HB300 Series of Half-Brick

Wide Input Range 180 to 425 Volts
Up to 150 Watts DC-DC Converter

PRODUCT OVERVIEW

This HB300 series offers 300 watts of output power in standard half brick package. This series features high efficiency up to 90%, high power density and 3000 Volts of AC isolation. These converters are reliable and compact, with a single output voltage. This HB300 series can deliver up to 60A of output current and provide precise regulated output voltage over a wide input range of 180 to 425 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.

FEATURES

- Industry standard Half Brick Package
- 300 Watts of output power
- Regulated Outputs, Fixed Switching Frequency
- Up to 90 % Efficiency
- Fully Isolated to 3000 AC Volts
- Over Current, Voltage and Temperature Protection
- Wide Input range (180 - 425 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 2014/30/EU
- Safety designed to meet UL60950-1

APPLICATIONS:

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

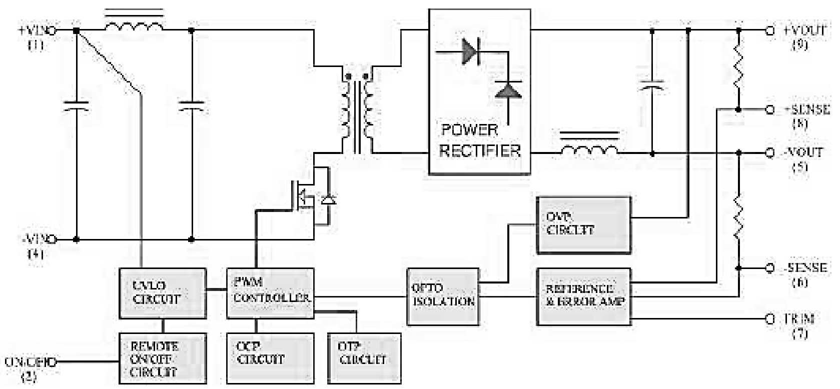
AVAILABLE OPTIONS

- Customizable Input/ Output voltages
- Heatsink, customizable packaging
- UL/ICE60950-1

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
HB300S5-60	180-425 VDC	5 VDC	60 A	89	± 0.2 %	N, M
HB300S12-25	180-425 VDC	12 VDC	25 A	88	± 0.2 %	N, M
HB300S24-12.5	180-425 VDC	24 VDC	12.5 A	90	± 0.2 %	N, M
HB300S28-10.7	180-425 VDC	28 VDC	10.7 A	90	± 0.2 %	N, M
HB300113S48-6.25	180-425 VDC	48 VDC	6.25 A	90	± 0.2 %	N, M

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	All	-0.3		425	Volts
Transient	100 ms, DC	All			500	Volts
Operating Case Temperature		All	-40		+100	°C
Storage Temperature		All	-55		+125	°C
Isolation Voltage	1 minute; input/output, AC	All	3000			Vac
	1 minute; input/case, AC	All	2250			
	1 minute; output/case, AC	All	1500			

Note: Stresses above the absolute maximum ratings can cause permanent damage to the device.

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	180	300	425	Volts
Input Under-voltage Lockout						
Turn-On Voltage Threshold	DC	All	165	170	175	Volts
Turn-Off Voltage Threshold	DC	All	155	160	165	Volts
Lockout Hysteresis Voltage	DC	All		10		Volts
Maximum Input Current	100% Load, V_{in}= 43V	All		1910		mA
No-Load Input Current	V_{in}=Nominal	Vo = 5 V Vo = 12 V Vo =24 V Vo = 28V Vo = 48V		10 10 10 10 10		mA
Inrush Current (I^2t)		All			0.1	A^2s
Input Filter	Pi Filter					
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=5V Vo=12V Vo=24V Vo=28V Vo=48V	4.95 11.88 23.76 27.72 47.52	5 12 24 28 48	5.05 12.12 24.24 28.28 48.48	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			±0.02	%/°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.	Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V			120 150 240 280 480	mV
RMS	Full load, 10μF solid tantalum and 1.0μF ceramic capacitors.	Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V			60 60 120 150 200	mV
Operating Output Current Range		Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V	0 0 0 0 0		60 25 12.5 10.7 6.25	A
Output DC Current Limit Inception	Vo = 90% Nominal Output Voltage	All	115	125	140	%
Maximum Output Capacitance	Full load (resistive)	Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V	0 0 0 0 0		10000 10000 6000 6000 3000	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			250	μs
Turn-On Delay and Rise Time						
Turn-On Delay Time, From On/Off control	$V_{on/off}$ to 10%V_{o_set}	All		50		ms
Turn-On Delay Time, From Input	$V_{in\ min}$ to 10%V_{o_set}	All		300		ms
Output Voltage Rise Time	10%V_{o_set} to 90%V_{o_set}	All		10		ms

EFFICIENCY

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
Full Load	Vin = 300V	Vo=5V Vo=12V Vo=24V Vo=28V Vo=48V		89 88 90 90 90		%

ISOLATION CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Isolation Voltage	1minute; input/output, AC	All			3000	Vac
	1 minute; input/case, AC	All			2500	Vac
	1 minute; output/case AC	All			500	Vac
Isolation Resistance	input/output	All	100			MΩ
Isolation Capacitance	input/output	All		10000		pF

FEATURE CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Switching Frequency		All	270	300	330	KHz
On/Off Control, Positive Remote On/Off logic						
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All			1.2	V
Logic High (Module On)	$V_{on/off}$ at $I_{on/off}$=0.0uA	All	3.5 or Open Circuit		75	V
On/Off Control, Negative Remote On/Off logic						
Logic Low (Module On)	Von/off at Ion/off=1.0mA	All			1.2	V
Logic High (Module Off)	Von/off at Ion/off=0.0uA	All	3.5 or Open Circuit		75	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		3	5	mA
Output Voltage Trim Range	P_{out}=max rated power	All	-20		+10	%
Output Over Voltage Protection		All	115	125	140	%
Over-Temperature Shutdown		All		105		°C
Over-Temperature Recovery		All		95		°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	Vo=5V Vo=12 Others		470 590 760		K hours
Weight		All		90		grams
Potting Materials	UL 94V-0					
Case Materials	Plastic, DAP					
Baseplate Materials	Aluminum					
Pin Materials	Base Copper, Platting: Nickel with Matte Tin					
Altitude	2000m Operating Altitude and 12000m Transport Altitude					
Humidity	95% RH max. Non Condensing					
Safety	Meet UL60950-1					
EMC (see Item 7.2)	Meet EN50121-3-2 (with External Filter) EN50155					
EMI	Meet EN55032/EN55022 Class A (External Filter is required)					
ESD	Meet EN61000-4-2 Air ±8000V Perf. Criteria A					
	Meet EN61000-4-2 Contact ±6KV Perf. Criteria A					
Radiated Immunity	Meet EN61000-4-3 20V/m Perf. Criteria A					
Fast Transient	Meet EN61000-4-4 ±2KV Perf. Criteria A (External capacitor is required)					
Surge	Meet EN61000-4-5 ±2KV Perf. Criteria A (External capacitor is required)					
Conducted Immunity	Meet EN61000-4-6 10Vr.m.s Perf. Criteria A					
Thermal Schock	MIL-STD-810F					
Shock/Vibration	MIL-STD-810F/EN61373					
Humidity	95% RH max. Non Condensing					
Environmental	Meet EN60068-2-1, EN60068-2-2, EN60068-2-30, EN50155,					

Operating Temperature Range

This HB300 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:

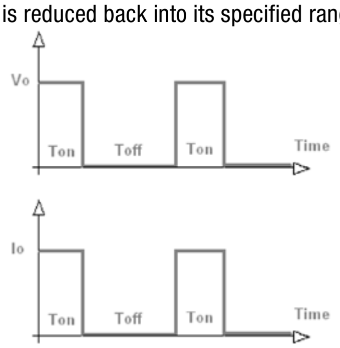
- Input voltage range
- Output load current
- Forced air or natural convection
- Heat Sink

Output Voltage Adjustment

The output voltage for the on HB300 series outputs of 5, 12 and 24 Volts models is adjustable within the range of +10% to –20%.

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.

Note: Please note that device inside the power supply might fail when voltage more than rate output voltage is applied to output pin. This could happen when the customer tests the over voltage protection of unit.

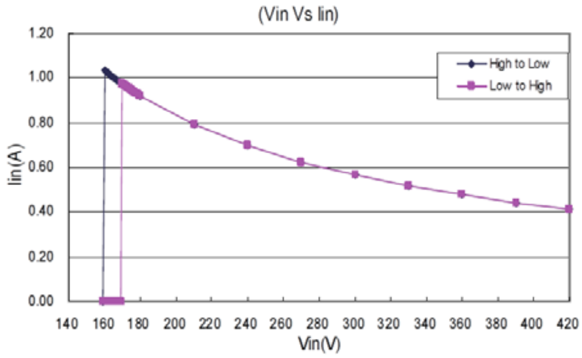
Remote On/Off

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. Models with part number suffix "N" are the "negative logic" remote on/off version. The unit turns off if the remote on/off pin is high (>3.5Vdc or open circuit). The converter turns on if the on/off pin input is low (<1.8Vdc). Note that the converter is off by default.

Logic State (Pin 2)	Negative Logic	Positive Logic
Logic Low – Switch Closed	Module on	Module off
Logic High – Switch Open	Module off	Module on

UVLO (Under Voltage Lock Out)

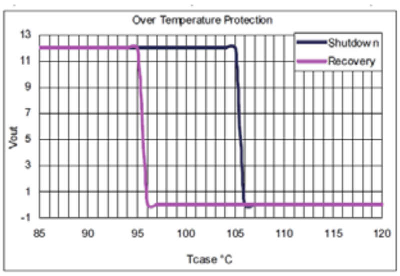
Input under voltage lockout is standard with this converter. At input voltages below the input under voltage lockout limit, the module operation is disabled. The unit will operate when the input voltage goes above the upper threshold.

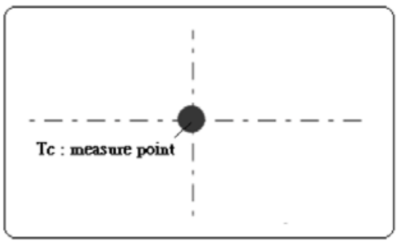


Over Temperature Protection

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. Shutdown occurs with the maximum case reference temperature is exceeded. Please measure case temperature of the center part of aluminum baseplate.

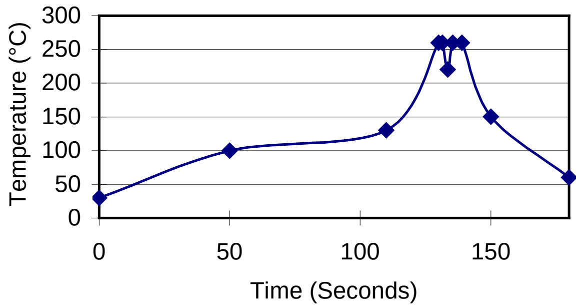




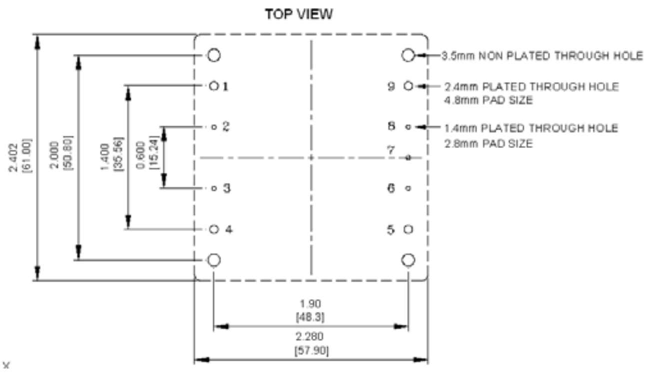
Recommended Layout, PCB Footprint and Soldering Information

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. Clean the soldered side of the module with a brush, Prevent liquid from getting into the module. Do not clean by soaking the module into liquid. Do not allow solvent to come in contact with product labels or resin case as this may changed the color of the resin case or cause deletion of the letters printed on the product label. After cleaning, dry the modules well. The suggested soldering iron is 450°C for up to 5seconds(less than 50W). Furthermore, the recommended soldering profile and PCB layout are shown below. 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 rate during cooling: -10.0 °C/Sec (From 260°C to 150°C)



Convection Requirements for Cooling

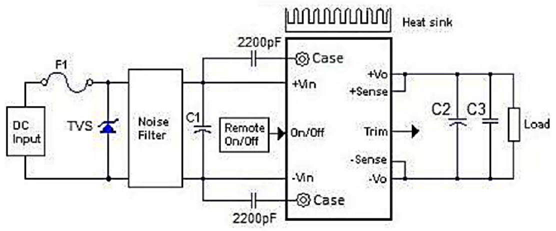
To predict the approximate cooling needed for the half brick module, refer to the power de-rating curves in the next section These de-rating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled 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}).

Connection for standard use

The connection for standard use is shown below. An external input capacitor (C1) 180uF for all models is recommended to reduce input ripple voltage. External output capacitors (C2, C3) are recommended to reduce output ripple and noise, 5Vout with 47uF T521 KO CAP. <55mR and 1uF ceramic capacitor, 48Vout with 10uF aluminum capacitor and 1uF ceramic capacitor and other modes with 10uF tantalum capacitor and 1uF ceramic capacitor for other models.

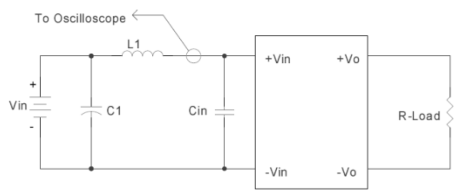


Symbol	Component	Reference
F1	Input Fuse	See **Safety & EMC** section
C1	External Input Capacitor	See Note below
C2 & C3	External Output Capacitor	See **Output Ripple, Noise & capacitance** section
Noise Filter	External input noise filter	See **EMC** Section
Remote On/Off	External Remote On/Off control	See **Parallel / Redundant operation** section
Trim	External output voltage adjustment	See **Output Voltage Adjustment** section
Heat Sink	External heat sink	See **Heat Sink** section
+Sense/-Sense		See **Output Remote Sensing** section

Note: If the impedance of input line is high, C1 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 °C.

Input Capacitance at the Power Module

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (Cin) should be placed close to the converter input pins to decouple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown as below represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L1).

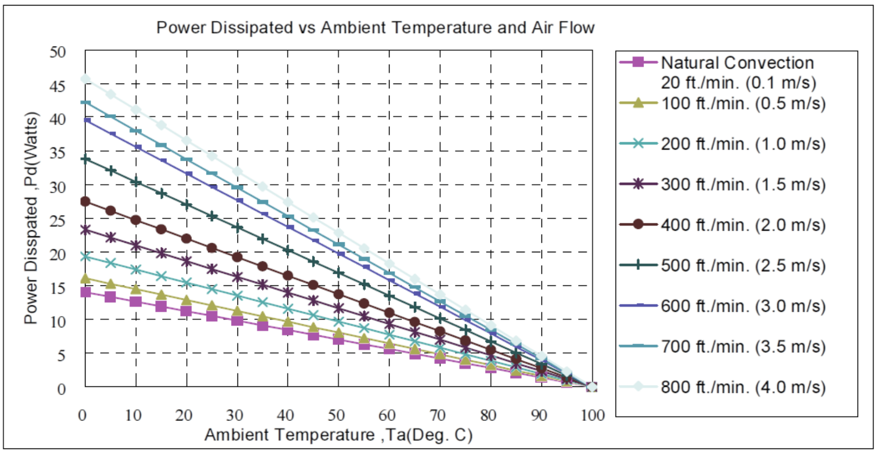


L1: 12uH ; C1: 330uF ESR<0.7ohm @100KHz ; Cin: 330uF ESR<0.7ohm @100KHz

Power De-rating

The operating case temperature range of HB300 series is -40°C to +100°C. When operating the HB300 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 HB300 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 HB300S48-6.25 operating at nominal line voltage, an output current of 6.25A, and a maximum ambient temperature of 25°C?

Solution:

Given: Vin=300Vdc, Vo=48Vdc, Io=6.25A

Determine Power dissipation (Pd):
$P_d = P_i - P_o = P_o(1-\eta)/\eta$
$P_d = 48V \times 6.25A \times (1-0.90)/0.90 = 33.33$Watts

Determine airflow:
Given: Pd = 33.33W and Ta=25°C

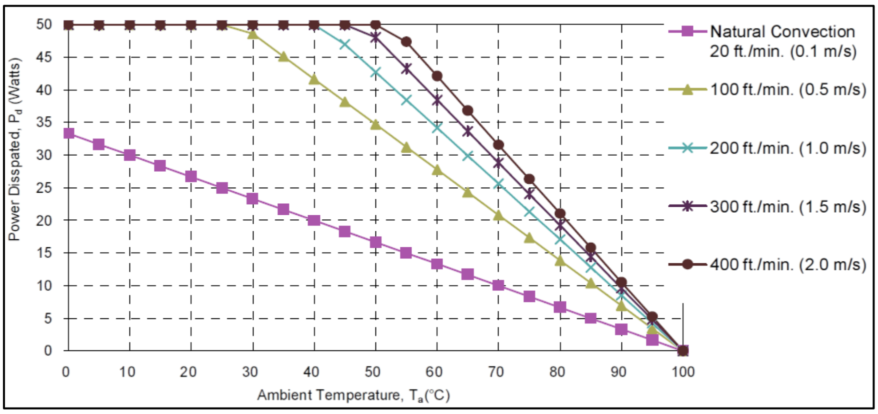
Check Power Derating curve:
Minimum airflow = 800 ft./min.
Verify:

Maximum temperature rise is
$\Delta T = Pd \times Rca = 33.33W \times 2.19 = 72.99°C$

Maximum case temperature is
$Tc = Ta + \Delta T = 97.99°C < 100°C$

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

The following curve is the de-rating curve of HB300 series with heat sink



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

Example (with heat sink M-C092):

What is the minimum airflow necessary for a HB300S5-60 operating at nominal line voltage, an output current of 60A, and a maximum ambient temperature of 45℃?

Solution:

Given:
Vin = 300Vdc, Vo = 5Vdc, Io = 60A

Determine Power dissipation (Pd):
$P_d = P_i - P_o = P_o(1-\eta)/\eta$
$P_d = 5 \times 60 \times (1-0.89)/0.89 = 37.08$Watts

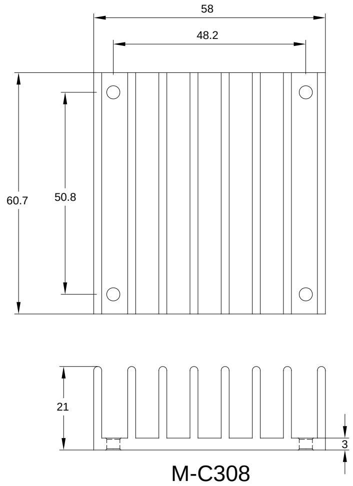
Determine airflow:
Given: Pd = 37.08W and Ta = 45℃

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

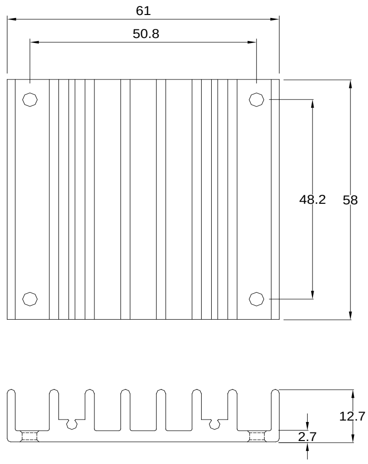
Verify:
Maximum temperature rise is:
$\triangle T = P_d \times R_{ca} = 37.08 \times 1.44 = 53.40$℃
Maximum case temperature is:
$T_c = T_a + \triangle T = 98.40$℃ <100℃

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

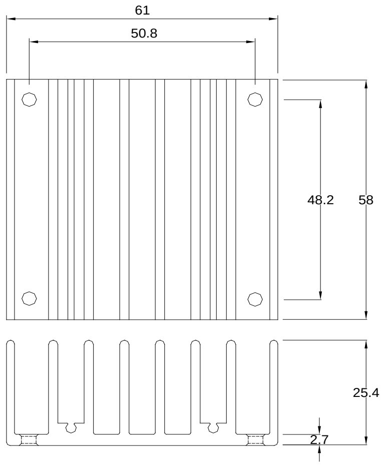
Half Brick Heat Sinks:



M-C308



M-C091



M-C092

M-C308 (G6620400201)
Longitudinal Heat Sink

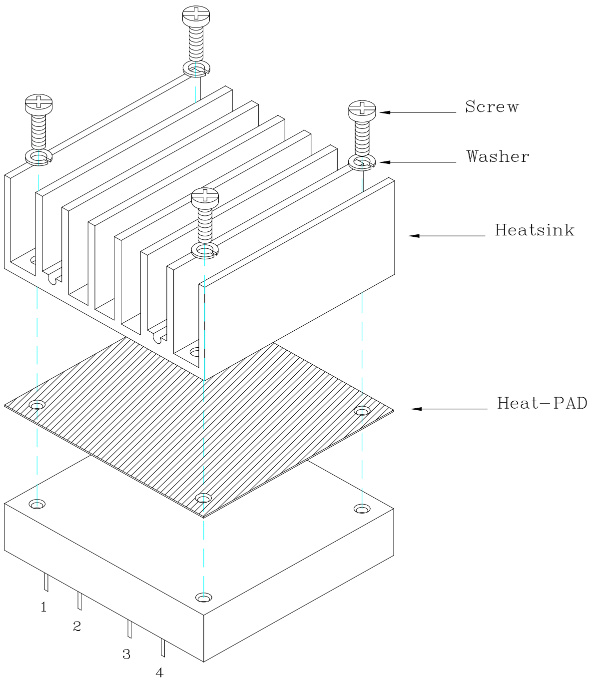
Rca:
3.90°C/W (typ.), natural convection
1.74°C/W (typ.), at 100LFM
1.33°C/W (typ.), at 200LFM
1.12°C/W (typ.), at 300LFM
0.97°C/W (typ.), at 400LFM

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

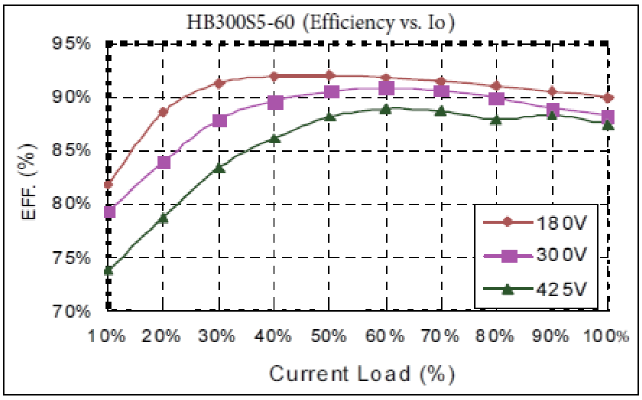
M-C092 (G6610130402)
Transverse Heat Sink

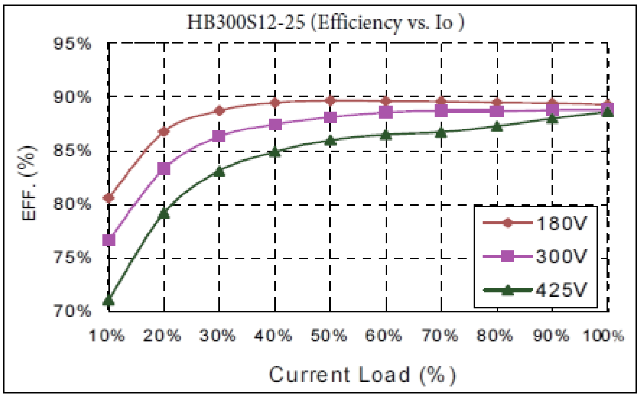
Rca:
3.00°C/W (typ.), natural convection
1.44°C/W (typ.), at 100LFM
1.17°C/W (typ.), at 200LFM
1.04°C/W (typ.), at 300LFM
0.95°C/W (typ.), at 400LFM

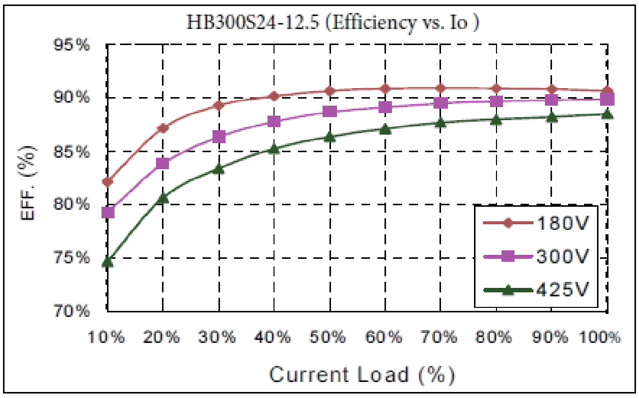


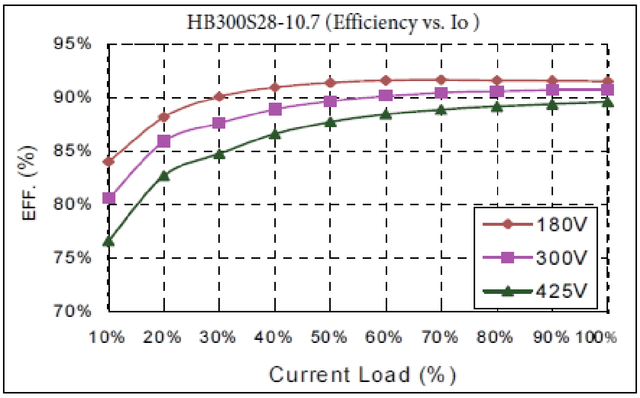
THERMAL PAD: SZ 56.9*60*0.25 mm (G6135041091)
SCREW: SMP+SW M3*8L
(G75A1300322)

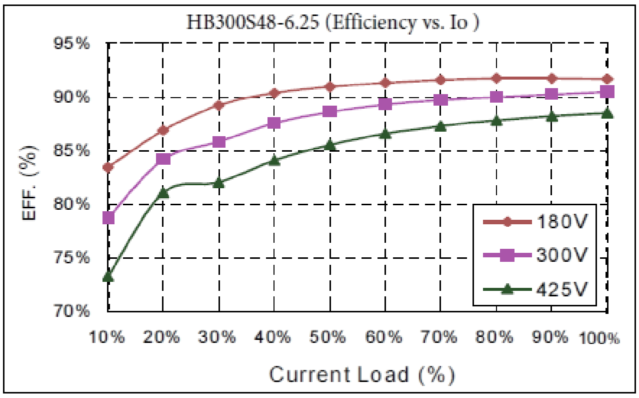
EFFICIENCY vs. LOAD











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:

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

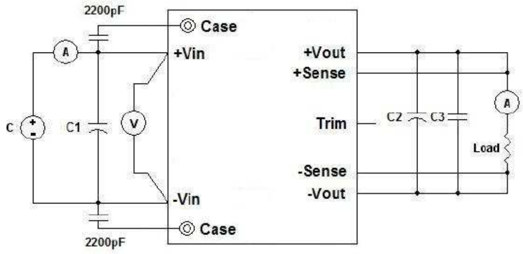
Where:

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.

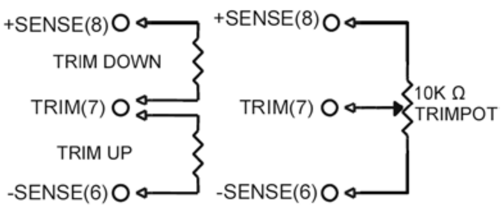


HB300 Series Test Setup

C1: 180uF/450V ESR<0.7Ω
C2: 10uF aluminum capacitor for 48 Vout.
47uF T521 KO CAP. <55mR for 5 Vout.
10uF tantalum capacitor for others.
C3: 1uF/ 1210 ceramic capacitor

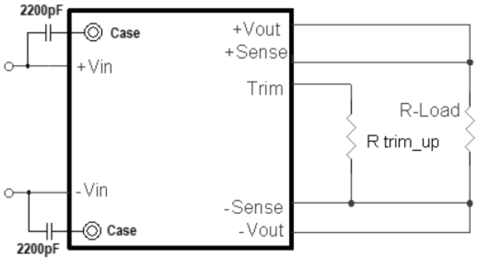
Output Voltage Adjustment

Output may be externally trimmed (-20% to +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

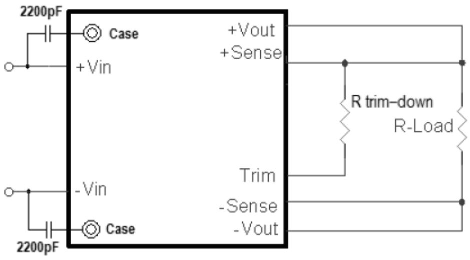


Output voltage trim circuit configuration

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)
5	2.32	1.8	0	2.5	0
12	9.1	24	5.1	2.5	0.50
24	20	68	7.5	2.5	0.50
28	23.7	82	6.2	2.5	0.50
48	36	82	5.1	2.5	0.50

For Vo=5V R_{trim_up} is defined as:

$$R_{trim\_up} = \frac{R_1 V_r}{Vo - V_{o\_nom}} - R_2 \ (K\Omega)$$

For others R_{trim_up} decision:

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

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 HB300S5-60 module by 5% to 5.25V, R $_{trim\_up}$ is calculated as follows:
Vo – Vo_nom = 5.25 – 5 = 0.25V
R1 = 2.32KΩ, R2 = 1.8 KΩ , R3 = 0KΩ, Vr= 2.5 V, Vf=0.5 V

$$R_{trim\_up} = \frac{2.32 \times 2.5}{5.25 - 5} - 1.8 = 21.40\,(K\Omega)$$

On the other hand, R trim_down is defined as:

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

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 12V module (HB300S12-25) by 5% to 11.4V, Rtrim_down is calculated as follows:

$V_{o\_nom} - V_o = 12 - 11.4 = 0.6$ V
R1 = 9.1 KΩ, R2 = 24 KΩ, Vr = 2.5 V

$$R_{trim\_down} = \frac{9.1\times(11.4-2.5)}{0.6} - 24 = 111.0\ (K\Omega)$$

Below is the Typical R $_{trim\_up}$ Value in KΩ:

Trim Up Value %	Vo=5V R trim_up	Vo=12V R trim_up	Vo=24V R trim_up	Vo=28V R trim_up	Vo=48V R trim_up
1%	114.2	154.1	164.1	167.1	147.4
2%	56.20	74.95	78.65	80.73	71.30
3%	36.87	48.56	50.18	51.93	45.93
4%	27.20	35.37	35.95	37.52	33.25
5%	21.40	27.46	27.41	28.88	25.64
6%	17.53	22.18	21.71	23.12	20.56
7%	14.77	18.41	17.65	19.01	16.94
8%	12.70	15.58	14.60	15.92	14.22
9%	11.09	13.38	12.22	13.52	12.11
10%	9.80	11.63	10.33	11.60	10.42

Below is the Typical R $_{trim\_down}$ Value in KΩ:

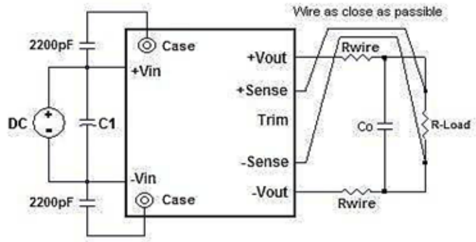
Trim Down Value %	Vo=5V R trim_down	Vo=12V R trim_down	Vo=24V R trim_down	Vo=28V R trim_down	Vo=48V R trim_down
1%	111.90	687.30	1704.00	2067.00	3295.00
2%	53.88	327.10	807.80	987.50	1588.00
3%	34.55	207.00	509.20	627.80	1020.00
4%	24.88	147.00	359.90	447.90	735.10
5%	19.08	111.00	270.30	340.00	564.50
6%	15.21	86.97	210.60	268.00	450.80
7%	12.45	69.82	168.00	216.60	369.50
8%	10.38	56.95	136.00	178.10	308.60
9%	8.77	46.95	111.10	148.10	261.20
10%	7.48	38.94	91.17	124.10	223.30
11%	6.425	32.39	74.88	104.50	192.20
12%	5.547	26.93	61.31	88.17	166.40
13%	4.803	22.32	49.82	74.33	144.50
14%	4.166	18.36	39.98	62.47	125.80
15%	3.613	14.93	31.44	52.19	109.50
16%	3.130	11.93	23.98	43.20	95.28
17%	2.704	9.277	17.39	35.26	82.74
18%	2.324	6.923	11.54	28.21	71.58
19%	1.985	4.817	6.298	21.90	61.61
20%	1.680	2.921	1.583	16.22	52.63

Output Remote Sensing

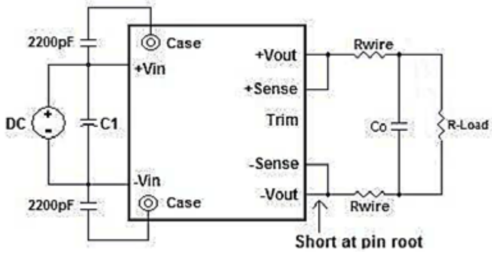
The HB300 SERIES converter has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the HB300 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 $V_{o\_nominal}$

When remote sense is in use, the sense should be connected by twisted-pair wire or shield wire. If the sensing patterns short, heave current flows and the pattern may be damaged. Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 400mm. This is shown in the schematic below:

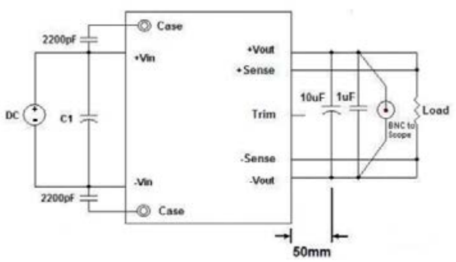


If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module.
This is shown in the schematic below:



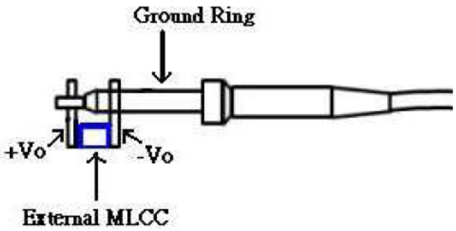
Note: Although the output voltage can be increased by both the remote sense and by the trim, the maximum increase for the output voltage is not the sum of both. The maximum increase is the larger of either the remote sense or the trim. The amount of power delivered by the module is defined as the voltage 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 measured with 47uF T521 KO CAP. <55mR and 1uF ceramic capacitor across output for 5Vout, 10uF aluminum capacitor and 1uF ceramic capacitor across output for 48Vout and with 10uF tantalum capacitor and 1uF ceramic capacitor for other models. A 20 MHz bandwidth oscilloscope is normally used for the measurement. The conventional ground clip on an oscilloscope probe should never be used in this kind of measurement. This clip, when placed in a field of radiated high frequency energy, acts as an antenna or inductive pickup loop, creating an extraneous voltage that is not part of the output noise of the converter.

Another method is shown in below, in case of coaxial cable/ BNC is not available. The noise pickup is eliminated by pressing scope probe ground ring directly against the -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.

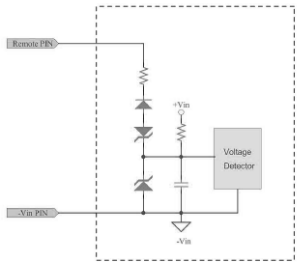


Output Capacitance

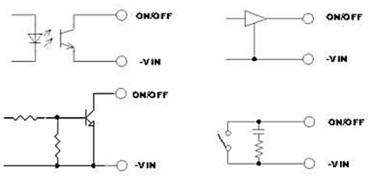
For good transient response, low ESR output capacitors should be located close to the point of load. PCB design emphasizes low resistance and inductance tracks in consideration of high current applications. Output capacitors with their associated ESR values have an impact on loop stability and bandwidth. For absolute maximum value of HB300 series' output capacitance, please refer to page 3 Maximum Output Capacitance. For values larger than this, please contact your local DATEL's representative.

Remote On/Off circuit

The converter remote On/Off circuit built-in on input side. The ground pin of input side remote On/Off circuit is –Vin pin. For connection examples, see below:

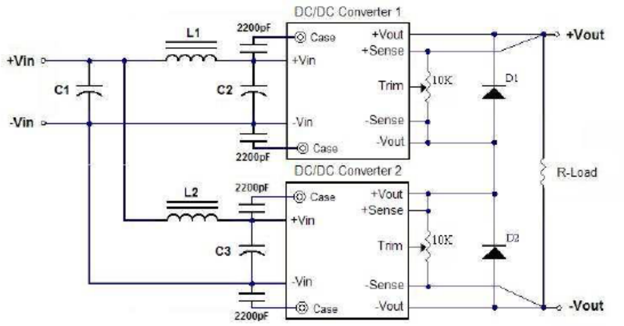


For External connection examples, see below:

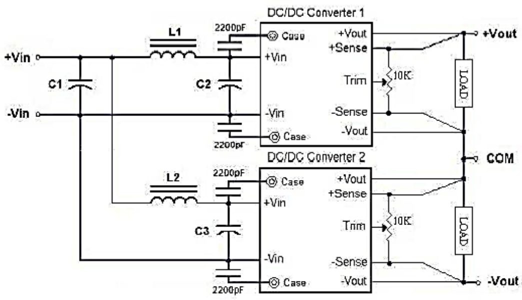


Series Operation

Series operation is possible by connecting the outputs two or more modules. Connection is shown in below. The output current in series connection should be lower than the lowest rate current in each power module.



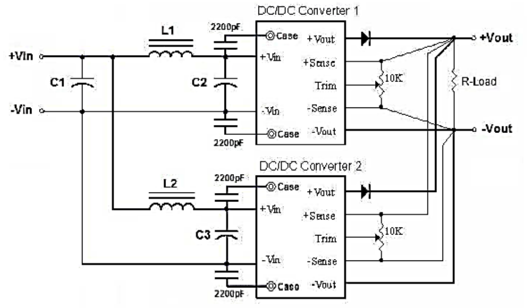
L1, L2: 1.0uH
C1, C2, C3: 180uF/450V ESR<0.7Ω
Note:
1. If the impedance of the input line is high then, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 °C
2. Recommend Schottky diode (D1, D2) to be connected across the output of each series connected converter, so that if one converter shuts down for any reason, then the output stage won't be thermally overstressed. Without this external diode, the output stage of the shut-down converter could carry the load current provided by the other series converters, with its MOSFETs conducting through the body diodes. The MOSFETs could then be overstressed and fail. The external diode should be capable of handling the full load current for as long as the application is expected to run with any unit shut down. Series for ±output operation is possible by connecting the outputs two units, as shown in the schematic below.



L1, L2: 1.0uH
C1, C2, C3: 180uF/450V ESR<0.7Ω
Note:
If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 °C

Parallel / Redundant operation

The HB300 series parallel operation is not possible. Parallel for redundancy operation is possible by connecting the units as shown in the schematic below. The current of each converter become unbalance by a slight difference of the output voltage. Make sure that the output voltage of units of equal value and the output current from each power supply does not exceed the rate current. Suggest use an external potentiometer to adjust output voltage from each power supply.

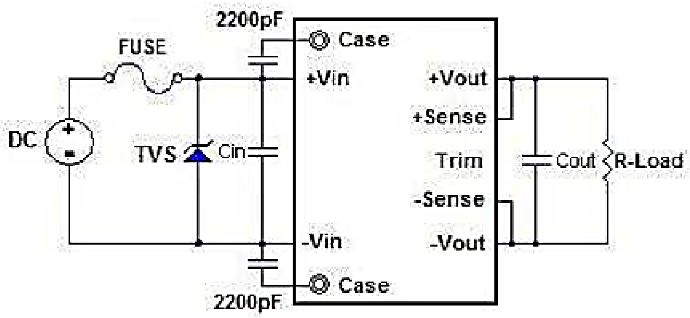


L1, L2: 1.0uH
C1, C2, C3: 180uF/450V ESR<0.7Ω
Note:
If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 ℃

SAFETY and EMC

Input Fusing and Safety Considerations

This HB300 series of converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 5A 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:

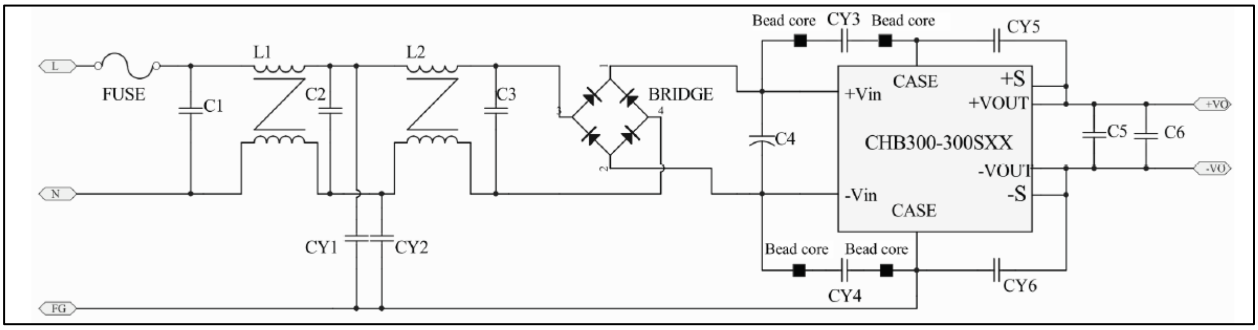


The external input capacitor Cin is required in order for the HB300 series to meet EN61000-4-4, EN61000-4-5. The HB300 requires an aluminum capacitor (Nippon Chemi-Con KMG series, 180uF/450V) to connect parallel.

EMC Considerations

EMI Test standard: EN55022 / EN55032 Class A Conducted Emission

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



Circuit Connection

Model Number	C1, C2, C3	C4	C5	C6	CY1	CY2	CY3	CY4	CY5	CY6	L1, L2	BEAD CORE
HB300S5-60	0.68uF/305V	150uF/450V	NC	1uF/100V	2200pF	3300pF	3300pF	3300pF	4700pF	4700pF	0.33mH	BRH 3.5*3.2*1.2
HB300S12-25	0.68uF/305V	150uF/450V	NC	1uF/100V	2200pF	3300pF	3300pF	3300pF	4700pF	4700pF	0.33mH	BRH 3.5*3.2*1.2
HB300S24-12.5	0.68uF/305V	150uF/450V	NC	1uF/100V	2200pF	3300pF	3300pF	3300pF	4700pF	4700pF	0.33mH	BRH 3.5*3.2*1.2
HB300S28-10.7	0.68uF/305V	150uF/450V	NC	1uF/100V	2200pF	3300pF	3300pF	3300pF	4700pF	4700pF	0.33mH	BRH 3.5*3.2*1.2
HB300S48-6.25	0.68uF/305V	150uF/450V	NC	1uF/100V	2200pF	3300pF	3300pF	3300pF	4700pF	4700pF	0.33mH	BRH 3.5*3.2*1.2

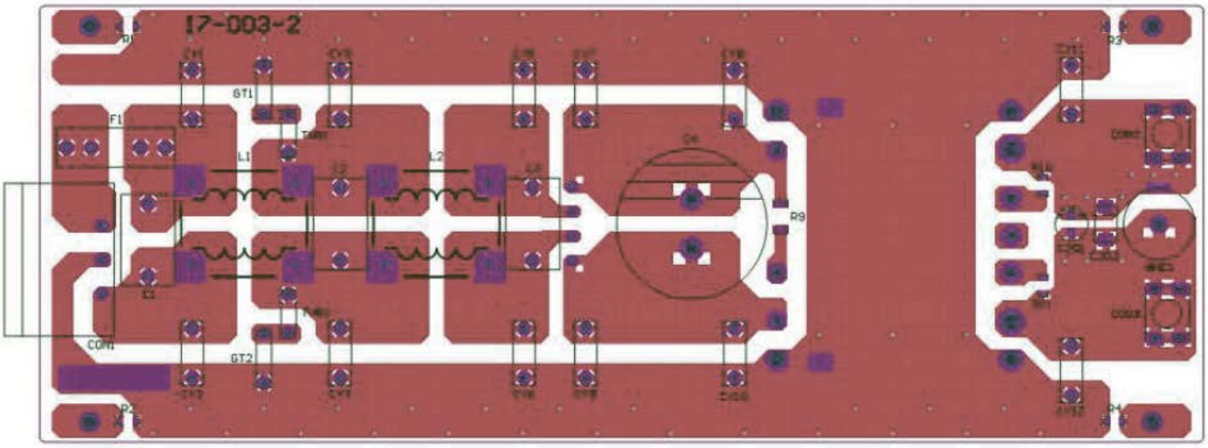
Note: C1, C2, C3 metallized polypropylene film capacitors, C4 aluminum capacitors, C6, CY1, CY2, CY3, CY4, CY5, CY6 ceramic capacitors.

C1, C2, C3: 0.68uF/305V (FARATRONIC MKP62 Series C42Q2684M6HC000) or equivalent. C4: 150uF/450V (NIPPON CHEMI-CON EKXG-451E-151MM45S) or equivalent.

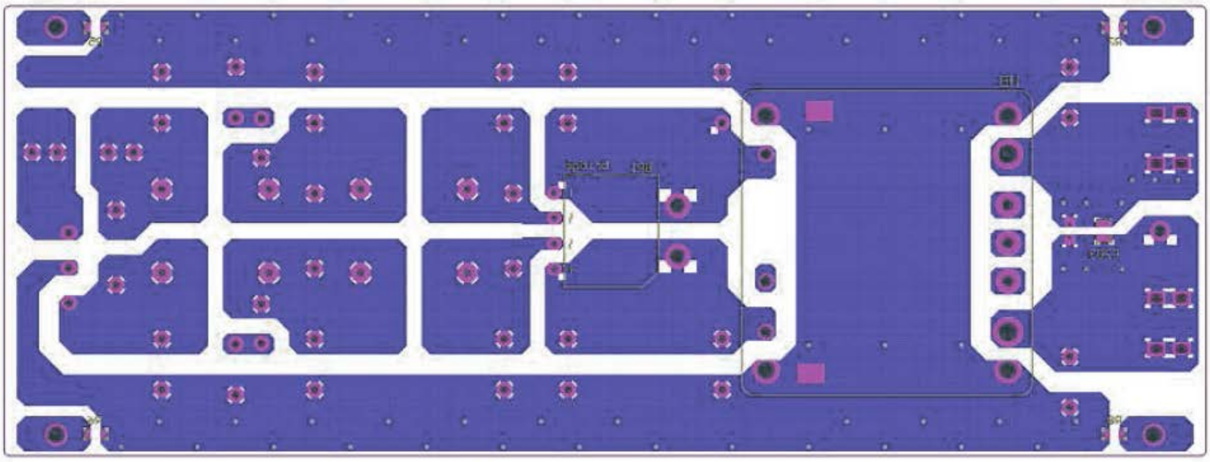
CY1, CY2, CY3, CY4, CY5, CY6: 2200pF (MURATA KX Series DC1B3KX222MA4BN01F) or equivalent. 3300pF (MURATA KX Series DC1E3KX332MA4BN01F) or equivalent. 4700pF (MURATA KX Series DC1E3KX472MA4BN01F) or equivalent.

L1, L2: 5mH /5A (BULL WILL URT24-050055H) or equivalent.

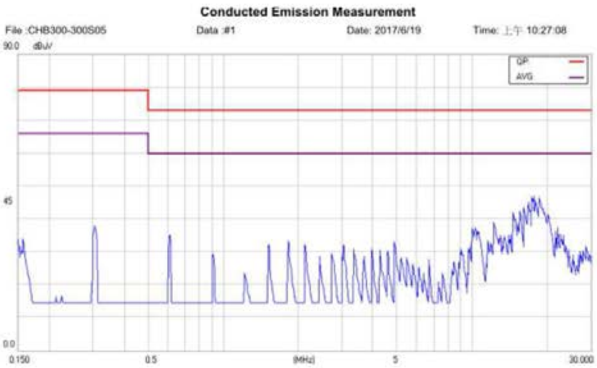
BEAD CORE: BRH 3.5*3.2*1.2 CHILISIN



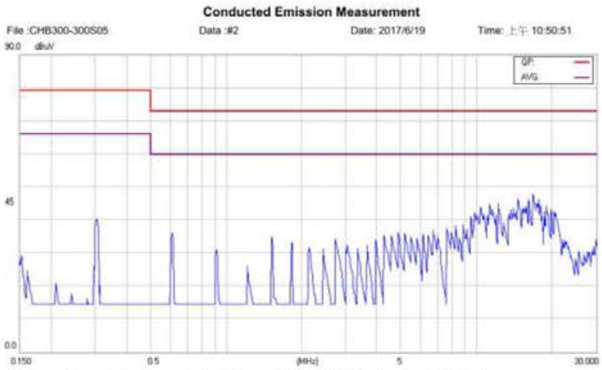
EMI test board top side



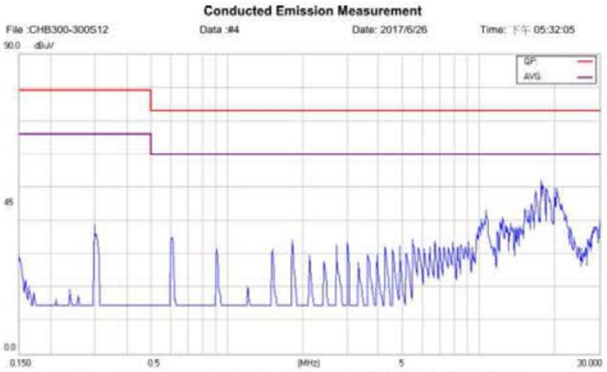
EMI test board bottom side



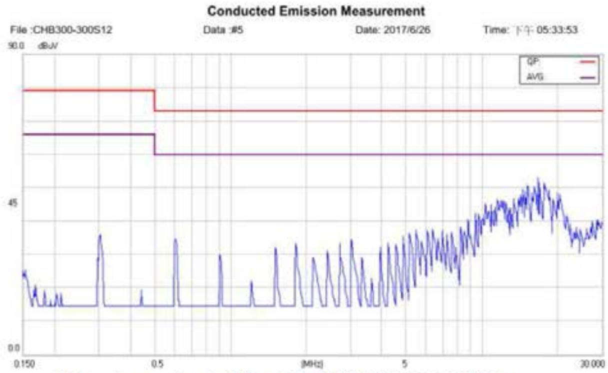
Class A conducted Test for HB300S5-60 Line



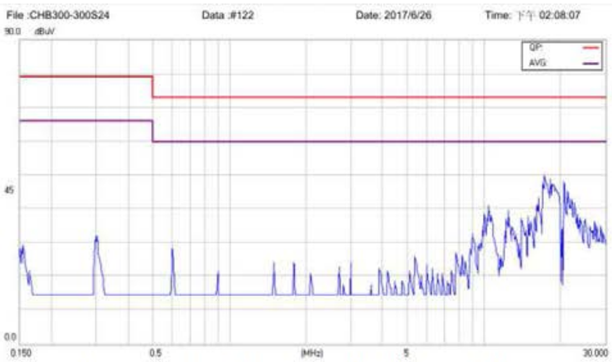
Class A conducted Test for HB300S5-60 Nature



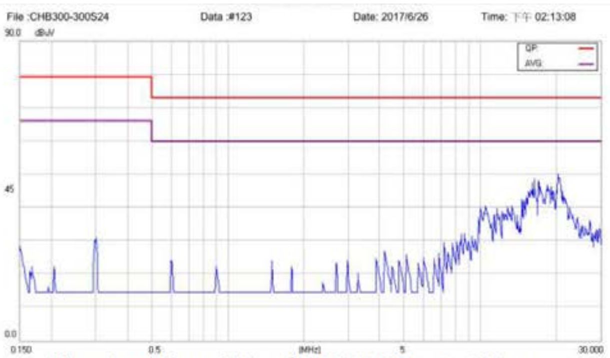
Class A conducted Test for HB300S12-25 Line



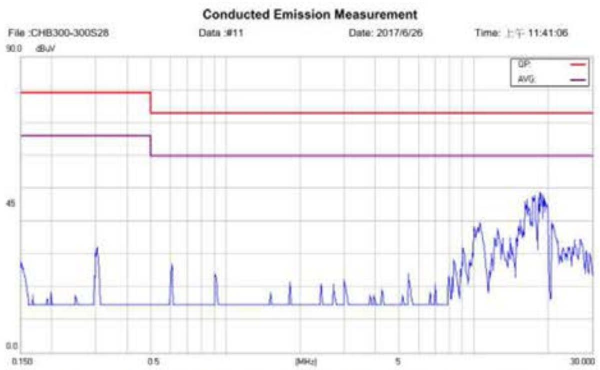
Class A conducted Test for HB300S12-25 Nature



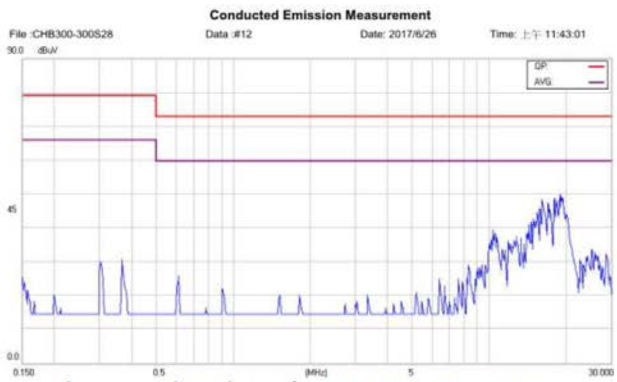
Class A conducted Test for HB300S24-12.5 Line



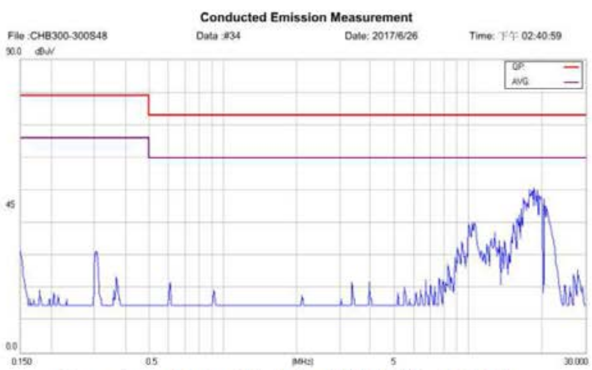
Class A conducted Test for HB300S24-12.5 Nature



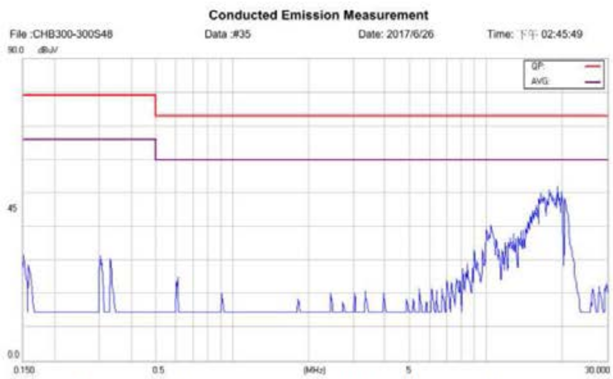
Class A conducted Test for HB300S28-10.7 Line



Class A conducted Test for HB300S28-10.7 Nature

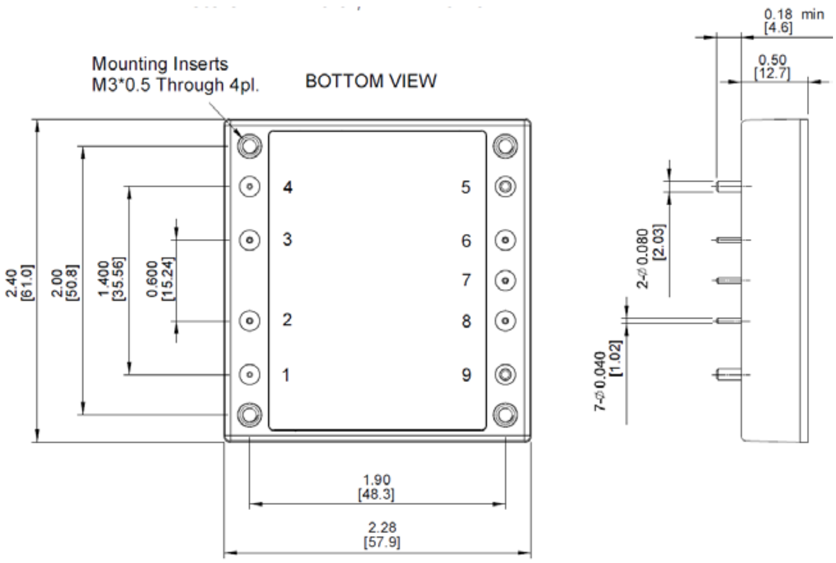


Class A conducted Test for HB300S48-6.25 Line



Class A conducted Test for HB300S48-6.25 Nature

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	NP
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	300	S	12	—	25	N, M

Nominal Input Voltage: (180-425) - 300Volts

Voltage Output:
5 Volts
12 Volts
24 Volts
28 Volts
48 Volts

Current Output (A):
5 Volts – 60
12 Volts – 25
24 Volts – 12.5
28 Volts – 10.7
48 Volts – 6.25

Options:
None – Positive On/Off Remote
N- Negative On/Off Remote
M- Clear Mounting Insert

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