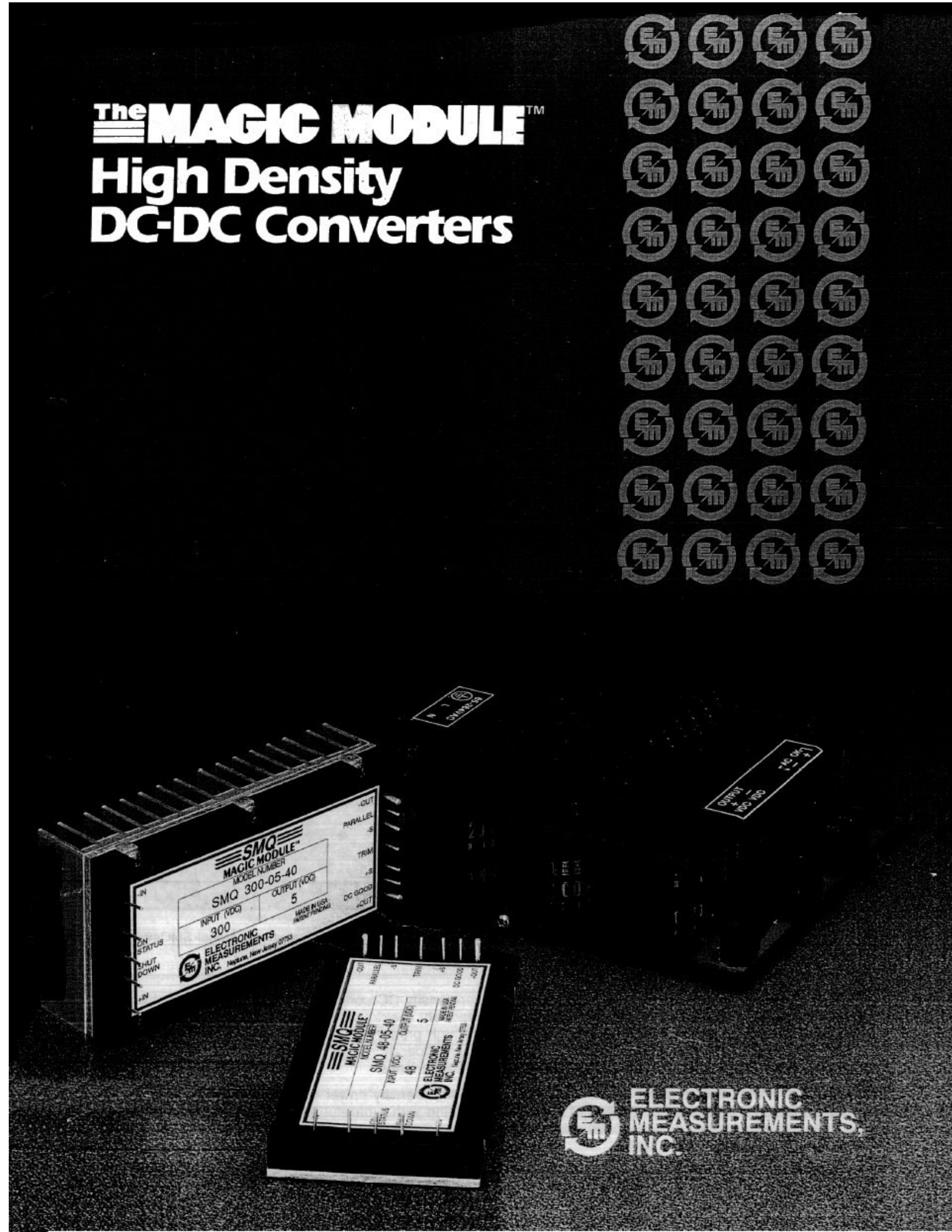
The MAGIC MODULE™
High Density DC-DC Converters



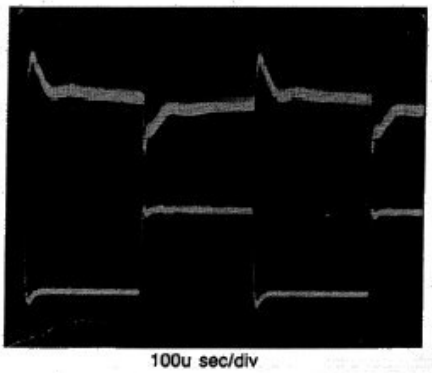
ELECTRONIC MEASUREMENTS, INC.

Table of Contents

Features of SMQ Converters

- More Watts Per Cubic Inch (43 W/Cu. Inch for 12V/20A unit)
- Proven Forward Converter Topology To Reduce Voltage and Current Stresses in Power MOSFET
- Fixed Frequency (250 KHz) For Reduced EMI, Better Stability and Greater Ease of Synchronization
- Short Circuit Current Limited to Negligible Level to Protect Load Circuit to Much Greater Degree Than Conventional Foldback Circuits
- Fast Response Overvoltage Protection Circuit Limits Voltage Excursions During Fault or Transient Condition
- Proprietary Planar Magnetics Design For Exceptional Repeatibility and Control of Leakage Inductance
- Excellent *Guaranteed* Transient Response

TRANSIENT RESPONSE



Output Transient Response — Model SMQ48-05-40
25% Full Load to 75% Full Load

There are numerous approaches to designing a high-power-density DC converter. With some approaches, as with high frequency resonant topologies, the required component restrictions and circuit nuances can result in subtle but serious performance tradeoffs. For example, the high primary-side peak current, high-line voltage stresses and reduced transient response are often a problem. Operation under short circuit or overvoltage conditions can result in additional undesirable performance characteristics.

The advanced SMQ series has been designed to meet the high density power objectives without giving in to the above tradeoffs. It represents a blend of proven engineering with a careful application of advanced concepts in semiconductor technology, magnetics design, thermal management, fault protection and packaging. It represents performance without risk.

Model Selection

NOMINAL INPUT VOLTAGE (VDC)	INPUT VOLTAGE RANGE (VDC)		OUTPUT VOLTAGE (VDC)					OUTPUT POWER (WATTS)
	MIN.	MAX.	3.3V	5V	12V	15V	24V	
300	200 (170)[1]	400 (425)[2]	SMQ300-03-50	SMQ300-05-40	SMQ300-12-16	SMQ300-15-16		240
				SMQ300-05-30	SMQ300-12-12	SMQ300-15-13		200
				SMQ300-05-20	SMQ300-12-8	SMQ300-15-10	SMQ300-24-6	150
			SMQ300-03-25	SMQ300-05-15	SMQ300-12-6	SMQ300-15-6	SMQ300-24-4	100
						SMQ300-15-5	SMQ300-24-3	75
150	100 (85)[1]	200 (210)[2]	SMQ150-03-50	SMQ150-05-40	SMQ150-12-16	SMQ150-15-13		200
				SMQ150-05-30	SMQ150-12-12	SMQ150-15-10		150
				SMQ150-03-20	SMQ150-12-8	SMQ150-15-6	SMQ150-24-4	100
			SMQ150-03-25	SMQ150-05-15	SMQ150-12-6	SMQ150-15-5	SMQ150-24-3	75
48	40 (36)[1]	60 (72)[2]	SMQ48-03-50	SMQ48-05-40	SMQ48-12-16	SMQ48-15-16		240
				SMQ48-05-30	SMQ48-12-12	SMQ48-15-13		200
				SMQ48-05-20	SMQ48-12-8	SMQ48-15-10	SMQ48-24-6	150
			SMQ48-03-25	SMQ48-05-15	SMQ48-12-6	SMQ48-15-6	SMQ48-24-4	100
						SMQ48-15-5	SMQ48-24-3	75
24	20 (18)[1]	30 (36)[2]	SMQ24-03-25	SMQ24-05-30	SMQ24-12-12	SMQ24-15-10	SMQ24-24-6	150
				SMQ24-05-15	SMQ24-12-6	SMQ24-15-5	SMQ24-24-3	75
12	11 (10)[1]	20 (24)[2]	SMQ12-03-20	SMQ12-05-20	SMQ12-12-8	SMQ12-15-6	SMQ12-24-4	100
				SMQ12-05-10	SMQ12-12-4	SMQ12-15-3	SMQ12-24-2	50

[1]Voltage at which unit will support 75% of full load and still maintain load regulation.
[2]Unit will withstand this input voltage for up to 10 seconds (maximum duty cycle of 1%).

NOTE: CONSULT FACTORY FOR NON-STANDARD OUTPUT VOLTAGES (1.2, 2.2, ETC.)

Operational Ratings and Characteristics

(AT 25°C UNLESS NOTED OTHERWISE)

INPUT	
Input Voltage	(See above)
Input Reflected Ripple	5% of Nominal Input Current
Turn-on Time	100 mS Typical
OUTPUT	
Voltage Accuracy	1%
Isolation (Input/Output), 24-48V input	1500 VDC Min.
Isolation (Input/Output), 150-300V input	4300 VDC
Efficiency (Nominal Line/Full Load)	80% Typical—All output voltages
Switching Frequency	250 KHZ ± 20%
Line Regulation	0.2%
Load Regulation	0.5%
Peak-to-Peak Output Ripple and Noise	3% (20 MHz Bandwidth)
Transient Response, 50-100% Full Load	500 uS Max.
Current Limit	110%-135% of Full Load Rating
Overvoltage Protection (OVP)	115%-135% of Nom. Output Voltage (Latches off until power is recycled)
Thermal Shutdown (Baseplate Temp.)	90-105°C (12V models and up - Auto recovery, 3.3-5V models - latching)
Short Circuit Current Limit (Current at which shutdown occurs)	135% of Load Rating (Min.) (Auto Recovery)
MECHANICAL SPECIFICATIONS	**REFER TO PAGE 9**

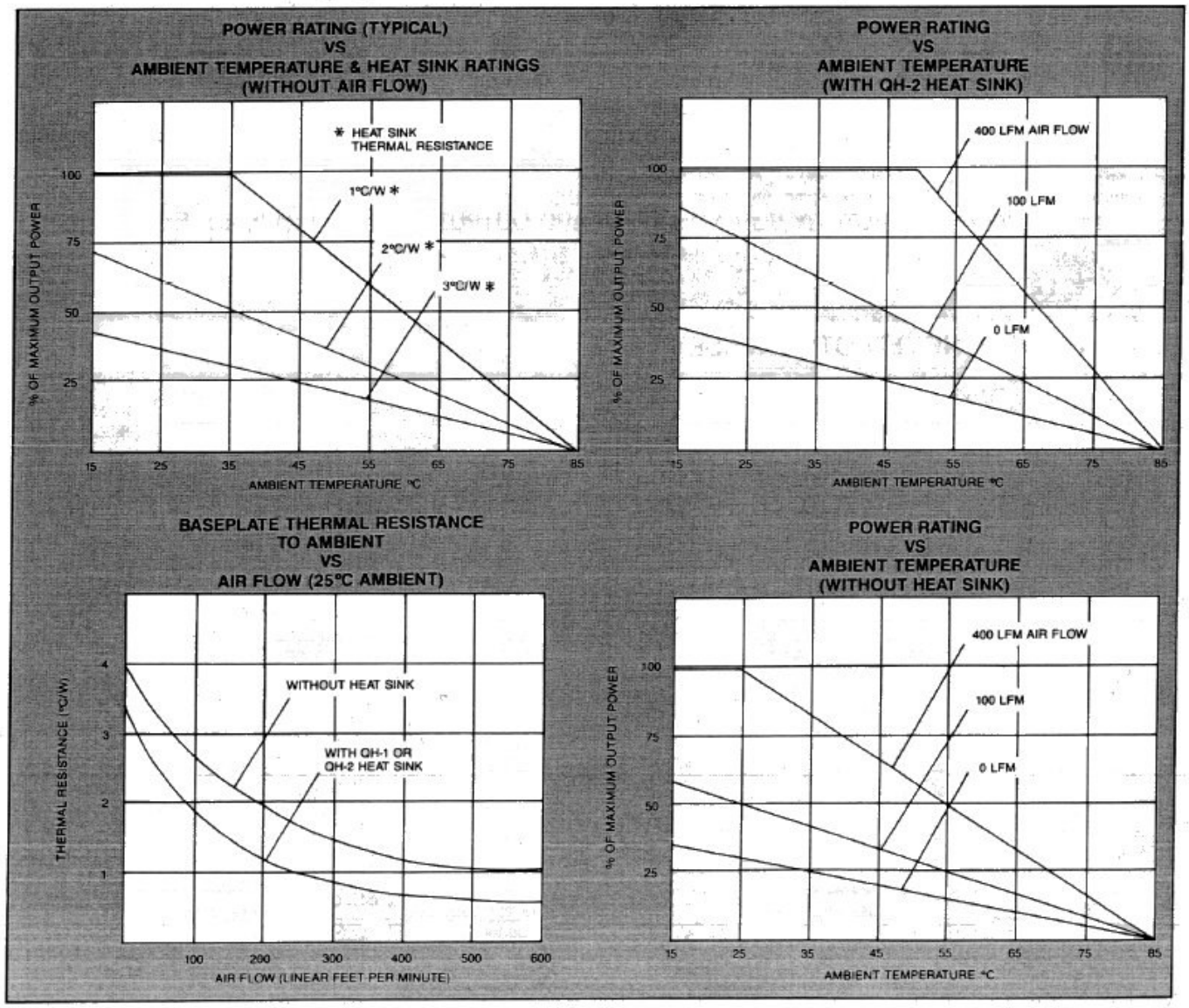
PRODUCT CHANGES - product information published in this brochure was current at time of printing, however, E/M reserves the right to change specifications, designs and models without prior notice.

Thermal Operating Characteristics

Storage Temperature	–40° to 100°C
Operating Temperature	0 to 85°C*

*Consult factory for operation to –20°C and –40°C

The SMQ Series requires that the baseplate temperature be kept below 85°C. Maintaining the baseplate at an appropriate temperature can be achieved by either providing an adequate amount of moving air and/or additional heatsinking. Illustrated below are typical performance curves for the SMQ Series.



Application Notes

BASIC CHARACTERISTICS

The SMQ DC-DC converter is a complete power supply capable of converting an unregulated or varying DC input voltage into a precisely regulated, fixed output voltage. That voltage, depending on model, may be higher or lower than the input and, being electrically isolated from the input, can be used as either a positive or negative voltage, depending on which terminal is used as output circuit ground.

INPUT SOURCE

The input voltage for an SMQ converter must be within the limits given in the data sheet (e.g. the SMQ 48-05-30 requires that the input remain between 36-72 volts). Excessive voltage can permanently damage the unit. Inadequate voltage will not damage the unit but can result in shutdown or loss of regulation. Input voltage polarity reversal should be avoided. However, damage will generally not occur as long as the RMS input current is limited to less than 10 amps.

In many cases, the converter input may come from another power supply. In most cases that supply will sense polarity reversal as a short circuit and switch into a power limiting mode, thereby protecting itself as well as the converter. When the converter input is supplied from a battery, it is suggested that a fuse be placed in series with the input.

TURN ON DELAY

An SMQ unit incorporates a small delay (typically, a hundred milliseconds) at turn on. This is done to eliminate the false indication of ort circuit which might occur in the presence igh-capacitance or tungsten lamp load. es of loads, at turn on, draw a surge current which could be sensed ent condition.

TRIM/MARGINING

The output voltage may be trimmed a minimum of ± 10% with a fixed resistor or by using a potentiometer as shown.

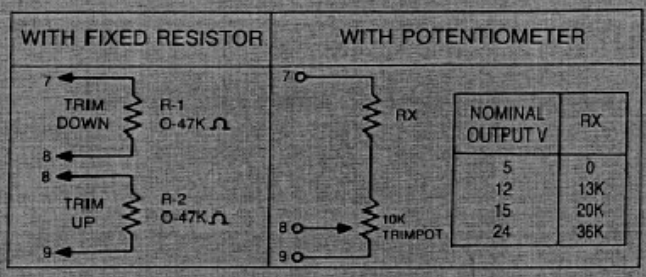


FIGURE 1 FIGURE 2

NOTE: FIGURE 1 APPLIES TO OUTPUTS 3.3V TO 24V.
FIGURE 2 APPLIES TO OUTPUTS 5V TO 24V ONLY.

REMOTE SENSE

Terminals 7 and 9 allow a four-wire connection between the converter and load. These connections can compensate for voltage drops up to .25 volts in each of the main connecting wires.

ON STATUS

Provides a steady 5 volt DC signal, once converter oscillator is fully on. Equivalent circuit is 5 volts out through a 1k resistor, signal pulses if overcurrent condition exists.

OUTPUT OVERLOAD

Should overload current exceed specified limits by a small amount (0-25%), the output voltage may no longer stay within its regulation limits. If output current exceeds the load rating by more than 35% the converter will not be damaged.

Application Notes

LOGIC INHIBIT/SHUTDOWN

With the SMQ Series, remote shutdown is achieved by bringing primary side pin 2 LOW (less than .5V with respect to the minus input terminal). When the shutdown pin is opened, the unit will turn back on.

OVERVOLTAGE PROTECTION

A momentary surge of output voltage to more than about 25% of specified limits will shut down and latch the converter in the Off condition. Momentary removal of input voltage will reset the unit. An overtemperature condition will shut down but not latch the converter. That is, reset will occur automatically once the unit cools to an acceptable level.

DC GOOD

Pin 12 provides a logic signal to signify that output voltage is within 5% of specified regulation limits. With the proper output voltage, pin 12 is logic low, capable of sinking at least 25 ma. With the output out of limit, pin 12 reverts to logic high (Q-1 off).

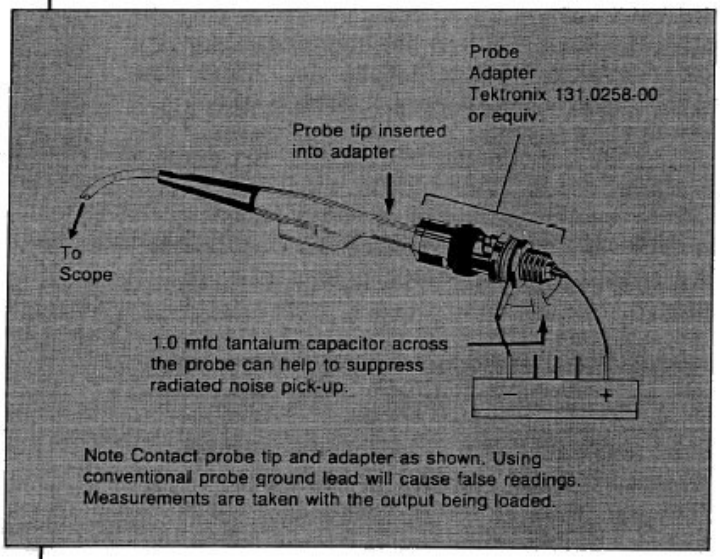
THERMAL CONSIDERATIONS

The SMQ unit requires that the baseplate be kept below 85°C in order for the full current rating to be realized. Maintaining the baseplate at an appropriate temperature can be achieved three ways: a) convection cooling (i.e. passing air flow over the baseplate or through the fins of a heat sink attached to the baseplate), b) attaching the baseplate to a heatsink having adequately low thermal resistance in still air (c) reducing the load current to a level which generates less internal heat.

Additional data is graphically shown on page 3.

RIPPLE AND NOISE MEASUREMENTS

Shown below is the appropriate method to measure output ripple and noise. The idea is to minimize the length of the oscilloscope probe ground lead. A standard ground lead, typically 3-4″ long, can pick up 50 millivolts or more of peak-to-peak noise per inch (i.e., the lead acts as an antenna). Hence the "tip and barrel" method serves to eliminate or minimize the erroneous portion of the measured value.



Note Contact probe tip and adapter as shown. Using conventional probe ground lead will cause false readings. Measurements are taken with the output being loaded.

Paralleling for Higher Current Capability and N+1 Applications

DC-DC converters are generally paralleled for two reasons: a) to achieve higher current capabilities or b) the more common use, to achieve N + 1 redundancy. All SMQ units are designed to be used in either application. Where close current sharing is necessary, pin 12 of respective units are connected to one another. If close sharing is not needed, units simply need their respective output pins interconnected. Please contact factory for assistance in unusual applications.

The SMQ converters incorporate a proprietary internal threshold circuit which activates whenever paralleled units exceed a predetermined difference in their respective output currents. The hysteresis-type feature prevents the oscillation occuring in some paralleling techniques.

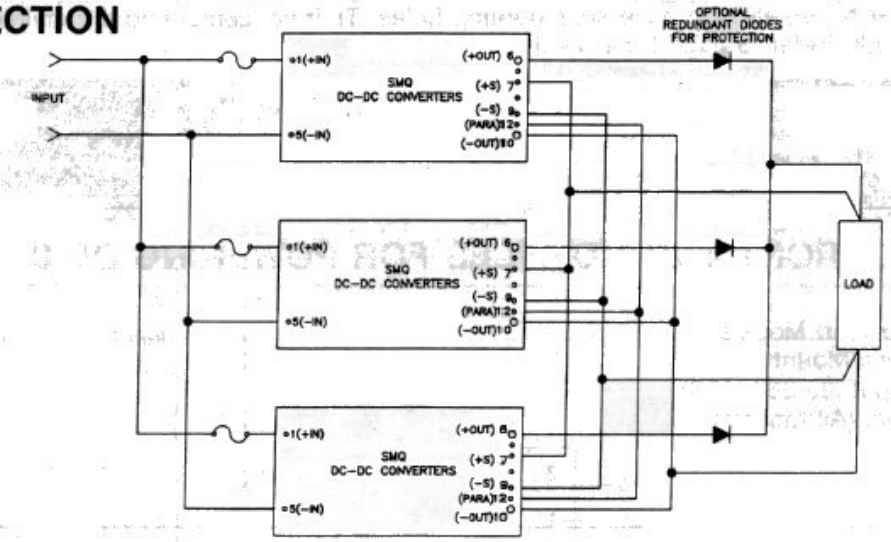
Unlike master/booster paralleling schemes, the SMQ method allows true redundancy. That is, the failure of one unit cannot disable the others.

An additional advantage of this approach is that it permits staggering the output frequencies of the units to result in lower peak noise generation.

FEATURES

- Current sharing to within 15% of the SMQ module current rating
- No degradation of load regulation or remote sense capability
- Failure of one converter will not compromise others

CIRCUIT CONNECTION



ical application to achieve N + 1 dancy. In the event of a failure in one the remaining converters can supply load current.

SMQ 300-5-40 converters in 0 amps of load current. OR e the converted output circuits from one another. This prevents a shorted output on one converter from disabling the others.

Where the objective is simply to increase total current capability, the OR diodes need not be used. In such a configuration, the three units could deliver 120 amps with accurate sharing.

SMQ Options

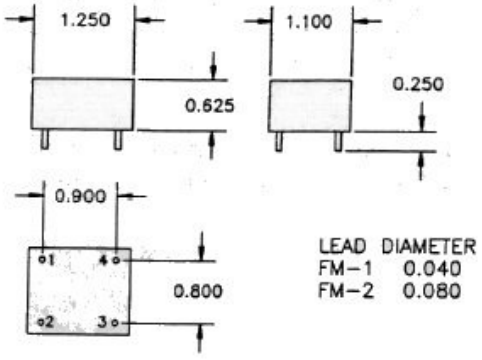
RIPPLE & NOISE ATTENUATION MODULE

The FM-1 and FM-2 filter modules are effective in providing substantial attenuation of both differential and common mode noise. In addition, they can reduce fundamental ripple to that approaching levels typically found in linear supplies (below 15 millivolts). For best results both the FM-1 and FM-2 should be used together. These miniature, cost effective modules are characterized for operation at power levels up to 200 watts and DC output currents up to 40 amps.

SPECIFICATIONS

MODEL	TYPE	TYPICAL DC RESISTANCE (EACH LEG, IN MILLIOHMS)	*CURRENT RATING (AMPS)
FM-1	INPUT	12.0	8
FM-2	OUTPUT	1.20	30

*CURRENT RATING 33% HIGHER WITH 200 LFM AIR FLOW



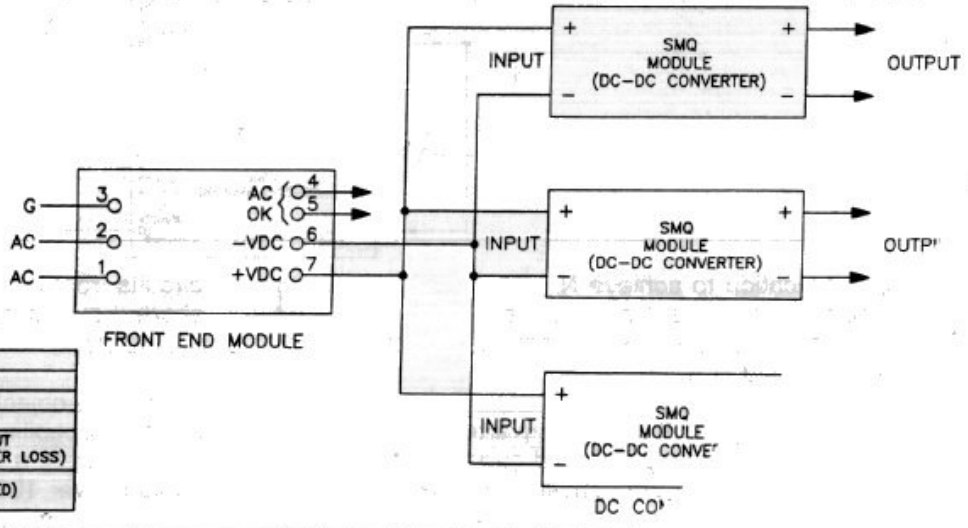
HEATSINKS

Two standard styles of Heatsinks are available for use with SMQ converters. Both Heatsinks match the outline of the converter baseplate and have six mounting holes. Thermal compound is required between the converter and the Heatsink. Refer to page 9 for mechanical outlines.

QFE Series

OFF-LINE FRONT END MODULES FOR POWERING DC-DC CONVERTERS

- 250 and 750 Watt Models
- PC or Chassis Mount
- Universal Input (85-264 VAC)
- AC OK Signal (All Models)

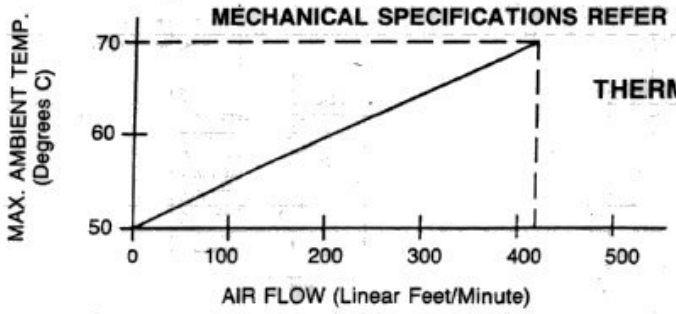


TERM	FUNCTION	
1	AC	
2	AC	
3	GROUND	
4	AC OK +	OPTO COUPLER OUTPUT (HIGH IN EVENT OF AC POWER LOSS)
5	AC OK –	
6	–V OUT	NORMAL 300VDC (UNISOLATED)
7	+V OUT	

ELECTRICAL SPECIFICATIONS:

AC Line Input	
Voltage	85 to 264 VAC, Auto Ranging
Line frequency	47 to 63 Hz
DC Bus Output Voltage (at full load)	
115/230 VAC operation	220 (low line) to 370 (high line), VDC
DC Bus Output Ripple (p-p at full load)	
115/230 VAC operation	12 to 18 volts
Line Inrush Current	
115 VAC operation	16 amps at peak line
230 VAC operation	31 amps at peak line
AC Leakage Current	
250 VAC, 63 Hz (250 Watt)	1.5 mA
250 VAC, 63 Hz (500 and 750 Watt)	2.5 mA
Efficiency (at full load)	
at 110 VAC	93% min
Power Factor (at full load)	
115/230 VAC operation	0.52 to 0.65 (max at low line input)
Holdup time (at full load)	
(From AC line fail to DC bus dropout @ 190 VDC ± 5%)	
90/180 VAC low line	15 mS min
115/230 VAC nom line	50 mS min
AC OK Output (500 and 750 Watt only)	
(Optoisolated NPN Collector-emitter junction output)	
Isolation (Line to AC OK output)	3000 VAC
AC OK	Active Low (1.5 mA min @ Vce max = 0.4 V; 2 mA min @ Vce max = 0.8V)
AC Power-Fail	Inactive (max off-state voltage 70 VDC; leakage 50 nA)
Turn-on AC voltage (no load)	75-85 VAC
Turn-off AC voltage (load dependent)	84-70 VAC (load dependent)
AC Fail Warning Time	10 mS min at full load
Conducted EMI	Exceeds VDE 0871/FCC Part 15, limit A
Dielectric Withstand	2200 VDC, 1 sec. line to ground
Operating Temperature	– 20°C to 50°C free air – 20°C to 70°C with air flow (see below)

MECHANICAL SPECIFICATIONS REFER TO PAGE 10

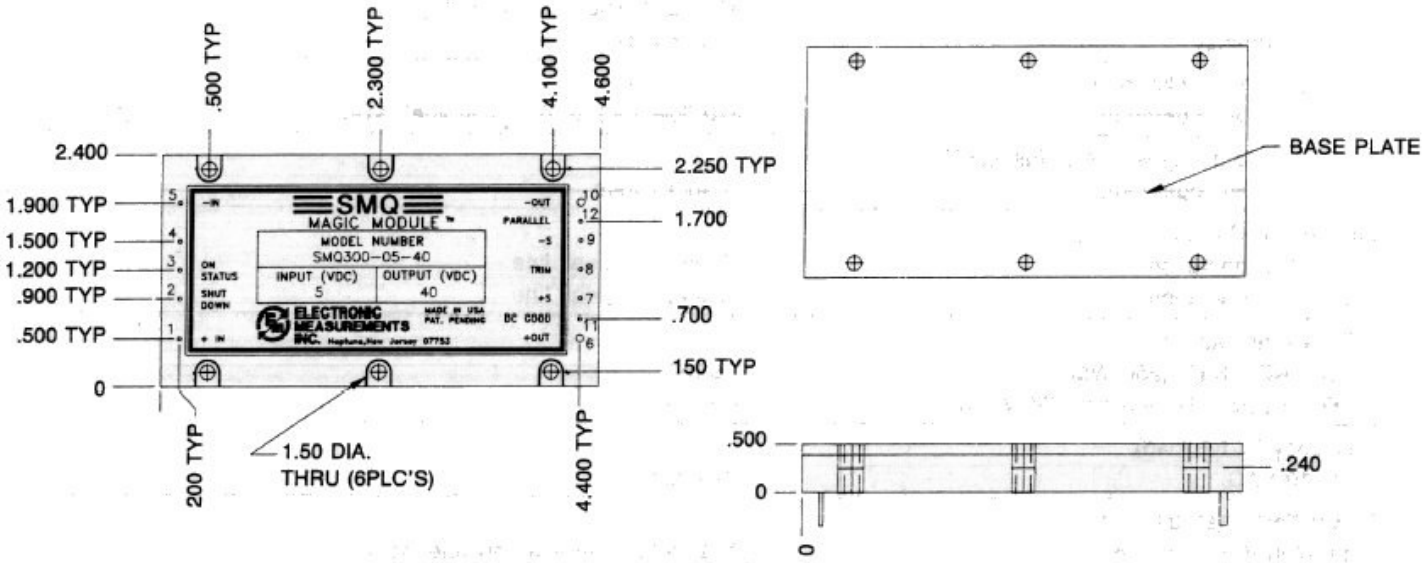


THERMAL CHARACTERISTICS

(All Models)

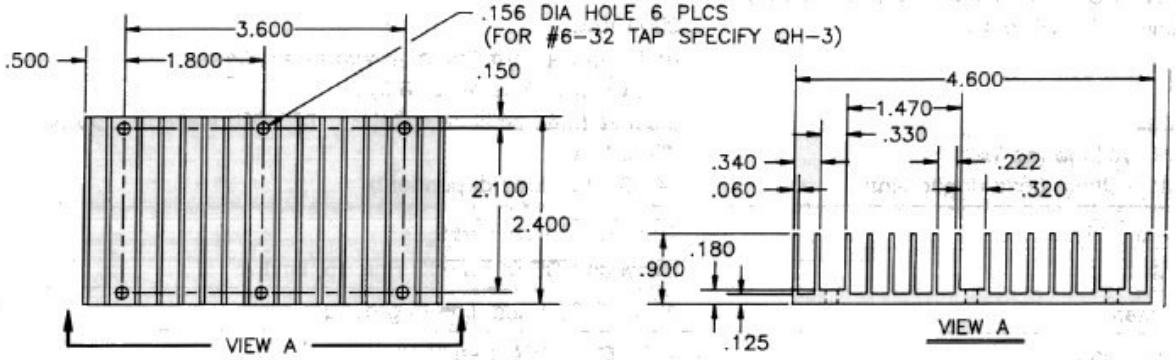
Mechanical Outlines

SMQ CONVERTERS

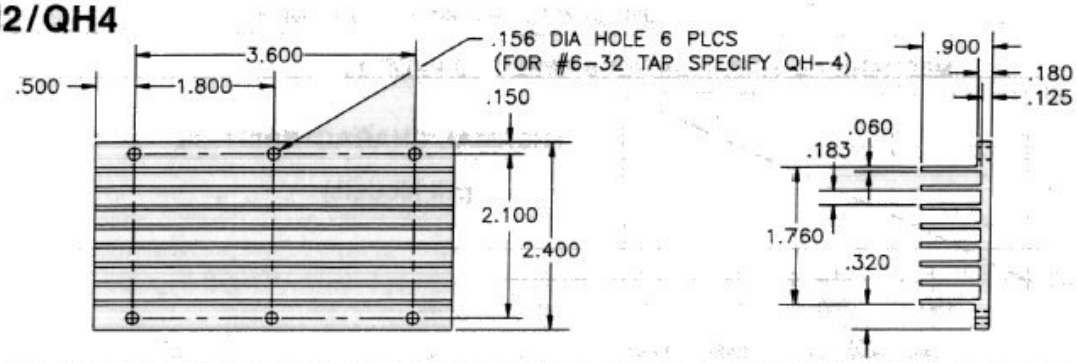


HEATSINKS

QH1/QH3

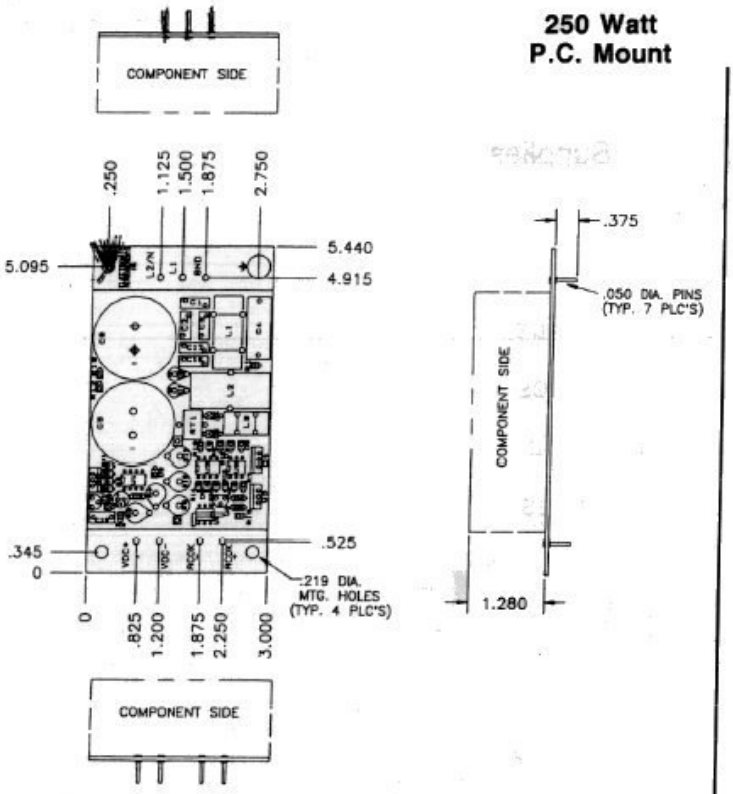


QH2/QH4

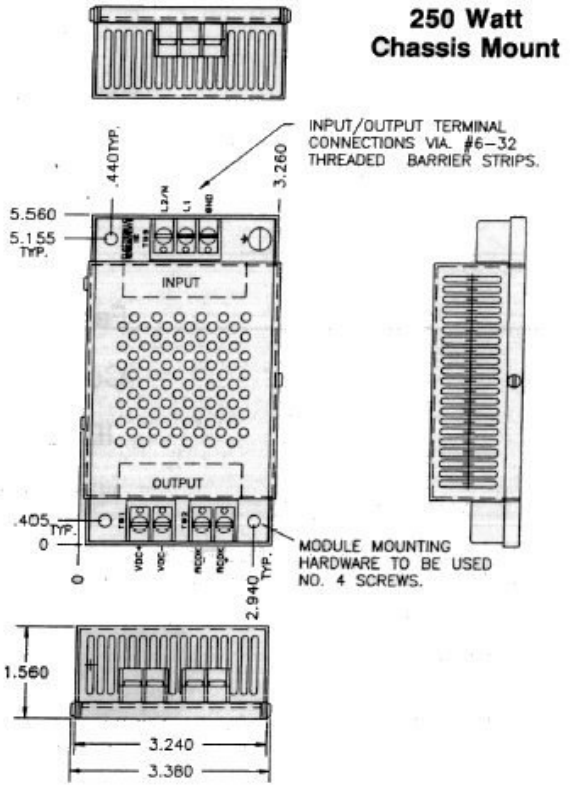


QFE FRONT END

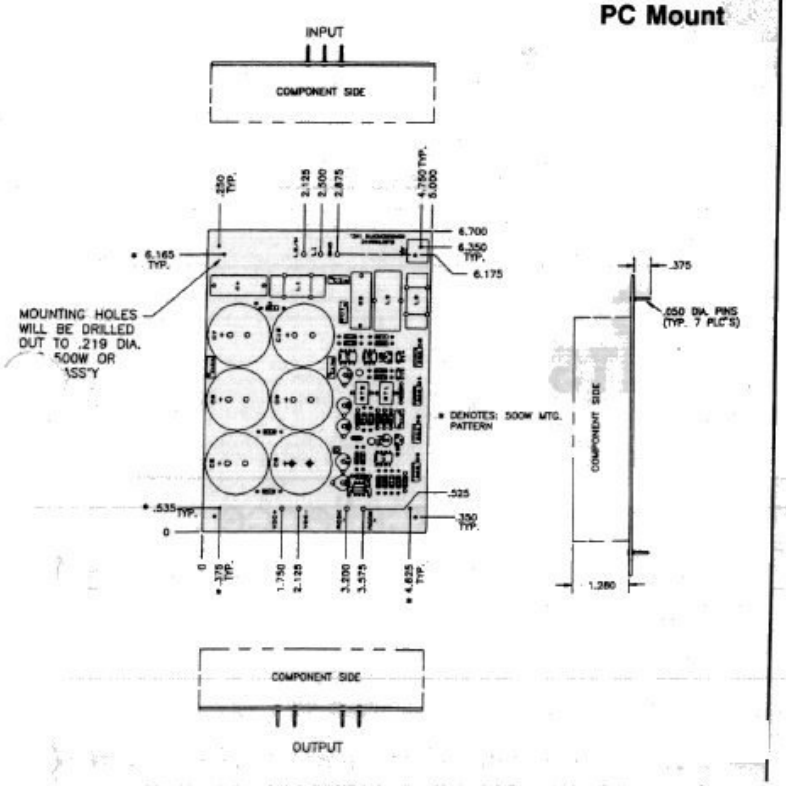
250 Watt P.C. Mount



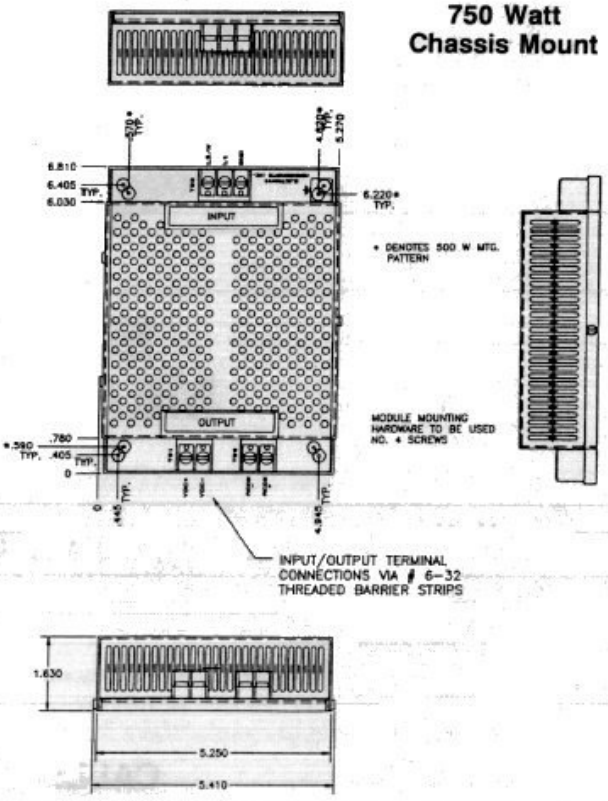
250 Watt Chassis Mount



750 Watt PC Mount



750 Watt Chassis Mount



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