HBR Series of Railway Half-Brick

Up to 100 Watts DC-DC Converter

PRODUCT OVERVIEW

The HBR series offers 100 watts of output power in standard half brick package. This series features high efficiency up to 89%, high power density and 3000 Volts RMS of DC isolation. These converters are reliable and compact, with a single output voltage. The HBR series can deliver up to 8.3A output current and provide precise regulated output voltage over a wide (3:1) input range of 66 -160 volts. These modules operate over a wide case temperature range of –40°C to +100°C. These converters offer Input Under Voltage Lockout Protection (UVLO). The main features of these converters include remote On/Off, remote sense, output voltage adjustment, over voltage, over current and over temperature protection.

APPLICATIONS:

- Railway Systems
- Distributed Power Architectures
- Telecommunication and Servers
- Mobile Equipment
- Military and industrial applications

FEATURES

- Industry standard Half Brick Package
- 100 Watts of output power
- Regulated Outputs, Fixed Switching Frequency
- Up to 89 % Efficiency
- Fully Isolated to 3000 Volts
- Over Current, Voltage and Temperature Protection
- 3:1 input range (66 -160 Volts)
- Input Under Voltage Lockout Protection (UVLO)
- Extended temperature range of -40°C to +100°C
- Remote On/Off logic control
- Continuous Short Circuit Protection
- Designed to meet CE 2004/108/EC
- Safety designed to meet UL60950-1 and EN50155

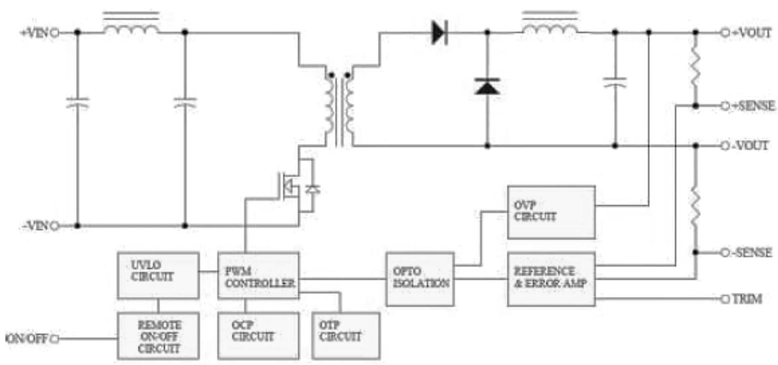
AVAILABLE OPTIONS

- Customizable Input/ Output voltages
- Heatsink, customizable packaging
- UL/CSA60950-1, EN50155, LVD

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

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	OPTIONS
HBR113S12-8.3	66-160 VDC	12VDC	8.3 A	86	± 0.2 %	H
HBR113S15-6.7	66-160 VDC	15 VDC	6.7 A	87	± 0.2 %	H
HBR113S24-4.17	66-160 VDC	24 VDC	4.17 A	87	± 0.2 %	H
HBR113S48-2.08	66-160 VDC	48 VDC	2.08 A	89	± 0.2 %	H

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	All	-0.3		160	Volts
Transient	100 ms, DC	All			180	Volts
Operating Case Temperature		All	-40		+100	°C
Storage Temperature		All	-55		+125	°C
Isolation Voltage	1 minute; input/output,	All	3000			Vrms
	1 minute; input/case, DC	All	1500			
	1 minute; output/case, DC	All	500			

Stresses above the absolute maximum ratings can cause permanent damage to the device. HBR railway family under voltage lock out will power up at 62 Vin and power down at 56 Vin

FUNCTIONAL SPECIFICATIONS

The following specifications apply over the operating temperature range, under the following conditions TA = +25°C unless otherwise specified

INPUT CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Operating Input Voltage	**DC**	All	66	110	160	Volts
Input Under-voltage Lockout						
Turn-On Voltage Threshold	DC	All	60	62	64	Volts
Turn-Off Voltage Threshold	DC	All	54	56	58	Volts
Lockout Hysteresis Voltage	DC	All		6		Volts
Maximum Input Current	100% Load, V_{in}= 43V	All		1780		mA
No-Load Input Current	V_{in}=Nominal	All		3		mA
Inrush Current (I^2t)		All			0.1	A^2s
Input Reflected Ripple Current	P-P thru 12μH inductor, 5Hz to 20MHz	All		50		mA

OUTPUT CHARACTERISTICS

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Tc=25°C Vin=Nominal, I_o=I_{o_min}	Vo=12V	11.82	12	12.18	Volts
		Vo=15V	14.775	15	15.225	
		Vo=24V	23.64	24	24.36	
		Vo=48V	47.28	48	48.72	
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 CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Output Voltage Ripple and Noise (5Hz to 20MHz bandwidth)						
Peak-to-Peak	Full load, 10μF tantalum and 1.0uF ceramic capacitors. Note for Vo = 48 V, use 47μF tantalum capacitor and 1.0uF ceramic capacitors	Vo=12V Vo=15V Vo=24V Vo=48V			150 150 240 480	mV
RMS	Full load, 10μF solid tantalum and 1.0μF ceramic capacitors. Note for Vo = 48 V, use 47μF tantalum capacitor and 1.0uF ceramic capacitors	Vo=12V Vo= 15V Vo=24V Vo=48V			60 60 100 200	mV
Operating Output Current Range		Vo=12V Vo=15V Vo=24V Vo=48V	0 0 0 0		8.3 6.7 4.17 2.08	A
Output DC Current Limit Inception	Vo = 90% Nominal Output Voltage	All	110	125	150	%
Maximum Output Capacitance	Full load (resistive)	Vo=12V Vo=15V Vo=24V Vo=48V	0 0 0 0		8300 4170 4170 1500	μF

DYNAMIC CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	75% to 100% of I_{o_max}	All			±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		10		ms
Turn-On Delay Time, From Input	$V_{in\ min}$ to 10%V_{o_set}	All		25		ms
Output Voltage Rise Time	10%V_{o_set} to 90%V_{o_set}	All		15		ms

EFFICIENCY

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
Full Load	V_{in}=Nominal V_{in}, Tc=25°C	Vo=12V Vo=15V Vo=24V Vo=48V		86.5 87.5 87.5 89		%

ISOLATION CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Isolation Voltage	1minute; input/output,	All			3000	Volts
	1 minute; input/case, DC	All			1500	
	1 minute; output/case	All			500	
Isolation Resistance		All	1000			MΩ
Isolation Capacitance		All		500		pF

FEATURE CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Switching Frequency		All		250		KHz
On/Off Control, Positive Remote On/Off logic						
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All			1.8	V
Logic High (Module On)	$V_{on/off}$ at $I_{on/off}$=0.0uA	All	Open Circuit			V
On/Off Current (for both remote on/off logic)	$I_{on/off}$ at $V_{on/off}$=0.0V	All		0.3	1	mA
Leakage Current (for both remote on/off logic)	Logic High, $V_{on/off}$=15V	All			30	μA
Off Converter Input Current	Shutdown input idle current	All		2	5	mA
Output Voltage Trim Range	P_{out}=max rated power	All	-10		+10	%
Output Over Voltage Protection		All	115	125	140	%
Over-Temperature Shutdown		All		105		°C

GENERAL SPECIFICATIONS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
MTBF	I_o=100% of $I_{o\ max}$; T_a=25°C per MIL-HDBK-217F	All		830		K hours
Weight		All		95		grams
Safety	UL60950-1, LVD					
EMC (see Item 7.2)	EN50121-3-2 (with External Filter) EN50155					
EMI	EN55011 Class A					
ESD	EN61000-4-2 Air ±8000V Perf. Criteria A					
	EN61000-4-2 Contact ±6KV Perf. Criteria A					
Radiated Immunity	EN61000-4-3 20V/m Perf. Criteria A					
Fast Transient	EN61000-4-4 ±2KV Perf. Criteria A					
Surge	EN61000-4-5 ±1KV Perf. Criteria B					
Conducted Immunity	EN61000-4-6 10Vr.m.s Perf. Criteria A					
Shock/Vibration	Meets EN61373, EN50155					
Humidity	95% RH max. Non Condensing					
Environmental	Meets EN60068-2-1, EN50155					

Operating Temperature Range

The HBR series of converters is rated to operate over 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 half brick models is influenced by usual factors, such as:

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

Output Voltage Adjustment

The output voltage for the on HBR series outputs of 3.3, 5 and 24 Volts models is adjustable within the range of +10% to –10%. For the 12, 15, 24 and 48 Volts model, see input and 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 hiccup mode of operation, whereby it shuts down and automatically attempts to restart. While the fault condition exists, the module will remain in this hiccup 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 output overvoltage protection consists of an internal circuit that limits the output voltage. If more accurate output over voltage protection is required, then an external circuit can be used via the remote on/off pin.

Remote On/Off

The 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. 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, leave the On/Off pin open.

UVLO (Under Voltage Lock Out)

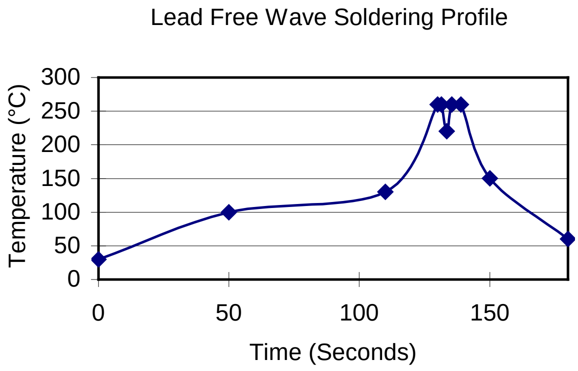
Input under voltage lockout is standard with this converter. At input voltages below the input under voltage lockout limit, the module operation is disabled.

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.

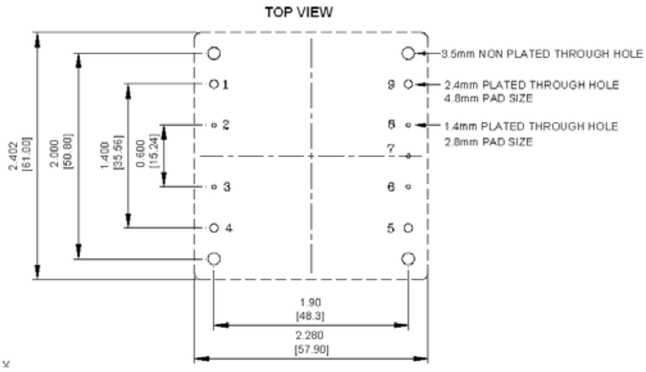
Recommended Layout, PCB Footprint and Soldering Information

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.



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 rate during cooling: -10.0 °C/Sec (From 260°C to 150°C)



Convection Requirements for Cooling

To predict the approximate cooling needed for the half brick module, refer to the power de-rating curves in the next section 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).

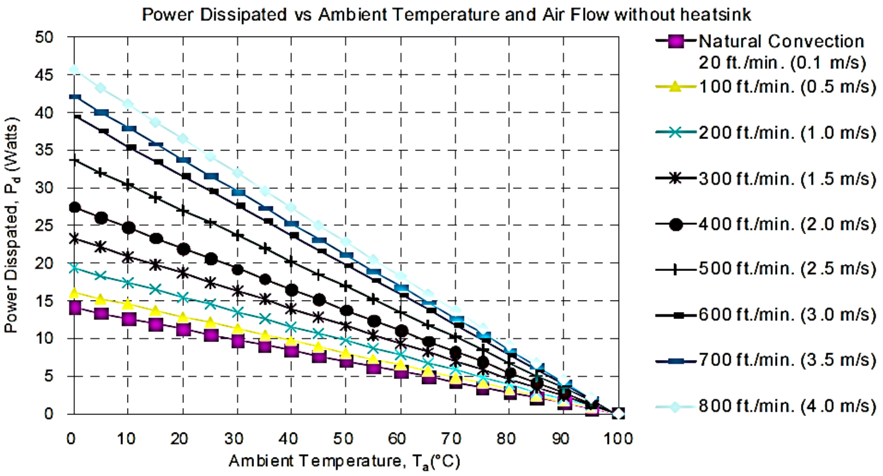
Thermal Considerations

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 test data is presented in the next section. 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 HBR series is -40°C to +100°C. When operating the HBR series, proper de-rating or cooling is needed. The maximum case temperature under any operating condition should not exceed + 100°C.

The following curve is the de-rating curve of HBR series without heat sink.



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

Example (without heat sink):

What is the minimum airflow necessary for a HBR113S12-8.3 operating at nominal line voltage, an output current of 8.3A, and a maximum ambient temperature of +40°C?

Solution:
Given:

Vin=110Vdc, Vo=12Vdc, Io=8.3A

Determine Power dissipation (Pd):

Pd =Pi-Po=Po(1-η)/η

Pd =12V×8.3A×(1-0.85)/0.85=17.58 Watts

Determine airflow:

Given: Pd =17.58W and Ta=+40°C

Check Power De-rating curve:

Minimum airflow= 500 ft./min.

Verify:

Maximum temperature rise is

ΔT = Pd × Rca=17.58W×2.96 =52.02°C.

Maximum case temperature is

Tc=Ta+ΔT=92.02°C <100°C.

Where:

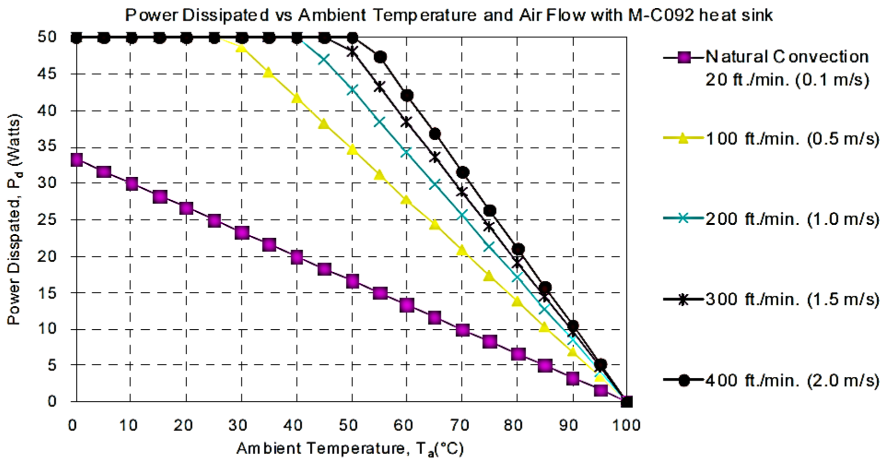
R_{ca} is thermal resistance from case to ambient environment.

Ta is ambient temperature

T_c is case temperature

AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	3 ℃/W
100 ft./min. (0.5m/s)	1.44 ℃/W
200 ft./min. (1.0m/s)	1.17 ℃/W
300 ft./min. (1.5m/s)	1.04 ℃/W
400 ft./min. (2.0m/s)	0.95 ℃/W

The following curve is the de-rating curve of HBR series with heat sink



Example (with heat sink M-C092):
What is the minimum airflow necessary for a HBR113S12-8.3 operating at nominal line voltage, an output current of 8.3A, and a maximum ambient temperature of 40°C?

Solution:
Given:

Vin = 110Vdc, Vo=24Vdc, Io=4.17A

Determine Power dissipation (Pd):

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

$Pd = 24V \times 4.17A \times (1-0.87)/0.87 = 14.95$ Watts

Determine airflow:

Given: Pd =14.95W and Ta=40°C

Check Power De-rating curve:

Pd<20W, Natural Convection

Verify:

Maximum temperature rise is

$\Delta T = Pd \times Rca = 14.95W \times 3 = 44.85°C$.

Maximum case temperature is

$Tc = Ta + \Delta T = 84.85°C < 100°C$.

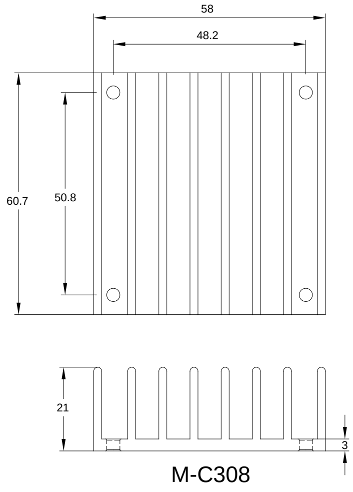
Where:

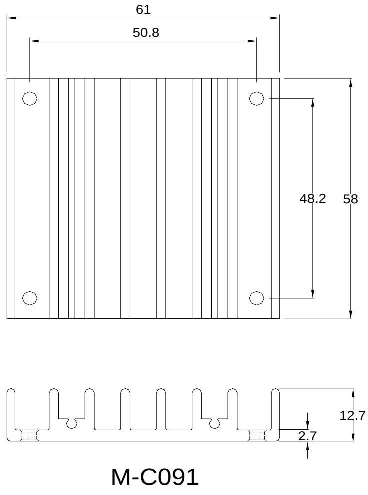
R_{ca} is thermal resistance from case to ambient environment.

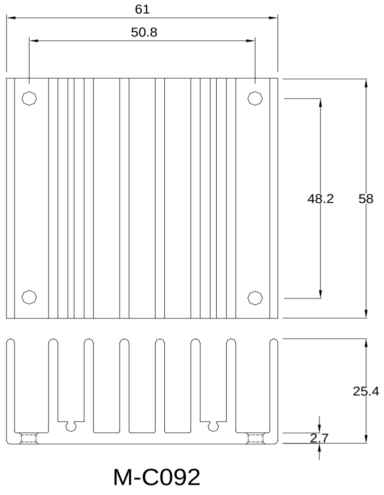
Ta is ambient temperature

Tc is case temperature

Half Brick Heat Sinks:







M-C308 (G6620400201)
Longitudinal Heat Sink

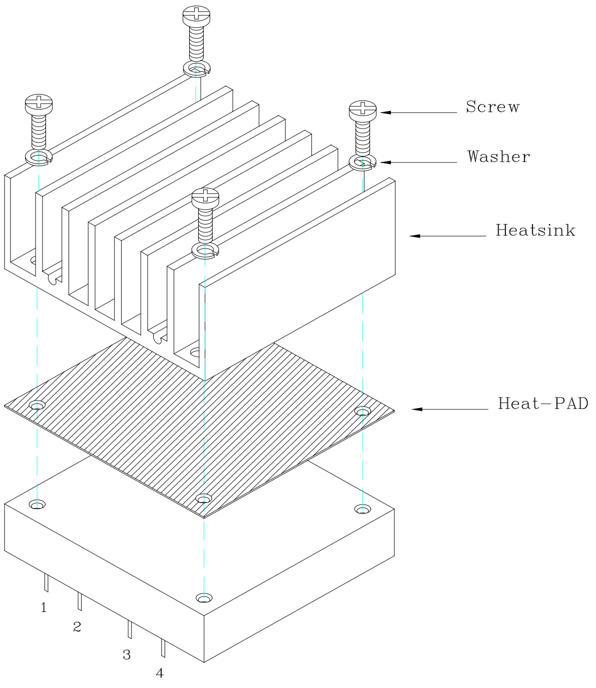
Rca:
3.90°C/W (typ.), natural convection
1.74°C/W (typ.), at 100LFM
1.33°C/W (typ.), at 200LFM
1.12°C/W (typ.), at 300LFM
0.97°C/W (typ.), at 400LFM

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

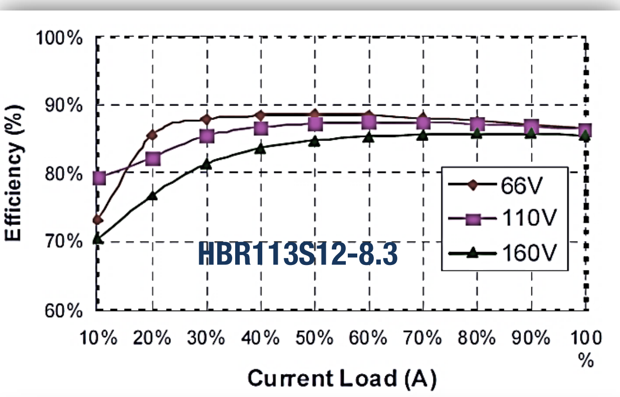
M-C092 (G6610130402)
Transverse Heat Sink

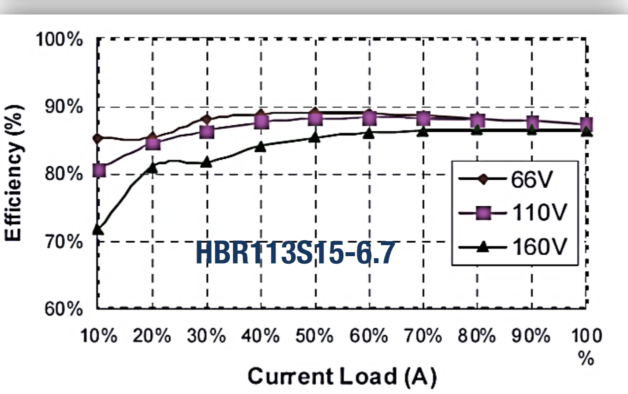
Rca:
3.00°C/W (typ.), natural convection
1.44°C/W (typ.), at 100LFM
1.17°C/W (typ.), at 200LFM
1.04°C/W (typ.), at 300LFM
0.95°C/W (typ.), at 400LFM

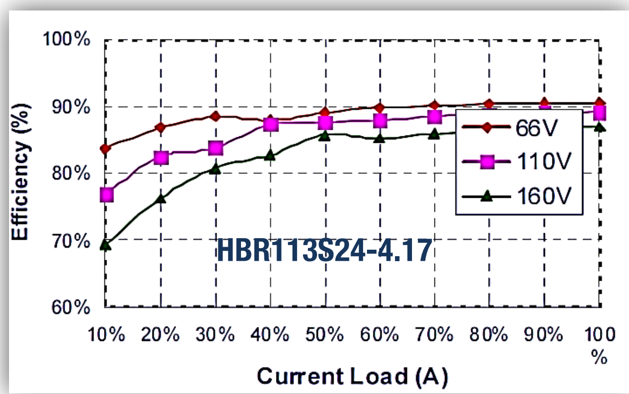


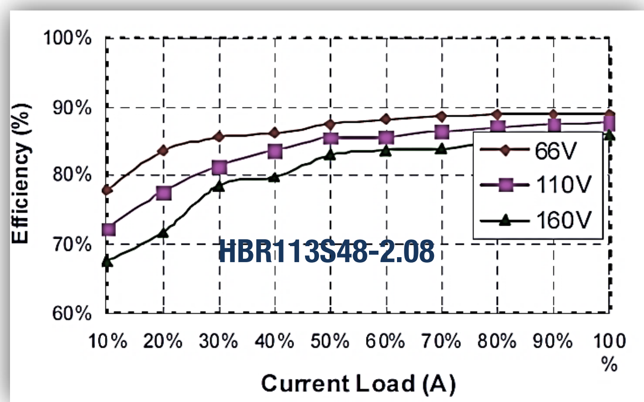
THERMAL PAD: SZ 56.9*60*0.25 mm (G6135041091)
SCREW: SMP+SW M3*8L
(G75A1300322)

EFFICIENCY vs. LOAD









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

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:

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

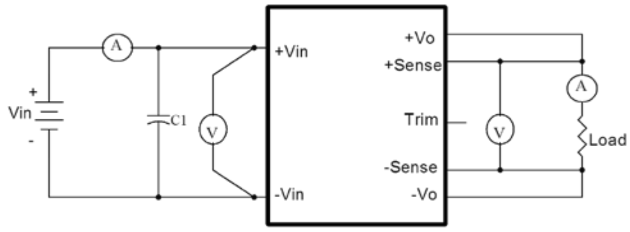
Where:

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:

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

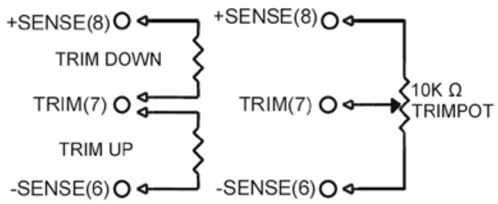
Where: V_{HL} is the output voltage of maximum input voltage at full load. V_{LL} is the output voltage of minimum input voltage at full load.



HBR Series Test Setup

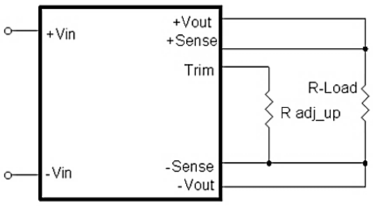
Output Voltage Adjustment

Output may be externally trimmed (±10%) with a fixed resistor or an external trim-pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document

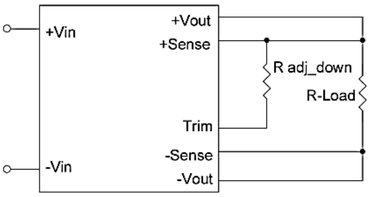


Output voltage trim circuit configuration

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 or between trim pin and +Vo for trim-down. The output voltage trim range is ±10%. This is shown in the figure below



Output voltage trim up circuit



Output voltage trim down circuit

The recommend Resistor Values:

V_{out} (V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	VR (KΩ)	Vf (KΩ)
12	9.1	51	5.1	2.5	0.46
15	9.1	51	5.1	2.5	0.46
24	20	130	6.2	2.5	0.46
48	40.2	270	5.1	2.5	0.46

For HBR series, R trim_up is defined as:

$$R_{trim\_up} = \left(\frac{R_1\left(V_r - V_f\left(\frac{R_2}{R_2 + R_3}\right)\right)}{Vo - V_{o\_nom}}\right) - \frac{R_2 R_3}{R_2 + R_3} \ (\text{K}\Omega)$$

Where:

1- R trim_up is the external resistor in KΩ.
2- V o_nom is the nominal output voltage.
3- Vo is the desired output voltage.
4- R1, R2, R3 and Vr are internal components.

For example: to trim-up the output voltage of the HBR113S12-8.3 module by 5% to 12.6V, R trim_up is calculated as follows:
Vo – V o_nom = 12.6 – 12 = 0.6V
R1 = 9.1 KΩ, R2 = 51 KΩ, R3 = 5.1KΩ, Vr= 2.5 V , Vf=0.46 V

$$R_{trim\_up} = \frac{18.944}{0.6} - 4.636 = 26.94 \ (\text{K}\Omega)$$

On the other hand, R trim_down is defined as:

$$R_{trim\_down} = \frac{R_1 \times (V_o - V_r)}{V_{o\_nom} - V_o} - R_2 \ (\text{K}\Omega)$$

Where:

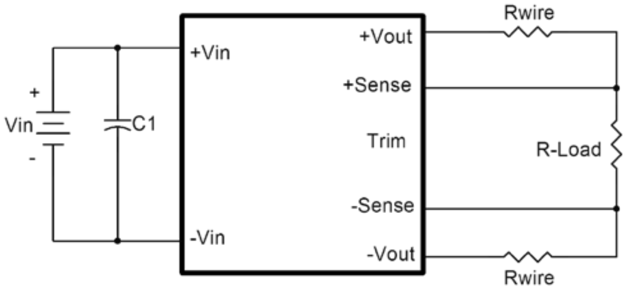
1- R trim_down is the external resistor in KΩ.
2- V o_nom is the nominal output voltage
3- Vo is the desired output voltage.
4- R1, R2, R3 and Vr are internal components.

For example: to trim-down the output voltage of the HBR113S12-8.3 module by 5% to 11.4V, R trim_down is calculated as follows:
Vo_nom – V o = 12 – 11.4 = 0.6 V
R1 = 9.1 KΩ, R2 = 51 KΩ, Vr = 2.5 V

$$R_{trim\_down} = \frac{9.1 \times (11.4 - 2.5)}{0.6} - 51 = 83.98 \ (\text{K}\Omega)$$

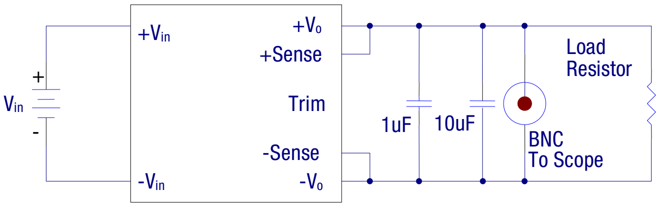
Output Remote Sensing

The HBR SERIES converter 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 HBR 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.

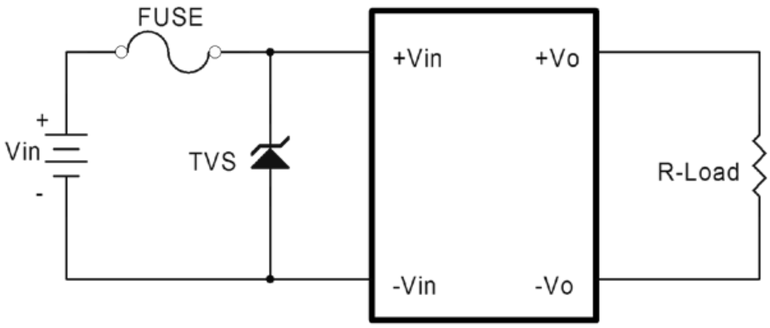
Output Capacitance

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. For absolute maximum value of HBR series' output capacitance, please refer to page 3 Maximum Output Capacitance. For values larger than this, please contact your local DATEL's representative.

SAFETY and EMC

Input Fusing and Safety Considerations

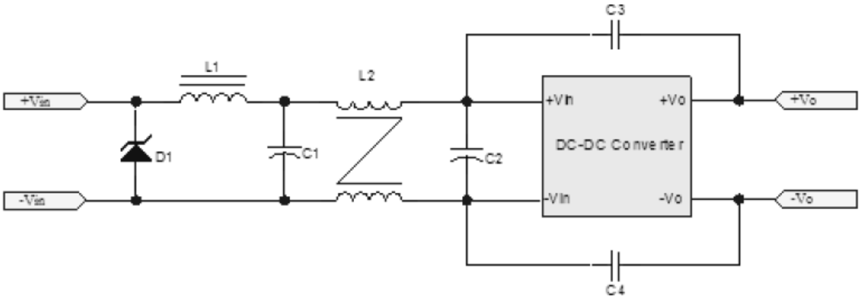
The HBR series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 4A time delay fuse. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage as shown below:



EMC Considerations

EMC Test standard: EN50121-3-2 (EN55011 Class A Conducted & Radiated Emission)

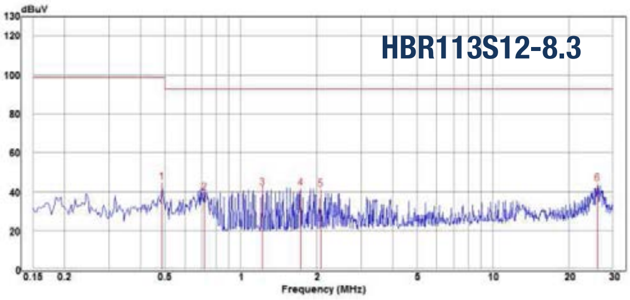
Test Condition: Input Voltage: Nominal, Output Load: Full Load

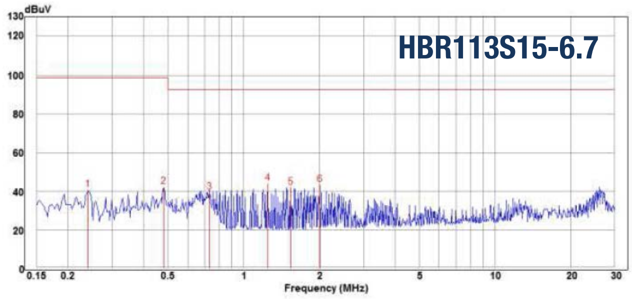


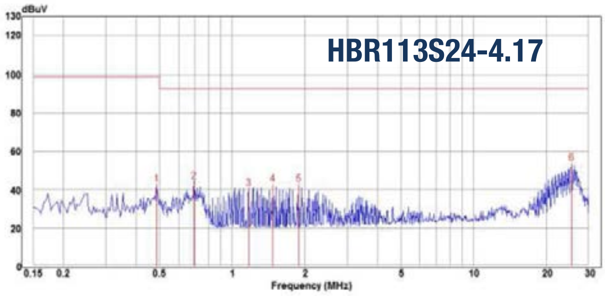
Model Number	C1	C2	C3	C4	L1	L2	D1
HBR113S12-8.3	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH	1.5KE180A Littelfuse
HBR113S15-6.7	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH	1.5KE180A Littelfuse
HBR113S24-4.17	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH	1.5KE180A Littelfuse
HBR113S48-2.08	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH	1.5KE180A Littelfuse

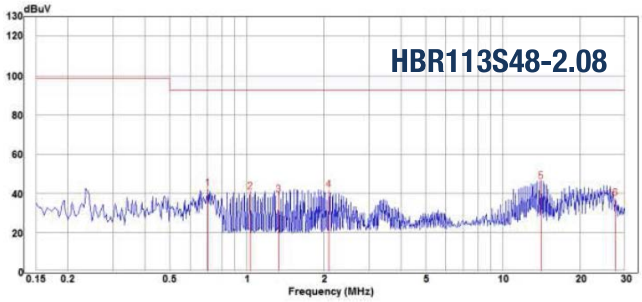
Note: C1, C2 Aluminum Capacitors and C3, C4 Ceramic Capacitor

EMI and conducted noise meet EN55011 Class A

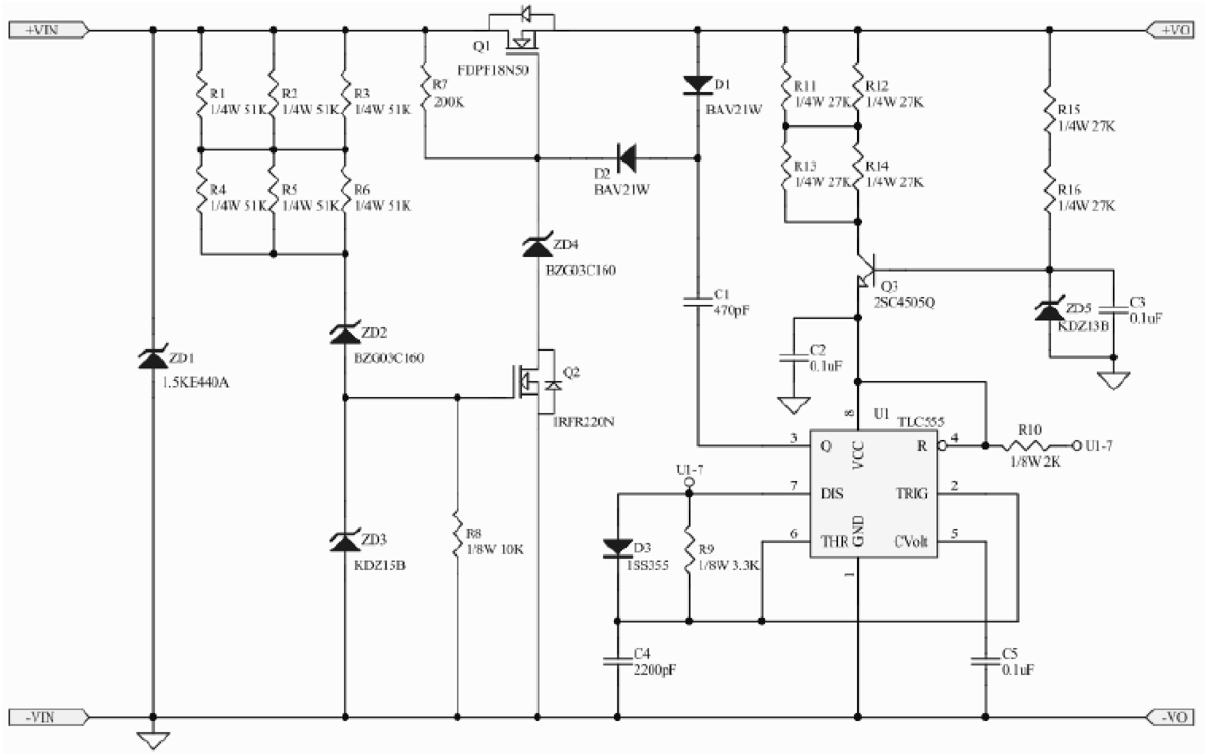






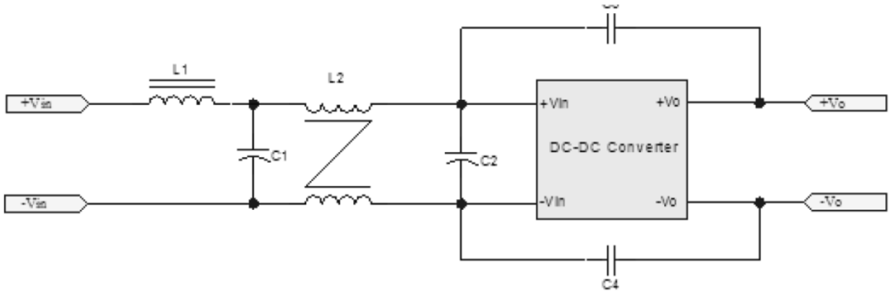


Suggested Configuration for RIA12 Surge Test



Suggested Circuits for Conducted EMI CLASS B

(1) EMI and conducted Emission meet EN55022 Class B:
Test Condition: Input Voltage: Nominal, Output Load: Full Load



Model Number	C1	C2	C3	C4	L1	L2
HBR113S12-8.3	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH
HBR113S15-6.7	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH
HBR113S24-4.17	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH
HBR113S48-2.08	220µF/200V YXF	220µF/200V YXF	2200 pF	2200 pF	5 µH	0.5mH

Note: C1, C2 Aluminum Capacitors and C3, C4 Ceramic Capacitors

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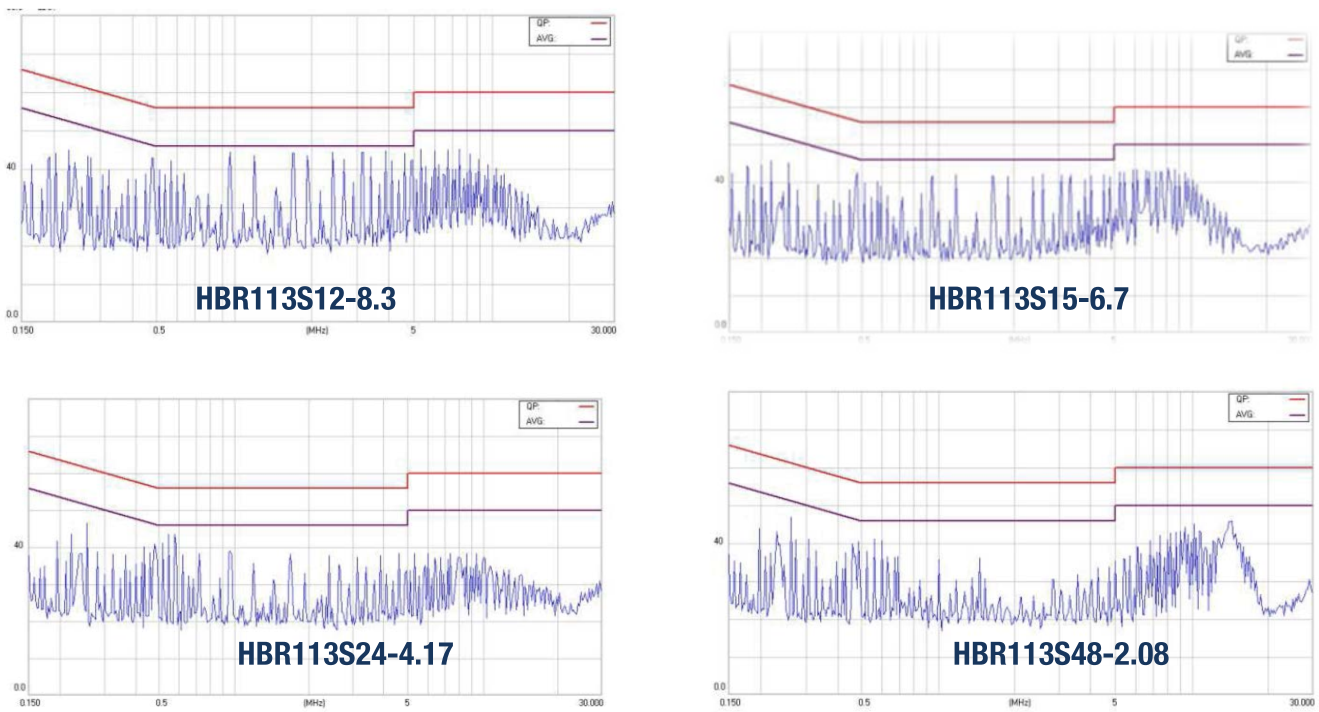
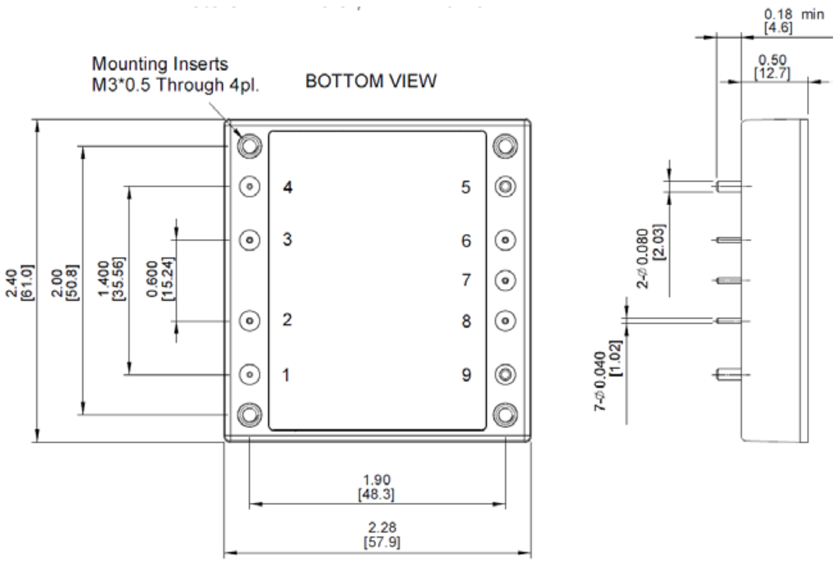
EMI and conducted noise test EN55022 Class B



MECHANICAL SPECIFICATIONS

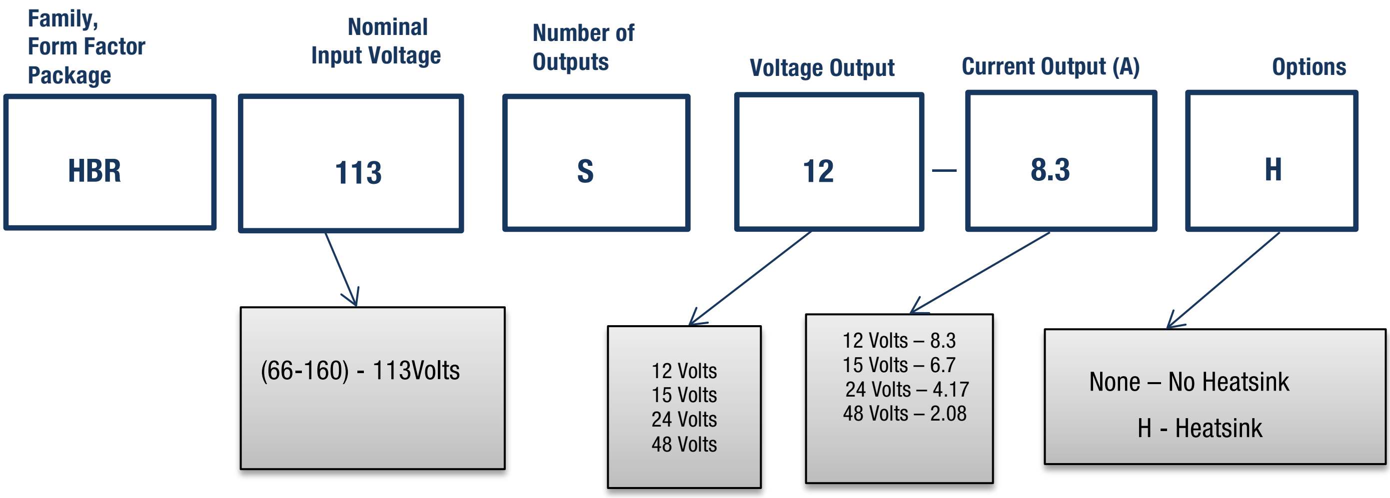


Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.02 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

PIN CONNECTIONS

PIN CONNECTION	
PIN	**SINGLE**
1	+ V Input
2	On/Off
3	No Connection
4	-V Input
5	- V Output
6	-Sense
7	Trim
8	+ Sense
9	+ V Output

PART NUMBER ORDERING INFORMATION



Note: For proper part ordering, enter option suffixes in order listed in table above