30 Watt CS Dual Series DC/DC Converters

Features

- +5 / +12 volt outputs for computer systems
- Up to 4 amps of +12 volt current for motor spinup
- Fully isolated design cuts ground loop problems
- Ultra Wide 4:1 Input Voltage Range
- Water washable shielded copper case
- 5 Year Warranty

Description

These dual output converters are designed for modern computer systems with motorized data storage. The +5 / +12 volt outputs permit operation of standard +5 volt microprocessor circuits while the +12 volt output allows driving of standard hard disks or CD ROMs. To make system use easy the +12 volt output is rated for up to 4 amps of surge current to insure quick startup of even the biggest drive motors.

The very wide input range (4:1) is ideal for battery or unregulated input applications while the low noise complements even the most sensitive analog circuitry.

The CS series has full input to output isolation to cut ground loop problems. This helps to make your system bullet proof from noisy input circuits such as those found in automotive and industrial applications.

These converters are state of the art 220 kHz MOSFET based designs that provide outstanding regulation and conversion efficiencies of up to 85%.

Remote ON/OFF and output voltage trim functions are also included.

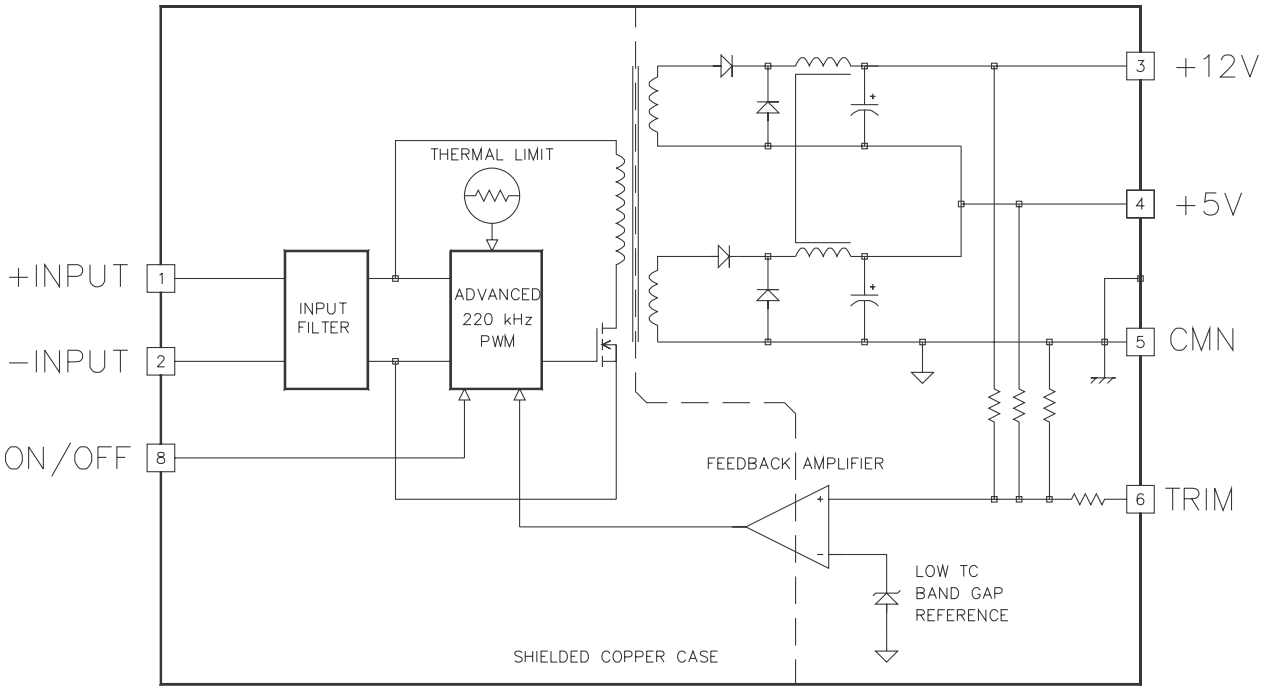
The converters are protected from output shorts to common by a high speed pulse by pulse digital current limit circuit and a self resetting thermal overload protection circuit.

As with all CALEX converters the 30 Watt CS Dual series is covered by our 5 Year Warranty.

Selection Chart

Model	Input Range VDC		OUTPUT			
	Min	Max	VDC	A	Power W	Total W
24D5.12CS	9	36	+5	3	15	31
			+12	1.3	16	
48D5.12CS	20	72	+5	3	15	31
			+12	1.3	16	

30 Watt CS Dual Series Block Diagram



Input Parameters*				
Model		**24D5.12CS**	**48D5.12CS**	**Units**
Voltage Range	MIN MAX	9 36	20 72	VDC
Input Current Full Load No Load Surge Load	TYP TYP TYP	1600 16 2670	785 15 1310	mA
Efficiency, Full Load	TYP	80	82	%
Reflected Ripple (1)	TYP	70	50	mA P-P
	TYP	5	5	mA RMS
Switching Frequency	TYP	220		kHz
Maximum Input Overvoltage, 100ms Maximum	MAX	45	80	VDC
Turn-on Time, 1% Output Error	TYP	40		ms
Recommended Fuse		(2)		

Output Parameters*				
Model		**24D5.12CS 48D5.12CS**	**24D5.12CS 48D5.12CS**	**Units**
Output Voltage		+5	+12	VDC
Output Voltage Accuracy	MIN TYP MAX	4.950 5.000 5.050	12.10 12.30 12.50	VDC
Rated Load Range (3)	MIN MAX	0 3000	0 1300	mA
Surge	MAX	6000	4000	
Load Regulation: 25% Load to Max Load (4)	TYP MAX	1.2 1.5	3.6 5.0	%
Cross Regulation (5)	TYP	2.0	1.4	%
Line Regulation Vin = Min-Max VDC	TYP MAX	0.28 0.50	0.36 0.50	%
Short Term Stability (6)	TYP	< 0.1	< 0.05	%/24Hrs
Long Term Stability	TYP	< 0.15	< 0.1	%/kHrs
Noise, Peak - Peak (1)	TYP	65	120	mV P-P
RMS Noise	TYP	23	45	mV RMS
Temperature Coefficient	TYP MAX	50 250	50 150	ppm/°C
Short Circuit Protection Outputs to Commmon		Current Limit Protection, Thermal Overload		

NOTES

* **All parameters measured at Tc = 25°C, nominal input voltage and full rated load unless otherwise noted. Refer to the CALEX Application Notes for the definition of terms, measurement circuits and other information.**

(1) Noise is measured per CALEX application notes. Measurement bandwidth is 0-20 MHz. RMS noise is measured over a 0.01-1 MHz bandwidth. To simulate standard PCB decoupling practices, output noise is measured with a 10µf, tantalum and 0.01µF, ceramic capacitor located 1 inch away from the converter. Input ripple is measured into a 10µH source impedance.

(2) See our application note for picking the correct fuse size.

(3) The converter may be safely operated at any load from zero to the full rating. Dynamic response of the converter will degrade if the converter is operated with less than 25% output load. See “Applying the Output” for more information.

(4) Load regulation is defined for loading/unloading one output while the other output is kept at full load. Load range is 25 to 100%.

(5) Cross regulation is defined for loading/unloading one output while the other output is kept at full load. Load range is 25 to 100%.

(6) Short term stability is specified after a 30 minute warmup at full load, constant line and recording the drift over a 24 hour period.

(7) Case is tied to the CMN output pin.

(8) The functional temperature range is intended to give an additional data point for use in evaluating this power supply. At the low functional temperature the power supply will function with no side effects, however sustained operation at the high functional temperature may reduce the expected operational life. The data sheet specifications are not guaranteed over the functional temperature range.

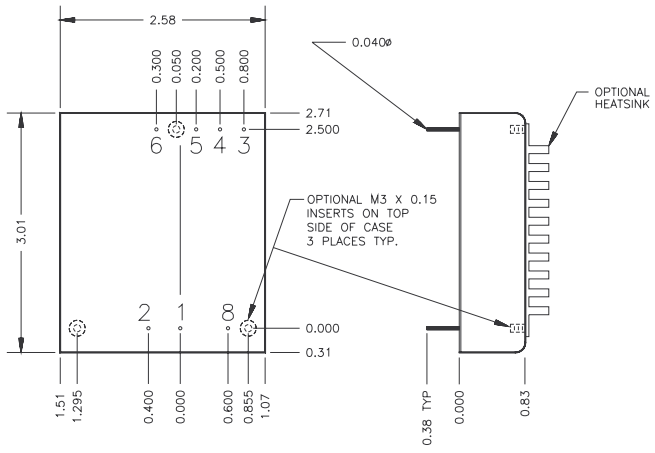
(9) The case thermal impedance is specified as the case temperature rise over ambient per package watt dissipated.

(10) Specifications subject to change without notice.

(11) Water Washability - Calex DC/DC converters are designed to withstand most solder/wash processes. Careful attention should be used when assessing the applicability in your specific manufacturing process. Converters are not hermetically sealed.

30 Watt CS Dual Series DC/DC Converters

General Specifications*			
All Models			**Units**
ON/OFF Function			
ON Logic Level or Leave Pin Open	MIN	4.0	VDC
OFF Logic Level or Tie Pin to -Input	MAX	1.0	VDC
Open Circuit Voltage	TYP	5	VDC
Input Resistance	TYP	6	kohms
Converter Idle Current ON/OFF Pin Low	TYP	10	mA
Isolation (7)			
Isolation Voltage Input to Output, 24D Input to Output, 48D 10µA Leakage	 MIN MIN	 700 1544	VDC
Input to Output Capacitance	TYP	500	pF
Output Trim Function			
Trim Range	MIN	±10	%
Input Resistance	MIN	30	kohms
Environmental			
Case Operating Range	MIN MAX	-40 85	°C
Case Functional Range (8)	MIN MAX	-55 90	°C
Storage Range	MIN MAX	-55 105	°C
Thermal Shutdown Case Temperature	TYP	100	°C
Thermal Impedance (9)	TYP	4.4	°C/Watt
Unit Weight	TYP	7	oz
Mounting Options			
Chassis Mounting Kit		MS9	
-I Suffix on Part Number		Inserts In Case	
-HS Suffix on Part Number		Heat Sink Option	



BOTTOM VIEW SIDE VIEW

Mechanical tolerances unless otherwise noted:

X.XX dimensions: ±0.020 inches

X.XXX dimensions: ±0.005 inches

Pin	Function
1	+INPUT
2	-INPUT
3	+12 V OUTPUT
4	+5 V OUTPUT
5	CMN
6	TRIM
8	ON/OFF

Applications Information

You truly get what you pay for in a CALEX converter, a complete system oriented and specified DC/DC converter - no surprises, no external noise filtering circuits needed, no heatsinking problems, just “plug and play”.

The 30 Watt CS Dual series like all CALEX converters carries the full 5 year CALEX no hassle warranty. We can offer a five year warranty where others can’t because with CALEX it’s rarely needed.

Keep reading, you’ll find out why.

General Information

The CS Dual series is mindful of battery operation for industrial, medical control and remote data collection applications. The remote ON/OFF pin places the converter in a very low power mode that draws typically less than 10 mA from the input source.

Full overload protection is provided by independent pulse-by-pulse current limiting and an over-temperature shutdown circuit. These protection features assure you that our CS Dual will provide you with zero failure rate operation.

Five sided shielding is standard along with specified operation over the full industrial temperature range of -40 to +85°C case temperature.

Applying The Input

Figure 1 shows the recommended input connections for the CS Dual DC/DC converter. A fuse is recommended to protect the input circuit and should not be omitted. The fuse serves to prevent unlimited current from flowing in the case of a catastrophic system failure.

No external capacitance on the input is required for normal operation, in fact it can degrade the converters performance. Normal RF bypass capacitors in the 1000 pF to 0.01 µF range may be used without harm.

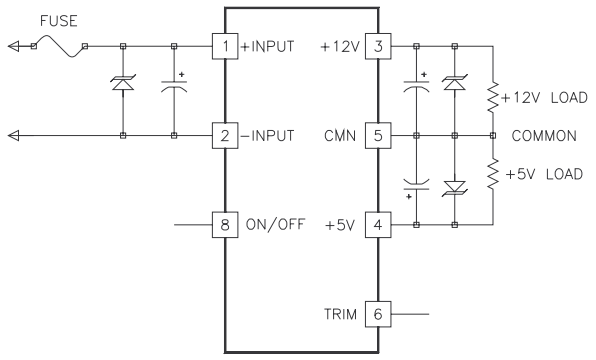


Figure 1.

Standard connections for the CS Dual. The ON/OFF and TRIM pins may be left floating if they are not used. The input protection fuse should not be omitted. If desired, external transient protection diodes can be used. See the text below for suggestions regarding input and output capacitance.

Ultra Low Noise Input Circuit

The circuit shown in figure 2 can be used to reduce the input noise to below 10 mA p-p over a 20 MHz bandwidth. It is important to size inductor L1 appropriately for the maximum expected load current plus any surge at the minimum input voltage. Capacitor C1 should be the moderate ESR type specified. The use of a very low ESR capacitor should be avoided as this will make a high-Q filter when we really want a low-Q, controlled cutoff filter.

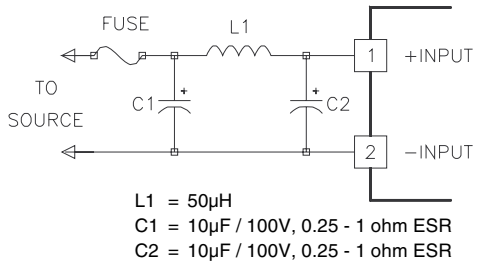


Figure 2.

This circuit may be used to reduce the input reflected ripple to less than 10 mA p-p. Capacitor C1 should be the moderate ESR type shown to prevent input filter response peaking. Size the current carrying capability of L1 for the maximum expected load and minimum input operating voltage.

Remote ON/OFF Pin Operation

The remote ON/OFF pin may be left floating if this function is not used. The equivalent input circuit for the ON/OFF pin is shown in figure 3. The best way to drive this pin is with an open collector/drain or relay contact. See our application note titled "Understanding the remote ON/OFF function" for more information about using the remote ON/OFF pin.

When the ON/OFF pin is pulled low with respect to the -Input, the converter is placed in a low power drain state. The ON/OFF pin turns the converter off while keeping the input bulk capacitor fully charged, this prevents the large inrush current spike that occurs when the +input pin is opened and closed.

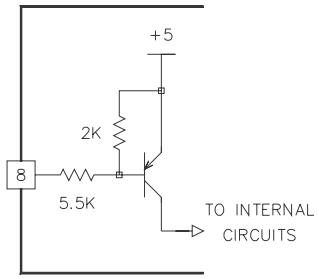


Figure 3.

The simplified schematic of the CS Dual series ON/OFF pin. The input impedance is approximately 6 k ohms. By leaving this pin floating the converter will be in the ON state. When the pin is pulled below 1.0 volts (with respect to the -Input pin) the converter is placed in the power down or OFF state. See our application note on the remote ON/OFF function for more information.

Applying The Output

Figure 1 shows typical output connections for the CS Dual. In most applications no external output capacitance will be necessary. Only your normal 1 to 10 µF and 0.001 to 0.1 µF bypass capacitors sprinkled around your circuit as needed locally are required. Do not add extra output capacitance and cost to your circuit "Just Because".

If you feel you must add external output capacitance, do not use the lowest ESR, biggest value capacitor that you can find! This can only lead to reduced system performance or oscillation. See our application note "Understanding Output Impedance For Optimum Decoupling" for more information. Instead use the ultra low noise output circuit in figure 5.

Output Power Allocation

To be as flexible as possible for your specific application the CS dual incorporates a primary side power limit scheme to limit the maximum power delivered to your load. The power limit circuitry is a pulse by pulse digital limit that causes the output voltages to droop gradually if an over power condition exists. This gradual droop prevents the load lockup phenomena associated with foldback current limit schemes.

The power limit is dependent on two factors. The first is the input voltage to the converter. At low input voltages the power limit will go down. This is a non-linear function of input voltage, it is akin to a drop out phenomena. The second factor is case temperature. As the case temperature goes up the maximum power limit goes down. This is a linear function of case temperature. The typical temperature coefficient is -0.4% per °C.

It is recommended that your system design be checked at the lowest input voltage and highest case temperature for your needs before committing to production. You should leave a design tolerance of at least 4% to be sure that any CS Dual converter will operate in your system.

The CS dual may be used continuously with the following loads,

Maximum Continuous Load:

+5 volts @ 3 amps

+12 volts at 1.3 amps

The maximum surge current allowed on the outputs are,

Maximum Surge Load:

+5 volts @ 6 amps

+12 volts at 4 amps

However the maximum power from all loads combined is limited to typically 50 watts maximum. This surge must not exceed a 10 second, 50 watt surge out of every minute and the case temperature must not exceed the maximum operational specification.

How this maximum power limit may be applied is best described by some examples:

Example 1:

If your load will use the +5 volts at 3 amps and the +12 volts at 1.3 amps continuously (31 watts) the CS still has typically 19 watts left for startup surges. This means that the +12 volt output may supply up to an additional 1.6 amps at startup, for a total startup current of 1.3 + 1.6 = 2.9 amps (or about 35 watts).

Example 2:

If your load will use the +5 volts at 1 amp and the +12 volts at 1 amp continuously (17 watts) the CS still has typically 33 watts left for startup surges. This means that the +12 volt output may supply up to an additional 2.7 amps at startup, for a total startup current of 1.0 + 2.7 = 3.7 amps (or about 44 watts).

Example 3:

If your load will use the +5 volts at 2 amps and the +12 volts at 0.5 amps continuously (16 watts) the CS still has typically 34 watts left for startup surges. This means that the +12 volt output may supply up to an additional 2.8 amps at startup, for a total startup current of 0.5 + 2.8 = 3.3 amps (or about 40 watts).

Example 4:

If your load will use the +5 volts at 2 amps and the +12 volts at 1.0 amps continuously (22 watts) the CS still has typically 28 watts left for startup surges. This means that the +5 volt output may supply up to an additional 5.6 amps at startup. The + 5 volt output is limited to a maximum of 6 amps however so the maximum surge power available from the +5 volt output is 30 watts maximum.

Output Trimming

The trim pin may be used to adjust the outputs from the nominal factory setting. The trim may be used to adjust for system wiring voltage drops. Figure 4 shows the proper connections to use the trim pin. If output trimming is not desired the trim pin may be safely left floating.

Trimming the output up reduces the output current proportionally to keep the maximum power constant. Output current is not increased over the listed maximum when trimming the output voltage down.

Down trim can actually reduce the minimum input voltage in some circuits. Full up trim may not be achievable at minimum input voltage and full rated load. The maximum current available does not increase from the listed maximum under low trim conditions.

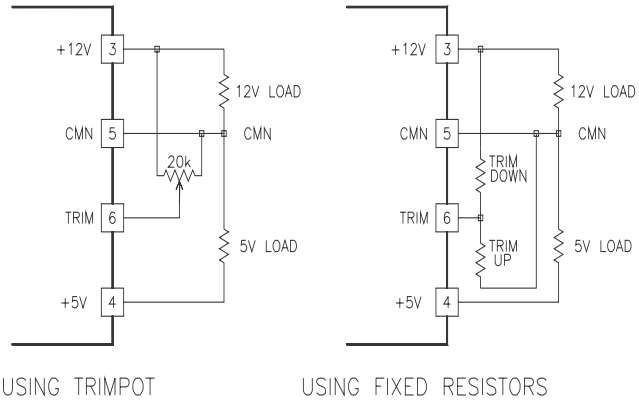


Figure 4.

The output can be trimmed by either a trimpot or fixed resistors. If fixed resistors are used their values may range from 0 to infinite ohms. The trimpot should be typically 20 k ohms.

Non Standard Output Voltages

The CS Duals will typically trim much lower than the -10% specified. This allows the CSs to be trimmed lower than specified for RF or other special applications.

The 5 and 12 volt outputs track each other so the trim operates on both outputs simultaneously. The typical trim range for the CS dual is,

5 volt output ..... 3.3 to 5.7 volts

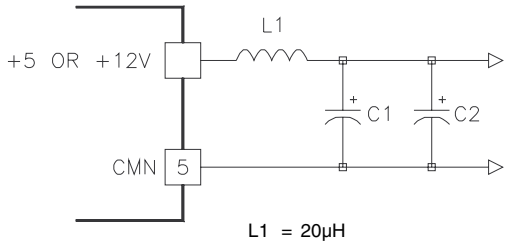
12 volt output ..... 8.2 to 14.2 volts

Ultra Low Noise Output Circuit

The circuit shown in figure 5 can be used to reduce the output noise to below 10 mV p-p over a 20 MHz bandwidth. Size the inductors appropriately for the maximum expected steady state and surge load current.

Operation With Very Light Loads

The dynamic response of the CS Dual will degrade when the unit is operated with less than about 25% of full rated power. The 5 volt output may go below 4.75 volts if only the 5 volt output is loaded. The solution is to load the +12 volt output from 10 to 200 mA as needed. The exact 12 volt loading depends on the 5 volt output loading and to a lesser extent the input voltage.



L1 = 20µH
C1 = 1000µF / 25V, ALUMINUM
C2 = 47µF / 25V, TANTALUM

Figure 5.

For very low noise applications this circuit will reduce the output noise to less than 10 mV p-p over a 0-20 MHz bandwidth. Be sure to size the inductor appropriately for the maximum expected load current.

Grounding

The input and output sections are fully floating from each other. They may be operated fully floating or with a common ground. If the input and output sections are connected either directly at the converter or at some remote location from the converter it is suggested that a 3.3 to 10 µF, 0.5 to 5 ohm ESR capacitor bypass be used directly at the converter output pins. This capacitor prevents any common mode switching currents from showing up at the converters output as normal mode output noise. See "Applying the Output" for more information.

Another "Trick" that can be used when operating with a common ground is to use a 10 to 100 µH choke between the grounds. This gives you a solid low frequency ground connection, but looks like a high impedance to the switching current effects and prevents them from flowing in the connection. This will have the effect of preventing the common mode currents from showing up as normal mode components in your input or output circuits.

Be sure that the inductor has a self resonant frequency of greater than 200 kHz and that the Q of the inductor is quite low. If necessary to keep the inductor Q under control, parallel it with a 200 to 1 k ohm resistor.

Case Grounding

The copper case serves not only as a heat sink but also as a EMI shield. The 0.25 inch thick case provides >30 dB of absorption loss to both electric and magnetic fields at 220 kHz, while at the same time providing 20 to 40 % better heat sinking over competitive thin steel, aluminum or plastic designs.

The case shield is tied to the output CMN pin. This connection is shown on the block diagram. The case is floating from the input sections. The input is coupled to the outputs only by the low 500 pF of isolation capacitance. This low I/O capacitance insures that any AC common mode noise on the inputs is not coupled to your output circuits.

Compare this isolation to the more usual 1000 - 2000 pF found on competitive designs and you will see that CALEX provides the very best DC and AC isolation available. After all, you are buying an isolated DC/DC to cut ground loops. Don't let the isolation capacitance add them back in.

Temperature Derating

The CS Dual series can operate up to 85°C case temperature without derating. Case temperature may be roughly calculated from ambient by knowing that the CS Dual case temperature rise is approximately 4.4°C per package watt dissipated.

For example: If a CS converter is outputting 25 Watts, at what ambient could it expect to run with no moving air and no extra heatsinking?

Efficiency is approximately 80%, this leads to an input power of 31 Watts. The case temperature rise would be 6 watts × 4.4 = 26°C. This number is subtracted from the maximum case temperature of 85°C to get: 59°C.

This example calculation is for a CS Dual without any extra heat sinking or appreciable air flow. Both of these factors can greatly effect the maximum ambient temperature (see below). Exact efficiency depends on input line and load conditions, check the efficiency curves for exact information. Repetitive surge loads can also increase the average case dissipation.

This is a rough approximation to the maximum ambient temperature. Because of the difficulty of defining ambient temperature and the possibility that the loads dissipation may actually increase the local ambient temperature significantly, these calculations should be verified by actual measurement before committing to a production design.

Heat Sinking

The CS Dual can be ordered in a "-I" configuration which provides a case with 3 X M3 inserts located on the top surface of the case for attaching a heat sink or mounting the converter on it's back using the inserts provided. The mounting surface should be flat to within ±0.01 inches to prevent warping the CS Dual's case.

The CALEX HS-1 heat sink was specially developed for this model and can reduce the case temperature rise to typically below 3.3°C per watt with natural convection and less with moving air. It also increases the heat removing efficiency of any cooling air flow.

When the CS Dual is ordered with the -HS option CALEX will ship the converter with inserts and a heatsink attached. For the exact size of the heatsink see the package outline drawing.

Customer installed heat sinks may also be used. It is recommended that either liquid heatsink compound or nothing be used on the heatsink interface. Stay away from the so called "Dry" pad heat sink materials, in our experience these materials are actually worse than no compound at all. Test them thoroughly before committing to production.

Additional heatsinking will lower internal temperatures and increase the expected operational life.

Mounting Kit

The MS9 chassis mounting kit allows for direct wire connection to the CS Dual series pins. The mounting kit includes two barrier strips for wire attachment. The MS9 may be conveniently attached to a chassis by use of the 4 - 0.156 inch diameter mounting holes provided at each corner.

Although the MS9 comes with solderless sockets, for improved reliability in severe temperature or vibration environments it is recommended that the CS Dual be soldered to the mounting kit.