
AMPSS[®]

Astec Modular Power Supply System

Gamma AK60A Economy Series

**50 100W Output Power
DC-DC Converter Module
Technical Reference Manual**

Series Highlights

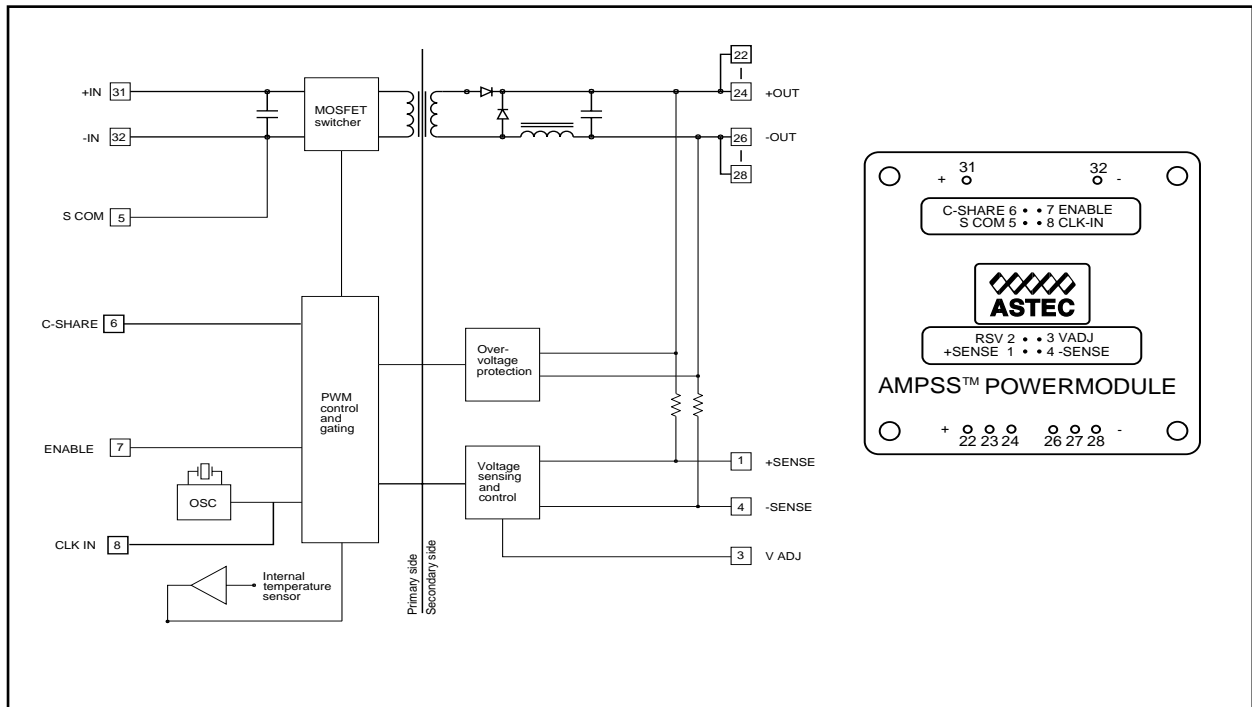
- High Efficiency - up to 87%
- 100W Output Power
- 100°C baseplate/case operating temperature
- Low output ripple and noise
- High Reliability - over 1 million hours MTBF
- Wide input voltage range
- Fixed switching frequency
- Excellent Transient Response
- Designed to meet Telecom specifications

Contents

Introduction	3
Special Features	3
Product Range	4
Safety	4
Bellcore Specifications	4
Electrical Specifications	5
Absolute Maximum Ratings – all models	5
Pin Connections - Gamma AK60A	6
Insulation - all models	7
Transient Response - all models	7
Electrical Specifications for Gamma AK60A 24V Input Models	8
Functional Description	10
Remote Sense (+SENSE, -SENSE)	10
Enable Control (ENABLE)	10
CLK IN	10
Current Sharing (C SHARE)	11
Output Voltage Adjustment (V ADJ)	11
Signal Common (S COM)	11
Design Considerations	12
Input Bulk Capacitors	12
Remote Loads	12
Input Undervoltage Protection	12
Conducted EMI	12
Output Ripple and Noise	12
Input Fusing	12
Break Regulation	13
Overtemperature Protection	13
MTBF	13
Thermal Data	13
Application Example	14

Mechanical Specifications	15
Dimensions Gamma AK60A	15
Recommended PCB Layout	16
Heatsink Mounting Information	17
Mechanical Requirements	19

Gamma AK60A Series DC-DC Converters



Introduction

The Gamma AK60A Series is an isolated, single output DC to DC converter module, providing up to 50-100W output. The Gamma AK60A features full safety isolations low voltage primary side control and a baseplate operating temperature of up to 100°C.

Special Features

- High Efficiency - 87% typical
- -40°C to 100°C. baseplate operating temperature (no derating).
- Low output ripple and noise (150mV max on 5V)
- Improved capacitive load limit on start-up
- Remote Sense Compensation
- Reliability - 1 million hours MTBF min.
- Output Voltage Regulation to zero load
- Fixed frequency switching (500KHz)
- Output Voltage Adjust $\pm 10\%$ of nominal
- Enable
- Clock in
- Pin compatible with AK60A Series.

Product Range

Model Number	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT	OUTPUT POWER
A K 60 A -024L-022F10G	24V	2.2V	10A	22W
A K 60 A -024L-033F10G	24V	3.3V	10A	33W
A K 60 A -024L-050F10G	24V	5V	10A	50W
A K 60 A -024L-120F04G	24V	12V	4.2A	50W
A K 60 A -024L-150F03G	24V	15V	3.3A	50W
A K 60 A -024L-240F02G	24V	24V	2.1A	50W
A K 60 A -024L-022F20G	24V	2.2V	20A	44W
A K 60 A -024L-033F20G	24V	3.3V	20A	66W
A K 60 A -024L-050F20G	24V	5V	20A	100W
A K 60 A -024L-120F08G	24V	12V	8.3A	100W
A K 60 A -024L-150F07G	24V	15V	6.7A	100W
A K 60 A -024L-240F04G	24V	24V	4.2A	100W

Safety

The modules are safety approved to the following standards :

UL:	UL1950
CSA:	CSA22.2-234 CSA22.2-950
VDE:	VDE 0805 EN60950
CE:	CE Mark

Bellcore Specifications-

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

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	24 V input
Continuous Input Voltage	36V
Input Surge Voltage (1 sec)	50V
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
VADJ	-0.5 to 7 VDC

Note: V_o = module nominal output voltage
Relative to -OUTPUT

Primary Control Pins	
CLK IN	-50 to 50 VDC
C-SHARE	
ENABLE	0 to 20 VDC

Note: Relative to -INPUT/SCOM

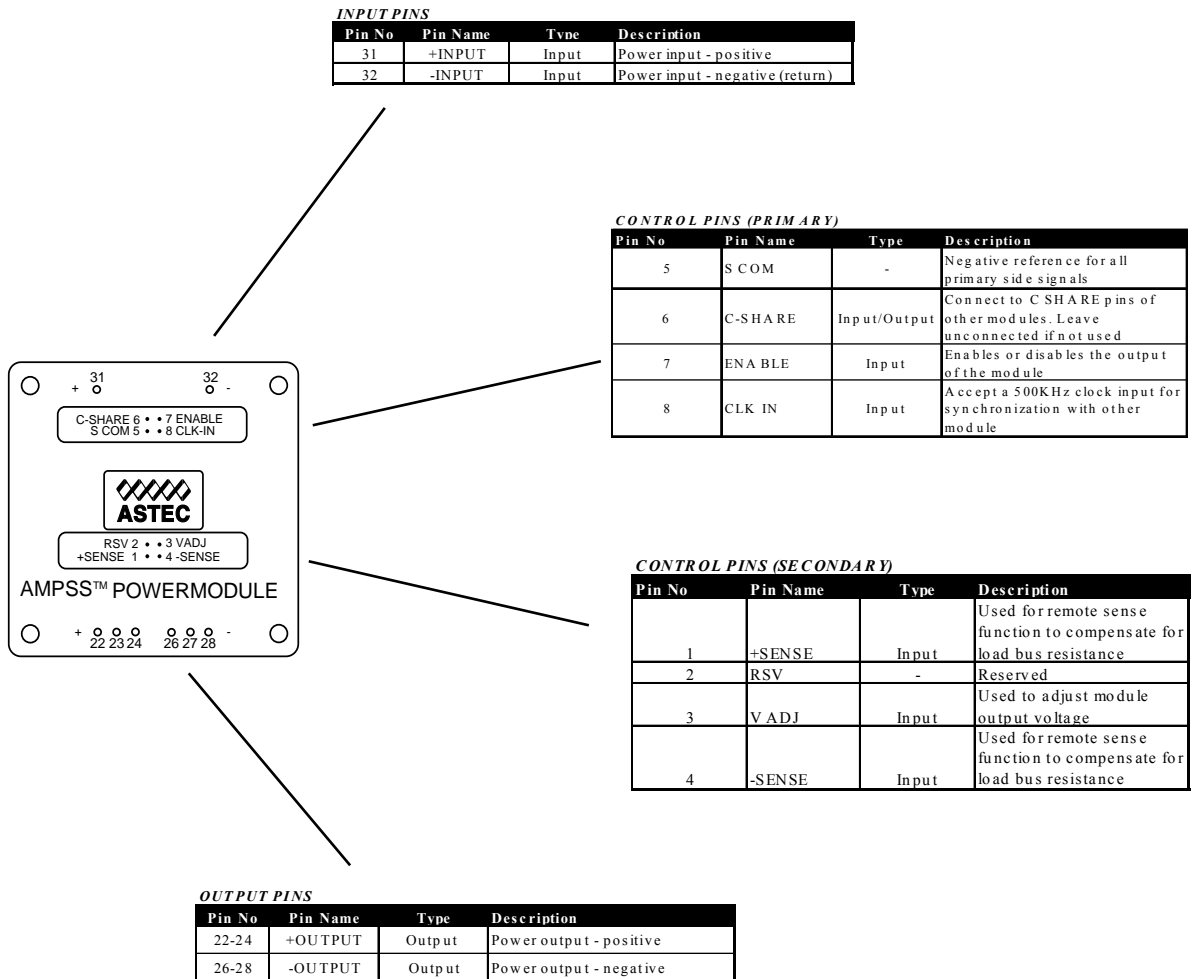
Specifications

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 - Gamma AK60A



CONTROL SIGNALS

Parameter	Conditions	Parameter	Min	Typ	Max	Units
C SHARE - current share function	C SHARE pins of modules in parallel connected	C SHARE accuracy		±5	±15	% I _{O rated}
		Max no. of units			5	
CLK IN - clock input		V _{CLK IN}	4.5	5.0	5.5	V _{p-p}
		Clock freq	495	500	505	KHz
V ADJ - voltage adjust	Adjust using external resistor	V _O	90		110	% V _{O nom}

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 _{I nom}			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 for Gamma AK60A 24V Input Models

INPUT CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Input voltage		18	24	36	V
Input low line power on voltage	Module power on	15.9		17.5	V
Input low line power off voltage	Module power off	13.5		16.5	V
No load input power	$V_I = V_{Inom}$			5	W
Input capacitance				5	μ F

OUTPUT CHARACTERISTICS

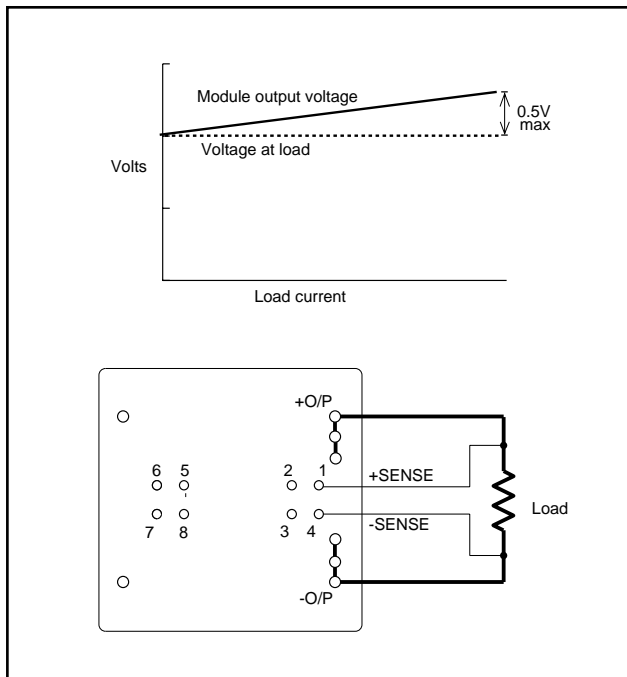
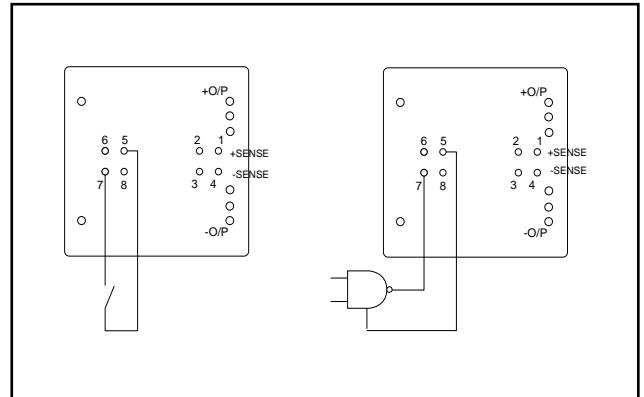
Parameter	Conditions	Min	Typ	Max	Units						
Nominal (factory set) output voltage			2.2		V						
			3.3		V						
			5.0		V						
			12.0		V						
			15.0		V						
Output voltage set point accuracy	$T_C = +25^\circ\text{C}$, $V_I = V_{Inom}$, $I_O = I_{Orated}$	-1		1	% V_{Onom}						
Remote sense compensation	$V_I = V_{Imin}$			0.5	V						
Output voltage adjust		90		110	% V_{Onom}						
Nominal (factory set) output overvoltage protection trip point	All models except 2.2V 3.3V	120 150 130	130 160 140	140 170 150	% V_{Onom}						
						Line regulation	V_{Imin} to V_{Imax} , all models except 2.2V, 3.3V			0.2	% V_{Onom}
									10	mV	
Load regulation	I_{Omin} to I_{Omax} , all models except 2.2V, 3.3V			0.2	% V_{Onom}						
				10	mV						
Noise and ripple (Differential)	20MHz bandwidth All models except 2.2V, 3.3V			3 150	% V_{Onom} 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 $^\circ\text{C}$ Baseplate temperature			0.02	% $V_O/^\circ\text{C}$						
Overtemperature shutdown	Baseplate temperature	103	110	115	$^\circ\text{C}$						
Efficiency	$V_O = V_{Onom}$, $I_O = I_{Onom}$, $I_O = I_{Orated}$										
						AK60A-024L-022F20G	74.5	75.5		%	
						AK60A-024L-022F10G	74.5	75.5		%	
						AK60A-024L-033F20G	78	79		%	
						AK60A-024L-033F10G	79	80		%	
						AK60A-024L-050F20G	79.5	80.5		%	
						AK60A-024L-050F10G	81.5	82.5		%	
						AK60A-024L-120F08G	84	85		%	
						AK60A-024L-120F04G	85.5	86.5		%	
						AK60A-024L-150F07G	84.5	85.5		%	
						AK60A-024L-150F03G	86	87		%	
						AK60A-024L-240F04G	86	87		%	
						AK60A-024L-240F02G	86	87		%	

Functional Description

This section explains how to implement the functions found on the Gamma AK60A 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)

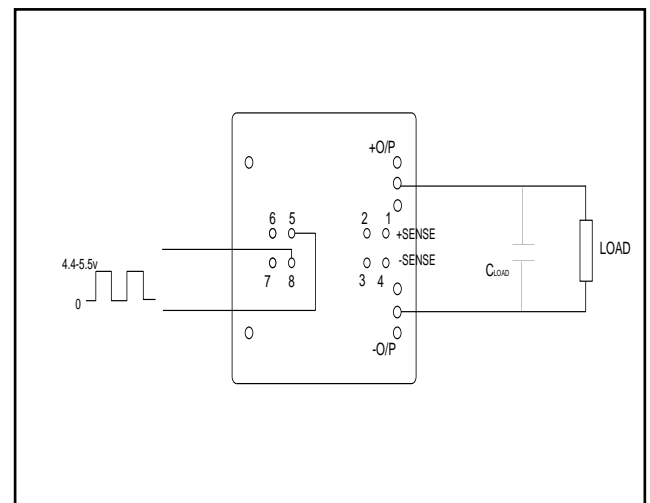
The enable pin is a TTL compatible input used to turn the output of the module on or off. The module output is enabled when the ENABLE pin is connected to S COM or driven to a logic low of $<0.8V$ (but not negative).

The output is disabled when the ENABLE pin is open or driven to a logic high $>2V$.

CLK IN

The CLK IN pin allows the Gamma AK60A to be synchronised to an external clock signal.

The clock signal is a 50% duty cycle square wave.

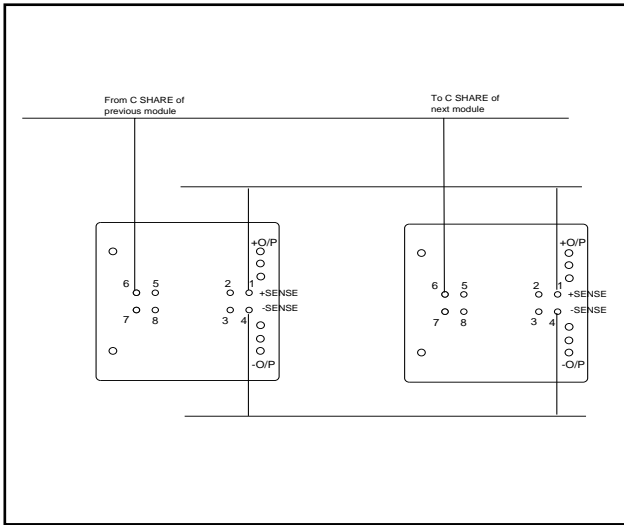


Current Sharing (C SHARE)

To ensure that all modules in a parallel system accurately share current, the C SHARE pins (pin 4) on each module should be connected together.

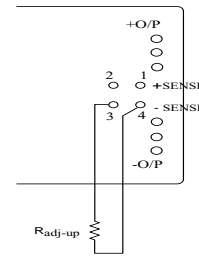
The voltage on the C SHARE pins represents the average load current per module. Each module compares this average with its own current and adjusts its output voltage to correct the error. In this way the module maintains accurate current sharing even under variable or light load conditions.

Note: The -SENSE and +SENSE pins of each module must also be connected to a common load point ensure accurate current sharing.



Output Voltage Adjustment (V ADJ)

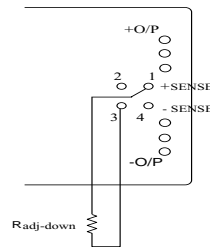
The output voltage of the module may be accurately adjusted by up to $\pm 10\%$ of the nominal factory set output. Adjustment is carried out using a resistor connected as to control Adjust Current (I_a).



Circuit Configuration to Increase Output Voltage

$$I_a = \frac{V_o - V_s}{R_2} \quad \text{Radj-up} = \frac{1}{\frac{V_s}{I_a} - R_3} - \frac{1}{R_4} - R_5$$

$$V_o = (100\% \text{ to } 110\%) V_{\text{nom}}$$



Circuit Configuration to Decrease Output Voltage

$$I_a = \frac{V_o - V_s}{R_2} \quad \text{Radj-down} = \frac{V_o - V_s + IR_3}{V_s - I_a(R_3 + R_4)} \times R_4 - R_5$$

$$V_o = (90\% \text{ to } 100\%) V_{\text{nom}}$$

MODEL	V _s	R ₂	R ₃	R ₄	R ₅
2.2V	1.24 V	910	300	910	2K2
3.3V	1.24 V	2K7	24	1K6	8K2
5.0V	2.5 V	2K7	300	2K4	8K2
12.0V	2.5 V	6K2	0	1K6	10K
15.0V	2.5 V	8K2	0	1K6	11K
24.0V	2.5 V	13K	0	1K5	11K

NOTE: Radj tolerance must be $< 1\%$ to achieve a 3% set accuracy

Signal Common (S COM)

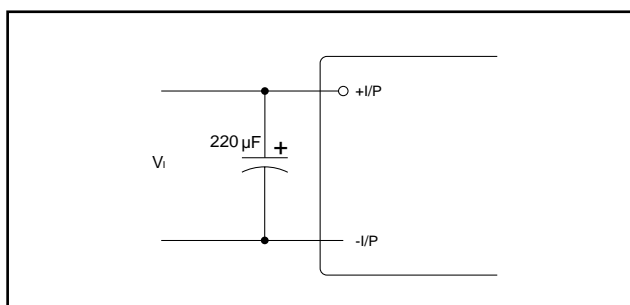
The S COM pin is the common signal return for all primary side controls.

Design Considerations

Input Bulk Capacitors

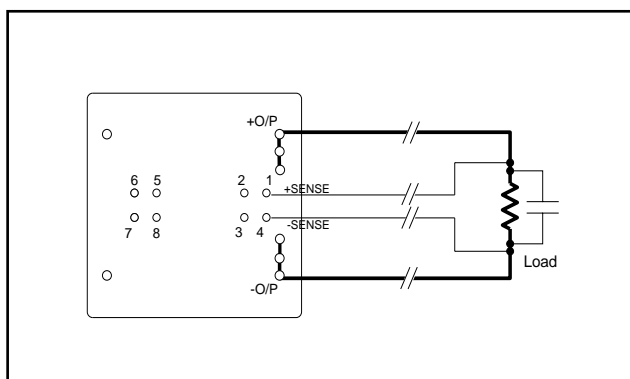
Electrolytic bulk reservoir capacitors placed close to the module input pins are recommended to ensure the module is fed with a low source impedance. For the AK60A Economy Series module typical values are 220 μ F/50V for 24V modules.

Remote Loads



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 bus 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

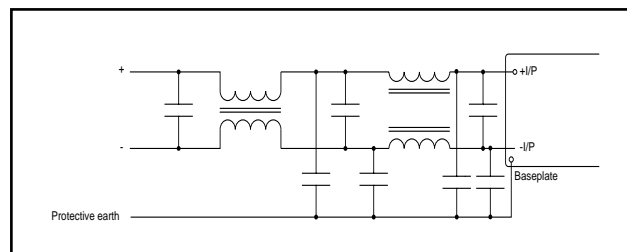
An input undervoltage protection circuit protects the module under low input voltage conditions. Hysteresis is built into the Gamma AK60A Series module to allow for high levels of ripple on the input supply voltage without

causing the module to cycle on and off. Typically 300V modules will turn on above 174V and turn off below 116V, 48V modules will turn on above 32V and turn off below 27V. 24V modules will turn on above 16V and turn off below 13V (see Electrical Specifications for exact figures).

Conducted EMI

Although Gamma AK60A Series modules 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.

Gamma AK60A modules have an effective input to ground (baseplate) capacitance of approximately 550pF. This should be accounted for when calculating the maximum EMI 'Y' capacitance to meet ground leakage current specifications.



Output Ripple and Noise

Gamma AK60A Series modules 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.

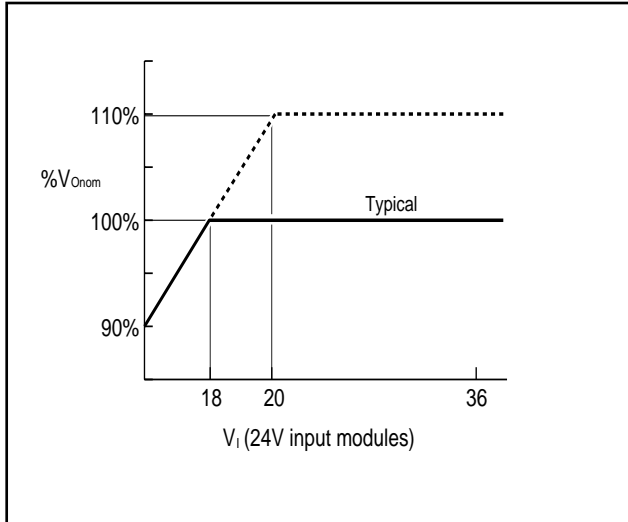
Input Fusing

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

Input	Fuse Rating
24 V	15 A / 250 V

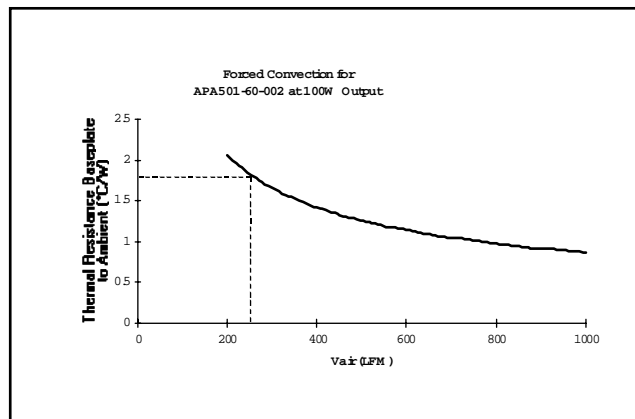
Break Regulation

Gamma AK60A Economy Series modules are designed to deliver full rated output current at up to 0.5V above $V_{O\text{nom}}$ at the minimum specified input voltage.



Thermal Data

Natural convection thermal impedance of the Gamma AK60A 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.



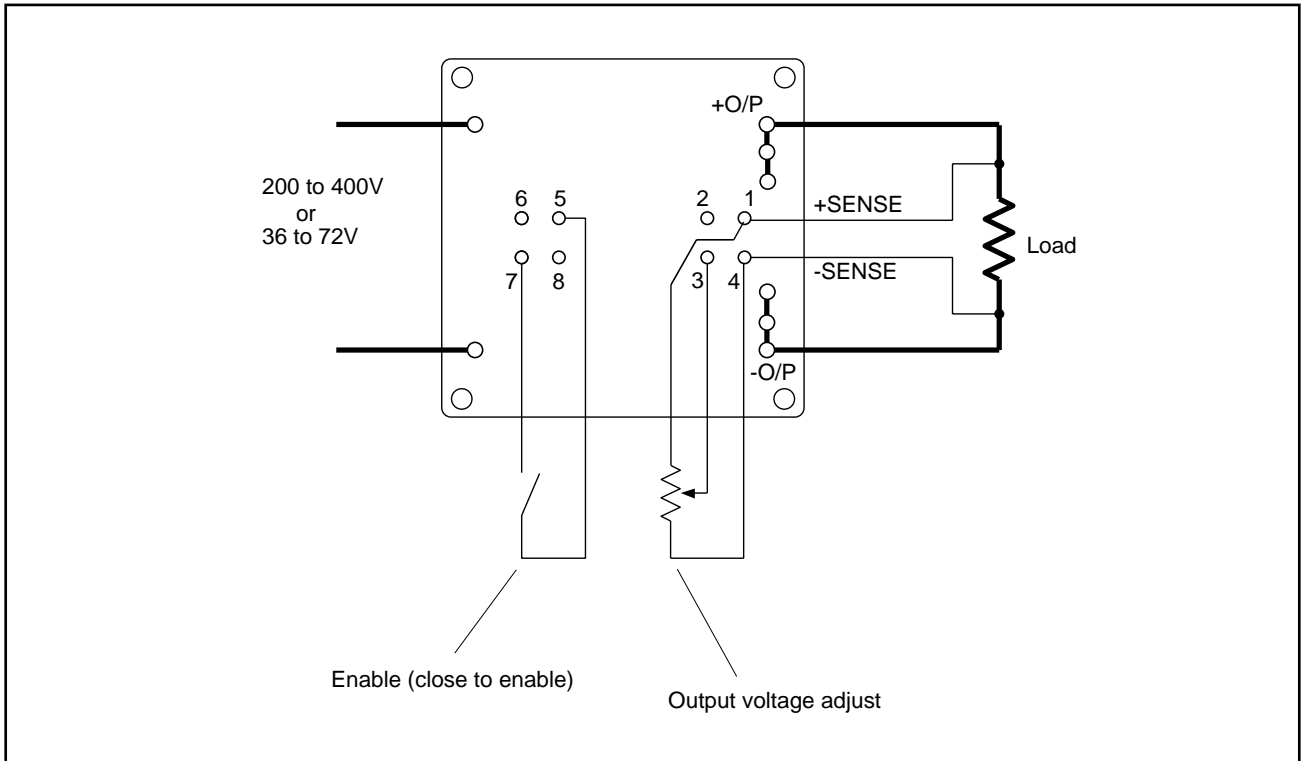
Overtemperature Protection

If the module's internal temperature exceeds 100°C, the module will latch off and automatically switch on again when the internal temperature has dropped by 5-10°C.

MTBF

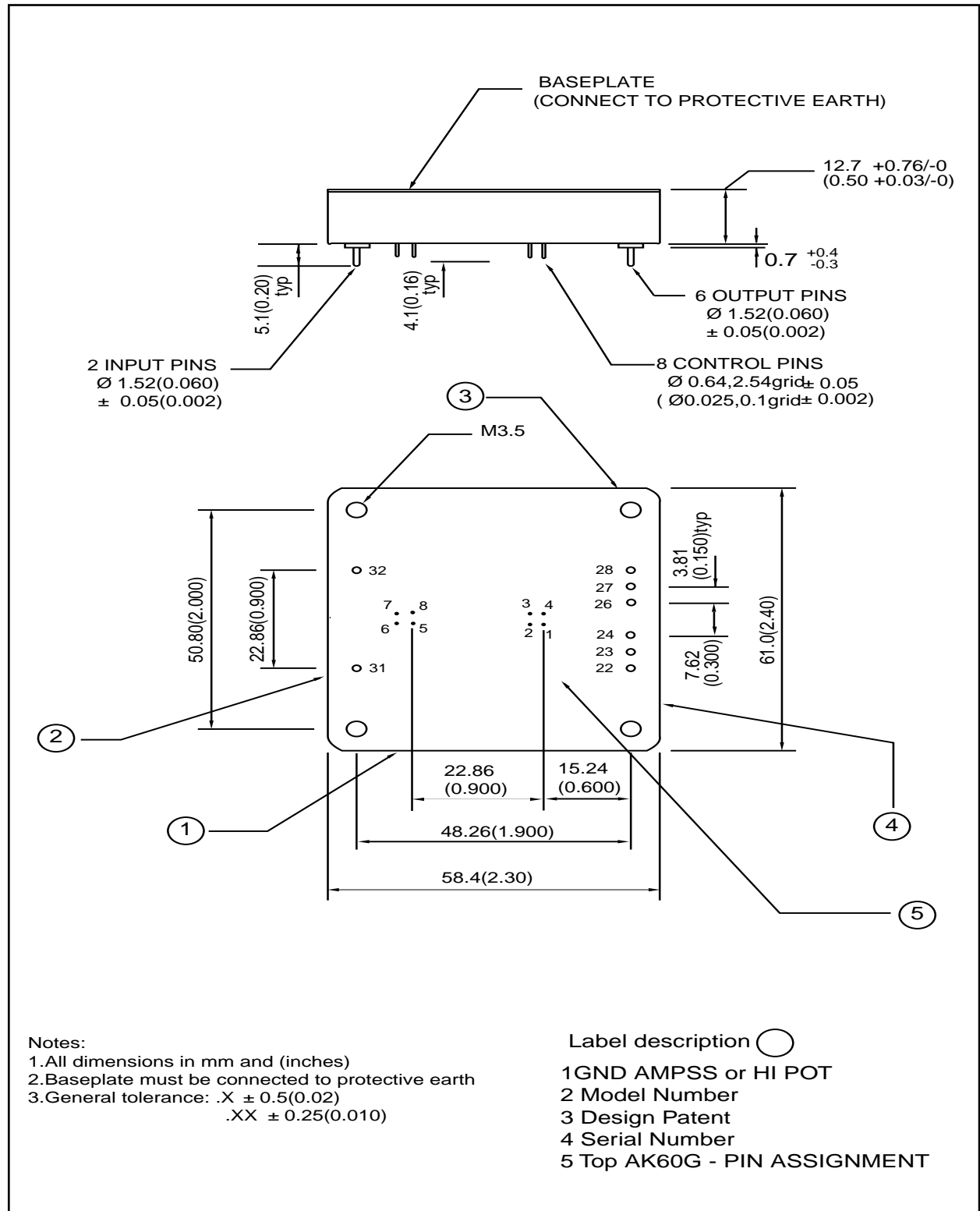
Predicted MTBF for the Gamma AK60A Economy Series is greater than 1,000,000 hours at maximum rated output and 50°C baseplate temperature.

Application Example



Mechanical Specifications

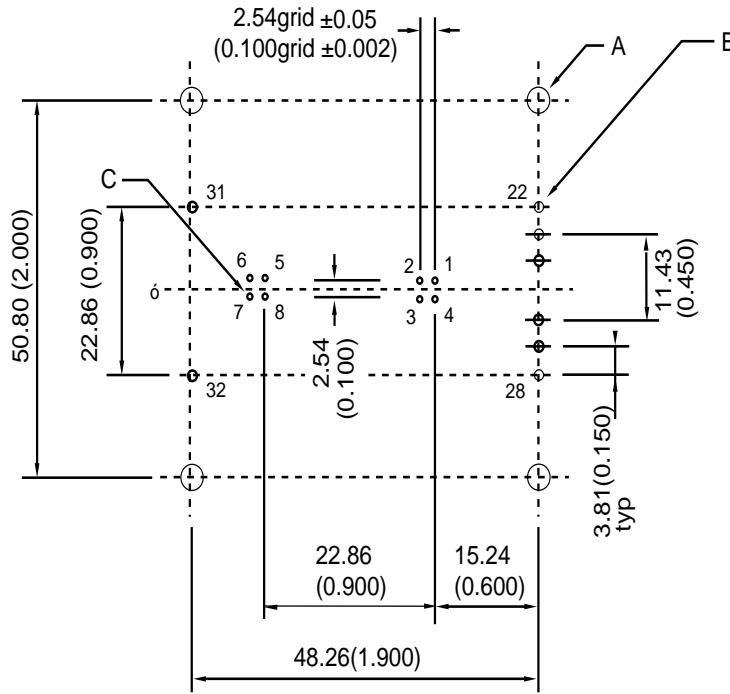
Dimensions Gamma AK60A



Recommended PCB Layout

The Gamma AK60A module may be mounted to a board either by soldering or by using spring sockets.

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		∅2.0+0.15/-0 (∅0.079+0.006/-0)	∅1.00+0.15/-0 (∅0.039+0.006/-0)
HOLE SIZE FOR SPRING SOCKET MOUNTING*		∅2.67±0.05 (∅0.105±0.002)	∅1.37±0.05 (∅0.054±0.002)
HOLE SIZE FOR M3.5 MACHINE SCREW	∅4.0+0.08/-0 (∅0.177+0.0031/-0) FOR M3.5		

*Spring sockets are available from Astec in packs of 20 control pin sockets and 15 power pin sockets, part no. APA504-00-001. Sockets are not suitable for output current greater than 10A per pin.

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 AK60A Gamma Series.

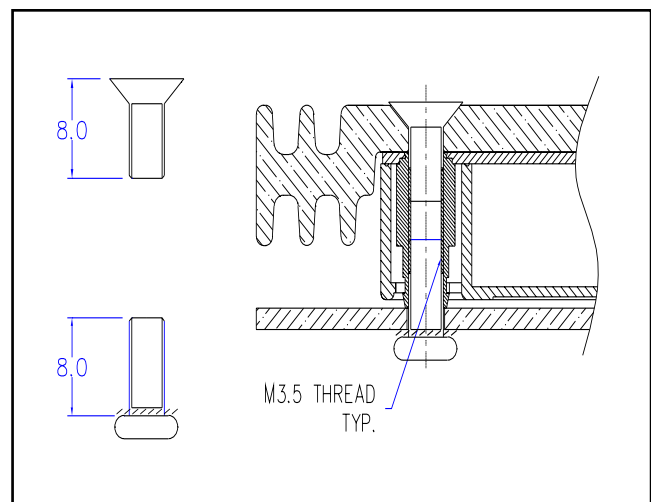
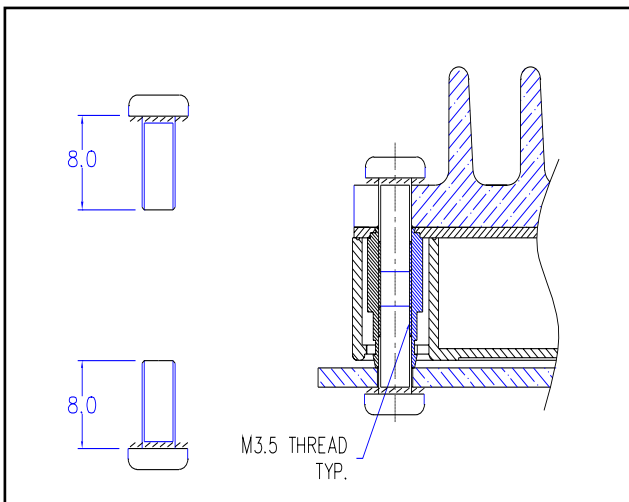
AMPSS™ modules may be retained by their input and output pins only provided no heatsink is fitted. Adequate mechanical support must be provided when a heatsink is fitted.

- 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			
Spring Sockets (20 cont. 15pwr)	APA504-00-001			

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.

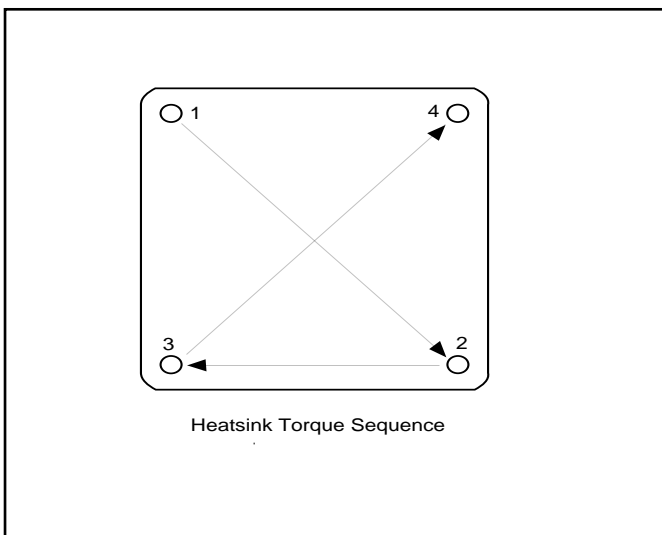
Recommend mounting method for heatsink and PCB



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

Screw size	Torque
M3.5	6-8kg-cm (5.2-6.9 lb-in)

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

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

EUROPE

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

ASIA

ASTEAMAGENCIES LIMITED
Units 2111-2116, Level 21
Tower 1, Metroplaza
223, Hing Fong Road
Kwai Fong
NT
Hong Kong
Tel : 852 2437-9662
Fax : 852 2402-4426

