AEE-10W 12V Input Series

Technical Reference Notes

3.3V, 5V, 12V, 15V Single Output

10W DC-DC Converter

(Rev01)

	USA	Europe	Asia
TEL:	1-760-930-4600	44-(0)1384-842-211	852-2437-9662
FAX:	1-760-930-0698	44-(0)1384-843-355	852-2402-4426

Publishing Date: 20020701

Introduction

The AEE-10W 12Vin single output series of switching DC-DC converters is one of the most cost effective options available in component power. The series uses an industry standard 1" X 2" package and pinout configuration, with Trim and CNT functions available.

AEE-10W 12Vin single output series uses a 2:1 input range of 9V to 18V, outputs are isolated from input and the converters are capable of providing up to 10 watts of output power.

At start up, input current passes through an input filter designed to help meet CISPR 22 level A radiated emissions, and Bellcore GR1089 conducted emissions. A fault clearing device such as a fuse should be used in line with the input to the module.

The AEE-10W 12Vin single output converters are pulse width modulated (PWM) and operate at a nominal fixed frequency of 330 kHz. Feedback to the PWM controller uses an opto-isolator, maintaining complete isolation between primary and secondary. Caution should be taken to avoid ground loops when connecting the converters to ground.

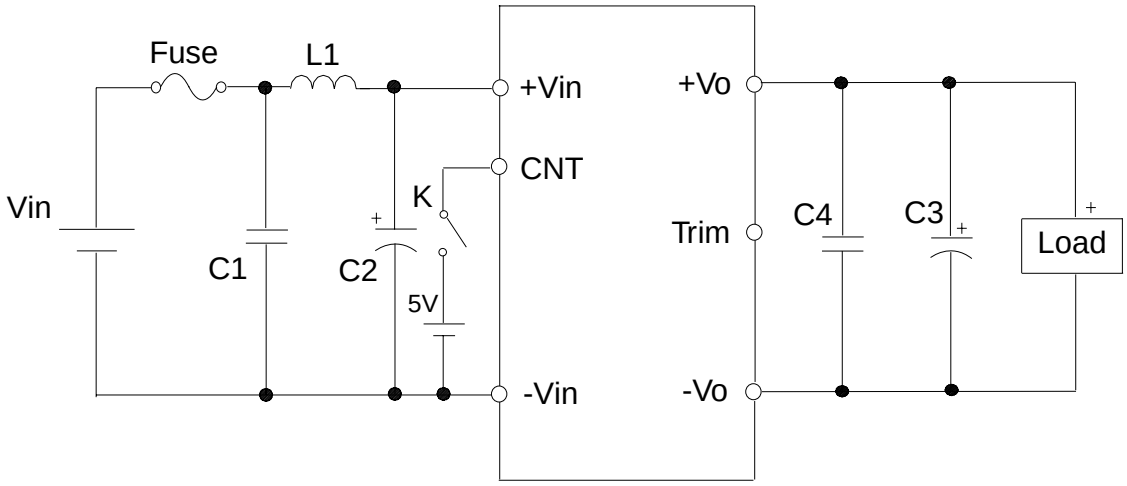
Design Features

- 2" X 1" package
- High efficiency
- High power density
- 10 watts of output power
- 2:1 wide input of 9-18V
- CNT function
- Trim function
- Input under-voltage lockout
- Output short circuit protection
- Output current limiting
- High input-output isolation voltage
- Wide operating case temperature range: -25°C~ +100°C

Options

- Choice of trim function
- Choice of CNT logic configuration

Typical Application



Note: The figure is Negative Control, and reverse Positive Control is available.

K connects, output OFF.

K disconnects or CNT is in midair, output ON.

Fuse: 12Vin--4A

C1 Recommended:

12Vin--220uF/25V electrolytic or ceramic type capacitor

C2 Recommended:

≥ 47uF/25V capacitor

C3 Recommended:

100uF/25V electrolytic or ceramic type capacitor

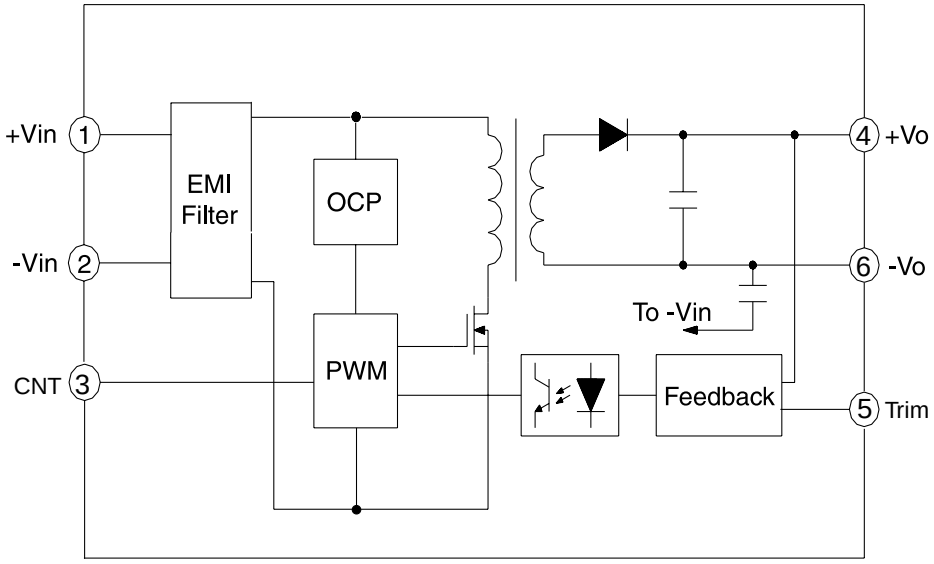
C4 Recommended:

0.47uF capacitor

L1 Recommended:

10--12uH

Block Diagram



Ordering Information

Model Number	Input Voltage	Output Voltage	Output Current	Ripple (mV rms) typ	Noise (mV pp) typ	Efficiency typ
AEE02F12(-49)	9-18V	3.3V	2.55A	7	40	78%
AEE02A12(-49)	9-18V	5V	2A	7	40	81%
AEE00B12(-49)	9-18V	12V	0.84A	10	40	83%
AEE00C12(-49)	9-18V	15V	0.68A	10	40	84%

Note: The items in the brackets are optional.
The detailed information can refer to the “Part Number Description” at the end of the maunal.

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Absolute Maximum Rating

Characteristic	Min	Typ	Max	Units	Notes
Input Voltage(continuous)	-0.3		20	Vdc	
Input Voltage(peak/surge)	-0.3		25	Vdc	50ms non-repetitive
Case temperature	-25		100	°C	
storage temperature	-40		125	°C	

Input Characteristics

Characteristic	Min	Typ	Max	Units	Notes
Input Voltage Range	9	12	18	Vdc	
Input Reflected Current			10	%Iin	
Turn-off Input Voltage			7.6	Vdc	
Turn-on Input Voltage	8.4			Vdc	
Turn On Time				ms	

CNT Function

Characteristic	Min	Typ	Max	Units	Notes
Logic High	3.6		6	Vdc	Reverse logic option “P” available
Logic Low	0		0.7	Vdc	
Control Current				mA	

General Specifications

Characteristic	Min	Typ	Max	Units	Notes
MTBF		3000		k Hrs	Bellcore TR332, Tc=30°C
Isolation			1500	Vdc	Input-Output
			1000	Vdc	Input-Case, Output-Case
Pin solder temperature			260	°C	wave solder < 10 s
Hand Soldering Time			5	s	iron temperature 425°C
Weight		25		grams	

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AEE02F12(-49) Output Characteristics

Characteristic	Min	Typ	Max	Units	Notes
Power		10		W	
Output Current		2.55		A	
Output Setpoint Voltage	3.24	3.3	3.36	Vdc	Vin=12V, Io=2.55A
Line Regulation			0.2	%Vo	Vin=9~18V, Io=2.55A
Load Regulation			1	%Vo	Io=0~2.55A, Vin=12V
Dynamic Response					
50-75% load			100	mV	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
50-25% load			100	mV	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
Current Limit Threshold	2.8		3.8	A	
Short Circuit Current		-------		A	can endure longterm shortcircuit
Efficiency	76	78		%	Vin=12V, Io=2.55A, Ta=25°C
Trim Range	90		110	%Vo	
Over Voltage Protection Setpoint		-------		V	
Temperature Regulation			0.02	%Vo/°C	
Ripple (rms)		10		mV	(0 to 20MHz Bandwidth)
Noise (p-p)		40		mV	(0 to 20MHz Bandwidth)
Switching Frequency		330		kHz	
Output Capacitor		100		µF	

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AEE02A12(-49) Output Characteristics

Characteristic	Min	Typ	Max	Units	Notes
Power		10		W	
Output Current		2		A	
Output Setpoint Voltage	4.95	5	5.05	Vdc	Vin=12V, Io=2A
Line Regulation			0.2	%Vo	Vin=9~18V, Io=2A
Load Regulation			0.5	%Vo	Io=0~2A, Vin=12V
Dynamic Response					
50-75% load			100	%Vo	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
50-25% load			100	%Vo	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
Current Limit Threshold	2.2		3.0	A	
Short Circuit Current		-------		A	can endure longterm shortcircuit
Efficiency	79	81		%	Vin=12V, Io=2A, Ta=25°C
Trim Range	90		110	%Vo	
Over Voltage Protection Setpoint		-------		V	
Temperature Regulation			0.02	%Vo/°C	
Ripple (rms)		10		mV	(0 to 20MHz Bandwidth)
Noise (p-p)		40		mV	(0 to 20MHz Bandwidth)
Switching Frequency		330		kHz	
Output Capacitor		100		µF	

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AEE00B12(-49) Output Characteristics

Characteristic	Min	Typ	Max	Units	Notes
Power		10		W	
Output Current		0.84		A	
Output Setpoint Voltage	11.88	12	12.12	Vdc	Vin=12V, Io=0.84A
Line Regulation			0.2	%Vo	Vin=9~18V, Io=0.84A
Load Regulation			0.5	%Vo	Io=0~0.84A, Vin=12V
Dynamic Response					
50-75% load			100	mV	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
50-25% load			100	mV	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
Current Limit Threshold	0.92		1.26	A	
Short Circuit Current		--------		A	can endure longterm shortcircuit
Efficiency	82	84		%	Vin=12V, Io=0.84A, Ta=25°C
Trim Range	90		110	%Vo	
Over Voltage Protection Setpoint		--------		V	
Temperature Regulation			0.02	%Vo/°C	
Ripple (rms)		10		mV	(0 to 20MHz Bandwidth)
Noise (pp)		40		mV	(0 to 20MHz Bandwidth)
Switching Frequency		330		kHz	
Output Capacitor		100		µF	

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AEE00C12(-49) Output Characteristics

Characteristic	Min	Typ	Max	Units	Notes
Power		10		W	
Output Current		0.68		A	
Output Setpoint Voltage	14.85	15	15.15	Vdc	Vin=12V, Io=0.68A
Line Regulation			0.2	%Vo	Vin=9~18V, Io=0.68A
Load Regulation			0.5	%Vo	Io=0~0.68A, Vin=12V
Dynamic Response					
50-75% load			100	mV	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
50-25% load			100	mV	Ta=25°C, DI/Dt=1A/10µs
			200	µs	Ta=25°C, DI/Dt=1A/10µs
Current Limit Threshold	0.75		1.02	A	
Short Circuit Current		---------		A	can endure longterm shortcircuit
Efficiency	83	85		%	Vin=12V, Io=0.68A, Ta=25°C
Trim Range	90		110	%Vo	
Over Voltage Protection Setpoint		---------		V	
Temperature Regulation			0.02	%Vo/°C	
Ripple (rms)		10		mV	(0 to 20MHz Bandwidth)
Noise (pp)		40		mV	(0 to 20MHz Bandwidth)
Switching Frequency		330		kHz	
Output Capacitor		100		µF	

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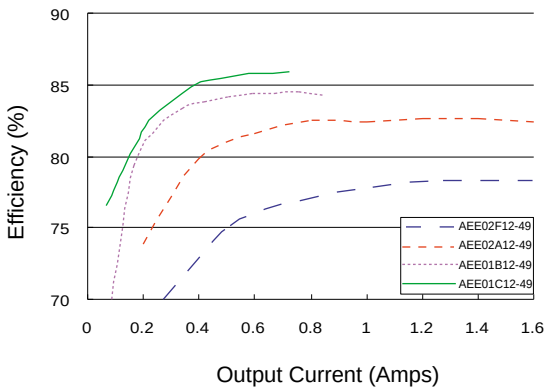
Characteristic Curves *(at 25 °C)*

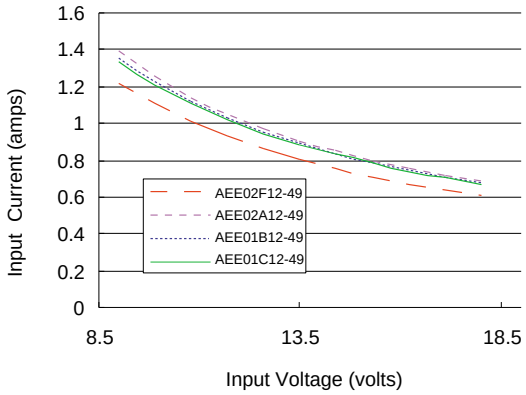
Typical Efficiency Curves

AEE-10W 12Vin Single Output Series



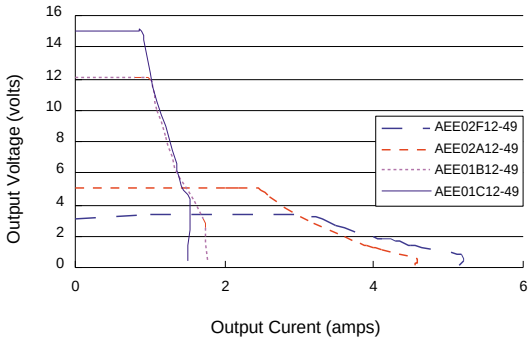
Typical Input-Output Curves

AEE-10W 12Vin Single Output Series



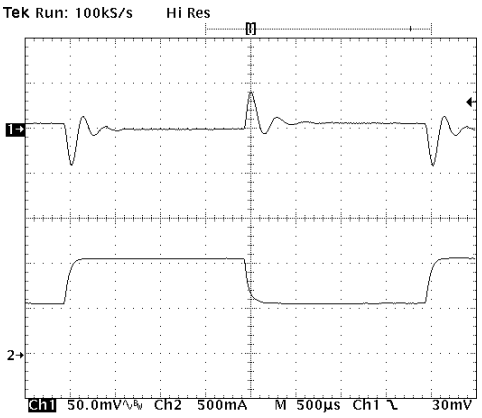
Typical Overcurrent Protection

AEE-10W 12Vin Single Output Series

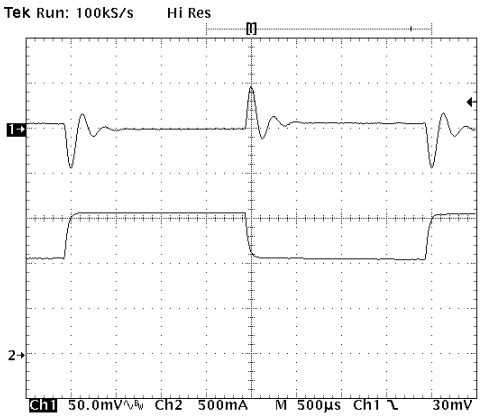


Transient response *(rated input voltage, step load, at 25 °C)*

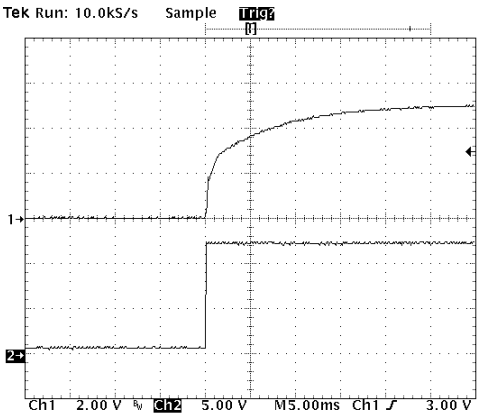
Typical Transient Response to Step Load Change from 50%-75%Iomax AEE02A12(-49)



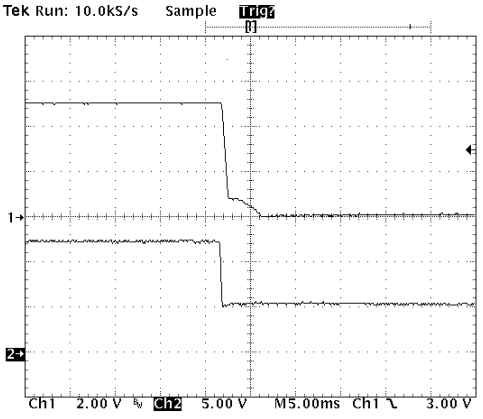
Typical Transient Response to Step Load Change from 75%-50%Iomax AEE02A12(-49)



Typical Start-Up from Power On AEE02A12(-49)



Typical Shutdown from Power Off AEE02A12(-49)



Pin Location

The +Vin and -Vin input connection pins are located as shown in Figure 1. AEE-10W 12V input converters have a 2:1 input voltage range of 9-18V.

Care should be taken to avoid applying reverse polarity to the input which can damage the converter.

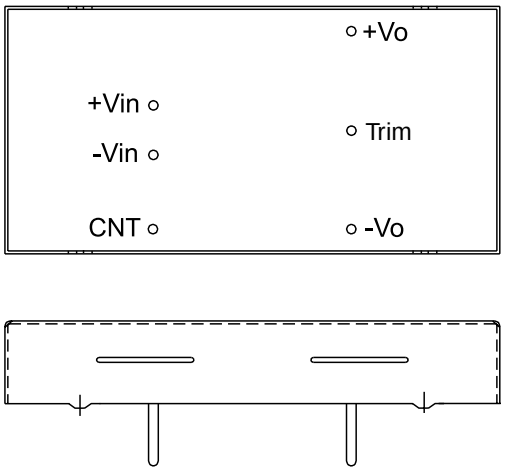


Fig.1 Pins

Input Characteristic

Fusing

The AEE-10W 12V input power module has no internal fuse. An external fuse must always be employed!

To meet international safety requirements, a 250 Volt rated fuse should be used. If one of the input lines is connected to chassis ground, then the fuse must be placed in the other input line. Standard safety agency regulations require input fusing. Recommended fuse ratings for the AEE-10W 12Vin Series are shown in Table 1.

Table 1

Series	Fuse Rating
12Vin	4A

Input Reverse Voltage Protection

Under installation and cabling conditions where reverse polarity across the input may occur, reverse polarity protection is recommended. Protection can easily be provided as shown in Figure 2. In both cases the diode rating is determined by the power of the converter. Diodes should be rated at 5A/25V for the AEE-10W 12Vin single output series.

Placing the diode across the inputs rather than in-line with the input offers an advantage in that the diode only conducts in a reverse polarity condition, which increases circuit efficiency and thermal performance.

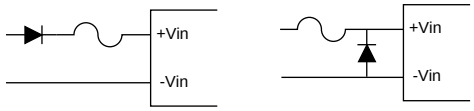


Fig.2 Reverse Polarity Protection Circuits

Input Filter

Input filters are included in the converters to help achieve standard system emissions certifications. Some users however, may find that additional input filtering is necessary. The AEE-

10W 12Vin series has an internal switching frequency of 330 kHz so a high frequency capacitor mounted close to the input terminals produces the best results. To reduce reflected noise, a capacitor can be added across the input as shown in Figure 3, forming a π filter. A 47μF/25V electrolytic capacitor is recommended for C1.

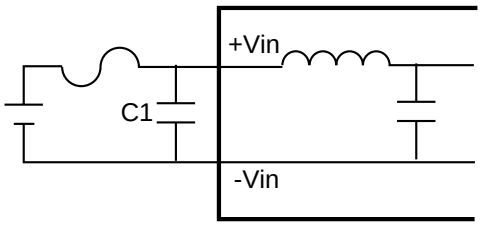


Fig.3 Ripple Rejection Input Filter

For conditions where EMI is a concern, a different input filter can be used. Figure 4 shows an input filter designed to reduce EMI effects. L1 is a 12 μH differential inductor, C1 is a 47μF/25V electrolytic capacitor, and C0 is a 1μF/25V metal film or ceramic high frequency capacitor. When a filter inductor L1 is connected in series with the power converter input, an input capacitor C0 should be added. An input capacitor C0 should also be used when the input wiring is long, since the wiring can act as an inductor. Failure to use an input capacitor under these conditions can produce large input voltage spikes and an unstable output.

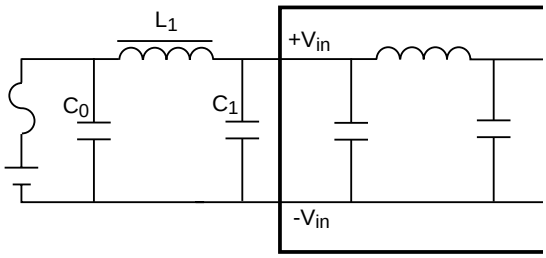


Fig.4 EMI Reduction Input Filter

CNT Function (optional)

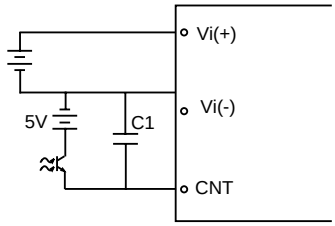
The AEE-10W 12Vin single output series is negative logic, CNT control turns the module off during a logic high on the CNT pin, and turns the module on during a logic low on the CNT pin.

To turn the power module on or off, the user must supply a switch to control the voltage on the CNT pin, the switcher may be an open collector or equivalent (see Fig.5.).

The logic low is V_{CNT} = 0 V to +0.7V.

The logic high is V_{CNT} = +3.6V to +6V.

The module does not have internal capacitance to reduce noise at the CNT pin. Additional capacitance is needed. A 1uF/25V electrolytic capacitor is recommended for C1.



Vcnt: ON--- Vcnt = 0 ~ +0.7V or CNT pin in midair
OFF--- Vcnt = +3.6V ~ +6V
C1: Recommended 1mF/25V

Fig.5 CNT Control

Input-Output Characteristic

Isolation

The isolation voltage between input to output, input to case and case to output are all greater than 1500 Volt DC. If the system using the power module needs to meet safety agency approval, certain rules must be followed in the design of the system using the module. In particular, all of the creepage and clearance requirements of the end-use safety requirement must be observed.

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Safety Consideration

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., UL1950, CSA C22.2 No. 950-95, and EN60950. The input-to-output 1500VDC isolation is an operational insulation. The DC/DC power module should be installed in end-use equipment, in compliance with the requirements of the ultimate application, and is intended to be supplied by an isolated secondary circuit. When the supply to the DC/DC power module meets all the requirements for SELV(<60Vdc), the output is considered to remain within SELV limits (level 3). If connected to a 60Vdc power system, double or reinforced insulation must be provided in the power supply that isolates the input from any hazardous voltages, including the ac mains. One Vi pin and one Vo pin are to be grounded or both the input and output pins are to be kept floating. Single fault testing in the power supply must be performed in combination with the DC/DC power module to demonstrate that the output meets the requirement for SELV. The input pins of the module are not operator accessible.

Note: Do not ground either of the input pins of the module, without grounding one of the output pins. This may allow a non-SELV voltage to appear between the output pin and ground.

Output Characteristics

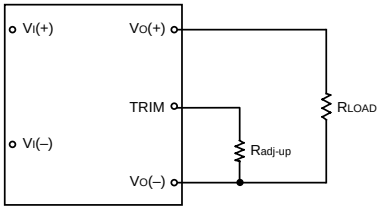
Minimum Load Requirement

There is **no minimum load requirement** for the AEE-10W 12V input single output series modules.

Output Trimming

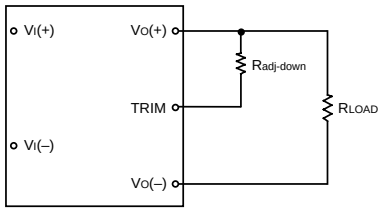
Users can increase or decrease the output voltage set point of a module by connecting an external resistor between the TRIM pin. The trim resistor should be positioned close to the module. **If not using the trim feature, leave the TRIM pin open.**

Trimming up by more than 10% of the nominal output may damage the converter or trig the OVP protection. Trimming down more than 10% can cause the converter to regulate improperly. Trim down and trim up circuits and the corresponding configuration are shown in Figure 6 to Figure 7.



$$R_{adj\text{-}up} = \frac{A\ L}{(Vo,adj - L) - C} - B \quad K\Omega$$

Fig.6 Trim Up Circuit and Equation



$$R_{adj\text{-}down} = \frac{(Vo,adj - L)\ A}{(Vo,nom - Vo,adj)} - B \quad K\Omega$$

Fig.7 Trim Down Circuit and Equation

The value of A,B,L are shown in the following:

Series	A	B	C	L
AEE02F12(-49)	2.05	2	2.083	1.26
AEE02A12(-49)	7.5	10	3.795	1.26
AEE00B12(-49)	9.53	10	12.757	2.5
AEE00C12(-49)	12.4	10	9.805	2.5

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Note that at elevated output voltages the maximum power rating of the module remains the same, and the output current capability will decrease correspondingly.

Output Over-Current Protection

AEE-10W 12V input series DC/DC converters feature foldback current limiting as part of their Overcurrent Protection (OCP) circuits. When output current exceeds 110 to 150% of rated current, such as during a short circuit condition, the output will shutdown. **Note if input voltage exceeds 20V, the continuous shortcircuit may damage the module or decrease its life.**

Output Filters

When the load is sensitive to ripple and noise, an output filter can be added to minimize the effects. A simple output filter to reduce output ripple and noise can be made by connecting a capacitor across the output as shown in Figure 8. The recommended value for the output capacitor is 100µF/25V.

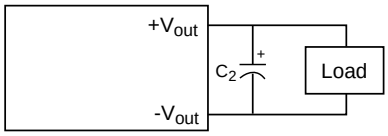

Fig.8 Output Ripple Filter

Extra care should be taken when long leads or traces are used to provide power to the load. Long lead lengths increase the chance for noise to appear on the lines. Under these conditions C2 can be added across the load as shown in Figure 9. The recommended component for C2 is 100µF/25V capacitor and connecting a 0.47µF/50V ceramic capacitor in parallel generally.

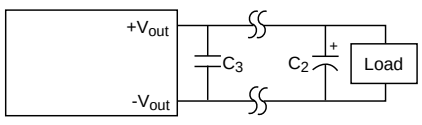

Fig.9 Output Ripple Filter For a Distant Load

Decoupling

Noise on the power distribution system is not always created by the converter. High speed analog or digital loads with dynamic power demands can cause noise to cross the power inductor back onto the input lines. Noise can be reduced by decoupling the load. In most cases, connecting a 10 µF tantalum capacitor in parallel with a 0.1µF ceramic capacitor across the load will decouple it. The capacitors should be connected as close to the load as possible.

Ground Loops

Ground loops occur when different circuits are given multiple paths to common or earth ground, as shown in Figure 10. Multiple ground points can slightly different potential and cause current flow through the circuit from one point to another. This can result in additional noise in all the circuits. To eliminate the problem, circuits should be designed with a single ground connection as shown in Figure 11.

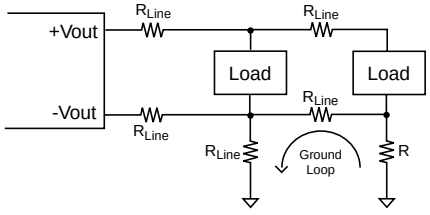

Fig. 10. Ground Loops

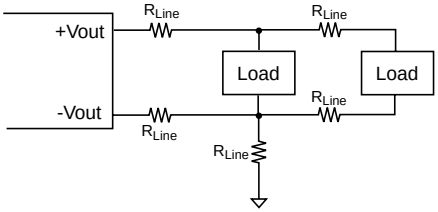

Fig.11 Single Point Ground

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Parallel Power Distribution

Figure 12 shows a typical parallel power distribution design. Such designs, sometimes called daisy chains, can be used for very low output currents, but are not normally recommended. The voltage across loads far from the source can vary greatly depending on the IR drops along the leads and changes in the loads closer to the source. Dynamic load conditions increase the potential problems.

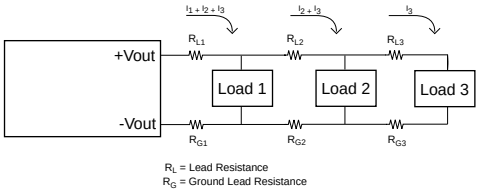


Fig.12 Parallel Power Distribution

Radial Power Distribution

Radial power distribution is the preferred method of providing power to the load. Figure 13. shows how individual loads are connected directly to the power source. This arrangement requires additional power leads, but it avoids the voltage variation problems associated with the parallel power distribution technique.

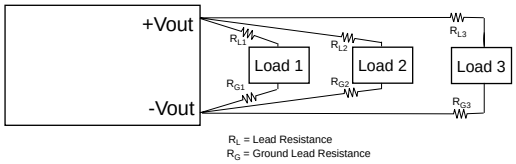


Fig.13 Radial Power Distribution

Mixed Distribution

In the real world a combination of parallel and radial power distribution is often used. Dynamic and high current loads are connected using a radial design, while static and low current loads can be connected in parallel. This combined approach minimizes the drawbacks of a parallel design when a purely radial design is not feasible.

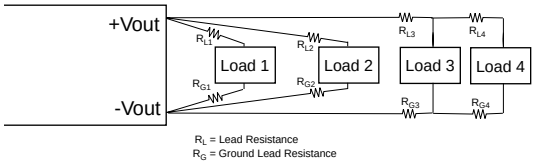


Fig.14 Mixed Power Distribution

Redundant Operation

A common requirement in high reliability systems is to provide redundant power supplies. The easiest way to do this is to place two converters in parallel, providing fault tolerance but not load sharing. Oring diodes should be used to ensure that failure of one converter will not cause failure of the second. Figure 15 shows such an arrangement. Upon application of power, one of the converters will provide a slightly higher output voltage and will support the full load demand. The second converter will see a zero load condition and will "idle". If the first converter should fail, the second converter will support the full load. When designing redundant converter circuits, Shottky diodes should be used to minimize the forward voltage drop. The voltage drop across the Shottky diodes must also be considered when determining load voltage requirements.

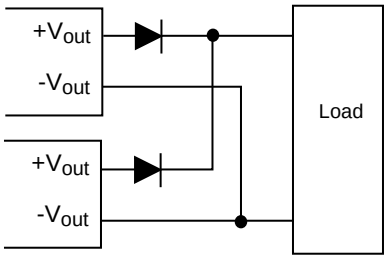
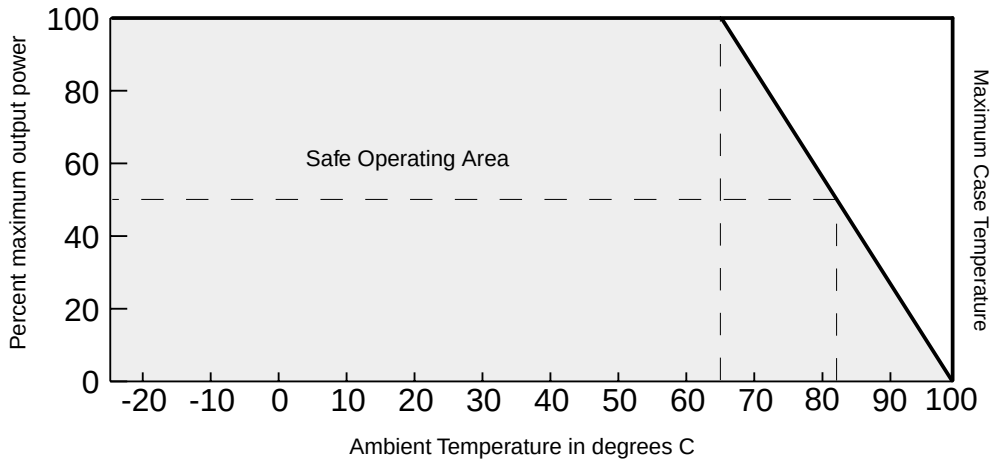


Fig.15 Redundant Operation

Module Derating

Typical Derating Curve



Mechanical Considerations

Installation

Although AEE-10W 12V input series converters can be mounted in any orientation, free air-flowing must be taken. Normally power components are always put at the end of the airflow path or have the separate airflow paths. This can keep other system equipment cooler and increase component life spans.

Soldering

AEE-10W 12V input series converters are compatible with standard wave soldering techniques. When wave soldering, the converter pins should be preheated for 20-30 seconds at 110°C, and wave soldered at 260°C for less than 10 seconds.

When hand soldering, the iron temperature should be maintained at 425°C and applied to the converter pins for less than 5 seconds. Longer exposure can cause internal damage to the converter. Cleaning can be performed with cleaning solvent IPA or with water.

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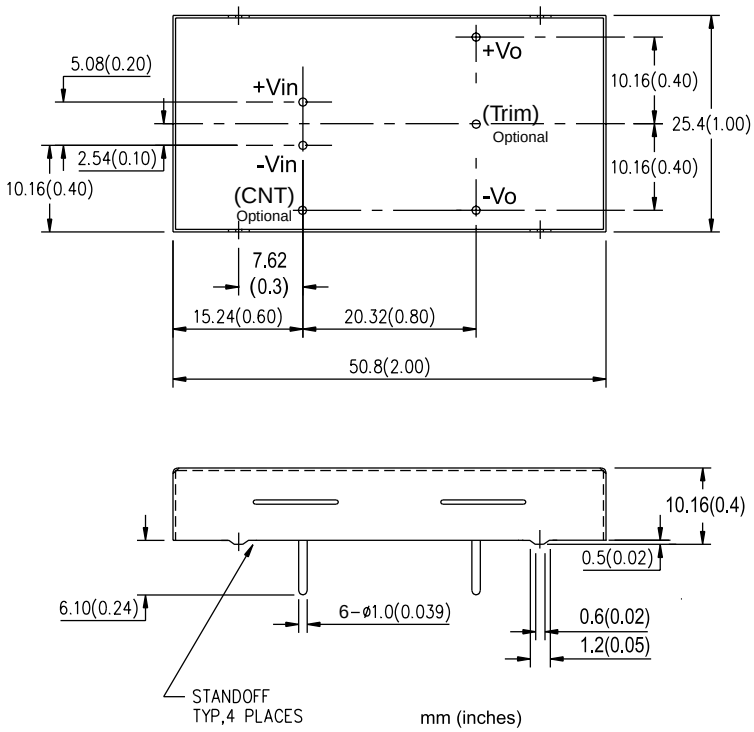
ASTEC

MTBF

The MTBF, calculated in accordance with Bellcore TR-NWT-000332 is 3,000,000 hours. Obtaining this MTBF in practice is entirely possible. If the ambient air temperature is expected to exceed +25°C, then we also advise a oriented for the best possible cooling in the air stream.

ASTEC can supply replacements for converters from other manufacturers, or offer custom solutions. Please contact the factory for details.

Mechanical Chart *(pin side view)*



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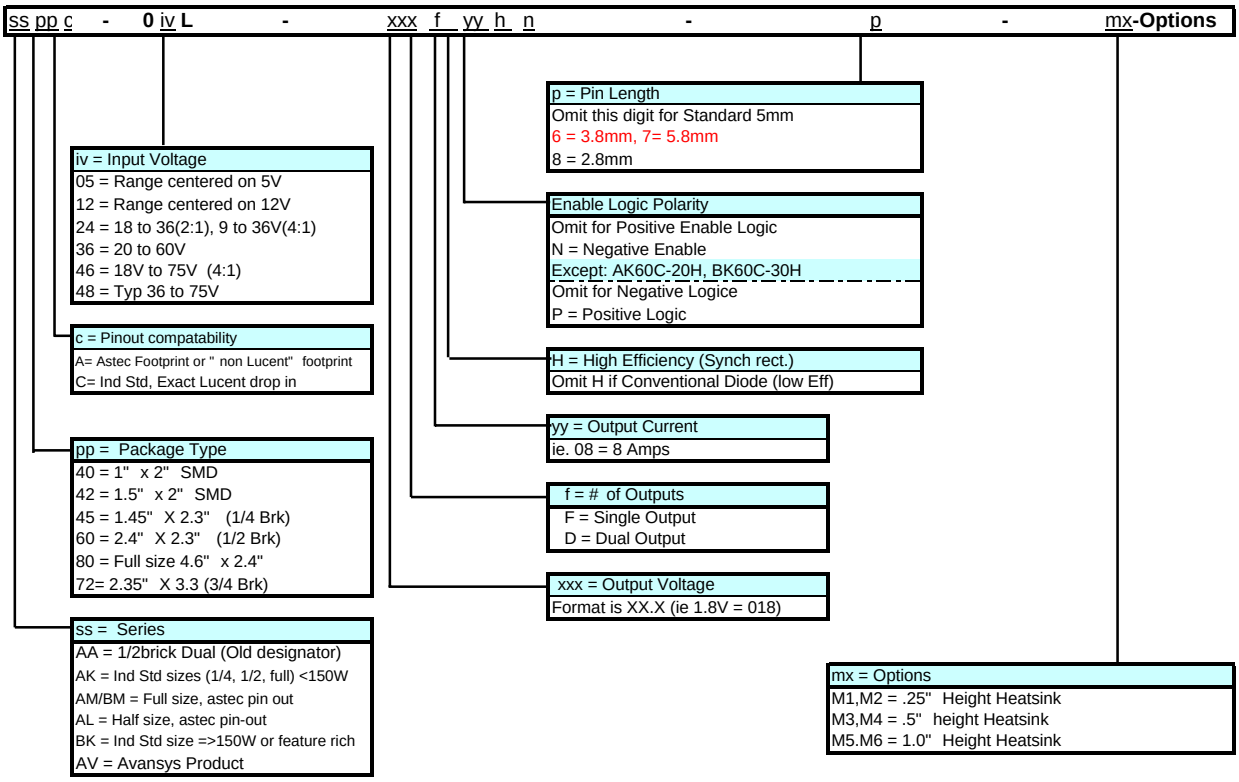
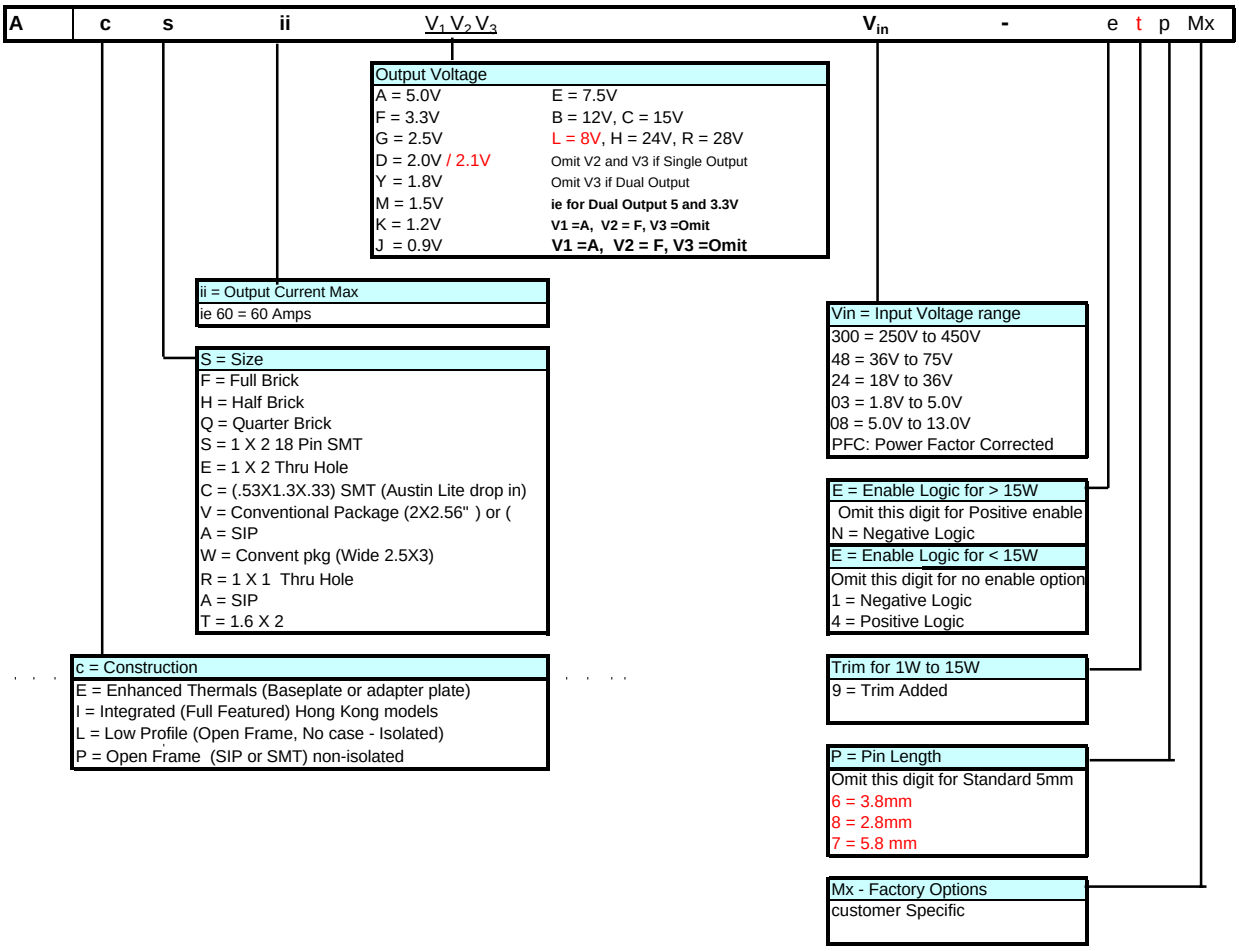
PART NUMBER DESCRIPTION



Note: For some products, they may not conform with the PART NUMBER DESCRIPTION above absolutely.

NEW PART NUMBER DESCRIPTION



Note: For some products, they may not conform with the NEW PART NUMBER DESCRIPTION above absolutely.