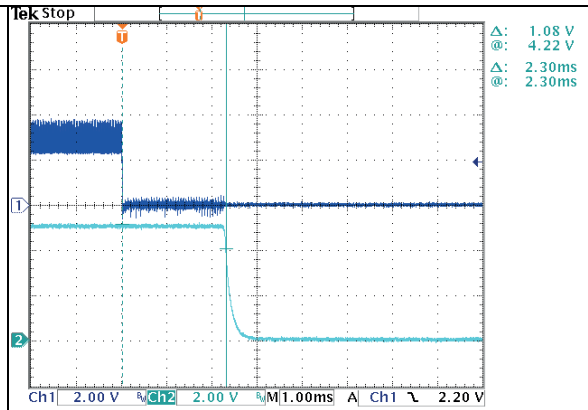
Model : PHB100-48S33  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 96.0us



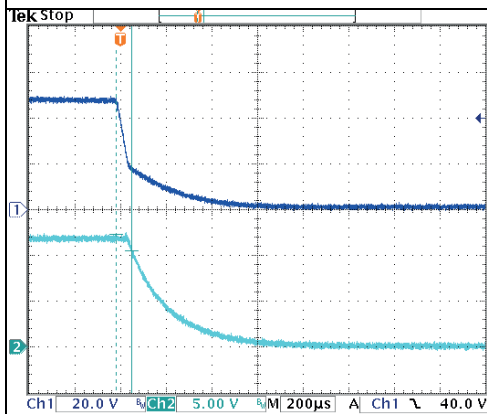
Model : PHB100-48S33 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.66ms



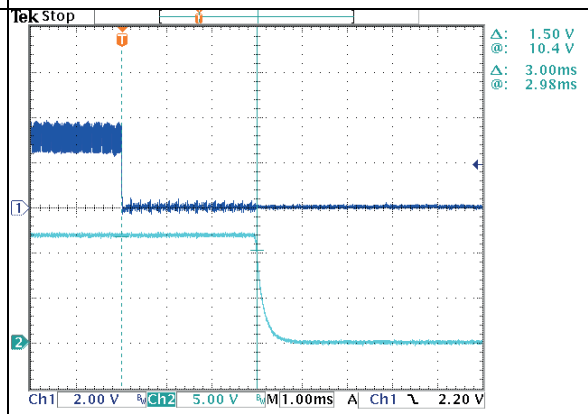
Model : PHB100-48S05  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 64.0us



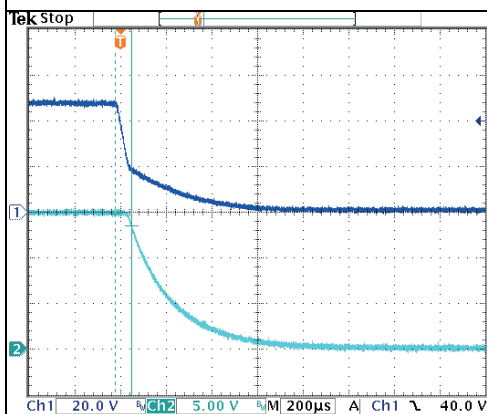
Model : PHB100-48S05 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.30ms



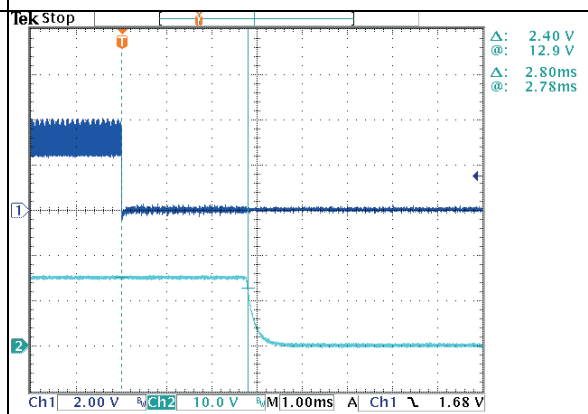
Model : PHB100-48S12  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 68.0us



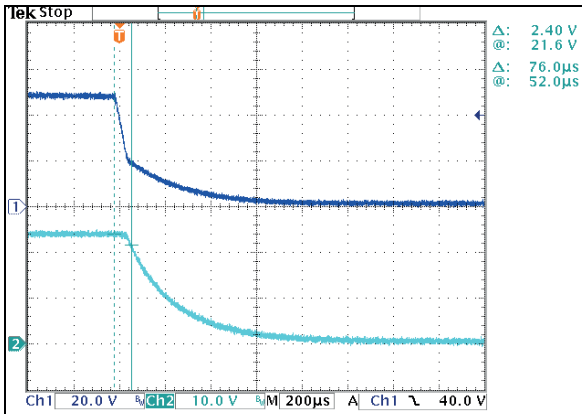
Model : PHB100-48S12 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 3.00ms



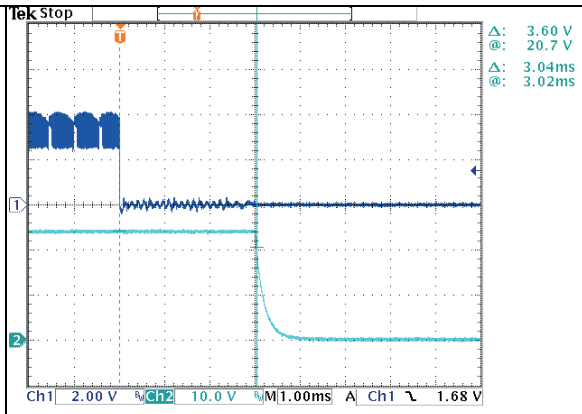
Model : PHB100-48S15  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 72.0us



Model : PHB100-48S15 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 2.80ms



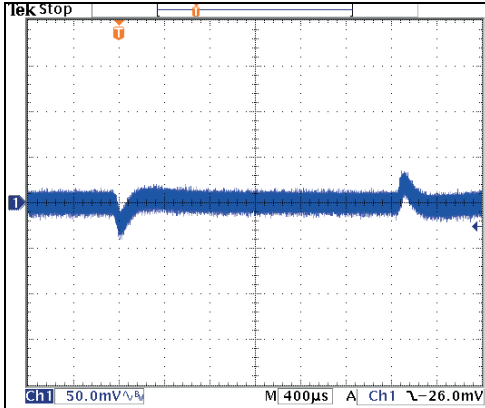
Model : PHB100-48S24  
 Ch1 : Vin Ch2 : Vout Hold  
 time : 76.0us



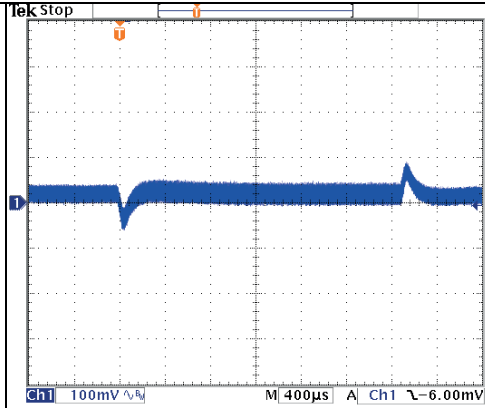
Model : PHB100-48S24 Ch1 :  
 Remote Ch2 : Vout Hold  
 time : 3.04ms

Dynamic Response

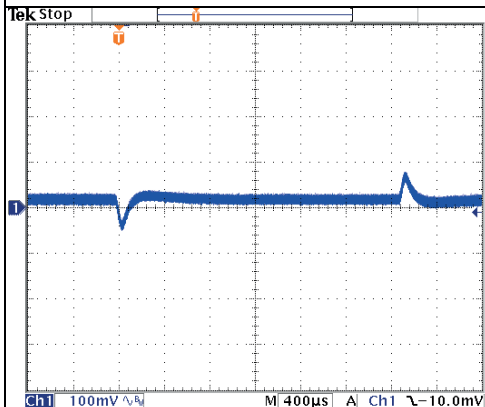
Output voltage dynamic response at nominal input and different load condition (load change 75% load to 100% load) and output with a 1.0uF ceramic capacitor and a 10uF tantalum capacitor. Load current=0.1A/us, Ton=Toff=2.5ms.



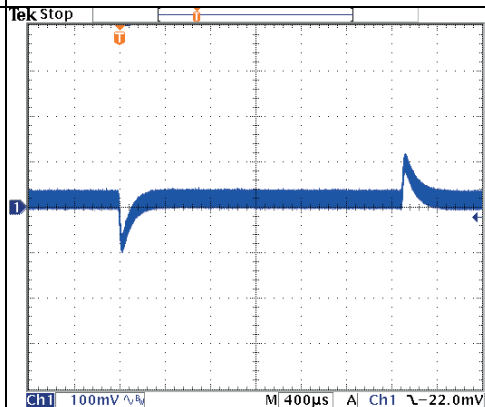
Model : PHB100-24S25  
 Ch1 : Vout



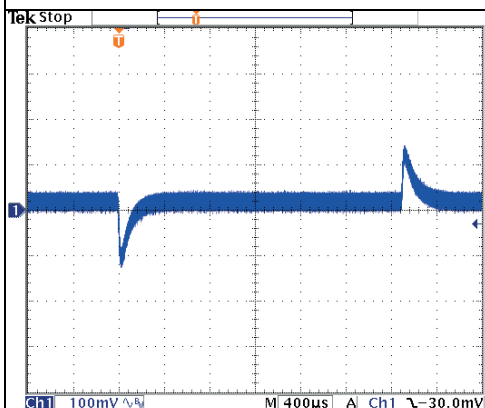
Model : PHB100-24S33  
 Ch1 : Vout



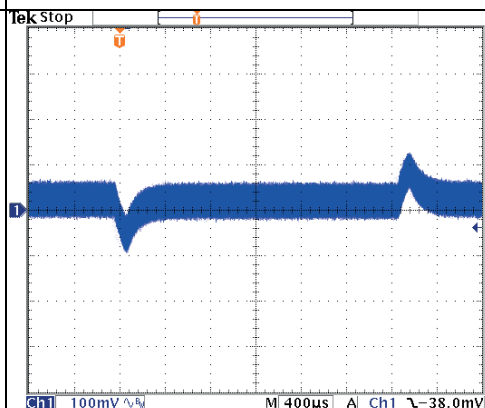
Model : PHB100-24S05  
 Ch1 : Vout



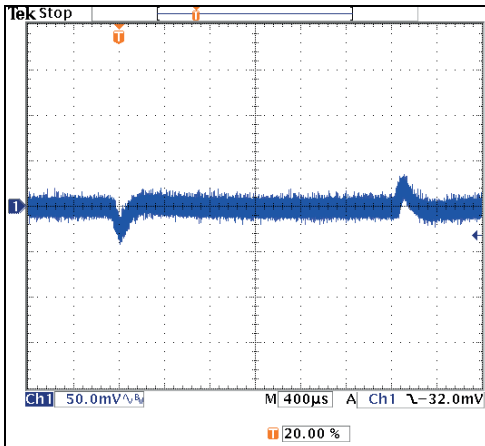
Model : PHB100-24S12  
 Ch1 : Vout



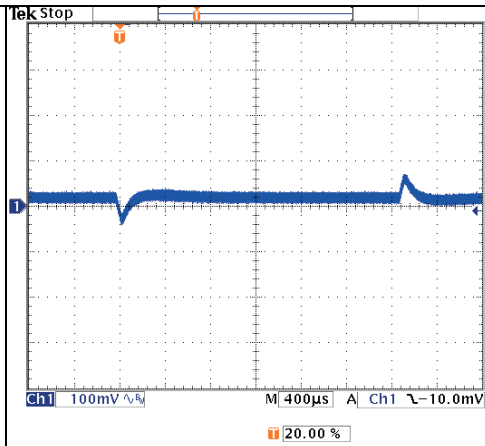
Model : PHB100-24S15  
 Ch1 : Vout



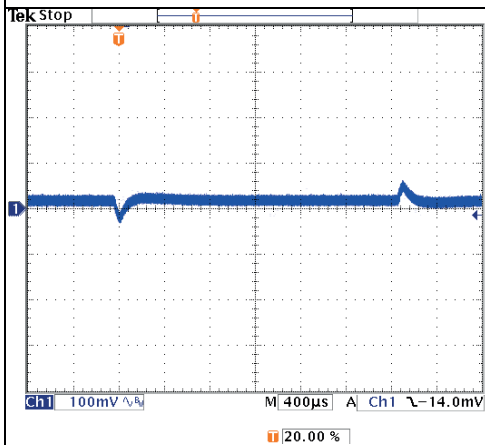
Model : PHB100-24S24  
 Ch1 : Vout



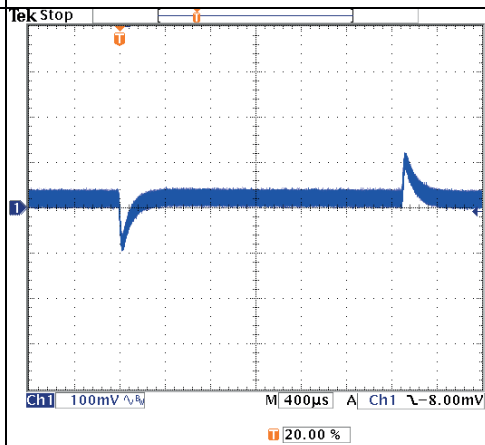
Model : PHB100-48S25  
 Ch1 : Vout



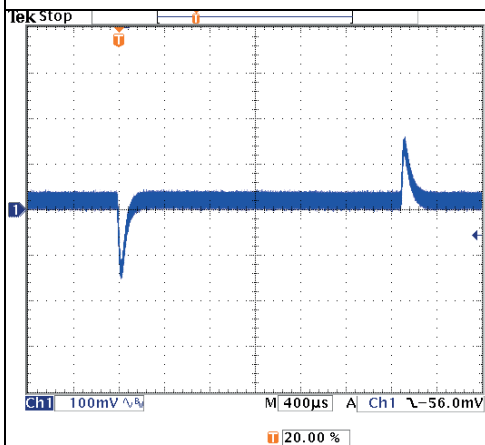
Model : PHB100-48S33  
 Ch1 : Vout



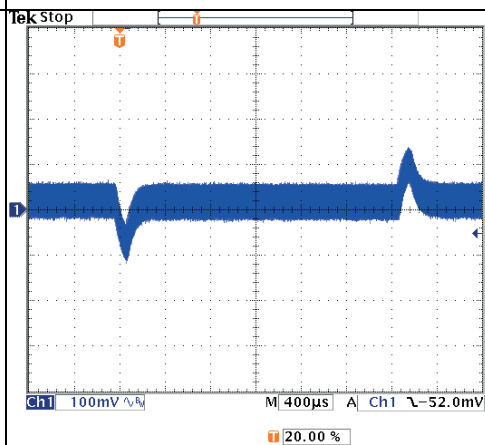
Model : PHB100-48S05  
 Ch1 : Vout



Model : PHB100-48S12  
 Ch1 : Vout



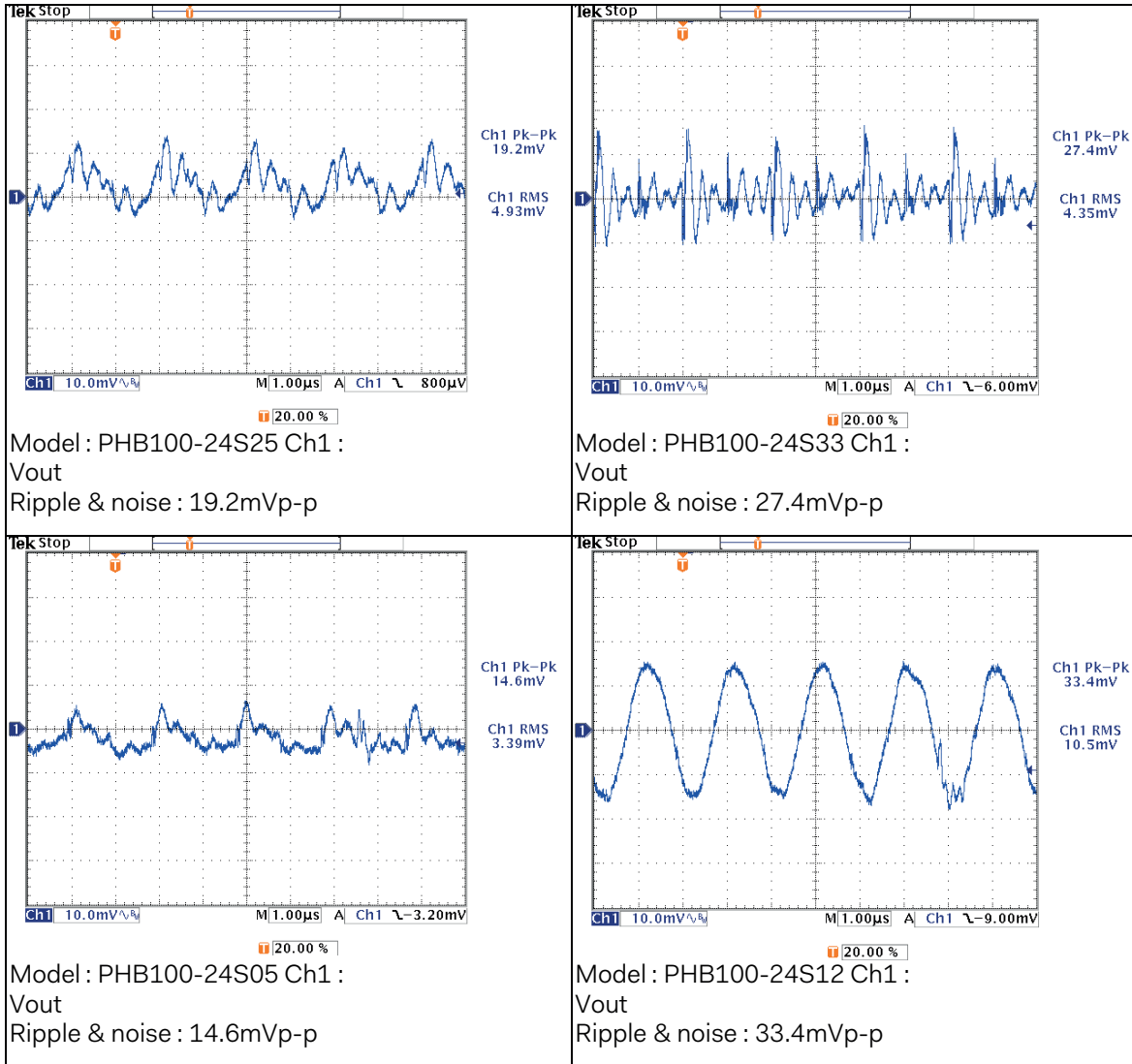
Model : PHB100-48S15  
 Ch1 : Vout



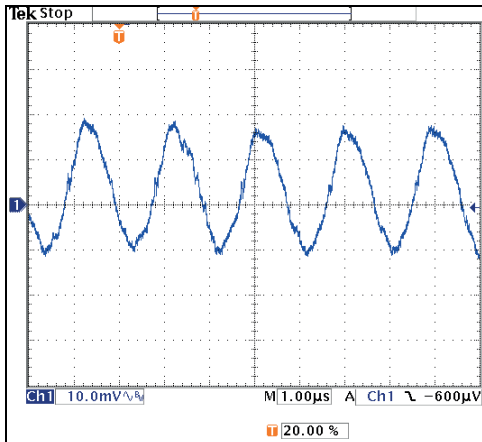
Model : PHB100-48S24  
 Ch1 : Vout

### Output Ripple and Noise

Measuring output ripple waveform peak to peak. Measure main bandwidth 20 MHz. At nominal input, maximum load and output with a 1.0uF ceramic capacitor and a 10uF tantalum capacitor.

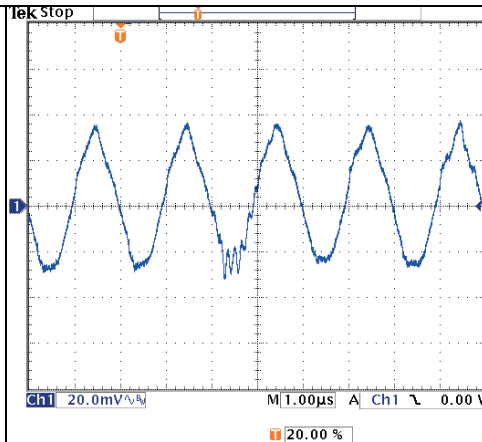






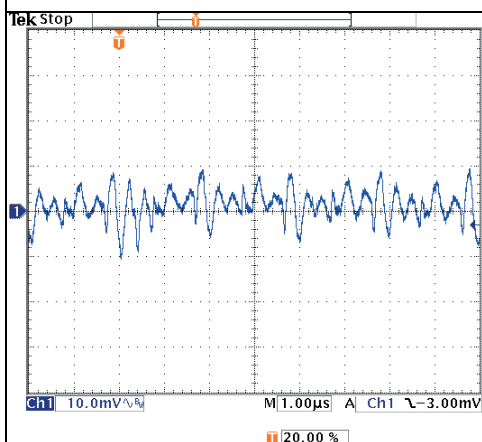
Ch1 Pk-Pk  
31.0mV  
Ch1 RMS  
9.86mV

Model : PHB100-24S15 Ch1 :  
 Vout  
 Ripple & noise : 31.0mVp-p



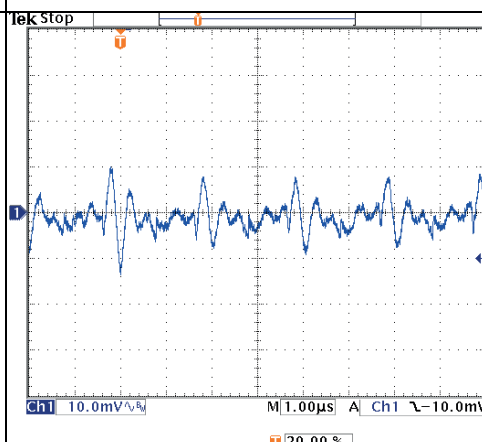
Ch1 Pk-Pk  
69.6mV  
Ch1 RMS  
20.6mV

Model : PHB100-24S24 Ch1 :  
 Vout  
 Ripple & noise : 69.6mVp-p



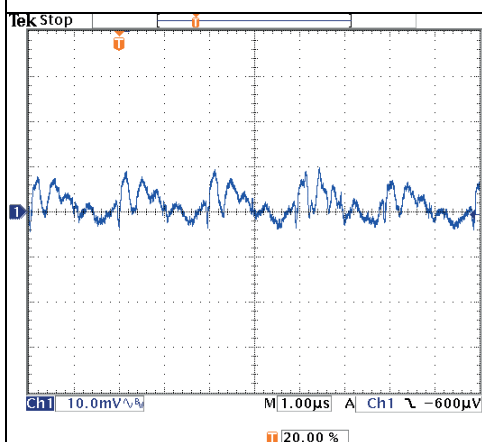
Ch1 Pk-Pk  
20.0mV  
Ch1 RMS  
3.58mV

Model : PHB100-48S25 Ch1 :  
 Vout  
 Ripple & noise : 20.0mVp-p



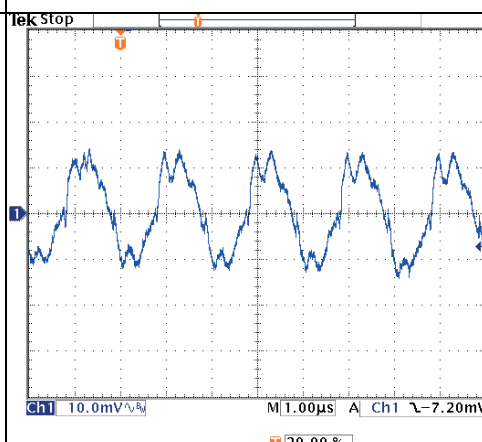
Ch1 Pk-Pk  
23.6mV  
Ch1 RMS  
3.30mV

Model : PHB100-48S33 Ch1 :  
 Vout  
 Ripple & noise : 23.6mVp-p



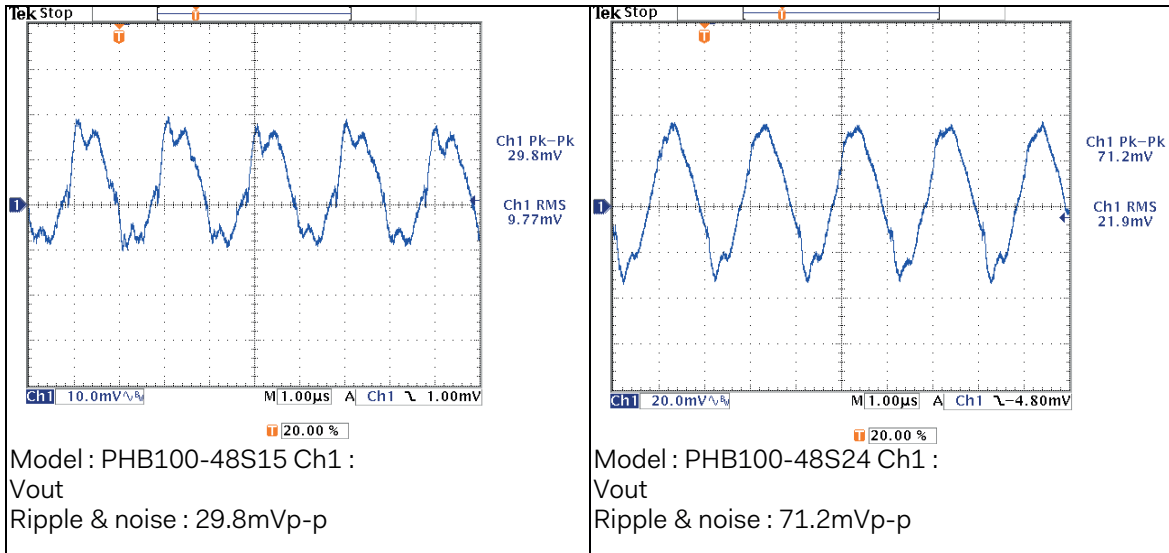
Ch1 Pk-Pk  
14.2mV  
Ch1 RMS  
3.29mV

Model : PHB100-48S05 Ch1 :  
 Vout  
 Ripple & noise : 14.2mVp-p



Ch1 Pk-Pk  
28.4mV  
Ch1 RMS  
8.26mV

Model : PHB100-48S12 Ch1 :  
 Vout  
 Ripple & noise : 28.4mVp-p

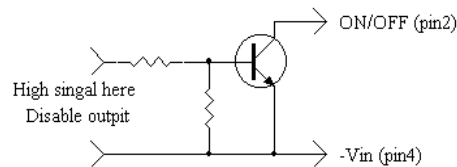


### Remote ON/OFF Control Circuit

The PHB100 series allows the user to switch the module on and off electronically with remote on/off feature. The PHB100 series are available with "Positive Logic" or "Negative Logic" (option).

#### Logic table

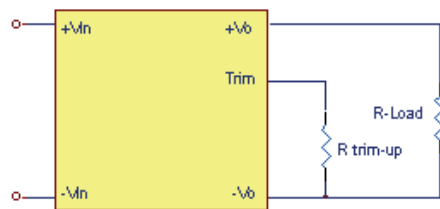
Logic State(pin2)	Negative logic	Positive logic
Logic Low-Switch Closed	Module on	Module off
Logic High-Switch Open	Module off	Module on



### External Output Trimming

In order to trim the voltage up or down one needs to connect the trim resistor either between the trim pin and -Vo for trim-up and between trim pin and +Vo for trim-down. The output voltage trim range is ±10%. This is shown in Figures 1 and Figures 2.

Figures 1 : trim-up voltage setup



The value of R trim-up defined as:

$$R_{trim-up} = \frac{R1 - R2 \times (V_o - V_{o, nom})}{(V_o - V_{o, nom})} \text{ (K}\Omega\text{)}$$

Where: R trim-up is the external resistor in Kohm. Vo,nom is the nominal output voltage. Vo is the desired output voltage. R1 and R2 are internal to the unit and are defined in Table 1

Output Voltage(V)	R1 (Kohm)	R2(Kohm)
2.5V	2.88	3
3.3V	3.168	7.2
5V	5.8	3.3
12V 1	8.945	4.636
15V	25.189	7.191
24V	41.442	6.977

Table 1

For example, to trim-up the output voltage of 5.0V module (PHB100-48S05) by 8% to 5.4V, Rtrim-up is calculated as follows:

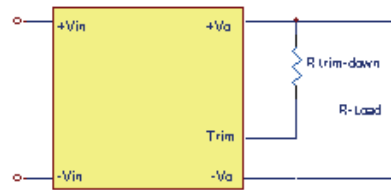
$$V_o - V_{o, nom} = 5.4 - 5.0 = 0.4V$$

$$R1 = 5.8 \text{ Kohm}$$

$$R2 = 3.3 \text{ Kohm}$$

$$R_{trim-up} = \frac{5.8 - 3.3 \times 0.4}{0.4} = 11.2 \text{ (K}\Omega\text{)}$$

Figures 2 : trim-down voltage setup



The value of R trim-down defined as:

$$R_{trim-down} = \frac{R1 - R2 \times (V_{o, nom} - V_o)}{(V_{o, nom} - V_o)} \text{ (K}\Omega\text{)}$$

Where: R trim-down is the external resistor in Kohm. Vo,nom is the nominal output voltage. Vo is the desired output voltage. R1 and R2 are internal to the unit and are defined in Table 2.

Output Voltage(V)	R1 (Kohm)	R2(Kohm)
2.5V	2.92	5.32
3.3V	6.18	15
5V	5.8	5.32
12V	86.45	60.1
15V	150	68
24V	430	120

Table 2

For example, to trim-down the output voltage of 5.0V module (PHB100-48S05) by 8% to 4.6V, Rtrim-down is calculated as follows :

$$V_{o, nom} - V_o = 5.0 - 4.6 = 0.4 V$$

$$R1 = 5.8 \text{ Kohm}$$

$$R2 = 5.32 \text{ Kohm}$$

$$R_{trim-down} = \frac{5.8 - 5.32 \times 0.4}{0.4} = 9.18 \text{ (K}\Omega\text{)}$$

**POWERBOX Industrial Line**  
**PHB100 Series**  
**50-100W 2:1 Single Output**  
**DC/DC Converter**  
**Manual V12**

**Power De-rating**

The operating case temperature rang of PHB series is -40°C to +100°C. When operating the PHB series, proper de-rating or cooling is needed. The maximum case temperature under any operating condition should not be exceeded 100°C. The following curve is the de-rating curve of PHB series without heat sink.

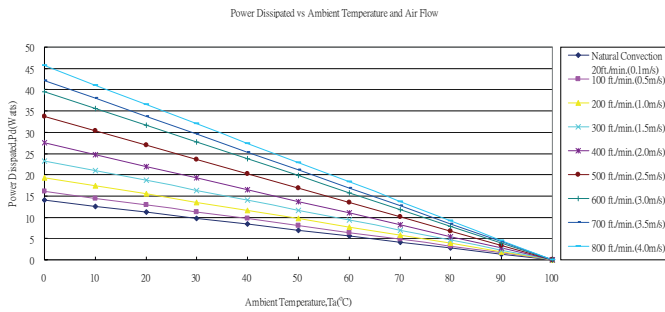


Chart of Thermal Resistance vs Air Flow

AIR FLOW RATE	TYPICAL Rca
Natural Convection 20 ft./min.(0.1m/s)	7.12°C/W
100 ft./min.(0.5m/s)	6.21°C/W
200 ft./min.(1.0m/s)	5.17°C/W
300 ft./min.(1.5m/s)	4.29°C/W
400 ft./min.(2.0m/s)	3.64°C/W
500 ft./min.(2.5m/s)	2.96°C/W
600 ft./min.(3.0m/s)	2.53°C/W
700 ft./min.(3.5m/s)	2.37°C/W
800 ft./min.(4.0m/s)	2.19°C/W

**Example**

What is the minimum airflow necessary for a PHB100-24S05 operating at nominal line voltage, an output current of 10A, and a maximum ambient temperature of 40°C?

Solution:

Given:  $V_{in}=24Vdc$   $V_o=5Vdc$   $I_o=10A$

Determine power dissipation (Pd):

$$Pd = P_i - P_o$$

$$Pd = P_o \times (1 - \text{Eff.}) / \text{Eff.}$$

$$Pd = 5 \times 10 \times (1 - 0.82) / 0.82 = 10.96 \text{ Watts}$$

Determine airflow:

Given:  $P_d = 10.96W$  and  $T_a = 40^\circ C$

Check above power de-rating curve:

Minimum airflow= 200 ft./min.

Verifying: The maximum temperature rise:

$$\Delta T = P_d \times R_{ca} = 10.96W \times 5.17 = 56.66^\circ C$$

The maximum case temperature:

$$T_c = T_a + \Delta T = 40 + 56.66 = 96.66^\circ C < 100^\circ C$$

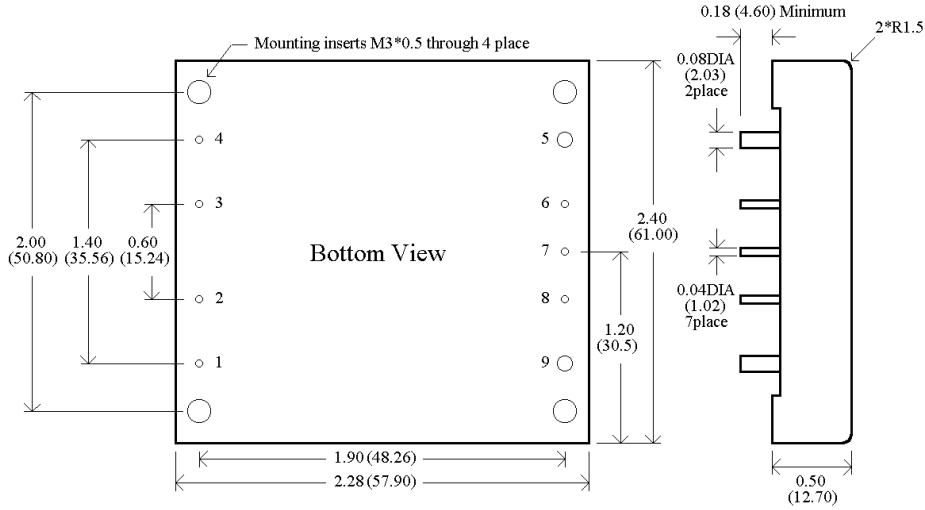
Where:

The  $R_{ca}$  is thermal resistance from case to ambient environment.

The  $T_a$  is ambient temperature and the  $T_c$  is case temperature.

Mechanical Specifications

HB case mechanical output diagrams



- Note : 1. All dimensions in inches(mm)  
 2. Tolerance inches .XX=±.02 , .XXX=±.010 , Pin±0.02  
 millimeters .X=±.5 , .XX=±.250 , Pin±0.5

Pin connection

Pin	Function
1	+V input
2	ON/OFF
3	Case
4	-V input
5	-V o utput
6	-Sense
7	Trim
8	+Sense
9	+V output