AMPSS®
Astec Modular Power Supply System

Gamma AK/BK60C High Efficiency Industry Standard Series

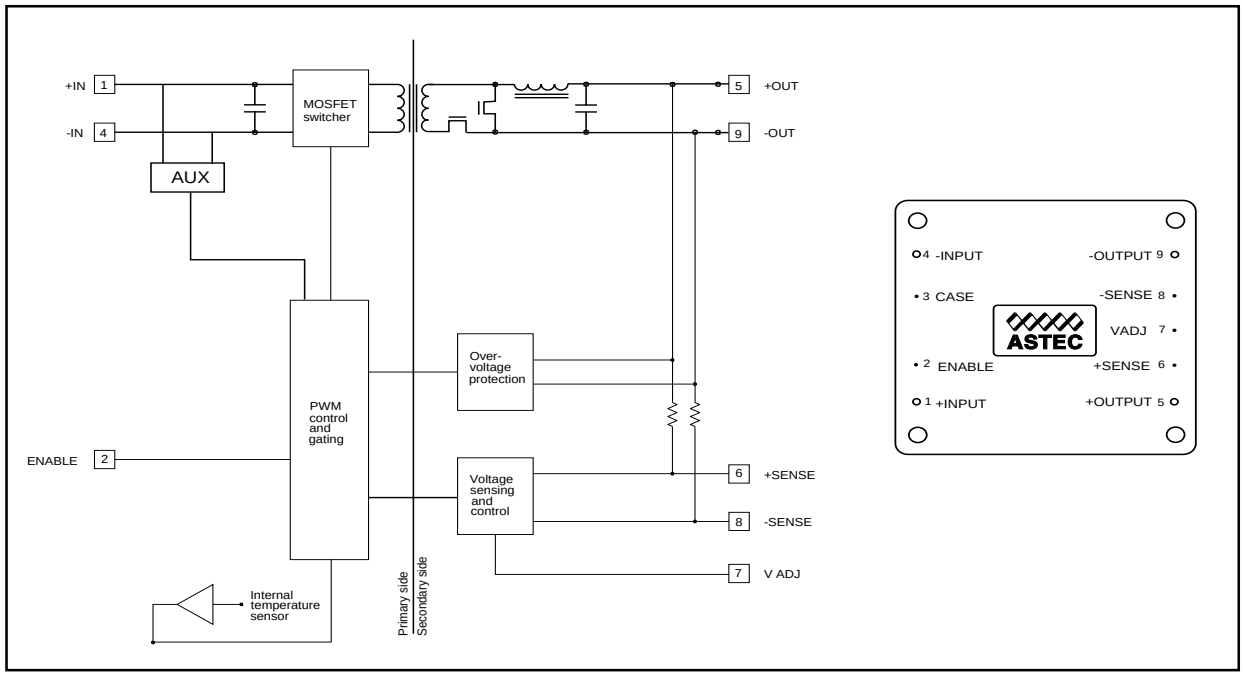
100-150W Output Power
DC-DC Converter Module
Technical Reference Manual

Series Highlights

- High Efficiency - up to 90%
- Industry standard pin out
- 100-150W Output Power
- 100°C baseplate/case operating temperature
- Low output ripple and noise
- High Reliability - over 1 million hours MTBF
- Wide input voltage range
- Fixed switching frequency
- Excellent Transient Response
- Designed to meet Telecom specifications

Contents

AK/BK60C High Efficiency Series DC-DC Converters



Introduction

The AK/BK60C High Efficiency Series is an isolated, single output DC to DC converter module, providing up to 150W output. The Industry Standard pin out series features full safety isolation, low voltage primary side control and a baseplate operating temperature of up to 100°C.

Key Requirements

- High Efficiency - 90% typical
- -40°C to 100°C baseplate operating temperature (no derating).
- Industry standard pin out
- Low output ripple and noise (150mV max on 5V)
- High capacitive load limit on start-up
- Remote Sense Compensation
- Reliability - 1 million hours MTBF min. at 50°C baseplate temperature
- Output Voltage Regulation to zero load
- Fixed frequency switching (300KHz)
- Output Voltage Adjust 80 - 120% of nominal
- Enable (high & low)
- Case pin

Safety Requirements

The modules will be safety approved to the following standards :

UL:	UL1950
cUL:	
TUV:	EN60950
CE:	CE Mark

Bellcore Specifications-

DC-DC converters conform to the standards pertaining to power supplies contained in the Bellcore Telecommunication specifications.

Related Products

FLTR100V10 and FLTR100V20 EMI filter.

Product Range

Model Number	INPUT VOLTAGE (V)	OUTPUT VOLTAGE (V)	OUTPUT POWER (W)
AK60C-048L-021F20H	48	2.1	42W (20A)
AK60C-048L-033F20H	48	3.3	66W (20A)
AK60C-048L-050F20H	48	5	100W (20A)
BK60C-048L-021F30H	48	2.1	63W (30A)
BK60C-048L-033F30H	48	3.3	99W (30A)
BK60C-048L-050F30H	48	5	150W (30A)
AK60C-048L-021F20HP	48	2.1	42W (20A)
AK60C-048L-033F20HP	48	3.3	66W (20A)
AK60C-048L-050F20HP	48	5	100W (20A)
BK60C-048L-021F30HP	48	2.1	63W (30A)
BK60C-048L-033F30HP	48	3.3	99W (30A)
BK60C-048L-050F30HP	48	5	150W (30A)

Electrical Specifications

Absolute Maximum Ratings – all models

These ratings are intended as guidelines for absolute worst case operating conditions and are not to be interpreted as recommended operating condition

General	48V Input
Continuous Input Voltage	75V
Input Surge Voltage (1 sec)	100V
Isolation, Input to Output	1500VDC
Isolation Input to Baseplate	1500VDC
Isolation, Output to Baseplate	500VDC
Operating Temperature (Baseplate)	-40 to 100°C
Start-up Temperature	-55°C min
Storage Temperature	-55 to 105°C
Operating Relative Humidity (non-condensing)	10% to 95%
Storage Relative Humidity (non-condensing)	95% Max
Altitude (Operating)	< 3000m
Altitude (Storage)	< 9000m
Lead Temperature (soldering 5 Seconds)	235°C

Secondary Control Pins	
+SENSE	(V_O - 0.5) to (V_O + 0.5) VDC
-SENSE	-0.5 to +0.5 VDC
V ADJ	-0.5 to 7 VDC
ENABLE	0 to 20 VDC

Note : V_O = module nominal output voltage

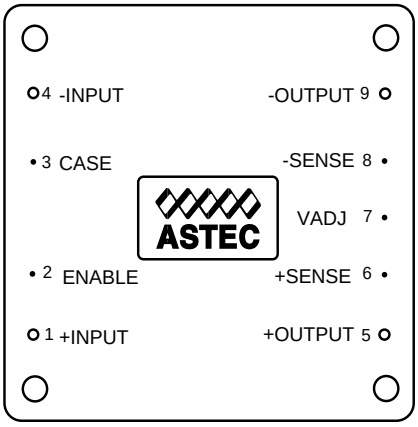
Specifications

Electrical characteristics are guaranteed over the full baseplate temperature range (-40 to 100°C) and for the full range of input voltage (V_I) and for the full load range (0 to I_O rated). Except where indicated , +SENSE and -SENSE to be connected to the output terminals at the point of measurement, Module is enabled. All other pins are left floating.

Definitions

V_I, V_O and I_O are actual operating conditions, V_{Inom}, V_{Onom} and I_{Orated} are nominal ratings.

Pin Connections



INPUT/OUTPUT/CONTROL PINS

Pin No	Pin Name	Type	Description
1	+ INPUT	Input	Power input - positive
2	ENABLE	Input	Enables or disables the output of the module
3	CASE		Connect to baseplate
4	- INPUT	Input	Power input - negative
5	+ OUTPUT	Output	Power output - positive
6	+ SENSE	Input	Used for remote sense function to compensate for load bus resistance
7	V ADJ	Input	Used to adjust module output voltage
8	- SENSE	Input	Used for remote sense function to compensate for load bus resistance
9	- OUTPUT	Output	Power output - negative

CONTROL SIGNALS

Parameter	Conditions	Parameter	Min	Typ	Max	Units
V ADJ - voltage adjust	Adjust using external resistor	V_O	80		120	$\%V_{Onom}$
ENABLE - module enable (Signal reference to -input)	Module enabled - H series	V_{ENABLE}	0		0.8	V
	V_{ENABLE} = 0.8V	ENABLE current source	100		450	µA
	Module enabled - HP series	V_{ENABLE}	4		5.2	V
	V_{ENABLE} = 5.2V	ENABLE leakage current			50	µA

Insulation - all models

INSULATION

Parameter	Conditions	Min	Typ	Max	Units
Input-output insulation resistance	500VDC	10			MΩ
Input-baseplate insulation resistance	500VDC	10			MΩ
Output-baseplate insulation resistance	500VDC	10			MΩ

Transient Response - all models

TRANSIENT CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Turn-on time	V_I = 0 to V_{Inom}			1	sec
Transient response (25% to 75% load change @ 0.1A/µS, recovery to 1% V_O)	Step-load excursion All models			10	$\%V_o$
	Step-load response			500	µS

Electrical Specifications

INPUT CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Input voltage		36	48	75	V
Input low line power on voltage	Module power on	32		34.3	V
Input low line power off voltage	Module power off	27.6		30.5	V
No load input power	$V_I = V_{Inom}$			7	W
Input capacitance				8	µF

OUTPUT CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Nominal (factory set) output voltage			2.1 3.3 5.0		V V V
Output voltage set point accuracy	T_C = +25°C, $V_I = V_{Inom}$, $I_O = I_{Orated}$	-1		1	$\%V_{Onom}$
Remote sense compensation	$V_I = V_{Imin}$			0.5	V
Output voltage adjust		80		120	$\%V_{Onom}$
Nominal (factory set) output overvoltage protection trip point	2.1V output 3.3V output 5V output	3.3 4.7 6.7		3.7 5 7	V V V
Line regulation	V_{Imin} to V_{Imax}, all modules		2	10	mV
Load regulation	I_{Omin} to I_{Omax}, all modules		2	10	mV
Noise and ripple (Differential) *	20Mhz bandwidth All modules			150	mV
Output Power	See product range table				
Steady State Output current limit	V_O falls to 90% of V_{Onom}	105	115	125	$\%I_{Omax}$
Short circuit current				170	$\%I_{Omax}$
Temperature coefficient	Per °C Baseplate temperature			0.02	$\%V_O$/°C
Overtemperature shutdown	Baseplate temperature	103	110	115	°C
Efficiency*	$V_O=V_{Onom}$, $V_I=V_{Inom}$, $I_O=I_{Orated}$				
	AK60A-048L-021F20H/HP	83.4	83.8		%
	AK60A-048L-033F20H/HP	87.8	88.2		%
	AK60A-048L-050F20H/HP	90	90.5		%
	BK60A-048L-021F30H/HP	81	81.5		%
	BK60A-048L-033F30H/HP	85.8	86.2		%
	BK60A-048L-050F30H/HP	88.5	89		%

* Please refer to figure1 for the output ripple, step load set up and figure 2 for the efficiency set up

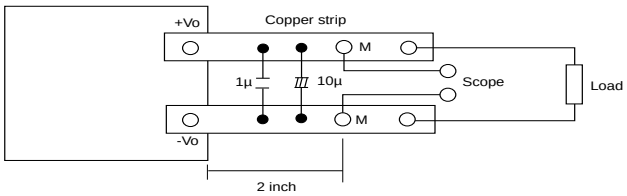


FIGURE 1 - OUTPUT RIPPLE AND STEP LOAD SETUP

Use a 1.0µ ceramic capacitor and a 10µ tan capacitor at the measuring points.
Scope use average mode to eliminate ripple component.

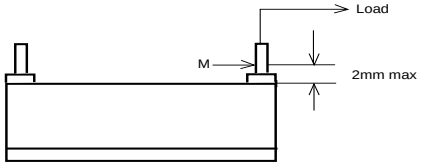


FIGURE 2 - EFFICIENCY TEST SET UP

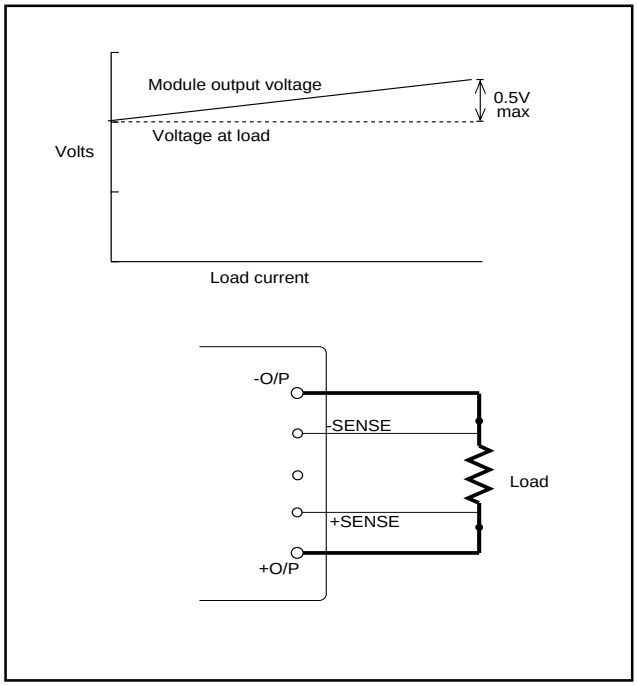
Output voltage measuring points (M) should be within 2mm from the cover.

Functional Description

This section explains how to implement the functions found on the AK/BK60C High Efficiency Series.

Remote Sense (+SENSE, -SENSE)

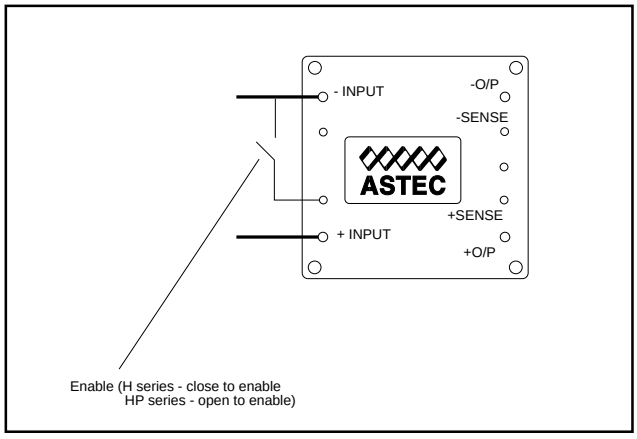
Connect the +SENSE and -SENSE pins directly to the load to allow the module to compensate for the voltage drop across the conductors carrying the load current. If remote sensing is not required (for example if the load is close to the module) the sense pins should be connected directly to the module's output pins to ensure accurate regulation.



Note: If the sense leads fail open circuit, the module will revert to local sense at the output pins. Incorrect connection of sense leads may damage the module

Enable Control (ENABLE)

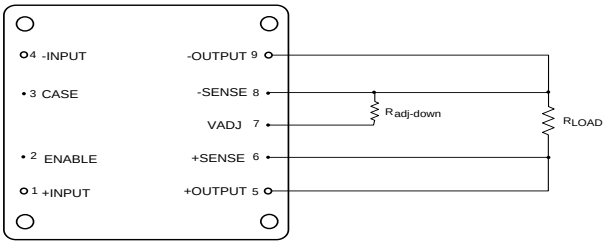
The enable pin is a TTL compatible input used to turn the output of the module on or off.
For H series, the module output is enabled when the ENABLE pin is connected to -Vin or driven to a logic low of <0.8V (but not negative). The output is disabled when the ENABLE pin is open or driven to a logic high >2V.
For HP series, the module output is enabled when the ENABLE pin is open. The output is disabled when the ENABLE pin is driven to a logic low <1.2V.



Output Voltage Adjustment (VADJ)

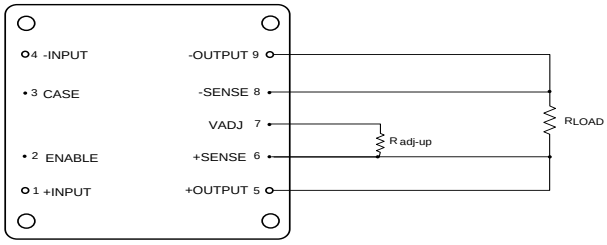
The output voltage of the module may be accurately adjusted by up to ±20% of the nominal factory set output. With an external resistor connected between the VADJ and +SENSE pins, the output voltage set point increases. With an external resistor connected between VADJ and -SENSE, the output voltage set point decreases.

The following equation determine the required external resistor value to obtain a percentage output voltage change of D%



Circuit Configuration to Decrease Output Voltage

$$Radj\text{-}down = \left(\frac{1000}{D\%} - 11\right) Kohm$$

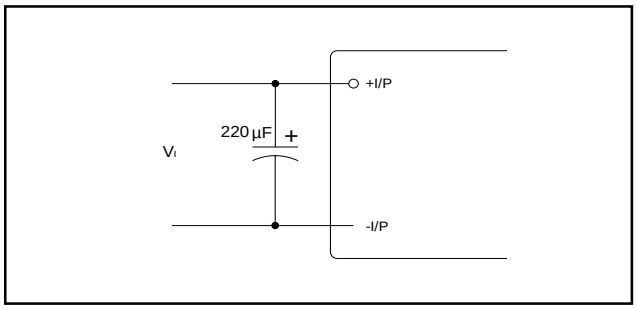


Circuit Configuration to Increase Output Voltage

$$Radj\text{-}up = \left(\frac{Vonom\left(1 + \frac{D\%}{100}\right) - 1.235}{1.235 \times D\%} 1000 - 11\right) Kohm$$

Design Considerations

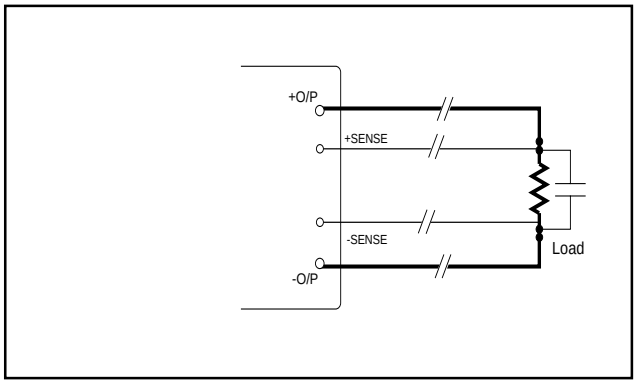
Input Bulk Capacitors



Electrolytic bulk reservoir capacitors placed close to the module input pins are recommended to ensure the module is fed with a low source impedance. Typical value is 220µF/100V.

Remote Load

If the sensed load is some distance from the module, the module's output voltage may rise sufficiently to trigger the OVP protection circuit during a step load change due to buss inductance. Fitting a decoupling capacitor at the load can reduce this effect.
It should be noted that a distributed power solution using *AMPSS*™ modules placed close to their loads will optimize transient response.

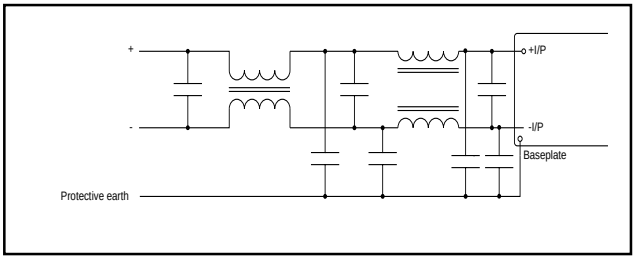


Input Undervoltage Protection

An input undervoltage protection circuit protects the module under low input voltage conditions. Hysteresis is built to allow for high levels of ripple on the input supply voltage without causing the module to cycle on and off. Typically module will turn on above 32V and turn off below 27V. (see Electrical Specifications for exact figures).

Conducted EMI

Although AK/BK60C High Efficiency Series contain differential mode input EMI filtering, power supply systems using these modules will require additional EMI filtering to enable the system to meet relevant EMI standards.
AK/BK60C High Efficiency Series have an effective



input to ground (baseplate) capacitance of approximately 3500pF. This should be accounted for when calculating the maximum EMI 'Y' capacitance to meet ground leakage current specifications.

Output Ripple and Noise

AK/BK60CHigh Efficiency Series are designed to generate very low ripple and noise. When mounted on logic boards, for example, sufficient decoupling is normally provided by the components used to decouple the logic ICs, and no additional decoupling is required.

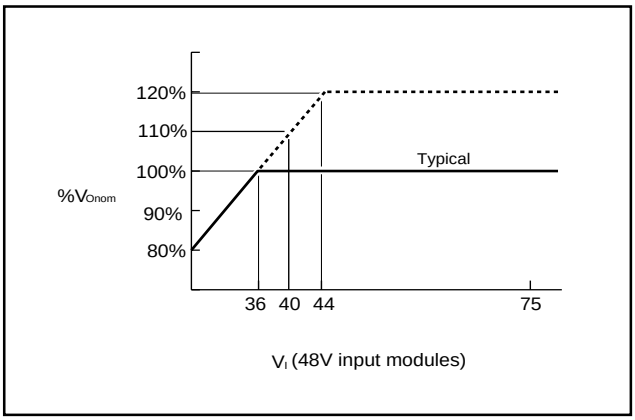
Input Fusing

AMPSS modules do not have an in-line fuse fitted internally. In order to comply with CSA, TUV and UL safety regulations it is recommended that a fuse of the following rating be fitted at the module's input.

Input	Fuse Rating
48V	10A / 250V

Break Regulation

AK/BK60C High Efficiency Series modules are designed to deliver full rated output current at up to 0.5V above $V_{O\,nom}$ at the minimum specified input voltage.



Overtemperature Protection

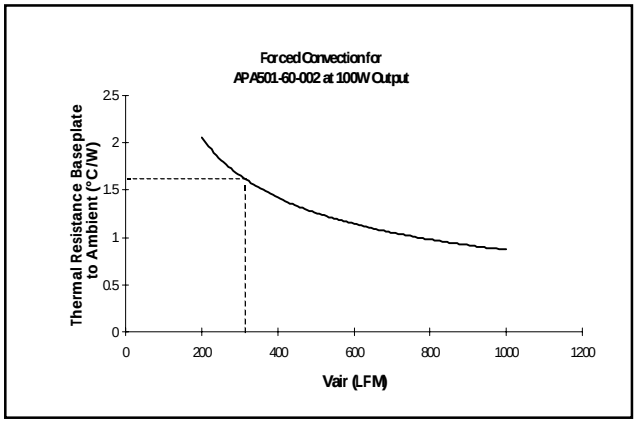
If the module's internal temperature exceeds 103°C, the module will latch off and automatically switch on again when the internal temperature has dropped by 5-10°C.

MTBF

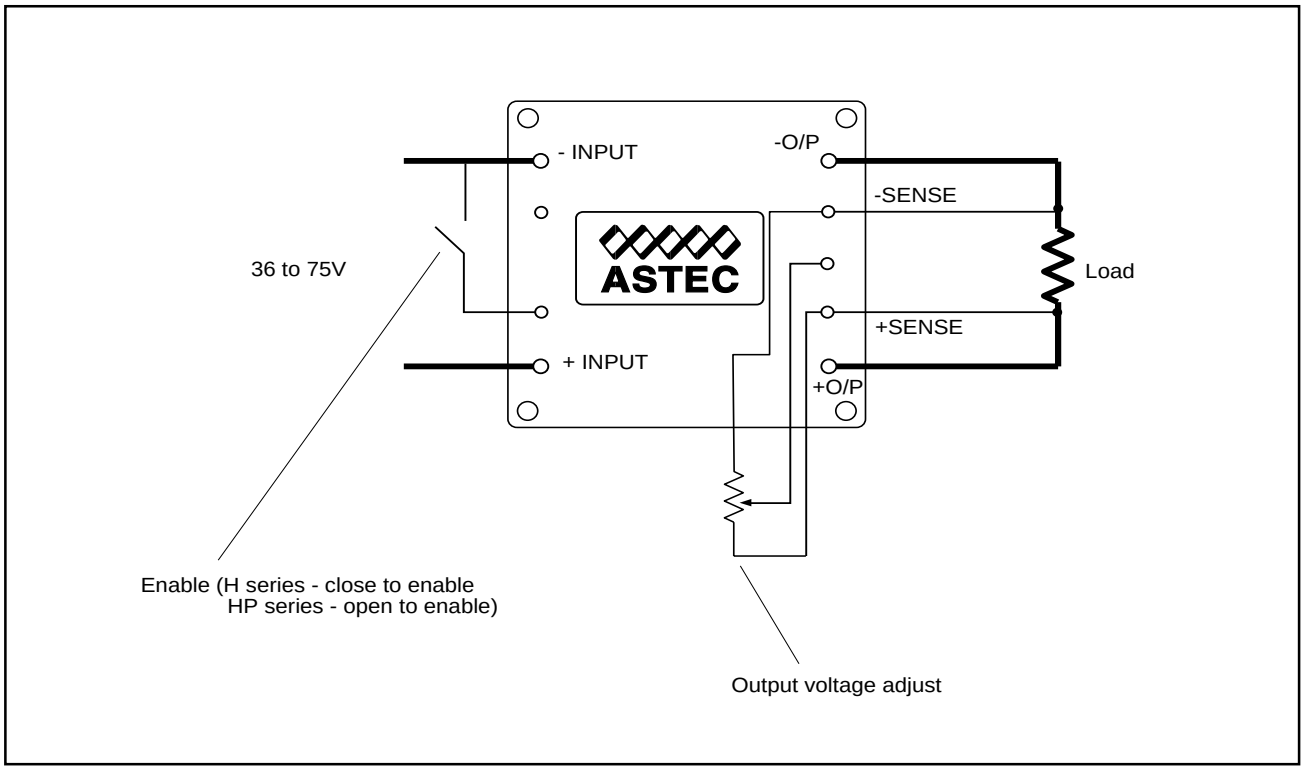
Predicted MTBF for the AK/BK60C High Efficiency Series is greater than 1,000,000 hours at maximum rated output and 50°C baseplate temperature.

Thermal Data

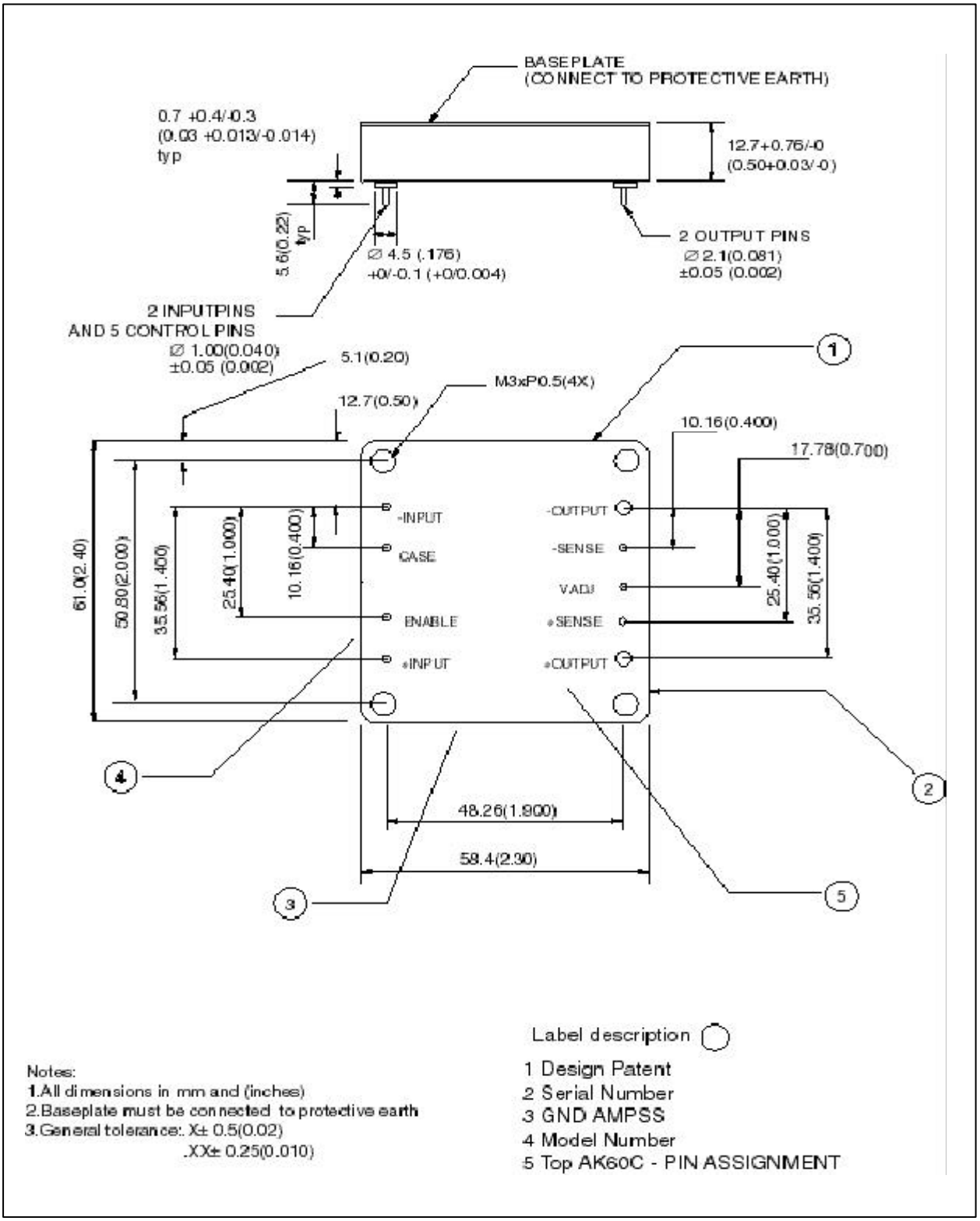
Natural convection thermal impedance of the AK/BK60C High Efficiency Series package is approximately 4.4°C/W(25W power dissipation). A standard horizontal fin heatsink available from Astec (part number APA501-60-002) with 11mm fins and 8mm pitch, will reduce module thermal impedance to 1.8°C/W with a forced air flow of 250 LFM when mounted with a thermal pad (ASTEC P/N APA502-60-001) between heatsink and module.



Application Example



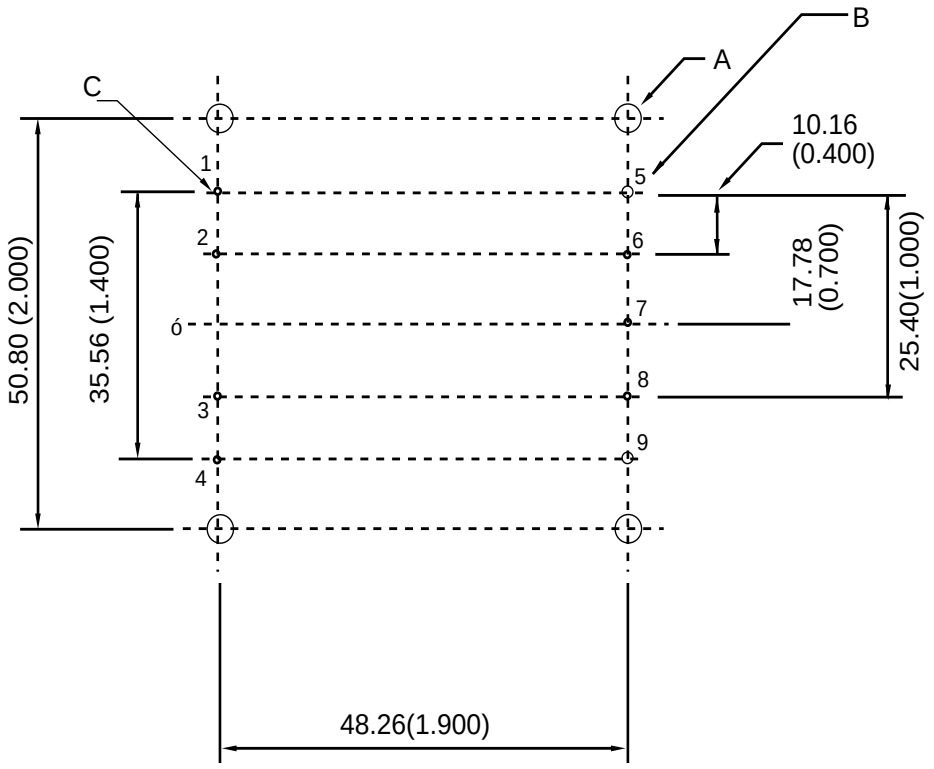
Mechanical Specifications



Recommended PCB Layout

The AK/BK60C High Efficiency module may be mounted to a board either by soldering

Materials :
Control pins are tin plated brass.
Input and output pins are tin plated brass.



VIEW FROM PCB COMPONENT SIDE

NOTES:
1. PCB COMPONENT SIDE VIEW IS SHOWN.
2. ALL DIMENSIONS IN mm AND (INCHES).
3. GENERAL TOLERANCE: .XX± 0.1(0.006).

RECOMMENDED HOLE SIZE TABLE: -

	A	B	C
HOLE SIZE FOR PCB DIRECT SOLDERING		∅ 2.4+0.15/-0 (∅ 0.095+0.006/-0)	∅ 1.3+0.15/-0 (∅ 0.051+0.006/-0)
HOLE SIZE FOR M3.0 MACHINE SCREW	∅ 3.5+0.08/-0 (∅ 0.177+0.0031/-0) FOR M3.0		

Heatsink Mounting Information

Heatsinks for AMPSS™ modules are available in a variety of sizes and fin orientation. The table below shows the options available for AK60C Series.

AMPSS™ modules may be retained by their input and output pins only provided no heatsink is fitted. Adequate mechanical support must be provide when a heatsink is fitted.

Note: *1) baseplate and heatsink must be connected to protective earth*
2) Mechanical support must not induce twist in the module baseplate and must incorporate strain relief, e.g. spring washers.

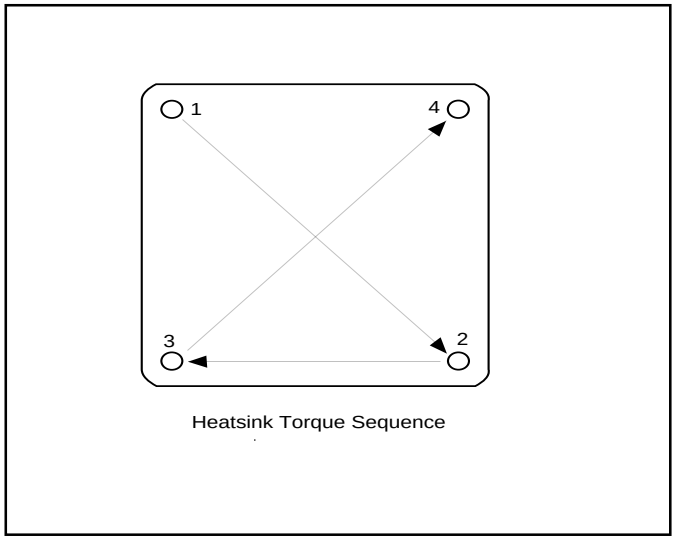
Description	Model Number	Dimensions		Free air thermal resistance
		inches	mm	
Heatsink, "60" size, vertical fin.	APA501-60-001	2.26x2.32x0.6	57.5x59x15	3.8°C/W
Heatsink, "60" size, horizontal fin	APA501-60-002	2.26x2.32x0.6	57.5x59x15	3.9°C/W
Heatsink, "60" size, vertical fin.	APA501-60-003	2.26x2.32x0.9	57.5x59x22.5	3.3°C/W
Heatsink, "60" size, horizontal fin	APA501-60-004	2.26x2.32x0.9	57.5x59x22.5	3.7°C/W
Heatsink, "60" size, vertical fin.	APA501-60-005	2.26x2.32x1.5	57.5x59x37	2.8°C/W
Heatsink, "60" size, horizontal fin	APA501-60-006	2.26x2.32x1.5	57.5x59x37	2.8°C/W
Heatsink, "60" size, low profile	APA501-60-007	2.25x3.50x0.5	57.2x89x12	3.6°C/W
Thermal Pad, "60" size	APA502-60-001			

To provide optimal thermal contact between heatsink and module, it is recommended that the mating surface of the heatsink should have a surface flatness of less than 0.1mm. The use of a thermal pad or thermal grease is also recommended.

The recommended torque of using metal screw for module/heatsink is:

Screw size	Torque
M3	4-6kg-cm (3.5-5.2 lb-in)

Torque sequence:



Heatsink Torque Sequence

It is assumed that all four mounting screws are being torqued to a common surface.

Other thermal management schemes are at customer discretion as long as the maximum thermal rating of the specific module is not exceeded.

Mechanical Requirements

1. Vibration - Swept tri-axial sinusoidal vibration per Bellcore TR-NWT-000063 Para 4.4.2
   5Hz - 50Hz 0.5g
   50Hz - 500Hz 3.0g

2. Earthquake - TR-NWT-000063 section 4.5. VERTEQ synthesised earthquake waveform, appears to be random vibration 1-100Hz, max 1.25g, but see the Bellcore spec for full details.

3. Flammability (Bellcore TR-NWT-000062 para 4.3.3.2)
   EITHER Needle flame test - self extinguish within 30 secs and flaming drippings do not ignite paper 2" below module
   OR Oxygen index (per ASTM standard D2863-77) > 28% AND materials used 94V-1 or better.

4. Airborne Contaminants - Must operate for intended service life (20 years for Telecom) in the presence of airborne contaminants (Outdoor Urban contamination levels) per Bellcore TR-NWT-000063 para 4.6.2. May need conformal coating on non-potted modules for this.

5. PIN pull strength Control TBA
   Power TBA

For further information contact :

NORTH AMERICA
ASTEC AMERICA, INC,.
5810 Van Allen Way,
Carlsbad CA 92008,
USA.
Tel : 760-930-4600
Fax : 760-930-0698

EUROPE
ASTEC EUROPE LTD.
Astec House, Unit 9
Waterfront Business Park
Merry Hill, Dudley
Wset Midlands DY5 1LX
U.K.
Tel : 01384-842211
Fax : 01384-843355

ASIA
ASTEC AGENCIES LIMITED
6th Floor, CDW Building,
382-392 Castle Peak Road,
Tsuen Wan,
N.T.
Hong Kong
Tel : 852 2437-9662
Fax : 852 2402-4426

ASTEC