

# SYRS1 Series

9 - 36V Wide Input

Encapsulated Sixteenth Brick Converters

## Features

- High efficiency and excellent thermal performance
- No minimum load requirement
- Protection against input under-voltage, output over-voltage/over-current/short circuit, and over-temperature.
- Output remote sense
- Fixed frequency operation
- 2,250Vdc input to output isolation
- Encapsulated for harsh environment
- Flanged baseplate available
- Different temperature grades available
- Designed to meet IEC60950-1 2<sup>nd</sup> edition
- Qualification/Screening satisfy: IPC-9592, MIL-STD-810, MIL-STD-883



## Absolute Maximum Ratings

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

Parameter	Symbol	Min	Max	Unit
Input Voltage (continuous)	V <sub>i</sub>	-0.5	40	Vdc
Input Voltage (< 100ms, operating)	V <sub>i</sub>	-	50	Vdc
Input Voltage (continuous, non-operating)	V <sub>i</sub>	-	50	Vdc
Storage Temperature	T <sub>stg</sub>	-55	125	°C

## Part Numbering System

SYR	S1	□□□	□	□□□	□	□	□	□	-	□
Family Name:	Input Voltage:	Output Voltage:	Enabling Logic:	Rated Output Current:	Pin Length:	Electrical Options:	Packaging	Suffix	-	Operating Temperature *Grade (°C)
SYR	S1:9-36V	Unit:0.1V 050:5V	P:positive N:negative	Unit:A 012:12A	K:0.110" N:0.145" R:0.180"	0:latch off 2:auto-restart	R: Potted, metal case S: Potted, metal shield, flange P: Potted, baseplate F: Potted, flange	Custom code	-	H: -40 to +100 M: -55 to +100

\* Operating temperature is the temperature measured at the center of the baseplate.

## Available Codes:

<b>Output Voltage</b>	3.3V	5V	6V	8V	12V	15V
<b>Output Current</b>	10A, 15A	8A, 12A	5A	4A, 7A	3A, 5A	2A, 4A

## SYRS1 Series 9 – 36V Input Sixteenth Brick Converters

### Electrical Specifications

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

#### Series Input Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Input Voltage	$V_i$	9	18	36	Vdc
Input Turn-on Voltage Threshold	-	8.0	8.5	9.0	V
Input Turn-off Voltage Threshold	-	7.0	7.5	8.0	V

#### Series Output Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Output Voltage Set Point Accuracy ( $V_i$ = Typical $V_{in}$ ; $I_o$ = $I_{o,max}$ ; $T_a$ = 25°C)	-	-1.5		+1.5	% $V_o$
Output Voltage Set Point Accuracy (over all conditions)	-	-3		+3	% $V_o$
Output Regulation:					
Line Regulation ( full range input voltage, 1/2 full load)	-	-	0.2	0.5	% $V_o$
Load Regulation (full range load, Typical $V_{in}$ )	-	-	0.2	0.5	% $V_o$
Temperature ( $T_a$ = -40°C to 85 °C)	-	-	0.1	-	% $V_o$
Output Trim Range in % of $V_o$ , typical	-	80	-	110	%

#### Series General Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Remote Enable					
Logic Low:					
ION/OFF = 1.0mA	$V_{ON/OFF}$	0	-	1.2	V
VON/OFF = 0.0V	$I_{ON/OFF}$	-	-	1.0	mA
Logic High:					
ION/OFF = 0.0 $\mu$ A	$V_{ON/OFF}$	3.5	-	15	V
Leakage Current	$I_{ON/OFF}$	-	-	50	$\mu$ A
Isolation Capacitance	-	-	1200	-	pF
Isolation Resistance	-	10	-	-	M $\Omega$

### Module Specific Specifications

#### 3.3V/10A Module (SYRS1033x010xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	$I_{in,Max}$	-	-	7	A
Quiescent Input Current (Typical $V_{in}$ )	$I_{in,Qsnt}$	-	80	120	mA
Standby Input Current	$I_{in,Stdby}$	-	8	15	mA
Efficiency (Typical $V_{in}$ ; $I_o$ , max, $T_A$ = 25°C)	$\eta$	-	90	-	%
Output Voltage Set Point	$V_o$		3.3		V
Output Over Current Protection Set Point / $I_{o\_max}$	$I_{o,cli}$	105	-	160	%
Output Over Voltage Protection Set Point / $V_o\_typical$	-	115	130	165	%
Output ripple frequency	-	280	300	320	kHz
Output Ripple and Noise Voltage					
RMS	-			50	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical $V_{in}$ )	-			130	mVp-p
External Load Capacitance	-	-	-	10,000	$\mu$ F

## SYRS1 Series 9 – 36V Input Sixteenth Brick Converters

### 3.3V/15A Module (SYRS1033x015xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	9	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	120	140	mA
Standby Input Current	lin,Stdby	-	10	18	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	89.0	-	%
Output Voltage Set Point	Vo		3.3		V
Output Over Current Protection Set Point / Io_max	Io,cli	110	-	160	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	130	165	%
Output ripple frequency	-	280	300	320	kHz
Output Ripple and Noise Voltage RMS	-			50	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			150	mVp-p
External Load Capacitance	-	-	-	10,000	$\mu$ F

### 5V/8A Module (SYRS1050x008xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	8	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	80	110	mA
Standby Input Current	lin,Stdby	-	8	20	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	91.5	-	%
Output Voltage Set Point	Vo		5.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	115	-	175	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	125	150	%
Output ripple frequency	-	230	250	270	kHz
Output Ripple and Noise Voltage RMS	-			40	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			150	mVp-p
External Load Capacitance	-	-	-	7,000	$\mu$ F

### 5V/12A Module (SYRS1050x012xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	10	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	100	130	mA
Standby Input Current	lin,Stdby	-	8	20	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	90.5	-	%
Output Voltage Set Point	Vo		5.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	108	-	170	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	125	150	%
Output ripple frequency	-	230	250	270	kHz
Output Ripple and Noise Voltage RMS	-			50	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			180	mVp-p
External Load Capacitance	-	-	-	8,000	$\mu$ F

### 6V/5A Module (SYRS1060x005xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	6	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	80	100	mA
Standby Input Current	lin,Stdby	-	6	15	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	91.5	-	%
Output Voltage Set Point	Vo		6.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	115	-	175	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	125	150	%
Output ripple frequency	-	240	260	280	kHz
Output Ripple and Noise Voltage RMS	-			40	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			120	mVp-p
External Load Capacitance	-	-	-	2,000	$\mu$ F

## SYRS1 Series 9 – 36V Input Sixteenth Brick Converters

### 8V/4A Module (SYRS1080x004xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	7	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	85	110	mA
Standby Input Current	lin,Stdby	-	6	18	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	91.5	-	%
Output Voltage Set Point	Vo		8.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	110	-	180	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	130	150	%
Output ripple frequency	-	230	250	270	kHz
Output Ripple and Noise Voltage RMS	-			40	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			100	mVp-p
External Load Capacitance	-	-	-	2,000	$\mu$ F

### 8V/7A Module (SYRS1080x007xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	11	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	100	120	mA
Standby Input Current	lin,Stdby	-	6	18	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	91.0	-	%
Output Voltage Set Point	Vo		8.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	110	-	165	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	130	150	%
Output ripple frequency	-	230	250	270	kHz
Output Ripple and Noise Voltage RMS	-			50	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			150	mVp-p
External Load Capacitance	-	-	-	2,000	$\mu$ F

### 12V/3A Module (SYRS1120x003xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	7	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	90	110	mA
Standby Input Current	lin,Stdby	-	6	18	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	92.0	-	%
Output Voltage Set Point	Vo		12.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	110	-	180	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	130	150	%
Output ripple frequency	-	200	220	240	kHz
Output Ripple and Noise Voltage RMS	-			40	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			120	mVp-p
External Load Capacitance	-	-	-	700	$\mu$ F

### 12V/5A Module (SYRS1120x005xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	11	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	100	120	mA
Standby Input Current	lin,Stdby	-	6	18	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	91.5	-	%
Output Voltage Set Point	Vo		12.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	110	-	160	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	130	150	%
Output ripple frequency	-	200	220	240	kHz
Output Ripple and Noise Voltage RMS	-			60	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			160	mVp-p
External Load Capacitance	-	-	-	1,000	$\mu$ F

## SYRS1 Series 9 – 36V Input Sixteenth Brick Converters

### 15V/2A Module (SYRS1150x002xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	7	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	70	90	mA
Standby Input Current	lin,Stdby	-	6	18	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	91.0	-	%
Output Voltage Set Point	Vo		15.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	110	-	190	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	130	160	%
Output ripple frequency	-	180	200	220	kHz
Output Ripple and Noise Voltage RMS	-			40	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			100	mVp-p
External Load Capacitance	-	-	-	700	$\mu$ F

### 15V/4A Module (SYRS1150x004xxx-x)

Parameter	Symbol	Min	Typical	Max	Unit
Input Current	lin,Max	-	-	12	A
Quiescent Input Current (Typical Vin)	lin,Qsnt	-	100	120	mA
Standby Input Current	lin,Stdby	-	6	18	mA
Efficiency (Typical Vin; Io,max, TA = 25°C)	$\eta$	-	90.0	-	%
Output Voltage Set Point	Vo		15.0		V
Output Over Current Protection Set Point / Io_max	Io,cli	110	-	180	%
Output Over Voltage Protection Set Point / Vo_typical	-	115	130	160	%
Output ripple frequency	-	180	200	220	kHz
Output Ripple and Noise Voltage RMS	-			60	mVrms
Peak-to-peak (5 Hz to 20 MHz bandwidth, Typical Vin)	-			200	mVp-p
External Load Capacitance	-	-	-	700	$\mu$ F

## Feature Descriptions

### ON/OFF

The converter can be turned on and off by changing the voltage between the ON/OFF pin and Vin(-). The SYRS1 Series of converters are available with 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.

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 50 $\mu$ A.

### 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 between the points where voltage regulation is desired. The voltage between the SENSE pins and the output pins must not exceed the smaller of 0.5V or 10% of typical output voltage.

$$[V_{out(+)} - V_{out(-)}] - [SENSE(+) - SENSE(-)] < \text{MIN}\{0.5V, 10\%V_o\}$$

When remote sense is not used, the SENSE pins should be connected to their corresponding output pins. If the SENSE pins are left floating, the converter will deliver an output voltage slightly higher than its specified typical output voltage.

**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 typical output voltage. The circuit configuration for trim down operation is shown in Figure 1.

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

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

Where

$$\Delta = \left( \frac{|V_{nom} - V_{adj}|}{V_{nom}} \right) \times 100$$

and

$V_{nom}$  = Typical Output Voltage

$V_{adj}$  = Adjusted Voltage

The circuit configuration for trim up operation is shown in Figure 2. To increase the output voltage, the value of the resistor should be:

$$R_{up} = \left( \frac{5.11V_o(100 + \Delta)}{1.225\Delta} - \frac{511}{\Delta} - 10.22 \right) (k\Omega)$$

Where

$V_o$  = Typical Output Voltage

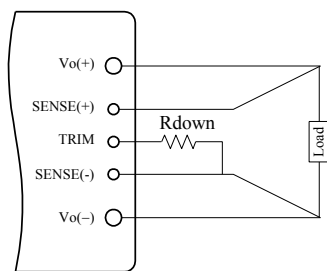


Figure 1. Circuit to Decrease Output Voltage

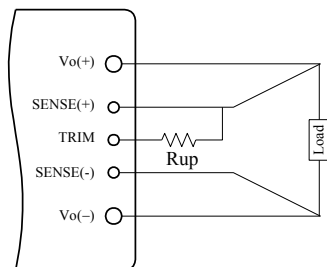


Figure 2. Circuit to Increase Output Voltage

**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**

As with any DC/DC converter, the stability of the SYRS1 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

## SYRS1 Series 9 – 36V Input Sixteenth Brick Converters

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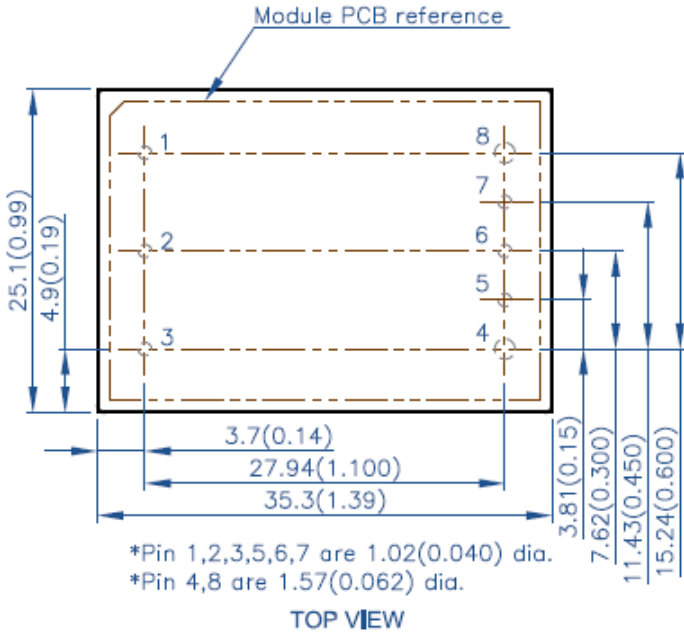
source impedance, it is recommended to add 220  $\mu\text{F}$  low ESR electrolytic capacitors at the input of the converter for each 100W output power, which reduces the potential negative impact of the source impedance on the converter stability. These electrolytic capacitors should have sufficient 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.

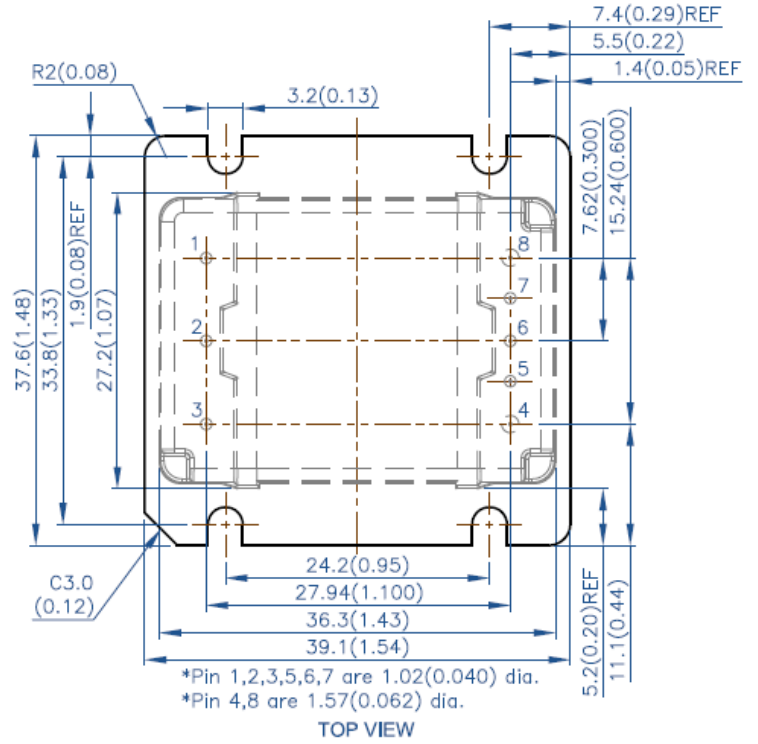
# SYRS1 Series 9 – 36V Input Sixteenth Brick Converters

## Mechanical Information

Potted, metal case



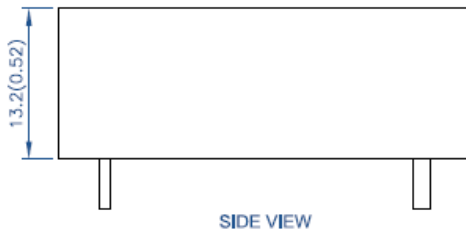
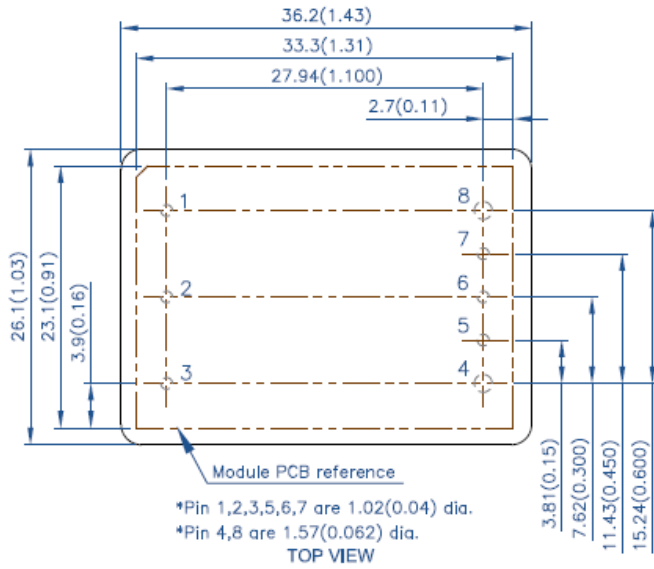
Potted, metal shield, flange



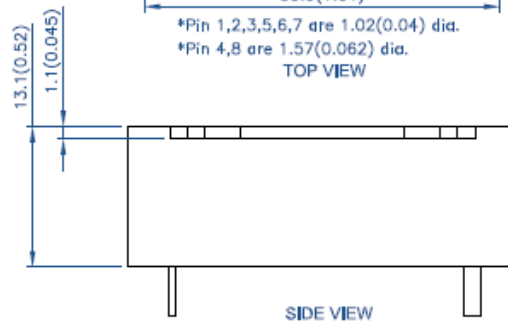
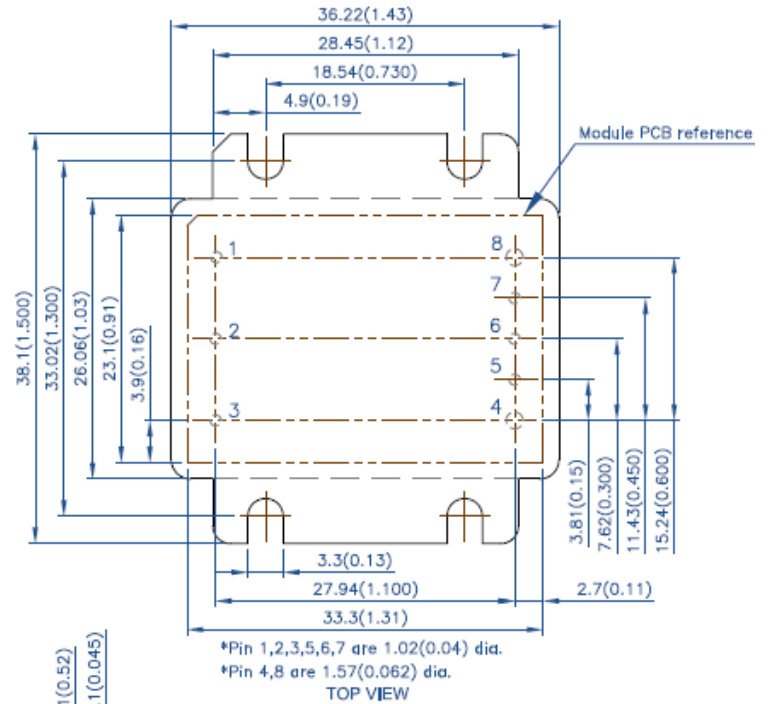


# SYRS1 Series 9 – 36V Input Sixteenth Brick Converters

## Potted, baseplate



## Potted, flange



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

## Notes:

- All dimensions in mm (inches)  
Tolerances:  $x \pm .5$  ( $.xx \pm 0.02$ )  
 $.xx \pm .25$  ( $.xxx \pm 0.010$ )
- 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 1.57 mm (0.062") dia. with +/- 0.10mm (0.004") tolerance; the standoff shoulders are 2.46mm (0.097") dia. with +/- 0.15mm (0.006") tolerance.
- All pins are coated with 90%/10% solder, Gold, or Matte Tin finish with Nickel underplating.
- Workmanship meets or exceeds IPC-A-610 Class II
- Baseplate flatness tolerance is 0.10mm (0.004") TIR for surface

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