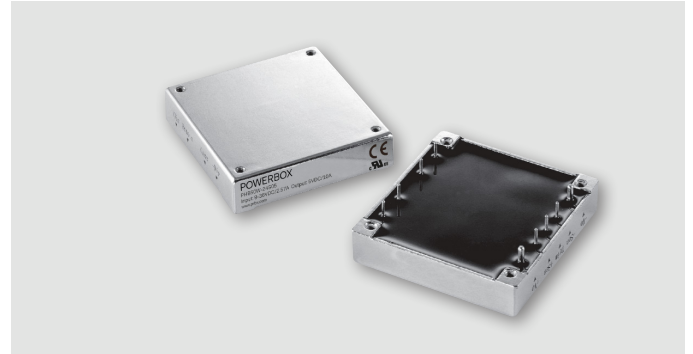


# PR BX

POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



## Table of Contents

1. Specification	P1
2. Efficiency	P2
3. Input ripple current	P5
4. Start up delay time	P8
5. Overshoot	P14
6. Hold time	P21
7. Dynamic response	P27
8. Output ripple and noise	P30
9. Remote on/off control circuit	P33
10. External output trimming	P34
11. Power derating	P35
12. Mechanical outline diagrams	P36

## Features

25-50W isolated output
Efficiency to 89%
300KHz switching frequency
2:1 input range
Regulated output
Continuous short circuit protection
Five-sided metal case
Industry standard half-brick package

## Input

Voltage range	12V	9-18VDC
	24V	18-36VDC
	48V	36-75VDC
Input filter	Pi type.	
Under voltage lockout	12Vin power up	8.8V
	12Vin power down	8V
	24Vin power up	17V
	24Vin power down	16V
	48Vin power up	34V
	48Vin power down	32.5V
Postive logic remote ON/OFF		
Logic compatibility	Open collector referenced to -input.	
	Model ON	Open circuit
	Model OFF	<0.8VDC.
	Suffix "N" to the model number with negative logic remot on/off.	

## Output

Voltage accuracy	±1%.
Transient response	500u sec, 25% step load change.
External trim adj. range	±10%.
Ripple and noise	2.5V & 3.3V & 5V: 20mVrms, 75mV p-p.
20MHz BW	12V & 15V: 30mVrms, 100mV p-p.
	24V: 100mVrms, 240mV p-p.
Temperature coefficient	±0.03%/°C max.
Short circuit protection	Continuous.
Line regulation	±0.2%, from high line to low line
Load regulation	±0.2%, from full load to zero load.
Overvoltage protection	115-140%, trip range, % Vo nom.
Current limit	110-150% nominal output.

## Environmental

Operating temperature	-40°C to +100°C.
Storage temperature	-55°C to +105°C.
Thermal shutdown	Case temperature 100°C.

## General

Isolation resistance	10 <sup>7</sup> ohm.
Switching frequency	400KHz typ (12/24Vin).
	300KHz typ (48Vin).
Isolation voltage	1500VDC input/output.
	1500VDC input/case.
	1500VDC, output/case.
Dimensions	57.9 x 61.0 x 12.7 mm.
Case material	Aluminum.

Model Number	Input Voltage	Output Voltage	Output Current	Input Current		Efficiency
				No Load	Full Load	
PHB50-12S33	9-18VDC	3.3VDC	10A	50mA	3525mA	79%
PHB50-12S05	9-18VDC	5VDC	10A	50mA	5145mA	83%
PHB50-12S12	9-18VDC	12VDC	4.16A	50mA	4950mA	87%
PHB50-12S15	9-18VDC	15VDC	3.33A	50mA	4950mA	87%
PHB50-12S24	9-18VDC	24VDC	2.08A	50mA	4950mA	87%
PHB50-24S33	18-36VDC	3.3VDC	10A	50mA	1740mA	81%
PHB50-24S05	18-36VDC	5VDC	10A	50mA	2540mA	85%
PHB50-24S12	18-36VDC	12VDC	4.16A	50mA	2450mA	88%
PHB50-24S15	18-36VDC	15VDC	3.33A	50mA	2450mA	88%
PHB50-24S24	18-36VDC	24VDC	2.08A	50mA	2419mA	88%
PHB50-48S33	36-75VDC	3.3VDC	10A	50mA	870mA	81%
PHB50-48S05	36-75VDC	5VDC	10A	50mA	1250mA	84%
PHB50-48S12	36-75VDC	12VDC	4.16A	50mA	1220mA	88%
PHB50-48S15	36-75VDC	15VDC	3.33A	50mA	1220mA	88%
PHB50-48S24	36-75VDC	24VDC	2.08A	50mA	1209mA	89%

### Note:

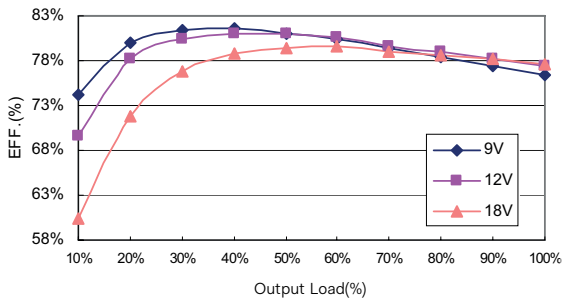
1. Nominal input voltages 12, 24 or 48 VDC.
2. All specifications typical at nominal line, full load and 25°C unless otherwise notes.

General Information

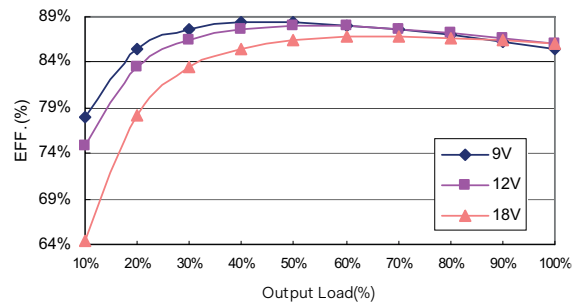
The PHB50 unit has many operational characterized aspects, including efficiency, start up delay time, overshoot, output ripple & noise, dynamic response to load.

Efficiency

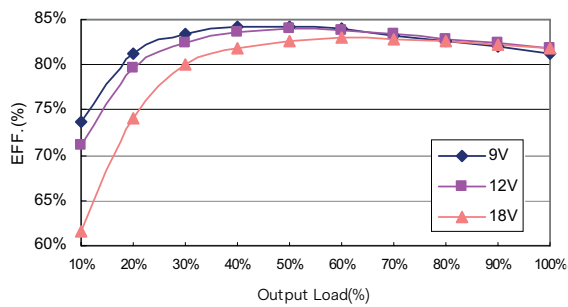
PHB50-12S33 Load VS EFF.



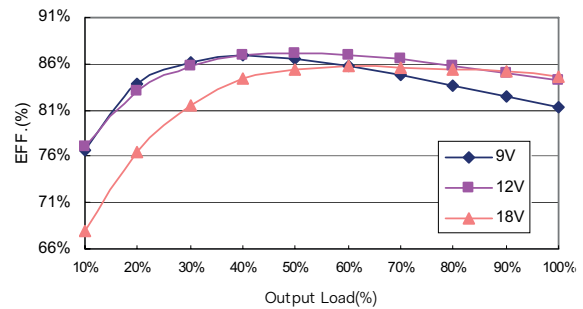
PHB50-12S12 Load VS EFF.



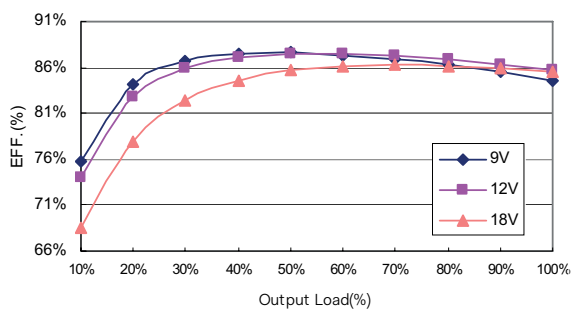
PHB50-12S05 Load VS EFF.



PHB50-12S24 Load VS EFF.

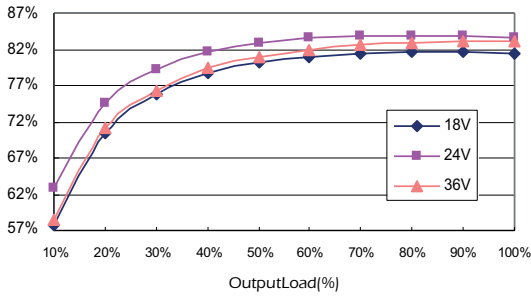


PHB50-12S15 Load VS EFF.

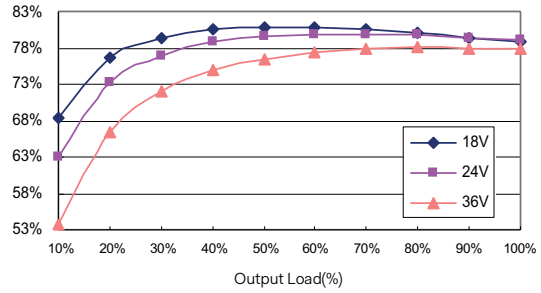


POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

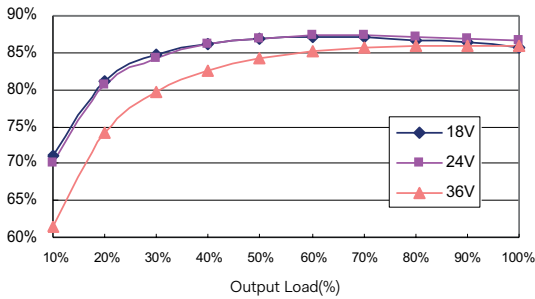
PHB50-24S05 Load VS EFF.



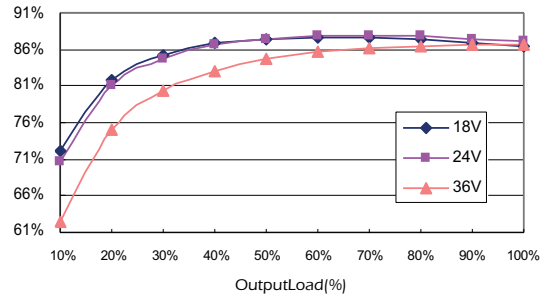
PHB50-24S33 Load VS EFF



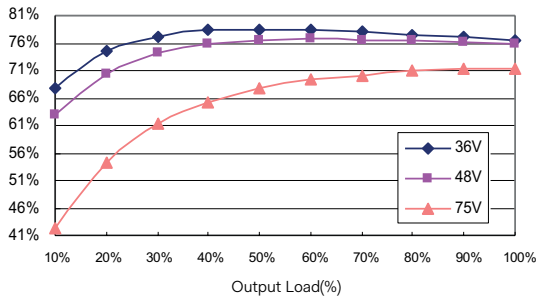
PHB50-24S15 Load VS EFF.



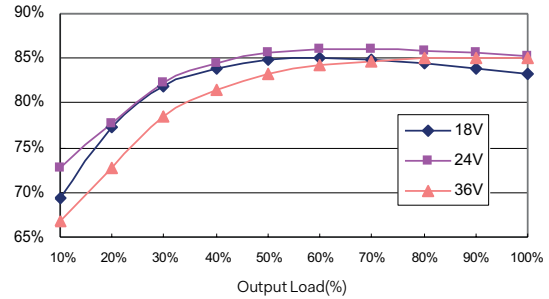
PHB50-24S12 Load VS EFF.



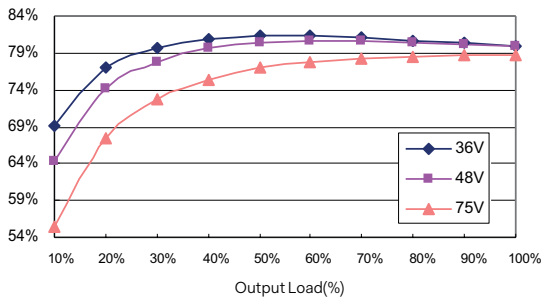
PHB50-48S25 Load VS EFF.



PHB50-24S24 Load VS EFF.

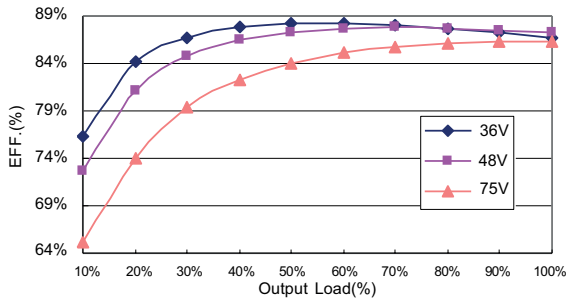


PHB50-48S33 Load VS EFF.

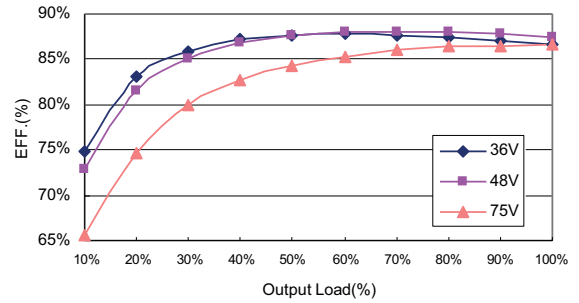


POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

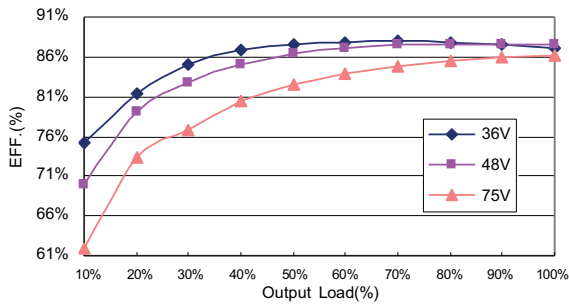
PHB50-48S15 Load VS EFF



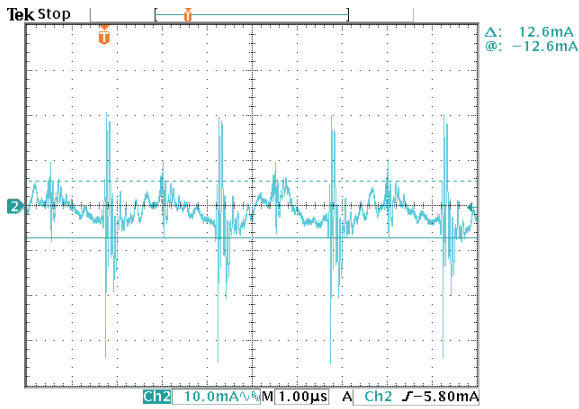
PHB50-48S05 Load VS EFF.



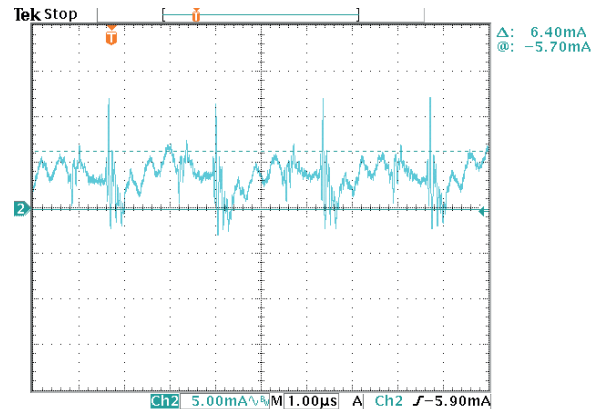
PHB50-48S24 Load VS EFF.



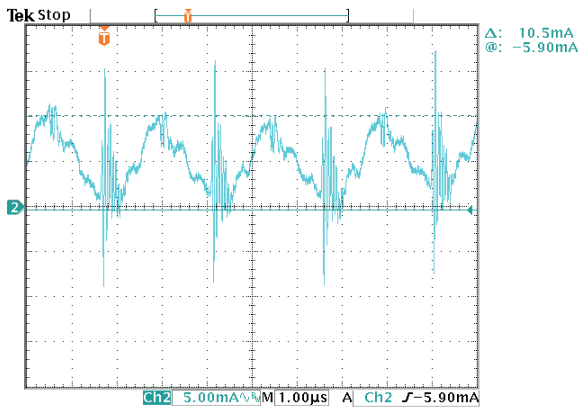
Input Ripple Current



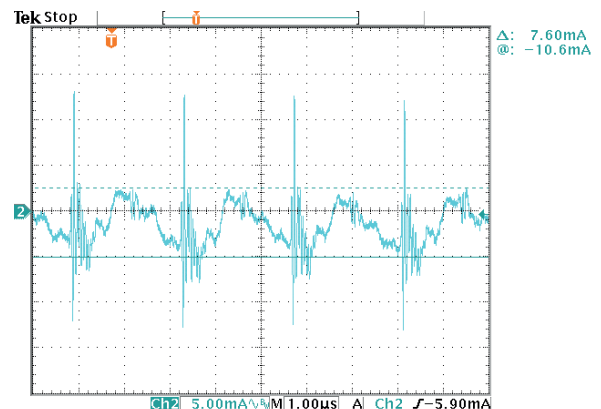
Model: PHB50-12S05  
 Ch2 : lin  
 Input Ripple Current : 12.6mA<sub>p-p</sub>



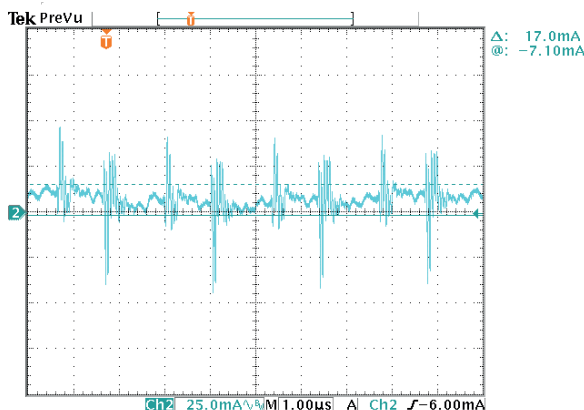
Model: PHB50-12S33  
 Ch2 : lin  
 Input Ripple Current : 6.40mA<sub>p-p</sub>



Model: PHB50-12S15  
 Ch2 : lin  
 Input Ripple Current : 10.5mA<sub>p-p</sub>

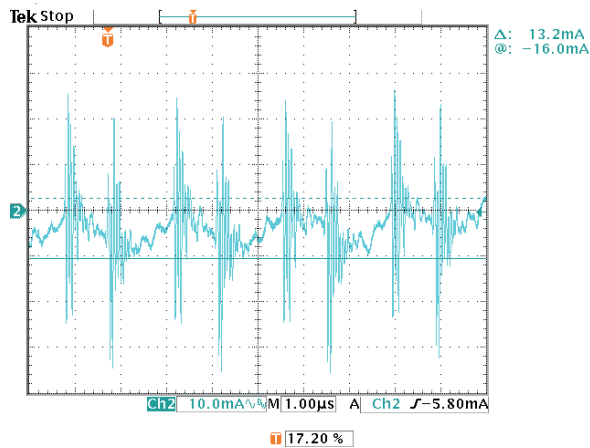
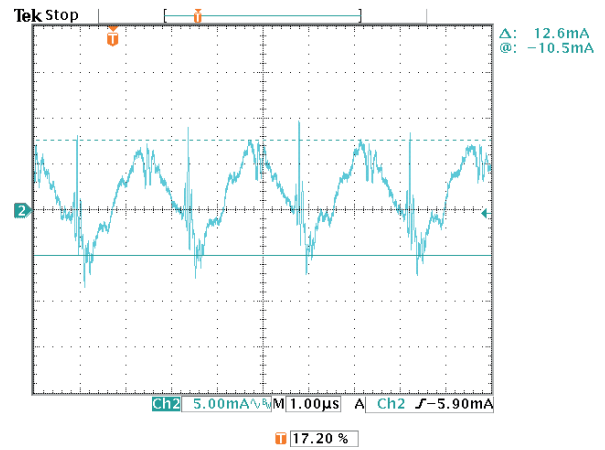
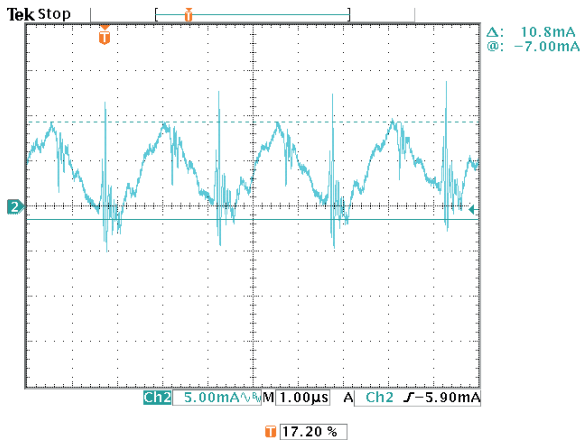
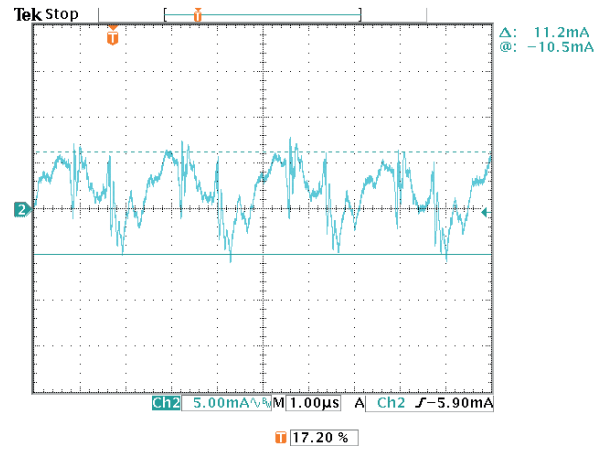
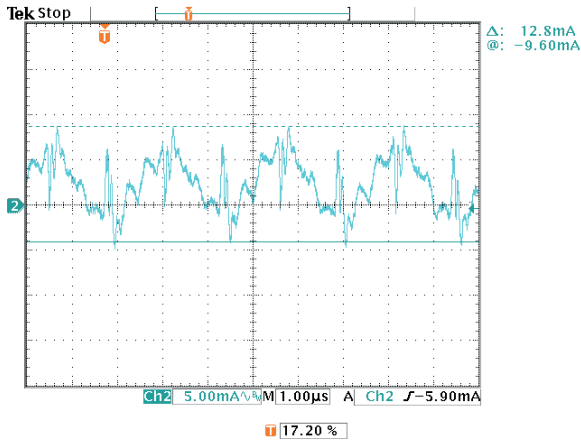


Model: PHB50-12S12  
 Ch2 : lin  
 Input Ripple Current : 7.60mA<sub>p-p</sub>

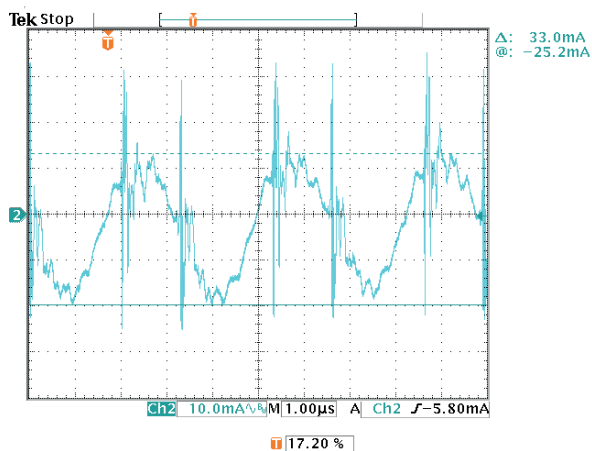
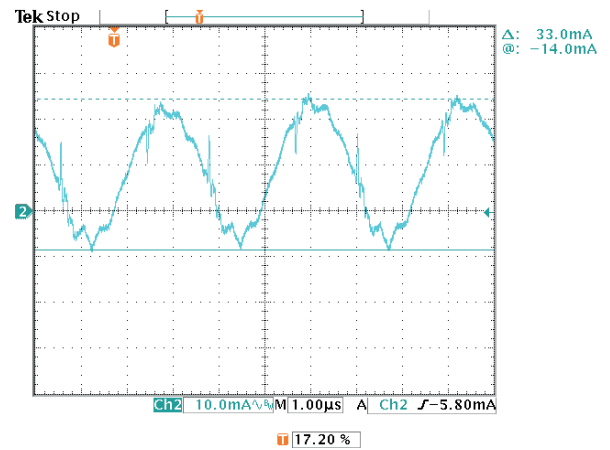
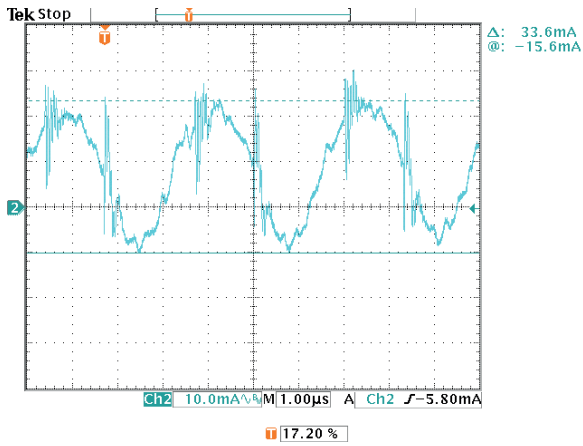
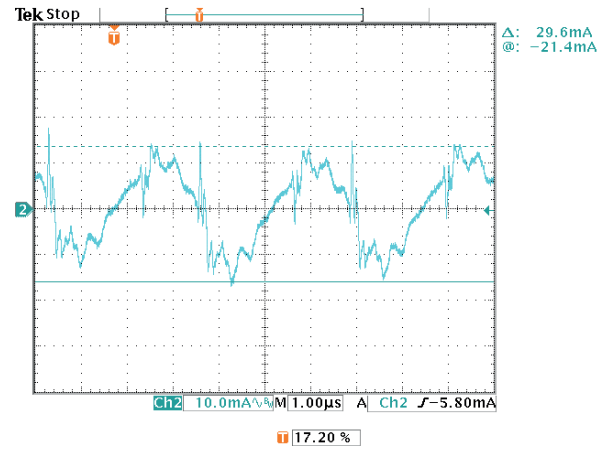
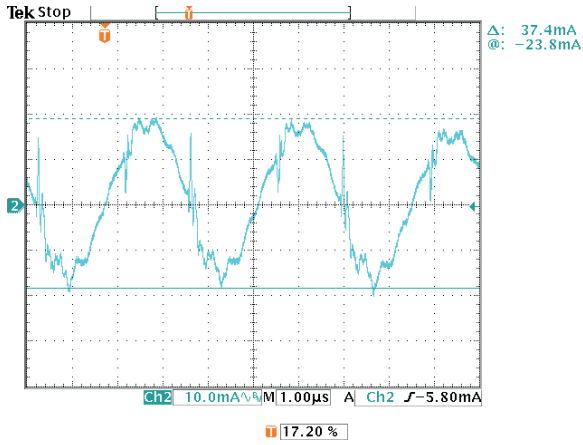


Model: PHB50-12S24  
 Ch2 : lin  
 Input Ripple Current : 17.0mA<sub>p-p</sub>

POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

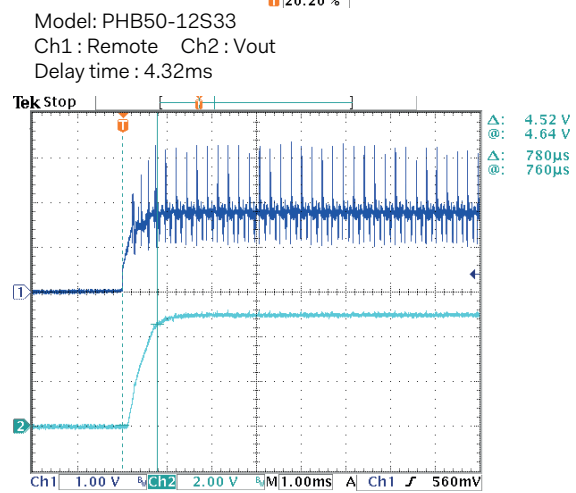
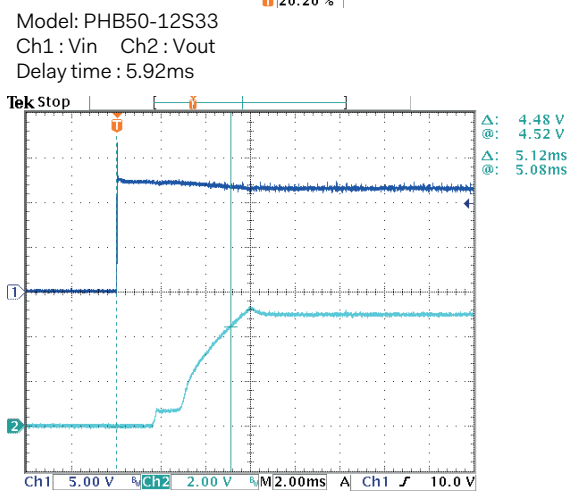
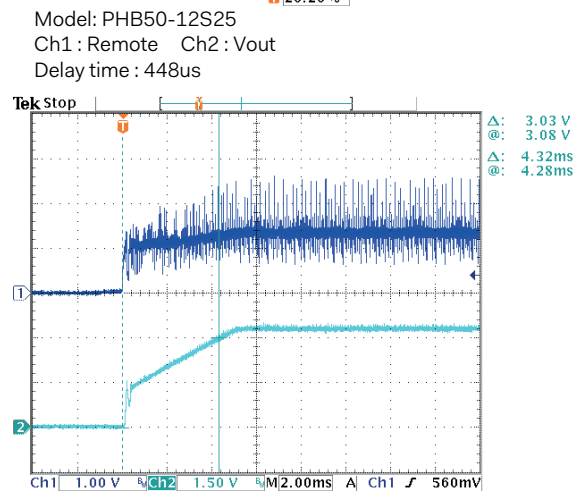
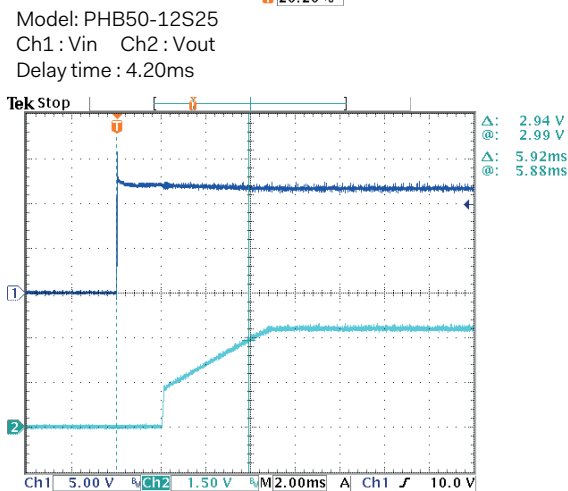
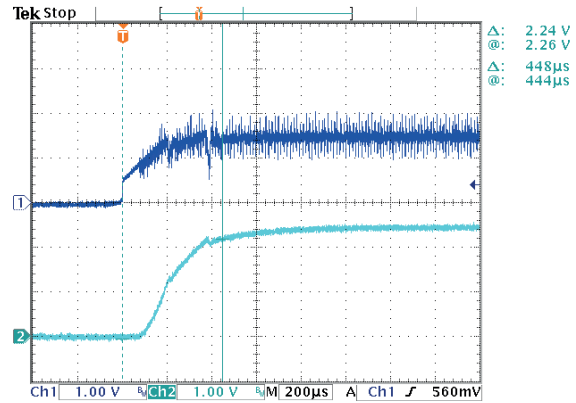
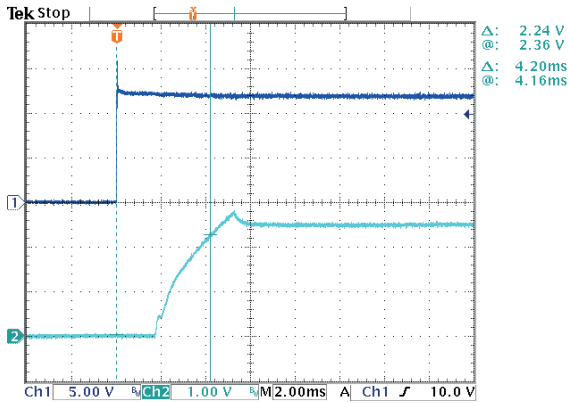


POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



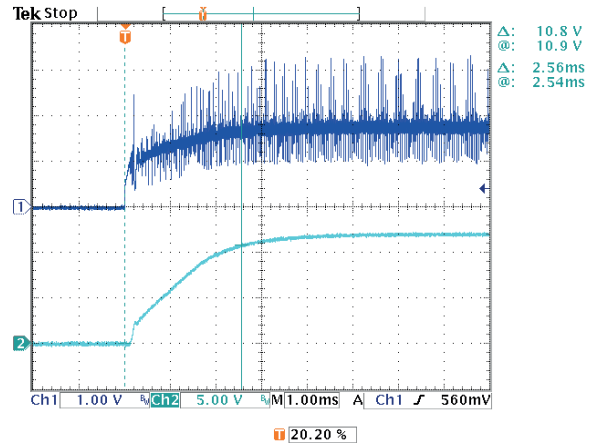
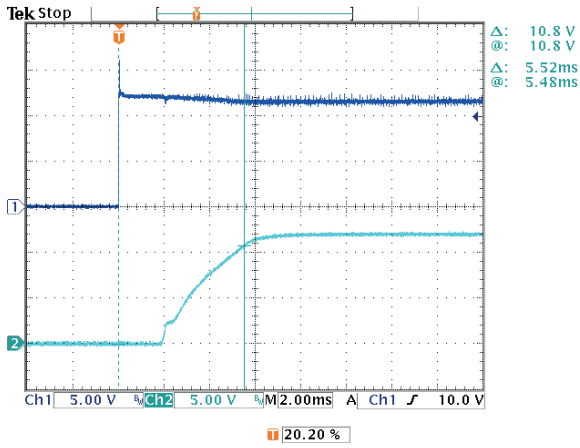
### Start up Delay Time

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



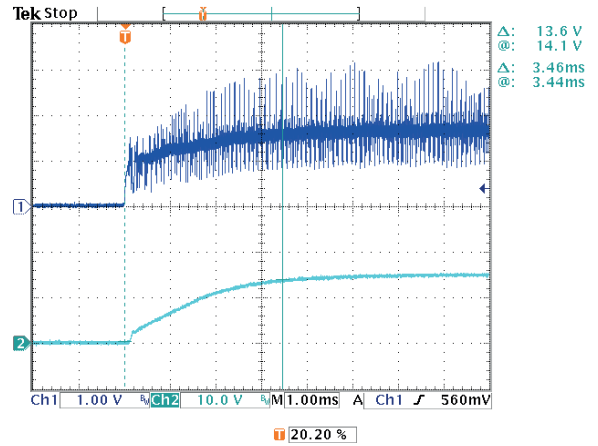
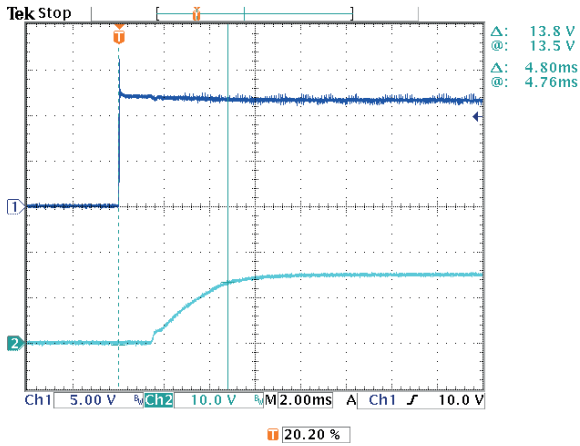


POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



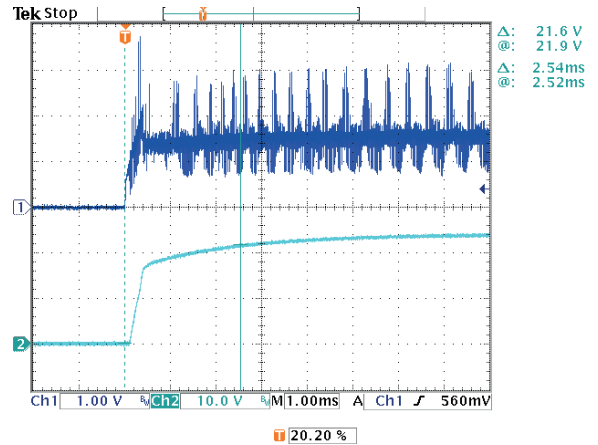
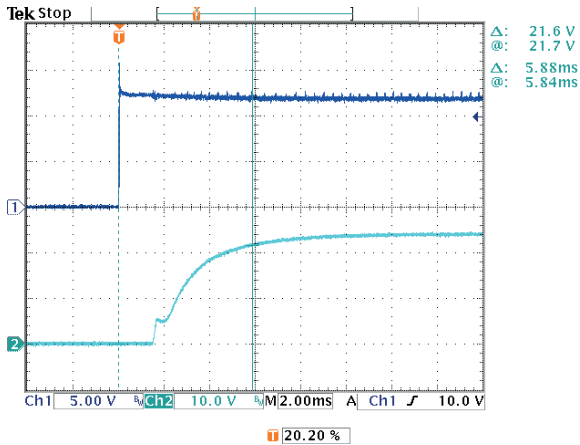
Model: PHB50-12S12  
 Ch1 : Vin Ch2 : Vout  
 Delay time : 5.52ms

Model: PHB50-12S12  
 Ch1 : Remote Ch2 : Vout  
 Delay time : 2.56ms



Model: PHB50-12S15  
 Ch1 : Vin Ch2 : Vout  
 Delay time : 4.80ms

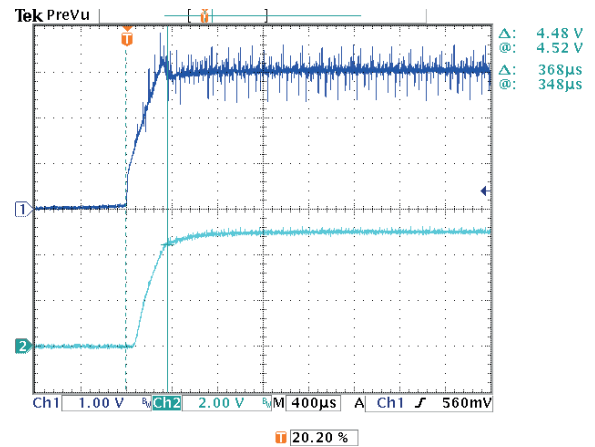
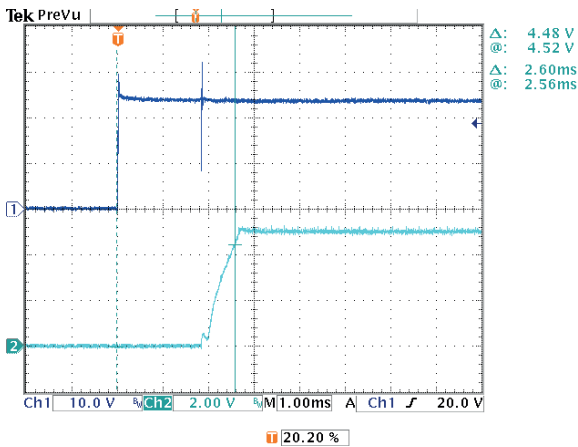
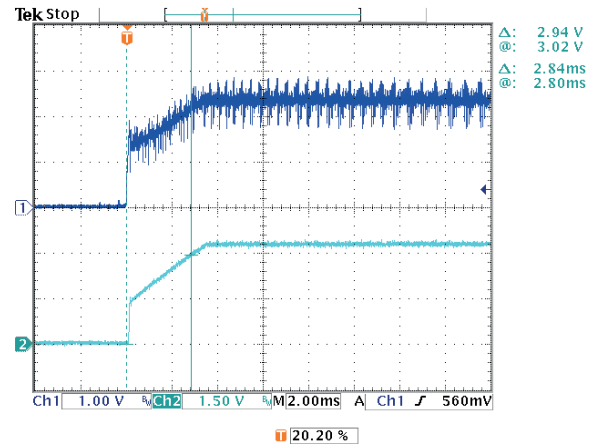
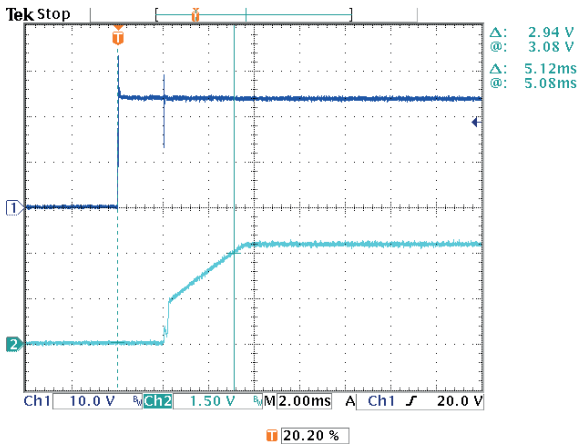
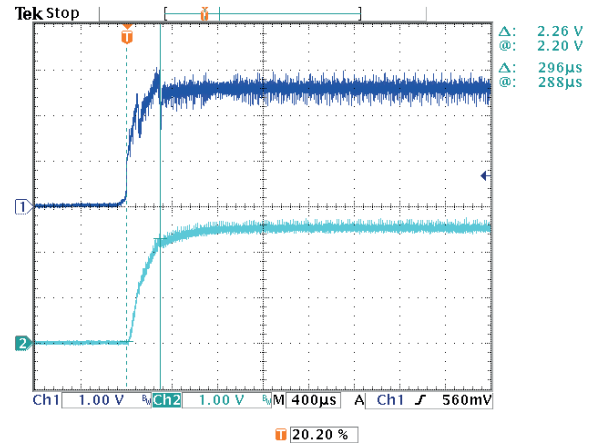
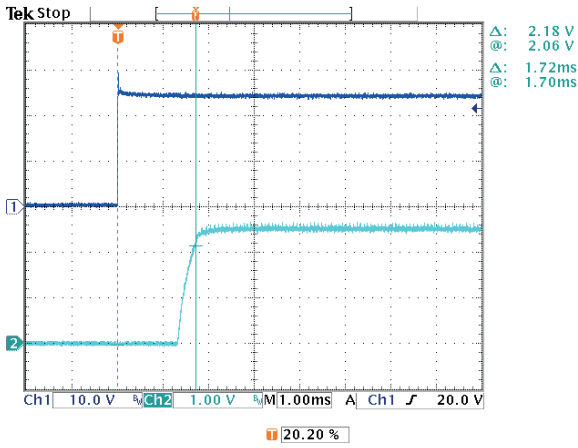
Model: PHB50-12S15  
 Ch1 : Remote Ch2 : Vout  
 Delay time : 3.46ms



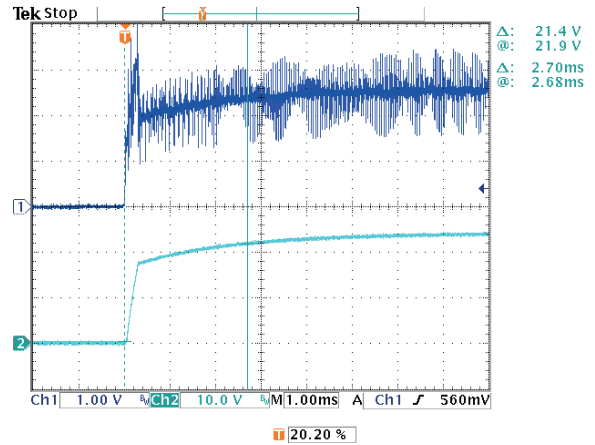
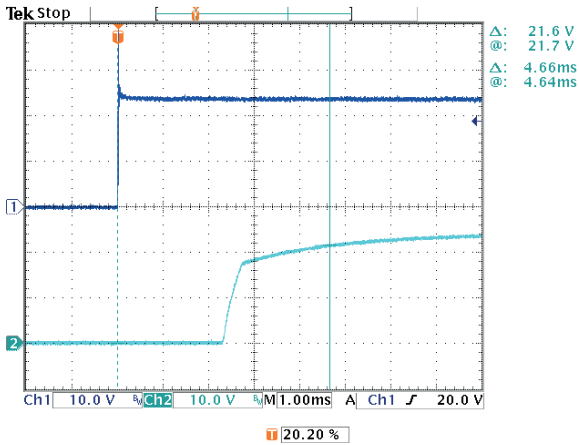
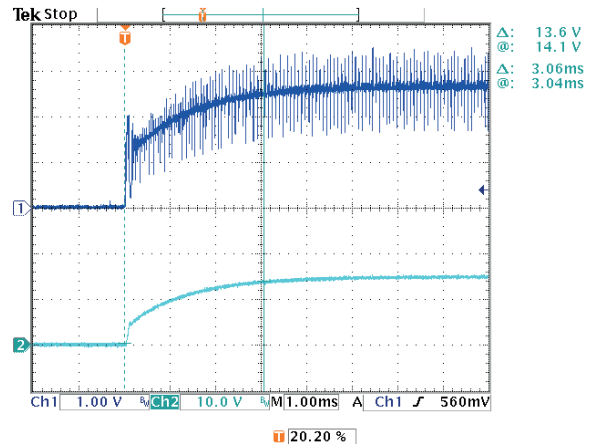
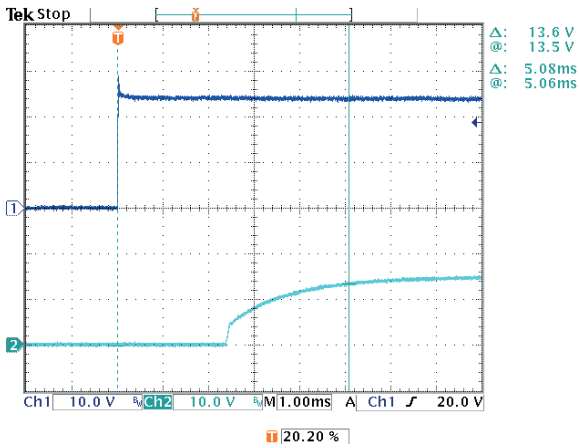
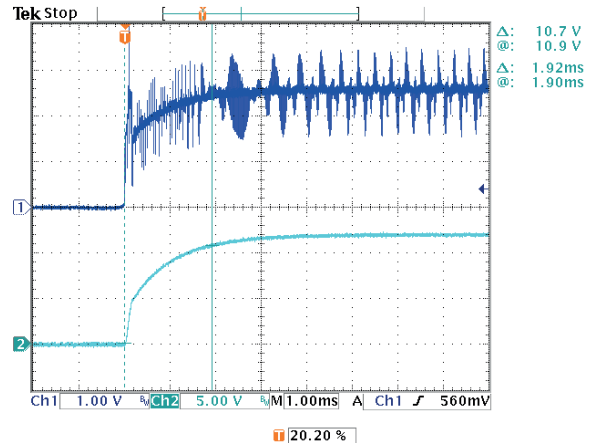
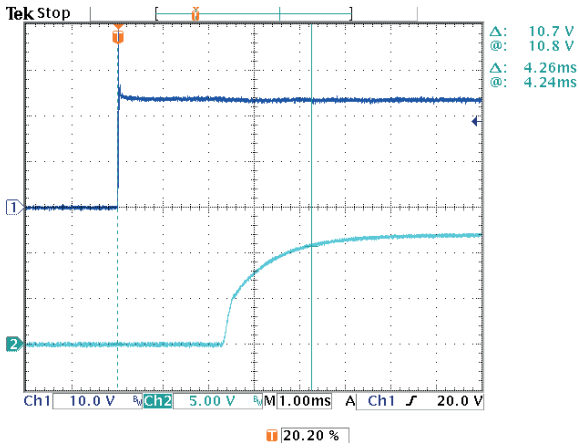
Model: PHB50-12S24  
 Ch1 : Vin Ch2 : Vout  
 Delay time : 5.88ms

Model: PHB50-12S24  
 Ch1 : Remote Ch2 : Vout  
 Delay time : 2.54ms

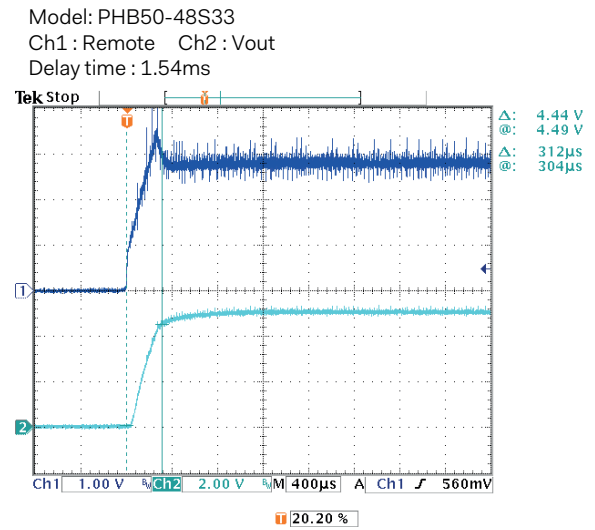
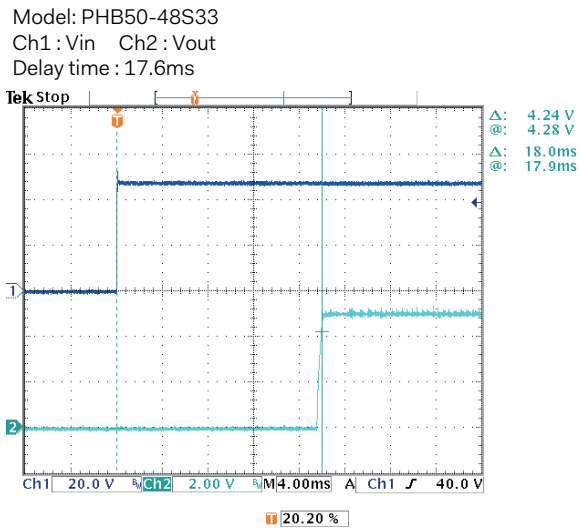
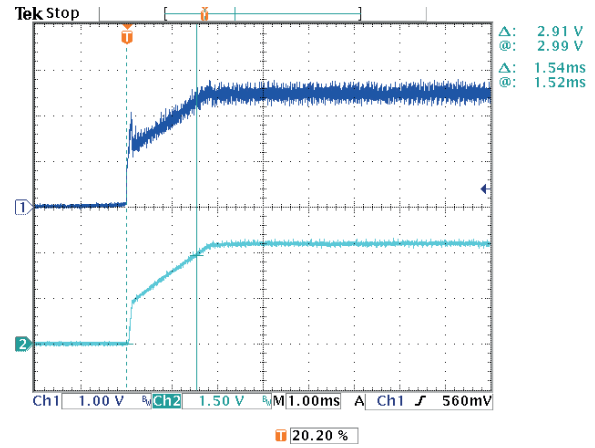
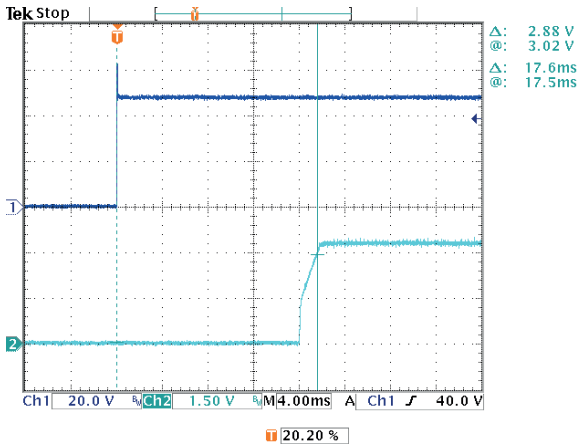
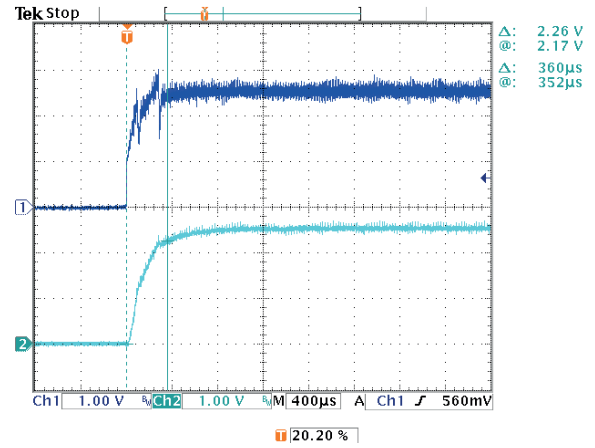
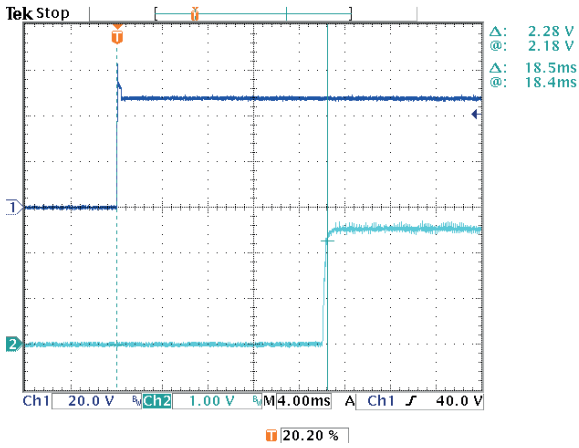
POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



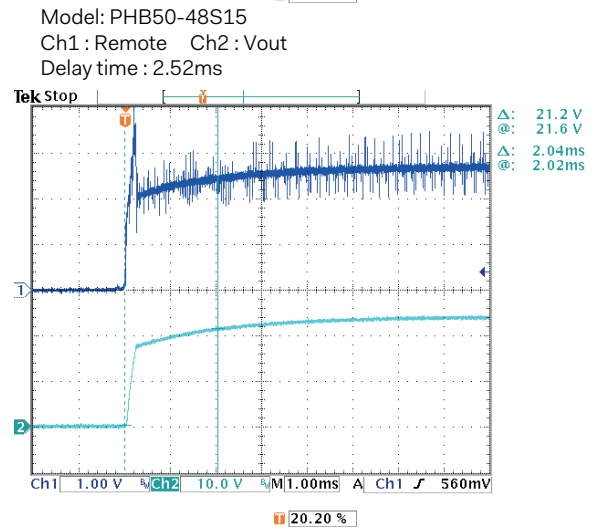
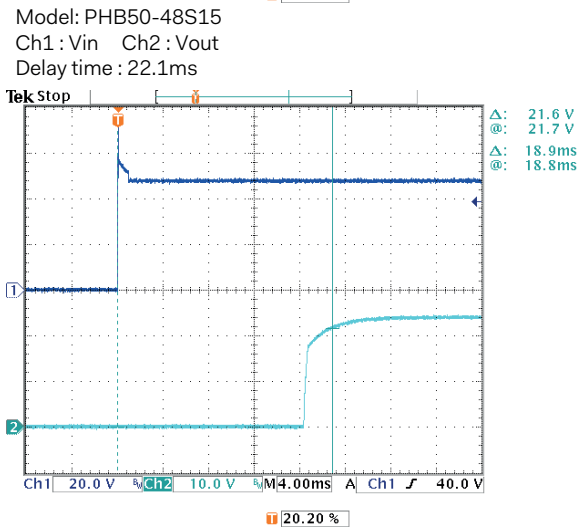
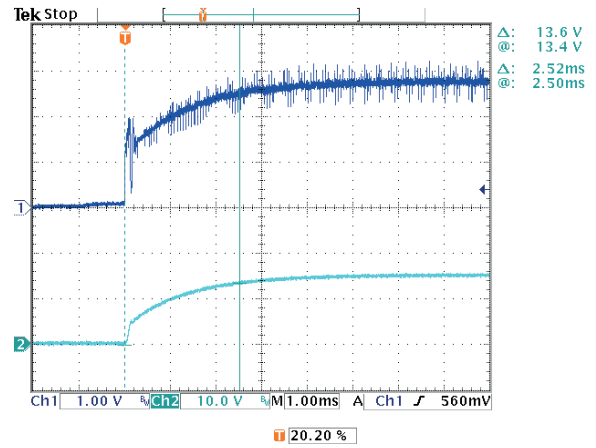
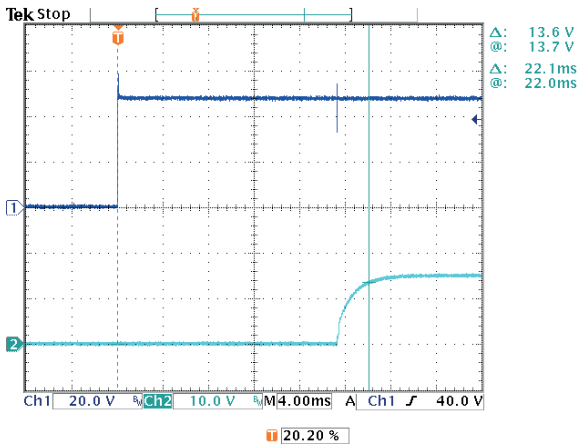
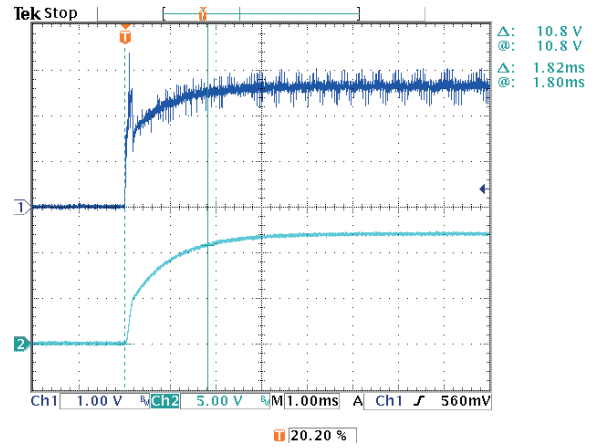
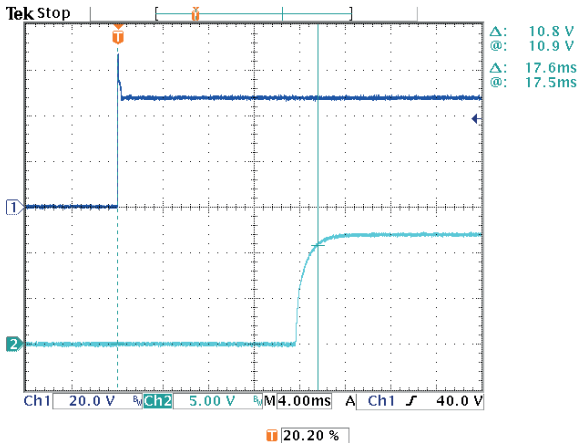
POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

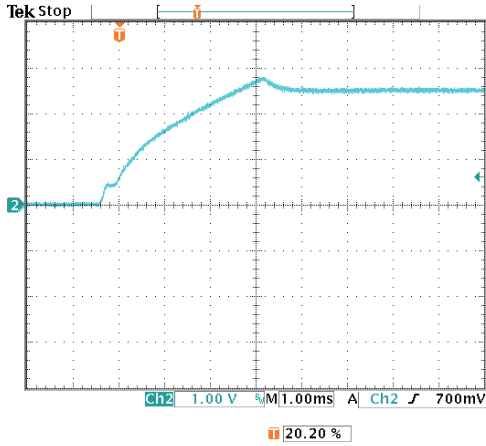


Overshoot

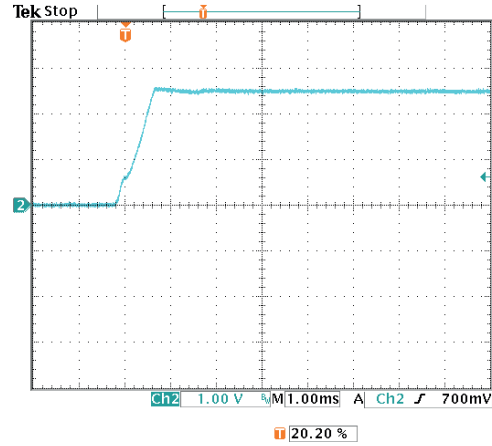
Start up input power, measuring the deviation which over the output. At nominal input , minimum load and maximum load.

Rise Time

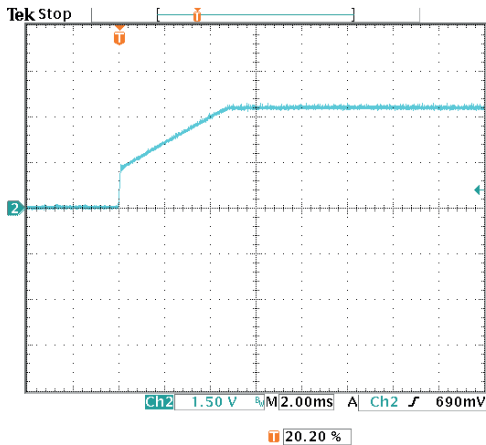
Measuring the time between 10%-Vout to 90%-Vout. At nominal input , minimum load and maximum load



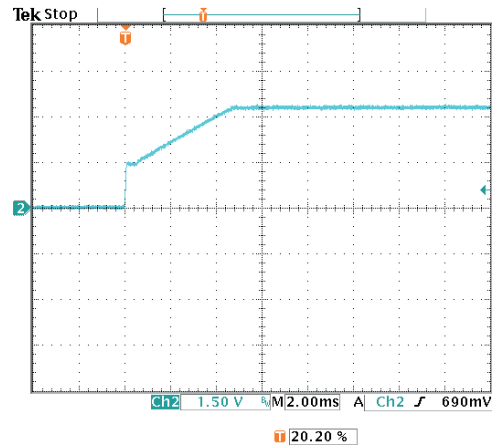
Model: PHB50-12S25(maximum load)  
 Ch2 : Vout  
 Rise time : 2.381ms  
 Overshoot : 15.2%



Model: PHB50-12S25(minimum load)  
 Ch2 : Vout  
 Rise time : 675.0us  
 Overshoot : 6.4%

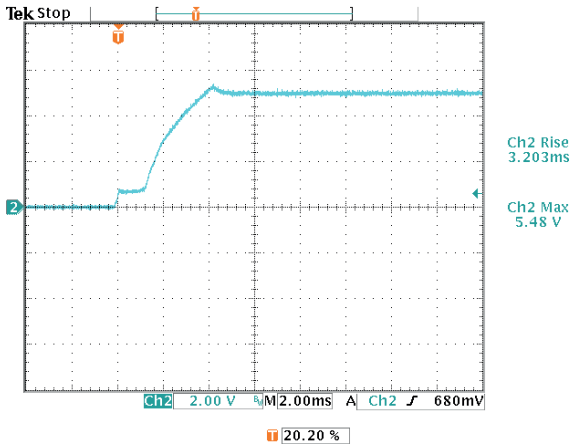


Model: PHB50-12S33(maximum load)  
 Ch2 : Vout  
 Rise time : 3.865ms  
 Overshoot : zero%

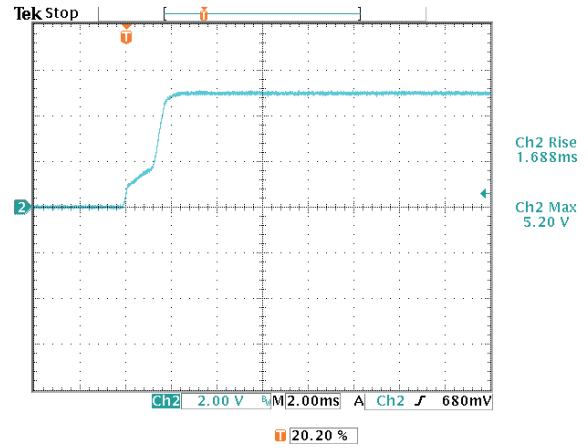


Model: PHB50-12S33(minimum load)  
 Ch2 : Vout  
 Rise time : 3.849ms  
 Overshoot : zero%

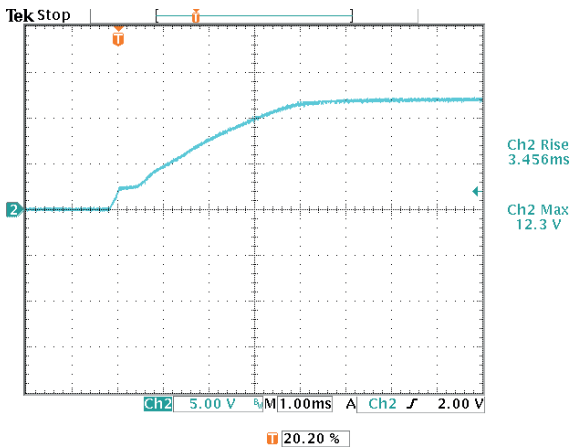
POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



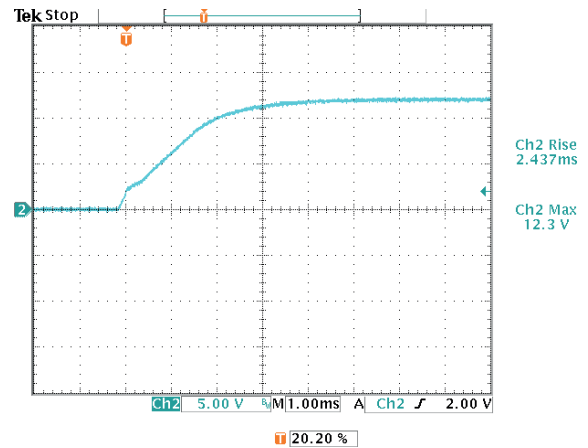
Model: PHB50-12S05(maximum load)  
 Ch2 : Vout  
 Rise time : 3.203ms  
 Overshoot : 9.6%



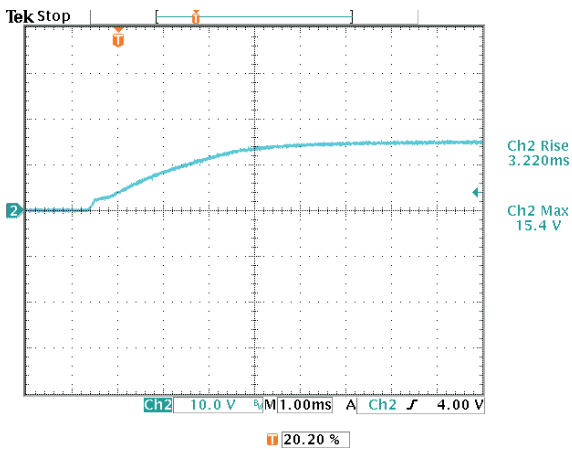
Model: PHB50-12S05(minimum load)  
 Ch2 : Vout  
 Rise time : 1.688ms  
 Overshoot : zero%



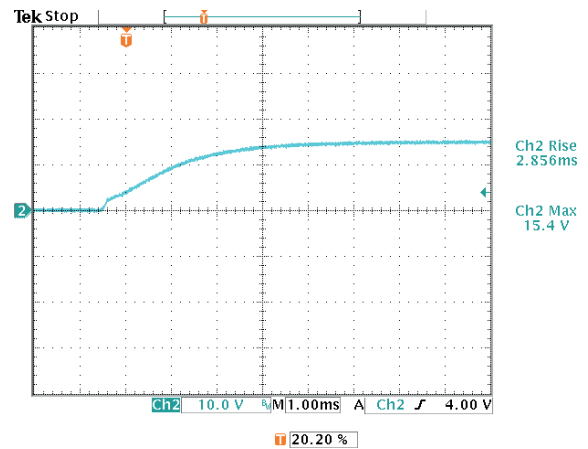
Model: PHB50-12S12(maximum load)  
 Ch2 : Vout  
 Rise time : 3.456ms  
 Overshoot : zero%



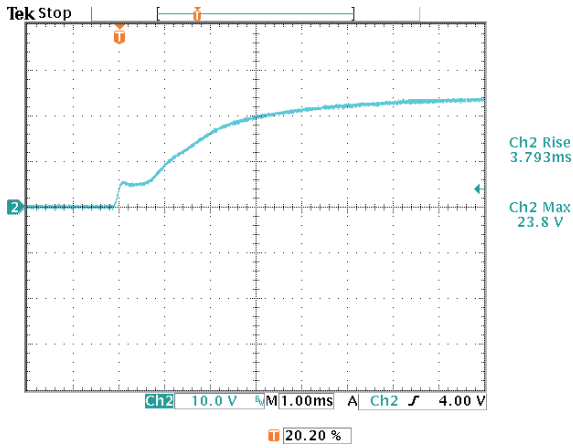
Model: PHB50-12S12(minimum load)  
 Ch2 : Vout  
 Rise time : 2.437ms  
 Overshoot : zero%



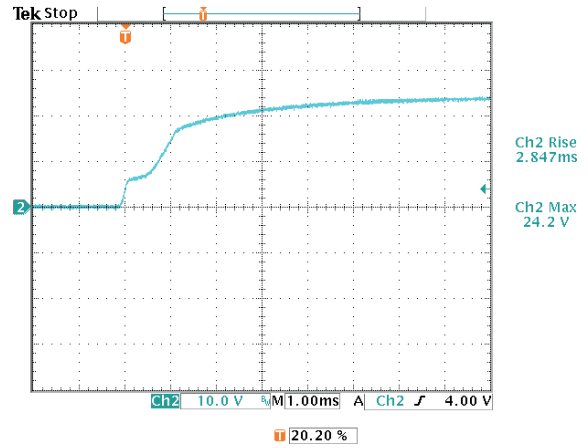
Model: PHB50-12S15(maximum load)  
 Ch2 : Vout  
 Rise time : 3.220ms  
 Overshoot : zero%



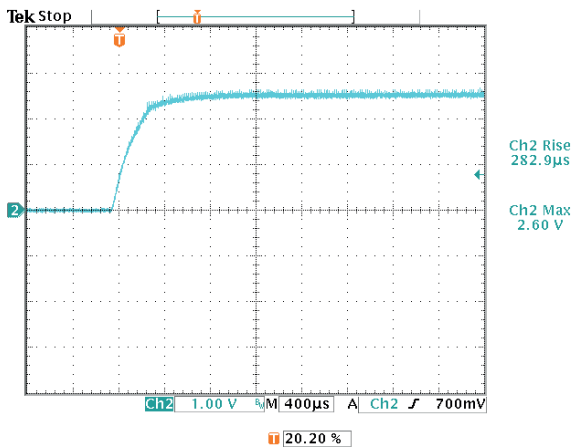
Model: PHB50-12S15(minimum load)  
 Ch2 : Vout  
 Rise time : 2.856ms  
 Overshoot : zero%



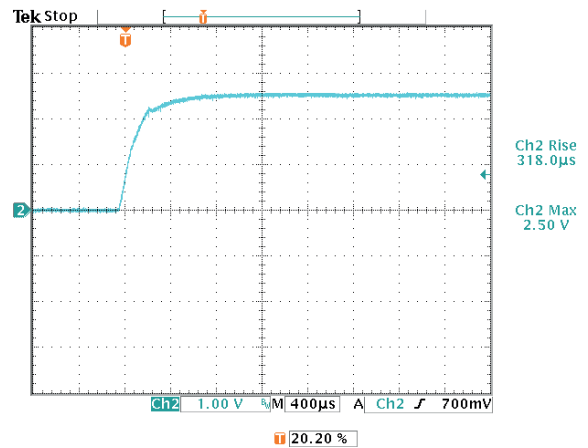
Model: PHB50-12S24(maximum load)  
 Ch2 : Vout  
 Rise time : 3.793ms  
 Overshoot : zero%



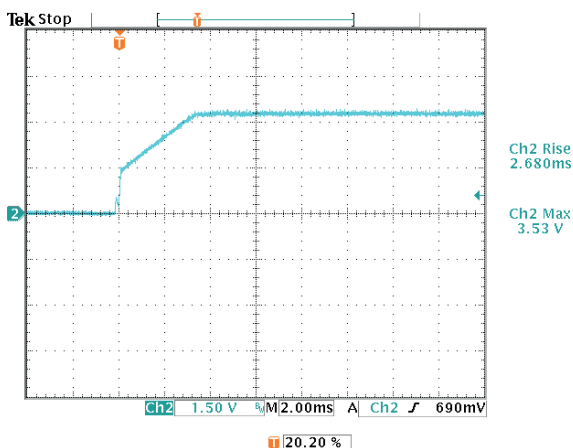
Model: PHB50-12S24(minimum load)  
 Ch2 : Vout  
 Rise time : 2.847ms  
 Overshoot : zero%



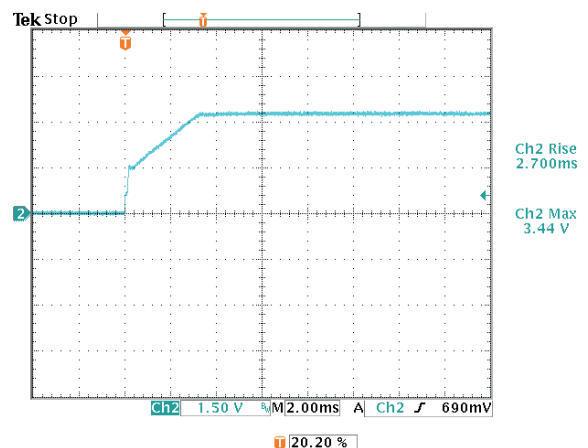
Model: PHB50-24S25(maximum load)  
 Ch2 : Vout  
 Rise time : 282.9µs  
 Overshoot : zero%



Model: PHB50-24S25(minimum load)  
 Ch2 : Vout  
 Rise time : 318.0µs  
 Overshoot : zero%

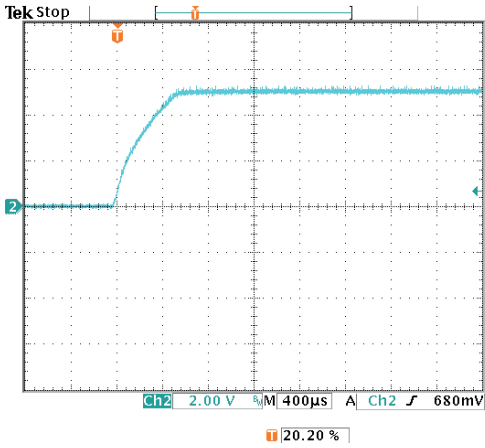


Model: PHB50-24S33(maximum load)  
 Ch2 : Vout  
 Rise time : 2.680ms  
 Overshoot : zero%

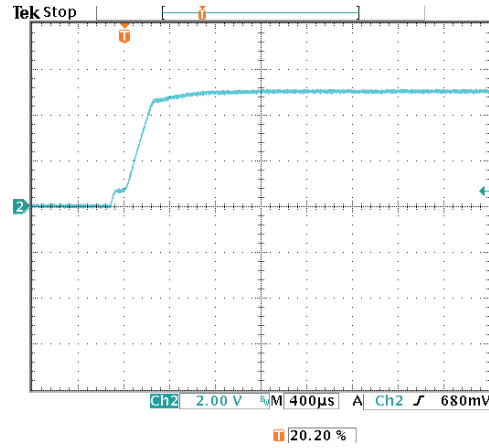


Model: PHB50-24S33(minimum load)  
 Ch2 : Vout  
 Rise time : 2.700ms  
 Overshoot : zero%

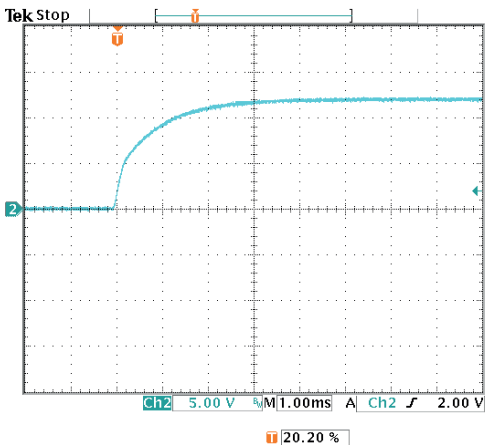




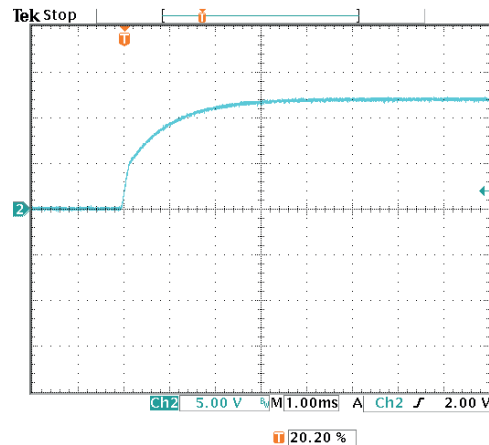
Model: PHB50-24S05(maximum load)  
 Ch2 : Vout  
 Rise time : 410.6us  
 Overshoot : zero%



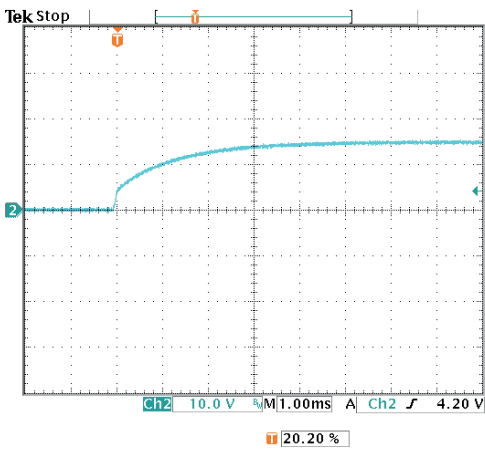
Model: PHB50-24S05(minimum load)  
 Ch2 : Vout  
 Rise time : 332.0us  
 Overshoot : zero%



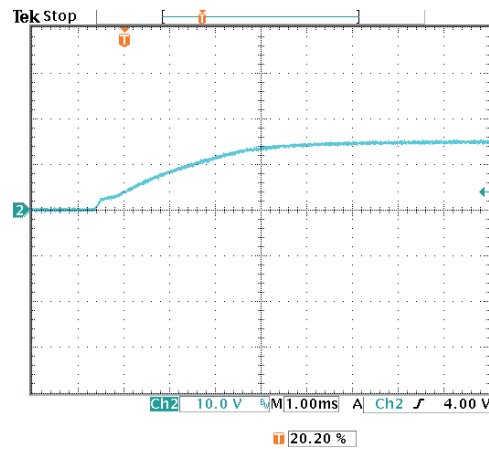
Model: PHB50-24S12(maximum load)  
 Ch2 : Vout  
 Rise time : 1.682ms  
 Overshoot : zero%



Model: PHB50-24S12(minimum load)  
 Ch2 : Vout  
 Rise time : 1.703ms  
 Overshoot : zero%

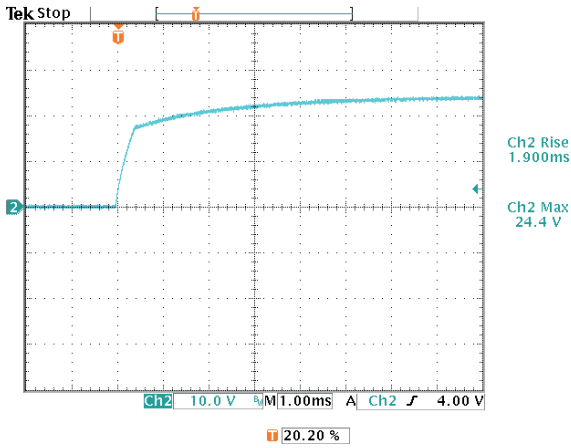


Model: PHB50-24S15(maximum load)  
 Ch2 : Vout  
 Rise time : 2.284ms  
 Overshoot : zero%

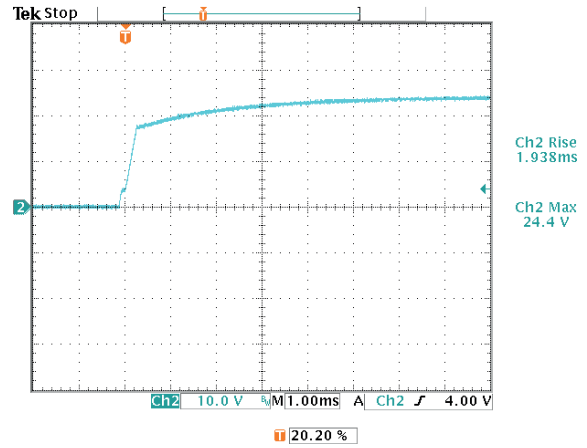


Model: PHB50-24S15(minimum load)  
 Ch2 : Vout  
 Rise time : 3.220ms  
 Overshoot : zero%

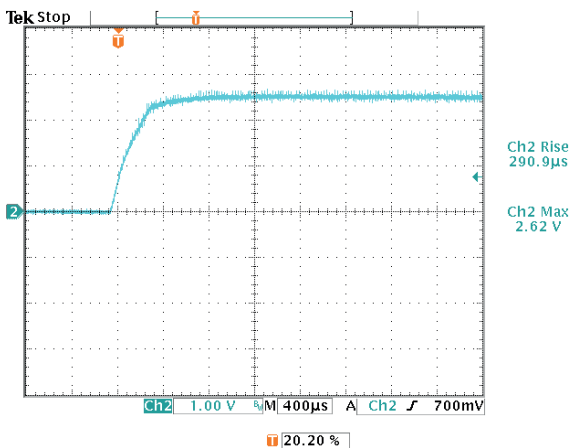
POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



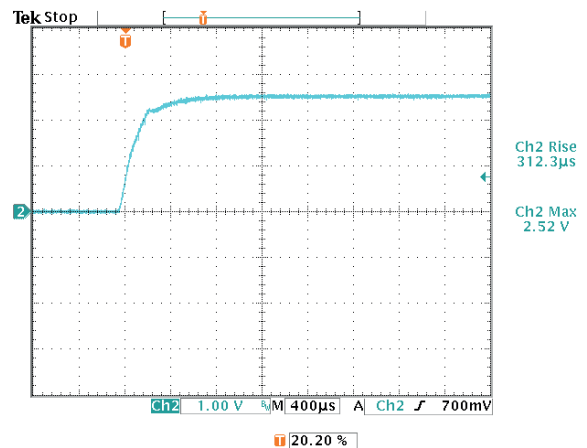
Model: PHB50-24S24(maximum load)  
 Ch2 : Vout  
 Rise time : 1.900ms  
 Overshoot : zero%



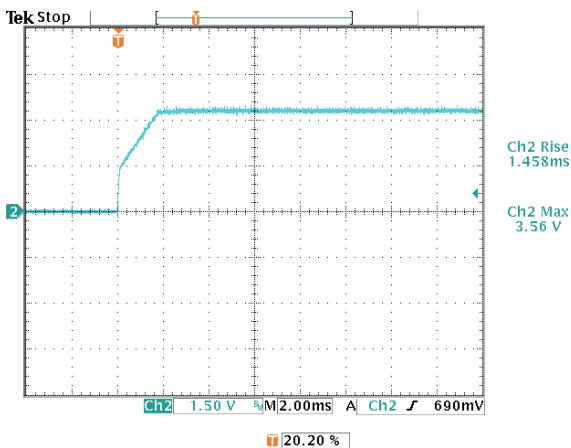
Model: PHB50-24S24(minimum load)  
 Ch2 : Vout  
 Rise time : 1.938ms  
 Overshoot : zero%



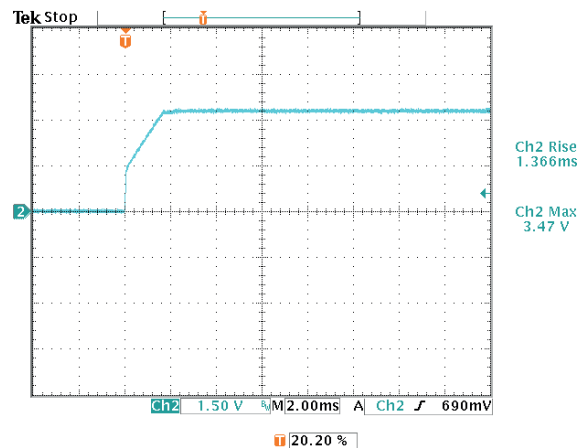
Model: PHB50-48S25(maximum load)  
 Ch2 : Vout  
 Rise time : 290.9µs  
 Overshoot : zero%



Model: PHB50-48S25(minimum load)  
 Ch2 : Vout  
 Rise time : 312.3µs  
 Overshoot : zero%

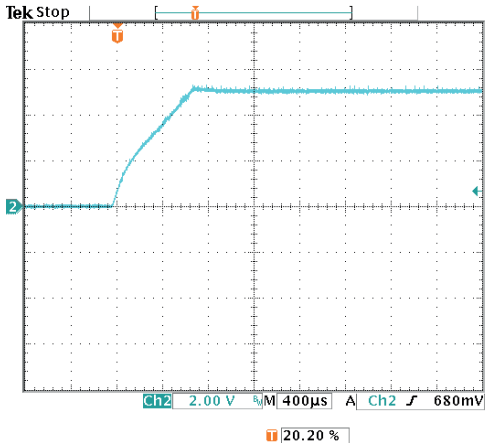


Model: PHB50-48S33(maximum load)  
 Ch2 : Vout  
 Rise time : 1.458ms  
 Overshoot : zero%

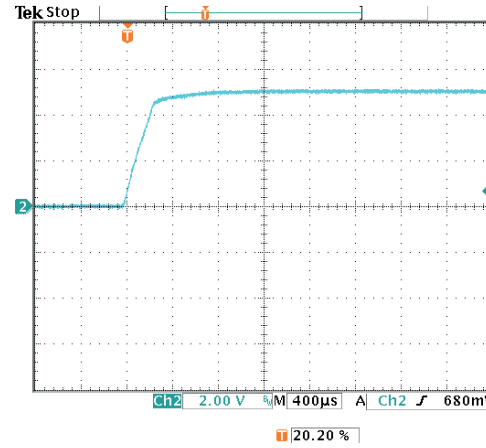


Model: PHB50-48S33(minimum load)  
 Ch2 : Vout  
 Rise time : 1.366ms  
 Overshoot : zero%

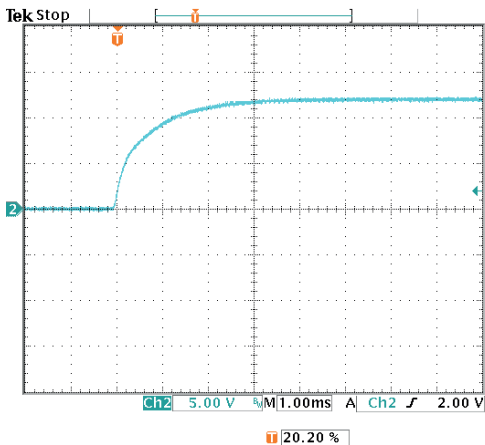
POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



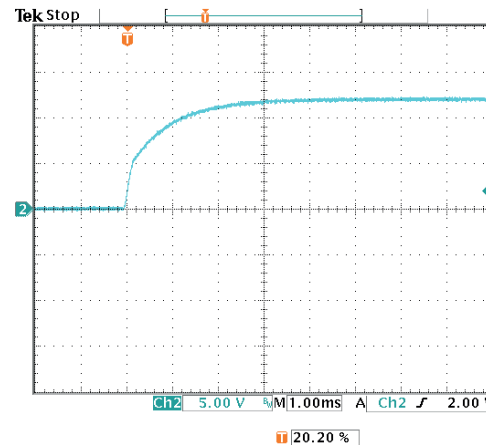
Model: PHB50-48S05(maximum load)  
 Ch2 : Vout  
 Rise time : 555.5us  
 Overshoot : 6.4%



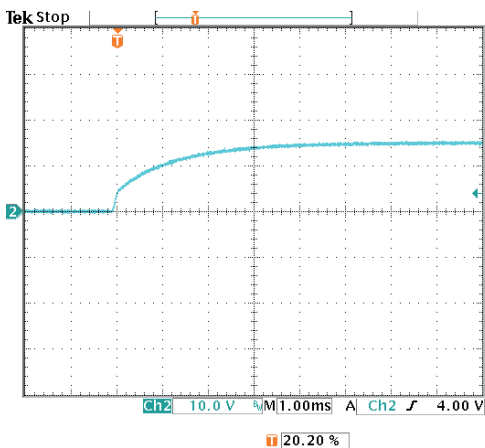
Model: PHB50-48S05(minimum load)  
 Ch2 : Vout  
 Rise time : 238.2us  
 Overshoot : zero%



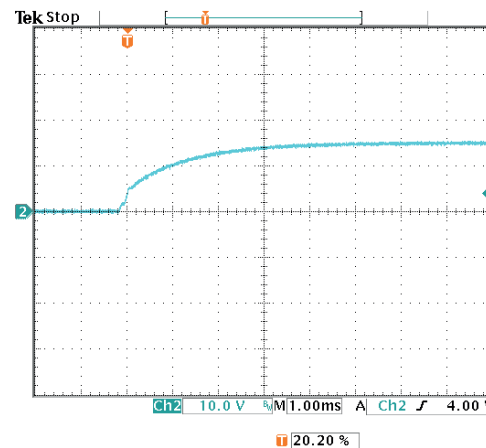
Model: PHB50-48S12(maximum load)  
 Ch2 : Vout  
 Rise time : 1.644ms  
 Overshoot : zero%



Model: PHB50-48S12(minimum load)  
 Ch2 : Vout  
 Rise time : 1.615ms  
 Overshoot : zero%

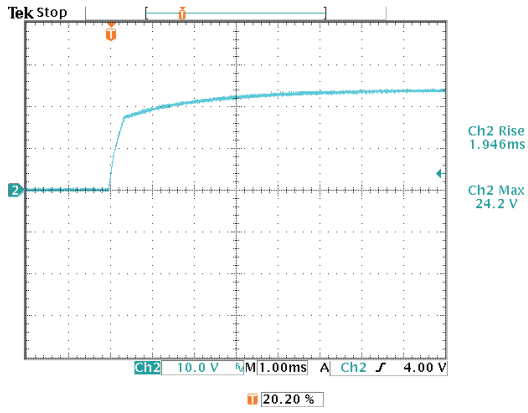


Model: PHB50-48S15(maximum load)  
 Ch2 : Vout  
 Rise time : 2.244ms  
 Overshoot : zero%

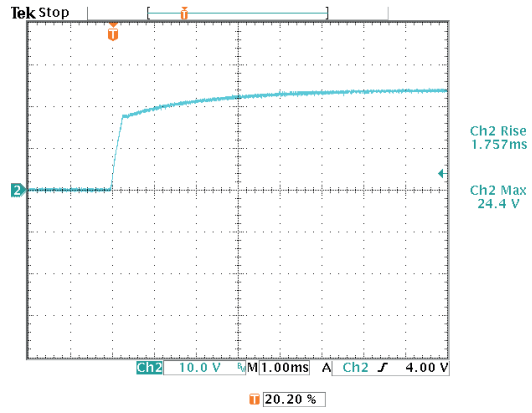


Model: PHB50-48S15(minimum load)  
 Ch2 : Vout  
 Rise time : 2.077ms  
 Overshoot : zero%

POWERBOX Industrial Line  
PHB50 Series  
33-50W 2:1 Single Output  
DC/DC Converter  
Manual V12



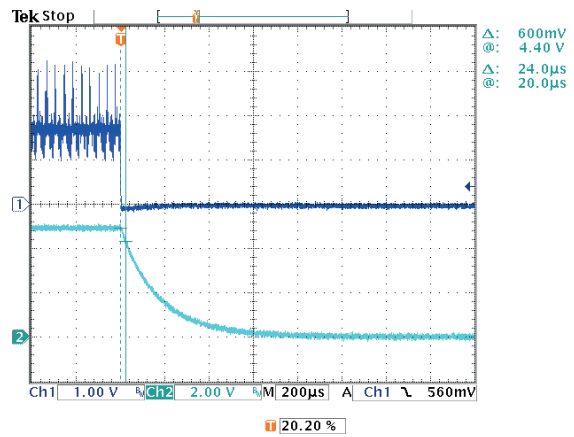
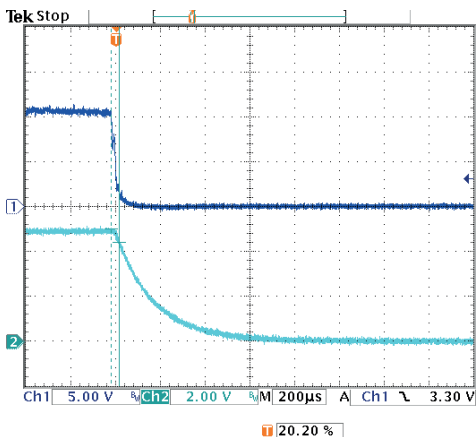
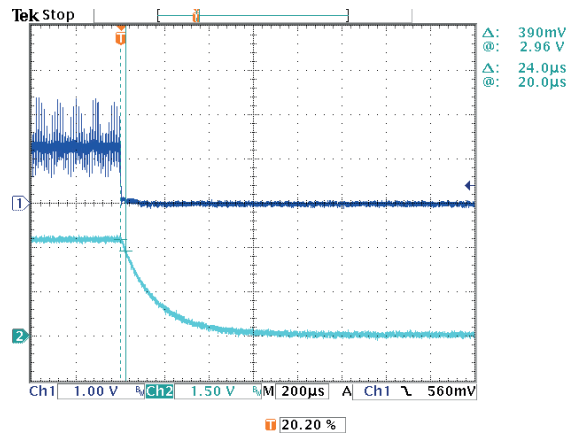
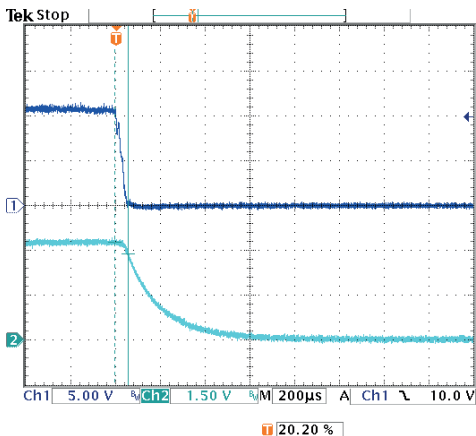
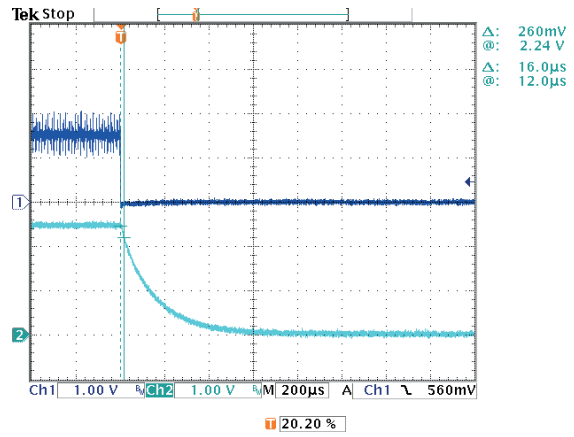
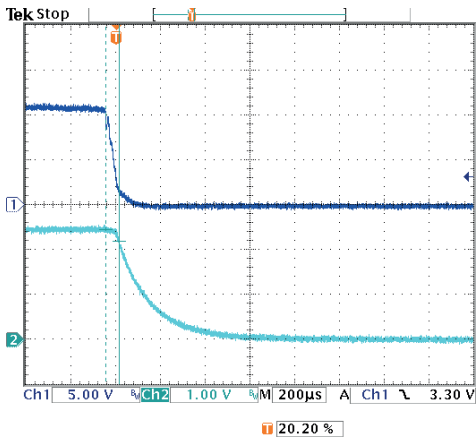
Model: PHB50-48S24(maximum load)  
Ch2 : Vout  
Rise time : 1.946ms  
Overshoot : zero%



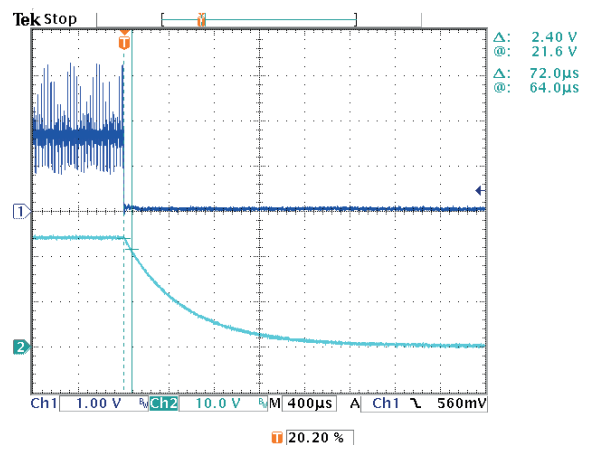
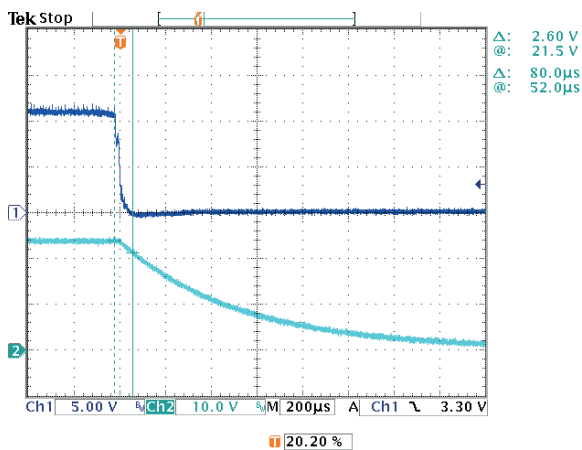
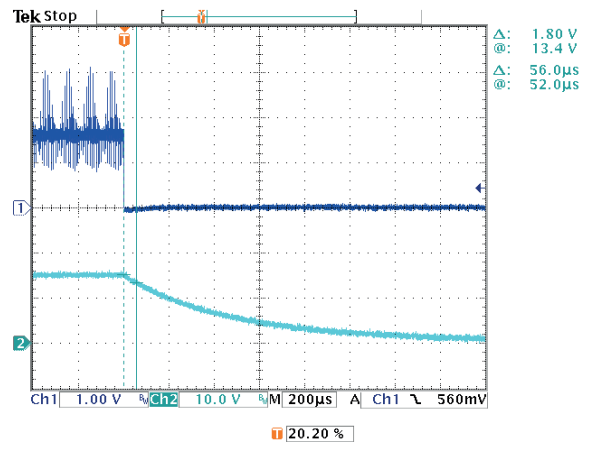
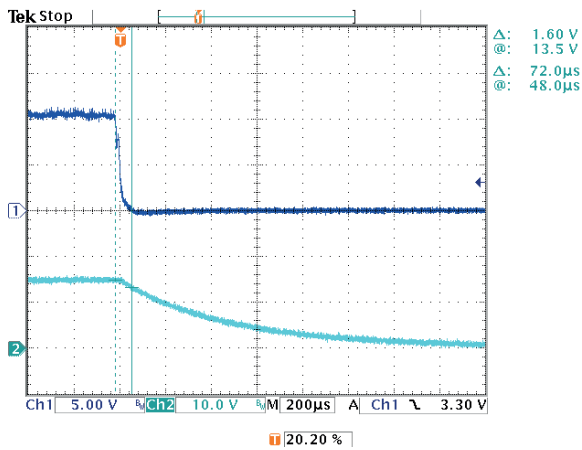
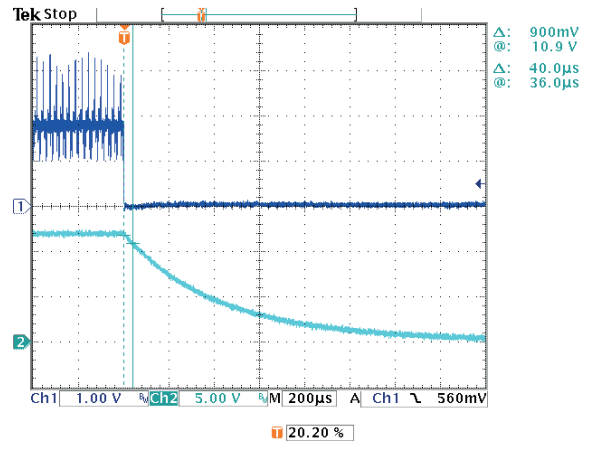
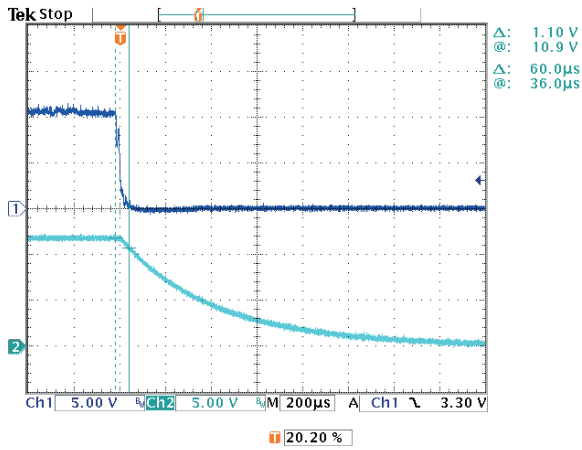
Model: PHB50-48S24(minimum load)  
Ch2 : Vout  
Rise time : 1.757ms  
Overshoot : zero%

Hold Time

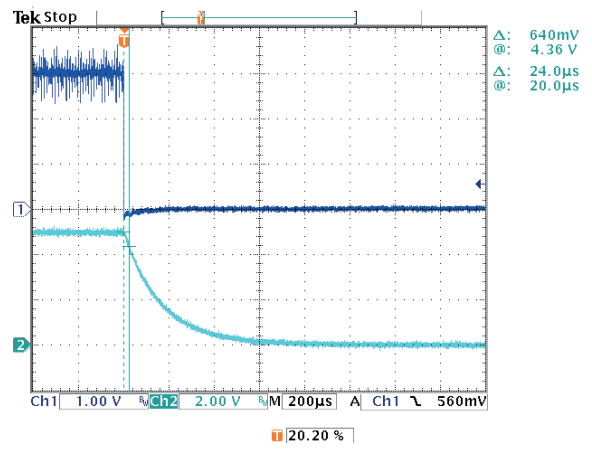
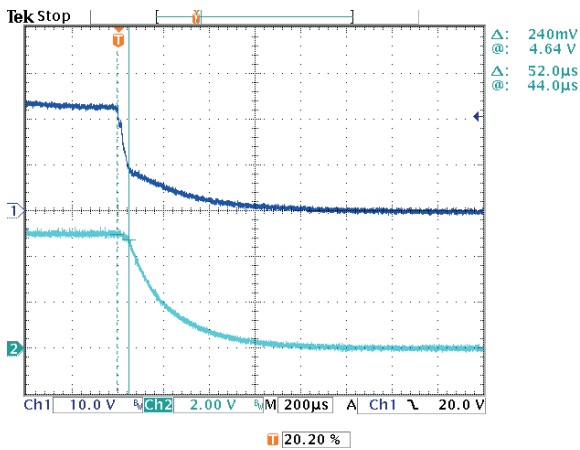
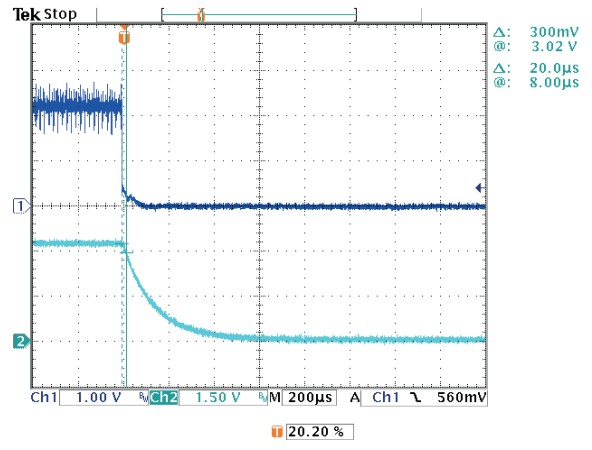
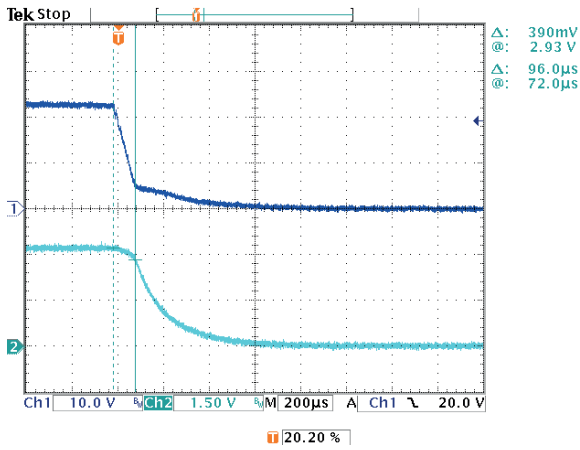
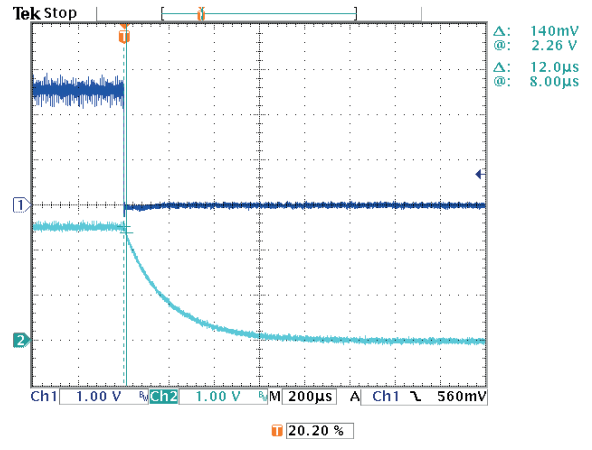
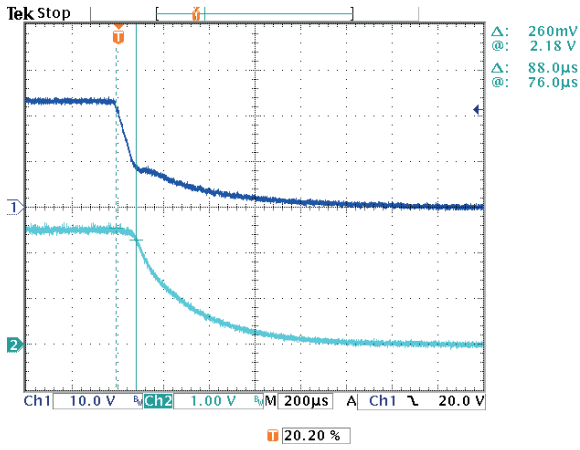
1. Measure from the power supply end to when Vout drop down to 90% output .At nominal input and maximum load.
2. Measure from the remote control end to when Vout drop down to 90% output .At nominal input and maximum load.



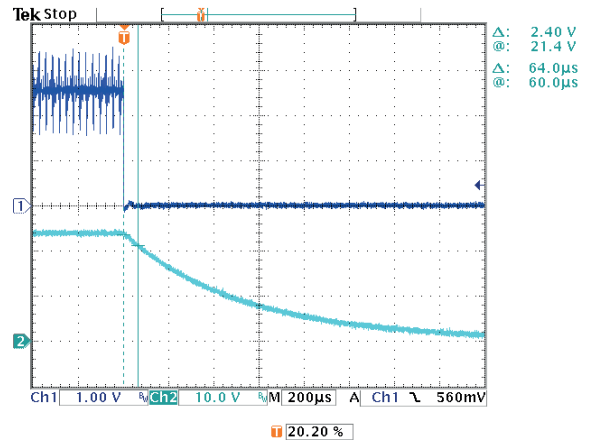
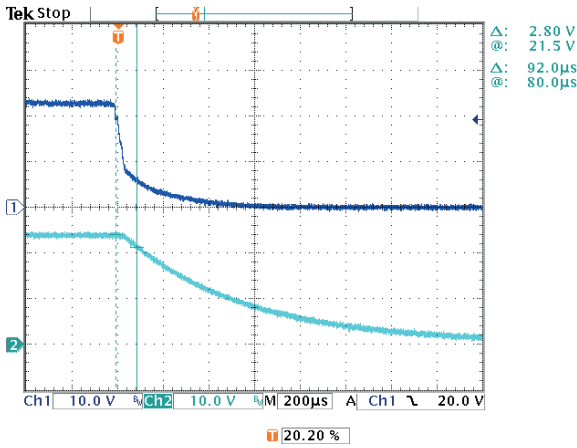
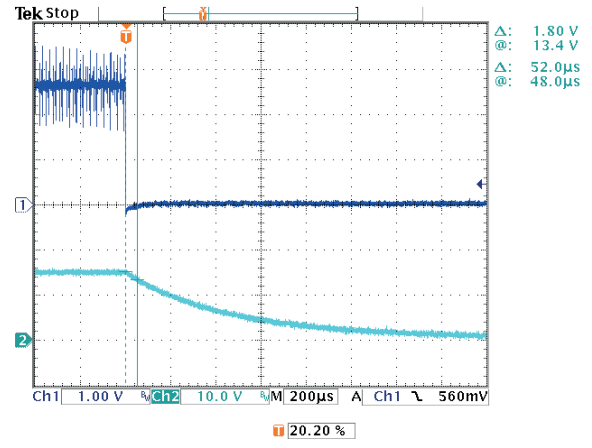
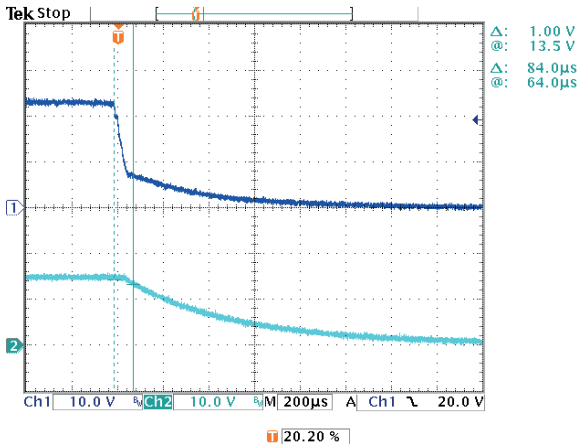
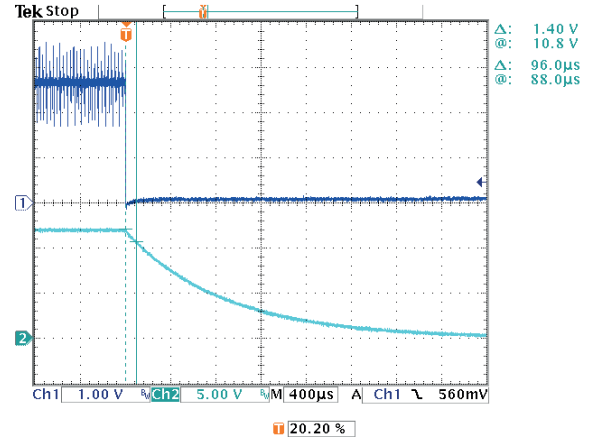
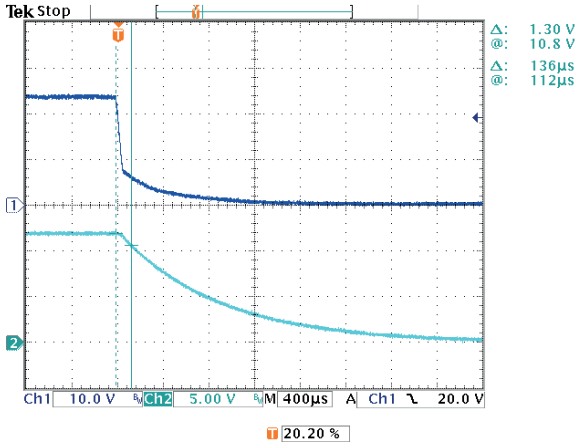
POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

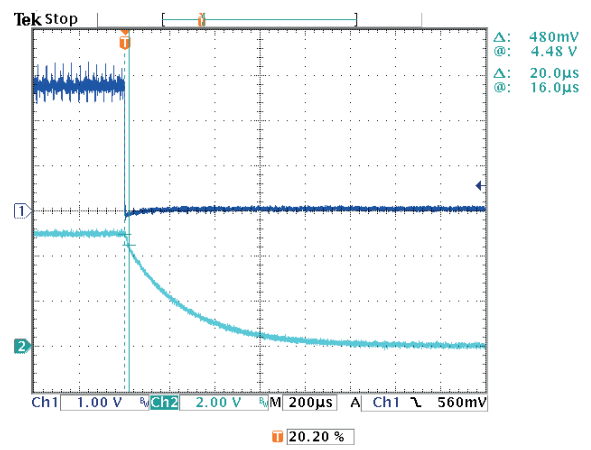
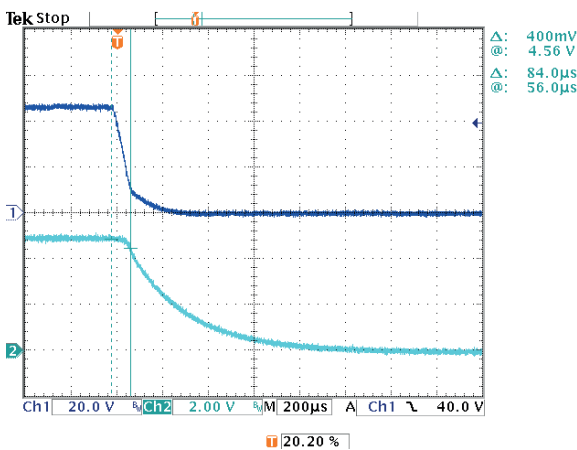
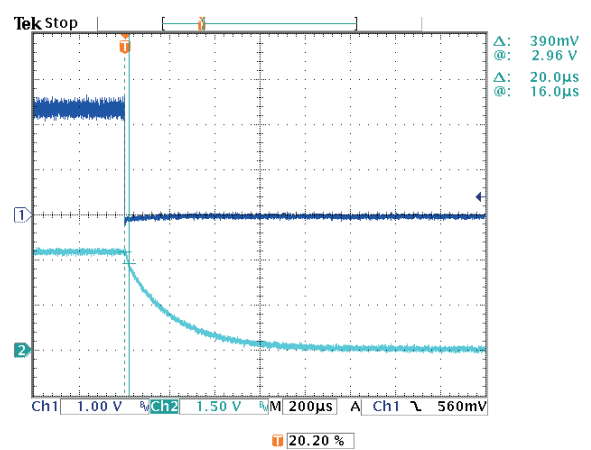
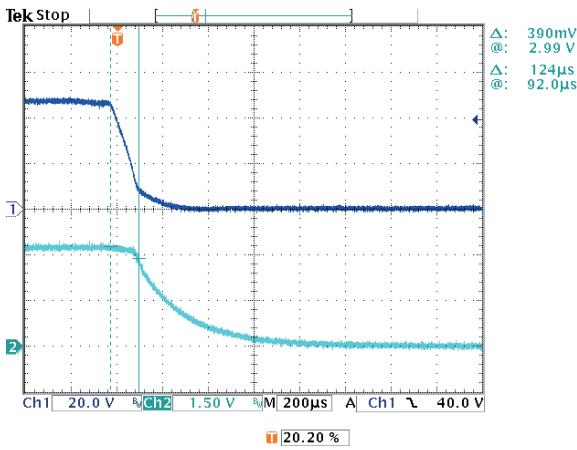
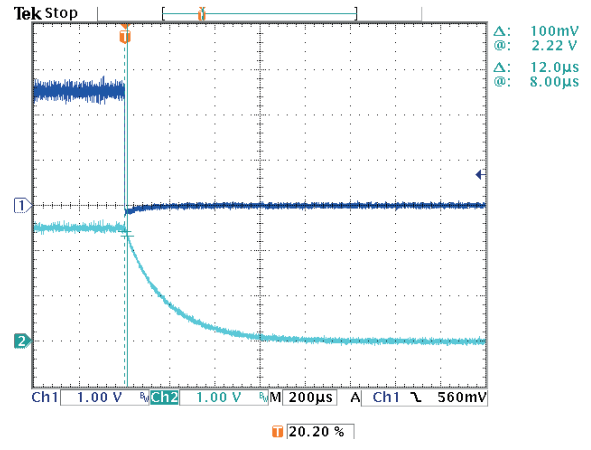
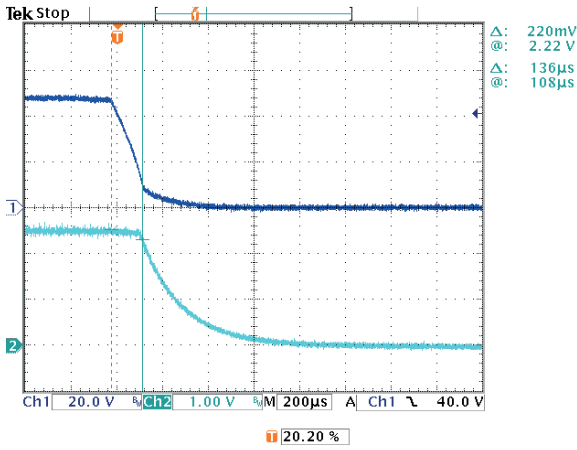


POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

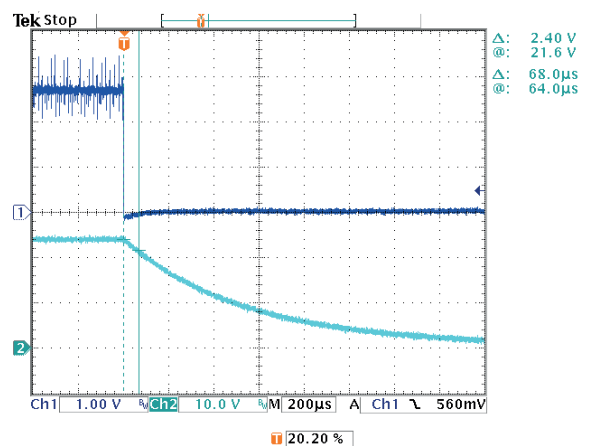
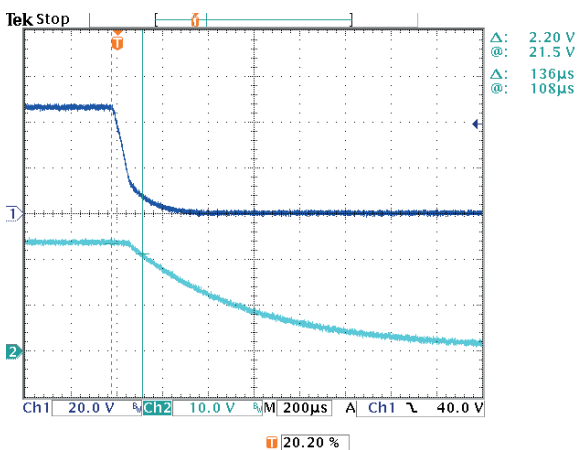
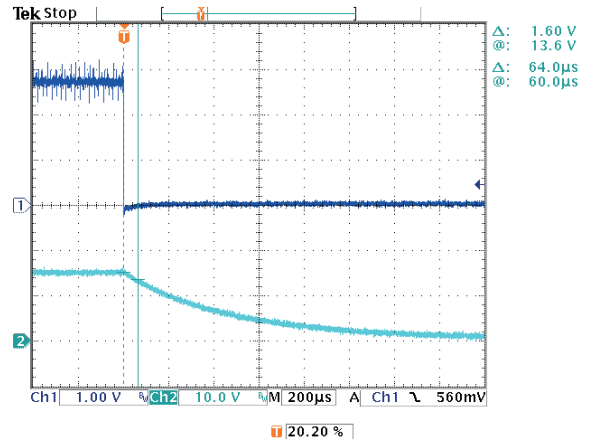
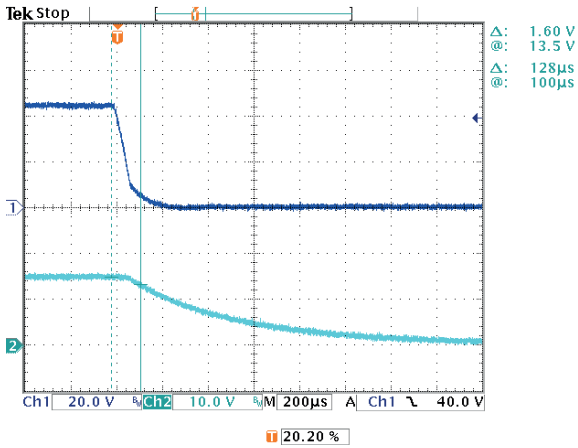
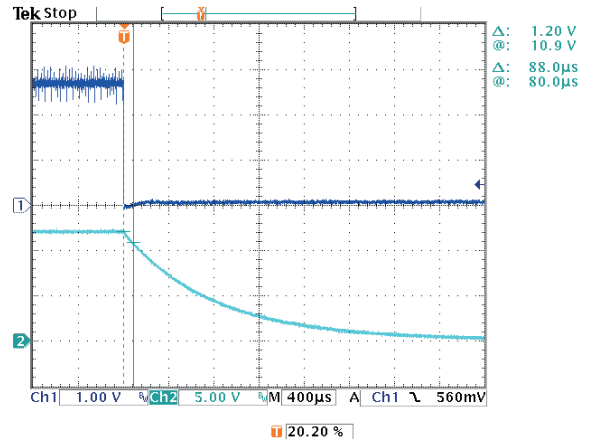
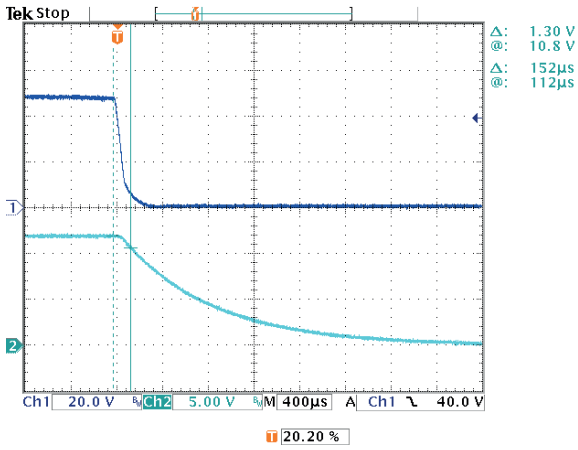




POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12

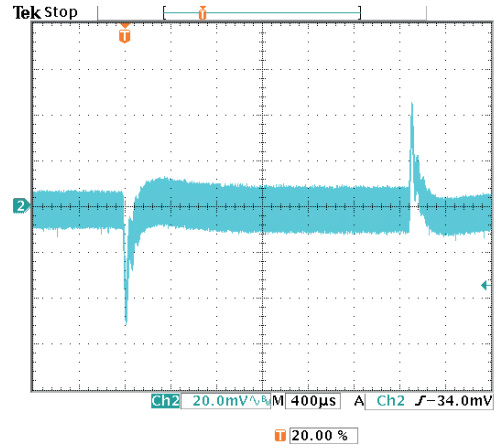
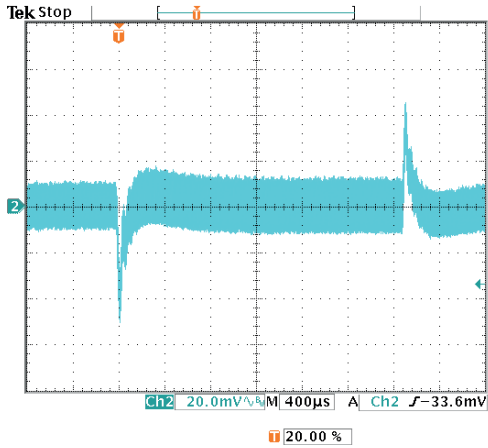


POWERBOX Industrial Line  
 PHB50 Series  
 33-50W 2:1 Single Output  
 DC/DC Converter  
 Manual V12



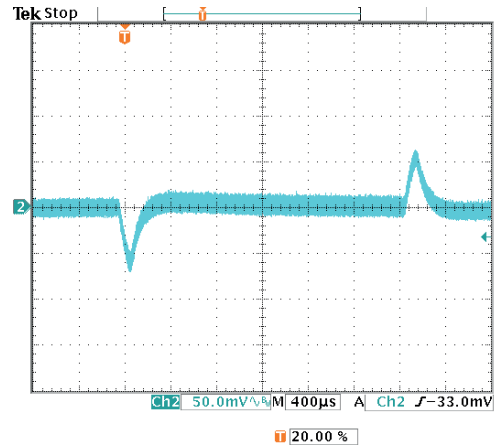
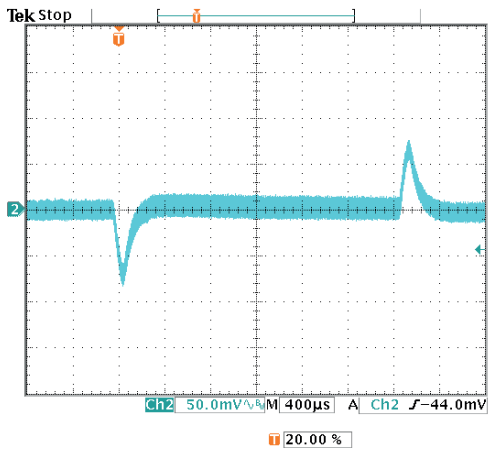
Dynamic Response

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



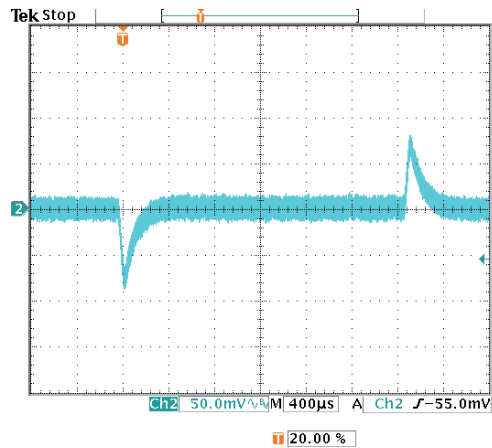
Model: PHB50-12S05  
 Ch2 : Vout

Model: PHB50-12S33  
 Ch2 : Vout



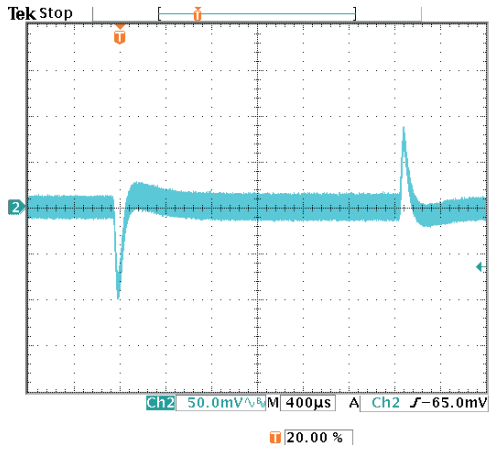
Model: PHB50-12S15  
 Ch2 : Vout

Model: PHB50-12S12  
 Ch2 : Vout

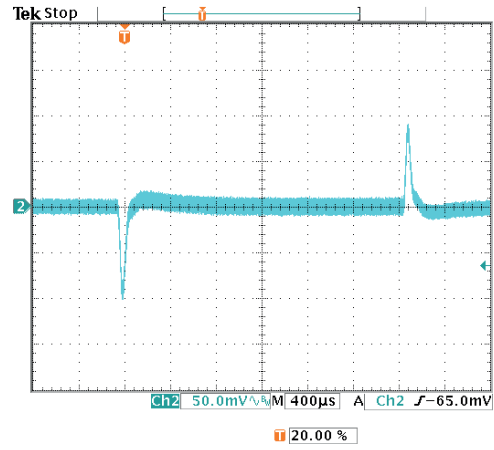


Model: PHB50-12S24  
 Ch2 : Vout

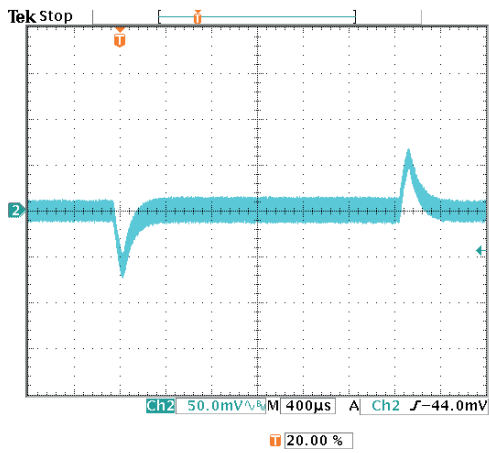
POWERBOX Industrial Line  
PHB50 Series  
33-50W 2:1 Single Output  
DC/DC Converter  
Manual V12



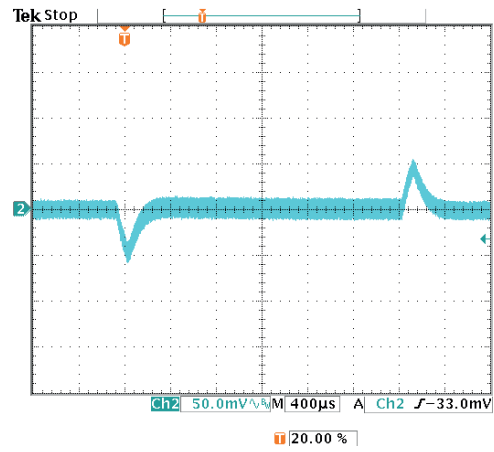
Model: PHB50-24S05  
Ch2 : Vout



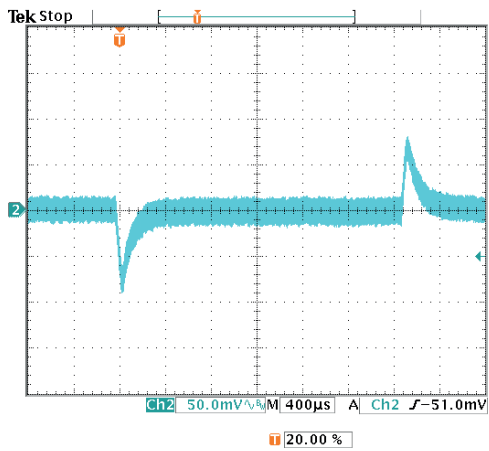
Model: PHB50-24S33  
Ch2 : Vout



Model: PHB50-24S15  
Ch2 : Vout

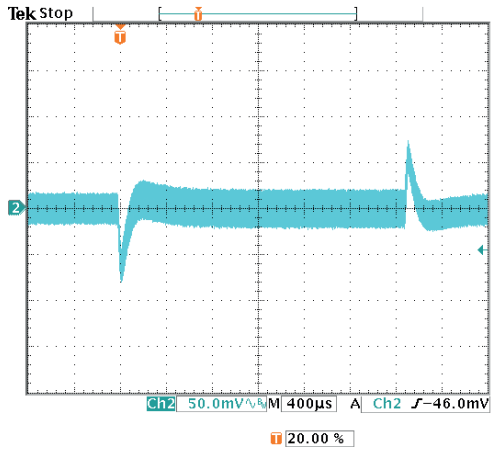


Model: PHB50-24S12  
Ch2 : Vout

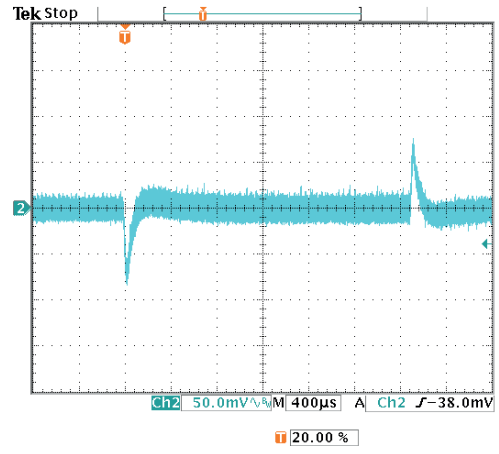


Model: PHB50-24S24  
Ch2 : Vout

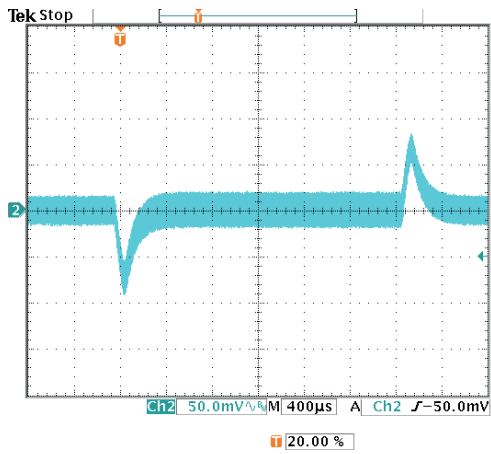
POWERBOX Industrial Line  
PHB50 Series  
33-50W 2:1 Single Output  
DC/DC Converter  
Manual V12



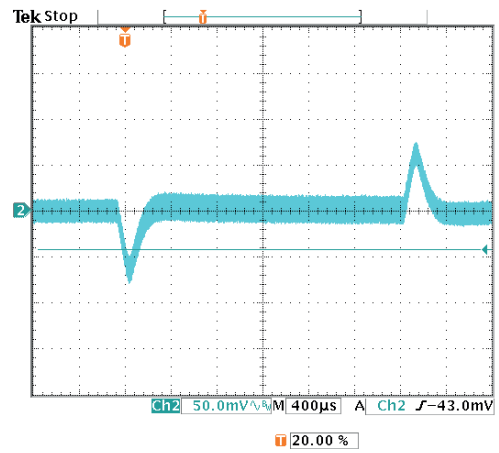
Model: PHB50-48S05  
Ch2 : Vout



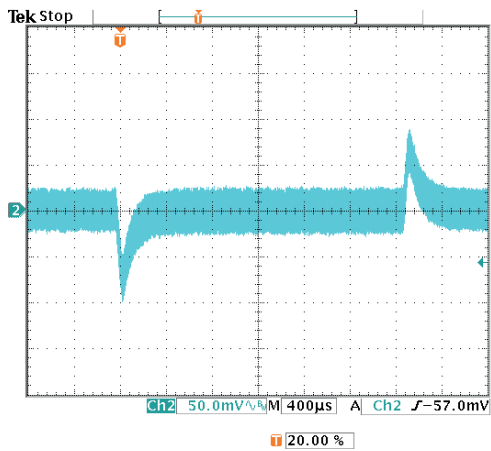
Model: PHB50-48S33  
Ch2 : Vout



Model: PHB50-48S15  
Ch2 : Vout



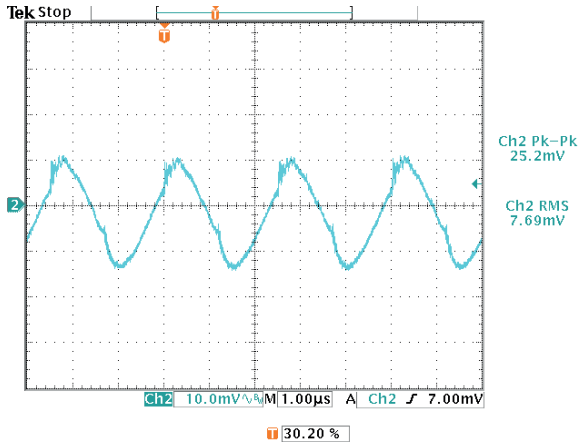
Model: PHB50-48S12  
Ch2 : Vout



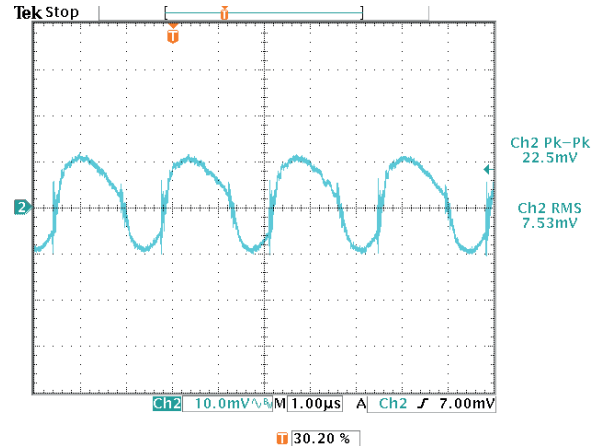
Model: PHB10048S24  
Ch2 : Vout

### Output Ripple and Noise

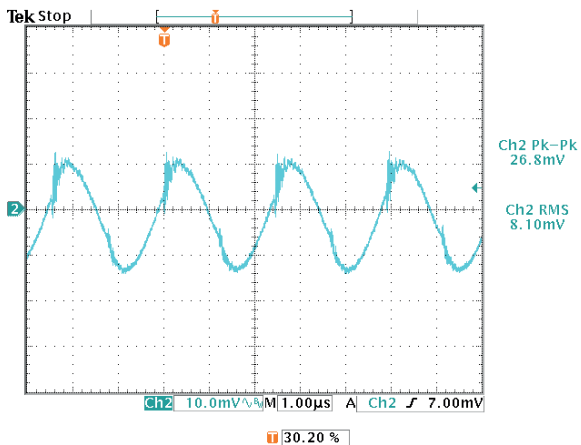
Measuring output ripple waveform peak to peak. Measure mane bandwidth 20 MHz. At nominal input, maximum lout and output with a 1.0uF ceramic capacitor and a 10uF tantalum capacitor.



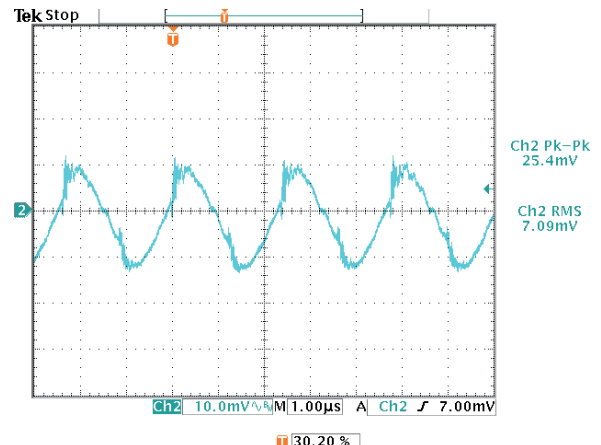
Model: PHB50-12S05  
 Ch2 : Vout  
 Ripple & noise : 25.2mVp-p



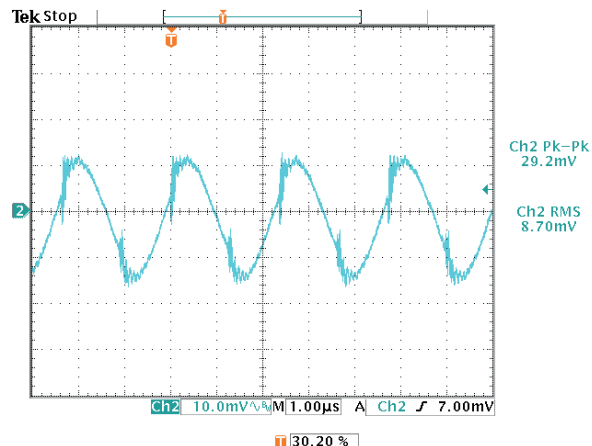
Model: PHB50-12S33  
 Ch2 : Vout  
 Ripple & noise : 22.5mVp-p



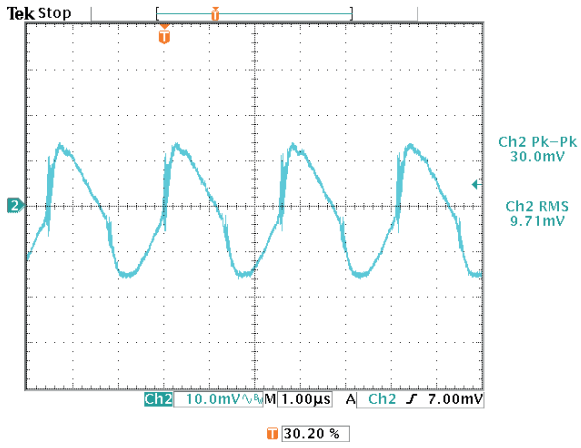
Model: PHB50-12S15  
 Ch2 : Vout  
 Ripple & noise : 26.8mVp-p



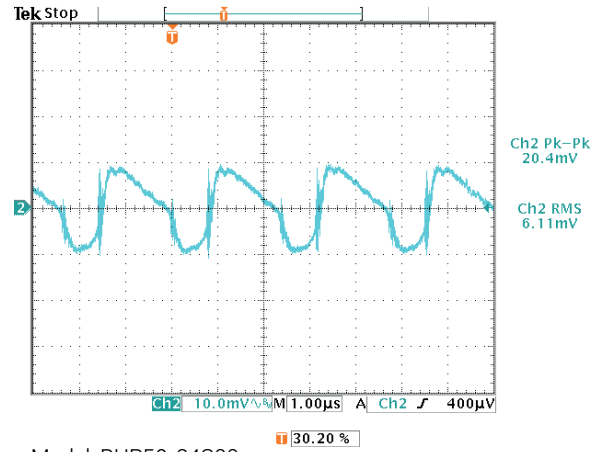
Model: PHB50-12S12  
 Ch2 : Vout  
 Ripple & noise : 25.4mVp-p



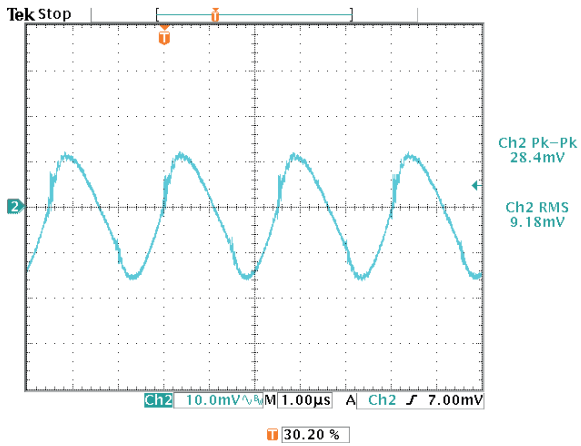
Model: PHB50-12S24  
 Ch2 : Vout  
 Ripple & noise : 29.2mVp-p



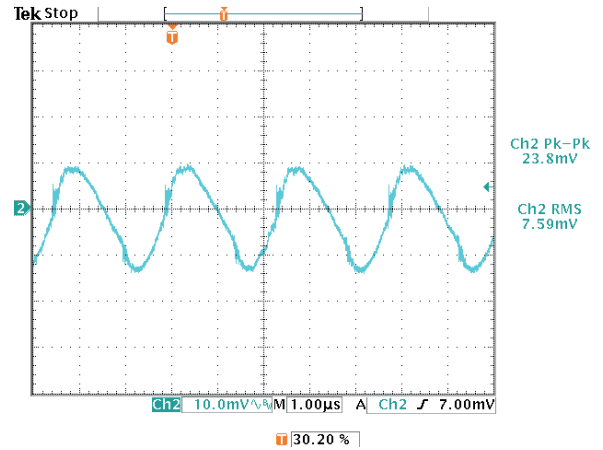
Model: PHB50-24S05  
 Ch2 : Vout  
 Ripple & noise : 30.0mVp-p



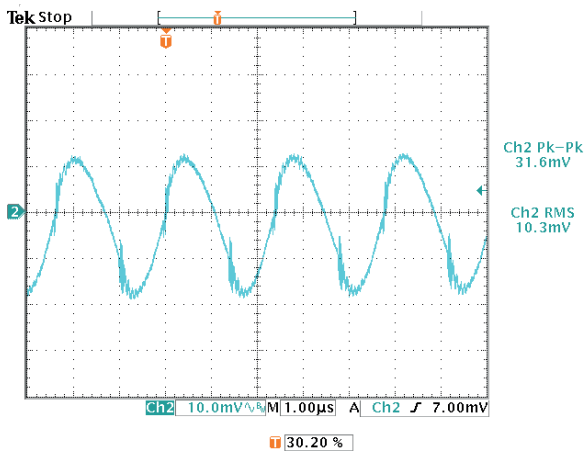
Model: PHB50-24S33  
 Ch2 : Vout  
 Ripple & noise : 20.4mVp-p



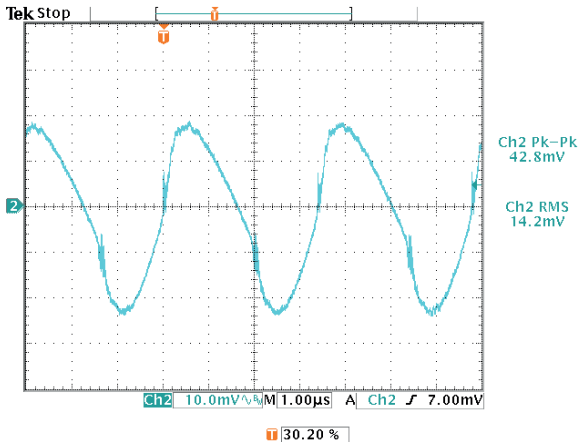
Model: PHB50-24S15  
 Ch2 : Vout  
 Ripple & noise : 28.4mVp-p



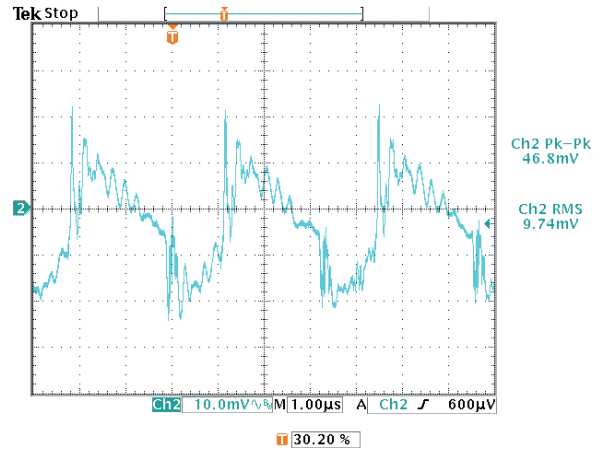
Model: PHB50-24S12  
 Ch2 : Vout  
 Ripple & noise : 23.8mVp-p



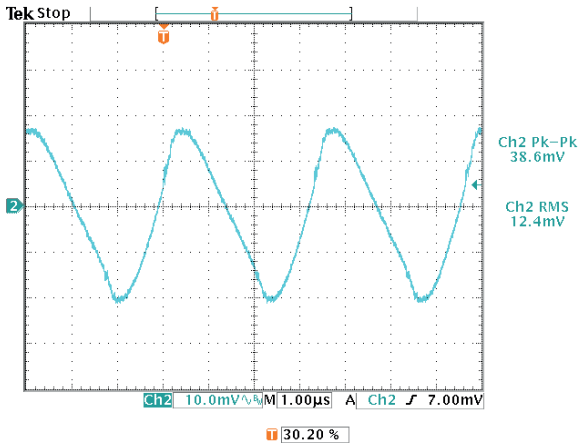
Model: PHB50-24S24  
 Ch2 : Vout  
 Ripple & noise : 31.6mVp-p



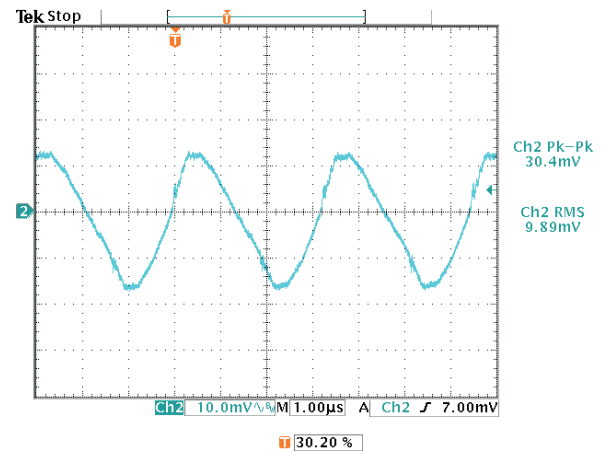
Model: PHB50-48S05  
 Ch2 : Vout  
 Ripple & noise : 42.8mVp-p



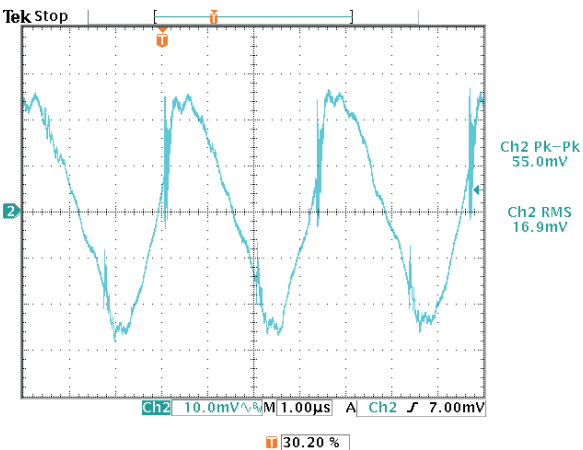
Model: PHB50-48S33  
 Ch2 : Vout  
 Ripple & noise : 46.8mVp-p



Model: PHB50-48S15  
 Ch2 : Vout  
 Ripple & noise : 38.6mVp-p



Model: PHB50-48S12  
 Ch2 : Vout  
 Ripple & noise : 30.4mVp-p

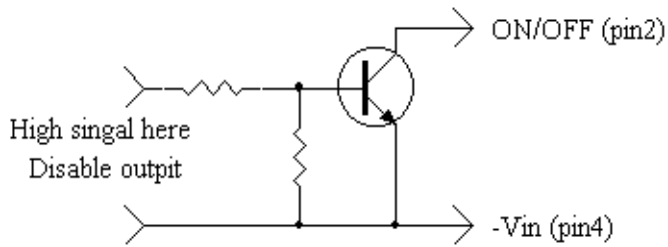


Model: PHB50-48S24  
 Ch2 : Vout  
 Ripple & noise : 55.0mVp-p



### Remote ON/OFF Control Circuit

The PHB50 series allows the user to switch the module on and off electronically with remote on/off feature. The PHB50 series are available with "Positive Logic" or "Negative Logic" (option).

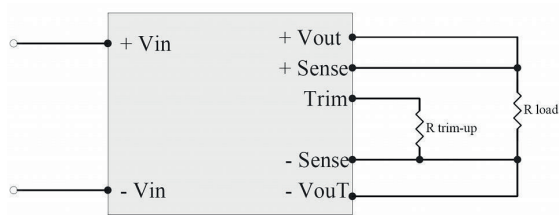


**Logic table**

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

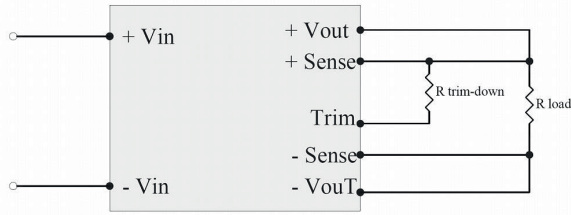
In order to trim the voltage up or down one needs to connect the trim resistor either between the trim pin and -Vo for trim-up and between trim pin and +Vo for trim-down. The output voltage trim range is ±10%. This is shown in Figures 1 and Figures 2.



Figures 1 : trim-up voltage setup  
 The value of R trim-up defined as:

$$R_{trim-up} = \frac{R_1[V_r - V_f \left(\frac{R_2}{R_2 + R_3}\right)]}{\Delta V_o} - \left(\frac{1}{R_2} + \frac{1}{R_3}\right)^{-1} (K\Omega)$$

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.



Figures 2 : trim-down voltage setup  
 The value of R trim-down defined as:

$$R_{trim-down} = \frac{R_1 \times (V_o - V_r)}{\Delta V_o} - R_2 (K\Omega)$$

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 1.

Table 1

Output Voltage(V)	R1(Kohm)	R2(Kohm)	R3(Kohm)	Vr(V)	Vf(V)
3.3V	3	12	18	2.5	0.46
5V	2.32	8.25	NC	2.5	0
12V	9.1	51	18	2.5	0.46
15V	12	82	18	2.5	0.46
24V	20	110	20	2.5	0.46

For example, to trim-up the output voltage of 5.0V module (PHB50-48S05) by 8% to 5.4V, R trim-up is calculated as follows:

$$\begin{aligned} \Delta V_o &= V_o - V_{o, nom} = 5.4 - 5.0 = 0.4V \\ V_r &= 2.5V \\ V_f &= 0V \\ R_1 &= 2.32K\Omega \\ R_2 &= 8.25K\Omega \end{aligned}$$

$$R_{trim-up} = \frac{2.32 \times (2.5 - 0)}{0.4} - \left(\frac{1}{8.25}\right)^{-1} = 6.25(K\Omega)$$

For example, to trim-down the output voltage of 5.0V module (PHB50-48S05) by 8% to 4.6V, R trim-down is calculated as follows:

$$\begin{aligned} \Delta V_o &= V_{o, nom} - V_o = 5.0 - 4.6 = 0.4V \\ V_r &= 2.5V \\ R_1 &= 2.32K\Omega \\ R_2 &= 8.25K\Omega \end{aligned}$$

$$R_{trim-down} = \frac{2.32 \times (4.6 - 2.5)}{0.4} - 8.25 = 3.93(K\Omega)$$

### Power Derating

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

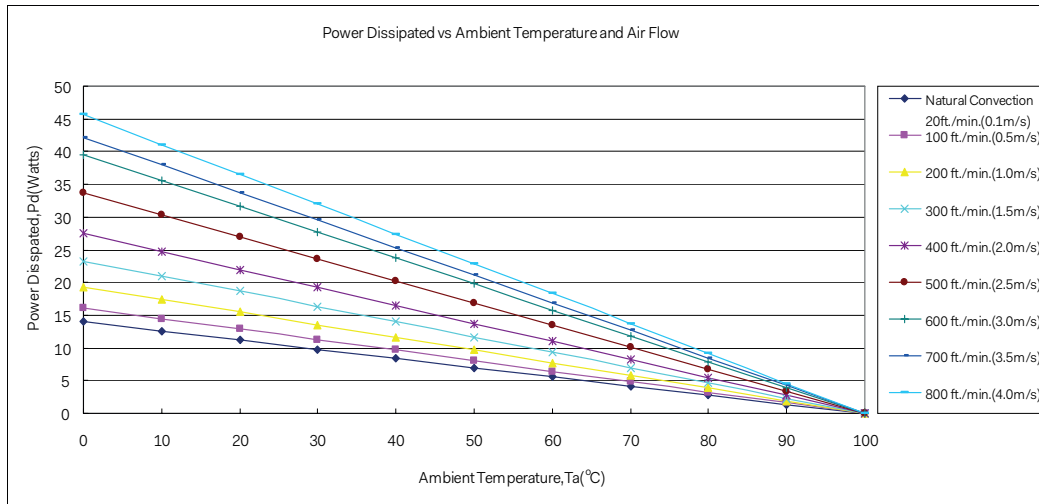


Chart of Thermal Resistance vs Air Flow

Air Flow Rate	Typical Rca
Natural Convection 20 ft./min.(0.1m/s)	7.12 oC/W
100 ft./min.(0.5m/s)	6.21 oC/W
200 ft./min.(1.0m/s)	5.17 oC/W
300 ft./min.(1.5m/s)	4.29 oC/W
400 ft./min.(2.0m/s)	3.64 oC/W
500 ft./min.(2.5m/s)	2.96 oC/W
600 ft./min.(3.0m/s)	2.53 oC/W
700 ft./min.(3.5m/s)	2.37 oC/W
800 ft./min.(4.0m/s)	2.19 oC/W

### Example

What is minimum airflow necessary for a PHB50-24S05 operation at nominal line, an output current of 10A, and a maximum ambient temperature of  $40^{\circ}\text{C}$ .

Solution:

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

Determine Power dissipation( $P_d$ ):

$$P_d = P_i - P_o$$

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

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

Determine airflow:

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

Check above Power de-rating curve:

Minimum airflow=200 ft./min.

Verifying:

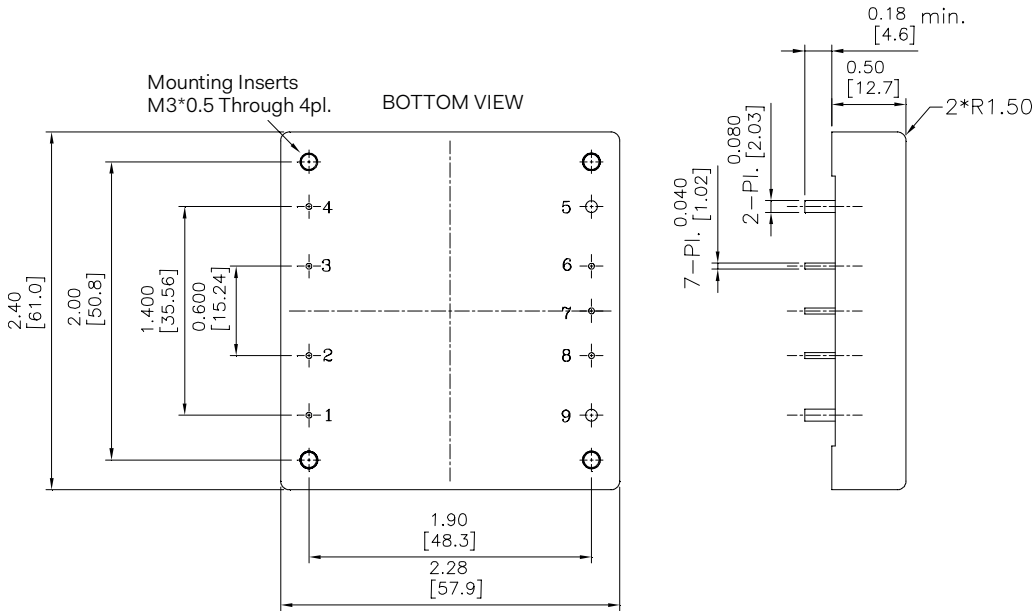
$$\text{The maximum temperature rise } \Delta T = P_d \times R_{ca} = 10.96 \times 5.17 = 56.66^{\circ}\text{C}$$

$$\text{The maximum case temperature } T_c = T_a + \Delta T = 40 + 56.66 = 96.66^{\circ}\text{C} < 100^{\circ}\text{C}$$

Where:

The  $R_{ca}$  is thermal resistance from case to ambient. The  $T_a$  is ambient temperature and  $T_c$  is case temperature.

Mechanical Outline Diagrams  
 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 output
6	-Sense
7	Trim
8	+Sense
9	+V output