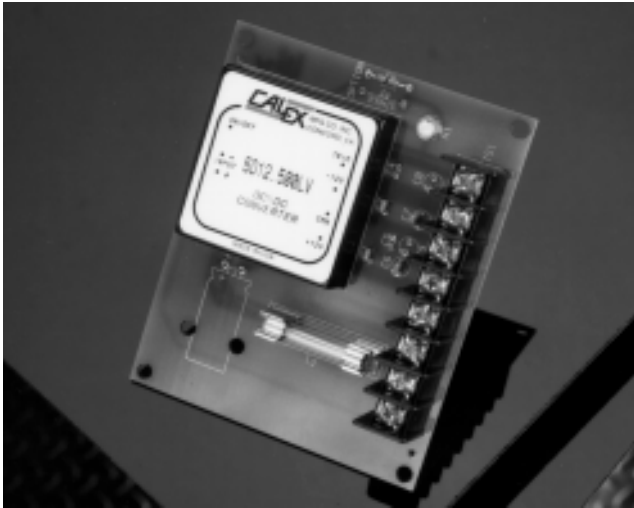


12 Watt LV Dual Series DC/DC Converters



Description

The universal input of the LV dual series spans 3.5 to 16 volts. This makes these converters ideal for 4.8 to 12 volt battery and the more traditional 5 volt logic powered systems.

Coupled with this is the very low output noise of typically less than 50 mV peak to peak. The noise is also fully specified for RMS value and if even these impressive noise figures aren't enough, our applications section shows a simple add on circuit that can reduce the output noise to less than 20 mV P-P.

Full isolation is provided to help cut ground loops in logic powered systems that could create havoc with sensitive, high precision analog circuitry.

No extra components or heatsinking are required for most applications saving you design time and valuable PCB space.

Features

- Universal 3.5 to 16 Volt Input Range
- Up to 12 Watts of PCB Mounted Power
- Efficiencies to 80%
- Fully Isolated, Filtered Design
- Low Noise Outputs, < 50 mV P-P
- Very Low I/O Capacitance, 375 pF Typical
- Water Washable Shielded Copper Case
- 5 Year Warranty

Selection Chart

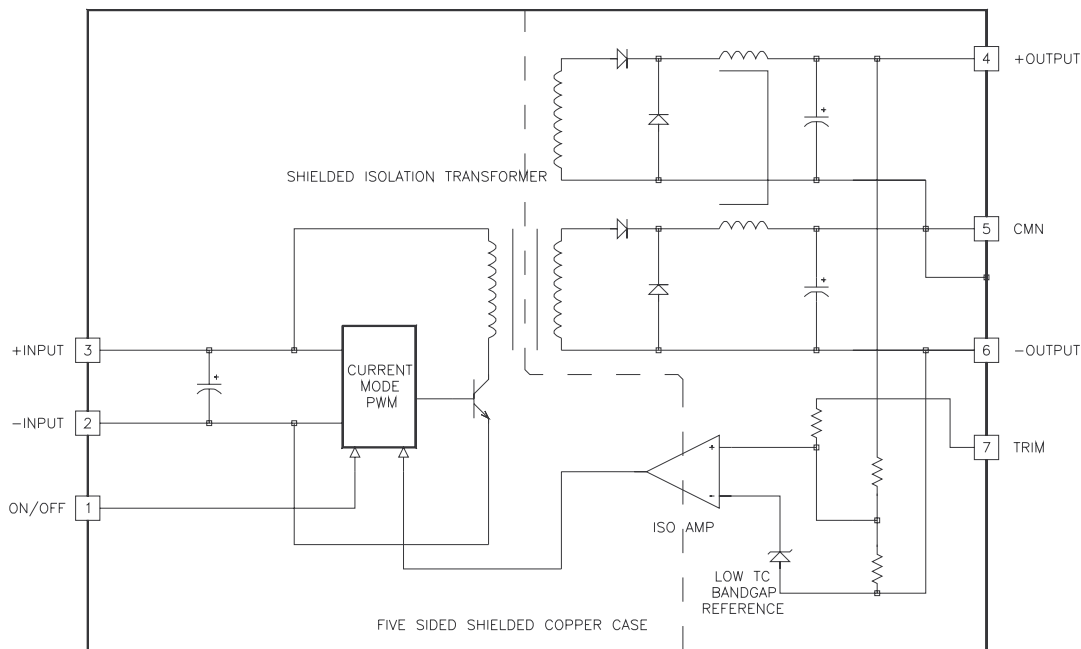
Model	Input Range VDC		Output VDC	Output mA
	Min	Max		
5D5.1000LV	3.5	16	±5	±1000
5D12.500LV	3.5	16	±12	±500
5D15.400LV	3.5	16	±15	±400

What all this means to you is a tighter, more compact overall system that has the capability of being universally powered. Full application information is provided to make integrating this supply in your system a snap.

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

Other input and output voltage combinations may be factory ordered, contact CALEX applications engineering at 1-800-542-3355 for more information.

12 Watt LV Dual Series Block Diagram



12 Watt LV Dual Series DC/DC Converters

Input Parameters*					
Model		5D5.1000LV	5D12.500LV	5D15.400LV	Units
Voltage Range (1)	MIN	3.5			VDC
	MAX	16			
Input Current	No Load	14	23	28	mA
	75% Load	2300	2650	2680	
Switching Frequency	TYP	60			kHz
Maximum Input Overvoltage, 100ms Maximum	MAX	20			VDC
Turn-on Time, 1% Output Error	TYP	10			ms
Recommended Fuse		(2)			AMPS

Output Parameters*					
Model		5D5.1000LV	5D12.500LV	5D15.400LV	Units
Output Voltage		±5	±12	±15	VDC
Output Voltage Accuracy	MIN	4.95	11.880	14.850	VDC
	TYP	5.00	12.000	15.000	
	MAX	5.05	12.120	15.150	
Output Balance Plus to Minus Output, Full Load	TYP	< 0.1			%
	MAX	1.0			
Rated Load Range (3)	MIN	0	0	0	mA
	MAX	±1000	±500	±400	
Load Regulation (4) Vin = 12 VDC	TYP	0.1	0.1	0.1	%
	MAX	0.7	0.5	0.5	
Cross Regulation (5)	TYP	2.5	1.5	1.5	%
Line Regulation Vin = Min-Max VDC	TYP	0.1			%
	MAX	0.2			
Short Term Stability (6)	TYP	< 0.05			%/24Hrs
Long Term Stability	TYP	< 0.1			%/kHrs
Transient Response (7) Vin = 12 VDC	TYP	200	50	50	µs
Dynamic Response (8)	TYP	100	120	150	mV peak
Noise, Peak - Peak (9)	TYP	120	50	50	mV P-P
RMS Noise, 0.01 - 1 MHz bw	TYP	35	15	15	mV RMS
Temperature Coefficient	TYP	50			ppm/°C
	MAX	150			
Short Circuit Protection to Common for all Outputs		Short Term Current Limit			

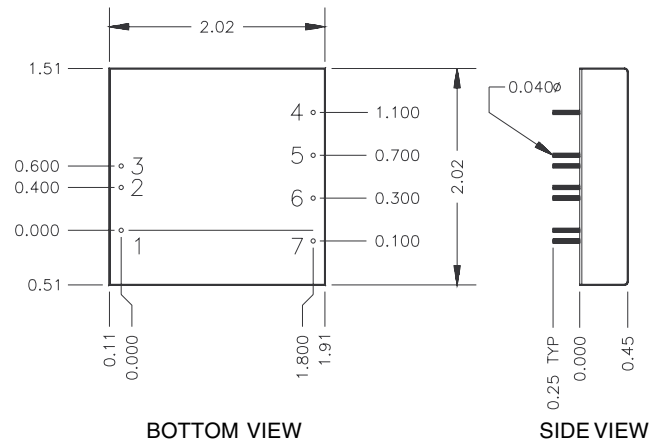
NOTES

* 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) Reduced output power available below 9 volts input. See applications section for more information.
- (2) To determine the correct fuse size, see CALEX Application Notes.
- (3) No minimum load required for operation. Reduced output power is available below 9 volts input. See applications section.
- (4) Load regulation is defined for loading/unloading both outputs simultaneously. 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) The transient response is specified as the time required to settle from a 50 to 75 % step load change (rise time of step = 2 µSec) to a 1% error band.
- (8) Dynamic response is the peak overshoot voltage during the transient response time as defined in note 7 above.
- (9) Noise is measured per CALEX Application Notes. Measurement bandwidth is 0-20 MHz for peak-peak measurements, 10 kHz to 1 MHz for RMS measurements. Output noise is measured with a 0.01µF ceramic in parallel with a 1µF/35V Tantalum capacitor located 1" away from the converter to simulate your PCB's standard decoupling.
- (10) See the applications section for more information on applying the ON/OFF pin.
- (11) The Case is tied to the CMN output pin.
- (12) 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 will reduce expected operational life. The data sheet specifications are not guaranteed over the functional temperature range.
- (13) The case thermal impedance is specified as the case temperature rise over ambient per package watt dissipated.
- (14) Specifications subject to change without notice.
- (15) 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.

12 Watt LV Dual Series DC/DC Converters

General Specifications*				
All Models				Units
ON/OFF Function				
OFF Logic Level or Tie Pin to -Input (10)	MAX	< 0.4		VDC
Open Circuit Voltage	TYP	1.4		VDC
Input Resistance	TYP	2		kohms
Converter Idle Current ON/OFF Pin Low	TYP	6		mA
Isolation (11)				
Isolation Voltage Input to Output 10µA Leakage	MIN	700		VDC
Input to Output Capacitance	TYP	375		pF
Output Trim Function				
Trim Range	MIN	±10		%
Input Resistance	MIN	10		kohms
Environmental				
Case Operating Range No Derating	MIN	-40		°C
	MAX	85		
Case Functional Range (12)	MIN	-50		°C
	MAX	100		
Storage Range	MIN	-55		°C
	MAX	105		
Thermal Impedance (13)	TYP	9.5		°C/Watt
General				
Unit Weight	TYP	2.3		oz
Chassis Mounting Kit		MS8		



Mechanical tolerances unless otherwise noted:

X.XX dimensions: ±0.020 inches

X.XXX dimensions: ±0.005 inches

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

12 Watt LV Dual Series DC/DC Converters

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 circuits needed, no heatsinking problems, just "plug and play".

The LV 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.

General Information

The universal 3.5 to 16 volt input of the LV Dual series allows you to specify your system for operation from any 5 volt logic supply or a 4.8 to 12 volt nominal battery input.

The series is also 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 6 mA from the input source.

Noise has also achieved new lows in this single design, while the industry standard is to specify output noise as 1 to 5% peak to peak typical with no mention of measurement bandwidth. The LV converters achieve noise levels of less than 50 mV peak to peak and are fully specified and tested to a wide bandwidth of 0-20 MHz.

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 LV Single 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.

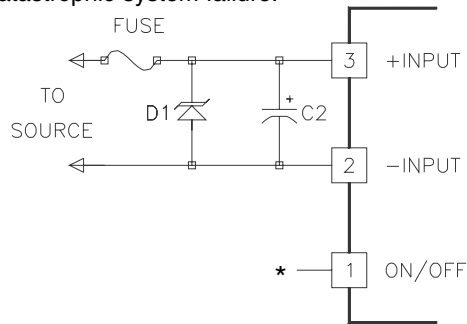


Figure 1. * ON/OFF MAY BE LEFT FLOATING IF NOT USED

If the source impedance driving the LV Converter is more than about 0.05 ohms the optional capacitor C2 may be required (See text for more information). Optional transient protector diode D1 may be used if desired for added protection. The fuse serves as a catastrophic failure protector and should not be omitted.

When using the LV Dual be sure that the impedance at the input to the converter is less than 0.05 ohms from DC to about 100 kHz, this is usually not a problem in battery powered systems when the converter is connected directly to the battery. If the converter is located more than about 1 inch from the input source an added capacitor may be required directly at the input pins for proper operation.

The maximum permissible source impedance is a function of output power and line voltage. The impedance can be higher when operating at less than full power. The minimum impedance is required when operating with a 9 volt input at full load. The impedance reduces as the input voltage is raised or lowered or the power is reduced. In general you should keep the peak to peak voltage measured across the input pins less than 0.15 volts peak to peak (not including the high frequency spikes) for maximum converter performance and life.

There is no lower limit on the allowed source impedance, it can be any physically realizable value, even approaching 0.

If the source impedance is too large in your system you should choose an external input capacitor as detailed below.

Picking An External Input Capacitor

If an input capacitor is needed at the input to the converter it must be sized correctly for proper converter operation. The curve "RMS Input Current Vs Line Input" shows the RMS ripple current that the input capacitor must withstand with varying loading conditions and input voltages.

Several system tradeoffs must be made for each particular system application to correctly size the input capacitor.

The probable result of undersizing the capacitor is increased self heating, shortening its life. Oversizing the capacitor can have a negative effect on your products cost and size, although this kind of overdesign does not result in shorter life of any components.

There is no one optimum value for the input capacitor. The size and capacity depend on the following factors:

- 1) Expected ambient temperature and your temperature derating guidelines.
- 2) Your ripple current derating guidelines.
- 3) The maximum anticipated load on the converter.
- 4) The input operating voltage, both nominal and excursions.
- 5) The statistical probability that your system will spend a significant time at any worst case extreme.

Factors 1 and 2 depend on your system design guidelines. These can range from 50 to 100% of the manufacturers listed maximum rating, although the usual derating factor applied is about 70%. 70% derating means if the manufacturer rated the capacitor at 1 A RMS you would not use it over 0.7 A RMS in your circuit.

Factors 3 and 4 realistically determine the worst case ripple current rating required for the capacitor along with the RMS ripple current curve.

Factor 5 is not easy to quantify. At CALEX we can make no

12 Watt LV Dual Series DC/DC Converters

assumptions about a customers system so we leave to you the decision of how you define how big is big enough. Suitable capacitors for use at the input of the converter are given at the end of this section.

Startup Current Demand

Because the LV Dual appears as a constant power load to your source and operation starts at about 3 volts, you should be sure that your source can supply the required current at low voltages when starting. If this presents a problem the ON/OFF pin and a simple voltage detector (comparator) may be used to prevent startup until some higher steady state voltage.

Generally this is not a problem with battery powered circuits and only appears when the LV Dual is powered by marginally sized 5 or 12 volt linear supplies that can't supply the required startup current. See the "Input Current Vs. Line Input" curve for the low voltage current requirements of the LV Dual.

Very Low Noise Input Circuit

Figure 2 shows a very low noise input circuit that may be used with the converters. This circuit will reduce the input reflected ripple current to less than 20 mA RMS ($V_{in} = 5\text{ V}$, 10 kHz to 1 MHz bw). See the discussion above for the optimum selection of C2.

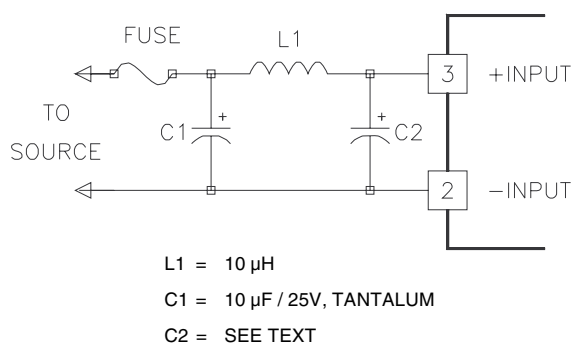


Figure 2.

This circuit will reduce the input reflected ripple current to less than 20 mA RMS. See the discussion in the text for help on the optimum selection of C2. L1 should be sized to handle the maximum input current at your lowest operating voltage and maximum expected output power.

Suggested Capacitor Sources

These capacitors may be used to lower your sources input impedance at the input of the converter. These capacitors will work for 100% load, worst case input voltage and ambient temperature extremes. They however, may be oversized for your exact usage, see "Picking An External Input Capacitor" above for more information. You may also use several smaller capacitors in parallel to achieve the same ripple current rating. This may save space in some systems.

United Chemi-Con SXE, RXC, RZ and RZA series
Suggested Part: SXE025VB820M12.5X20LL
820µF, 25V, 105°C Rated
ESR=0.085 ohms
Allowable Ripple at 85°C = 1.96 A

Nichicon	PR and PF series
Suggested Part:	UPR1E222MRH
	2200µF, 25V, 105°C Rated
	ESR=0.053 ohms
	Allowable Ripple at 85°C = 1.98 A
Panasonic	HFG and HFQ Series
Suggested Part:	ECEA1EFE332L
	3300µF, 25V, 105°C Rated
	ESR=0.045 ohms
	Allowable Ripple at 85 °C = 1.94 A

Remote ON/OFF Pin Operation

The remote ON/OFF pin may be left floating if this function is not used. The best way to drive this pin is with an open collector/drain or relay contact.

Do not drive this input from a logic gate directly. The ON/OFF pin must be left floating to turn the converter on and insure proper operation. This input is noise sensitive so it should not be routed all over your PCB.

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 capacitors fully charged, this prevents the large inrush current spike that occurs when the +input pin is opened and closed.

The ON/OFF pin should never be pulled more that 0.3 volts below the -Input or have a voltage of greater than +2 volts applied to it.

Applying The Output

Figure 3 shows typical output connections for the LV Dual. In most applications no external output capacitance will be necessary. Only your normal 1 to 10 uF tantalum and 0.001 to 0.1 µF ceramic bypass capacitors sprinkled around your circuit as needed locally are required. Do not add extra output capacitance and cost to your circuit "Just Because".

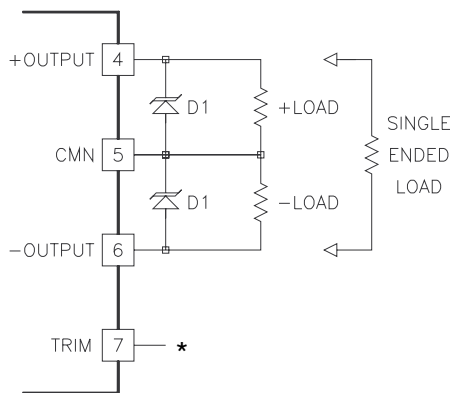
If you feel you must add external output capacitance, do not use the lowest ESR, biggest value capacitor that you can find! This can only lead to reduced system performance or oscillation. See our application note "Understanding Output Impedance For Optimum Decoupling" for more information.

Output Power

The available output power of the LV Dual is reduced when operating below 9 and 4.6 volts. See the "Low Voltage Power" curve for more information. In general, from 9 to 16 volts full power is available from the LV Dual. From 4.6 to 9 volts input the available output power is 75% of the full load value. Below 4.6 volts the output power is linearly derated from 75% at 4.6 volts to 40% at 3.5 volts. For example a LV Dual is capable of providing 4.8 watts of output power at 3.5 volts input.

Table 1 summarizes the output current available versus input voltage.

12 Watt LV Dual Series DC/DC Converters



* TRIM MAY BE LEFT FLOATING IF NOT USED

Figure 3.

The LV Dual may be directly connected to your load without any external components required for most applications. The outputs may also be used in single ended mode. Transient overvoltage diodes may be added for extra protection against output faults or if the input has the possibility of being shorted to the loads.

Table 1			
Model	Input Voltage / Maximum Output Current		
	3.5 V	4.6 V	9 V
5D5.1000LV	400 mA	750 mA	1000 mA
5D12.500LV	200 mA	375 mA	500 mA
5D15.400LV	160 mA	300 mA	400 mA

Note: The maximum current is linearly derated between the break points. See the output power graph for more information.

Ultra Low Noise Output Circuit

The circuit shown in figure 4 can be used to reduce the output noise to below 20 mV P-P over a 20 MHz bandwidth. Size inductor L1 appropriately for the maximum expected load current. All of the ground connections must be as short as possible back to the CMN pin. The filter should be placed as close to the LV Dual as possible, even if your load is at some distance from the converter.

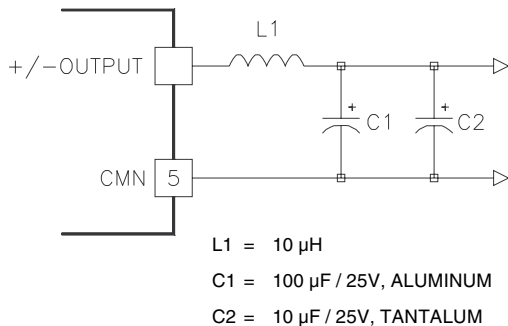


Figure 4.

This circuit can reduce the output noise to below 15 mV P-P over a 20 MHz bandwidth. Size inductor L1 appropriately for the maximum expected load current. All of the ground connections must be as short as possible back to the CMN pin.

Operation With Very Light Loads

Dynamic response of the LV Dual will degrade when the unit is operated with less than 25% of full rated power.

Output Trimming

The trim pin may be used to adjust the outputs by up to $\pm 10\%$ from the nominal factory setting. The trim may be used to adjust for system wiring voltage drops. Figure 5 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.

Full up trim may not be achievable at minimum input voltage and full rated load.

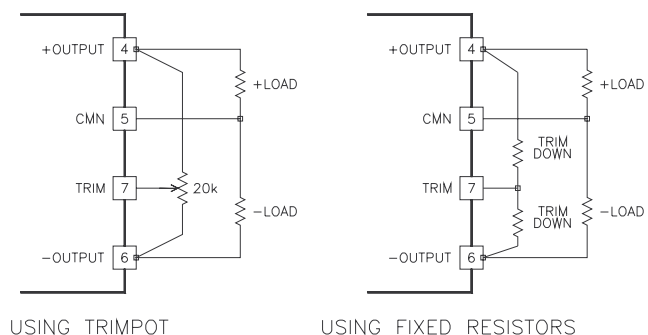


Figure 5.

Output trimming may be accomplished by using a Dual fixed resistor or a trimpot as shown. When using fixed resistors the values may range from 0 to infinity ohms. See the text for more information on output power when trimming. The trimpot should be approximately 20K ohms.

Non Standard Output Voltages

The LV Duals will typically trim much lower than the -10% specified. This allows the 12 and 15 volt LV's to be trimmed lower than specified for RF or other special applications.

The 5 volt LV's can be typically trimmed over a range of 3.8 to 5.6 volts. The 12 volt LV's can be typically trimmed over a range of 6.4 to 13.3 volts. The 15 volt LV's can be typically trimmed over a range of 6.7 to 16.9 volts.

The dual outputs may also be used in a single ended mode as shown in figure 3 to get 10, 24 or 30 volts of output at the full rated power levels (i.e. 1A, 0.5A or 0.4A). To use the single ended mode just connect your load to the + and - Output pins and leave the CMN pin floating. Trimming of the outputs may also be done while using the single ended mode.

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 1 to 10 μ F, 0.5 to 5 ohm ESR

12 Watt LV Dual Series DC/DC Converters

capacitor bypass be used directly at the converters output pins. These capacitors prevent any common mode switching currents from showing up at the converters output as normal mode output noise. See "Applying the Output" for more information on selecting output capacitors.

Also see the CALEX application note "Dealing With Common Mode Noise" for more information on using common grounds.

Case Grounding

The copper case serves not only as a heat sink but also as a EMI shield. The 0.017 inch thick case provides >15 dB of absorption loss to both electric and magnetic fields at 60 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 CMN output 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 375 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 LV Dual series can operate up to 85°C case temperature without derating. Case temperature may be roughly calculated from ambient by knowing that the case temperature rise is approximately 9.5°C per package watt dissipated.

For example: If a 12 volt output converter is delivering 9 Watts with a 12 volt input, at what ambient could it expect to run with no moving air and no extra heatsinking?

Efficiency of the converter is approximately 76% at 9 watts of output power, this leads to an input power of about 12 Watts. The case temperature rise would be 12 - 9 Watts or 3 Watts $\times$ 9.5 = 28.5°C. This number is subtracted from the maximum case temperature of 85°C to get: 56.5°C.

This example calculation is for an LV 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.

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.

Remember, it is the system designers responsibility to be sure that the case temperature of the LV Dual does not exceed 85 °C for maximum reliability in operation.

Typical Performance (Tc=25°C, Vin=Nom VDC, Rated Load).

