

# 400 Watts

## QSB Series



- Up to 89% Efficiency
- 4:1 Input Range
- Industry Standard Full Brick Package
- -40 °C to +100 °C Operating Temperature
- Baseplate-cooled
- Remote On/Off & Remote Sense
- 3 Year Warranty

### Specification

#### Input

|                                  |                                                                                      |
|----------------------------------|--------------------------------------------------------------------------------------|
| Input Voltage Range              | • 24 V (9-36 V), 48 V (18-75 V)                                                      |
| Input Current                    | • See table                                                                          |
| Idle Current                     | • 50 mA                                                                              |
| Input Reverse Voltage Protection | • None                                                                               |
| Input Filter                     | • Pi network                                                                         |
| Undervoltage Lockout             | • 24 Vin: turn on 8.5 V, turn off 7.5 V<br>48 Vin: turn on 17.0 V, turn off 15.0 V   |
| Overvoltage Lockout              | • 24 Vin: turn off 42.0 V, turn on 40.0 V<br>48 Vin: turn off 83.0 V, turn on 80.0 V |

#### Output

|                          |                                                                                                                                                                                                                                     |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Output Voltage Trim      | • 80-110% of nominal output, see application notes                                                                                                                                                                                  |
| Initial Set Accuracy     | • $\pm 1.5\%$ max                                                                                                                                                                                                                   |
| Minimum Load             | • No minimum load required                                                                                                                                                                                                          |
| Line Regulation          | • $\pm 0.2\%$ max measured from high line to low line                                                                                                                                                                               |
| Load Regulation          | • $\pm 0.5\%$ max measured from 0-100% load                                                                                                                                                                                         |
| Start Up Time            | • 120 ms typical                                                                                                                                                                                                                    |
| Transient Response       | • 5% max deviation, recovery to within 1% in 500 $\mu$ s, 25% step load change                                                                                                                                                      |
| Ripple & Noise           | • 5 V models: 100 mV pk-pk, other models 1% pk-pk, 20 MHz bandwidth (see note 1)                                                                                                                                                    |
| Overvoltage Protection   | • 115-140%                                                                                                                                                                                                                          |
| Short Circuit Protection | • Continuous, constant current                                                                                                                                                                                                      |
| Over Load Protection     | • 110-150% nominal output                                                                                                                                                                                                           |
| Thermal Shutdown         | • Case temperature 110 °C typical                                                                                                                                                                                                   |
| Temperature Coefficient  | • $\pm 0.03\%/^{\circ}\text{C}$                                                                                                                                                                                                     |
| Remote Enable            | • Referenced to -ve input, Module on: 1-10 mA.<br>Module off: < 1 mA or open circuit<br>Optional '-P' version<br>Module on: <1 mA or open circuit<br>Module off: 1-10 mA.<br>Internal 1k $\Omega$ current limit resistor is fitted. |
| Remote Sense             | • Compensates up to 10% of Vout nominal, total of output trim and remote sense                                                                                                                                                      |
| Current Share            | • Parallel up to 4 modules using the parallel pin $\pm 10\%$ load share accuracy from 50% to 100% load                                                                                                                              |
| Auxiliary Output         | • 10 V $\pm 3$ V/20 mA max<br>Auxiliary return is -Sense Pin                                                                                                                                                                        |

#### General

|                       |                                                                                 |
|-----------------------|---------------------------------------------------------------------------------|
| Efficiency            | • See tables                                                                    |
| Isolation Voltage     | • 1500 VDC Input to Output<br>1500 VDC Input to Case<br>1500 VDC Output to Case |
| Isolation Resistance  | • 10 <sup>7</sup> $\Omega$                                                      |
| Isolation Capacitance | • 4000 pF typical                                                               |
| Switching Frequency   | • 230 kHz typical                                                               |
| DC OK Signal          | • DC OK open collector signal (see note 4)                                      |
| Power Density         | • 79 W/in <sup>3</sup>                                                          |
| MTBF                  | • 300 kHrs typical to MIL-HDBK-217F at 25 °C, GB                                |

#### Environmental

|                                  |                                                                                        |
|----------------------------------|----------------------------------------------------------------------------------------|
| Operating Base Plate Temperature | • -40 °C to +100 °C, see derating curve                                                |
| Storage Temperature              | • -55 °C to +105 °C                                                                    |
| Operating Humidity               | • Up to 90% non-condensing                                                             |
| Cooling                          | • Baseplate-cooled, see derating curve                                                 |
| Shock                            | • 75g pk, sawtooth wave for 10 ms, 3 pulses per face, all 6 faces tested on all 3 axes |
| Vibration                        | • 15-2000 Hz at 4g, 1 hour per axis                                                    |

#### EMC & Safety

|           |                                                                                |
|-----------|--------------------------------------------------------------------------------|
| Emissions | • EN55022, level A conducted, with external components. See application notes. |
|-----------|--------------------------------------------------------------------------------|

## Models &amp; Ratings

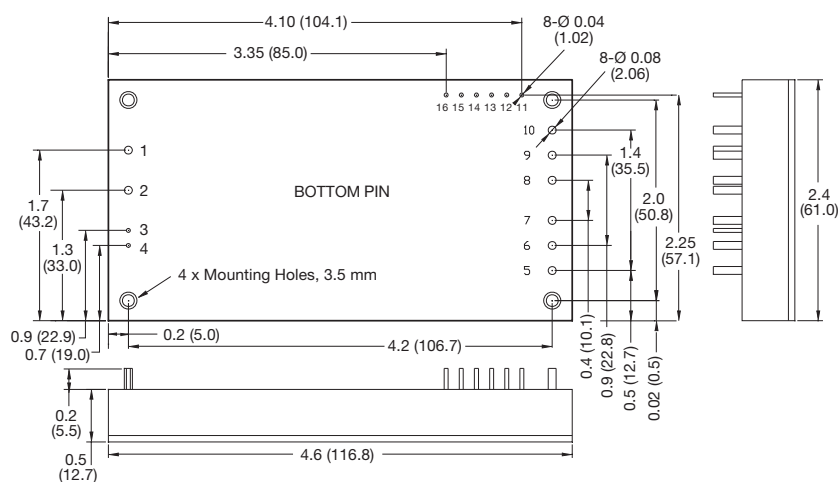
QSB400 **XP**

| Input Voltage | Output Voltage | Output Current | Input Current |           | Efficiency | Max Capacitive Load | Model Number <sup>2</sup> |
|---------------|----------------|----------------|---------------|-----------|------------|---------------------|---------------------------|
|               |                |                | No Load       | Full Load |            |                     |                           |
| 9-36 V        | 5.0 V          | 80.0 A         | 600 mA        | 19.05 A   | 87.5%      | 10000 $\mu$ F       | QSB40024S05               |
|               | 12.0 V         | 33.3 A         | 120 mA        | 19.36 A   | 86.0%      | 10000 $\mu$ F       | QSB40024S12               |
|               | 24.0 V         | 16.6 A         | 120 mA        | 19.19 A   | 87.0%      | 4700 $\mu$ F        | QSB40024S24               |
|               | 28.0 V         | 14.3 A         | 120 mA        | 19.19 A   | 87.0%      | 4700 $\mu$ F        | QSB40024S28               |
|               | 48.0 V         | 8.30 A         | 120 mA        | 19.19 A   | 86.5%      | 2200 $\mu$ F        | QSB40024S48               |
| 18-75 V       | 5.0 V          | 80.0 A         | 300 mA        | 9.36 A    | 89.0%      | 10000 $\mu$ F       | QSB40048S05               |
|               | 12.0 V         | 33.3 A         | 60 mA         | 9.41 A    | 88.5%      | 10000 $\mu$ F       | QSB40048S12               |
|               | 24.0 V         | 16.6 A         | 60 mA         | 9.28 A    | 90.0%      | 4700 $\mu$ F        | QSB40048S24               |
|               | 28.0 V         | 14.3 A         | 60 mA         | 9.27 A    | 90.0%      | 4700 $\mu$ F        | QSB40048S28               |
|               | 48.0 V         | 8.30 A         | 60 mA         | 9.27 A    | 89.5%      | 2200 $\mu$ F        | QSB40048S48               |

## Notes

- Output Ripple and Noise measured with 10  $\mu$ F tantalum and 1  $\mu$ F ceramic capacitor across output.
- Add suffix 'P' to the model number to receive the unit with positive logic Remote On/Off.
- Minimum of 330  $\mu$ F capacitance required on output to maintain regulation. Except S05 models which require 680  $\mu$ F
- Open collector signal is pulled low when DC is OK, floating when DC is NOT OK WRT-Sense pin. Maximum current is 20 mA

## Mechanical Details



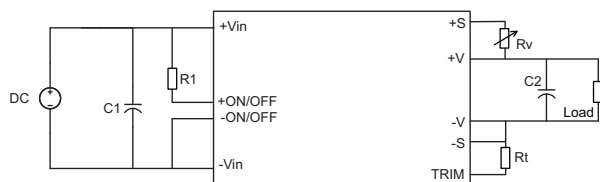
| PIN CONNECTIONS |          |
|-----------------|----------|
| Pin             | Function |
| 1               | -Vin     |
| 2               | +Vin     |
| 3               | -On/Off  |
| 4               | +On/Off  |
| 5-7             | +Vout    |
| 8-10            | -Vout    |
| 11              | -Sense   |
| 12              | +Sense   |
| 13              | Trim     |
| 14              | Parallel |
| 15              | DC OK    |
| 16              | Aux      |

## Notes

- All dimensions are in inches (mm)
- Weight: 0.57 lbs (260 g) approx
- Tolerances: X.XX =  $\pm 0.02$  (X.X =  $\pm 0.5$ )  
X.XXX =  $\pm 0.01$  (X.XX =  $\pm 0.25$ )

## Output Voltage Adjustment

The Trim input permits the user to adjust the output voltage up or down according to the trim range specification (80% to 110% of nominal output). This is accomplished by connecting an external resistor between the +Vout and +Sense pin for trim up and between the TRIM and -Sense pin for trim down, see figure:



The Trim pin should be left open if trimming is not being used. The output voltage can be determined by the following equations:

$$V_f = \frac{1.24 \times \left( \frac{R_t \times 33}{R_t + 33} \right)}{7.68 + \frac{R_t \times 33}{R_t + 33}}$$

Recommended Value of  $R_t$  is 6.8k $\Omega$ , therefore  $V_f = 0.525$

$$V_{out} = (V_{nom} + R_v) \times V_f$$

$$R_v = \frac{V_{out}}{V_f} - V_{nom}$$

Examples:

1. To trim 12 V unit up by 10%

$$R_v = \frac{13.2}{0.525} - 12 = 13.145k\Omega$$

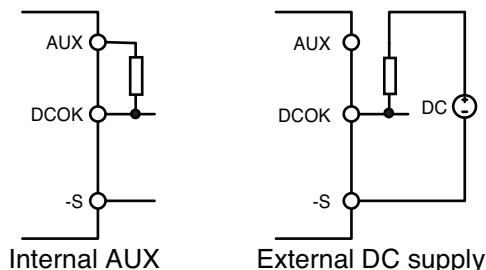
2. To trim 24 V unit up by 20%

$$R_v = \frac{19.2}{0.525} - 24 = 12.57k\Omega$$

# Application Notes

## DC OK Signal

Normal and abnormal operation of the converter can be monitored by using the DC OK signal. Output of this signal monitor is located at the secondary side and is an open collector output with the -Sense pin as the ground reference. The internal aux power supply or an external DC supply can be used as a pull up voltage.



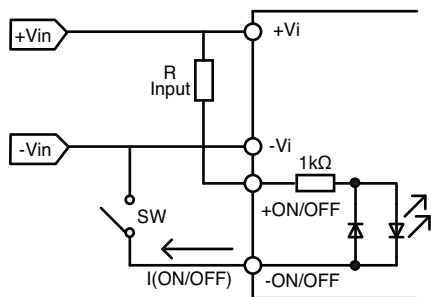
This signal is LOW when the converter is operating normally and HIGH when the converter is disabled or when the converter is operating abnormally.

## Remote ON/OFF Control

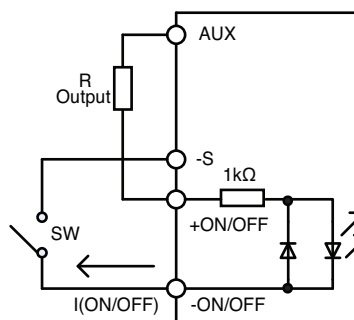
The converter's output ON/OFF function can be controlled from the input side or the output side.

Output voltage turns on when current flows through ON/OFF pins by opening or closing the switch. The maximum current through the ON/OFF pin is 10mA, and is determined by current limit resistor R.

(A) Turning output ON and OFF from the input side, recommended R value is 30K (0.5W) for 48Vin and 15K (0.25W) for 24Vin.



(B) Turning output ON and OFF from the output side, recommended R value is 5.1k (0.1W).

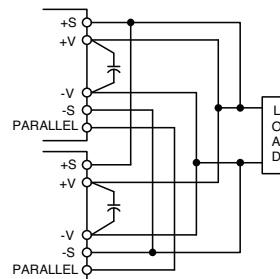


## Parallel Operation

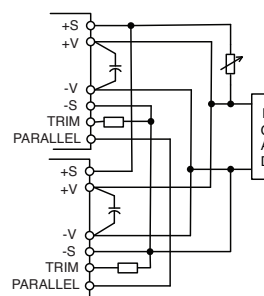
The QSB400 series are designed for parallel operation. When paralleled, the load current can be equally shared between the modules by connecting the Parallel pins together.

There are two different parallel operations for QSB400 series, one is parallel operation when load can't be supplied by only one power unit; the other is for N+1 redundant operation.

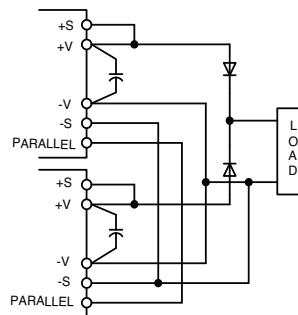
### (a) Parallel Operation



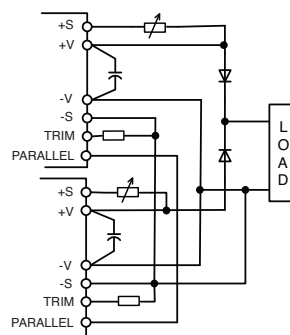
### (b) Parallel Operation with adjustable output



### (c) N+1 redundant connection



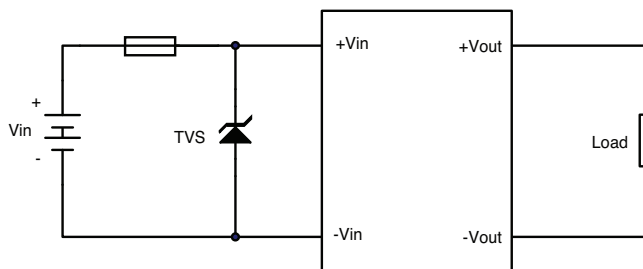
### (d) N+1 redundant connection adjustable output voltage



## Input Fusing and Safety Considerations

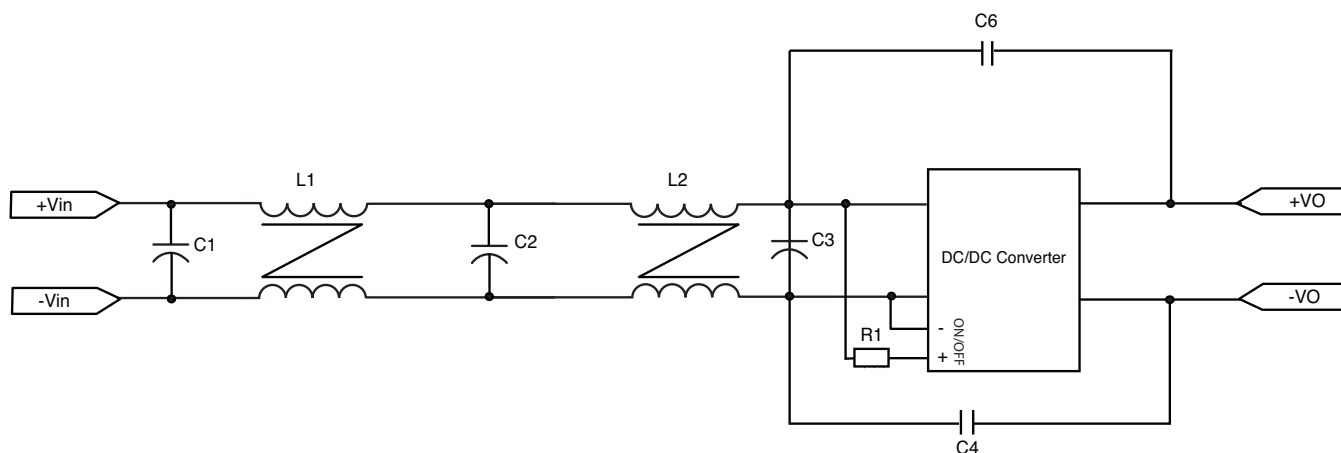
QSB400 **XP**

The QSB400 series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 60A time delay fuse for 24Vin models, and 30A for 48Vin models. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage (as shown).



## EMC Considerations

### Suggested Circuits for Conducted EMI Class A



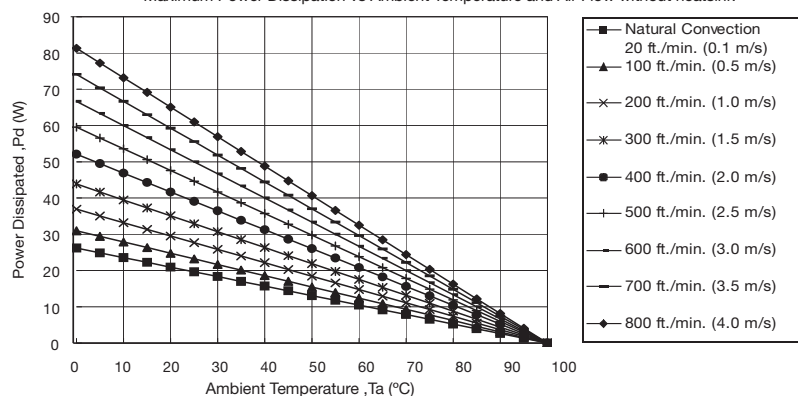
| C1         | C2         | C3         | C4         | C6         | L1    | L2  |
|------------|------------|------------|------------|------------|-------|-----|
| 470uF/100V | 470uF/100V | 470uF/100V | 2200pF/2kV | 2200pF/2kV | 0.8mH | 8mH |

Note: 470uF/100V NIPPON CHEMI-CON KMF series aluminum capacitors and C4, C6 ceramic capacitors

## Thermal Resistance Information

### Derating Curve

Maximum Power Dissipation vs Ambient Temperature and Air Flow without heatsink



| Air Flow Rate                             | Typical R <sub>ca</sub> |
|-------------------------------------------|-------------------------|
| Natural Convection<br>20 ft./min (0.1 ms) | 3.82 °C/W               |
| 100 ft./min (0.5 ms)                      | 3.23 °C/W               |
| 200 ft./min (1.0 ms)                      | 2.71 °C/W               |
| 300 ft./min (1.5 ms)                      | 2.28 °C/W               |
| 400 ft./min (2.0 ms)                      | 1.92 °C/W               |
| 500 ft./min (2.5 ms)                      | 1.68 °C/W               |
| 600 ft./min (3.0 ms)                      | 1.50 °C/W               |
| 700 ft./min (3.5 ms)                      | 1.35 °C/W               |
| 800 ft./min (4.0 ms)                      | 1.23 °C/W               |

R<sub>ca</sub> = Thermal resistance from case to ambient