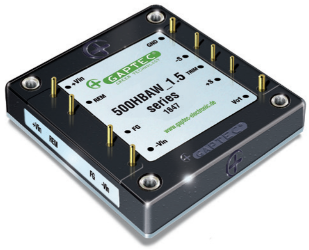


500HBAW_1.5 series

500W Half-Brick - Single Output DC-DC Converter - Wide Input - Isolated & Regulated

DC-DC Converter 500 Watt

- Compliance with RoHS6 EU Directive 2011/65/EU
- Delivers up to 10A output current
- High efficiency, typ.93% at Vout 100% load
- Low output ripple and noise
- Exceptional thermal performance
- Industry standard "Half-brick" footprint
- Remote On/Off positive logic
- Fixed switching frequency (270 kHz typical)
- Remote Sense
- Input under voltage lockout
- Output over voltage protection
- Over temperature protection
- Output over current protection
- Adjustable output voltage: 25V~57.6V
- Meets the voltage and current requirements for ETSI 300-132-2 and complies with and licensed for Basic Insulation rating per IEC60950-1

The 500HBAW_1.5 series are half-brick DC-DC converters that provide high efficiency single output. They can operate from 36VDC to 75VDC input and 50V/10A output. The output can be trimmed from 25V to 57.6V. The remote on/off feature on the module can be either negative or positive logic. Negative logic turns the module on during a logic low and off during a logic high. Positive logic turns the modules on during a logic high and off during a logic low. The output voltage trim can be either negative or positive trim logic. Positive trim logic indicates that the output voltage will increase when the TRIM pins are connected to "+Vo1" and decrease when connected to "GND". Negative trim logic indicates that the output voltage will decrease when the TRIM pins are connected to "+Vo1" and increase when connected to "GND".

Output specifications

Item	Test condition	Min	Typ	Max	
Short circuit protection	Hiccup Mode Automatic recovery	4			h
Efficiency	Vin=48V, 100%load ambient temperature 25°C	91.5 93	93		% %
Operating temp		-40		100	°C
Storage temperature		-55		125	°C
Operating Humidity				90	%RH
Storage Humidity				90	%RH
Operating Altitude		0		3000	m
Storage Altitude		0		3000	m
Switching Frequency	Vin=Vin(nom); Io=Io(max); Fixed frequency	220	270	320	kHz
MTBF	Telcordia SR332, 40°C Ta	2,800,000			h
FIT	109/MTBF		357		
Thermal Stability Time		-	30		min
Weight		70	75	80	g
Safety	Compliant to IEC60950-1,UL60950-1,EN60950-1,GB4943				
Vibration	IEC60068-2-6:10-500Hz sweep,0.75mm excursion,10g acceleration, 10min in each 3 perpendicular directions				
Transportation	ETS300019-1-2				
Shock	IEC60068-2-27:200g acceleration, duration 3 ms,6 drops in each 3 perpendicular directions				

Input specifications

Item	Test condition	Min	Typ	Max	Units
Input voltage	• Continuous • Transient (100ms)			80 100	VDC VDC
Operating Input Voltage		36	48	75	VDC
Max. Input Current	100% load Vin=36V			17	A
No load Input Current	No load Full Input Voltage			200	mA
Standby Input Current	mA		10	100	mA
Input Reflected Ripple Current Peak-to-Peak	12 µH source impedance, add 470µFelectrolytic and 1µF ceramic capacitor at input		150	300	mA
Recommended External Input Capacitance	Low ESR capacitor recommended	330			µF
Inrush Transient				1	A^2S
Input fuse				20	A

Output specifications

Item	Test condition	Min	Typ	Max	
Voltage set point	Vin=Vin(nom); Io=Io(max)	49.5	50	50.5	VDC
Output Current				10	A
Line regulation	Vin=Vin(min) to Vin(max) Io= Io(max)		±0.2	±0.5	%
Load regulation	Io=0 to Io(max);Vin=Vin(nom)		±0.2	±0.5	%
Voltage accuracy			±0.5	±1.0	%
Voltage adj. range	Vin=Vin(min) to Vin(max) Io=0 to Io(max)	-25		57.6	%Vo
Remote sense compensation				1	VDC
Output current limit inception		110		150	%Io
External load capacitance	ESR<200mΩ at -40°C, recommend 2~3PCS KY, KZE and KZH series aluminum capacitors in parallel	680		2200	µF
Temperature coefficient	Ambient Temperature -40°C ~85°C			200	ppm/°C
Dynamic response	25%-50%-25%&50%-75%-50% Io(max), di/dt=2.5A/µS		350/100	900/200	mV/µS
	1A(3.5ms)~8A(1.5ms);di/dt=1.5A/µS 1A(3.5ms)~8A(1.5ms), di/dt=1.5A/µS		1.5/100	2.2/200	V/µS
Ripple & Noise*	Measured with 10µF Tantalum external and 1µF ceramic capacitor at output, 100%load, 20MHz bandwidth		120	200	mV
Turn-on delay time	Time from instant at which Vin=Vin(min) until Vo=10% of Vo(nom)			500	ms
Turn-on Rise Time	Time for Vo to rise from 10% of Vo(nom) to 90% of Vo(nom)			300	ms
Output Voltage Overshoot				5	%Vo

* Test ripple and noise by "parallel cable" method. Measured with 10µF Tantalum and 1µF ceramic

Example:
500HBAW_4848S1.5
W = 500 Watt; HB = Half-Brick; A = Pinning; W = Wide input (2:1);
48 = 36-72 Vin; 48 = 48Vout; S = Single Output; 1.5 = 1.5kVDC Isolation

Note:
1. Operation under minimum load will not damage the converter; However, they may not meet all specification listed, and that will reduce the life of product.
2. All specifications measured at Ta = 25°C, humidity <75%, nominal input voltage and rated output load unless otherwise specified.
3. In this datasheet, all the test methods of indications are based on corporate standards.

Isolation specifications

Item	Test condition	Min	Typ	Max	Units
Isolation voltage	Tested for 1 minute leak current <10mA • Input-output • Input-case • Output-case		1500 1050 500		VDC VDC VDC
Isolation resistance	Normal air pressure, 500Vdc, the isolation resistance is no more than 10 MΩ	10			MΩ
Isolation Capacitor (Input-Output)			4400		pF

Remote control specifications

Item	Test condition	Min	Typ	Max	Units
Logic Low Voltage	Converter guaranteed logic high when REM pin is left open	0		1.2	V
Logic High Voltage	Converter guaranteed logic high when REM pin is left open	2.4		20	V
Remote On/ Off Current				3	mA

Protection specifications

Item	Test condition	Min	Typ	Max	Units
Input under voltage lockout	• Turn-off threshold • Turn-on treshold • Hysteresis	32 31 1	 2	35 34 3	VDC VDC VDC
Output over voltage protection	Under the converter's maximum allowable output power. hiccup	58		65	VDC
Output over current protection	Hiccup mode, automatic recovery		Yes		
Over temperature protection	Automatic recovery See OTP section	102	110	120	°C
Over temperature protection Hysteresis	Automatic recovery See OTP section	2	5	10	°C

Product Selection Guide

Part Number	Input Voltage [V]	Input current [A, max]	Output Voltage [VDC]	Output Current [A, typ/max]	Efficiency* [%, min/typ]
450HBAW_4848S1.5	36-72	2.45	48	8.3/9.1	87/90

* Vin = Vin(nom); Io = Io(max), ambient temperature 25°C

Typical Characteristic Curves

Converter efficiency vs output current (figure 1)

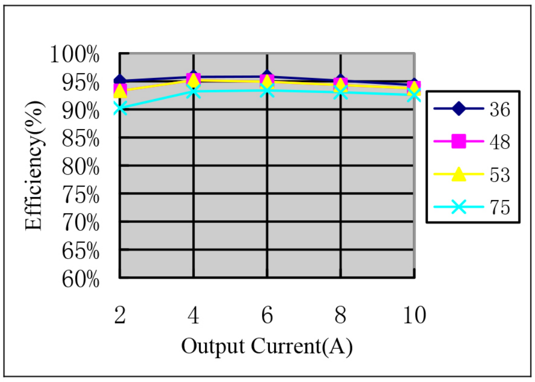


Figure1. Converter Efficiency Vs. Output Current@25℃

Derating output current vs local ambient temperature (figure 2)

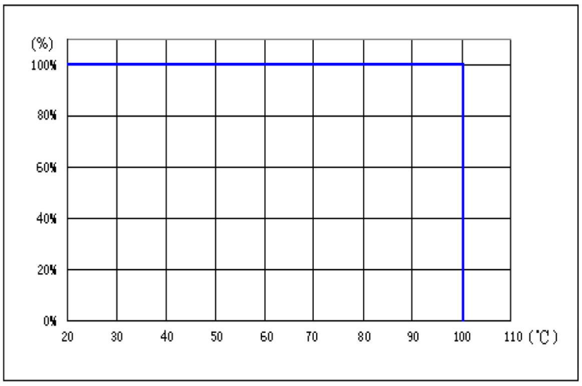


Figure2. Output power derating curve, load current Vs. aluminum baseplate temperature,48Vin

Dynamic Response

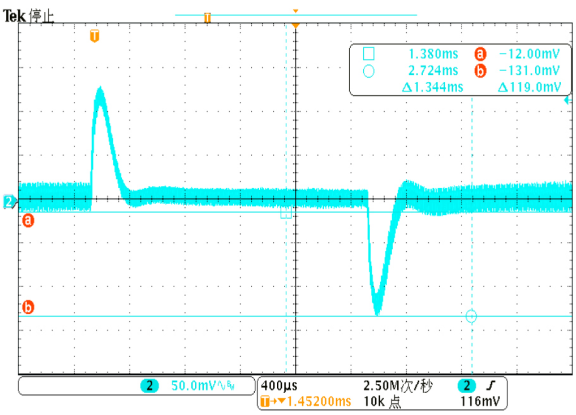


Figure3.Vin=48V/Vo=50V, 25%-50%~25%load. 2.5A/μS@25℃

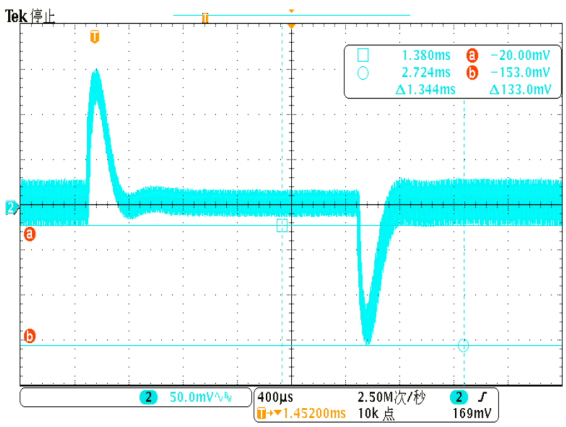


Figure4.Vin=48V/Vo=50V, 50%-75%-50%load, 2.5A/μS@25℃

Typical Output Ripple and Noise (figure 5)
Vin = Vin, nom; Io=Io, max)

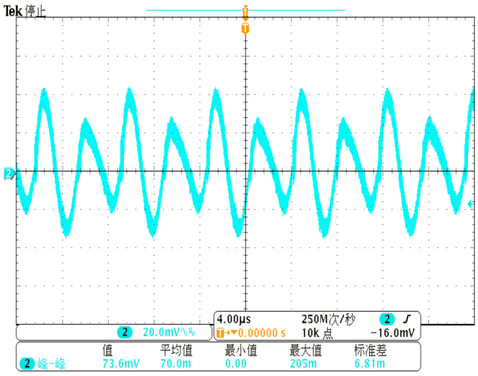


Figure5. Output ripple and noise @ Vin=48V, 100%load(20MHz bandwidth@25℃)

Typical Start-up using Input Voltage (figure 6)

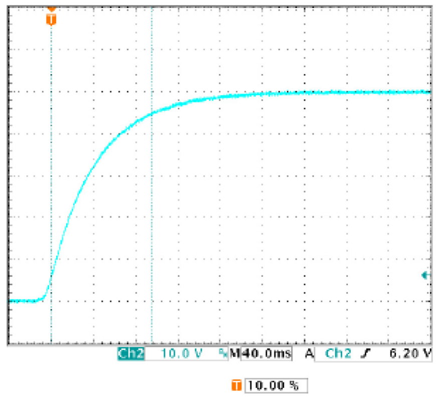
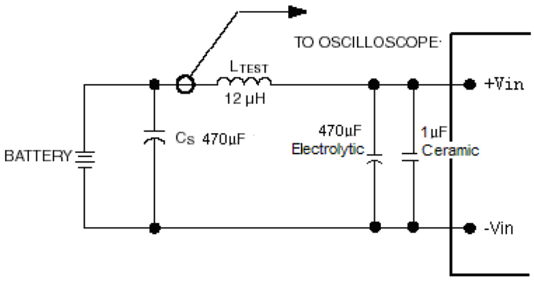


Figure6. Typical Start-up (Vin=36V,100% load@25℃)

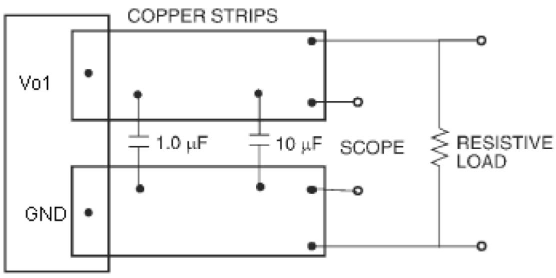
Test configurations

Input Reflected Ripple Current Test Setup (figure 7)



Note: Measure input reflected ripple current with a simulated source inductance of 12µH. The measurement points for input reflected ripple current is showed above.

Output Ripple and Noise Test Setup (figure 8)



Note: Scope measurements should be made using a BNC socket with a 1µF ceramic capacitor and a 10µF tantalum capacitor. Position the oscilloscope probe between 51mm and 76mm (2in and 3in) from the module

Design considerations

Input filtering

The power module should be connected to a low acimpedance input source. Highly inductive source impedances can affect the stability of the power module. For the test configuration in Figure7 a 470µF electrolytic capacitor and a 1µF ceramic capacitor, mounted close to the power module helps ensure stability of the unit.

Safety considerations

For safety-agency approval of the system in which the power module is used, the power module must be installed in compliance with the spacing and separation requirements of the end-use safety agency standard, i.e. UL60950-1, CAN/CSA-C22.2, No. 60950-1 and EN60950-1:2001(+A11) and IEC60950-1:2005, if the system in which the power module is to be used must meet safety agency requirements.

These converters have been evaluated to the spacing requirements for Basic Insulation, per the above safety standards.

For all input voltages, other than DC mains, where the input voltage is less than 60Vdc, if the input meets all of the requirements for SELV, the output is considered to remain with SELV limits. Signal component failure and fault tests were performed in the power converters.

If the input source is non-SELV (ELV or hazardous voltage greater than 60Vdc and less than or equal to 75Vdc), for the module's output to be considered as meeting the requirements for safety extra-low voltage (SELV), all of the following must be true.

1. The input source is to be provided with reinforced insulation from any other hazardous voltage, including the AC mains.
2. One VIN pin and one VOUT pin are to be grounded, orboth the input and output pins are to be kept floating.
3. The input pins of the module are not operatoraccessible.
4. Another SELV reliability test is conducted on the whole system as required by the safety agencies, to verify that under a single fault, hazardous voltages do not appear at the module's output.

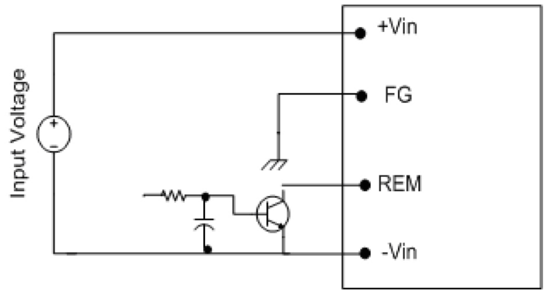
All flammable materials used in the manufacturing of these modules are rated 94V-0.

To preserve maximum flexibility, internal fusing is not included, however, to achieve maximum safety and system protection, always use an input line fuse. The safety agencies require a time delay fuse with a maximum rating of 30A. Based on the information provided in this data sheet on inrush energy and maximum dc input current, the same type of fuse with a lower rating can be used. Refer to the fuse manufacturer's data sheet for further information.

Feature descriptions

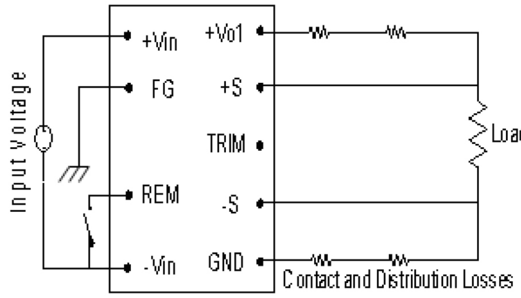
Remote on/off

The REM pin is used to turn the power converter remote on or off via a system signal. Two remote on/off logic are available. Negative logic turns the module on when the REM pin is at logic low and off when it is at logic high. Positive logic turns the module on during logic high and off during logic low.
To turn the power module on and off, the user must supply a switch to control the voltage between the REM pin and -Vin terminal (see Figure 9). A logic low is VREM =0 to 0.8 V. During logic high, the maximum VREM voltage generated by the power module is 20V. If not using the remote on/off feature, perform one of the following to turn the converter on:
For negative logic, short REM pin to -Vin.
For positive logic, leave REM pin open.



Remote sense

Remote sense minimizes the effects of distribution losses by regulating the voltage at the remote sense connections (see Figure 10). The voltage between the remote sense pins and the output terminals must not exceed the output voltage sense range. The voltage between the +Vo1 and GND terminals must not exceed the minimum output overvoltage protection value shown in the Electrical Specifications table. This limit includes any increase in voltage due to remote sense compensation and output voltage programming (trim). If not using the remote sense feature to regulate the output at the point of load, then connect +S to +VO1 and -S to GND. 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, which at the same time the output current would increase the power output of the module. Care should be taken to ensure that the maximum output power of the module remains at or below the maximum rated power.

Output Voltage Programming
Resistance adjustment mode

Output voltage trim allows the user to increase or decrease the output voltage set point of a module. This is accomplished by connecting an external resistor between the TRIM pin and either the +S or -S pins. If not using the trim feature, leave the TRIM pin open.
To increase the output voltage, refer to figure 12. A trim resistor, R_{trimup}, connected between the TRIM and +S pin. The maximum trim up voltage can reach up to 57.6V at input voltage from 36-75V. See figure 11.

$$R_{trimup} = \left(\frac{V_{OUT} \times (100 + \Delta)}{1.225 \times \Delta} - \frac{(100 + 2 \times \Delta)}{\Delta}\right) K\Omega$$

R_{trimup} = Required value of trim-up resistor [kΩ]

$$\Delta = \left|\frac{V_{OUT} - V_{trimup}}{V_{OUT}}\right| \times 100$$

V_{OUT} = Nominal value of output voltage [V]

V_{trimup} = Desired (trimmed) output voltage [V].

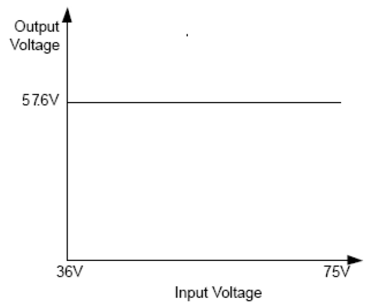


Figure 11 Max. adjustable output voltage vs. input voltage

Trimming beyond 57.6V is not an acceptable design practice, as this condition could cause unwanted triggering of the output over-voltage protection (OVP) circuit .When trimming up, care must be taken not to exceed the converter's maximum allowable output power.
To decrease the output voltage (see Figure13.), a trim resistor, Rtrimdown, should be connected between the TRIM and -S, with a value of

$$R_{trimdown} = \left(\frac{100}{\Delta} - 2\right) \quad K\Omega$$

$R_{trimdown}$ = Required value of trim-down resistor [kΩ]

$$\Delta = \left|\frac{V_{OUT} - V_{trimdown}}{V_{OUT}}\right| \times 100$$

V_{OUT} = Nominal value of output voltage [V]

$V_{trimdownt}$ = Desired (trimmed) output voltage [V]

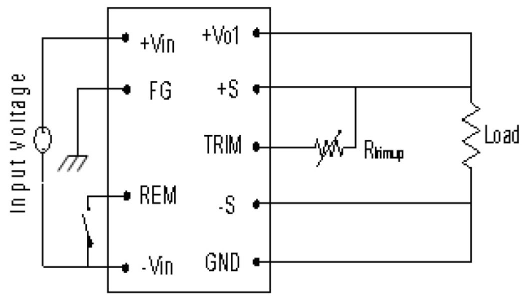


Figure12. Circuit Configuration to Increase Output Voltage.

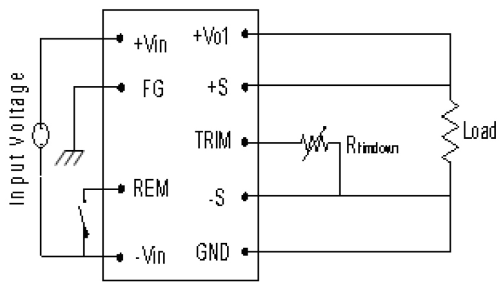
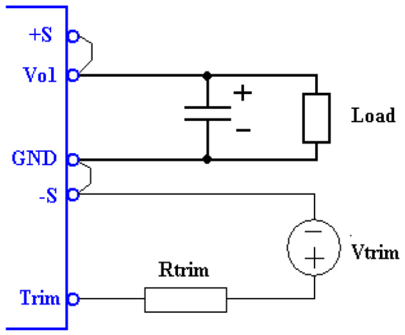


Figure13. Circuit Configuration to Decrease Output

Voltage adjustment mode

The output voltage can also be trimmed by potential applied at the trim pin. An external trim resistor is connected between trim pin and Vtrim. See Figure 14.



The relationship between Vtrim and Vo is described as below:

$$V_{trim} = \frac{(2 + \text{Rtrim}) * \text{Vout}}{40.32} - (1 + Rtrim) * 1.24$$

V_{nom} = Nominal value of output voltage, 50V

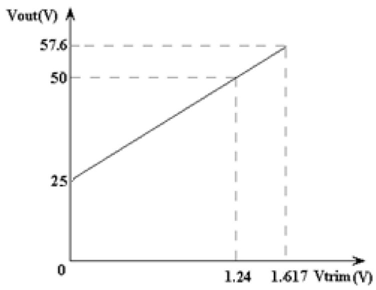
V_{out} = Desired (trimmed) output voltage [V]

V_{trim} =The potential applied at the trim pin [V]

Rtrim =The external trim resistor [kΩ]
When Rtrim=0 kΩ

V trim = 0.0496 * Vout - 1.24 trim

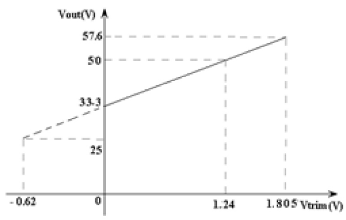
The trim curve is shown as Figure 15.



When Rtrim=1 kΩ

V trim = 0.0744 * Vout - 2.48

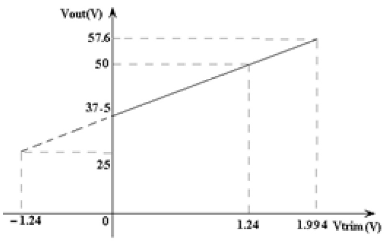
The trim curve is shown as Figure 16.



When Rtrim=2kΩ

V trim = 0.0992 * Vout - 3.72

The trim curve is shown as Figure 17.



Protection features

Over current Protection
To provide protection in an output overload fault condition, the module is equipped with internal current limiting circuitry, and can endure current limiting continuously. At the point of current limit inception, the unit enters hiccup mode. The unit is configured with the auto-restart function, it will remain in the hiccup mode as long as the overcurrent condition exists, it operates normally once the output current is reduced back into its specified range.

Output Overvoltage Protection
The output over voltage protection consists of circuitry that monitors the voltage on the output terminals. When the output voltage exceeds the overvoltage protection threshold, the module will operate in a hiccup mode until overvoltage cause is cleared.

Over temperature Protection
To provide protection under certain fault conditions, the module is equipped with a thermal shutdown circuit. The module will shutdown when the aluminum baseplate temperature exceeds OTP set value, but the thermal shutdown is not intended as a guarantee that the module will survive when the temperatures beyond its rating. The module will automatically restarts after it cools down.

Input Undervoltage Lockout
Input under-voltage lockout is standard with this converter, when input voltages below the input under-voltage lockout limit, the module operation is disabled. It will only begin to operate once the input voltage is raised above the undervoltage lockout turn-on threshold

Thermal considerations

The power modules operate in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit.

Considerations include ambient temperature, airflow, module power dissipation, and the need for increased reliability. A reduction in the operating temperature of the module will result in an increase in re-liability.

Through-Hole Soldering Information
The product is intended for through-hole mounting in a PCB. When wave soldering is used, the temperature on the pins is specified to maximum 270 °C for maximum 10 seconds.

Maximum preheat rate of 4 °C/s and temperature of max 150 °C is suggested, when hands soldering care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

A no-clean (NC) flux is recommended to avoid entrapment of A noclean (NC) flux is recommended to avoid entrapment of cleaning fluids in cavities inside of the DC/DC power module. The residues may affect long time reliability and isolation voltage.

EMC Considerations

The Figure 18 shows a suggested configuration to meet the conducted emission limits of EN55022 Class B.

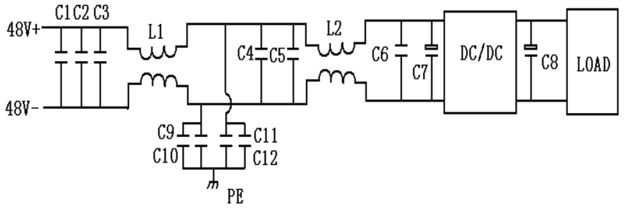
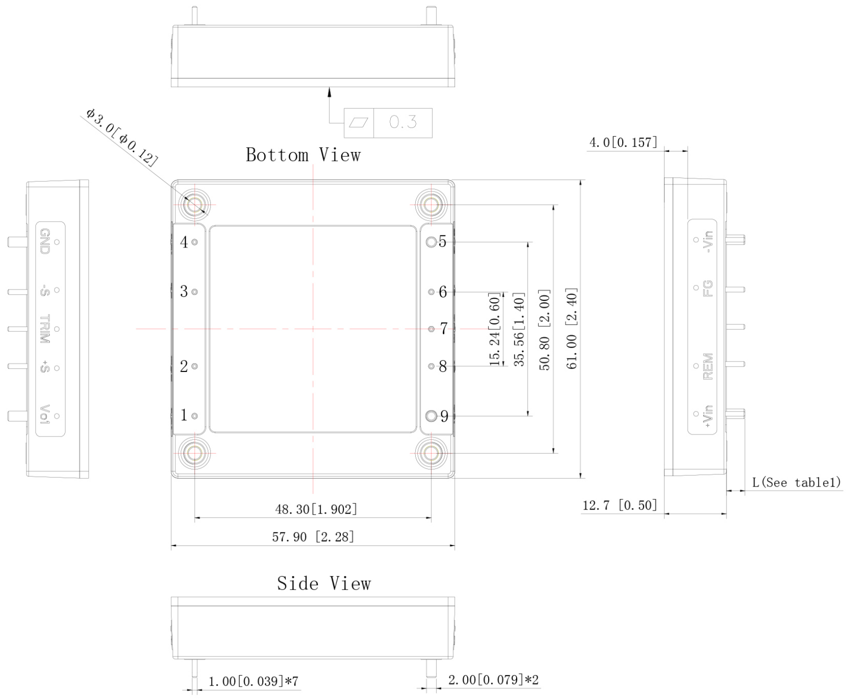


Figure18. EMC testing typical application circuit

Component	parameters
C1 C2 C3 C4 C5	1uF SMD ceramic capacitor
C6	0.1uF SMD ceramic capacitor
L1 L2	470uH Common-mode inductance
C9 C10 C11 C12	0.22uF Isolation voltage SMD capacitor
C7	470µF electrolytic capacitor
C8	1000µF electrolytic capacitor

Outline Diagram

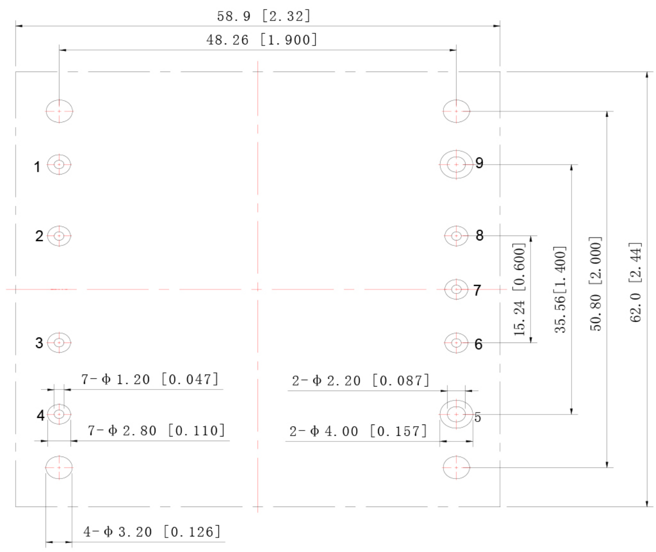


Pin options	L(Pin length)
standard	3.6(0.14)
Z1	2.8(0.11)
Z2	4.6(0.18)
Z3	-5.8(0.23)
Z4	6.4(0.25)

Figure19. Outline Diagram

Dimensions are in millimeters and (inches).
Tolerances: x mm ± 1 mm(x.x in. ± 0.04in.)
x.x mm ± 0.5 mm (x.xx in. ± 0.02 in.)
x.xx mm ± 0.25 mm (x.xxx in. ± 0.010 in.) [unless otherwise indicated]

Recommended Pad Layout



Pin	S	Function
1	+Vin	Positive input voltage
2	REM	Remote control
3	FG	Case
4	-Vin	Negative input voltage
5	GND	Negative output voltage
6	-S	Negative remote compensation
7	TRIM	Output voltage trim
8	+S	Positive remote compensation
9	+Vo1	Positive output voltage

Figure20. Recommended Pad Layout

Dimensions are in millimeters and (inches).
Tolerances: x.x mm ± 0.5 mm (x.xx in. ± 0.02 in.) [unless otherwise indicated]
x.xx mm ± 0.25 mm (x.xxx in. ± 0.010 in.)