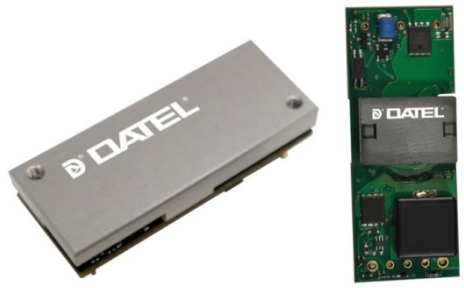
4:1Vin EB Series Eighth - Brick

Up to 120 Watt DC-DC Converter



FEATURES

- DOSA – Standard Form, Fit & Function
- Industry standard 1/8th brick footprint
- 4:1 input voltage range: 9- 36 or 18 – 72Vin
- ROHS 3 Directive 20151/8635/EU Compliant
- -40 ^{0}C to +85 ^{0}C operation with derating.
- Baseplate Optional 0.500" (12.7mm) tall
- Withstands input transients (2X Nominal Vin)
- Fixed-frequency operation
- Industry standard 1/8th brick footprint
- Full protection (OTP, OCP, OVP, UVLO – auto-restart)
- Remote ON/OFF and Remote sense
- Output voltage trim range: ±10%
- On-board input differential LC filter
- Meets UL94, V-0 flammability rating
- Compliant to REACH (EC) No 1907/2006, 205 SVHC update
- Designed to meet Class B conducted emissions per FCC and EN55022 when used with external filter
- Designed to meet UL/CSA60950-1, TUV per IEC/EN60950-1, 2nd edition (45Vin nominal models)

PRODUCT OVERVIEW

This EB series of DC-DC converters is an open frame eighth-brick DC-DC converter that conforms to industry standard specifications. These converters operate over an ultra-wide input voltage range of 9 to 36 or 18 to 75 VDC and provide tightly regulated output voltages. The high efficiency of this EB series allows operation over a wide ambient temperature range of – 40°C to +85°C with minimal derating. The output is fully isolated from the input and the converter meets Basic Insulation requirements. The standard feature set includes remote On/Off (positive or negative enable), input under-voltage lockout, output overvoltage protection, overcurrent and short circuit protection, output voltage trim, remote sense and over-temperature shutdown with hysteresis.

APPLICATIONS:

- Distributed Power Architectures
- Instrumentation
- Data and Wireless Communications
- Servers
- "Bus" Converter Applications

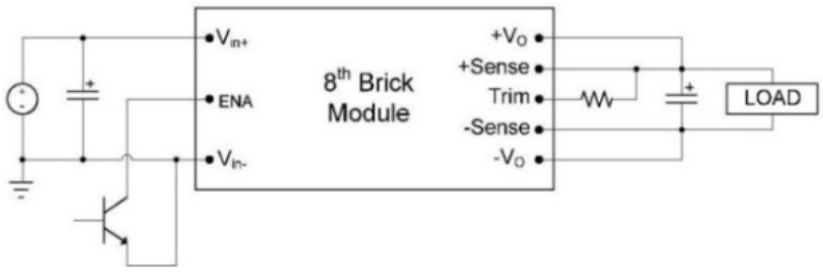
AVAILABLE OPTIONS

- Customizable Input / Output voltages
- SMT or Thru-Hole Mounting
- Higher Power
- Optional Baseplate

Contact DATEL for other series of 8TH - Brick footprint, optimized for Cost Savings or higher performance

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	OPTIONS
EB22S3.3-30	9 – 36 VDC	3.3 VDC	30 A	90	± 0.2 %	B, S, N, P
EB22S5-20	9 – 36 VDC	5 VDC	20 A	90	± 0.2 %	B, S, N, P
EB22S12-8	9 – 36 VDC	12 VDC	8 A	92	± 0.2 %	B, S, N, P
EB22S15-5	9 – 36 VDC	15 VDC	5 A	92	± 0.2 %	B, S, N, P
EB22S24-4	9 – 36 VDC	24 VDC	4 A	92	± 0.2 %	B, S, N, P
EB22S48-1.8	9 – 36 VDC	48 VDC	1.8 A	90	± 0.2 %	B, S, N, P
EB45S3.3-30	18 – 75 VDC	3.3 VDC	30 A	90	± 0.2 %	B, S, N, P
EB45S5-20	18 – 75 VDC	5 VDC	20 A	92	± 0.2 %	B, S, N, P
EB45S12-10	18 – 72 VDC	12 VDC	8 A	92	± 0.2 %	B, S, N, P
EB45S15-7	20 – 75 VDC	15 VDC	7 A	92	± 0.2 %	B, S, N, P
EB45S24-4	18 – 72 VDC	24 VDC	4 A	92	± 0.2 %	B, S, N, P
EB45S48-1.8	18 – 72 VDC	48 VDC	1.8 A	90	± 0.2 %	B, S, N, P

CONNECTION DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	$24V_{in}$ $48V_{in}$	0 0		36 72*	Volts
Operating Ambient Temperature	With Derating	All	-40		+85	°C
Storage Temperature		All	-55		+125	°C
Operating Temperature T_{ref}, Consult Factory for Thermal Derating	Open Frame		-40		+123	°C
	Optional Baseplate		-40		+115	°C

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

ELECTRICAL SPECIFICATIONS

Note: All specifications are typical at nominal input, full load at 25°C, Airflow=300 LFM, Vin=48 VDC, Cin=33 μF, unless otherwise noted

INPUT CHARACTERISTICS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Operating Input Voltage		$24V_{in}$ $48V_{in}$	9 18	24 48	36 72*	Volts
Input Under Voltage Lockout						
Turn-On Voltage Threshold		$24V_{in}$ $48V_{in}$	8.8 17.2	9.0 17.6	9.2 18.0	Volts
Turn-Off Voltage Threshold		$24V_{in}$ $48V_{in}$	7.7 15.8	8 16.2	8.3 16.6	Volts
Lockout Hysteresis Voltage		$24V_{in}$ $48V_{in}$		0.5 1		Volts
Maximum Input Current	100% Load, V_{in} =9V	24Vin			9200	mA
	100% Load, V_{in} =18V	48Vin			7400	
No-Load Input Current	V_{in} = Nominal input	EB22S3.3-30 EB22S5-20 EB22S12-8 EB22S15-5 EB22S24-4 EB22S48-1.8 EB45S3.3-30 EB45S5-20 EB45S12-10 EB45S15-7 EB45S24-4 EB45S48-1.8		200 200 200 200 200 100 100 100 100 100 100 100		mA
Off Converter Input Current (Standby)	Shutdown input idle current			5	10	mA
Short Circuit input Current	RMS	All		30		mA
Input Voltage Ripple Rejection	120HZ	All		50		dB
Inrush Current (I^2t)	As per ETS300 132-2	All			0.01	A^2s
Input Reflected-Ripple Current	5Hz to 50MHz	All			40	mA_{PK-PK}

*Certain models are able to withstand continuous input voltage of up-to 75Vin. Please consult factory.

OUTPUT CHARACTERISTICS

Parameters	Conditions	Model	Min.	Typical	Max.	Units
Output Voltage Set Point	V_{in} =Nominal V_{in}, I_o = I_{o_max}, Tc=25°C	Vo=3.3 Vo=5.0 Vo=12 Vo=15 Vo=24 Vo=48	3.2505 4.925 11.82 14.775 23.64 47.33	3.3 5 12 15 24 48	3.3495 5.075 12.18 15.225 24.36 48.67	Volts
Output Voltage Regulation						
Line Regulation	V_{in} =High line to Low line Full Load	Single			±0.2	%
Load Regulation	I_o = Full Load to min. Load	Single			±0.2	%
Temperature Coefficient	TC=-40°C to 80°C				±0.03	%/°C
Output Voltage Ripple and Noise	5Hz to 20MHz bandwidth					
Peak-to-Peak	Full Load, 20MHz bandwidth 10uF tantalum and 1uF ceramic capacitor	Vo=3.3V Vo=5V Vo=15V Vo=12V Vo=24V		60 60 80 80 80		mV
Output DC Current-Limit Inception	Output Voltage=90% $V_{o,\ nominal}$	All	110	140	170	%
Maximum Output Capacitance	Full load, Resistance	Vo=3.3V Vo=5V Vo=12V (10A) Vo=15V Vo= 24V Vo= 48V			10000 10000 4700 2200 1000 330	µF

FEATURE CHARACTERISTICS

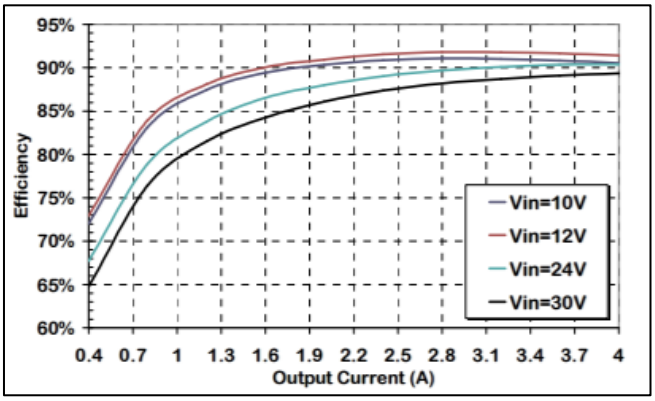
Parameter	Conditions	Model	Min	Typ	Max	Unit
Switching Frequency		EB22S3.3-30 EB22S5-20 EB22S12-8 EB22S15-5 EB22S24-4 EB22S48-1.8 EB45S3.3-30 EB45S5-20 EB45S12-10 EB45S15-7 EB45S24-4 EB45S48-1.8		410 350 TBD 325 325 410 350 350 350 410 325 350		kHz
Output Voltage Trim Range[1]		Vo=3.3, 5, 12 Vo= 15, 24 V0= 48 (POE)	-10 -20 -20		+10 +5 +10	%
Remote Sense Compensation[1]		Vo=3.3, 5, 12, 48 Vo= 15, 24			+10 +5	%
Output Over-voltage Protection	Non-latching	All	115	120	140	%
Over-temperature Protection	Avg. PCB temp, non-latching	All		135		°C
Peak Backdrive Output Current during startup into pre-biased output	C_{OUT}=220µF, aluminum Sinking current from external voltage source equal to V_{OUT} – 0.6V and connected to the output via 1Ω resistor.	All		500		mA

Backdrive Output Current in OFF state	Converter disabled			0	5	mA
Enable to Output Turn-ON Time	V_{OUT} = 0.9*V_{OUT_NOM}			20		ms
Output Enable ON/OFF Negative Enable Converter ON Converter OFF Positive Enable Converter ON Converter OFF Enable Pin Current Source/Sink	All voltages are WRT – Vin. Converter has internal pull-up of approx. 5V		 -0.5 2.4 2.4 -0.5	 0.25	 0.8 20 20 0.8 1	 VDC VDC VDC VDC mA
Output Voltage Overshoot @ startup				0	2	%Vo
Auto-Restart Period	With all protection features			100		ms

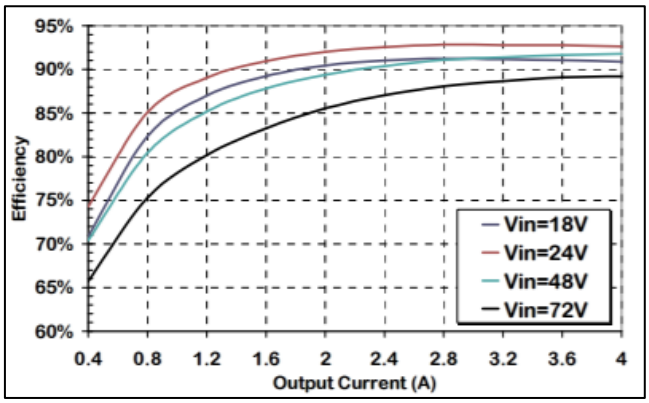
Parameter	Conditions	Models	Min	Typ.	Max	Unit
Load Change 50%-75% or 25% to 50% of Iout Max, di/dt = 0.1 A/µs	Co = 1 µF ceramic + 10 µF tantalum	All		100	200	mV
Settling Time to 1% of Vout		All		50		µs
Load Change 50%-75% or 25% to 50% of Iout Max, di/dt = 1.0 A/µs	Co = 1 µF ceramic + 330 µF Tantalum	All		100	400	mV
Settling Time to 1% of Vout		EB45S12-9		50		µs
		Others		10		
Isolation Capacitance				1000		pF
Isolation Resistance			10			MΩ
Isolation Voltage – Input to Output			2250			V_{DC}
Isolation Voltage – Input to Baseplate			1500			V
Isolation Voltage –Output to baseplate			1000			V
RELIABILITY						
Per Telcordia SR-332, Issue 2: Method I, Case 3 (I_O=80% of I_O_max, T_A=40°C, airflow = 200 lfm, 90% confidence)	MTFB	EB22S3.3-30 EB22S5-20 EB22S12-8 EB22S15-5 EB22S24-4 EB22S48-1.8 EB45S3.3-30 EB45S5-20 EB45S12-10 EB45S15-7 EB45S24-4 EB45S48-1.8	TBD 3,172,654 3,323,205 2,252,974 2,752,974 TBD TBD 3,172,654 2,980,488 TBD 2,750,260 TBD				Hours
	FITs (failures in 10^9 hours)	EB22S3.3-30 EB22S5-20 EB22S12-8 EB22S15-5 EB22S24-4 EB22S48-1.8 EB45S3.3-30 EB45S5-20 EB45S12-10 EB45S15-7 EB45S24-4 EB45S48-1.8	TBD 315 301 312 363 TBD TBD 330 336 TBD 364 TBD				$/10^9$ Hours

Notes: Combination of trim + remote sense cannot exceed 10% of V_{o_nom}

Select Efficiency vs. Load Curves (consult factory for specific models)

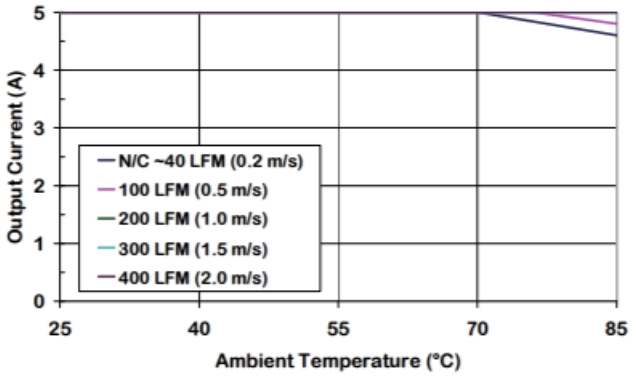


EB22S24-4

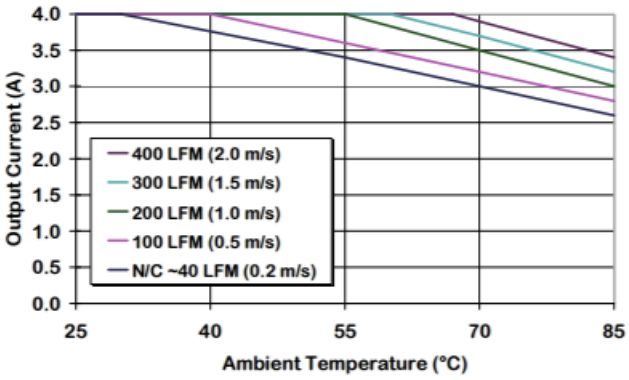


EB45S24-4

Select Output Current Derating vs Ambient Temperature & Airflow (consult factory for specific models)

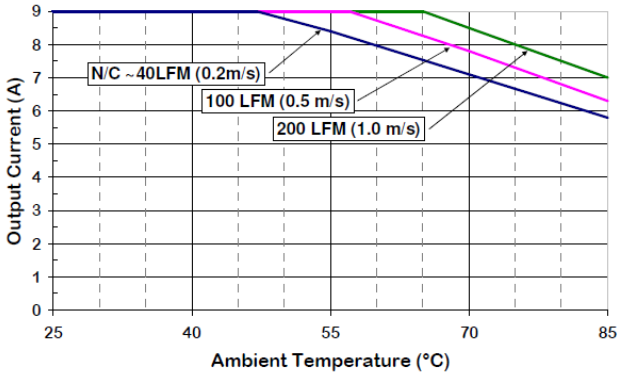


EB22S15-5 at Vin = 24 V, without baseplate

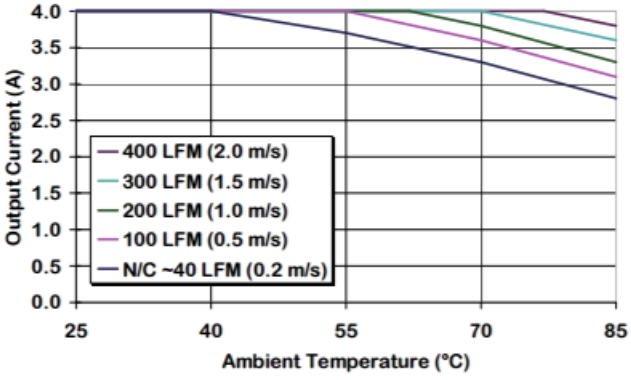


EB22S24-4 at Vin = 24 V, without baseplate

Select Output Current Derating vs Ambient Temperature & Airflow (consult factory for specific models)

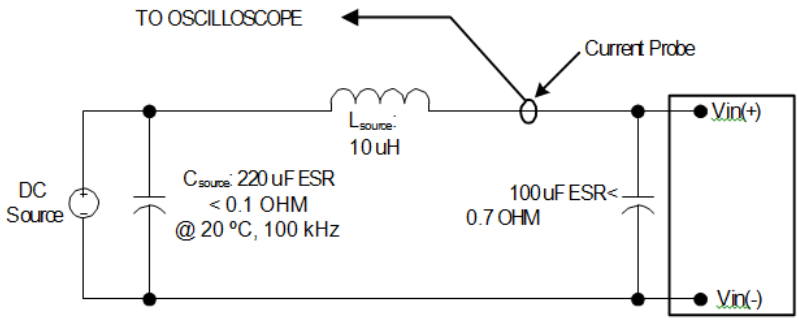


EB45S12-9 at Vin = 48 V, without baseplate



EB45S24-4 at Vin = 48 V, without baseplate

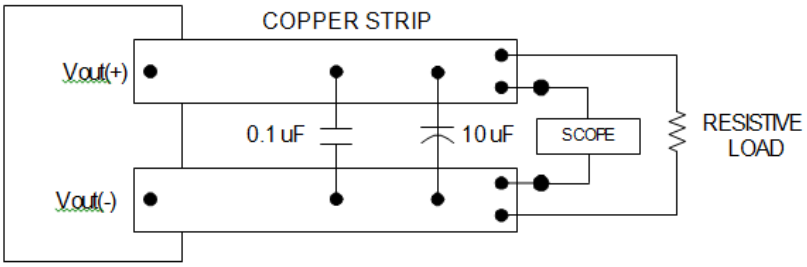
INPUT REFLECTED RIPPLE TEST SETUP:



Note: Measure input reflected-ripple current with a simulated source inductance (Ltest) of 10 uH. Capacitor CS offsets possible source impedance.

Input Reflected-ripple Current Test Setup.

OUTPUT RIPPLE TEST SETUP:



Note: Use a 0.1µF X7R ceramic capacitor and a 10µF @ 25V tantalum capacitor. Scope measurement should be made using a BNC socket. Position the load 3 in. [76mm] from module.

Peak-to-Peak Output Noise Measurement Test Setup.

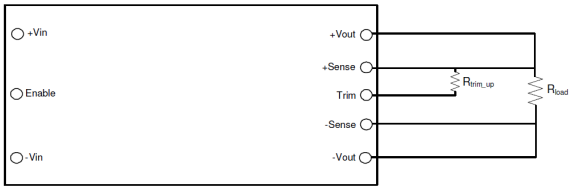
OUTPUT VOLTAGE TRIM

Output voltage adjustment is accomplished by connecting an external resistor between the Trim Pin and either the +Sense or –Sense pins.

TRIM UP EQUATION:

Where Rtrim_up is the resistance value in k-ohms and Δ% is the percent change in the output voltage.

$$R_{trim\_up} = \left[\frac{5.1 \times Vo\_nom \times (100 + \Delta\%)}{1.225 \times \Delta\%} - \frac{510}{\Delta\%} - 10.2 \right] \times k\Omega$$

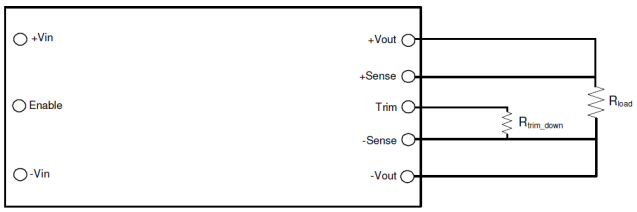


Trim UP circuit configuration

TRIM DOWN EQUATION:

$$R_{trim\_down} = \left(\frac{510}{\Delta\%} - 10.2 \right) \times k\Omega$$

Where **Rtrim_down** is the resistance value in k ohms and Δ% is the percent change in the output voltage.



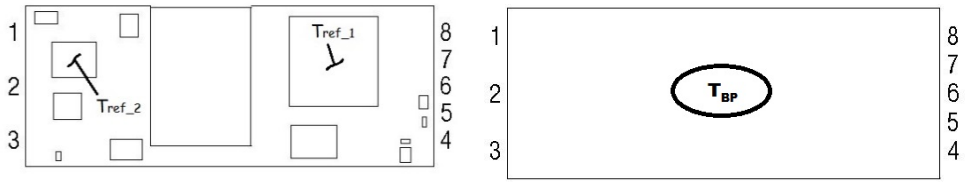
Trim DOWN circuit configuration

THERMAL DERATING

It is preferable that the DC-DC module has an unobstructed flow of air across the unit for best thermal performance. Components taller than ~ 2mm in front of the module can deflect airflow and possibly create hotspots.

Significant cooling is achieved through conductive flow from the modules I/O pins to the host PCB. Sufficiently large traces connecting the dc-dc converter to the source and load will help ensure thermal derating performance will meet or exceed the derating curves published in this datasheet. Thermal reliefs are not recommended on power pin connections.

If the module is expected to be operated near the load limits defined in the derating curves, in-system verification of module derating performance should be performed to ensure long-term system reliability. Peak temperatures are to be measured using infrared thermography or by gluing a fine gauge (AWG #40) thermocouple at the TREF location(s) shown below. Temperature at the specified location is not to exceed 123ºC in order to maintain converter reliability.



INPUT UNDERVOLTAGE LOCKOUT

The converter is disabled until the input voltage has exceeded the UVLO turn-on threshold. Once the input voltage exceeds this level (see Input Under-Voltage Lock-out in Electrical Specifications table) the module will commence soft-start. Hysteresis of 2-3 volts minimizes the likelihood of pulling the input voltage below the turn-off threshold during startup which could create an undesirable on/off cycling condition. Once started, the converter will continue to operate until the input voltage subsequently falls below the UVLO turn-off threshold.

ENABLE PIN FUNCTION

The module has a remote enable function that allows it to be turned on or off remotely. The Enable pin is referenced to the negative input pin (-Vin) of the converter. Modules can be ordered with either negative or positive enable.

With the negative enable option, the converter will not turn on unless the enable pin is connected to –Vin. The positive enable option allows the converter to turn on as soon as voltage sufficient to exceed the UVLO threshold of the converter has been applied to the input terminals. In this case the module is turned off by connecting the Enable pin to –Vin. On/off thresholds are shown in the Electrical Specifications table.

OUTPUT OVERVOLTAGE PROTECTION

The module has an independent feedback loop that will disable the output of the converter if a voltage greater than about 125% of the nominal set point is detected. When this threshold is reached, the converter will shut down and remain off for the amount of time specified by the Auto-Restart Period. The converter will attempt a restart once this period of time has elapsed.

OUTPUT OVER-TEMPERATURE PROTECTION

To provide protection under certain fault conditions, the unit is equipped with a thermal shutdown circuit. The unit will shut-down if the average PCB temperature exceeds approx. 135ºC. Keep in mind that thermal shutdown is not intended as a guarantee that the unit will survive temperatures beyond its rating. The module will automatically restart once it has cooled below the shutdown temperature minus hysteresis (typically 20°C.)

SMT VERSION LAYOUT CONSIDERATIONS (IF APPLICABLE)

Copper traces with sufficient cross-section must be provided for all output & input pins. SMT pads tied to internal power/ground planes must have multiple vias around each SMT pad to couple expected current loads from module pins into internal traces/planes. One 0.024" (0.6mm) diameter via for each 4A of expected source or load current must be provided as close to the termination as possible, preferably in the direction of current flow from SMT pad to load. Vias must be at least 0.024" (0.6 mm) away from the SMT pad to prevent solder from flowing into the vias.

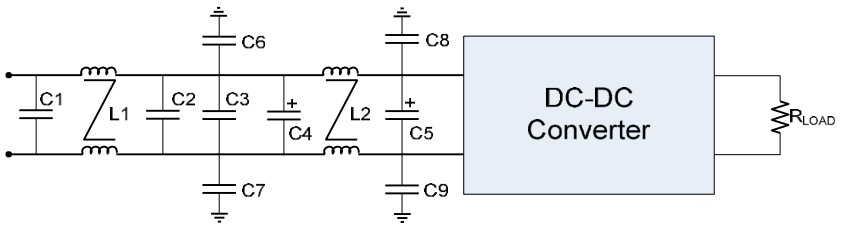
SMT pads on the host card are to be 0.080" (2.03mm) diameter. Solder paste screen opening should be 0.075" (1.9mm) diameter and the screen should be 0.006" (0.15 mm) thick (other thicknesses are possible; 0.006" provides a good compromise between solder volume and co-planarity compensation.)

PARALLELING CONVERTERS

Modules may be paralleled but it is recommended that the total power draw not exceed the output power rating of a single module. External sharing controllers are recommended for reliability and to ensure equal distribution of the load to the converters. In lower current applications, ORing diodes can be used to prevent converter interactions and improve current sharing.

EMC COMPLIANCE:

To meet Class B compliance for EN55022 (CISPR 22) or FCC part 15 sub part j, the following input filter is required:

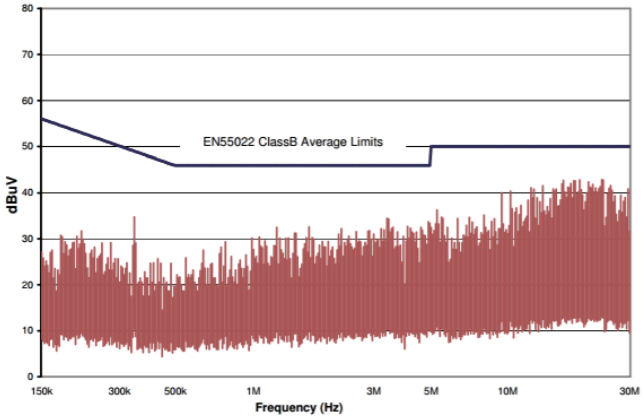


EMI Filter

Model No.*	C1, C2, C3	C4	C5	C6, C7	C8, C9	L1	L2
EB22S3.3-30	2.2µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.77mH	0.77mH
EB22S5-20	2.2µF Ceramic	Not Used	220µF Electrolytic	8.2 nF	8.2 nF	0.63mH	0.63mH
EB22S12-8	4.7µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.85mH	0.85mH
EB22S15-5	4.7µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.81mH	0.81mH
EB22S24-4	2.2µF Ceramic	Not Used	220µF Electrolytic	8.2 nF	8.2 nF	0.63mH	0.63mH
EB22S48-1.8	2.2µF Ceramic	Not Used	220µF Electrolytic	8.2 nF	8.2 nF	0.63mH	0.63mH
EB45S3.3-30	2.2µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.77mH	0.77mH
EB45S5-20	2.2µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.59mH	0.59mH
EB45S12-10	2.2µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.59mH	0.59mH
EB45S15-5	2.2µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.77mH	0.77mH
EB45S24-4	2.2µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.59mH	0.59mH
EB45S48-1.8	2.2µF Ceramic	Not Used	100µF Electrolytic	8.2 nF	8.2 nF	0.59mH	0.59mH

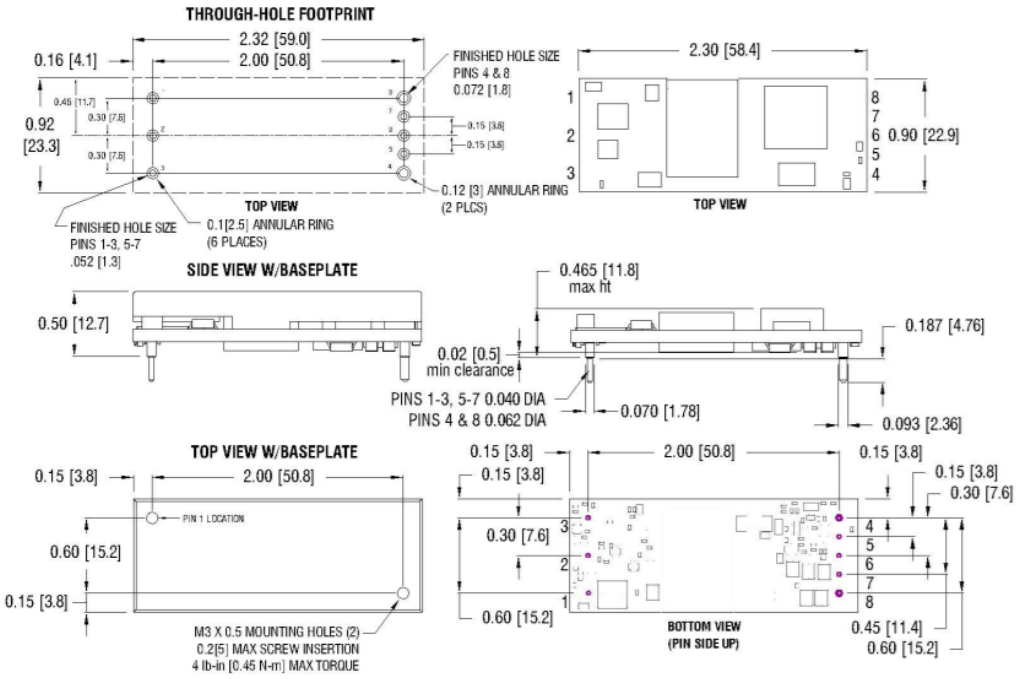
*Please consult factory for updated values

Selected Conducted Emissions Using Specified Input Filter (please consult factory for specific models)



EB22S5-15

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 #	DESIGNATION	NOTES
1	V_{IN} (+)	**1)** All dimensions in inches [mm] Tolerances: .xx ± 0.02 [.x ± .5] .xxx ± 0.010 [.xx ± .25] **2)** Input, on/off control and sense/trim pins are Ø 0.040" [1.02] ± 0.002" [0.05] with Ø 0.070" [1.77] standoff shoulders. 3) Output pins 4 & 8 are Ø 0.062" [1.57] ± 0.003" [0.08] with Ø 0.093" [2.36] standoff shoulders 4) All pins are gold plated with nickel under plating. 5) Weight: 12.8 g (0.45 oz.) 6) Workmanship: Meets or exceeds IPC-A-610 Class II
2	On/Off	
3	V_{IN} (-)	
4	V_{OUT} (-)	
5	Sense (-)	
6	Trim	
7	Sense (+)	
8	V_{OUT} (+)	

PART NUMBER ORDERING INFORMATION

Family, Form, Factor, Package	Nominal Input Voltage	Number of Outputs	Voltage Output		Current Output (A)	Options
EB	22	S	5	–	20	B, N, P, S
	(9-36) 22 Volts (18-72) 45 Volts	S - Single	3.3 Volts 5 Volts 12 Volts 15 Volts 24 Volts 48 Volts		Output Current (A)	None – Open Frame N - Negative On/Off control P - Positive On/Off control B - Baseplate S – SMT Construction

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