

6000 Series

Distributed By:
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IEC950



Key Features:

- 2:1 Input Voltage Range
- 60 Watts of Output Power
- Board and Chassis Mount Models
- 800 VDC Input/Output Isolation
- UL 1950 Approved
- CSA 22.2 Approved
- VDE / EN 60950 Approved
- MTBF >600,000 Hours per MIL-HDBK-217F

General Description

The 6000 series is a family of high power density, 60W single, dual and triple output DC/DC converters. This series utilizes a proprietary topology, high frequency switching control circuits and innovative packaging to combine high power, high performance features and economic pricing at no sacrifice to reliability. Standard features include a wide 2:1 input voltage range, efficiency as high as 87% and continuous short circuit protection by input current limiting. Per MIL-HDBK-217F, the MTBF is over 600,000 hours (+25°C, ground benign).

Twenty four models operate from wide (2:1) input voltage ranges of 9-18 VDC, 18-36 VDC and 36-72 VDC and provide tightly regulated output combinations of 5, 12, 15, ± 5 , ± 12 , ± 15 , 5/ ± 12 or 5/ ± 15 VDC. High performance features include 1400 VDC input/output isolation, an input π (Pi) filter to reduce reflected ripple current, output voltage accuracy of $\pm 1\%$, and a remote ON/OFF control input.

All models are packaged in a compact 4.56 x 3.60 x 0.75 inch metal case. Alternative pin-outs are offered, as well as a chassis mount package with terminal strip connections. Operation is specified over wide operating temperature range of -30°C to +70°C.

Electrical Specifications

Input Specifications:

Input Voltage Range	See Model Selection Guide
Input Filter	π (Pi) Network
Reverse Polarity Input Protection	Internal Shunt Diode
Short Circuit Current Limit	150% of I_{in}
Overvoltage Shutdown	22, 40 or 76 VDC
Undervoltage Shutdown	8 VDC
Reflected Ripple Current	75 mA, Pk-Pk
Remote ON/OFF Control;	
Supply ON	5.5V or Open Circuit
Supply OFF	0 VDC to 0.8 VDC
Logic Input Reference	Negative (-) Input
Logic Compatibility	TTL Open Collector or CMOS Open Drain
Converter Standby Current	32 mA, Max.

Output Specifications:

Voltage and Current Ratings ⁽¹⁾	See Model Selection Guide
Output Voltage Accuracy;	
Single, Dual Output Models	$\pm 1\%$, Max.
Triple Output Models; Primary	$\pm 1\%$ (Adj to Zero)
Auxiliaries	$\pm 6\%$, Max.
Voltage Adjustment Range (External Trim):	
Single, Dual Output Models	$\pm 10\%$, Max.
Voltage Balance;	
Dual Output Models	$\pm 2\%$, Max.
Triple Output Models	± 100 mV, Max.
Ripple & Noise (20 MHz BW)	1% Pk-Pk of V_{out}
Minimum Load	10% of Full Load
Line Regulation;	
Single Output Models	$\pm 0.5\%$, Max.
Dual Output Models	$\pm 1.0\%$, Max.
Triple Output Models; Primary	$\pm 0.2\%$, Max.
Auxiliaries	$\pm 3.0\%$, Max.
Load Regulation;	
Single Output Models ⁽²⁾	$\pm 0.5\%$, Max.
Dual Output Models ⁽²⁾	$\pm 1.0\%$, Max.
Triple Output Models; Primary ⁽²⁾	$\pm 0.5\%$, Max.
Auxiliaries	$\pm 2.0\%$, Max.
Temperature Coefficient @ FL	$\pm 0.02\%/^{\circ}\text{C}$, Max.

Temp. Coefficient Balance (w/Equal Loads)	$\pm 1\%$
Short Circuit Protection	By Input Current Limiting
Over Voltage Protection	See Model Selection Guide

General Specifications:

Efficiency	See Model Selection Guide
Dielectric Voltage Isolation (1 min.)	1400 VDC, Min.
Isolation Resistance	$10^9\Omega$
Switching Frequency	100 kHz, Min.

Environmental Specifications:

Operating Temperature Range (W/Heatsink)	-30°C to +70°C Ambient (+85°C Baseplate)
Derating (See Figure 7)	Linearly to 0% power @ +90°C Baseplate
Thermal Protection	See Application Note
Storage Temperature Range	-50°C to +115°C
Cooling	Free-air Convection or Conduction
EMI/RFI	Six-sided Continuous Shielded Metal Case

Physical Characteristics:

Case Size (Without Heatsink)	2.56 x 4.56 x 0.75 inches (65 x 115.8 x 19.0 mm)
Case Size (With Heatsink)	2.56 x 4.56 x 1.25 inches (65 x 115.8 x 31.75 mm)
Case Material	Coated Copper
Weight	14.0 Oz (395g)
Shielding	Six-sided, Continuous
Shielding Connection (Case K)	
12V, 24V Input Models	Pin 5 (- Input)
48V Input Models	Pin 1 (+ Input)
Shielding Connection (Case L)	Pin 7

Reliability Specifications:

MTBF; Ground Benign, @ +25°C Ambient	605,000 Hours
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Accessories:

Mounting Socket (Case K)	CD-S01
Mounting Socket (Case L)	CD-S02
Heatsink ($q_{CA}=5^{\circ}\text{C/W}$)	CD-HS01
Heatsink ($q_{CA}=3.5^{\circ}\text{C/W}$)	CD-HS02

Specifications typical @ +25°C with nominal input voltage and under full output load conditions, unless otherwise noted. Specifications subject to change without notice.

Model Selection Guide

Model Number	Input				Output			Efficiency @FL (%)	Fuse (Amps)
	Voltage (VDC)		Current (mA)		Voltage (VDC)	Current (A)	Over Voltage (VDC)		
	Nominal	Range	No-Load	Full-Load					
6005S12	12	9 - 18	45	5342	5	10.0	6.8	78	10
6012S12	12	9 - 18	45	6500	12	5.0	15.0	77	10
6015S12	12	9 - 18	45	6173	15	4.0	18.0	81	10
6005D12	12	9 - 18	45	5342	±5	±5.0	±6.8	78	10
6012D12	12	9 - 18	45	6500	±12	±2.5	±15.0	77	10
6015D12	12	9 - 18	45	6410	±15	±2.0	±18.0	78	10
6005S24	24	18 - 36	34	2572	5	10.0	6.8	81	6
6012S24	24	18 - 36	34	3125	12	5.0	15.0	80	6
6015S24	24	18 - 36	34	3086	15	4.0	18.0	81	6
6005D24	24	18 - 36	40	2572	±5	±5.0	±6.8	81	6
6012D24	24	18 - 36	45	3125	±12	±2.5	±15.0	80	6
6015D24	24	18 - 36	45	3086	±15	±2.0	±18.0	81	6
6005S48	48	36 - 72	32	1255	5	10.0	6.8	83	3
6012S48	48	36 - 72	34	1543	12	5.0	15.0	81	3
6015S48	48	36 - 72	34	1543	15	4.0	18.0	81	3
6005D48	48	36 - 72	35	1255	±5	±5.0	±6.8	83	3
6012D48	48	36 - 72	35	1488	±12	±2.5	±15.0	84	3
6015D48	48	36 - 72	35	1440	±15	±2.0	±18.0	87	3
6005/12T12	12	9 - 18	45	6410	5/±12	6/±1.25	6.8/±15	78	10
6005/15T12	12	9 - 18	45	6410	5/±15	6/±1.00	6.8/±18	78	10
6005/12T24	24	18 - 36	45	3010	5/±12	6/±1.25	6.8/±15	83	6
6005/15T24	24	18 - 36	45	3010	5/±15	6/±1.00	6.8/±18	83	6
6005/12T48	48	36 - 72	34	1490	5/±12	6/±1.25	6.8/±15	84	3
6005/15T48	48	36 - 72	34	1490	5/±15	6/±1.00	6.8/±18	84	3

Specification Notes:

1. A Slow-blow fuse with a rating of 2X I_{in} max. is recommended in series with the input.
2. Minimum load requirement is 10% of FL.

Application Notes:

Thermal Characteristics:

The converter case (baseplate) has a thermal resistance (q_{CA}) of 2.4°C/W (internally dissipated). The internal thermal protection circuit will be activated above a case temperature of +85°C. Therefore, for proper operation and free air cooling, a heatsink is supplied with the converter. The heatsink is permanently mounted (standard model CD-HS01) to achieve an equivalent baseplate temperature. (See Figure 7, Note B).

An optional heatsink with a lower thermal resistance ($q_{CA} = 1.8°C/W$) is available to extend the operating ambient temperature of the converter (See Figure 7, Note C).

The application of forced air combined with the appropriate heatsink may improve the thermal resistance of the heatsink-to-air junction by as much as an order of magnitude when compared to free-air convection cooling. For example, a forced air flow of 400 LFM velocity will allow the converter to be operated at full output power at +70°C ambient (See Figure 7, Note D).

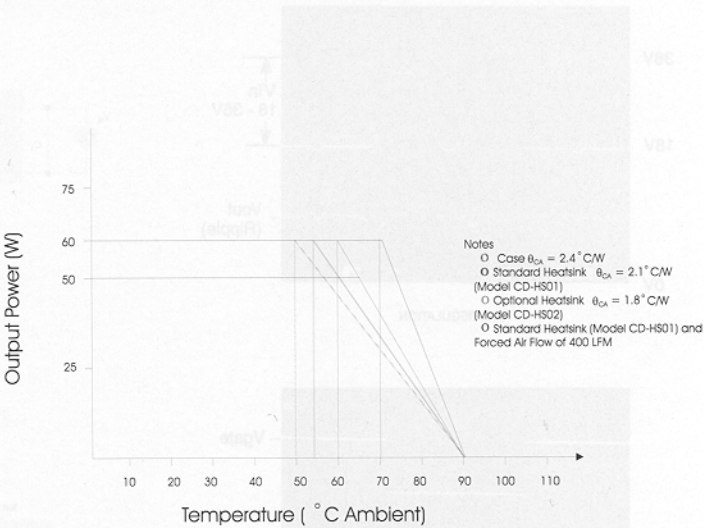


Figure 7: 6000 Series Temperature Derating Curves

6000 Series

Application Notes Cont'd.:

Converter Synchronization:

Up to five (5) converters can be synchronized to the same clock frequency. The converter with a slightly higher internal clock frequency becomes the master, driving additional modules that have a slightly lower clock frequency.

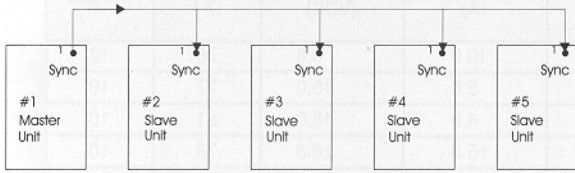


Figure 4: Master/Slave Synchronization of Case K Converters

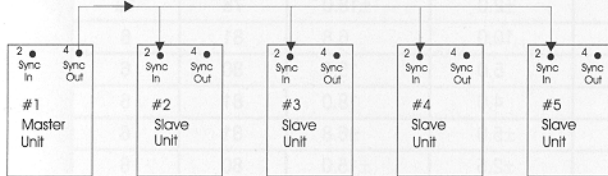


Figure 5: Master/Slave Synchronization of Case L Converters

Input Line Protection; Overvoltage and Reverse Voltage

Although the 6000 Series includes internal protection circuits, it's recommended the user connect a Schottky type diode and a slow-blow fuse as shown below.

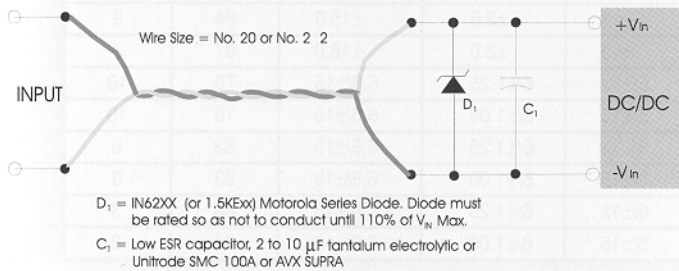
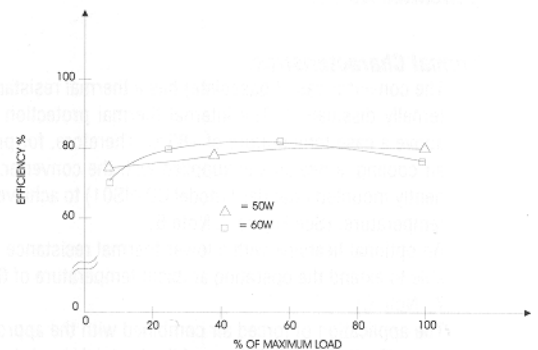
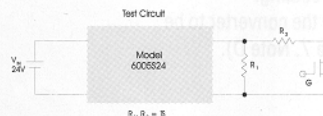
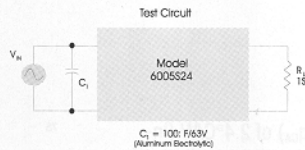
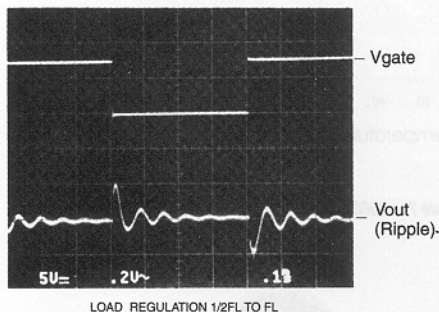
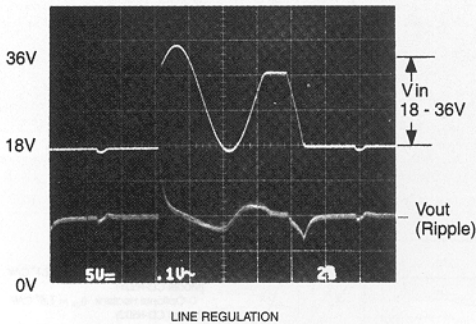


Figure 2

Line / Load Regulation



Efficiency Vs Load

External Trimming of Output:

To trim the output voltage DOWN, connect a 5%, 1/4W resistor (R_{T1}) between the + (plus) output and trim pins of the converter. To trim the output voltage UP, connect a 5%, 1/4W resistor (R_{T2}) between the - (minus) output and trim pins of the converter. For UP/DOWN trimming capability, connect a 10kΩ potentiometer between the + (plus) and - (minus) pins, with the wiper arm connected to the trim pin.

The trim resistors/potentiometer can be connected at the converter output pins or the load. However, if connected at the load, the resistance of the runs becomes part of the feedback network, improving load regulation. If the load is some distance from the converter, the use of #20 gauge wire is recommended to avoid excessive voltage drop due to circuit resistance.

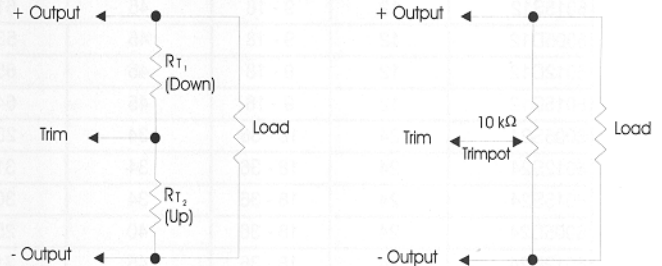


Figure 6

External Clock Synchronization.

All models in the 6000 Series can be synchronized to an external clock by driving the sync pin directly with an open collector - open drain (1TTL). The signal frequency must be 220 kHz, $\pm 5\%$ (20% low, 80% high duty cycle).

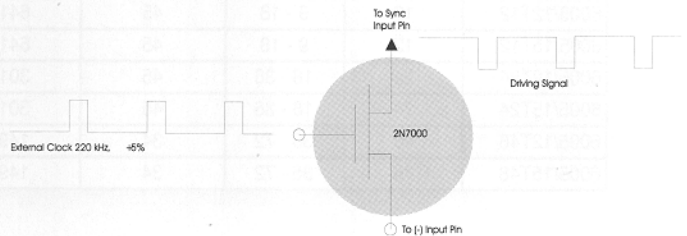
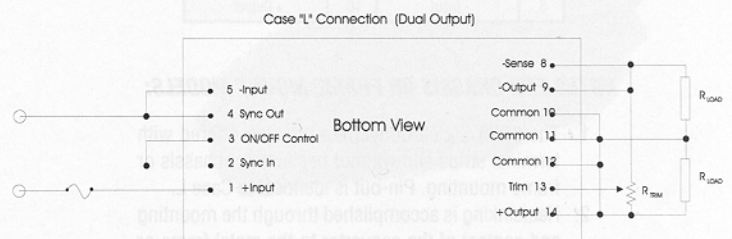
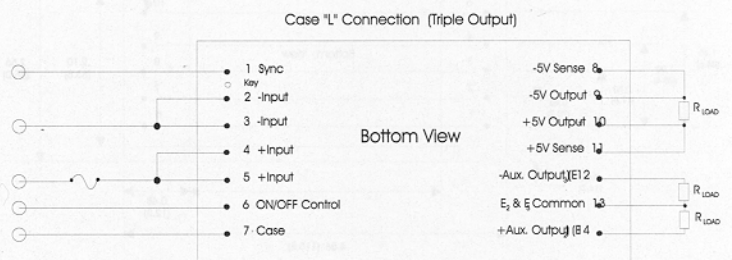
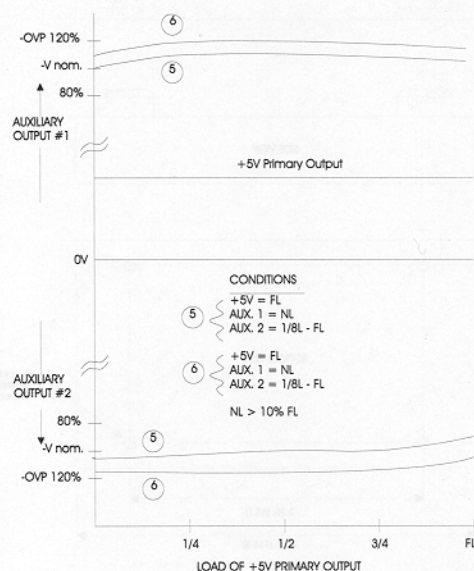
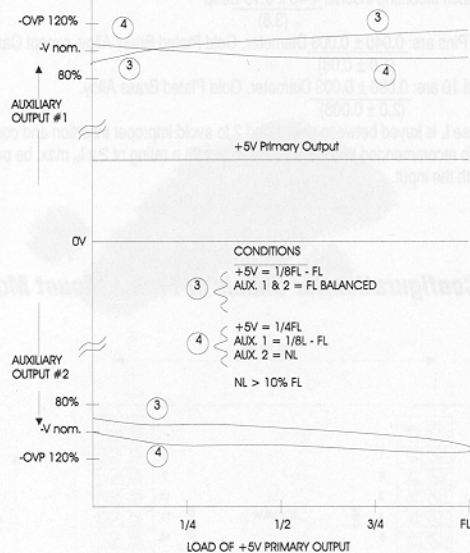
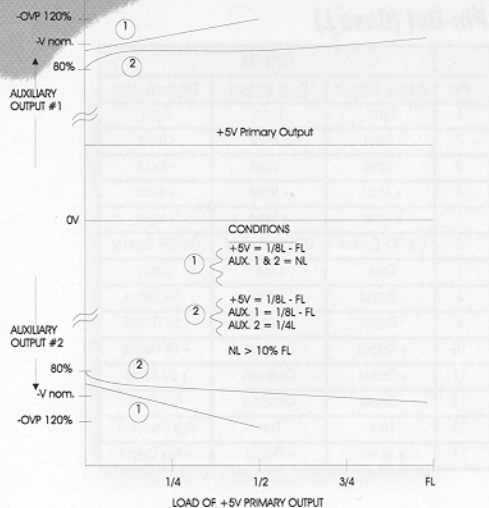


Figure 3

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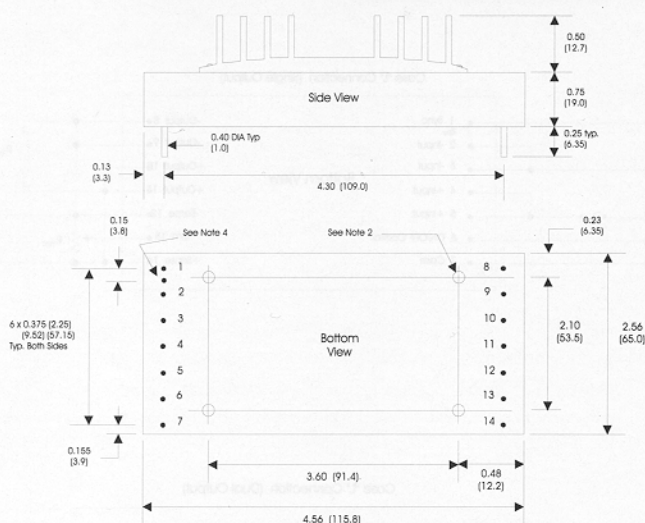
Cross Load Regulation of 6000 Series Triple Output



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Case L Mechanical Configuration



Pin-Out (Case L)

Pin	Outputs		
	Single Output	Dual Output	Triple Output
1	Sync	Sync	Sync
2	- Input	- Input	- Input
3	- Input	- Input	- Input
4	+ Input	+ Input	+ Input
5	+ Input	+ Input	+ Input
6	ON/OFF Control	ON/OFF Control	ON/OFF Control
7	Case	Case	Case
8	- Output	- Sense	- 5V Sense
9	- Output	- Output	- 5V Output
10	+ Output	Common	+ 5V Output
11	+ Output	Common	+ 5V Sense
12	- Sense	Common	- Aux Output
13	Trim	Trim	Aux Common
14	+ Sense	+ Output	+ Aux Output

Notes: 1. All dimensions are typical in Inches

(MM)

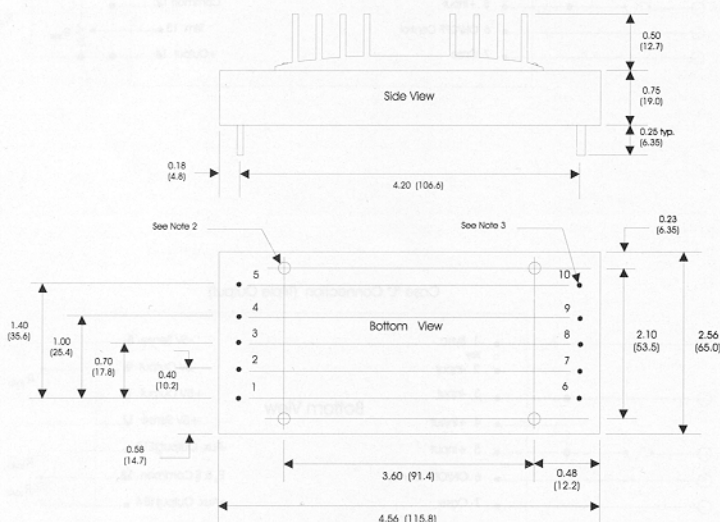
2. 4 each Mounting inserts: 4-40 x 0.15 Deep (3.8)

3. All Pins are: 0.040 ± 0.003 Diameter, Gold Plated Brass Alloy, except Case K pins 6 and 10 are: 0.080 ± 0.003 Diameter, Gold Plated Brass Alloy. (2.0 \pm 0.008)

4. Case L is keyed between pins 1 and 2 to avoid improper insertion and connection.

5. It is recommended that a slow-blow fuse with a rating of $2 \times I_{in}$ max. be put in series with the input.

Case K Mechanical Configuration



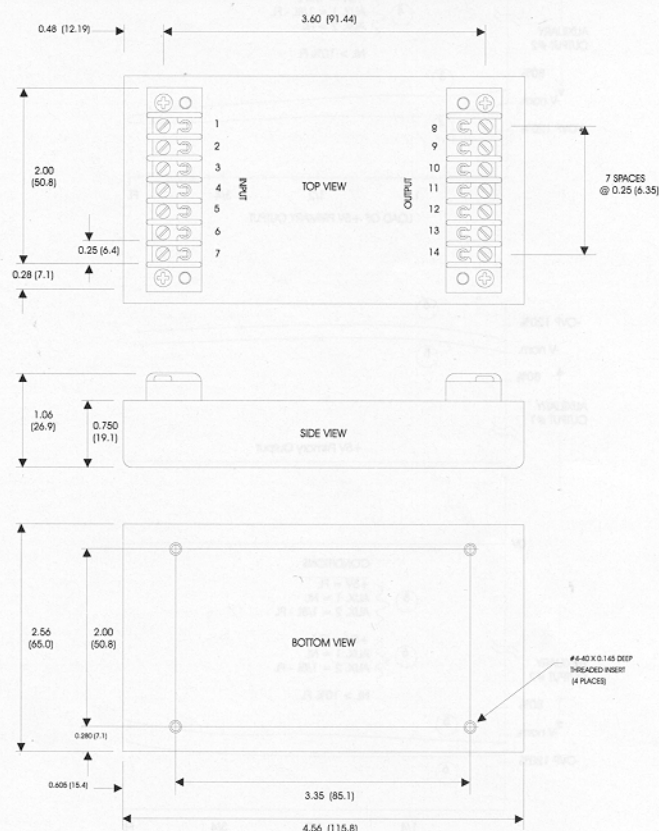
Pin-Out (Case K)

Pin	Function	Pin	Function
1	+ Input	6	+ Output
2	Sync IN	7	+ Sense
3	ON/OFF Control	8	Trim
4	Sync OUT	9	- Sense
5	- Input	10	+ Output

NOTES FOR CHASSIS OR FRAME MOUNT MODELS:

- The 6000 Series Converters are also offered with terminal strips and without heatsink for chassis or frame mounting. Pin-out is identical to Case L.
- Heatsinking is accomplished through the mounting and contact of the converter to the metal frame or chassis of the system.
- For this reason the bottom of the module is equipped with four (4) #4-40 size, .145" deep threaded inserts as shown in the mechanical configuration.
- Heatsinks are also available for optional use.

Mechanical Configuration for Chassis or Frame Mount Models:

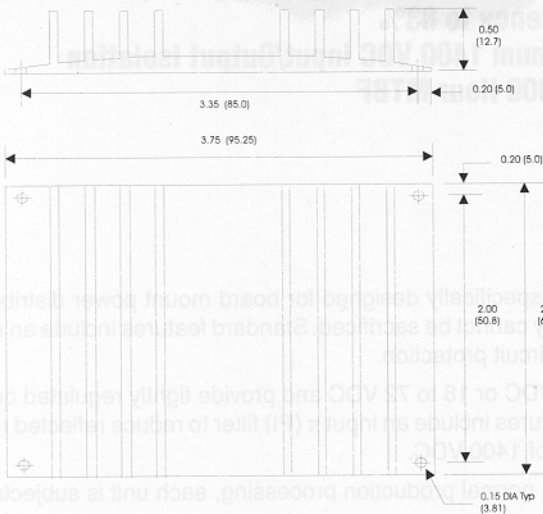


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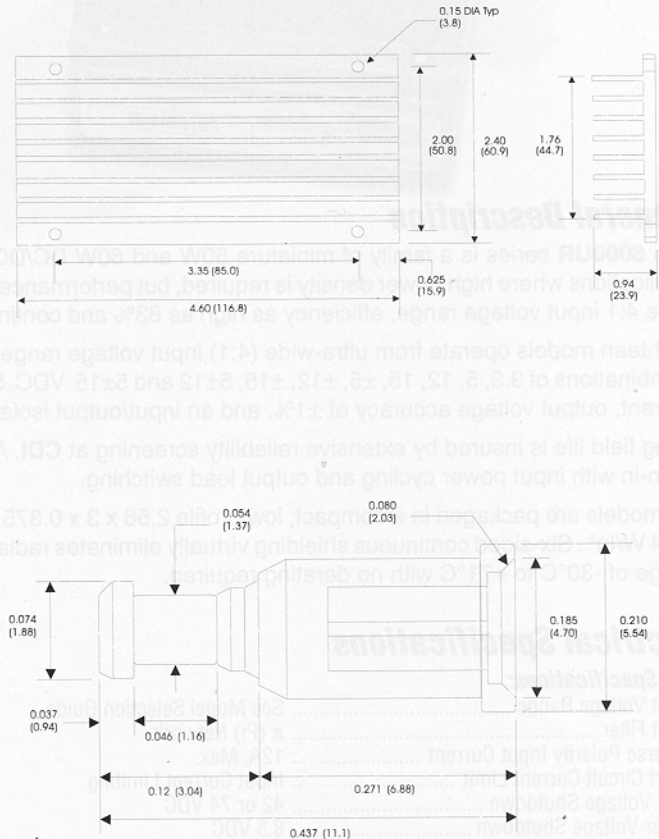
6000 Series

Accessories:

HEAT SINK $\theta_{CA} = 5^{\circ}\text{C} / \text{W}$
 PART NUMBER: CD-HS01



HEAT SINK $\theta_{CA} = 3.5^{\circ}\text{C} / \text{W}$
 PART NUMBER: CD-HS02



Ordering Information

All **6000 Series** converters are supplied with the standard Heat Sink Model CD-HS01 with $q_{CA} = 5^{\circ}\text{C} / \text{W}$, except the chassis mount models.

An optional Heat Sink Model CD-HS02 with $q_{CA} = 3.5^{\circ}\text{C} / \text{W}$ is also available at a slight additional cost.

A. Case "K" Models:

1. With standard Heat Sink Model CD-HS01, add the letter K at the end of the part number.
 Example: **6005S24K**
2. With optional Heat Sink Model CD-HS02, add the letter K and 2 at the end of the part number.
 Example: **6005S24K2**

B. Case "L" Models:

1. With standard Heat Sink Model CD-HS01, add the letter L at the end of the part number.
 Example: **6005S24L** or **6005/15T12L**
2. With optional Heat Sink Model CD-HS02, add the letter L and 2 at the end of the part number.
 Example: **6005S24L2** or **6005/15T12L2**

C. Chassis Mount Models

Add the letter C at the end of standard part number.
 Example: **6005S24LC** or **6005/15T12LC**

D. Accessories:

1. Heat Sinks:

CD-HS01; $q_{CA} = 5^{\circ}\text{C} / \text{W}$
 CD-HS02; $q_{CA} = 3.5^{\circ}\text{C} / \text{W}$

2. Sockets:

For installation and/or removal from PCB
 CD-KS02; Socket Kit and mounting screws for Case K
 CD-KS01; Socket Kit and mounting screws for Case L

For Easy Ordering Use

