11 to 17 Watt SD Single Series DC/DC Converters

Features

- Power Density of up to 25 Watts Per Cubic Inch
- Only 1 Square Inch of PCB Area Required
- Efficiencies to >90%
- Low Noise Outputs, 60 mV P-P Typical
- Water Washable Case
- Surface Mount Package Available
- Five Year Warranty

Selection Chart				
Model	Input Range VDC		Output VDC	Output mA
	Min	Max		
5S3.3500SD	4.5	6	3.33	3500
12S5.3500SD	6.5	15.5	5.00	3500

Description

The SD single series breaks new ground on several fronts. First is their power density of up to 25 watts per cubic inch. The second is the operating efficiency that can exceed 90%.

The outputs are 3.3 and 5 volts with 5 volt or 6-15.5 volt inputs respectively. This makes these converters ideal for logic powered 3.3 volt down conversion or battery operation of the more traditional 5 volt logic powered systems.

Coupled with this is the very low output noise of typically less than 60 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.

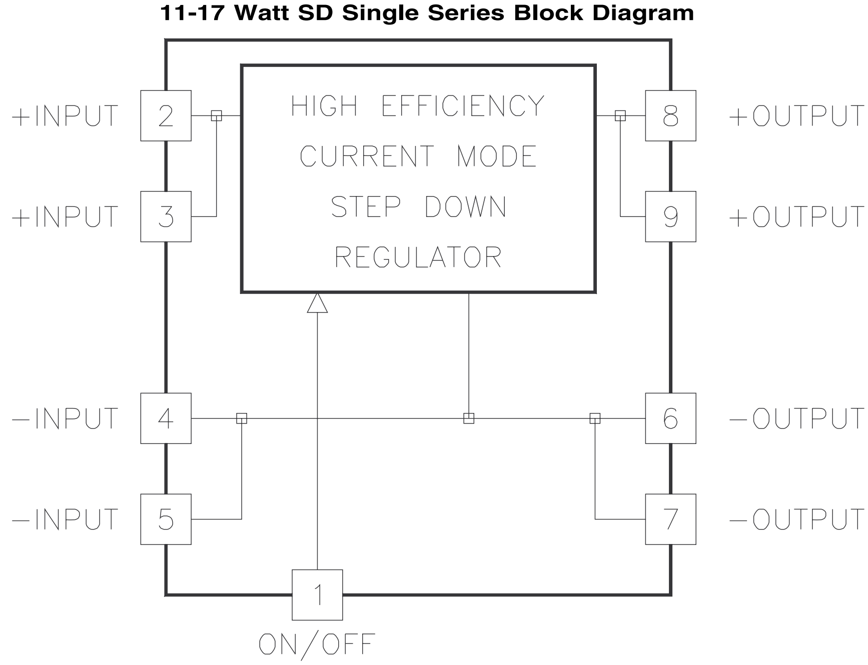
The traditional flat package design has been stood on end so that it takes up only 1 square inch of PCB area. No extra heatsinking is required for most applications saving you design time and valuable PCB space.

What all this means to you is a tighter, more compact overall system. Full application information is provided to make integrating this supply in your system a snap.

A remote ON/OFF function is included that places the converter in a very low power state.

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

11-17 Watt SD Single Series Block Diagram



11 to 17 Watt SD Single Series DC/DC Converters

Input Parameters*				
Model		**5S3.3500SD**	**12S5.3500SD**	**Units**
Voltage Range	MIN MAX	4.5 6.0	6.5 15.5	VDC
Input Current Full Load No Load	TYP TYP	2615 1	1635 1	mA
Efficiency	TYP	86	88	%
Switching Frequency	TYP	100		kHz
Maximum Input Overvoltage, 200ms Maximum	MAX	7.5	17.0	VDC
Turn-on Time, 1% Output Error	TYP	200	10	ms
Recommended Fuse		(2)		AMPS

Output Parameters*				
Model		**5S3.3500SD**	**12S5.3500SD**	**Units**
Output Voltage		3.33	5.00	VDC
Output Voltage Accuracy (3) Worst Case	MIN TYP MAX	3.200 3.330 3.390	4.800 5.000 5.250	VDC
Rated Load Range (4)	MIN MAX	0 3500		mA
Load Regulation 25% Max Load - Max Load	TYP MAX	1.7 2.5		%
Line Regulation Vin = Min-Max VDC	TYP MAX	0.2 1.0	0.4 1.0	%
Short Term Stability (5)	TYP	< 0.01		%/24Hrs
Long Term Stability	TYP	< 0.1	< 0.05	%/kHrs
Transient Response (6)	TYP	100	200	µs
Dynamic Response (7)	TYP	50	75	mV peak
Noise, Peak - Peak (1)	TYP	40	60	mV P-P
RMS Noise	TYP	5	8	mV RMS
Temperature Coefficient	TYP MAX	50 150		ppm/°C
Short Circuit Protection to Common		Continuous 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) 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 1uF tantalum and 0.01µF ceramic capacitor located 1 inch away from the converter.

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

(3) The worst case output voltage includes line, load and temperature effects.

(4) Dynamic response of the converter will degrade when the SD series is operated with less than 25% load.

(5) Short term stability is defined as the drift over 24 hours with constant line, load and ambient temperature conditions.

(6) Transient response is specified for a 50 to 75% step load change. Rise time of step is 2 microseconds.

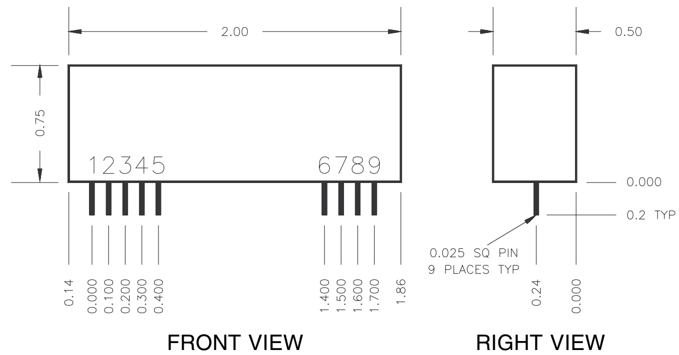
(7) Dynamic response is the peak overshoot for a transient as described in note 6.

(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 will reduce 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) 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
ON/OFF Function			
OFF Logic Level or Leave Pin Open	MIN	> 2.0	VDC
ON Logic Level or Tie Pin to -Input	MAX	< 0.5	VDC
Maximum Voltage	MAX	Vin +0.3	VDC
Converter Idle Current ON/OFF Pin High	TYP	5	µA
Environmental			
Case Operating Range No Derating	MIN MAX	-40 85	°C
Case Functional Range (8)	MIN MAX	-50 95	°C
Storage Range	MIN MAX	-55 105	°C
Thermal Impedance (9)	TYP	20	°C/Watt
Unit Weight	TYP	1.0	oz



Mechanical tolerances unless otherwise noted:

X.XX dimensions: ±0.020 inches

X.XXX dimensions: ±0.005 inches

Pin	Function	Pin	Function
1	ON/OFF	6	-OUTPUT
2	+INPUT	7	-OUTPUT
3	+INPUT	8	+OUTPUT
4	-INPUT	9	+OUTPUT
5	-INPUT		

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 component selection problems, no heatsinking problems, just “plug and play”.

The SD 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 100 kHz operating frequency of the SD Single series allows an increased power density of up 25 watts per cubic inch while still including adequate heat sinking and full filtering on both the input and output. This prevents the need for additional filtering and heatsinking in most applications.

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 5 µA 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 SD converters achieve 60 mV peak to peak typical and are fully specified and tested to a wide bandwidth of 0-20 MHz.

Full overload protection is provided by independent pulse-by-pulse current limiting. This protection scheme assures you that our SD single will provide you with zero failure rate operation.

A non-conductive / water washable 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 SD 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.

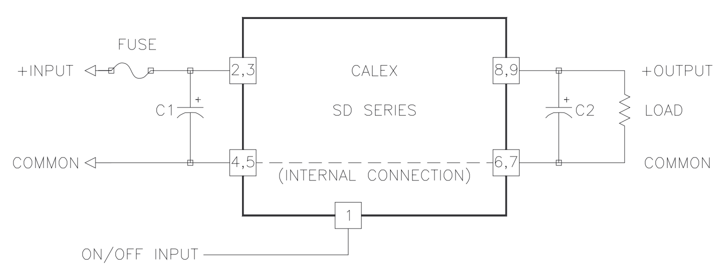


Figure 1.

Standard connections for the SD single input. The ON/OFF pin must be connected to common for proper operation. The input protection fuse should not be omitted. See the text for suggestions regarding C1 and C2.

When using the SD Single be sure that the impedance at the input to the converter is less than about 0.075 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 2 inches 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 required impedance reduces as the input voltage is raised or the power is reduced. In general you should keep the voltage measured across the input pins less than 0.2 volts peak to peak (not including any 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 zero.

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

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

Factor 1 depends 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%.

Factors 2 and 3 realistically determine the worst case ripple current rating required for the capacitor.

Factor 4 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.

Suggested Input 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. You may also use several smaller capacitors in parallel to achieve the same ripple current rating. This may save space in some systems.

Lowest Cost:

United Chemi-Con SXE, RXC, RZ and RZA series
Suggested Part: SXE016VB681M12.5X15LL
680µF, 16V, 105°C RATED
ESR=0.12 OHMS
Allowable Ripple at 85°C = 1.7 A

Panasonic HFG and HFQ Series
Suggested Part: ECA1CFG102
1000µF, 16V, 105°C RATED
ESR=0.076 OHMS
Allowable Ripple at 85°C = 1.6 A

Smallest Size:

Sprague/Vishay 195D Series (SMT)
Suggested Part: 195D686X0016R2T
68µF, 16V, 125°C RATED
ESR=0.2 OHMS (maximum)
Allowable Ripple at 85°C = 1.1 A

Applying The Output

Figure 1 shows typical output connections for the SD single. The specified capacitor should be used for improved dynamic performance. The capacitance can be a low cost aluminum electrolytic type and can be broken up or "Distributed" around your circuit.

The ESR requirements of the output capacitance are not particularly stringent. Any capacitor with an ESR of less than about 0.7 ohms will work well. Use the low cost / general purpose types for maximum cost effectiveness. The use of a high performance / low ESR type will help to reduce the high frequency noise and add extra stability at light loads.

Suggested Output Capacitor Sources

These capacitors will work for 100% load, worst case input voltage and ambient temperature extremes. They however, may be oversized for your exact usage. You may also use several smaller capacitors in parallel to achieve the same capacitance rating. This may save space in some systems.

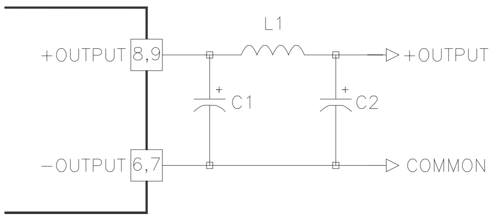
United Chemi-Con KME, KMC and KRG series
Suggested Part: KRG6.3VB102M12.5X12.5LL
1000µF, 6.3V, 105°C Rated

Nichicon VZ and VX series
Suggested Part: UVZ0J102MPH
1000µF, 6.3V, 105°C Rated

Panasonic NHE and NXS Series
Suggested Part: ECEA0JGE102
1000µF, 6.3V, 105°C Rated

Ultra Low Noise Output Circuit

The circuit shown in figure 2 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. C1 and C2 are United Chemi-Con 1200µF, 6.3 volt SXE types or equivalent.



L1 = 30µH / 3.5 AMP INDUCTOR

C1, C2 = SEE TEXT

Figure 2.

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

Operation With Very Light Loads

At output loads less than about 25% of rated load, the SD single will operate in a "Burst Mode". That is the SD will cease PWM operation and instead operate in more of a burst mode. This mode significantly increases the light load efficiency of the SD single. Under these conditions the output of the SD will contain a larger than normal (compared to full load) output noise, but at a lower frequency.

If this is a problem in your application the SD single may be used with a dummy load resistor to keep the static output current above about 25% load (check the exact value required by your circuit). Another alternative is to connect an inexpensive 1000 to 10,000 µF output capacitor with an ESR of 0.075 to 1 ohm to the output. This will help to dampen the low frequency output ripple without upsetting the dynamic operation of the SD.

Perhaps the best solution to the "No Load" condition is to use the ON/OFF pin to control no load operation and shut the converter down totally.

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

Grounding

The input and output sections are connected together internally (not isolated). The best way to operate the converter is by using the -Input and -Output pins independently. That is the input source to output circuit connections should be through the converter itself. This is shown in figure 1. The converter may also be operated with the -Input and -Output pins connected to a common ground plane. This can create an "Extra" ground loop and may increase the output noise depending on the impedance of the extra loop.

Remote ON/OFF Pin Operation

The remote ON/OFF pin should be tied to -Input if this function is not used. The best way to drive this pin is with a CMOS or TTL gate. An open collector or relay contact may also be used in conjunction with a 2.2 to 50 kohm resistor tied to +Input.

When the ON/OFF pin is high 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.

The OFF state current is typically less than 5 µA. Leakage in external components may increase this value.

Temperature Derating

The SD Single series can operate up to 85°C case temperature without derating. Case temperature may be roughly calculated from ambient by knowing that the SD Singles case temperature rise is approximately 20°C per package watt dissipated.

For example: If a 12S5.3500SD converter is outputting 10 Watts, at what ambient could it expect to run with no moving air and no extra heatsinking?

Efficiency is approximately 90%, this leads to an input power of 11 watts. The case temperature rise would be 1 watt × 20 = 20°C. This number is subtracted from the maximum case temperature of 85°C to get: 65°C.

This example calculation is for an SD single 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.

Heat sinking action can be improved by forced air over the length of the converter or by using the SMT package and placing the SD flat against a copper ground plane. The use of a thin structural adhesive or thermal epoxy can increase the heat conduction into the ground plane.

A heat sink can also be clamped or thermally glued to the length of the SD. Suitable heat sinks made for DIL IC packages can reduce the thermal impedance by 50% or more with forced air.

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