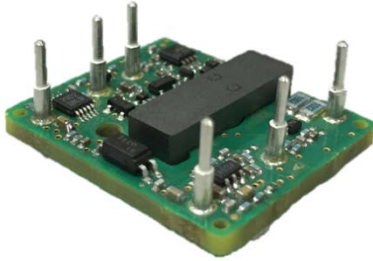




## 12V 1.5A 1X1 Isolated Converter



### Features

- High efficiency, 87% (12V/1.5A)
- Optimal thermal performance
- Industry standard footprint and pin out
- Low profile, 0.39" (9.91mm)
- Robust stability
- Monotonic start-up
- Fixed frequency operation
- Basic Insulation, 2250Vdc input-to-output isolation
- Designed to meet UL 60950-1 2<sup>nd</sup> edition<sup>†</sup>

### Options

- Negative/Positive enable logic
- Auto-restart after fault shutdown
- Various pin lengths

### Part Numbering System

LRS	3	120	□	1A5	□	□	5	W
Series Name:	Input Voltage:	Output Voltage:	Enabling Logic:	Rated Output Current:	Pin Length Options:	Electrical Options:	Mechanical Options Lead-free, (ROHS-6 Compliant)	Suffix
LRS	3: 18-60V or 18-75V	Unit: 0.1V 120:12V	P: positive N:negative	Unit: A 1A5:1.5A	K:0.110" N:0.145" R:0.180"	0:latch-up 2:auto-restart	5: open frame	W:18-75V Input voltage

<sup>†</sup>UL is a registered trademark of Underwriters Laboratory Inc.

## Absolute Maximum Ratings

Excessive stresses over these absolute maximum ratings can cause permanent damage to the converter. Operation should be limited to the conditions outlined under the Electrical Specification Section.

Parameter	Symbol	Min	Max	Unit
Input Voltage (continuous)	$V_i$	-0.5	75	Vdc
Input Voltage (continuous, non-operating)	$V_i$	-	100	Vdc
Operating Ambient Temperature (See Thermal Consideration section)	$T_o$	-40	85*	°C
Storage Temperature	$T_{stg}$	-55	125	°C

\* Derating curves provided in this datasheet end at 85°C ambient temperature. Operation above 85°C ambient temperature is allowed provided the temperatures of the key components do not exceed the limit stated in the Thermal Considerations section.

## Electrical Specifications

These specifications are valid over the converter's full range of input voltage, resistive load, and temperature unless noted otherwise.

### Input Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Input Voltage	$V_i$	18	36	75	Vdc
Input Current	$I_{i,max}$	-	-	3	A
Quiescent Input Current (Typical $V_{in}$ )	$I_{i,Qsnt}$	-	16	20	mA
Standby Input Current	$I_{i,stdby}$	-	3	5	mA
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 $\mu$ H source impedance)	-	-	10	-	mA
Input Ripple Rejection (120 Hz)	-	-	-	-	dB
Input Turn-on Voltage Threshold	-	16	17	18	V
Input Turn-off Voltage Threshold	-	14	15	16	V
Input Voltage ON/OFF Hysteresis	-	1	2	4	V

### Output Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Output Voltage Set Point (Typical $V_{in}$ ; $I_o = I_{o,max}$ ; $T_a = 25^\circ\text{C}$ )		11.8	12.0	12.2	Vdc
Output Voltage Set Point (over all conditions)	-	11.7	-	12.3	Vdc
Output Regulation:					
Line Regulation (Over full input range, $I_o = 1/2$ of load)	-	-	0.05	0.2	% $V_o$
Load Regulation ( $I_o = I_{o,min}$ to $I_{o,max}$ , typical $V_{in}$ )	-	-	0.05	0.2	% $V_o$
Temperature ( $T_a = -40^\circ\text{C}$ to $85^\circ\text{C}$ )	-	-	15	50	mV
Output Ripple and Noise Voltage RMS	-	-	20	30	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, $V_{in} = 36\text{V}$ )	-	-	60	100	mVp-p
External Load Capacitance	-	-	-	500	$\mu\text{F}$
Output Current	$I_o$	0	-	1.5	A
Output Power	$P_o$	0	-	18	W
Efficiency (Typical $V_{in}$ ; $I_o = I_{o,max}$ ; $T_a = 25^\circ\text{C}$ )	$\eta$	-	87	-	%
Startup Delay (from the toggle of the enable to $V_o$ reaching 10% of set point; Typical $V_{in}$ ; $I_o = I_{o,max}$ ; $T_a = 25^\circ\text{C}$ )		-	5	10	ms
Startup Time ( $V_o$ from 10% to 90% of output set point; Typical $V_{in}$ ; $I_o = I_{o,max}$ ; $T_a = 25^\circ\text{C}$ )		10	15	20	ms



## Output Specifications (continued)

Parameter	Symbol	Min	Typical	Max	Unit
Total turn on time (from the toggle of the enable to Vo reaching in regulation of the output set point; Overall condition)		15	20	25	ms
Output Over Current Protection trip point/Iomax	I <sub>o,cli</sub>	105		150	%I <sub>o</sub>
Output Over Voltage trip point		115	125	140	%V <sub>o</sub>
Output ripple frequency	-	370	400	430	kHz
Dynamic Response (Typical V <sub>in</sub> ; T <sub>a</sub> = 25°C; Load transient 0.1A/μs) Load step from 50% to 75% of full load:					
Peak deviation			3		%V <sub>o</sub>
Settling time (to 10% band of V <sub>o</sub> deviation)			200		μs
Load step from 50% to 25% of full load					
Peak deviation			3		%V <sub>o</sub>
Settling time (to 10% band of V <sub>o</sub> deviation)			200		μs

## General Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Remote Enable Negative Logic:					
Logic Low – Module On	-	-	-	-	-
Logic High – Module Off	-	-	-	-	-
Positive Logic:					
Logic High – Module On	-	-	-	-	-
Logic Low – Module Off	-	-	-	-	-
Logic Low:					
I <sub>ON/OFF</sub> = 1.0mA					
V <sub>ON/OFF</sub> = 0.0V					
Logic High:					
I <sub>ON/OFF</sub> = 0.0μA					
Leakage Current					
Output Voltage Trim Range	-	80	-	110	%V <sub>o</sub>
Isolation Capacitance	-	-	1200	-	pF
Isolation Resistance	-	10	-	-	MΩ
Calculated MTBF (Telecordia SR-332, 2011, Issue 3), full load, 40°C, typical input voltage			12.0		10 <sup>6</sup> -hour

## Characteristic Curves

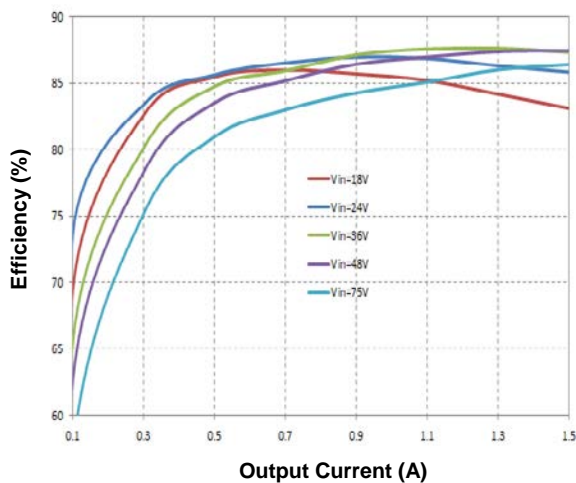


Figure 1. Efficiency vs. Load Current (25°C)

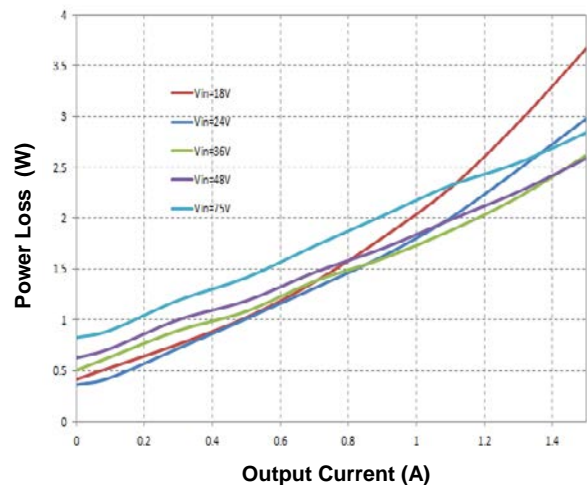
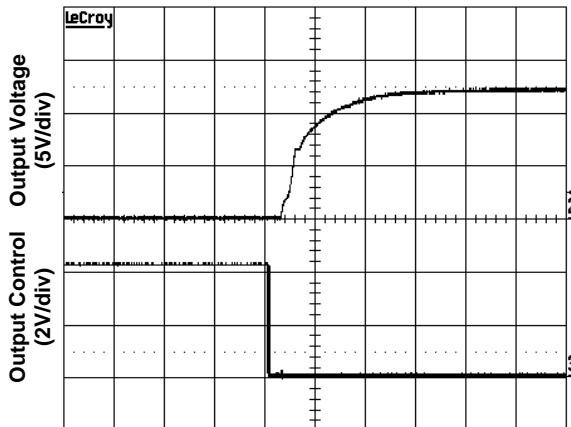
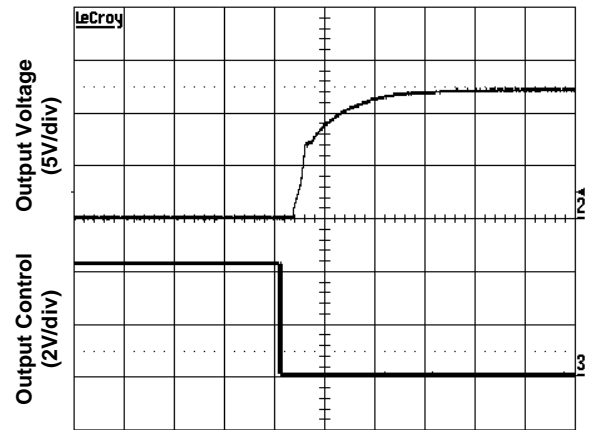


Figure 2. Power Loss vs. Load Current (25°C)



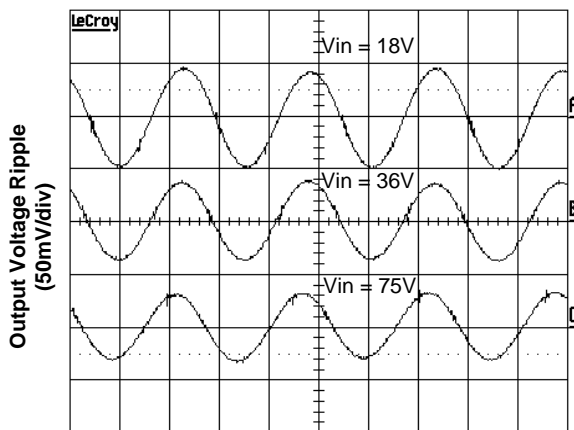
Time - t (10ms/div)

Figure 3. Start-Up from Enable Control  
(Typical Vin, full load)



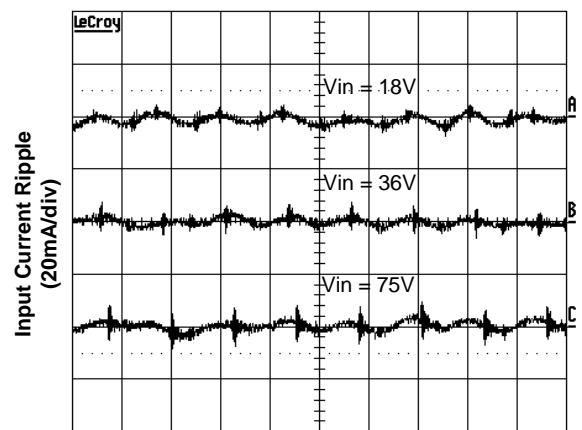
Time - t (10ms/div)

Figure 4. Start-Up from Enable Control  
(Typical Vin, zero load)



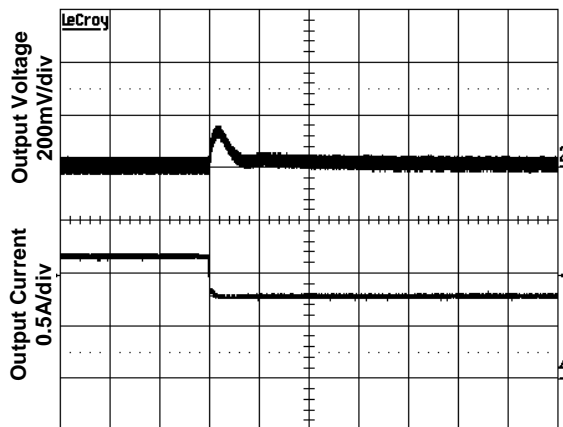
Time - t (1µs/div)

Figure 5. Output Ripple Voltage at Full Load



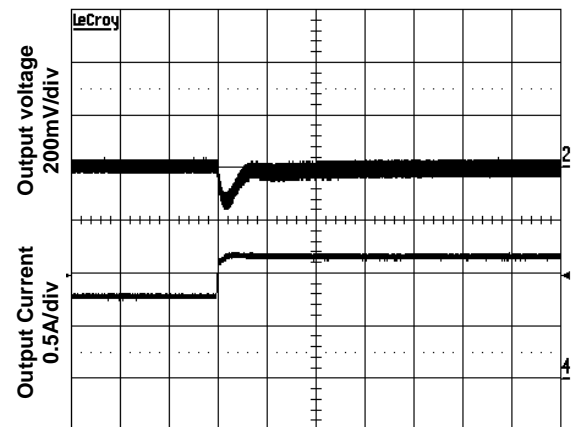
Time - t (2µs/div)

Figure 6. Input Reflected Ripple Current at Full Load



Time - t (200µs/div)

Figure 7. Transient Load Response  
Top: Output voltage deviation  
Bottom: Load current step (-25% full load)  
Test Cond.: Output current at 50% full load, typical Vin, slew rate 0.1A/µs



Time - t (200µs/div)

Figure 8. Transient Load Response  
Top: Output voltage deviation  
Bottom: Load current step (+25% full load)  
Test Cond.: Output current at 50% full load, typical Vin, slew rate 0.1A/µs

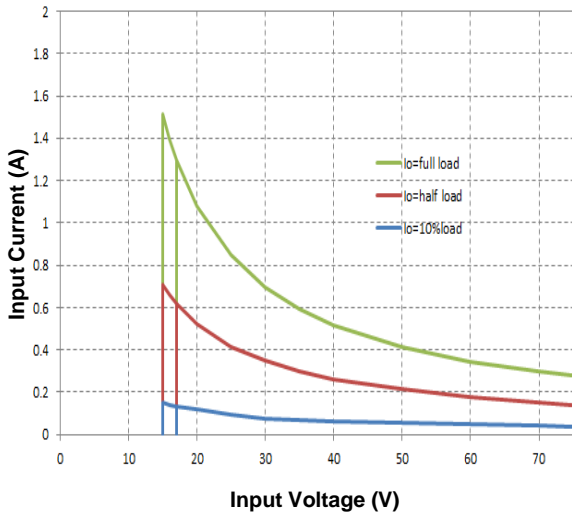


Figure 9. Input Characteristics

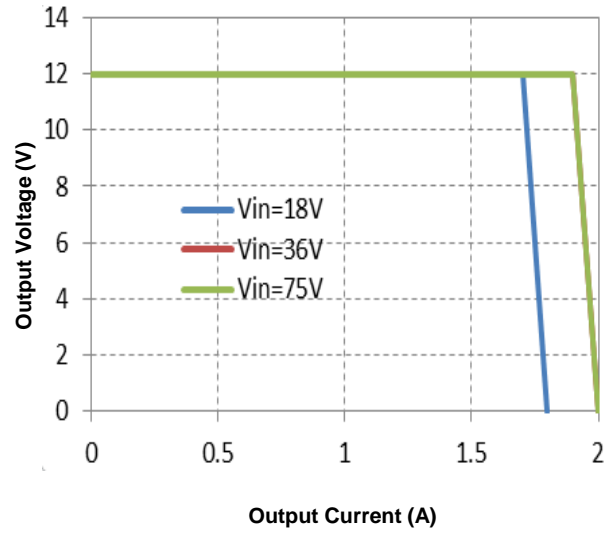


Figure 10. Output Characteristics

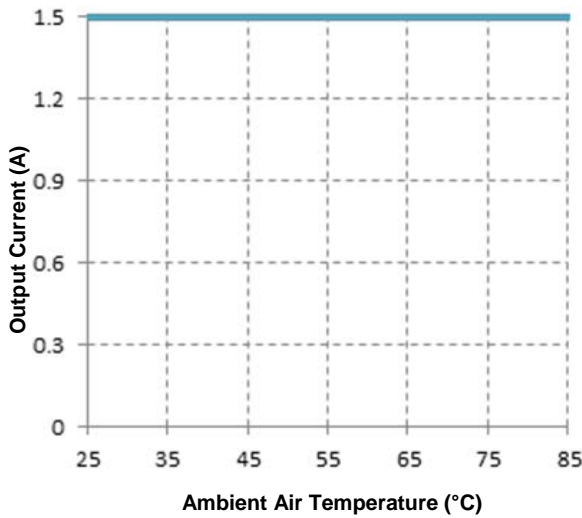


Figure 11. Current Derating Curve under Nature Convection (open frame unit using soldered interface)

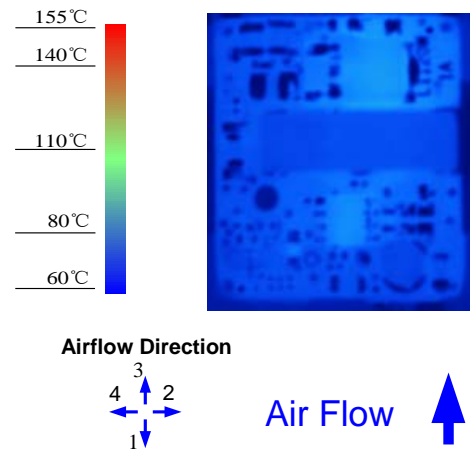


Figure 12. Thermal Image for Airflow Direction 3 (1.5A output, 55°C ambient, 200 LFM, typical Vin, open frame unit using soldered interface)

## Feature Descriptions

### Remote ON/OFF

The converter can be turned on and off by changing the voltage or resistance between the ON/OFF pin and Vin(-). The LRS3 Series of converters is available with factory selectable positive logic or negative enabling logic.

For the negative control logic, the converter is ON when the ON/OFF pin is at a logic low level and OFF when the ON/OFF pin is at a logic high level. With positive control logic, the converter is ON when the ON/OFF pin is at a logic high level and OFF when the ON/OFF pin is at a logic low level.

With the internal pull-up circuitry, a simple external switch between the ON/OFF pin and Vin(-) can control the converter. A few example circuits for controlling the ON/OFF pin are shown in Figures 13, 14 and 15.

The logic low level is from 0V to 1.2V and the maximum sink current during logic low is 1mA. The external switch must be capable of maintaining a logic-low level while sinking up to this current. The logic high level is from 3.5V to 15V. The converter has an internal pull-up circuit that ensures the ON/OFF pin at a high logic level when the leakage current at ON/OFF pin is no greater than 50µA.

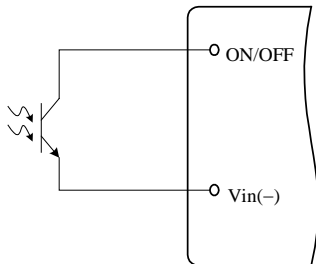


Figure 13. Opto Coupler Enable Circuit

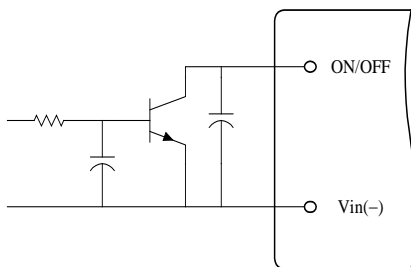


Figure 14. Open Collector Enable Circuit

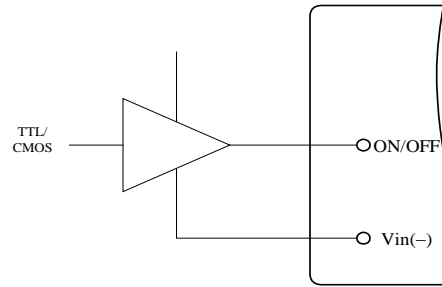


Figure 15. Direct Logic Drive

### Output Voltage Adjustment (Trim)

The trim pin allows the user to adjust the output voltage set point. To increase the output voltage, an external resistor is connected between the TRIM pin and Vout(-). To decrease the output voltage, an external resistor is connected between the TRIM pin and Vout(+). The output voltage trim range is 80% to 110% of its specified nominal output voltage. The circuit configuration for trim down operation is shown in Figure16.

To decrease the output voltage, the value of the external resistor should be

$$R_{down} = \left( \frac{V_{adj} - 2.5}{12 - V_{adj}} - 0.511 \right) (k\Omega)$$

Where

$V_{adj}$ = Adjusted Output Voltage

The circuit configuration for trim up operation is shown in Figure17. To increase the output voltage, the value of the resistor should be

$$R_{up} = \left( \frac{2.5 \cdot 10}{V_{adj} - 12} - 0.511 \right) (k\Omega)$$

Where

$V_{adj}$ = Adjusted Output Voltage

As the output voltage at the converter output terminals are higher than the specified nominal level when using the trim up and/or remote sense functions, it is important not to exceed the maximum power rating of the converter as given in the Specifications table.

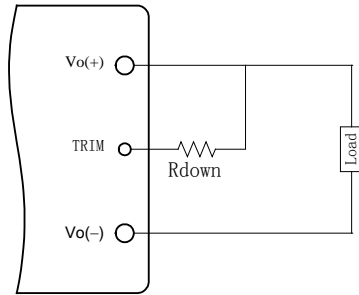


Figure 16. Circuit to Decrease Output Voltage

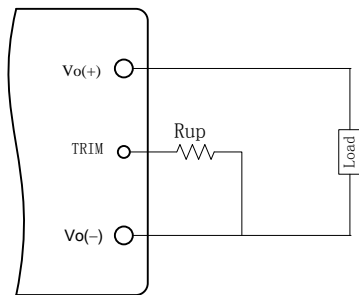


Figure 17. Circuit to Increase Output Voltage

## Input Under-Voltage Lockout

This feature prevents the converter from starting until the input voltage reaches the turn-on voltage threshold, and keeps the converter running until the input voltage falls below the turn-off voltage threshold. Both turn-on and turn-off voltage thresholds are defined in the Input Specifications table. The hysteresis prevents oscillations.

## Output Over-Current Protection (OCP)

This converter can be ordered in either latch-off or auto-restart version upon OCP, OVP, and OTP.

With the latch-off version, the converter will latch off when the load current exceeds the limit. The converter can be restarted by toggling the ON/OFF switch or recycling the input voltage.

With the auto-restart version, the converter will operate in a hiccup mode (repeatedly try to restart) until the cause of the over-current condition is cleared.

## Output Over-Voltage Protection (OVP)

With the latch-off version, the converter will latch off when the output voltage exceeds the limit. The converter can be restarted by toggling the ON/OFF switch or recycling the input voltage.

With the auto-restart version, the converter will operate in a hiccup mode (repeatedly try to restart) until the cause of the over-voltage condition is cleared.

## Over Temperature Protection (OTP)

With the latch-off version, the converter will shut down and latch off if an over-temperature condition is detected. The converter has a temperature sensor located at a carefully selected position in the converter circuit board, which represents the thermal condition of key components of the converter. The thermal shutdown circuit is designed to turn the converter off when the temperature at the sensor reaches 120°C. The module can be restarted by toggling the ON/OFF switch or recycling the input voltage.

With the auto-restart version, the converter will resume operation after the converter cools down.

## Design Considerations

### Input Source Impedance

As with any DC/DC converter, the stability of the LRS3 converters may be compromised if the source impedance is too high or inductive. It's desirable to keep the input source ac-impedance as low as possible. Although the converters are designed to be stable without adding external input capacitors for typical source impedance, it is recommended to add a 33µF low ESR electrolytic capacitors at the input of the converter, which reduces the potential negative impact of the source impedance on the converter stability. These electrolytic capacitors should have sufficient RMS current rating over the operating temperature range.

The converter is designed to be stable without additional output capacitors. To further reduce the output voltage ripple or improve the transient response, additional output capacitors are often used



in applications. When additional output capacitors are used, a combination of ceramic capacitors and tantalum/polymer capacitors shall be used to provide good filtering while assuring the stability of the converter.

## Safety Considerations

The LRS3 Series of converters are designed in accordance with EN 60950 Safety of Information Technology Equipment Including Electrical Equipment. Flammability ratings of the PWB and plastic components in the converter meet 94V-0.

To protect the converter and the system, an input line fuse is highly recommended on the un-grounded input end.

## Thermal Considerations

The LRS3 Series of converters can operate in various thermal environments. Due to the high efficiency and optimal heat distribution, these converters exhibit excellent thermal performance.

The maximum allowable output power of any power converter is usually determined by the electrical design and the maximum operating temperature of its components. The LRS3 Series of converters have been tested comprehensively under various conditions to generate the derating curves with the consideration for long term reliability.

The thermal derating curves are highly influenced by the test conditions. One of the critical variables is the interface method between the converter and the test fixture board. There is no standard method in the industry for the derating tests. Some suppliers use sockets to plug in the converter, while others solder the converter into the fixture board. It should be noticed that these two methods produce significantly different results for a given converter. When the converter is soldered into the fixture board, the thermal performance of the converter is significantly improved compared to using sockets due to the reduction of the contact loss and the thermal impedance from the pins to the fixture board. Other factors affecting the results include the board spacing, construction (especially copper weight, holes and openings) of the fixture board and the spacing board,

temperature measurement method and ambient temperature measurement point. The thermal derating curves in this datasheet are obtained using a PWB fixture board and a PWB spacing board with no opening, a board-to-board spacing of 1", and the converter is soldered to the test board with thermal relieves.

Note that the natural convection condition was measured at 0.05 m/s to 0.15 m/s (10ft./min. to 30 ft./min).

## Heat Transfer

With single-board DC/DC converter designs, convection heat transfer is the primary cooling means for converters without a baseplate. Therefore, airflow speed should be checked carefully for the intended operating environment. Increasing the airflow over the converter enhances the heat transfer via convection.

Figure 18 shows a recommended temperature monitoring point for open frame modules. For reliable operation, the temperature at this location should not continuously exceed 120 °C.

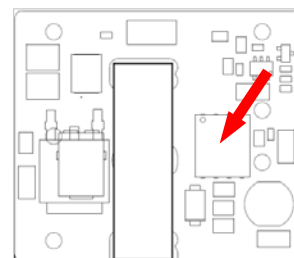


Figure 18. Temperature Monitoring Location

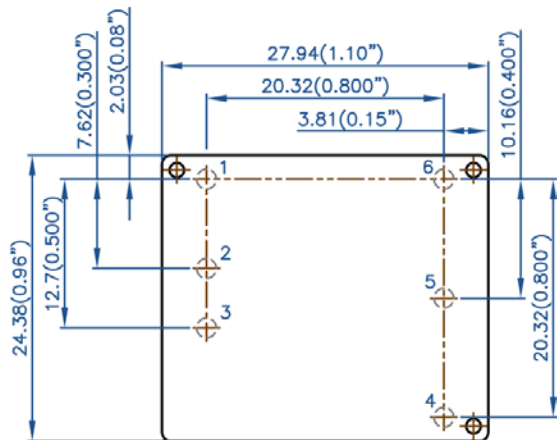
## EMC Considerations

The EMC performance of the converter is related to the layout and filtering design of the customer board. Careful layout and adequate filtering around the converter are important to confine noise generated by the switching actions in the converter and to optimize system EMC performance.

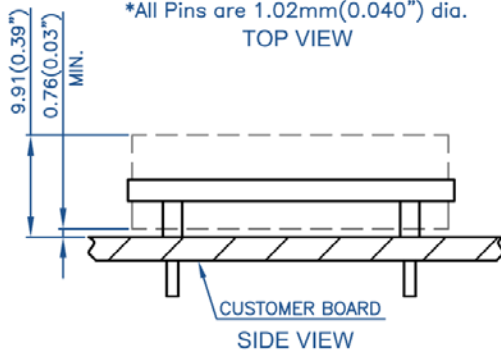




## Mechanical Information



\*All Pins are 1.02mm(0.040") dia.  
TOP VIEW



SIDE VIEW

Pin	Name	Function
1	ON/OFF	Remote control
2	Vin(-)	Negative input
3	Vin(+)	Positive input
4	Vout(+)	Positive output
5	TRIM	Output voltage adjust
6	Vout(-)	Negative output

## Notes

- All dimensions in mm (inches)  
Tolerances: .x ± .5 (.xx ± 0.02)  
.xx ± .25 (.xxx ± 0.010)
- Regular input and function pins are 1.02mm (0.040") dia. with +/- 0.10mm (0.004") tolerance; the standoff shoulders are 2.00mm (0.078") dia. with +/- 0.15mm (0.006") tolerance.
- Output pins are 1.02mm (0.040") dia. with +/- 0.10mm (0.004") tolerance; the standoff shoulders are 2.00mm (0.078") dia. with +/- 0.15mm (0.006") tolerance.
- All pins are coated with 90%/10% solder, Gold, or Matte Tin finish with Nickel under plating.
- Workmanship meets or exceeds IPC-A-610 Class II