6 Watt LV Single Series DC/DC Converters

Features

- Universal 3.5 to 16 Volt Input Range
- Up to 6 Watts of PCB Mounted Power
- Efficiencies to 77%
- Fully Isolated, Filtered Design
- -40 to 85°C Operation
- Very Low I/O Capacitance, 300 pF Typical
- Small Water Washable Nonconductive Case
- 5 Year Warranty

Selection Chart

Model	Input Range VDC		Output VDC	Output mA
	Min	Max		
5S5.1200LV	3.5	16	5	1200
5S5R2.1200LV	3.5	16	5.2	1200
5S12.500LV	3.5	16	12	500
5S15.400LV	3.5	16	15	400

Description

The universal input of the LV single 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 nonconductive case which makes for safe installation on tight, multi-board systems. No extra components or heatsinking are required for most applications saving you design time and valuable PCB space.

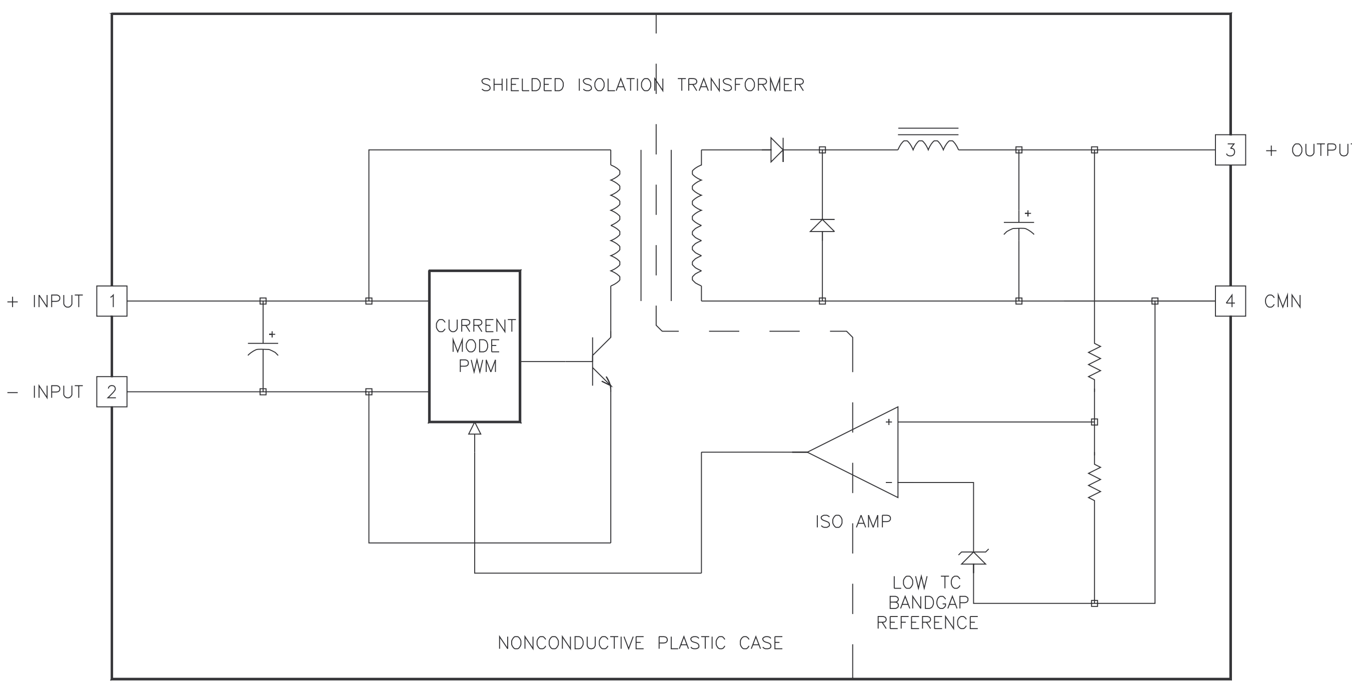
Full isolation is provided to help cut ground loops in logic powered systems that could create havoc with sensitive, high precision analog circuitry.

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.

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

As with all CALEX converters the LV Single series is covered by our 5 Year Warranty.

6 Watt LV Single Series Block Diagram



Input Parameters*

Model		5S5.1200LV	5S5R2.1200LV	5S12.500LV	5S15.400LV	Units
Voltage Range (1)	MIN MAX	3.5 16				VDC
Input Current Full Load No Load	TYP TYP	1680 10	1750 10	1680 10	1670 20	mA
Switching Frequency	TYP	100				kHz
Maximum Input Overvoltage, 100ms Maximum	MAX	20				VDC
Turn-on Time, 1% Output Error	TYP	10				ms
Recommended Fuse		(3)				AMPS

Output Parameters*

Model		5S5.1200LV	5S5R2.1200LV	5S12.500LV	5S15.400LV	Units
Output Voltage		5	5.2	12	15	VDC
Output Voltage Accuracy	MIN TYP MAX	4.95 5.00 5.05	5.15 5.20 5.25	11.900 12.000 12.100	14.900 15.000 15.100	VDC
Rated Load Range (9)	MIN MAX	0 1200	0 1200	0 500	0 400	mA
Load Regulation 25% Max Load - Max Load	TYP MAX	0.3 0.7	0.3 0.7	0.1 0.5	0.1 0.5	%
Line Regulation Vin = Min-Max VDC	TYP MAX	0.1 0.2				%
Short Term Stability (4)	TYP	< 0.05				%/24Hrs
Long Term Stability	TYP	< 0.1				%/kHrs
Transient Response (5)	TYP	100	100	200	100	µs
Dynamic Response (6)	TYP	60	60	190	150	mV peak
Noise, Peak - Peak (2)	TYP	75	75	50	40	mV P-P
RMS Noise	TYP	20	20	10	8	mV RMS
Temperature Coefficient	TYP MAX	50 150				ppm/°C
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 at 3.5V input. Full output power is available above 4.6V input. See applications section for more information.

(2) 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.

(3) To determine the correct fuse size, see CALEX Application Notes.

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

(5) 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.

(6) Dynamic response is the peak overshoot voltage during the transient response time as defined in note 5 above.

(7) 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.

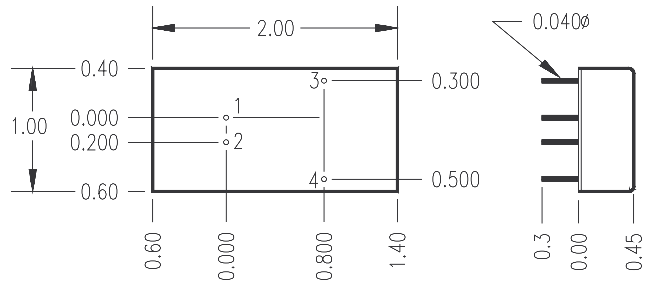
(8) The case thermal impedance is specified as the case temperature rise over ambient per package watt dissipated.

(9) No minimum load required for operation . Dynamic regulation may degrade when run with less than 5% load.

(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.

General Specifications*			
All Models			**Units**
Isolation			
Isolation Voltage Input to Output 10μA Leakage	MIN	700	VDC
Input to Output Capacitance	TYP	300	pF
Environmental			
Case Operating Range No Derating	MIN MAX	-40 85	°C
Case Functional Range (7)	MIN MAX	-50 100	°C
Storage Range	MIN MAX	-55 105	°C
Thermal Impedance (8)	TYP	19	°C/Watt
General			
Unit Weight	TYP	0.9	oz
Chassis Mounting Kit		MS6, MS8, MS15	



Mechanical tolerances unless otherwise noted:

X.XX dimensions: ±0.020 inches

X.XXX dimensions: ±0.005 inches

Pin	Function
1	+INPUT
2	-INPUT
3	+OUTPUT
4	CMN

Application 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 Single 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 universal 3.5 to 16 volt input allows you to specify your system for operation from any 5 volt logic supply or a 4.8 to 12 volt nominal battery input.

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 (S12 and S15 models) and are fully specified and tested to a wide bandwidth of 0-20 MHz.

A water washable, non-conductive case 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.

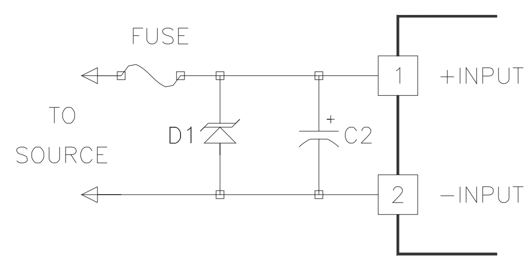


Figure 1.

If the source impedance driving the LV Converter is more than 0.15 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 Single be sure that the impedance at the input to the converter is less than 0.15 ohms from DC to about 200 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 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 about a 6 volt input. 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 0.25 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 it’s 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%. For example 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 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 Single 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.

Generally this is not a problem with battery powered circuits and only appears when the LV Single 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 Single.

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 5 mA RMS (Vin = 5 V, 10 kHz to 1 MHz bw). See the discussion above for the optimum selection of C2.

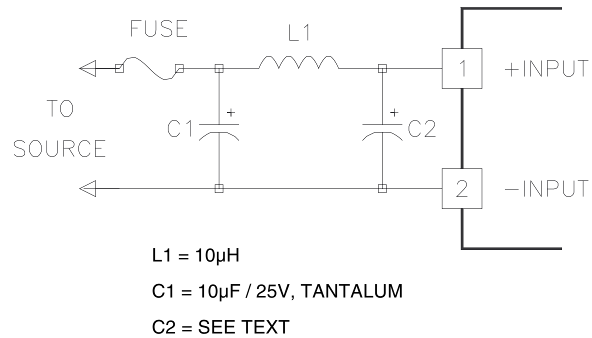


Figure 2.

This circuit will reduce the input reflected ripple current to less than 5 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 the 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 LXF, SXE, RXC, RZ and RZA series
Suggested Part: LXF25VB221M8X15LL
220µF, 25V, 105°C Rated
ESR = 0.13 ohms
Allowable Ripple at 85 °C = 960 mA

Nichicon PR and PF series
Suggested Part: UPR1E102MRH
1000µF, 25V, 105°C Rated
ESR = 0.1 ohms
Allowable Ripple at 85°C = 1.2 A

Panasonic HFG and HFQ Series
Suggested Part: ECEA1EFG102
1000µF, 25V, 105°C Rated
ESR = 0.05 ohms
Allowable Ripple at 105°C = 1.28 A

Applying the Output

Figure 3 shows typical output connections for the LV Single. In most applications no external output capacitance will be necessary. Only your normal 1 to 10 µF 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.

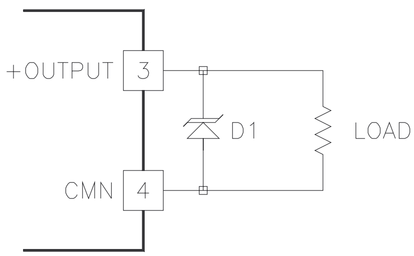


Figure 3.

The LV Single may be directly connected to your load without any external components required for most applications. Transient overvoltage diode D1 may be added for extra protection against output faults or if the input has the possibility of being shorted to the load. General Semiconductor or Motorola SA and 1.5KE series devices provide excellent protection.

Output Power

The available output power of the LV Single is reduced when operating below 4.6 volts. See the “Low Voltage Power” curve for more information. In general, from 4.6 to 16 volts full power is available from the LV Single. Below 4.6 volts input the available output power is linearly derated from 100% at 4.6 volts to 50% at 3.5 volts. For example a 5S12.500LV is capable of providing 3 watts of output power at 3.5 volts input.

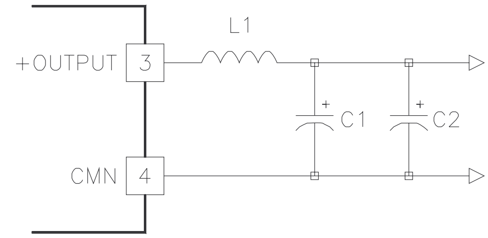
Ultra Low Noise Output Circuit

The circuit shown in figure 4 can be used to reduce the output noise to below 10 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 Single as possible, even if your load is at some distance from the converter.

Operation With Very Light Loads

The LV Single conserves power when operating at very light loads by operating in a burst power mode. This may cause the output noise to increase with a repetition rate of 10’s of milliseconds. If this causes a problem the LV Single may be operated with a pre-load of about 5% of it’s full rated power. The exact value will depend on the external components in your system.

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



L1 = 10µH

C1 = 100µF / 25V, ALUMINUM

C2 = 10µF / 25V, TANTALUM

Figure 4.

This circuit can reduce the output noise to below 10 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.

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 µF, 0.5 to 5 ohm ESR 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 case is made from a non-conductive high temperature plastic material. The case is floating from the input sections. The input is coupled to the outputs only by the low 300 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.

Temperature Derating

The LV Single 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 19°C per package watt dissipated.

For example: If a 12 volt output converter is delivering 4.5 watts with a 5 volt input, at what ambient could it expect to run with no moving air and no extra heatsinking?

Efficiency of the converter is approximately 74% at 4.5 watts of output power, this leads to an input power of about 6 watts. The case temperature rise would be 6 - 4.5 watts or 1.5 watts $\times$ 19 = 29°C. This number is subtracted from the maximum case temperature of 85°C to get: 56°C.

This example calculation is for an LV Single without any extra heat sinking or appreciable air flow. Both of these factors can greatly effect the maximum ambient temperature. 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 Single does not exceed 85°C for maximum reliability in operation.

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