REV	Description	Date	Approved
PR-A	Preliminary Release	3/30/00	
PR-B	Updated Efficiency Specs	2/12/01	

ASTEC

TECHNICAL REFERENCE NOTES (TRN)

AA10C SERIES

DC-DC CONVERTER

ASTEC POWER

ANDOVER, MA

Electrical Specifications

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 TRN. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

Table 1. Absolute Maximum Ratings

Parameter	Device	Symbol	Min	Typ	Max	Unit
Input Voltage:						
Continuous:	All	V_I	0	-	80	Vdc
Transient (100ms)	All	$V_{I,\ trans}$	0	-	100	Vdc
Operating Case Temperature	All	Tc	-40	-	115	ºC
Storage Temperature	All	Tstg	-55	-	125	ºC
Operating Humidity	All	-	-	-	95	%
I/O Isolation	All	-	-	-	1500	Vdc

Input Specifications

Table 2. Input Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Operating Input Voltage	All	V_I	36	48	75	Vdc
Maximum Input Current (V_I = 0 to $V_{I,max}$: Io = Io,max)	015S-X	$I_{I,max}$	-	-	0.15	A
	020S-X	$I_{I,max}$	-	-	0.18	A
	025S-X*	$I_{I,max}$	-	-	0.22	A
	033S-X	$I_{I,max}$	-	-	0.30	A
	050S-X	$I_{I,max}$	-	-	0.40	A
	120S-X	$I_{I,max}$	-	-	0.37	A
	150S-X	$I_{I,max}$	-	-	0.37	
Input Reflected-ripple Current (5Hz to 20MHz: 12uH source impedance: T_A = 25 ºC.) See Figure 12.	All	I_I	-	-	10	mAp-p
No Load Input Power (V_I = $V_{I,nom}$)	All	-	-	-	0.75	W
Maximum Input Capacitance	All	-	-	-	1.4	uF

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

Output Specifications

Table 3. 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)	015S-X	Vo,set	1.44	1.5	1.56	Vdc
	020S-X	Vo,set	1.92	2.0	2.08	Vdc
	025S-X*	Vo,set	-	2.5	-	Vdc
	033S-X	Vo,set	3.17	3.3	3.43	Vdc
	050S-X	Vo,set	4.85	5.0	5.20	Vdc
	120S-X	Vo,set	11.52	12.0	12.48	Vdc
	150S-X	Vo,set	14.40	15.0	15.60	Vdc

* For a 2.5V output, use the 2V output model (020S-X) with an the output voltage adjustment option.

Output Specifications (continued)

Table 3. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Regulation:						
Line ($V_I = V_{I,min}$ to $V_{I,max}$)	All	-	-	-	5	mV
	120S-X	-	-	-	0.1	%
	150S-X	-	-	-	0.1	%
Load(Io = Io,min to Io,max)	All	-	-	-	15	mV
	120S-X	-	-	-	0.2	%
	150S-X	-	-	-	0.2	%
Temperature (Tc = -40 ºC to +105 ºC)	All	-	-	25	100	mV
	120S-X	-	-	0.5	2	%Vo
	150S-X	-	-	0.5	2	%Vo
Output Ripple and Noise (Across 2 x 0.47 uF ceramic capacitors) See Figure 13.						
Peak-to-Peak (5 Hz to 20 MHz)	All	-	-	50	100	mVp-p
	120S-X	-	-	75	120	mVp-p
	150S-X	-	-	75	120	mVp-p
RMS	All	-	-	-	30	mVrms
	120S-X	-	-	-	35	mVrms
	150S-X	-	-	-	35	mVrms
External Load Capacitance	All	-	-	-	1000	uF
	120S-X	-	-	-	200	uF
	150S-X	-	-	-	200	uF
Output Current	015S-X	Io	0.20	-	2.0	A
	020S-X	Io	0.20	-	2.0	A
	025S-X*	Io	0.20	-	2.0	A
	033S-X	Io	0.15	-	2.42	A
	050S-X	Io	0.10	-	2.0	A
	120S-X	Io	0.08	-	0.83	A
	150S-X	Io	0.06	-	0.67	A
Output Current-limit Inception (Vo = 90% Vo,set)	015S-X	Io	-	-	4	A
	020S-X	Io	-	-	4	A
	025S-X*	Io	-	-	4	A
	033S-X	Io	-	-	4	A
	050S-X	Io	-	-	4	A
	120S-X	Io	-	-	1.4	A
	150S-X	Io	-	-	1.1	A
Output Short-circuit Current (Vo = 250mV)	All	-	-	-	190	%Io,max

* For a 2.5V output, use the 2V output model (020S-X) with an the output voltage adjustment option.

Output Specifications (continued)

Table 3. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Efficiency (V_I = $V_{I,nom}$; Io = Io,max; T_A = 25 ºC)	015S-X	Io	64	66	-	%
	020S-X	Io	67	70	-	%
	025S-X*	Io	67	70	-	%
	033S-X	Io	73	76	-	%
	050S-X	Io	77	81	-	%
	120S-X	Io	77	81	-	%
	150S-X	Io	77	81	-	%
Switching Frequency	All	-	405	450	495	kHz
Dynamic Response: (ΔIo/Δt = 1A/10us; V_I = $V_{I,nom}$; T_A = 25 ºC)						
Load Change from Io = 50% to 75% of Io, max: Peak Deviation	All	-	-	2	6	%Vo
Settling Time (to Vo,nom)		-	-	250	500	usec
Load Change from Io = 50% to 25% of Io, max: Peak Deviation	All	-	-	2	6	%Vo
Settling Time (to Vo,nom)		-	-	250	500	usec
Turn-on Time (Io = Io,max; Vo within 1%)	All	-	-	1	5	msec
Output Voltage Overshoot (Io = Io,max; T_A = 25 ºC)	All	-	-	-	5	%Vo

Isolation Specifications

Table 4. Isolation Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Isolation Capacitance	All	-	-	260	-	pF
Isolation Resistance	All	-	-	1000	-	Mohm

General Specifications

Table 5. General Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Calculated MTBF (Io = Io,max; T_A = 25 ºC)	All	-	-	TBD	-	hours
Weight	All	-	-	-	18(0.63)	g (oz.)

* For a 2.5V output, use the 2V output model (020S-X) with an the output voltage adjustment option.

Feature Specifications

Table 6. Feature Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Remote On/Off Signal Interface: (V_I = 0 to $V_{I,max}$; Open collector or equivalent compatible; Signal referenced to V_I (-) terminal.)						
Positive Logic –Suffix “-4”						
Low Logic – Module Off						
High Logic – Module On						
Negative Logic –Suffix “-1”						
Low Logic – Module On						
High Logic – Module Off						
Module Specifications:						
On/Off Current – Logic Low	All	Ion/off	-	-	1.0	mA
On/Off Voltage:						
Logic Low	All	Von/off	-0.7	-	1.2	V
Logic High (Ion/off = 0)	All	Von/off	-	-	10	V
Open Collector Switch Specifications:						
Leakage Current – Logic High (Von/off = 10V)	All	Ion/off	-	-	50	uA
Output Voltage – Logic Low (Ion/off = 1mA)	All	Von/off	-	-	1.2	V
Output Voltage Adjustment Suffix “-9”						
Voltage Adjustment Range	All	-	90	-	110	%Vo
	020S-X	-	90	-	125	%Vo
Output Overvoltage Clamp	015S-X	Vo,clamp	1.8	-	2.1	V
	020S-X	Vo,clamp	3.0	-	3.5	V
	025S-X*	Vo,clamp	3.0	-	3.5	V
	033S-X	Vo,clamp	3.9	-	5.7	V
	050S-X	Vo,clamp	5.9	-	7.0	V
	120S-X	Vo,clamp	13.5	-	16.0	V
	150S-X	Vo,clamp	16.8	-	20.0	V
Undervoltage Lockout						
Turn-on Point	All	-	-	34.5	35	V
Turn-off Point	All	-	32	32.5	-	V

* For a 2.5V output, use the 2V output model (020S-X) with an the output voltage adjustment option.

Characteristic Curves

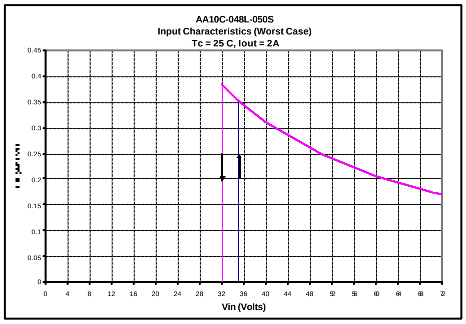


Figure 1. Typical Input Current vs Input Voltage.

Figure 2. 015S Efficiency vs Load Current.

Figure 3. 020S Efficiency vs Load Current.

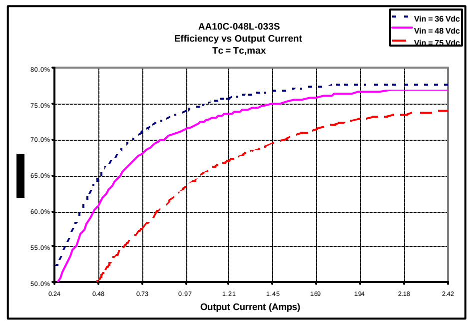


Figure 4. 033S Efficiency vs Load Current.

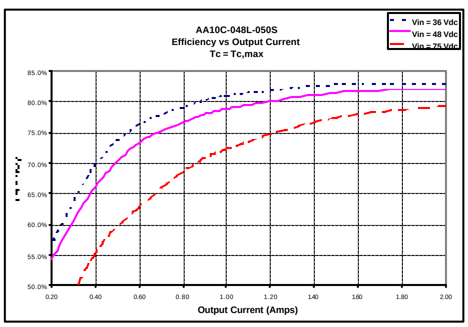


Figure 5. 050S Efficiency vs Load Current.

Figure 6. 120S Efficiency vs Load Current.

Figure 7. 150S Efficiency vs Load Current.

Characteristic Curves (continued)

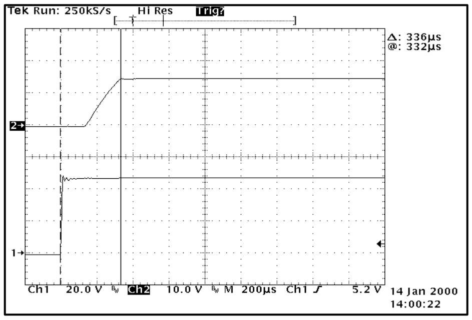
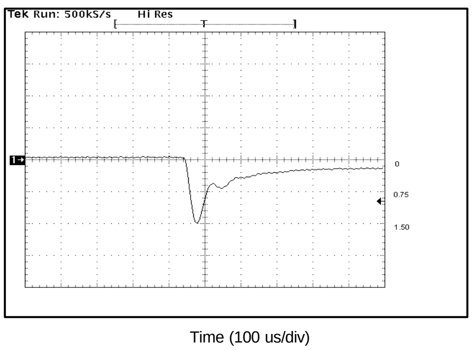


Figure 8. Typical Output Voltage Startup
Vi = Vi,nom, Io = Io,max.

Figure 9. Typical Output Ripple
Vi = Vi,nom, Io = Io,max.



Normalized Output Voltage

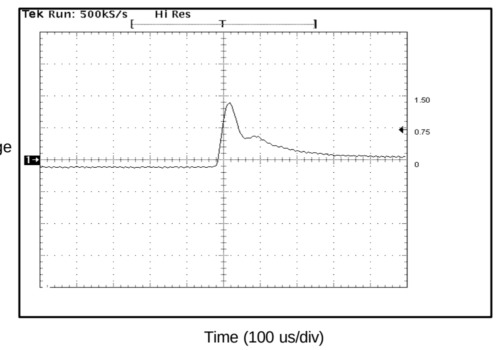
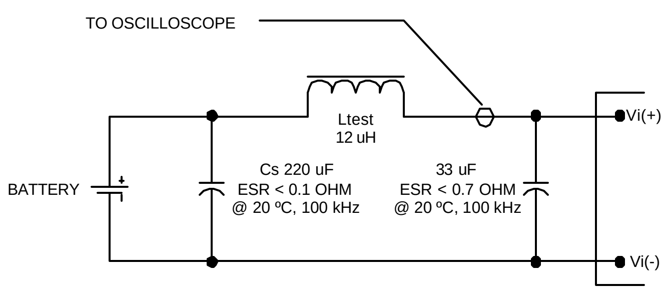


Figure 10. Typical Dynamic Response
Step Load Change from 50% to 75% Io,max

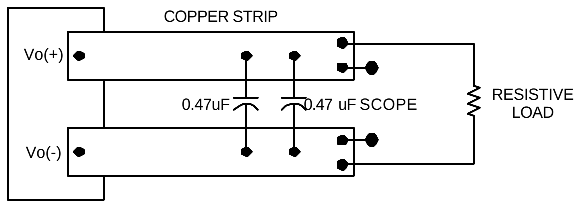
Figure 11. Typical Dynamic Response
Step Load Change from 50% to 25% Io,max

Test Configurations



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 12. Input Reflected-ripple Test Setup.



Note: Use a 2 x 0.47 uF ceramic capacitors. 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 13. Peak-to-Peak Output Noise Measurement Test Setup.

Feature Descriptions

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 $V_{o,clamp,max}$. 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 (Optional)

Two enable option are available. Positive Logic Enable, suffix “4”, and Negative Logic Enable, suffix “1”. 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 of during a logic-high and on during a logic-low.

Output Voltage Adjustment (Optional)

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

With an external resistor between the Vadj Pin and +Vout Pin ($R_{adj-down}$) the output voltage set point ($V_{o,adj}$) decreases (see Figure 14). The following equation determines the required external resistor value to obtain an adjusted output voltage:

Feature Descriptions (continued)

$$Radj\_down = \left[\frac{(Vo, adj - L) \cdot G}{(Vo, nom - Vo, adj)} - H \right] \cdot ohm$$

Where $R_{adj\text{-}down}$ is the resistance value and G, H, and L are defined in Table 7.

With an external resistor between the Vadj Pin and -Vout Pin ($R_{adj\text{-}up}$) the output voltage set point (Vo,adj) increases (see Figure 15). The following equation determines the required external resistor value to obtain an adjusted output voltage:

$$Radj\_up = \left[\frac{G \cdot L}{((Vo, adj - L) - K)} - H \right] \cdot ohm$$

Where $R_{adj\text{-}up}$ is the resistance value and G, H, K, and L are defined in Table 7:

Table 7 Output Adjustment Variables.

Model	G	H	K	L
015S	5110	2050	0.26	1.24
020S	5110	2050	0.76	1.24
033S	5110	2050	0.80	2.5
050S	5110	2050	2.5	2.5
120S	10,000	5110	9.5	2.5
150S	10,000	5110	12.5	2.5

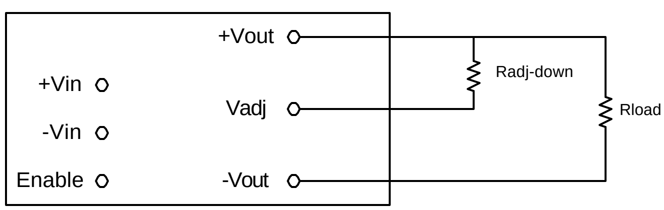


Figure 14 . Circuit Configuration to Decrease Output Voltage.

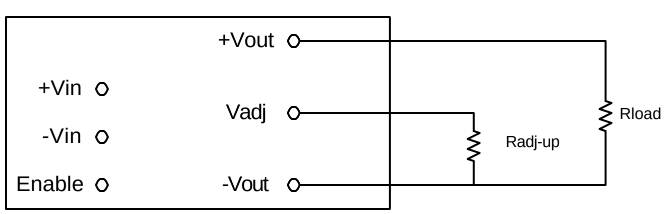


Figure 15 . Circuit Configuration to Increase Output Voltage.

Thermal Considerations

The power converter operates in a variety of thermal environments: however, sufficient cooling should be provided to help ensure reliable operation of the converter. Heat-dissipating components are thermally coupled to the PCB. Heat is removed by conduction, convection, and radiation to the surrounding environment. Proper cooling can be verified by measuring the PCB temperature. See figure 23 for PCB temperature measurement location.

Heat Transfer Characteristics

Increasing airflow over the converter enhances the heat transfer via convection. Figure 16 shows the maximum power that can be dissipated by the converter without exceeding the maximum case temperature versus local ambient temperature (T_A) for natural convection through 3.0 m/s (600 ft/min).

Systems in which these converters are used generate airflow rates of 0.25 m/s (50 ft/min) due to other heat dissipating components in the system. Therefore, the natural convection condition represents airflow rates of approximately 0.25 m/s (50 ft/min). Use of Figure 16 is shown in the following example.

Example

What is the minimum airflow required for an 050S operating at 48 V, an output current of 2.0 A, and maximum ambient temperature of 95 ºC.

Solution:

Given: Vi = 48 V, Io = 3.0 A, T_A = 95 ºC.
Determine P_D (Figure 20): P_D = 2.2 W.
Determine airflow (Figure 16): v = 1.0 m/s (200 ft/min)

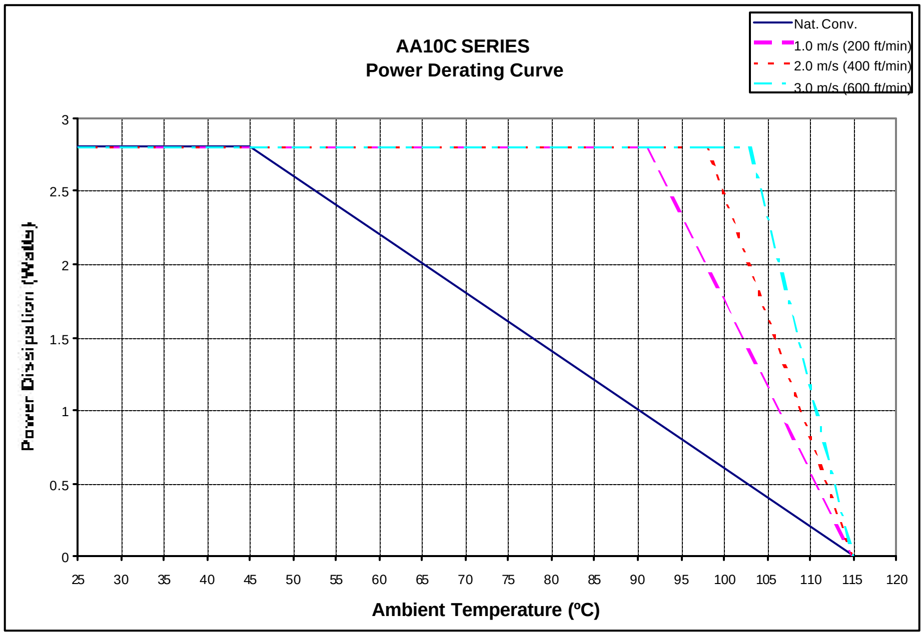


Figure 16. Forced Convection Power Derating

Thermal Considerations (continued)

Figure 17. 015S Pwr. Diss. vs Load Current.

Figure 18. 020S Pwr. Diss. vs Load Current.

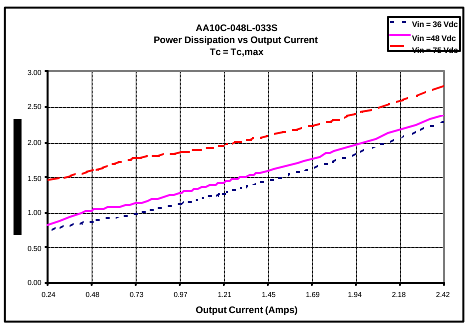


Figure 19. 033S Pwr. Diss. vs Load Current.

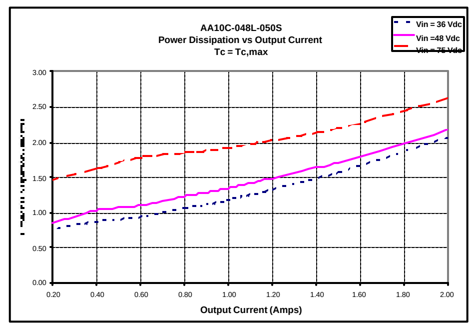


Figure 20. 050S Pwr. Diss. vs Load Current.

Figure 21. 120S Pwr. Diss. vs Load Current.

Figure 22. 150S Pwr. Diss. vs Load Current.

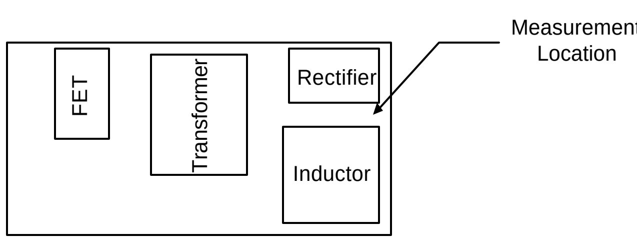
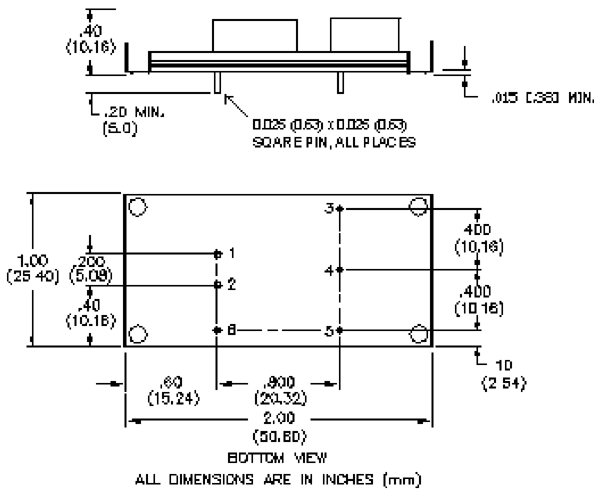


Figure 23. PCB Temperature Measurement Location

Outline Drawing

Dimensions are in inches (millimeters)
Tolerances: x.xx +/- 0.02 in (x.x +/- 0.5mm)
x.xx +/- 010 in (x.xx +/- 0.25mm)



Pin Assignment

1. +Vin
2. - Vin
3. + Output
4. Trim
5. - Output
6. Enable (on/off)

Ordering Information

Table 8 Part Numbers.

Input Voltage	Output Voltage	Output Power	Part Number
36 V – 75 V	1.5 V	3 W	AA10C-048L-015S
36 V – 75 V	2.0 V	4 W	AA10C-048L-020S
36 V – 75 V	3.3 V	8 W	AA10C-048L-033S
36 V – 75 V	5.0 V	10 W	AA10C-048L-050S
36 V – 75 V	12.0 V	10 W	AA10C-048L-120S
36 V – 75 V	15.0V	10 W	AA10C-048L-150S

Table 9 Option Codes.

Suffix	Option
-1	Negative Logic Enable
-4	Positive Logic Enable
-6	3.7 mm Pin Length
-8	2.8 mm Pin Length
-9	Output Voltage Adjustment