INNOVATION and EXCELLENCE

HB Series Half-Brick

Up to 350 Watts DC-DC Converter

PRODUCT OVERVIEW

The HB series offers up to 350 watts of output power in standard Half-Brick package. This series features high efficiency up to 92%, high power density and 1500 Volts of DC isolation. These converters are reliable, and compact with a single output voltage. The HB series can deliver up to 70A of output current and provide a precise regulated output voltage over a wide input range of 18 to 36 or 36 to 75 volts. These modules operate over a wide case temperature range of –40°C to +100°C. This series offers direct cooling of dissipative components for excellent thermal performance. The main features of these converters include remote On/Off (positive or negative), remote sense, output voltage adjustment, over voltage, over current and over temperature protection.

FEATURES

- Industry standard Half-Brick Package
- Up to 350 Watts of output power
- Regulated Output, Fixed Switching Frequency
- Up to 92 % Efficiency
- Fully Isolated to 1500 Volts
- Over Current Protection
- Input Under Voltage Lockout Protection
- Extended temperature range of -40°C to +100°C
- Remote On/Off logic control
- Continuous Short Circuit Protection
- Safety meets UL60950-1 and EN60950-1

APPLICATIONS:

- Distributed Power Architectures
- Telecommunication
- Data and Wireless communications
- Servers
- Military and industrial applications

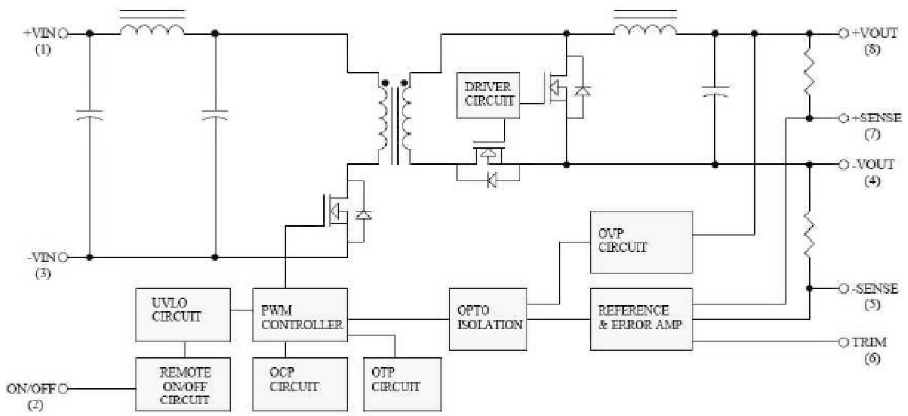
AVAILABLE OPTIONS

- Customizable Input/ Output voltages
- Heatsink, customizable packaging

Contact DATEL for other series of Half-Brick footprint, Cost Saving, Lower Power, different output voltage, etc.

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	OPTIONS
HB24S3.3-70	18-36 VDC	3.3 VDC	70A	88	±0.2	N, H
HB24S5-70	18-36 VDC	5 VDC	70 A	89	±0.2	N, H
HB24S12-29.2	18-36 VDC	12 VDC	29.2 A	90	±0.2	N, H
HB24S24-14.6	18-36 VDC	24 VDC	14.6 A	89	±0.2	N, H
HB24S28-12.5	18-36 VDC	28 VDC	12.5 A	90	±0.2	N, H
HB24S48-7.3	18-36 VDC	48 VDC	7.3 A	90	±0.2	N, H
HB48S3.3-70	36-75VDC	3.3 VDC	70 A	89	±0.2	N, H
HB48S5-70	36-75VDC	5 VDC	70 A	91	±0.2	N, H
HB48S12-29.2	36-75VDC	12 VDC	29.2 A	92.5	±0.2	N, H
HB48S24-14.6	36-75VDC	24 VDC	14.6 A	91.5	±0.2	N, H
HB48S28-12.5	36-75VDC	28 VDC	12.5 A	92	±0.2	N, H
HB48S48-7.3	36-75VDC	48 VDC	7.3 A	92	±0.2	N, H

Block Diagram



ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	$24V_{in}$ $48V_{in}$	-0.3 -0.3		36 75	Volts
Operating case Temperature		All	-40		+100	°C
Storage Temperature		All	-55		+105	°C
Transient	100 ms	$24V_{in}$ $48V_{in}$			50 100	VDC
Input / Output Isolation Voltage	1 minute	$48V_{in}$	1500			Volts

Note: Stresses above the absolute maximum ratings can cause permanent damage to the device. Exposure to absolute maximum ratings for extended periods can affect the device reliability.

INPUT CHARACTERISTICS

Note: All specifications are typical at nominal input, full load at 25°C unless otherwise noted

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Operating Input Voltage		$24V_{in}$ $48V_{in}$	18 36	24 48	36 75	Volts
Input Under Voltage Lockout						
Turn-On Voltage Threshold		$24V_{in}$ $48V_{in}$	16 34	17 35	18 36	Volts
Turn-Off Voltage Threshold		$24V_{in}$ $48V_{in}$	15 32	16 33	17 34	Volts
Lockout Hysteresis Voltage		$24V_{in}$ $48V_{in}$		1 2		Volts
Maximum Input Current	100% Load, V_{in}= 18V for HB24SXX	24Vin		21.9		A
	100% Load, V_{in} =36V for HB48SXX	48Vin		10.8		
No-Load Input Current	V_{in} =Nominal input	HB24S3.3-70 HB24S5-70 HB24S12-29.2 HB24S24-14.6 HB24S28-12.5 HB24S48-7.3 HB48S3.3-70 HB48S5-70 HB48S12-29.2 HB48S24-14.6 HB48S28-12.5 HB48S48-7.3		140 250 260 60 60 60 90 130 100 60 60 60		mA
External input Capacitance	ESR < 0.7	24 Vin 48 Vin		220 440		μA
Recommended Input Fuse	Fast Blow	24Vin 48 Vin		20 40		A
Inrush Current (I^2t)	As per ETS300 132-2	All			0.1	A^2s

OUTPUT CHARACTERISTIC

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Output Voltage Set Point	V_{in} =Nominal V_{in} , $I_o = I_{o\_max}$, Tc=25°C	Vo=3.3V Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V	3.25 4.925 11.82 23.64 27.58 47.28	3.3 5 12.00 24.00 28.00 48.00	3.35 5.075 12.18 24.36 28.42 48.72	Volts
Output Voltage Regulation						
Load Regulation	$I_o = I_{o\_min}$ to I_{o_max}	All			±0.2	%
Line Regulation	V_{in}=low line to high line	All			±0.2	%
Temperature Coefficient	TC=-40°C to 100°C	All			±0.03	%/°C
Output Voltage Ripple and Noise						
Peak-to-Peak	20MHz bandwidth, Full load, 10μF tantalum and 1.0μF ceramic capacitors	Vo=3.3V Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V			100 100 120 240 280 480	mV
RMS	5Hz to 20MHz bandwidth, Full load, 10uF solid tantalum and 1.0uF ceramic capacitors	Vo=3.3V Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V			40 40 60 100 100 150	mV
Operating Output Current Range		Vo=3.3V Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V	0		70 70 29.2 14.6 12.5 7.3	A
Output DC Current Limit Inception	Output Voltage=90% Nominal Output Voltage	All	110	125	140	%
Output Capacitance	Full load (resistive)	Vin = 3.3, 5, 12, 24	470		10000	μF
Output Capacitance	Full load (resistive)	Vin = 28V Vin = 48V	470		7000 2200	μF

DYNAMIC CHARACTERISTICS

PARAMETER	CONDITIONS	MODEL	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	d_i/d_t=0.1A/us, Load change from 75% to 100% to 75% of Io,max	All		±3	±5	%
Setting Time (within 1% Vout nominal)	d_i/d_t=0.1A/us	All			500	μs
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off Control	$V_{on/off}$ to 10%V_{o_set}	All			55	ms
Turn-On Delay Time, From Input	V_{in_min} to 10%V_{o_set}	All			165	ms
Output Voltage Rise Time	10%V_{o_set} to 90%V_{o_set}	All			35	ms

FEATURE CHARACTERISTICS

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
100% Load Efficiency	V_{in} =24 V_{dc}, I_o = I_{o_max}, Tc=25°C	HB24S3.3-70 HB24S5-70 HB24S12-29.2 HB24S24-14.6 HB24S28-12.5 HB24D48-7.3		88 89 90.5 89 90.5 91		%
	V_{in} =48 V_{dc}, I_o = I_{o_max}, Tc=25°C	HB48S3.3-70 HB48S5-70 HB48S12-50 HB48S24-25 HB48S28-25 HB48D48-12.5		89 91 92.5 91.5 92 92		%
ISOLATION CHARACTERISTICS						
Isolation Voltage	1 minute; input/output, input/case, output/case input/remote, output/remote				1500	Volts
Isolation Resistance			10			MΩ
Isolation Capacitance				2000		pF
Switching Frequency		Vo=3.3, 5V		300		KHz
		Vo=12, 24, 28, 48V		330		KHz
ON/OFF Control Negative Remote On/Off logic						
Logic Low (Module Off)					1.2	Volts
Logic High (Module On)			3.5 V or open Circuit		75	Volts
ON/OFF Control Positive Remote On/Off logic						
Logic Low (Module Off)			3.5 V or open Circuit		75	Volts
Logic High (Module On)					1.2	Volts
ON/OFF Current (for both Remote on/off logic)	$I_{on/off}$ at $V_{on/off}$=0.0V	All			1	mA
Leakage Current (for both Remote on/off logic)	Logic High, $V_{on/off}$=15V	All			1	mA
Off Converter Input Current	Shutdown input idle current				15	mA
Off Converter Input Current	Shutdown input idle current				50	mA
Output Voltage Trim Range	V_{in}=high line-low line, P_{out}=max rated power, I_{out}=max rated current		-10		+10	%
Output Over Voltage Trim Range	Vin=18-19V for 24S12, 24S28, 24S48 Vin=36-38V for 48S28, 48S48 I_{out}=max rated current		-10		0	%
Over-voltage protection			115	125	140	%
Over-Temperature Shutdown		All		110		°C
MTBF	I_o=100% of I_{o_max}: T_a=25°C per MIL-HDBK-217F			700		K hours
Weight				114		grams

Operating Temperature Range

The HB series converters can operate within a wide case temperature range of -40°C to +100°C. Consideration must be given to the de-rating curves when ascertaining maximum power that can be drawn from the converter. The maximum power drawn from the full brick models is influenced by multiple factors, such as:

1- Input voltage range
2- Output load current
3- Forced air or natural convection

Output Voltage Adjustment

The output voltage of the 3.3, 5 and 24 Volts is adjustable to within the range of +10% to –10%. For the 12V, 28 and 48V models, please see the output trim curves.

Over Current Protection

The converter is protected against over current or short circuit conditions. At the instance of current-limit inception, the module enters a constant current mode of operation. While the fault condition exists, the module will remain in this constant current mode, and can remain in this mode until the fault is cleared. The unit operates normally once the output current is reduced back into its specified range.

Output over Voltage Protection

The converter is protected against output over voltage conditions. When the output voltage is higher than the specified range, the module enters a hiccup mode of operation.

Remote On/Off

The Remote On/Off input pin permits the user to turn the power module on or off via a system signal. Two remote on/off options are available. Positive logic turns the module on during a logic high voltage on the On/Off pin, and off during a logic low. Negative logic remote On/Off turns the module off during a logic high and on during a logic low. The On/Off pin is internally pulled up through a resistor. A properly de-bounced mechanical switch, open collector transistor, or FET can be used to drive the input of the On/Off pin. If not using the remote on/off feature is not used: 1- For positive logic, leave the On/Off pin open. 2- For negative logic, short the On/Off pin to VIN(-).

Under/Over Voltage Lock Out (UVLO &OVLO)

Input under/over voltage lockout is standard on this series of converters. At input voltages below/beyond the input under voltage lockout limit, the module operation is disabled.

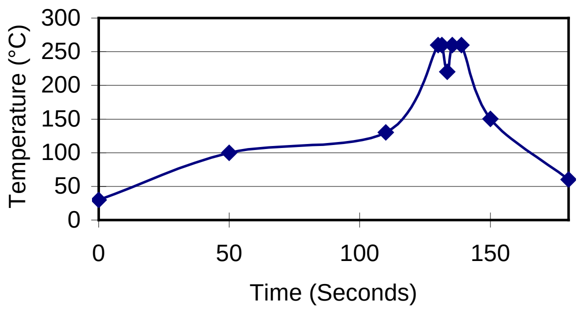
Over Temperature Protection

These modules have an over temperature protection circuit to safeguard against thermal damage. When the case temperature rises above over temperature shutdown threshold, the converter will shut down to protect it from overheating. The module will automatically restart after it cools down.

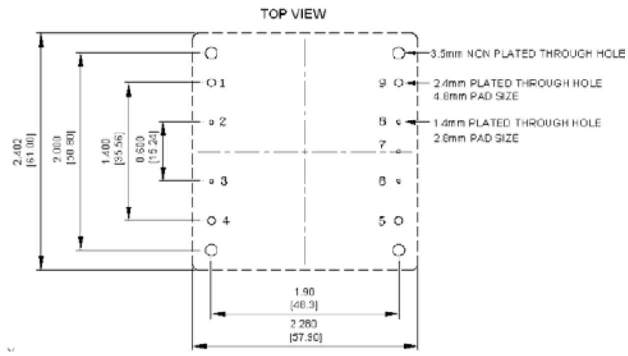
Recommended Layout, PCB Footprint and Soldering Information

The user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout should be used where possible. Proper attention must also be given to low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown in the next two figures.

Lead Free Wave Soldering Profile



Note：
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 °C/Sec (From 50°C to 100°C)
3. Soaking temperature: 0.5 °C/Sec (From 100°C to 130°C), 60±20 seconds
4. Peak temperature: 260°C, above 250°C 3~6 Seconds
5. Ramp up rate during cooling:-10.0 °C/Sec (From 260°C to 150°C)



Recommend PCB Pad layout

Convection Requirements for Cooling

To predict the approximate cooling needed for the full brick module, refer to the power de-rating curves. These de-rating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be monitored to ensure it does not exceed 100°C as being measured at the center of the top of the case (thus verifying proper cooling).

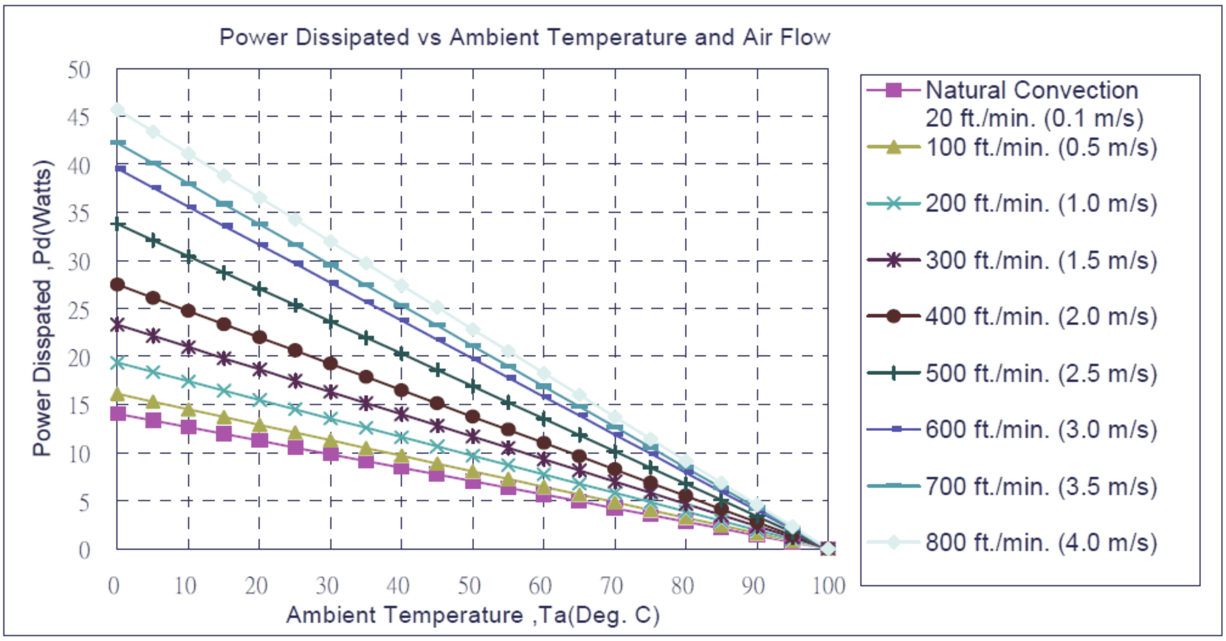
Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. The power output of the module should not be allowed to exceed rated power (V_{o_set} x I_{o_max}).

Power De-rating

The operating case temperature range of the HB series is -40°C to +100°C. When operating the HB 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 HB series without heat sink:



Example:

Example (without heat sink): What is the minimum airflow necessary for an HB48D3.3-70 operating at nominal line voltage, an output current of 70A, and a maximum ambient temperature of 30°C?

Solution:

Given:

Vin=48Vdc, Vo=3.3Vdc, Io=70A

Determine Power dissipation (Pd):

$Pd = Pi-Po = Po(1-\eta)/\eta$

$Pd = 3.3V \times 70A \times (1-0.89)/0.89 = 28.6Watts$

Determine airflow:

Given: Pd =28.6W and Ta=30°C

Check Power De-rating curve:

Minimum airflow= 800 ft./min.

Verify:

Maximum temperature rise is

$\triangle T = Pd \times Rca = 28.6W \times 2.19 = 62.6^{\circ}C$.

Maximum case temperature is

$Tc = Ta + \triangle T = 92.6^{\circ}C < 100^{\circ}C$.

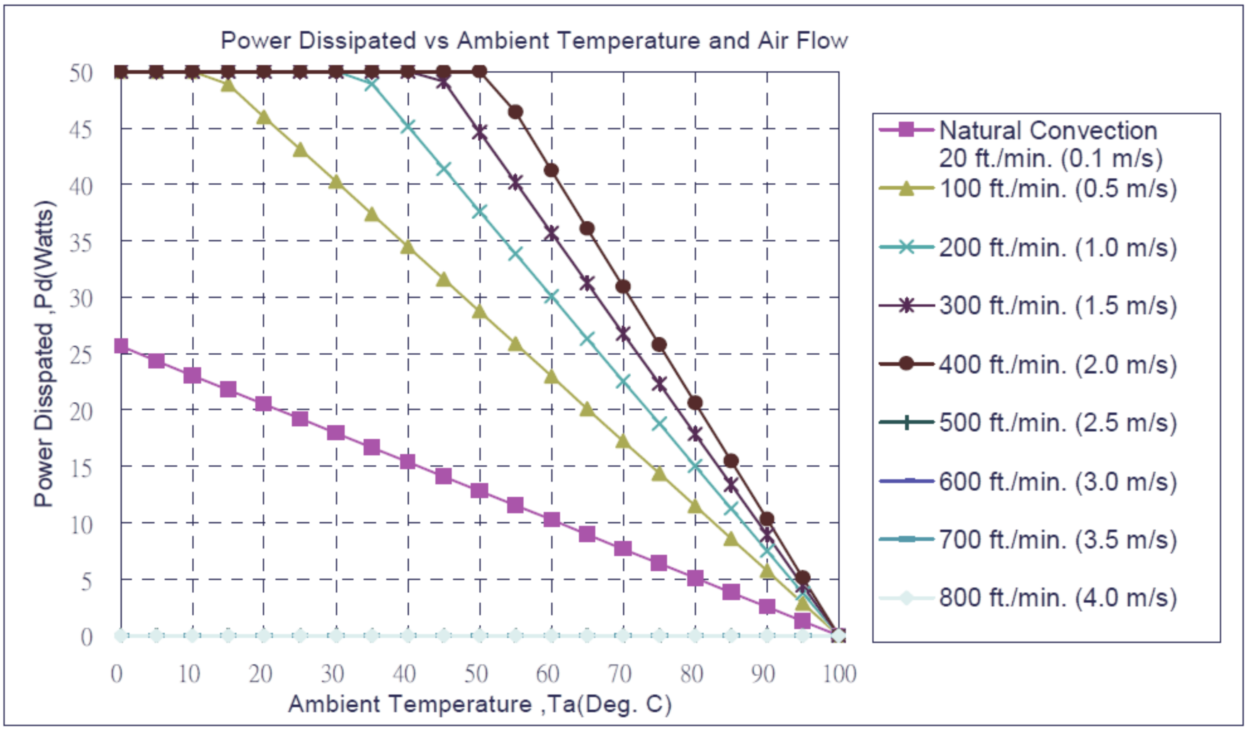
Where:

The Rca is thermal resistance from case to ambient environment.

Ta is ambient temperature and Tc is case temperature

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

The following curve is the de-rating curve of HB series with heat sink M-C308:



Forced Convection Power De-rating with Heat Sink M-C308

Example (with heat sink M-C308):
Solution:
Given:

Vin=48Vdc, Vo=3.3Vdc, Io=70A

Determine Power dissipation (Pd):

Pd =Pi-Po=Po(1-η)/η
Pd =3.3V×70A×(1-0.89)/0.89=28.6Watts

Determine airflow:
Given: Pd =28.6W and Ta=40°C

Check Power De-rating curve:
Minimum airflow= 100 ft./min.

Verify:

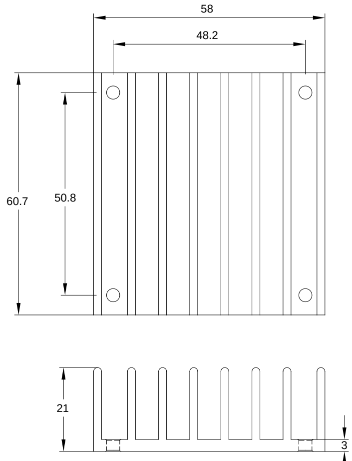
Maximum temperature rise is
ΔT = Pd × Rca=28.6W×1.74=49.8°C.

Maximum case temperature is
Tc=Ta + ΔT=89.8°C <100°C.

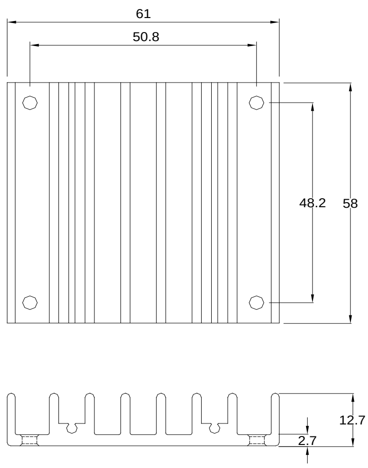
Where:
The Rca is thermal resistance from case to ambient environment.
Ta is ambient temperature and Tc is case temperature.Example:

AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	3.9 ℃/W
100 ft./min. (0.5m/s)	1.74 ℃/W
200 ft./min. (1.0m/s)	1.33 ℃/W
300 ft./min. (1.5m/s)	1.12 ℃/W
400 ft./min. (2.0m/s)	0.97 ℃/W

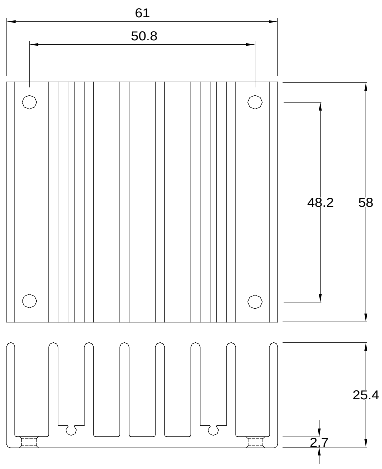
Full Brick Heat Sinks:



M-C308



M-C091



M-C092

M-C308 (G6620400201)
Longitudinal Heat Sink

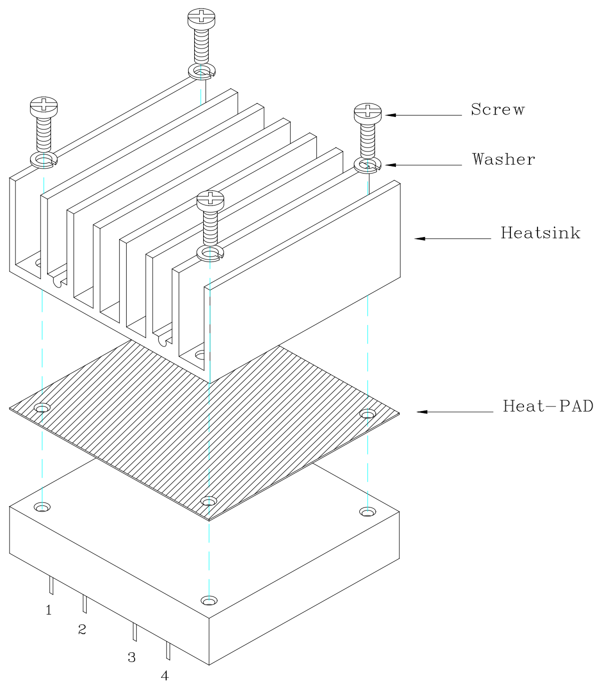
Rca:
3.90°C/W (typ.), natural convection
1.74°C/W (typ.), at 100LFM
1.33°C/W (typ.), at 200LFM
1.12°C/W (typ.), at 300LFM
0.97°C/W (typ.), at 400LFM

M-C091 (G6610120402)
Transverse Heat Sink

Rca:
4.70°C/W (typ.), natural convection
2.89°C/W (typ.), at 100LFM
2.30°C/W (typ.), at 200LFM
1.88°C/W (typ.), at 300LFM
1.59°C/W (typ.), at 400LFM

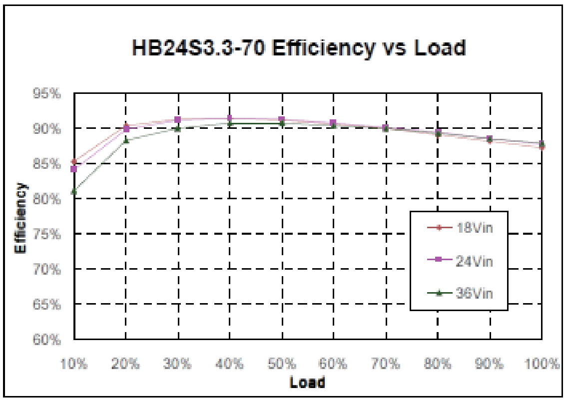
M-C092 (G6610130402)
Transverse Heat Sink

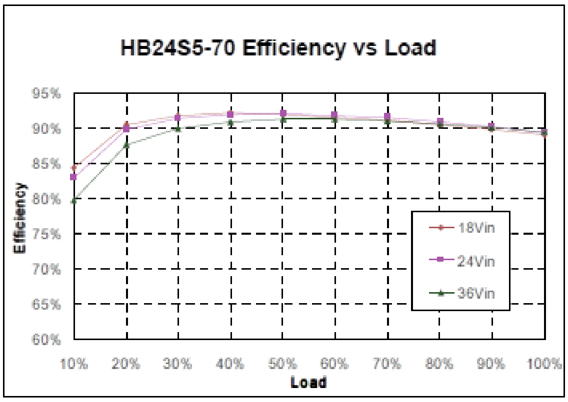
Rca:
3.00°C/W (typ.), natural convection
1.44°C/W (typ.), at 100LFM
1.17°C/W (typ.), at 200LFM
1.04°C/W (typ.), at 300LFM
0.95°C/W (typ.), at 400LFM

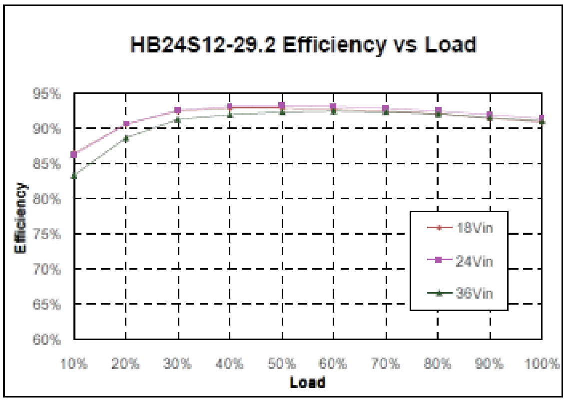


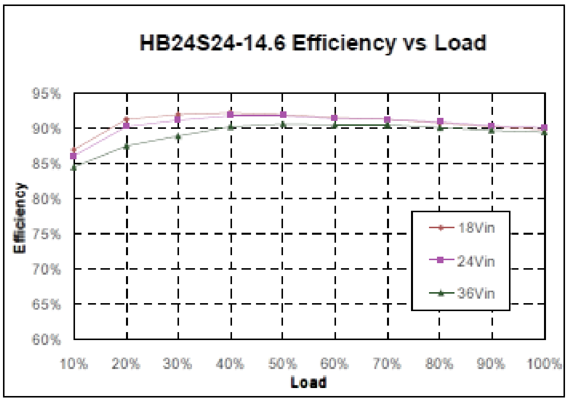
THERMAL PAD: SZ 56.9*60*0.25 mm (G6135041091)
SCREW: SMP+SW M3*8L
(G75A1300322)

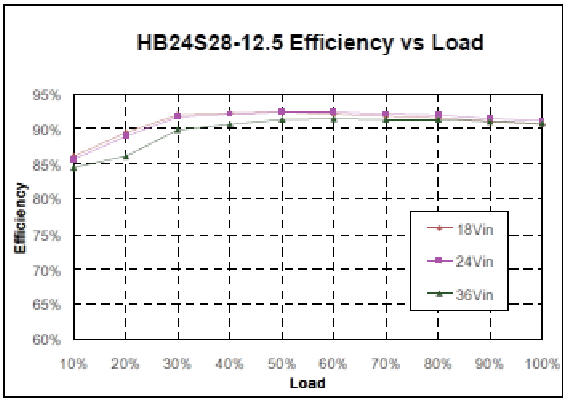
EFFICIENCY vs. LOAD

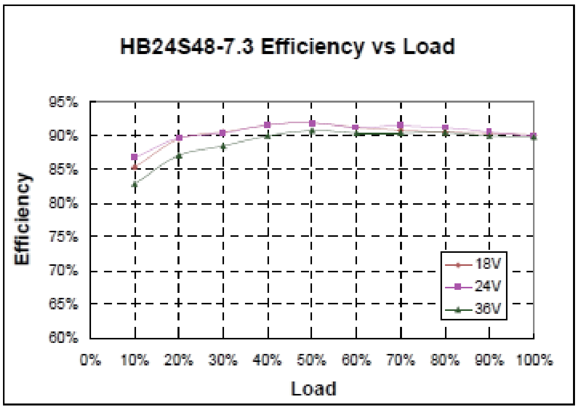


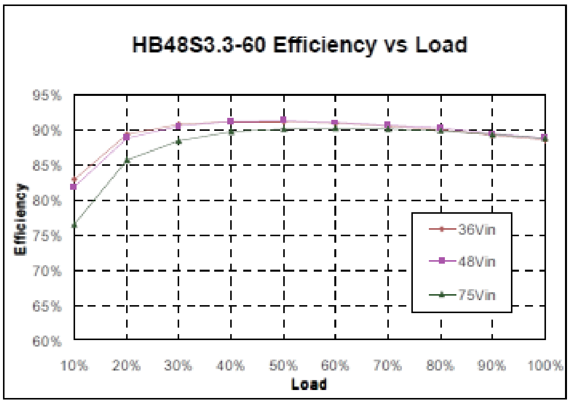




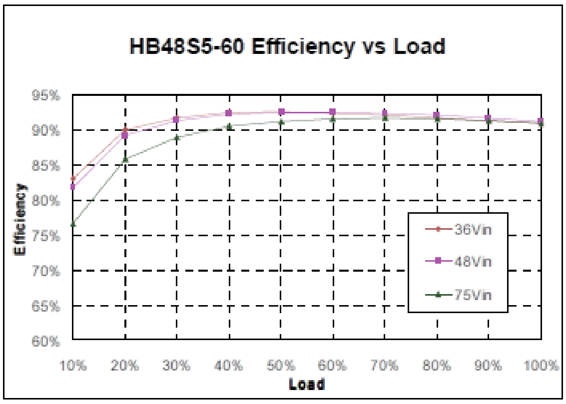




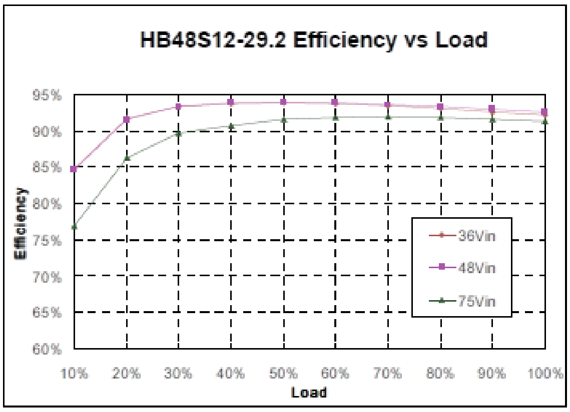




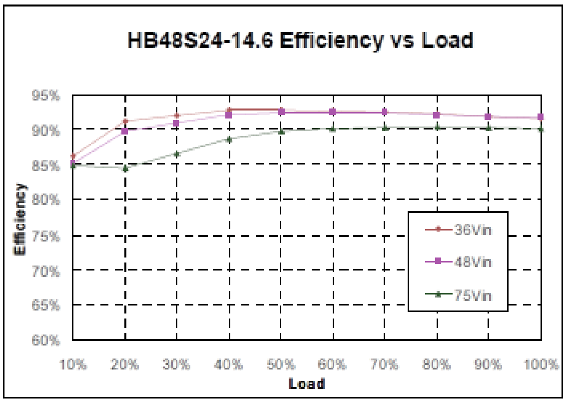
HB48S3.3-60 Efficiency vs Load
Efficiency
Load
36Vin
48Vin
75Vin



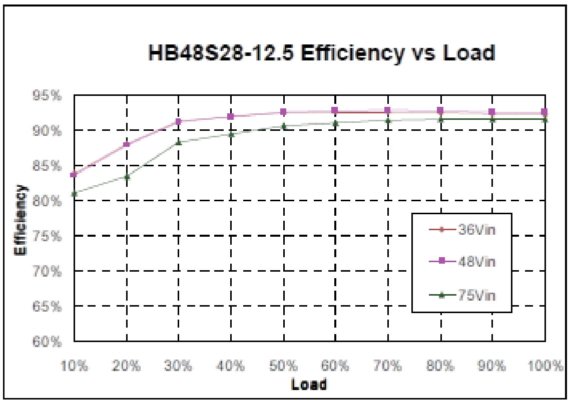
HB48S5-60 Efficiency vs Load
Efficiency
Load
36Vin
48Vin
75Vin



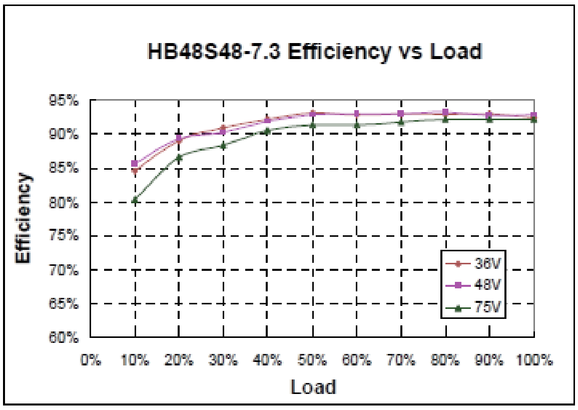
HB48S12-29.2 Efficiency vs Load
Efficiency
Load
36Vin
48Vin
75Vin



HB48S24-14.6 Efficiency vs Load
Efficiency
Load
36Vin
48Vin
75Vin



HB48S28-12.5 Efficiency vs Load
Efficiency
Load
36Vin
48Vin
75Vin



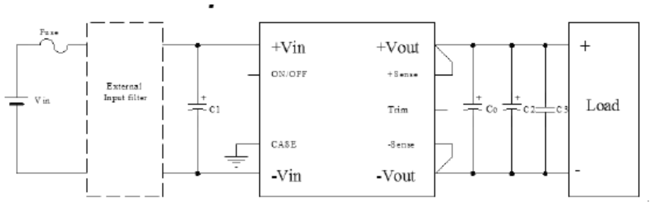
HB48S48-7.3 Efficiency vs Load
Efficiency
Load
36V
48V
75V

Test Set-Up

The basic test set-up to measure efficiency, load regulation, line regulation and other parameters is shown in the next figure. When testing the converter under any transient conditions, the user should ensure that the transient response of the source is sufficient to power the equipment under test. Below is the calculation of:

1- Efficiency
2- Load regulation
3- Line regulation

For typical electrical connection, please refer to the connections in the below figure:



The value of input capacitor C1should be more than 220uF for 48Vin models and more than 440uF for 24Vin models. If the ambient temperature is less than -20, then use twice of the recommended capacitor above. If the impedance of input line is high, the input capacitor must be more than above.
The value of the output capacitor Co should be chosen per recommendation on page 3. If the ambient temperature is less than -20, use at least 3 pieces of the recommended minimum capacitors. C2 and C3 are 1.0uF ceramic and 10uF solid tantalum capacitors across the output. Also, use external fuse for each unit.

The value of efficiency is defined as:

$$\eta = \frac{Vo \times Io}{Vin \times Iin} \times 100\%$$

Where:

V_o is output voltage,
I_o is output current,
V_{in} is input voltage,
I_{in} is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

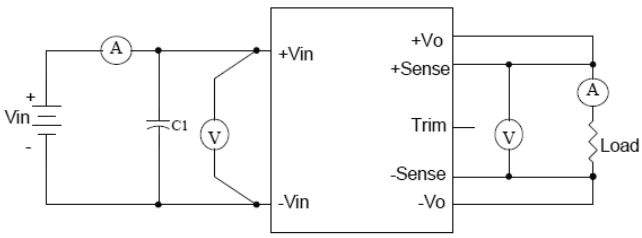
Where:

V_{FL} is the output voltage at full load
V_{NL} is the output voltage at no load

The value of line regulation is defined as:

$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

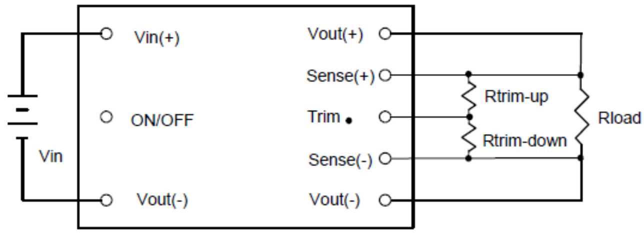
Where: V_{HL} is the output voltage of maximum input voltage at full load.
V_{LL} is the output voltage of minimum input voltage at full load.



HB Series Test Setup

Output Voltage Adjustment

The Trim input permits the user to adjust the output voltage up or down 10%. This is accomplished by connecting an external resistor between the Trim pin and either the Vout (+) pin or the Vout(-) pin (COM pin), see Figure:



Output voltage trim circuit configuration

The Trim pin should be left open if trimming is not being used. Connecting an external resistor (Rtrim-down) between the Trim pin and the Vout(-) (or Sense(-)) pin decreases the output voltage. The following equation determines the required external resistor value to obtain a down percentage output voltage change of △%

$$R_{trim-down} = \left[\frac{511}{\Delta\%} - 10.22 \right] k\Omega$$

Where:

$$\Delta\% = \left(\frac{V_{o,set} - V_{desired}}{V_{o,set}} \right) \times 100$$

For example, to trim-down the output voltage of 12V module (HB48S12-29.2) by 5% to 11.4V, Rtrim-down is calculated as follow:

Δ%=5

$$R_{trim-down} = (\frac{511}{5} - 10.22) k\Omega$$

$$R_{trim-down} = 91.98 k\Omega$$

Connecting an external resistor (Rtrim-up) between the Trim pin and the Vout (+) (or Sense (+)) pin increases the output voltage. The following equations determine the required external resistor value to obtain a up percentage output voltage change of Δ%.

$$R_{trim-up} = \left[\frac{5.11 V_{out}(100 + \Delta\%)}{1.24 \times \Delta\%} - \frac{511}{\Delta\%} - 10.22 \right] k\Omega$$

Where:

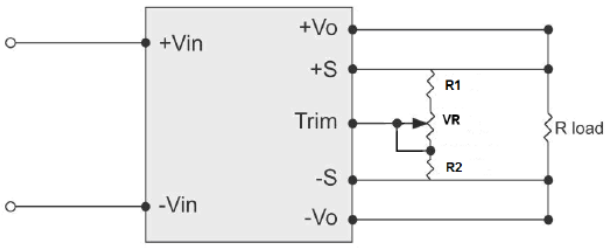
$$V_{out} = V_{o,set}, \quad \Delta\% = \left(\frac{V_{desired} - V_{o,set}}{V_{o,set}} \right) \times 100$$

For example, to trim-up the output voltage of 12V module (HB48S12-29.2) by 5% to 12.6V, Rtrim-up is calculated as follow:

△%=5

$$R_{trim-up} = (\frac{5.11 \times 12 \times (100 + 5)}{1.24 \times 5} - \frac{511}{5} - 10.22) k\Omega$$

$$R_{trim-up} = 924 k\Omega$$



Output voltage trim circuit configuration using VR

Recommend Resistor Values:

V_{out} (V)	R1 (KΩ)	R2 (KΩ)	VR (KΩ)
3.3	9.1	7.5	10
5	13	5.6	10
12	33	4.7	20
15	36	3.9	20
24	47.5	3	20
28	75	2.2	20
48	9.1	7.5	10

For 3.3, 5, 12, 24, 28 Volts output:

$$R1 + VR \geq \frac{37.089 \times R3 \times Vo - 40.88 \times R2}{40.88 - R2}(K\Omega) \cdots\cdots\cdots\cdots\ (1)$$

$$R1 \leq \frac{45.331 \times R2 \times Vo - 61.32 \times R2}{61.32 + R2}(K\Omega) \cdots\cdots\ \cdots\cdots\cdots\ (2)$$

$$VR \geq (1) - (2)$$

For 48 Volts output:

$$R1 + VR \geq \frac{145.161 \times R2 \times Vo - 160 \times R2}{160 - R2}(K\Omega) \cdots\cdots\cdots\cdots\ (1)$$

$$R1 \leq \frac{177.419 \times R2 \times Vo - 240 \times R2}{240 + R2}(K\Omega) \cdots\cdots\ \cdots\cdots\ (2)$$

$$VR \geq (1) - (2)$$

Example for HB24S24-14.6 and If R3=3KΩ

$$R1 + VR \geq \frac{37.089 \times 3 \times 24 - 40.88 \times 3}{40.88 - 3} = 67.259K\Omega$$

$$R1 \leq \frac{45.331 \times 3 \times 24 - 61.32 \times 3}{61.32 + 3} = 47.884K\Omega$$

$$VR \geq 67.259 - 47.884 = 19.375K\Omega$$

For R1 use 47.5K and VR use 20K

Example: HB24S48-7.2 and If R3=2.2K

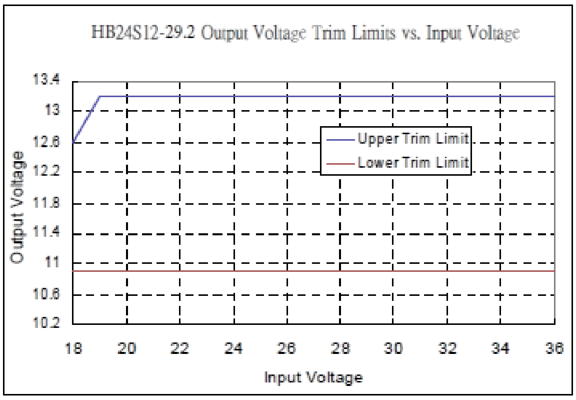
$$R1 + VR \geq \frac{145.161 \times 2.2 \times 48 - 160 \times 2.2}{160 - 2.2} = 94.911K\Omega$$

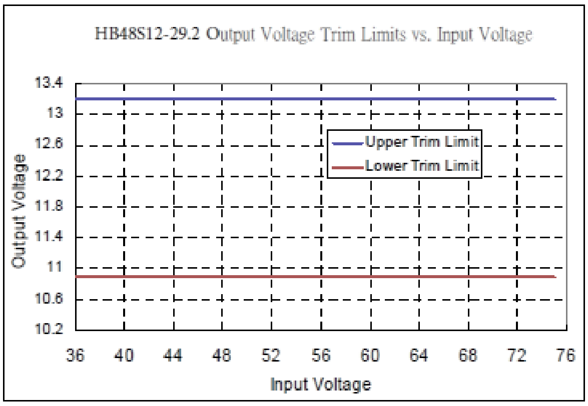
$$R1 \leq \frac{177.419 \times 2.2 \times 48 - 240 \times 2.2}{240 + 2.2} = 75.175K\Omega$$

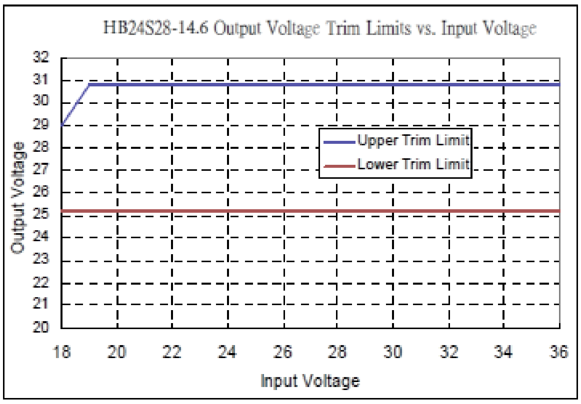
$$VR \geq 94.911 - 75.175 = 19.736K\Omega$$

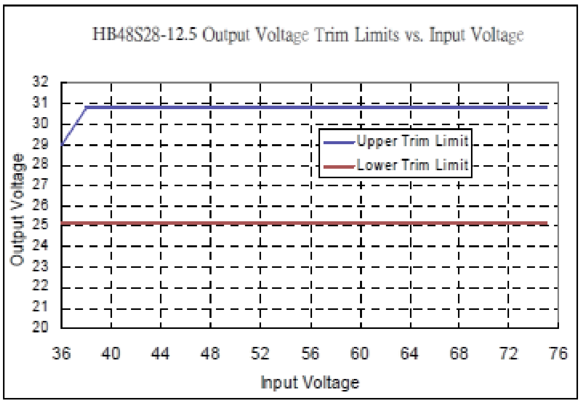
For R1 use 75K and VR use 20K

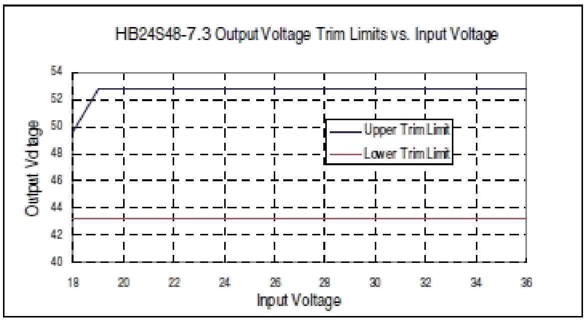
The output voltage on 3.3 , 5 and 24V models is adjustable within the range of +10% to –10%. For 12, ,28 and 48Volts models, see input & output trim curves for trim up and trim down is -10%.

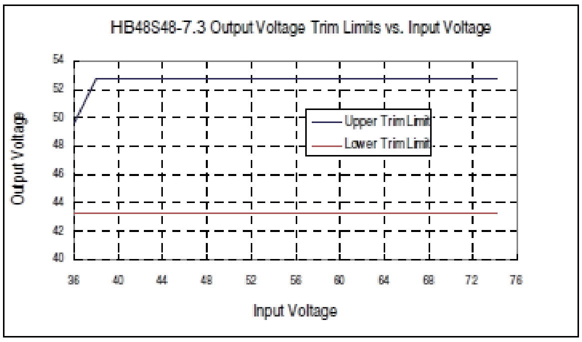












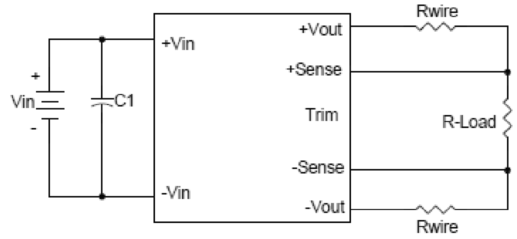
Output Remote Sensing

The HB series of converters has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the HB series in order to compensate for voltage drops in distribution and maintain a regulated voltage at the point of load. The remote-sense voltage range is:

$[(+V_{out}) - (-V_{out})] - [(+Sense) - (-Sense)] \leqq 10\%$ of $V_{o\_nominal}$

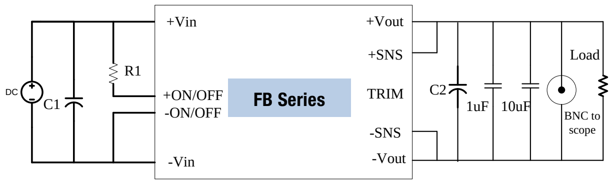
If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module.

This is shown in the schematic below.



Note: Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. The amount of power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. When using remote sense and trim, the output voltage of the module can be increased and consequently increase the power output of the module if output current remains unchanged. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power (Maximum rated power = $V_{o,set}$ x $I_{o,max}$)

Output Ripple and Noise



Output ripple and noise is measured with 1.0uF ceramic and 10uF solid tantalum capacitors across the output.

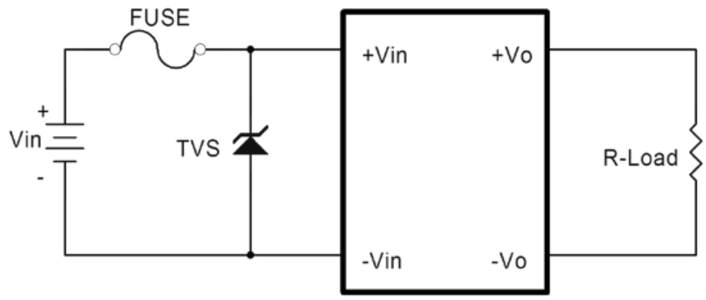
6.11 Output Capacitance

The HB series converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitors should be located close to the point of load. PCB design emphasizes low resistance and inductance tracks in consideration of high current applications. Output capacitors with their associated ESR values have an impact on loop stability and bandwidth. The minimum output capacitance is 470μF which need three or four times capacitance when operating below -20°C and the absolute maximum value of HB series' output capacitance is 10000μF. For values larger than this, please contact your local DATEL's representative.

SAFETY and EMC

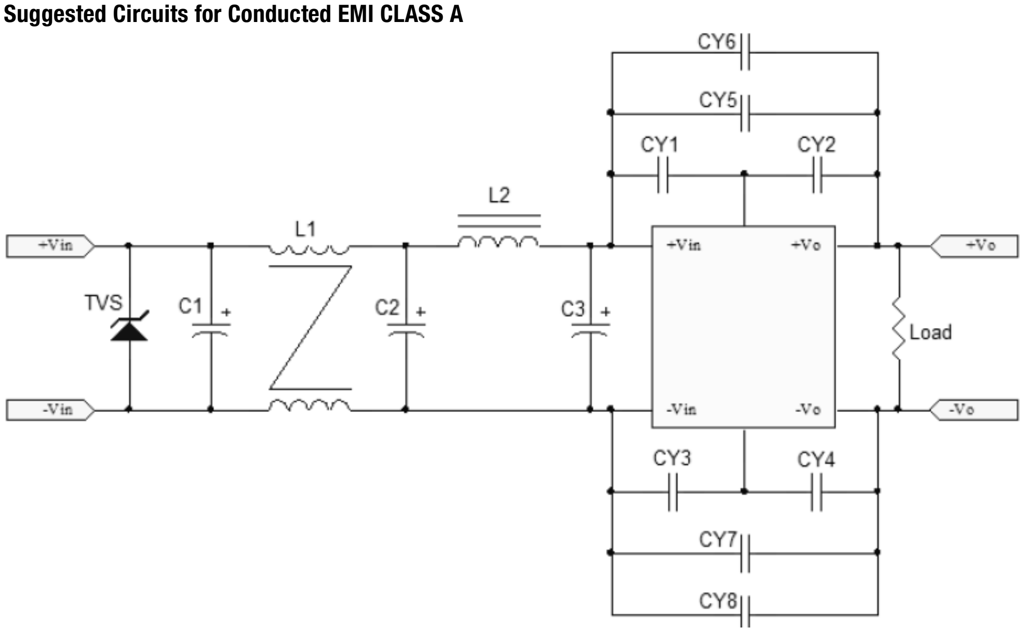
Input Fusing and Safety Considerations

The HB series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 40A time delay fuse for 24V_{in} models, and 20A for 48V_{in} models. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage (as shown).



EMC Considerations

Suggested Circuits for Conducted EMI CLASS A



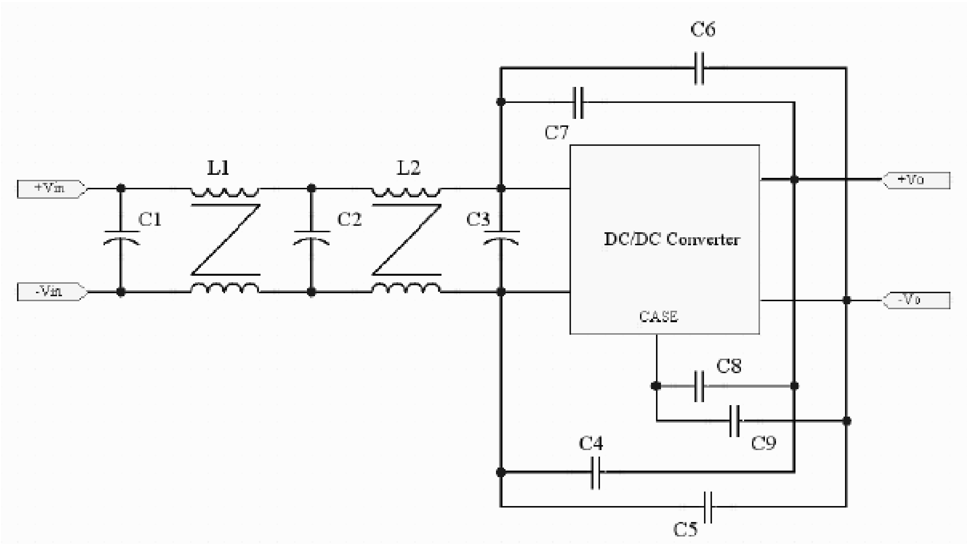
(1) EMI and conducted noise meet EN55022 Class A specifications:

Model No.	Class A												
	C1	C2	C3	CY1	CY2	CY3	CY4	CY5	CY6	CY7	CY8	L1	L2
HB24S3.3-60	220uF/100V	470uF/100V	NC	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB24S5-60	220uF/100V	470uF/100V	NC	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB24S12-29.2	220uF/100V	470uF/100V	NC	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
CHB24S24-14.6	220uF/100V	470uF/100V	NC	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB24S28-12.5	220uF/100V	470uF/100V	NC	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB24S48-7.3	220uF/100V	470uF/100V	NC	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB48S3.3-60	100uF/100V	220uF/100V	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB48S5-60	100uF/100V	220uF/100V	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB48S12-29.2	100uF/100V	220uF/100V	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB48S24-14.6	100uF/100V	220uF/100V	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB48S28-12.5	100uF/100V	220uF/100V	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short
HB48S48-7.3	100uF/100V	220uF/100V	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	NC	1000pF/2KV	NC	0.9mH	Short

Note: C1 NIPPON CHEMI-CON KY series aluminum capacitors

KMF series aluminum capacitors, 24SXX Models C2 NICHICON PS series aluminum capacitors, 48SXX Models C2 NIPPON CHEMI-CON KY series aluminum capacitors, CY3, CY4, CY5, CY7 are ceramic capacitors.

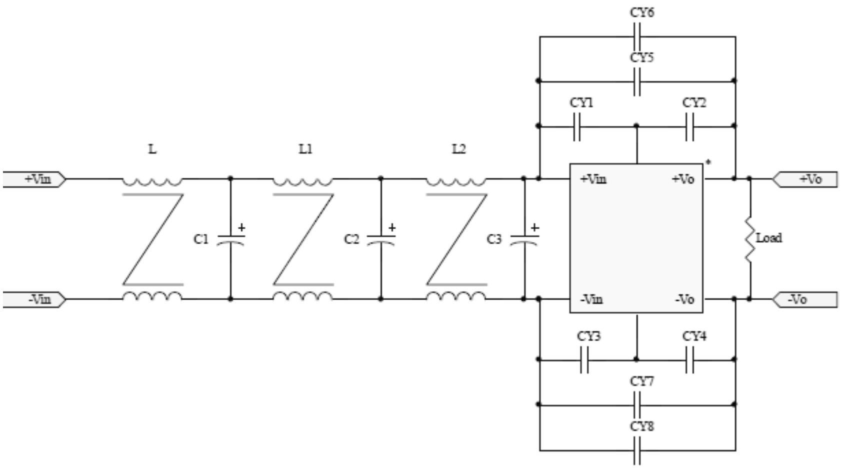
2) EMI and conducted noise meet EN55022 Class B:



Model No.	Class B										
	C1	C2	C3	C4	C5	C6	C7	C8	C9	L1	L2
HB24S12-29.2	470uF/100V	470uF/100V	470uF/100V	1000pF/2KV	2200pF/2KV	1000pF/2KV	2200pF/2KV	NC	NC	0.8mH	1.2mH
HB24S48-7.3	470uF/100V	470uF/100V	470uF/100V	1000pF/2KV	2200pF/2KV	1000pF/2KV	2200pF/2KV	1000pF/2KV	1000pF/2KV	0.8mH	1.0mH
HB48S12-29.2	470uF/100V	470uF/100V	470uF/100V	1000pF/2KV	2200pF/2KV	1000pF/2KV	2200pF/2KV	NC	NC	0.8mH	1.2mH

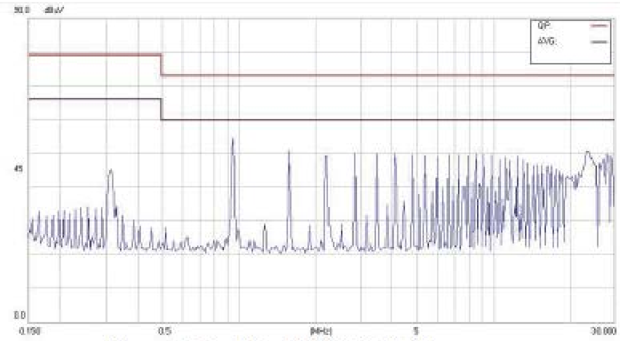
Note: The C1, C2, C3 NIPPON CHEMI-CON KMF series aluminum capacitors, C4, C5, C6, C7,C8, C9 are ceramic capacitors

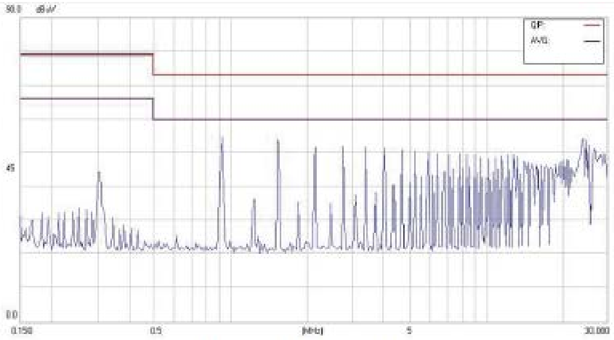
2) EMI and conducted noise meet EN55022 Class B:

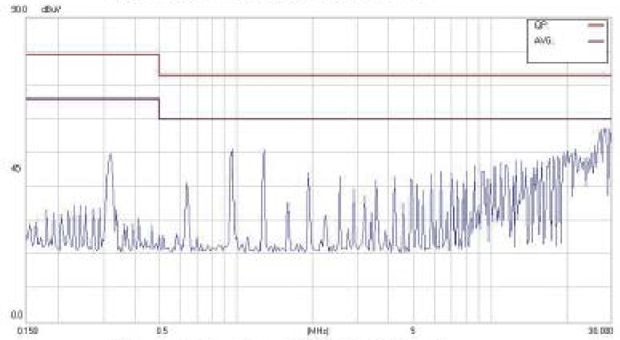


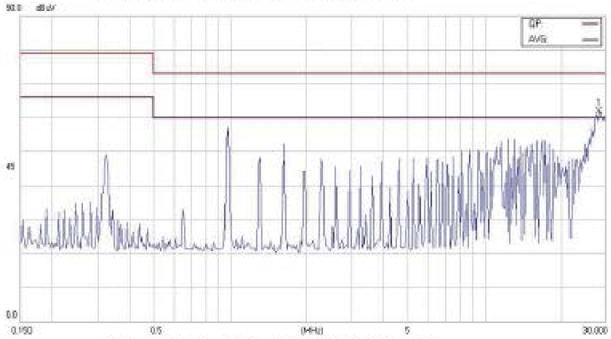
Model No.	Class B													
	C1	C2	C3	CY1	CY2	CY3	CY4	CY5	CY6	CY7	CY8	L	L1	L2
HB24S3.3-60	470uF/100V	470uF/100V	470uF/100V	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	Short	0.9mH	0.9mH
HB24S5-60	470uF/100V	470uF/100V	470uF/100V	NC	NC	NC	NC	1000pF/2KV	NC	1000pF/2KV	NC	Short	0.9mH	0.9mH
HB24S28-12.5	470uF/100V	470uF/100V	470uF/100V	NC	NC	NC	1000pF/2KV	2200pF/2KV	NC	2200pF/2KV	NC	Short	0.9mH	0.9mH
HB48S3.3-60	470uF/100V	470uF/100V	470uF/100V	NC	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	1000pF/2KV	Short	0.9mH	0.9mH
HB48S5-60	470uF/100V	470uF/100V	470uF/100V	NC	NC	NC	NC	1000pF/2KV	1000pF/2KV	1000pF/2KV	1000pF/2KV	Short	0.9mH	0.9mH

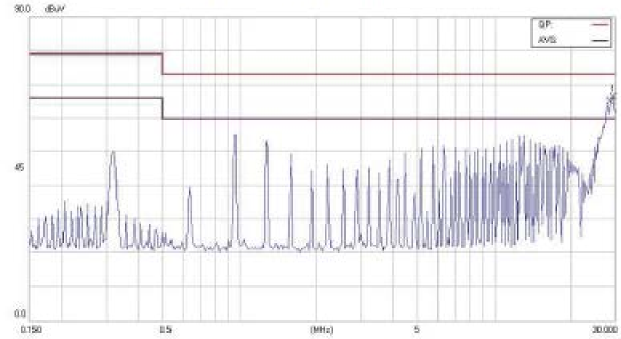
Note: The C1, C2, C3 NICHICON PS series aluminum capacitors, C4, C5, C6, C7 is ceramic capacitors.

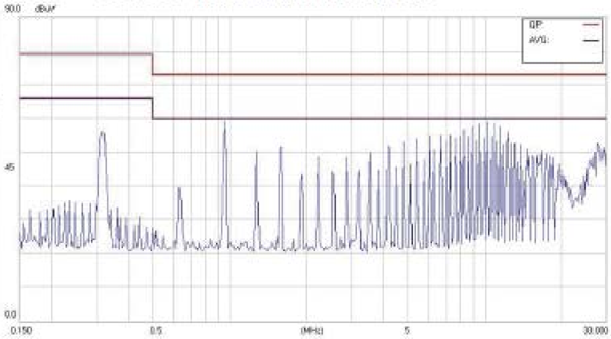

Class A Test for HB24S3.3-60

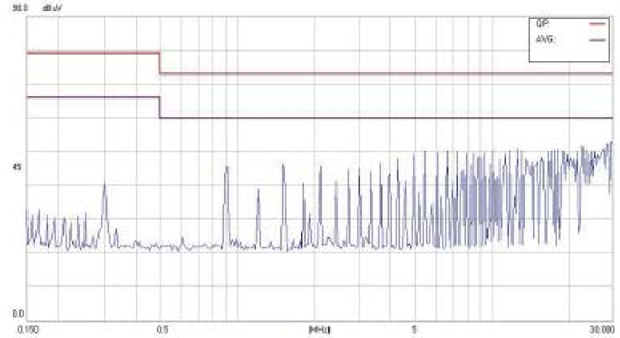

Class A Test for HB24S5-60


Class A Test for HB24S12-29.2


Class A Test for HB24S24-14.6


Class A Test for HB24S28-12.5


Class A Test for HB24S48-7.3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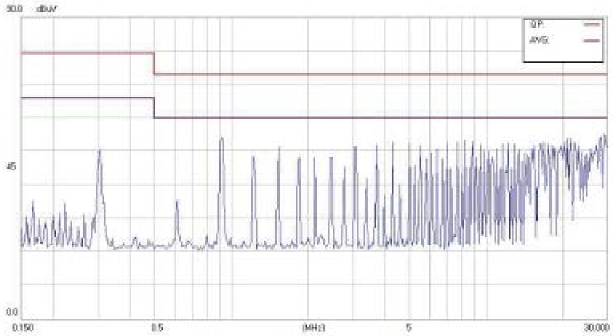
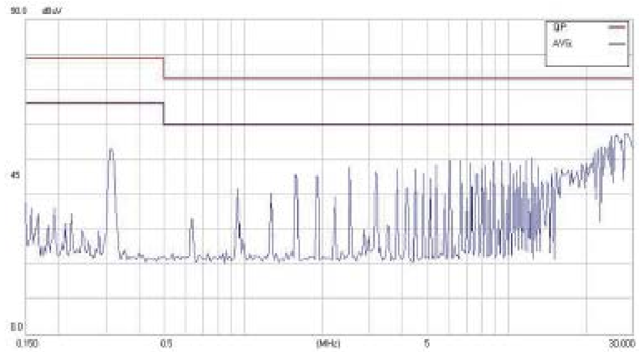
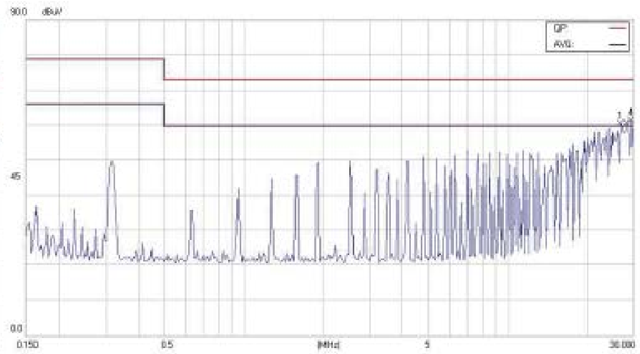
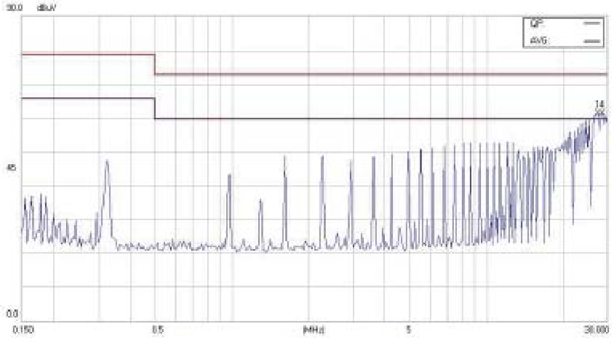
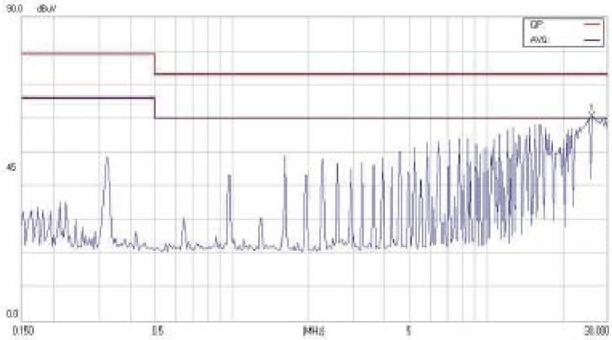

Class A Test for HB48S5-60


Class A Test for HB48S12-29.2

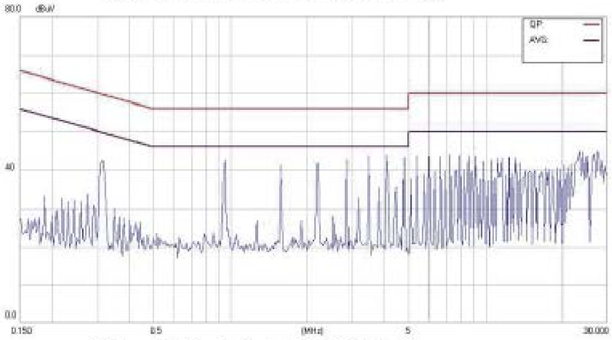

Class A Test for HB48S24-14.6



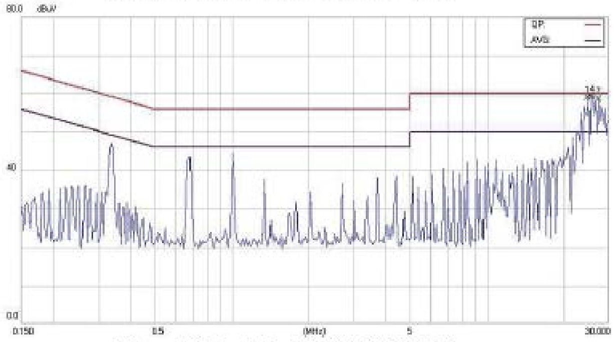
Class A Test for HB48S28-12.5



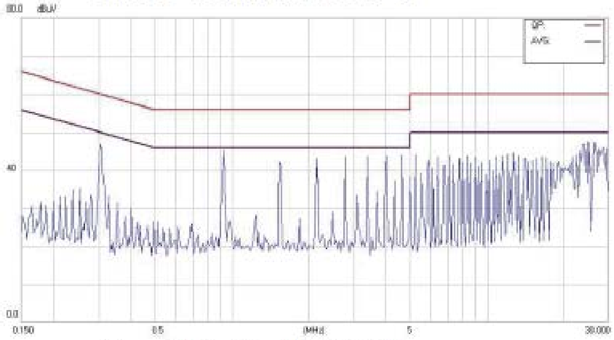
Class A Test for of HB48S48-7.3



Class B Test for HB24S3.3-60



Class B Test for HB24S12-29.2



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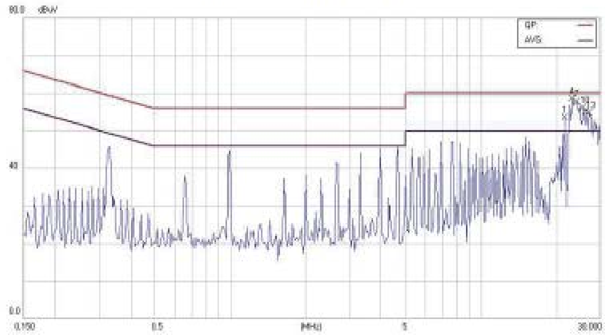
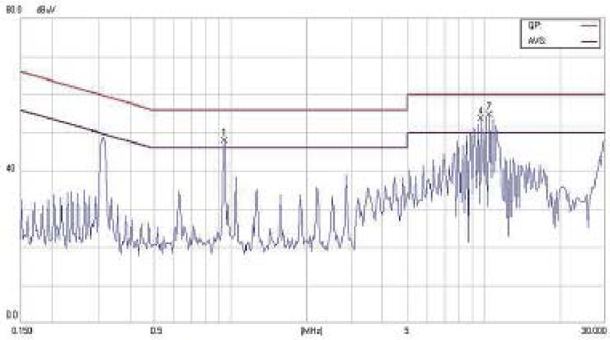
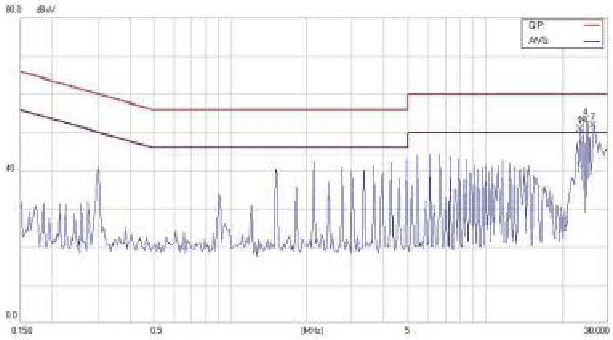


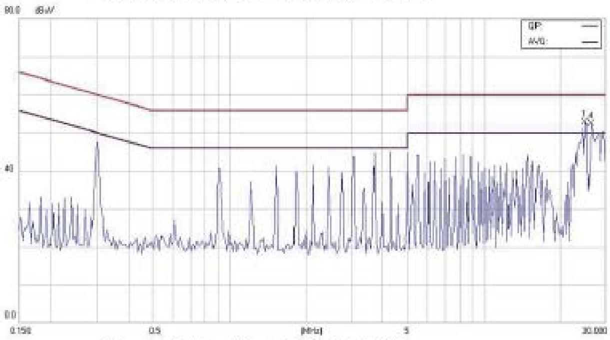
Class B Test for HB24S28-12.5



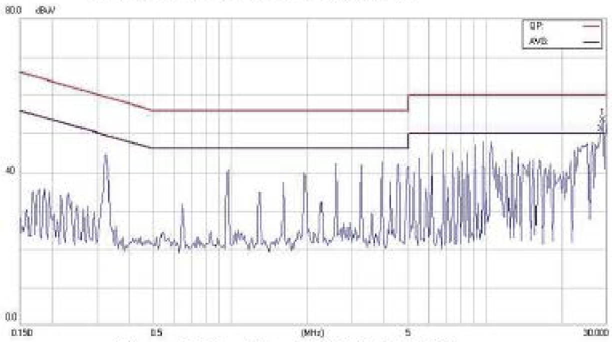
Class B Test for HB24S48-7.2



Class B Test for HB48S3.3-60



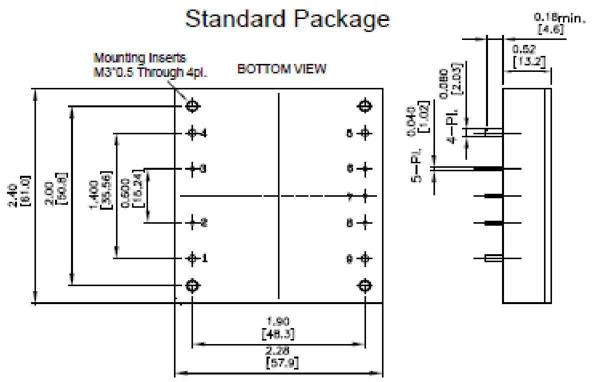
Class B Test for HB48S5-60



Class B Test for HB48S12-29.2

MECHANICAL SPECIFICATIONS

All Dimensions in Inches(mm)
Tolerances Inches: X.XX= ±0.02 , X.XXX= ±0.010
Millimeters: X.X= ±0.5 , X.XX=±0.25



Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.02 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

PIN CONNECTIONS

PIN CONNECTION	
PIN	**SINGLE**
1	+ V Input
2	ON/OFF
3	Case
4	- V Input
5	- V Output
6	- Sense
7	Trim
8	+ Sense
9	+ V Output

PART NUMBER ORDERING INFORMATION

Family, Form Factor Package	Nominal Input Voltage	Number of Outputs	Voltage Output		Current Output (A)	Options
HB	**24**	**S**	**12**	**–**	**29.2**	**N, H**

- Nominal Input Voltage: (18-36) 24 Volts; (36-75) 48 Volts
- Number of Outputs: S- Single
- Voltage Output: 3.3 Volts, 5 Volts, 12 Volts, 24Volts, 28 Volts, 48 Volts
- Current Output (A): 3.3 Volts - 60A, 5 Volts - 60A, 12 Volts – 29.2A, 24 Volts – 14.6A, 28 Volts – 12.5A, 48 Volts – 7.2A
- Options: None-Positive On/Off control; N - Negative On/Off control; H - Heatsink

1. For proper part ordering, enter option suffixes in order listed in table above