Leading the Advancement of Power Conversion

SRS4010x035 1/16 Brick Power Converters

RoHS

Features

- High Output current: 35A
- High Efficiency: 83.5% at 1.0 Vo, 35A
- Excellent thermal performance
- Low profile in standard footprint: 1.3"x0.9"x0.37''
- 43% smaller than industry standard 1/8 brick
- Wide input-voltage range: 36 – 75V
- +10%/-20% output trim
- Remote sense, remote control, over-voltage, over-current, short-circuit, and over temperature protection
- Monotonic start-up into pre-biased load
- 1500V Basic Isolation between input and output
- UL 60950 Certified
- RoHS Compliant products available

Applications

- Wireless Networks
- Telecom / Datacom
- Electronic Data Processing / Servers
- Distributed Power Architectures

Options

- SMT or through-hole package
- Baseplate
- Auto-restart/lock-up protection mode
- Negative / Positive enable logic
- Various standard lead lengths

NetPower Technologies' SRS Series of 1/16-Brick DC/DC Converters utilize proprietary technologies to achieve market leading efficiencies and thermal performance in the latest industry standard package. The 1/16-brick footprint is 43% smaller than standard 1/8 brick's, thus saving valuable board real estate. The SRS Series incorporates automated assembly techniques on a single board, low profile design, and are available in both through-hole and surface mount versions. For higher current operation in extreme thermal environment, a baseplate is provided as an option. The industry leading performance makes the SRS Series an excellent choice for today's densely packed systems.

NetPower's SRS converters provide a monotonic start-up from both the input voltage and the ON/OFF control under all load conditions, including pre-biased output. These converters have a fast dynamic response and are stable over the full range of input voltage, load current, load capacitance, capacitor ESR, and temperature. They feature tight line and load regulations, and are fully protected from abnormal conditions of input/output voltages, output current and operating temperature. NetPower's converters are an ideal choice for any limited board space, high current and/or low output voltage applications such as telecom, datacom, wireless networks, or servers.

General Specification

Absolute Maximum Rating

Excessive stresses over these absolute maximum ratings can cause permanent damage to the converter. Also, exposure to absolute maximum ratings for extended periods of time can adversely affect the reliability of the converter. Operation should be limited to the conditions outlined under the Electrical Specification Section.

Parameter	Symbol	Min	Max	Unit
Input Voltage (continuous)*	Vi	-0.5	80	Vdc
Input Voltage (continuous, non-operating)	Vi	-	100	Vdc
I/O Isolation Voltage (for 1 minute)		1500	-	Vdc
Operating Ambient Temperature (See Thermal Consideration section)	To	-40	85**	˚C
Storage Temperature	Tstg	-55	125	˚C

* The converter can operate at 100V input for 100 ms.
** For operation above 85ºC ambient temperature, please consult NetPower for derating guidance.

Electrical Specifications

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

Parameter	Symbol	Min	Typical	Max	Unit
Input Voltage	Vi	36	48	75	Vdc
Standby Input Current	Iin,Stdby	-	4	6	mA
Inrush Transient	I^2t	-	-	1.0	A^2s
Input Turn-on Voltage Threshold	-	34	35	36	V
Input Turn-off Voltage Threshold	-	30	32	34	V
Input Voltage ON/OFF Hysteresis	-		3		V
Remote Enable					
Negative Logic:					
Logic Low – Module On Logic High – Module Off	-	-	-	-	-
Positive Logic:					
Logic High – Module On Logic Low – Module Off	-	-	-	-	-
Logic Low:					
$I_{ON/OFF}$ = 1.0mA	$V_{ON/OFF}$	0	-	1.2	V
$V_{ON/OFF}$ = 0.0V	$I_{ON/OFF}$	-	-	1.0	mA
Logic High: $I_{ON/OFF}$ = 0.0µA	$V_{ON/OFF}$	-	-	15	V
Leakage Current	$I_{ON/OFF}$	-	-	50	µA
Output Voltage Set Point Accuracy (Vi = 48 V; Io = Iomax; Ta = 25°C)	-	-1.5		+1.5	%Vo
Output Voltage Set Point Accuracy (over all conditions)	-	-3		+3	%Vo
Output Regulaton:					
Line Regulation (Vi = 36V to 75V, Io = 1/2 of full load)	-	-	0.05	0.2	%Vo
Load Regulation (Io = Io,min to Io,max, Vi = 48V)	-	-	0.05	0.2	%Vo
Temperature (Ta = -40°C to 85 °C)	-	-	0.1		%Vo
Output over current protection		103%	-	150%	Iomax
Output over Voltage protection*		115%	125%	135%	Vo
Output Trim Range		80%	-	110%	Vo
Output Remote Sense Range				15%Vo	
Over-temperature Protection	To	-	120	-	°C
Isolation Capacitance	-	-	1200	-	pF
Isolation Resistance	-	10	-	-	MΩ
Calculated MTBF Telecordia SR-332, 100% load, 40°C, 48Vin			3.9		10^6-hour
Calculated MTBF Telecordia SR-332, 50% load, 25°C, 48Vin			6.5		10^6-hour

*: this is the static set point for the output over-voltage protection. If the converter's output is forced to increase fast after the output voltage reaches the trip point, the delay and filtering inside the protection circuit may cause the peak output voltage to be higher than the trip point, up to 170% of the nominal output voltage.

Input Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	Iin, Max	-	-	1.5	A
Quiescent Input Current (Vin = 48V)	Iin, Qsnt	-	40	60	mA
Input Reflected-ripple Current, Peak-to-peak (5 Hz to 20 MHz, 12 µH source impedance)	-	-	10	-	mA
Input Ripple Rejection			-60		dB

Output Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Output Current	Io	0	-	35	A
Output Power	Po	0		350	W
Efficiency (Vi = 48V; Io = Iomax, TA = 25ºC)	η	-	83.5	-	%
Output Ripple and Noise Voltage					
RMS	-	-	-	45	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Vin = 48V)			80		mVp-p
External Load Capacitance	-	-	-	15,000	µF
Startup Delay, from enabling signal to Vo reaches 10% (Vi = 48V; Io = Iomax, TA = 25ºC)			1.5		mS
Startup Time, Vo from 10% to within regulation (Vi = 48V; Io = Iomax, TA = 25ºC)			4		mS
Switching frequency	-	280	300	320	kHz
Dynamic Response (Vi = 48V; Ta = 25°C; Load transient 0.1A/µs) Load step from 50% to 75% of full load: Peak deviation Settling time (to 10% band of Vo deviation) Load step from 50% to 25% of full load Peak deviation Settling time (to 10% band of Vo deviation)			 4 100 4 100		 %Vo µs %Vo µs

Characteristic Curves

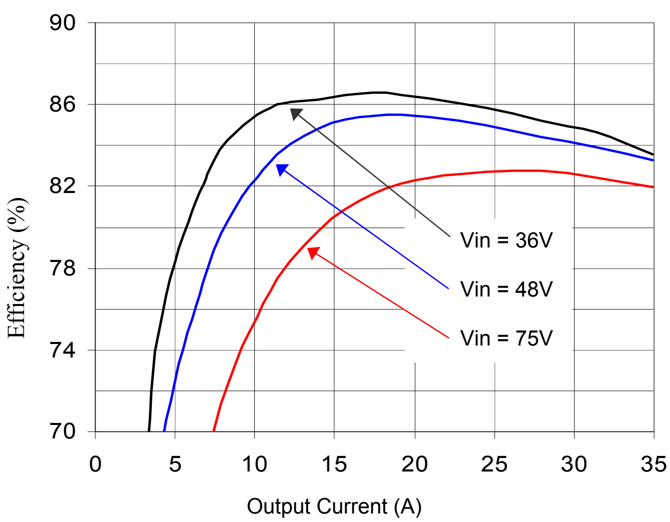


Figure 1. Efficiency vs. Load Current (25°C)

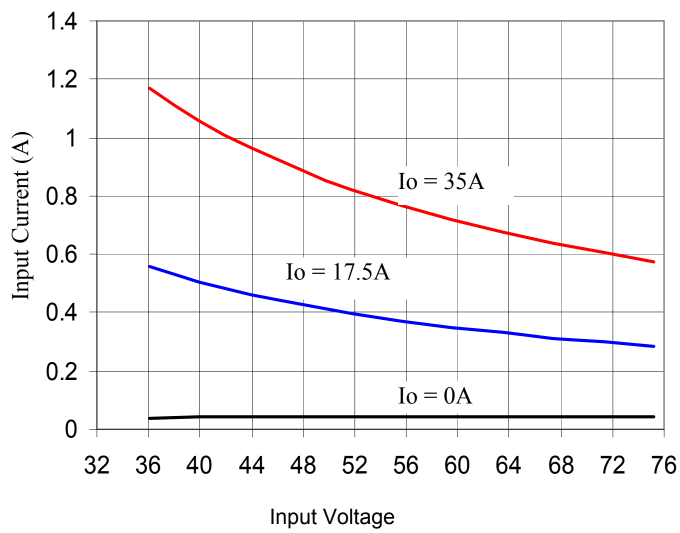


Figure 2. Input Characteristics

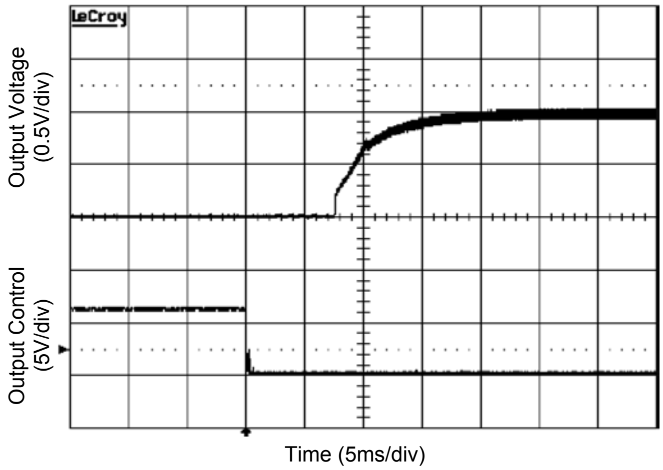


Figure 3. Start-Up from Enable Control
Input voltage 48V, Output current 35A)

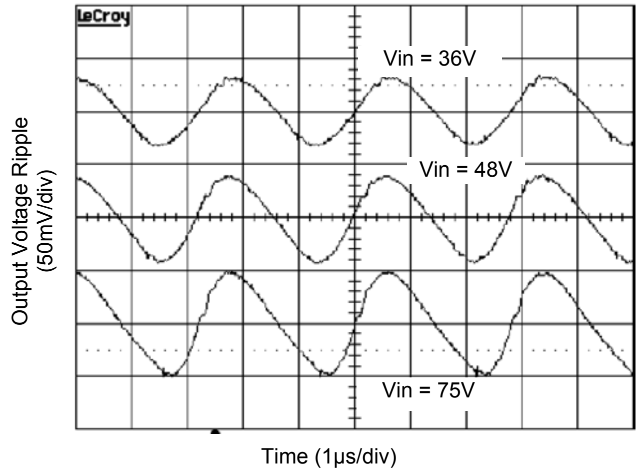


Figure 4. Output Ripple Voltage at 35A Load

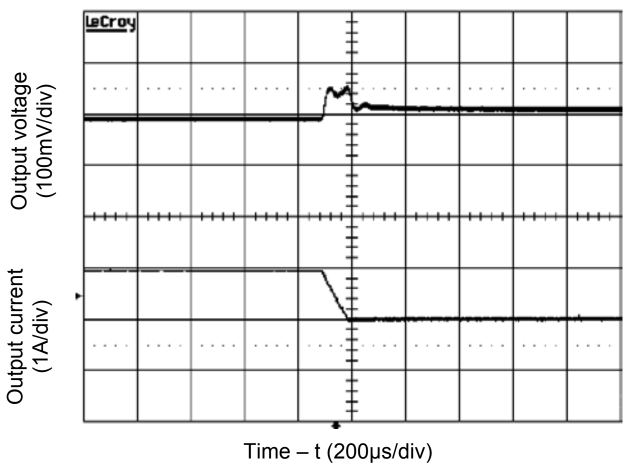


Figure 5. Transient Load Response
(Vin= 48V; Io changes from 26.25A to 17.5A; Slew rate 0.1A/µs)

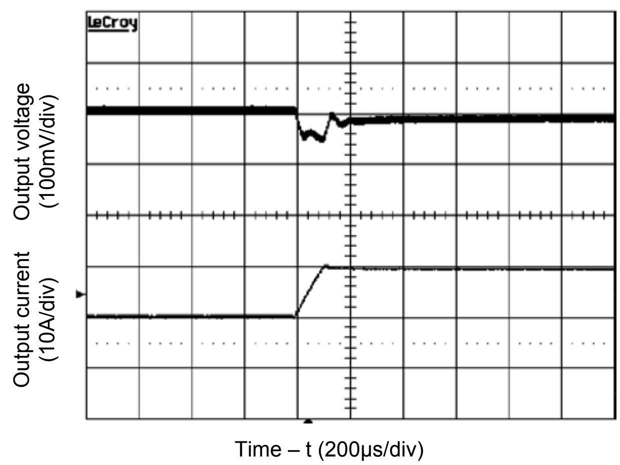


Figure 6 Transient Load Response
(Vin= 48V; Io changes from 17.5A to 26.25A; Slew rate 0.1A/µs)

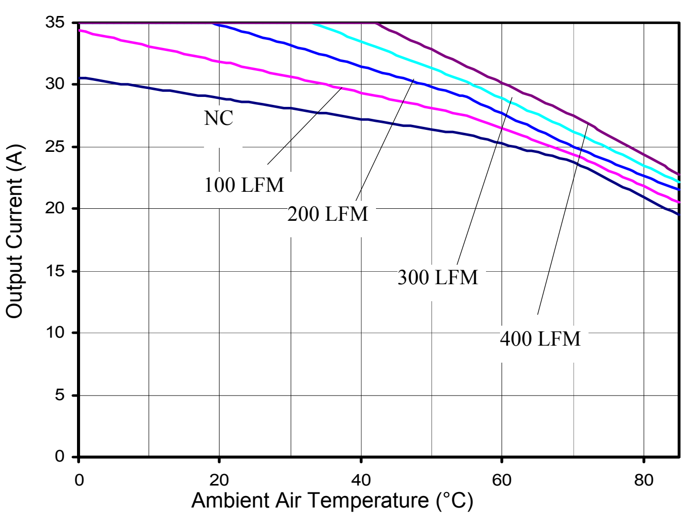


Figure 7. Current Derating Curve for Airflow Direction 1
(Ref. Figure. 8 for Airflow Direction; Vin = 48V; open frame; soldering interface)

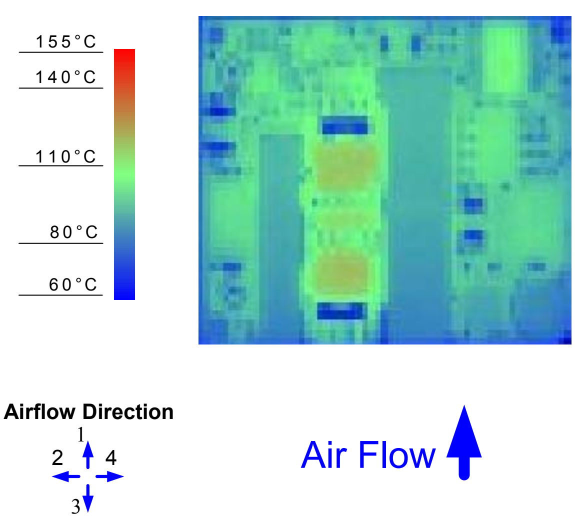


Figure 8. Thermal Image for Airflow Direction 1
(29A output, 75°C ambient, 200 LFM, Vin = 48V
open frame soldering interface)

Feature Descriptions

Remote ON/OFF

The converter can be turned on and off by changing the voltage between the ON/OFF pin and Vin(-). The SRS Series of converters is available with factory selectable positive logic and negative 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. For the 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 9, 10 and 11.

The logic low level is from 0V to 1.2V and the maximum switch 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 maximum voltage at the ON/OFF pin generated by the converter internal circuitry is less than 15V. The maximum allowable leakage current is 50µA.

Remote SENSE

The remote SENSE pins are used to sense the voltage at the load point to accurately regulate the load voltage and eliminate the impact of the voltage drop in the power distribution path.

SENSE(+) and SENSE(-) pins should be connected to the point where regulation is desired. The voltage between the SENSE pins and the output pins must not exceed 0.5V or 15% of nominal output voltage:

[Vout(+) - Vout(-)] - [SENSE(+) - SENSE (-)] < MIN{0.5V, 15%Vo}

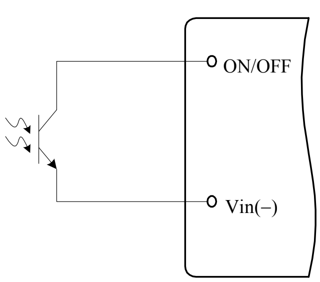


Figure 9. Opto Coupler Enable Circuit

When remote sense is not used, the SENSE pins should be connected to their corresponding output terminals (positive and negative). If the SENSE pins are left floating, the converter will deliver an output voltage slightly higher than its specified typical output voltage. Since the OVP (output over-voltage protection) circuit senses the voltage across the output pins (Pin 8 and Pin 4), the total voltage rise should not exceed the minimum OVP setpoint given in the Specifications table.

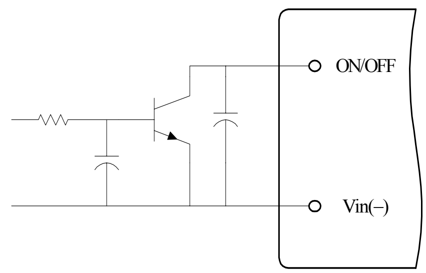


Figure 10. Open Collector Enable Circuit

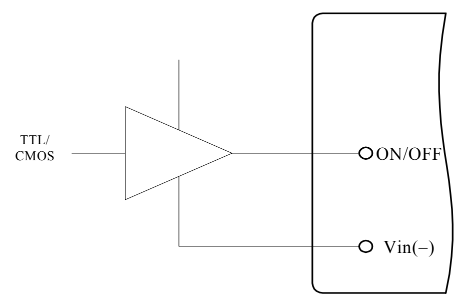


Figure 11. Direct Logic Drive

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 SENSE(+). To decrease the output voltage, an external resistor is connected between the TRIM pin and SENSE(-). The output voltage trim range is 80% to 110% of the specified nominal output voltage. The circuit configuration for trim down operation is shown in Figure 14.

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

$$Rdown = \left(\frac{511}{\Delta} - 10.22\right)(k\Omega)$$

Where

$$\Delta = \left(\frac{|Vnom - Vadj|}{Vnom}\right) \times 100$$

and

V_{nom} = Nominal Voltage
V_{adj} = Adjusted Voltage

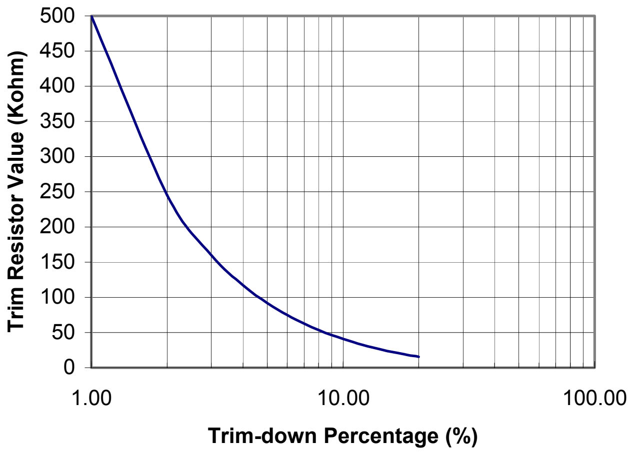


Figure 12. Trim-Down Resistor Selection

The circuit configuration for trim up operation is shown in Figure 15.

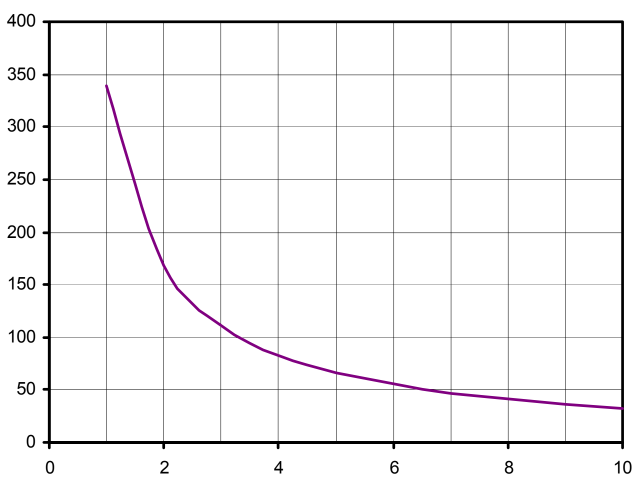


Figure 13. Trim-Up Resistor Selection

To increase the output voltage, the value of the resistor should be:

If the nominal output voltage is 1.5V or higher:

$$Rup = \left(\frac{5.11\,Vo\,(100 + \Delta)}{1.225\,\Delta} - \frac{511}{\Delta} - 10.22\right)(k\Omega)$$

If the nominal output voltage is 1.2V or lower:

$$Rup = \left(\frac{5.11\,Vo\,(100 + \Delta)}{0.6\,\Delta} - \frac{511}{\Delta} - 10.22\right)(k\Omega)$$

Where Vo = Nominal 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 to make sure that the voltage at the output terminals does exceed the maximum power rating of the converter as given in the Specifications table.

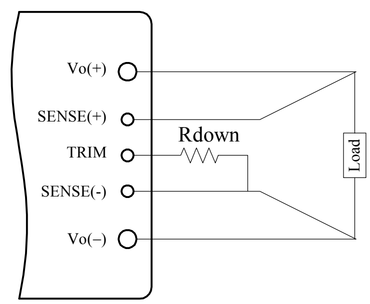


Figure 14. Circuit to Decrease Output Voltage

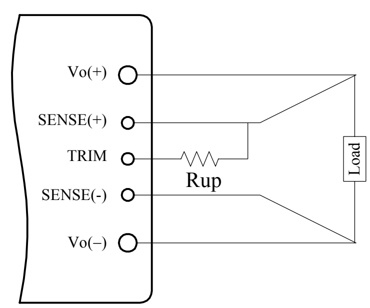


Figure 15. Circuit to Increase Output Voltage

Input Under-Voltage Lockout

This feature prevents the converter from turning on until the input voltage reaches 35V typical, and shuts down the converter if the input voltage falls below 32V typical. The 3V hysteresis prevents oscillations during the startup process.

Output Over-Current Protection

As a standard feature, the converter will latch off when the load current exceeds the current limit. The converter can be restarted by toggling the ON/OFF switch or recycling the input voltage. With the auto-restart option, the converter will operate in a hiccup mode (repeatedly try to restart) until the over-current condition is cleared.

Output Over-Voltage Protection

If the voltage across the output pins exceeds the output voltage protection threshold as given in the Specifications table, the converter will shut down to protect the converter and the load.

As a standard feature, the converter will shut down and latch off when this fault occurs. The converter can be restarted by toggling the ON/OFF switch or recycling the input voltage. With the auto-restart option, the converter will operate in a hiccup mode until the over-voltage cause is cleared.

Thermal Shutdown

As a standard feature, 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 option, 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 SRS 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 an additional input capacitor for typical source impedance, it is recommended to use at least a 33 - 100 μF low ESR electrolytic capacitor at the input of the converter to reduce the potential impact of the source impedance. This electrolytic capacitor should have sufficient RMS current rating over the operating temperature range.

Safety Considerations

The SRS 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 94V0.

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

A maximum rating of 10A normal-blow fuse should be connected at the un-grounded input lead of each SRS converter.

Thermal Considerations

The SRS Series of converters can operate in various thermal environments. Due to the high efficiency and optimal heat distribution, these converters exhibit excellent thermal performance. Most heat generating components are mounted on the topside of the module, so the heat can be easily removed by conduction, convection and radiation. Proper cooling can be verified by monitoring the temperature of key components. Figure 16 shows a recommended temperature monitoring point. The temperature at this location should not continuously exceed 120 °C.

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 SRS Series of converters has been tested comprehensively under various conditions to generate the derating curves with the consideration for long term reliability.

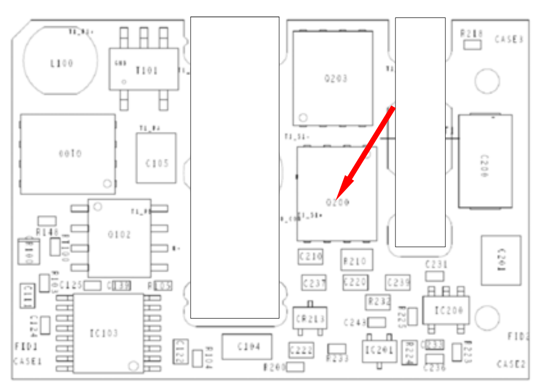


Figure 16. Temperature Monitoring Location

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 pin 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. NetPower's thermal derating curves are obtained using a PWB fixture board and a PWB spacing board with no opening, a board-to-board spacing of 1", and thermal couplers to monitor all temperatures. For thermal considerations specific to your application environment, please contact NetPower's technical support team for further advice.

Heat Transfer Without a Baseplate

As with other 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.

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 a Baseplate

The SRS Series of converters has the heat transfer options of using a baseplate for enhanced thermal performance.

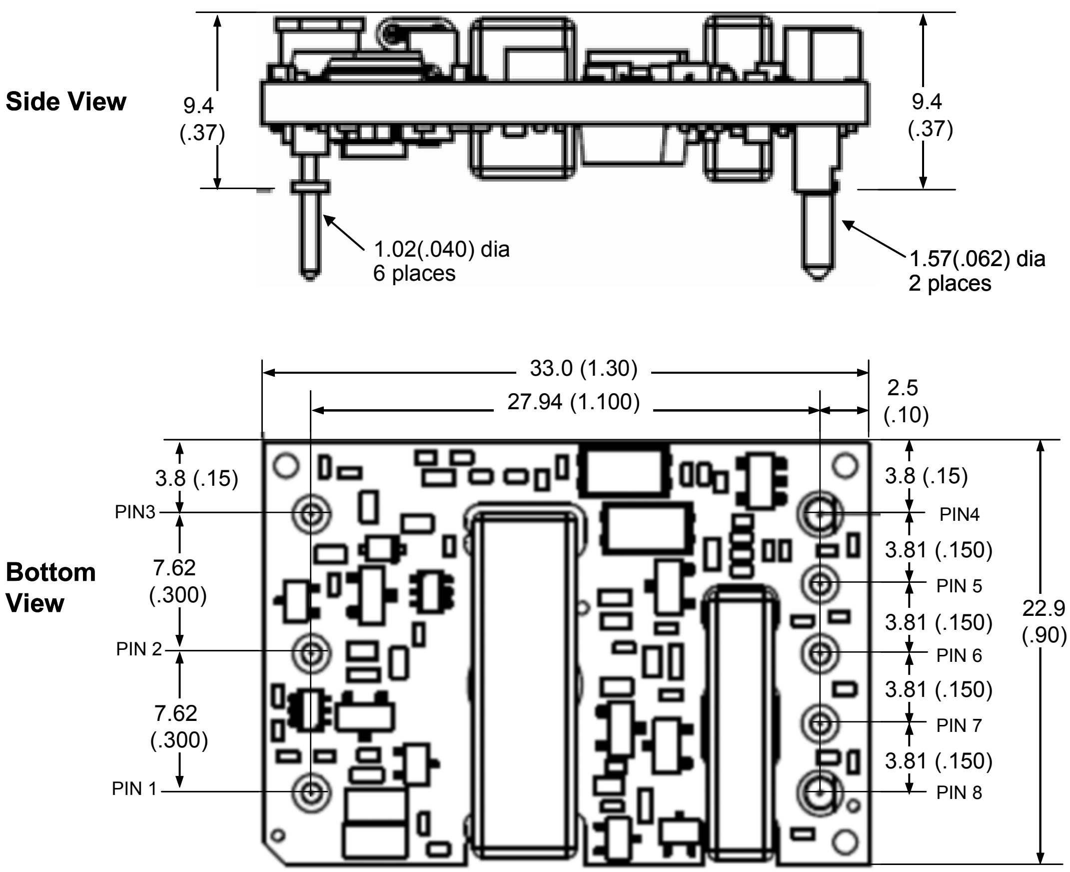
The nominal height of the converter with the baseplate option is 0.50''.

EMC Considerations

The SRS Series of converters meet EN55022 class B and FCC part 15J requirements with an external filter. The EMC performance of the converter is related to the layout and filtering design of the customer board. As with other switch-mode power supplies, careful layout and adequate filtering around the module are important to confine noise generated by the switching in the converter and to optimize system EMC performance.

For assistance with designing for EMC compliance, please contact NetPower's technical support team at support@netpowercorp.com.

Mechanical Information



PIN	Function
1	Vin(+)
2	ON/OFF
3	Vin(-)
4	Vo(-)
5	Sense(-)
6	Trim
7	Sense(+)
8	Vo(+)

Figure 17. Open Frame Converter

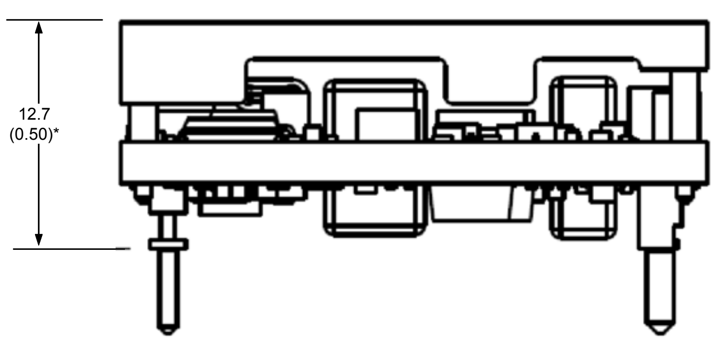


Figure 18. Converter with a Baseplate

Notes:

1) All dimensions in mm (inches)
Tolerances:.x $\pm$ .5 (.xx $\pm$ 0.02)
.xx $\pm$ .25 (.xxx $\pm$ 0.010)
2) Input and function pins are 1.02mm (0.040") dia. with 1.68mm (0.066") dia. standoff shoulders.
3) Output power pins are 1.57 mm (0.062") dia.
4) All pins are coated with 90%/10% solder, Gold, or Matte Tin finish with Nickel underplating.
5) Weight: 15 g open frame converter
30 g baseplated converter
6) Workmanship meets or exceeds IPC-A-610 Class II
7) Torque applied on screw should not exceed 6in-lb. (0.7 Nm)
8) Baseplate flatness tolerance is 0.10mm (0.004") TIR for surface

Part Numbering System

SRS	4	010	N	035	N	2	5	
Series Name:	**Nominal Input Voltage:**	**Nominal Output Voltage:**	**Enabling Logic:**	**Rated Output Current:**	**Pin Length:**	**Electrical Options:**	**Mechanical Options**	
							Lead-free, ROHS Compliant	**Leaded (ROHS-5 Compliant)**
SRS	**4**: 48Vin	Unit: 0.1V 010 = 1.0V 120 = 12.0V	**P:** Positive **N**: Negative	Unit: A 035 = 35A 006 = 6A	**K:** 0.110" **N**: 0.145" **R**: 0.180" **S**: SMT*	**0:** None **2:** Auto Restart	**5:** None **6:** Baseplate	**0:** None **1:** Baseplate

*: SMT pins are metal block pins at the same locations as the through-hole pins. The recommended diameter for pad/stencil opening and solder mask opening for these pins is 0.12''.

The above example denotes a 1.0V, 35A output module with negative enabling logic, 0.145'' pins, and auto restart option with Lead-free.

For more information, please contact:

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