AEH60F48 Isolated DC/DC Converter Module
Industry Standard ½ Brick – 36-75V Input, 5.0V Output

Astec's Ultra High Density ½ Brick capable of running 60Amps at 5.0V output. With Efficiencies up to 90% typical at 5.0V, 60Amps this product provides a 1% to 2% performance increase in efficiency over the leading 60Amp. The operating temperature range (-40C to 100C baseplate) assures maximum reliability. The new single-output model also features superior transient response with excellent stability in high capacitance/low ESR load applications.

Industry Standard
½ Brick Package

Special Features

- **High efficiency, 5.0V@90%**
- **-40°C to 100°C baseplate operating temperature**
- **Positive and Negative enable function**
- **Low output ripple and noise**
- **High capacitive load limit on start-up**
- **Remote sense compensation**
- **Regulation to zero load**
- **Fixed frequency switching (400 kHz)**

Environmental Specifications

- **Operating temperature:**
  -40°C to +100°C (Baseplate)
- **Storage temperature: -55°C to +125C**
- **MTBF: >1 million hours**

Electrical Parameters

Input

Input range	**36-75 VDC**
Input Surge	**100V / 100ms**
Efficiency	**90%@5.0V (Typical)**

Control

Enable TTL compatible
(positive & negative enable options)

Output

Regulation (Line, Load, Temp)	**<2%**
Ripple and noise	**2% typical (100mV p-p max)**
Remote sense	**Up to 10%Vout**
Output voltage adjust range	**+/-10% of nominal output**
Transient Response	**4% max deviation with 50% to 75% full load 300 µS (max) recovery**
Overvoltage Protection	**130% nominal output**

Safety

UL, cUL	**1950 Recognized**
TUV	**EN60950 Licensed**

AEH60A48 series

THIS SPECIFICATION COVERS THE REQUIREMENTS FOR AN INDUSTRY STANDARD ½ BRICK (MAX 300W @ 5.0V) SINGLE OUTPUT ULTRA HIGH EFFICIENCY ISOLATED DCDC CONVERTER

PART NUMBERS

MODEL NAME / SIS CODE	Construction	Vout, Iout
AEH60A48N	Heatsinkable	5.0V/60A
AEH60A48	Heatsinkable	5.0V/60A

OPTIONS

Suffix	Option
N	Negative Logic Enable
No Suffix	Positive Logic Enable

ELECTRICAL SPECIFICATIONS

Unless otherwise indicated, specifications apply over all operating input voltage and temperature conditions. Standard test condition on a single unit.

Tambient :	25°C
+Vin :	48V +/ –2%
–Vin :	return pin for +Vin
Enable :	Open
+Vout :	connect to load
–Vout :	connect to load (return)
Trim(Vadj) :	Open
+Sense :	connected to +Vout
-Sense :	connected to -Vout

ABSOLUTE MAXIMUM RATINGS

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device in not implied at these or any other conditions in excess of those given in the operational sections of the IPS. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Device	Symbol	Min	Typ	Max	Unit
Input Voltage:						
Continuous:	All	V_I	0	-	75	Vdc
Transient (100ms)	All	$V_{I, trans}$	0	-	100	Vdc
Operating Base/Ambient Temperature	All	Tc/Ta	-40	-	100	ºC
Storage Temperature	All	T_{STG}	-55	-	125	ºC
Operating Humidity	All	-	-	-	85	%
I/O Isolation (Conditions : 50µA for 5 sec, slew rate of 1500V/10sec)						
Input-Output	All	-	-	-	1500	Vdc
Input-Case		-	-	-	1500	Vdc
Output-Case		-	-	-	1500	Vdc
Output Power	5.0V	Po,max	-	-	300	W

INPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
a) Operating Input Voltage	All	V_I	36	48	75	V_{DC}
b) Maximum Input Current (V_I = 0 to $V_{I,max}$: Io = Io,max)	All	$I_{I,max}$	-	-	10.0	A
c) Input Reflected-ripple Current (5Hz to 20MHz: 12uH source impedance: T_A = 25 ºC.) See Figure 1.	All	I_I	-	-	20	mAp-p
d) No Load Input Power (V_I = $V_{I,nom}$)	All	-	-	-	8	W

CAUTION: This power module is not internally fused. An input line fuse must always be used.

OUTPUT SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Voltage Setpoint ($V_I = V_{I,min}$ to $V_{I,max}$: Io = Io,max; T_A = 25 ºC)	5.0V	$V_{o,set}$	4.9	5.0	5.1	Vdc
Output Regulation:						
Line	All	-	-	0.1	0.4	%
Load(Io = Io,min to Io,max)	All	-	-	0.1	0.4	%
Temperature (Tc = -40 ºC to +100ºC)	All	-	-	-	1.0	%Vo
Output Ripple and Noise (Across 1µF @50V, X7R ceramic capacitor & 10µF @25V tantalum capacitor) See Figure 2.	All	-	-	60	100	mVp-p
Peak-to-Peak (5 Hz to 20 MHz)						
External Load Capacitance (See Stability Curves for Detail)	All	-	-	-	50000	µF
Rated Output Current	All	Io	0	-	60	A
Output Current-limit Inception (Hiccup mode)	All	Io	65	-	77	A
Maximum Overload Current (Hiccup Mode)	All	-	-	-	150	$\%I_{out,max}$
Efficiency ($V_I = V_{I,nom}$; $I_{o,max}$; T_A = 25°C)	All	-		90	-	%
Switching Frequency	All	-	190	200	210	KHz

OUTPUT SPECIFICATIONS (Cont)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Dynamic Response : ($\Delta Io/\Delta t$ = 1A/10µs ; $V_I = V_{I,nom}$; TA = 25°C)						
Load Change from Io = 50% to 75% of Io,max : Peak Deviation Settling Time (to $V_{o,nom}$)	All	- -	- -	- -	6 250	%Vo µsec
Load Change from Io = 50% to 25% of Io,max : Peak Deviation Settling Time (to $V_{o,nom}$)	All	- -	- -	- -	6 250	%Vo µsec
Turn-On Time (Io = Io,max ; Vo within 1%)	All	-	-	4	10	msec
Output Voltage Overshoot (Io = Io,max ; T_A = 25°C)	All	-	-	0	4	%Vo

FEATURE SPECIFICATIONS

Parameter	Device	Symbol	Min	Typ	Max	Unit
Enable pin voltage :						
Logic Low	All		-0.7	-	1.2	V
Logic High	All		2.5	-	10	V
Enable pin current :						
Logic Low	All		-	-	1.0	mA
Logic High(leakage current, @10V)	All		-	-	50	µA
Module Output voltage @ Logic High	AEH60A48N		-	-	1.2	V
Module Output voltage @ Logic Low	AEH60A48		-	-	1.2	V
Output Voltage Adjustment Range	All	-	90	-	110	%Vo
Output Overvoltage Clamp	All	Vo_{clamp}	5.90	-	6.00	V
Undervoltage Lockout						
Turn-on Point	All	-	-	35	35.5	V
Turn-off Point	All	-	33	33.5	-	V
Isolation Capacitance	All	-	-	2700	-	PF
Isolation Resistance	All	-	10	-	-	MΩ
Calculated MTBF (Io = Io,max ; T_A = 25°C)	All	-	-	TBD	-	Hours
Weight	All	-	-	-	TBD	g(oz.)

Basic Operation and Features

The AEH/ALH60 was designed specifically to address applications where ultra high power density is required. This modules provides basic insulation and 1500V isolation with very high output current cability in an Industry Standard Half Size Module. It operates from a 36 to 75V and has several standard features such as Sense, Trim, OVP, OCP, OTP protection. The AEH60 series is designed to accept industry standard heatsinks which will enhance the modules thermal performance in application where conductive cooling is required.

Remote Sense (+Sense, -Sense)

Connect the + Sense and – Sense pins directly to the load to allow the module to compensate for the voltage drop across the conductors carrying the load current. IF remote sense is not required (For example if the load is close to the module) the sense pins should be connected directly to the corresponding output pins. The maximum compensation is limited to 10% Vout.

Output Overvoltage Clamp

The output overvoltage clamp consists of a separate control loop, independent of the primary control loop. This control loop has a higher voltage setpoint than the primary loop. In a fault condition the converter goes into “Hiccup Mode”, and the output overvoltage clamp ensures that the output voltage does not exceed Vo,clamp,max. This secondary control loop provides a redundant voltage-control that reduces the risk of output overvoltage.

Output Current Protection

To provide protection in an output overload or short circuit condition, the converter is equipped with current limiting circuitry and can endure the fault condition for an unlimited duration. At the point of current-limit inception, the converter goes into “Hiccup Mode”, causing the output current to be limited both in peak and duration. The converter operates normally once the output current is brought back into its specified range.

Enable Function

Two enable option are available. Positive Logic Enable, no suffix, and Negative Logic Enable, suffix “N”. Positive Logic Enable turns the converter on during a logic-high voltage on the enable pin, and off during a logic-low. Negative Logic Enable turns the converter off during a logic-high and on during a logic-low.

Trim Function

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

With an external resistor(Radj_up) connected between the Trim Pin and +Sense Pin the output voltage set point (Vo,adj) increases. See Figure 4 for connection. The following equation determines the required external resistor value to obtain an adjusted output voltage:

$$\text{Radj\_up} = \left[\frac{5.1Vo(100 + \%Vo,adj)}{1.225\%Vo,adj} - \frac{510}{\%Vo,adj} - 10.2\right]\cdot \text{kohm}$$

Trim Function

Where $R_{adj\text{-}up}$ is the resistance value in kOhm and %Vo,adj is the percent change in the output voltage.

With an external resistor(Radj_down) connected between the Trim Pin and -Sense Pin ($R_{adj\text{-}up}$) the output voltage set point (Vo,adj) decreases. See Figure 5 for connection. The following equation determines the required external resistor value to obtain an adjusted output voltage:

$$Radj\_down = \left(\frac{510}{\%Vo,adj} - 10.2\right)\cdot kohm$$

Where $R_{adj\text{-}down}$ is the resistance value in kOhm and %Vo,adj is the percent change in the output voltage.

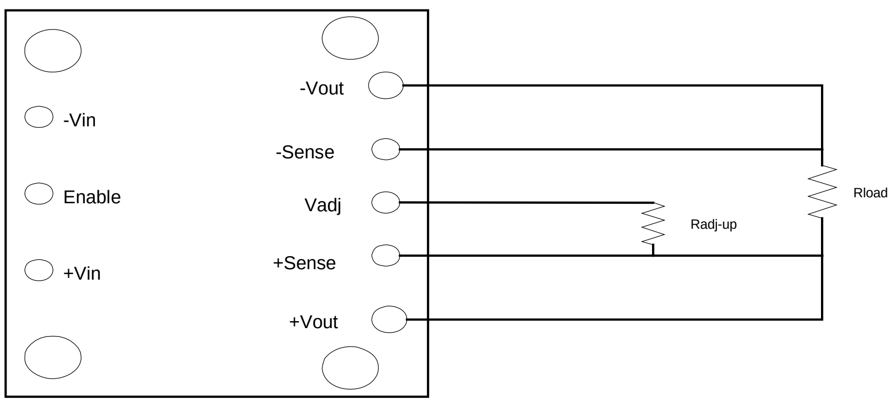


Figure 4. Circuit Configuration to Increase Output Voltage.

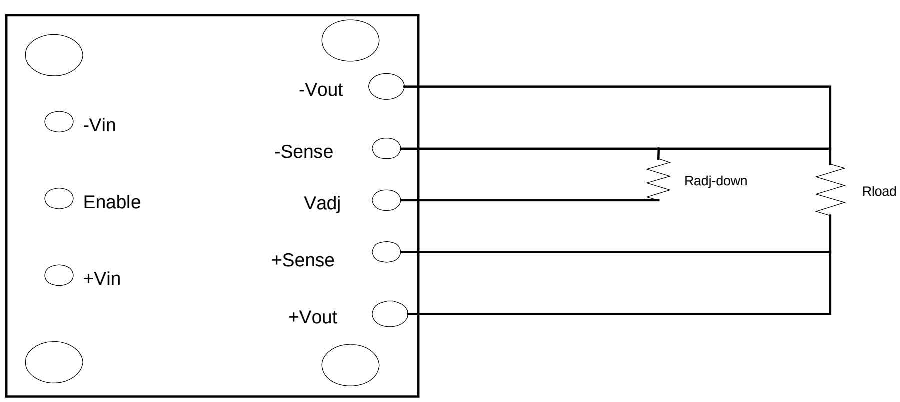


Figure 5. Circuit Configuration to Decrease Output Voltage.

Performance Curves – Efficiency (AEH60A48)

TBD

Figure 6: AEH60A48 (5.0) Efficiency vs Load Current **(25°C)**

TBD

Figure 7: AEH60A48 (5.0V) Efficiency vs Load Current **(70°C)**

Performance Curves – Output Performance Curves

Figure 9: AEH60A48 (5.0V) Output Current vs Temperature (Baseplate)

Performance Curves – Transient Reponse

Figure 10: AEH60FA8 (5.0V) – 50% to 75% to 50% load with no Ext Cap. (1.0A/uS)	Figure 11: AEH60A48 (5.0V) – 50% to 75% to 50% load with 9.4KuF Ext Cap. (1.0A/uS)

Performance Curves – Startup Characteristics

AEH60A48 (5.0V) – No Ext. Cap, 20A Resistive Load	AEH60A48 (5.0V) - 9.4K uF Ext. Cap, 20A Resistive Load

Input Filtering Considerations for FCC Class B Conducted:

A reference design for an input filter that can provide FCC Class B conducted noise levels is shown below. Two common mode connected inductors are used in the circuit along with balanced bypass capacitors to shunt common mode currents into the ground plane and back to the converter thereby reducing the amount of energy reaching the input LISN for measurement.
The application circuit shown has an earth ground (frame ground) connected to the converter output (-) terminal. Such a configuration is common practice to accommodate safety agency requirements. Grounding an output terminal results in much higher conducted emissions as measured at the input LISN because a hard path for common mode current back to the LISN is created by the frame ground. "Floating" loads generally result in much lower measured emissions. The electrical equivalent of a floating load, for EMI measurement purposes, can be created by grounding the converter output (load) through a suitably sized inductor(s) while maintaining the necessary safety bonding.

Also shown is a sketch of a PCB layout used to achieve Class B conducted noise levels. It is important to avoid extending the ground plane or any other conductors under the inductors (particularly L2) because capacitive coupling to that track or plane can effectively bypass the inductor and degrade high frequency performance of the filter.

Components:

L1, L2 Pulse Engineering P0353 590 uh

C1,3,4,5,6,11,12 0.01uf /2000V
C2,7,9 100uf / 100V Aluminum
C13,14 470pf / 100V Ceramic
C8,10 2.2uf / 100V Film

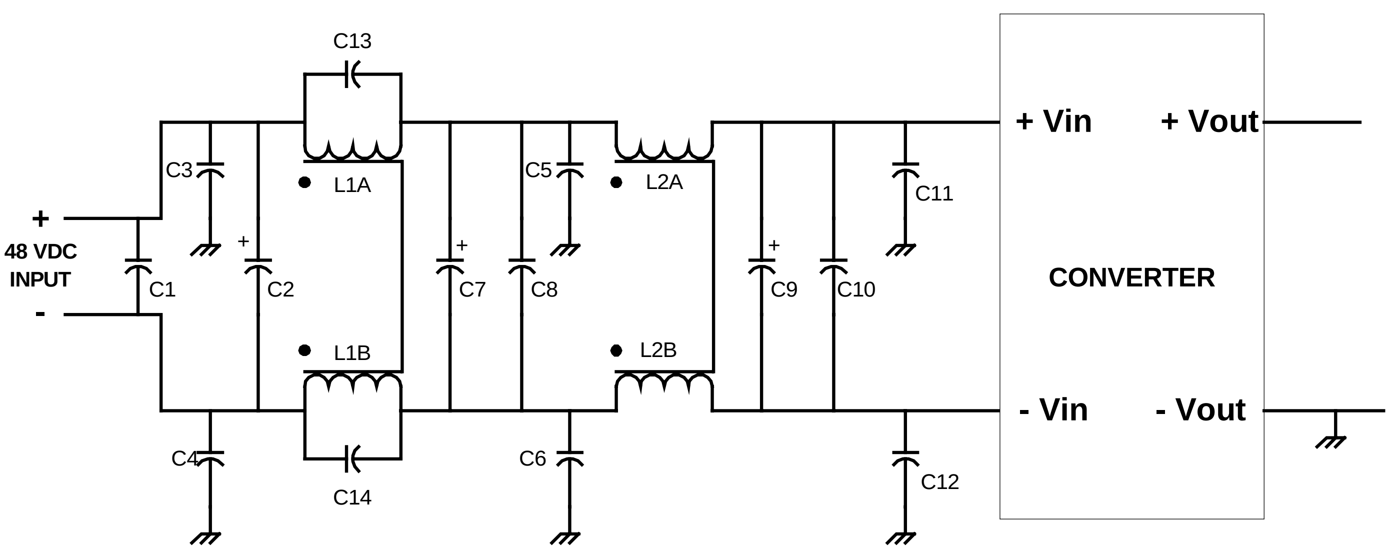


Figure 12: Class B Filter Circuit

Input Filtering: (Cont)

TBD

Figure 13: Recommended PCB Layout for Class B Filter

TBD

Figure 14: AEH60A48 Noise Spectrum

Mechanical Dimensions and Module Pin Assignment

.

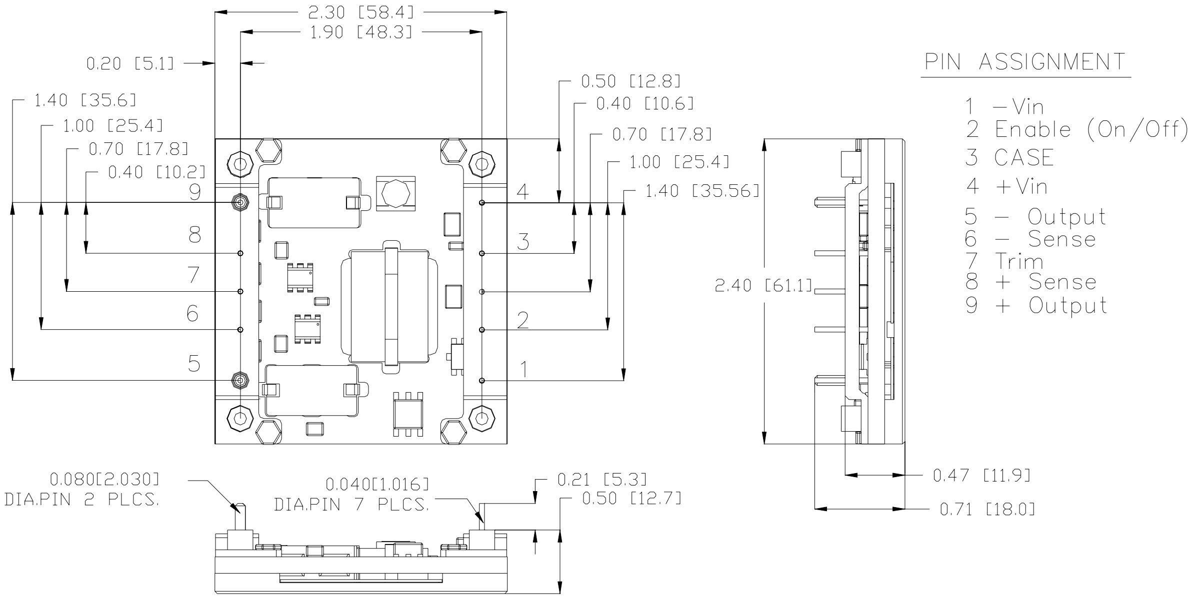
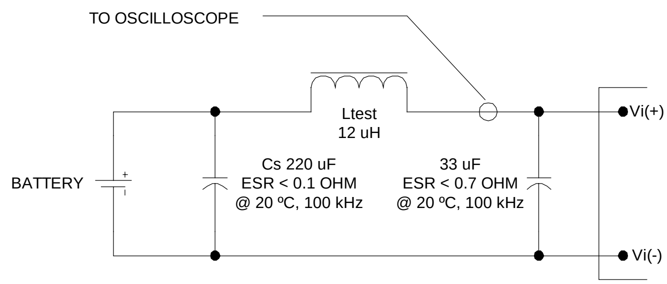


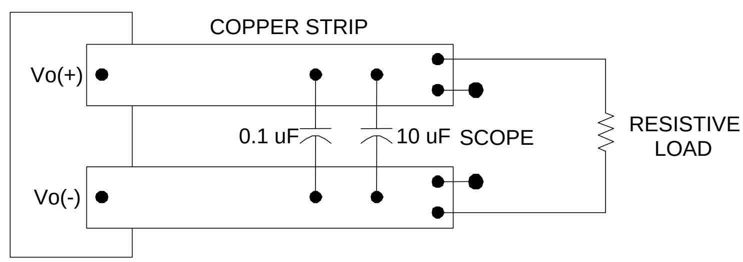
Figure 19 : Outline Drawing for AEH60

TEST SETUP



Note: Measure input reflected-ripple current with a simulated source inductance (Ltest) of 12 uH. Capacitor Cs offsets possible battery impedance. Measure current as shown above.

Figure 23: Input Reflected-ripple Test Setup.



Note: Use a 0.1µF @50V X7R ceramic capacitor and a 10µF @ 25V tantalum capacitor. Scope measurement should be made using a BNC socket. Position the load between 51 mm and 76 mm (2 in. and 3 in.) from module.

Figure 24.: Peak-to-Peak Output Noise Measurement Test Setup.

SOLDERING CONSIDERATIONS

TBD

Recommend Storage Condition

Maximum storage period:	6 months
Storage condition:	30 deg C, 60%RH

Recommend baking the module at 100degC for 24 hours if storage period is longer than 6 months.