REV	Description	Date	Approved
PR-A	Preliminary Release	4/30/00	
PR-B	Preliminary Release	9/05/00	
PR-C	Remove 1.5, 2, 5V unit – misc. updates	3/28/01	KTF

TECHNICAL REFERENCE NOTES (TRN)

BK60C-H SERIES HIGH EFFICIENCY

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: Transient (100ms)	 All All	 V_I $V_{I, trans}$	 0 0	 - -	 80 100	 Vdc Vdc
Operating Case Temperature	All	Tc	-40	-	100	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)	018FX 025FX 033FX	$I_{I,max}$ $I_{I,max}$ $I_{I,max}$	- - -	- - -	3.0 4.0 5.0	A A A
Input Reflected-ripple Current (5Hz to 20MHz: 12uH source impedance: T_A = 25 ºC.) See Figure 9.	All	I_I	-	10	-	mAp-p
No Load Input Power (V_I = $V_{I,nom}$)	All	-	-	-	7.5	W
Internal Input Capacitance	All	-	-	-	3.7	uF

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)	018FX 025FX 033FX	Vo,set Vo,set Vo,set	1.77 2.46 3.25	1.8 2.5 3.3	1.83 2.54 3.35	Vdc Vdc Vdc

Output Specifications (continued)

Table 3. Output Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Regulation: Line ($V_I = V_{I,min}$ to $V_{I,max}$) Load(Io = Io,min to Io,max) Temperature (Tc = -40 ºC to +100 ºC)	All	- - -	- - -	0.05 0.1 15	0.2 0.3 50	%Vo %Vo mV
Output Ripple and Noise (Across 0.1uF ceramic and 10uF tantalum capacitors) See Figure 10.	All	-	-	-	150	mVp-p
External Load Capacitance	All	- -	- -	- -	10,000	uF
Output Current	018FX 025FX 033FX	Io Io Io	0.5 0.5 0.5	- - -	40 40 40	A A A
Output Current-limit Inception (Vo = 90% Vo,set)	All	Io	45	-	55	A
Output Short-circuit Current (Vo = 250mV)	All	-	-	-	190	%Io,max
Efficiency ($V_I = V_{I,nom}$; Io = Io,max; Tc = 25°C)	018FX 025FX 033FX	Io Io Io	80 82 84	82 84 86	- - -	% % %
Switching Frequency	018FX 025FX 033FX	f f f	- - -	330 330 400	- - -	kHz kHz kHz
Dynamic Response: ($\Delta Io/\Delta t$ = 1A/10us; $V_I = V_{I,nom}$; T_c = 70 ºC) Load Change from Io = 50% to 75% of Io, max: Peak Deviation Settling Time Load Change from Io = 50% to 25% of Io, max: Peak Deviation Settling Time	All All	- - - -	- - - -	- - - -	6 300 6 300	%Vo usec %Vo usec
Turn-on Time (Io = Io,max; Vo within 1%)	All	-	-	2	5	msec
Output Voltage Overshoot (Io = Io,max; T_c = 70 ºC)	All	-	-	-	5	%Vo

Isolation Specifications

Table 4. Isolation Specifications

Parameter	Device	Symbol	Min	Typ	Max	Unit
Isolation Capacitance	All	-	-	2300	-	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	-	-	-	100(3.5)	g (oz.)

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 – No Suffix						
Low Logic – Module Off						
High Logic – Module On						
Negative Logic –Suffix “N”						
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						
Remote Sense Range	All	-	-	-	0.5	V
Voltage Adjustment Range	All	-	90	-	110	%Vo

Feature Specifications (continued)

Table 6. Feature Specifications (continued)

Parameter	Device	Symbol	Min	Typ	Max	Unit
Output Overvoltage Clamp	018FX	Vo,clamp	2.4	-	2.7	V
	025FX	Vo,clamp	3.1	-	3.5	V
	033FX	Vo,clamp	3.9	-	4.6	V
Overtemperature Shutdown	All	Tc	105	110	120	ºC
Undervoltage Lockout						
Turn-on Point	All	-	-	34.5	35	V
Turn-off Point	All	-	32	32.5	-	V

Characteristic Curves

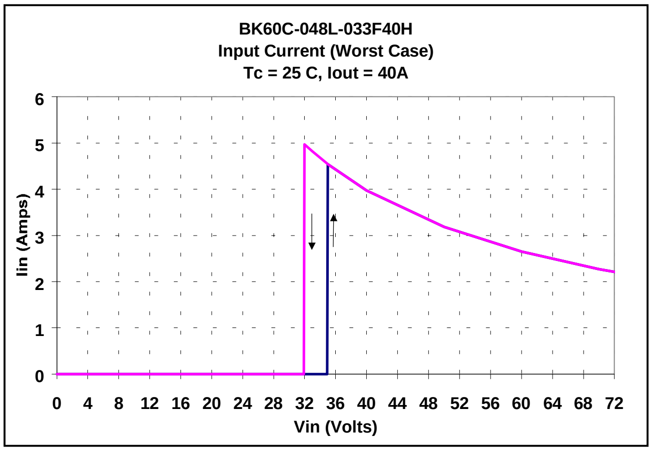


Figure 1. Typical Input Current vs Input Voltage.

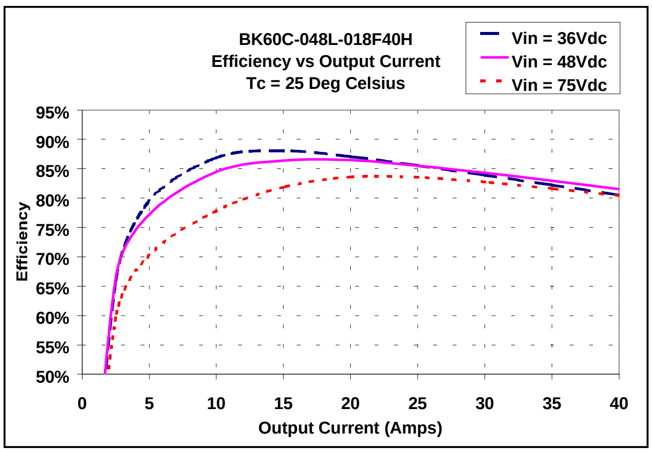


Figure 2. 018F Efficiency vs Load Current.

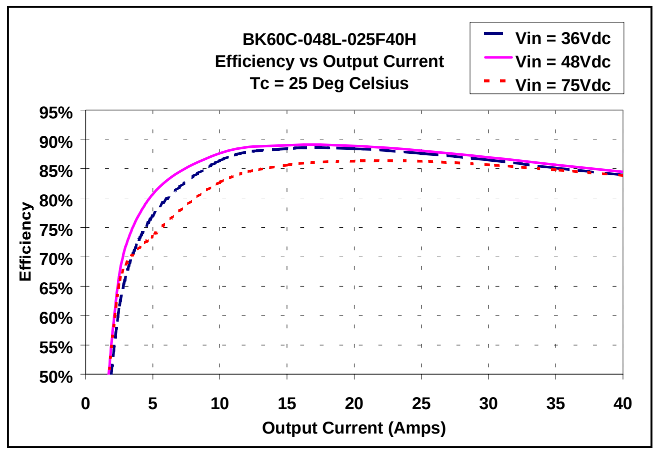


Figure 3. 025F Efficiency vs Load Current.

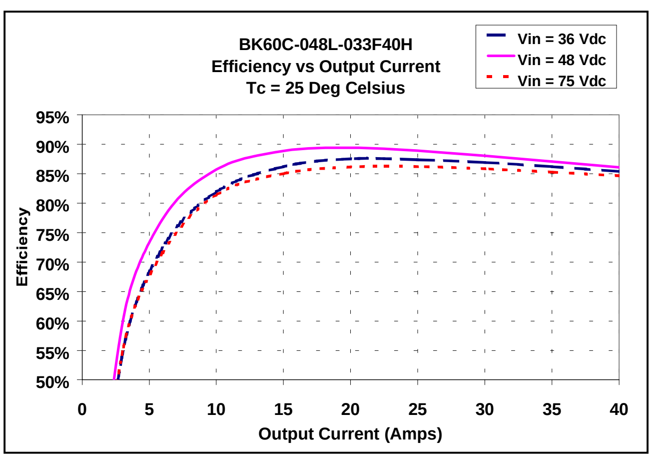


Figure 4. 033F Efficiency vs Load Current.

Characteristic Curves (continued)

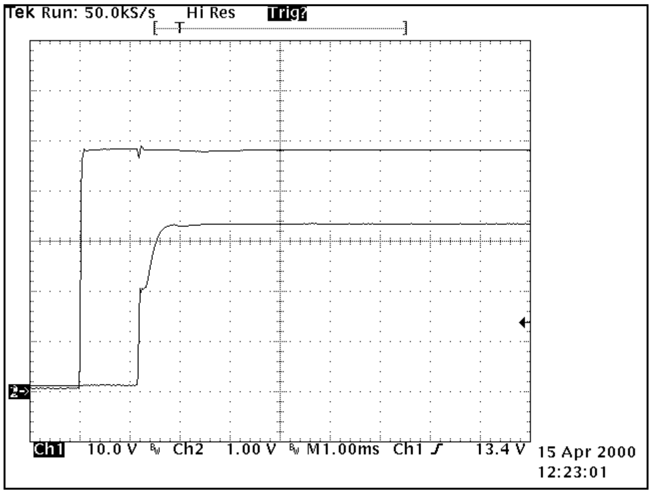


Figure 5. Typical Output Voltage Startup
Vi = Vi,nom, Io = Io,max.

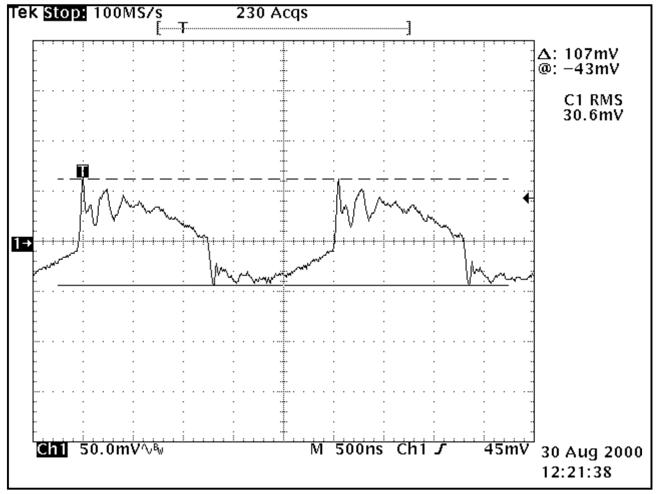


Figure 6. Typical Output Ripple (033F)
Vi = Vi,nom, Io = Io,max.

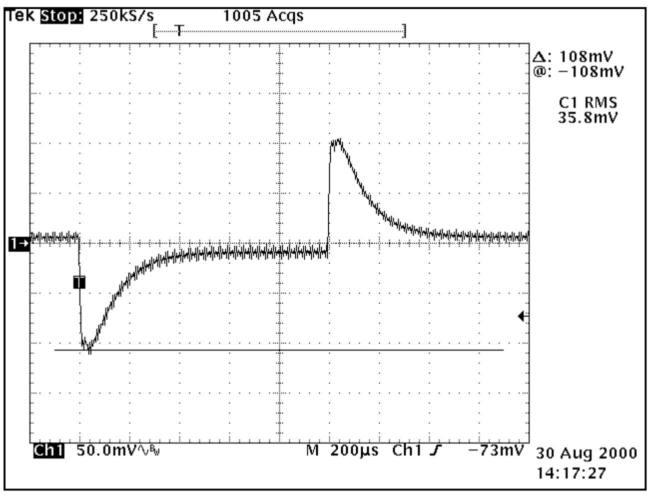


Figure 7. Typical Dynamic Response (033F)
Step Load Change from 50% to 75% Io,max

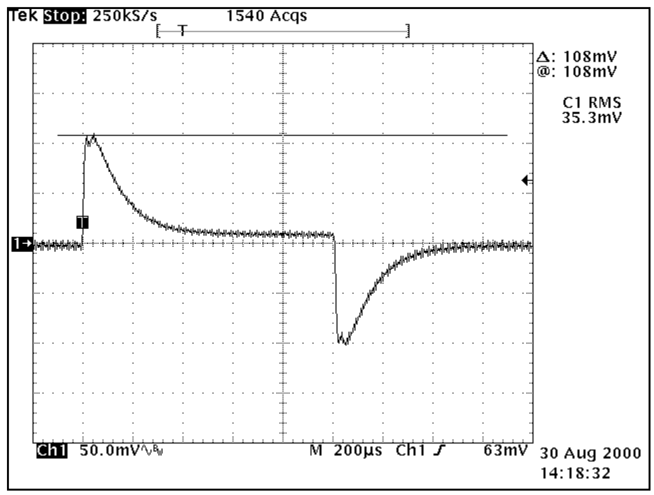
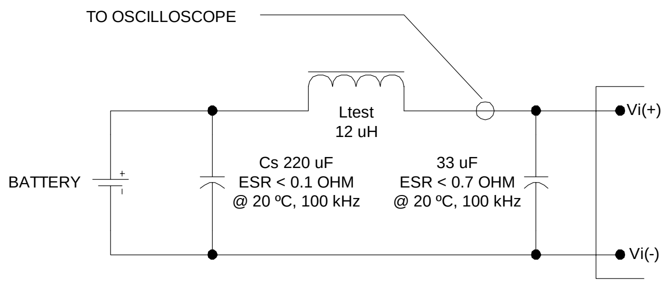


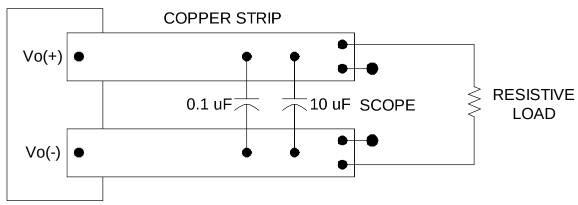
Figure 8. Typical Dynamic Response (033F)
Step Load Change from 50% to 25% Io,max

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 9. Input Reflected-ripple Test Setup.



Note: Use a 0.1 uF ceramic capacitor and a 10 uF 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 10. 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 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 (Optional)

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.

Output Voltage Adjustment

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 between the Vadj Pin and -Sense Pin ($R_{adj\text{-}down}$) the output voltage set point (Vo,adj) decreases (see Figure 11). The following equation determines the required external resistor value to obtain an adjusted output voltage:

$$Radj\_down = \left(\frac{100}{\%Vo,adj} - 2\right)\cdot kohm$$

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

With an external resistor between the Vadj Pin and +Sense Pin ($R_{adj\text{-}up}$) the output voltage set point (Vo,adj) increases (see Figure 12). The following equation determines the required external resistor value to obtain an adjusted output voltage:

$$Radj\_up = \left[\frac{Vo\cdot(100 + \%Vo,adj)}{1.225\%Vo,adj} - \frac{100 + 2\cdot\%Vo,adj}{\%Vo,adj}\right]\cdot kohm$$

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

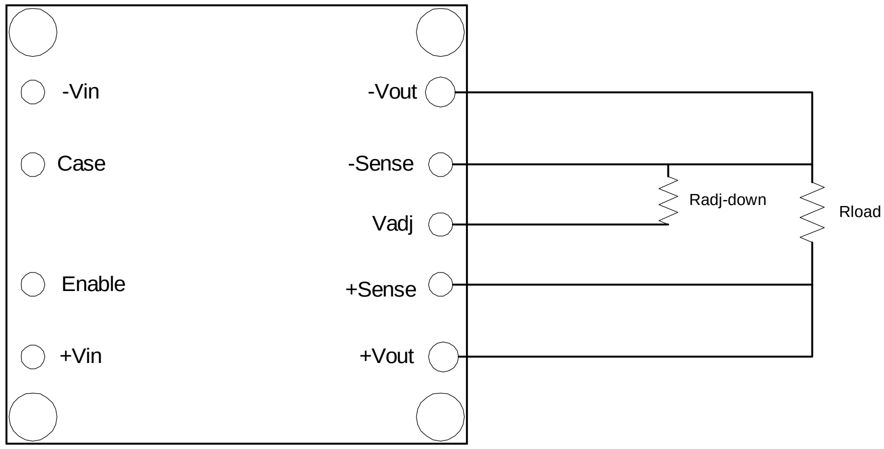


Figure 11 . Circuit Configuration to Decrease Output Voltage.

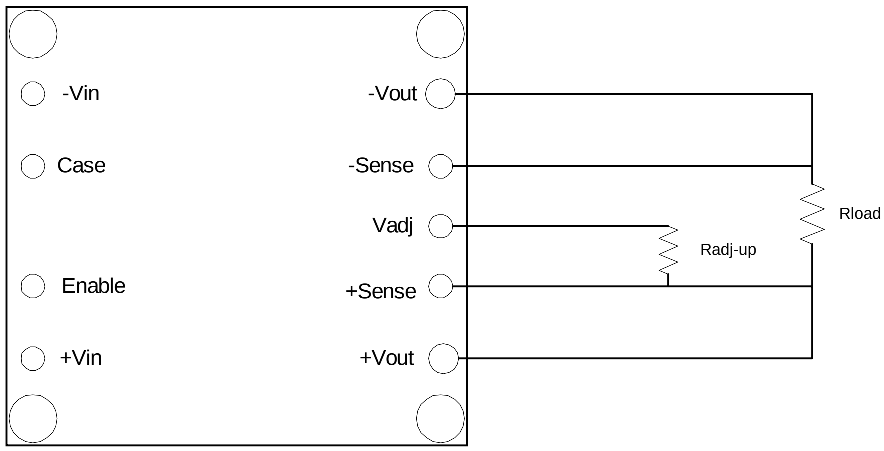


Figure 12 . Circuit Configuration to Increase Output Voltage.

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 case. Heat is removed by conduction, convection and radiation to the surrounding environment. Proper cooling can be verified by measuring the case temperature.

Heat Transfer Characteristics

Increasing airflow over the converter enhances the heat transfer via convection. Figure 13 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 2.0 m/s (400 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 13 is shown in the following example.

Example

What is the minimum airflow required for an 033F40H operating at 48 V, an output current of 25 A, and maximum ambient temperature of 55 ºC.

Solution:

Given: Vi = 48 V, Io = 25 A, T_A = 55 ºC.
Determine P_D (Figure 16): P_D = 13 W.
Determine airflow (Figure 16): v = 1.0 m/s (200 ft/min)

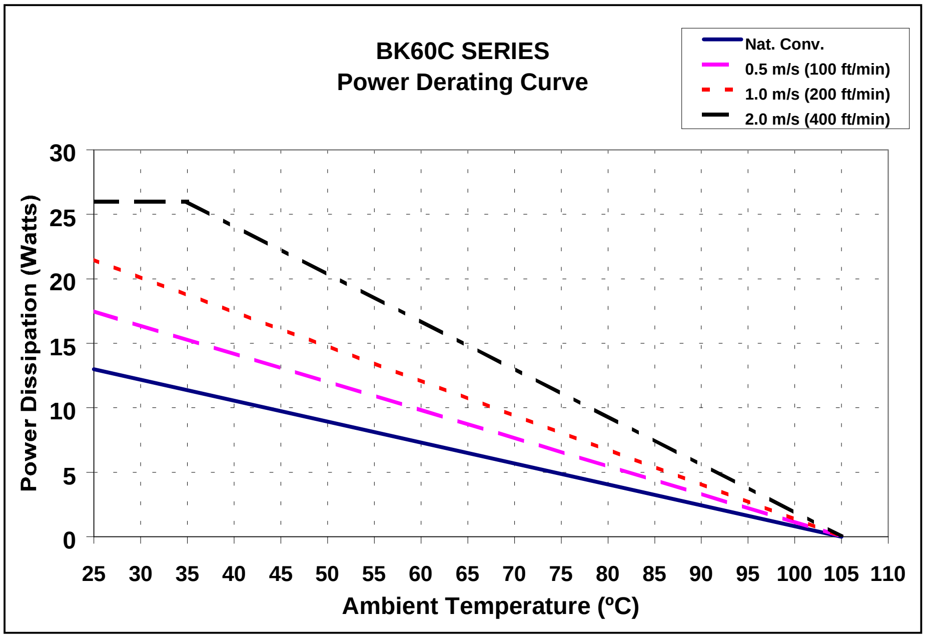


Figure 13. Forced Convection Power Derating

Thermal Considerations (continued)

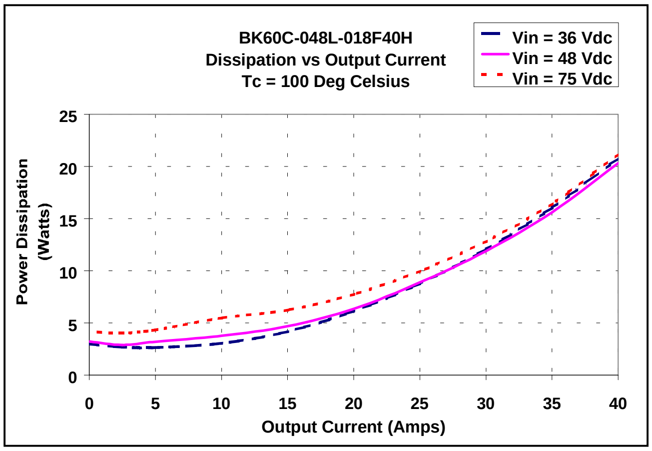


Figure 14. 018F Pwr. Diss. vs Load Current.

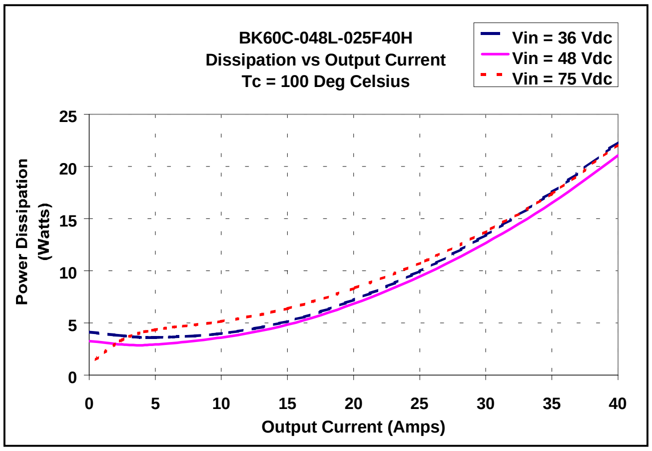


Figure 15. 025F Pwr. Diss. vs Load Current.

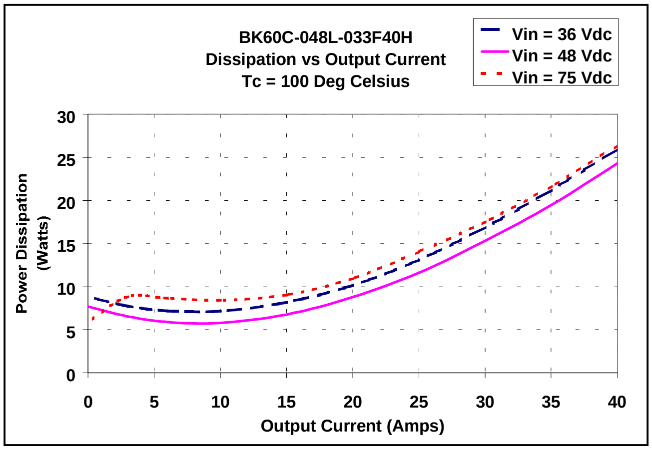
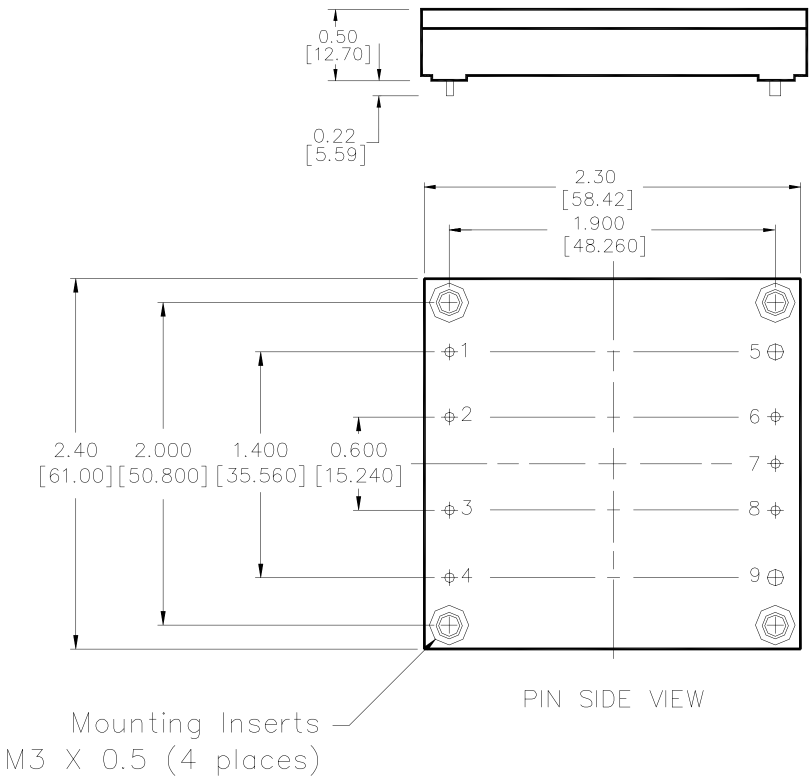


Figure 16. 033F Pwr. Diss. vs Load Current.

Outline Drawing

Tolerances: x.xx +/- 0.02 in (x.x +/- 0.5mm)
x.xxx +/- 0.010 in (x.xx +/- 0.25mm



Pin Assignment

1. -Vin
2. Case
3. Enable (on/off)
4. + Vin
5. - Output
6. - Sense
7. Trim
8. + Sense
9. + Output

All pins are 0.040 diameter except pins 5 & 9 which are 0.080 diameter.

Table 8 Part Numbers.

Model Designation	Part Number
018FN	BK60C-048L-018F40HN
025FN	BK60C-048L-025F40HN
033FN	BK60C-048L-033F40HN
018F	BK60C-048L-018F40H
025F	BK60C-048L-025F40H
033F	BK60C-048L-033F40H

Table 9. Options

Suffix	Option
N	Negative Logic Enable
No Suffix	Positive Logic Enable
-6	3.7 mm Pin Length
-8	2.8 mm Pin Length