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# Mini Family
## 24V Input



Actual size:
2.28 x 2.2 x 0.5in
[57,9 x 55,9 x 12,7mm]

## DC-DC Converter Module

## Features & Benefits

- DC input range: 18 – 36V
- Isolated output
- Operation to 16V at 75% power after start up
- Input surge withstand: 50V for 100ms
- DC output: 3.3 – 48V
- Programmable output: 10 – 110%
- Regulation: ±0.5% no load to full load
- Efficiency: Up to 89%
- Maximum operating temp: 100°C, full load
- Power density: up to 80W per cubic inch
- Height above board: 0.43in [10,9mm]
- Parallelable, with N+M fault tolerance
- Low-noise ZCS/ZVS architecture
- RoHS Compliant (with F or G pin option)

## Product Overview

These DC-DC converter modules use advanced power processing, control and packaging technologies to provide the performance, flexibility, reliability and cost effectiveness of a mature power component.

High-frequency ZCS/ZVS switching provides high power density with low noise and high efficiency.

## Applications

Industrial and process control, distributed power, medical, ATE, communications, defense and aerospace.

For details on proper operation please refer to the:
Design Guide & Applications Manual for Maxi, Mini, Micro Family.

## Absolute Maximum Ratings

| Parameter | Rating | Unit | Notes |
|---|---|---|---|
| +IN to –IN voltage | –0.5 to +53 | $V_{DC}$ | |
| PC to –IN voltage | –0.5 to +7.0 | $V_{DC}$ | |
| PR to –IN voltage | –0.5 to +7.0 | $V_{DC}$ | |
| SC to –OUT voltage | –0.5 to +1.5 | $V_{DC}$ | |
| –Sense to –OUT voltage | 1.0 | $V_{DC}$ | |
| Isolation voltage | | | |
| IN to OUT | 3000 | $V_{RMS}$ | Test voltage |
| IN to base | 1500 | $V_{RMS}$ | Test voltage |
| OUT to base | 500 | $V_{RMS}$ | Test voltage |
| Operating Temperature | –55 to +100 | °C | M-Grade |
| Storage Temperature | –65 to +125 | °C | M-Grade |
| Pin soldering temperature | 500 [260] | °F [°C] | <5sec; wave solder |
| | 750 [390] | °F [°C] | <7sec; hand solder |
| Mounting torque | 5 [0.57] | in·lbs [N·m] | 6 each |

## Part Numbering

**e.g. V24B12T200BL2**

**24B** ☐ ☐ ☐ **B** ☐ ☐

***Product Type***
***V*** = *Standard*
***S*** = *Enhanced efficiency (avail. ≤12 $V_{OUT}$ only)*

***Output Voltage***
***3V3*** = *3.3V*
***5*** = *5V*
***6.5*** = *6.5V*
***8*** = *8V*
***12*** = *12V*
***15*** = *15V*
***24*** = *24V*
***28*** = *28V*
***36*** = *36V*
***48*** = *48V*

***Product Grade Temperatures (°C)***

| Grade | | Operating | Storage |
|---|---|---|---|
| ***E*** | = | *–10 to +100* | *–20 to +125* |
| ***C*** | = | *–20 to +100* | *–40 to +125* |
| ***T*** | = | *–40 to +100* | *–40 to +125* |
| ***H*** | = | *–40 to +100* | *–55 to +125* |
| ***M*** | = | *–55 to +100* | *–65 to +125* |

***Output Power***

| $V_{out}$ | $P_{out}$ |
|---|---|
| *3.3V* | ***100W, 150W*** |
| *5V* | ***150W, 200W*** |
| *6.5V* | ***200W*** |
| *8V* | ***200W*** |
| *12V* | ***150W, 200W, 250W*** |
| *15V* | ***150W, 200W*** |
| *24V* | ***150W, 200W, 250W*** |
| *28V* | ***150W, 200W, 250W*** |
| *36V* | ***150W, 200W*** |
| *48V* | ***150W, 200W, 250W*** |

| ***Pin Style*** | ***Finish*** |
|---|---|
| ***Blank:*** *Short* | *Tin/Lead* |
| ***L:*** *Long* | *Tin/Lead* |
| ***S:*** *Short ModuMate* | *Gold* |
| ***N:*** *Long ModuMate* | *Gold* |
| ***F:*** *Short RoHS* | *Gold* |
| ***G:*** *Long RoHS* | *Gold* |
| ***K:*** *Extra Long RoHS* | *Gold* |

***Baseplate***
***Blank:*** *Slotted*
***2:*** *Threaded*
***3:*** *Through-hole*

**Note:** Product images may not highlight current product markings.

## Module Family Electrical Characteristics

Electrical characteristics apply over the full operating range of input voltage, output load (resistive) and baseplate temperature, unless otherwise specified. All temperatures refer to the operating temperature at the center of the baseplate.

### Module Input Specifications

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Operating input voltage | 18 | 24 | 36 | $V_{DC}$ | |
| Input surge withstand | | | 50 | $V_{DC}$ | <100ms |
| Undervoltage turn–on | | 17.5 | 17.9 | $V_{DC}$ | |
| Undervoltage turn–off | 14.8 | 15.3 | | $V_{DC}$ | |
| Overvoltage turn–off/on | 36.3 | 37.8 | 39.6 | $V_{DC}$ | |
| Disabled input current | | | 4.0 | mA | PC pin low |

### Module Output Specifications

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Output voltage set point | | | ±1 | % | Of nominal output voltage. Nominal input; full load; 25°C |
| Line regulation | | ±0.02 | ±0.20 | % | Low line to high line; full load |
| Temperature regulation | | ±0.002 | ±0.005 | %/°C | Over operating temperature range |
| Power sharing accuracy | | ±2 | ±5 | % | 10 – 100% of full load |
| Programming range | 10 | | 110 | % | Of nominal output voltage. For trimming below 90% of nominal, a minimum load of 10% of maximum rated power may be required. |
| **+OUT to –OUT, +Sense to –OUT — Absolute Maximum Ratings** | | | | | |
| 3.3V | | | –0.5 to 4.7 | $V_{DC}$ | Externally applied |
| 5V | | | –0.5 to 7.0 | $V_{DC}$ | Externally applied |
| 6.5V | | | –0.5 to 9.1 | $V_{DC}$ | Externally applied |
| 8V | | | –0.5 to 10.9 | $V_{DC}$ | Externally applied |
| 12V | | | –0.5 to 16.1 | $V_{DC}$ | Externally applied |
| 15V | | | –0.5 to 20.0 | $V_{DC}$ | Externally applied |
| 24V | | | –0.5 to 31.7 | $V_{DC}$ | Externally applied |
| 28V | | | –0.5 to 36.9 | $V_{DC}$ | Externally applied |
| 36V | | | –0.5 to 47.1 | $V_{DC}$ | Externally applied |
| 48V | | | –0.5 to 62.9 | $V_{DC}$ | Externally applied |

**Note:** The permissible load current must never be exceeded during normal, abnormal or test conditions. For additional output related application information, please refer to output connections on page 10.

### Thermal Resistance and Capacity

| Parameter | Min | Typ | Max | Unit |
|---|---|---|---|---|
| Baseplate to sink; flat, greased surface | | 0.16 | | °C/Watt |
| Baseplate to sink; thermal pad (P/N 20264) | | 0.14 | | °C/Watt |
| Baseplate to ambient | | 8.0 | | °C/Watt |
| Baseplate to ambient; 1000LFM | | 1.9 | | °C/Watt |
| Thermal capacity | | 83 | | Watt-sec/°C |

## Module Family Electrical Characteristics (Cont.)

### Module Control Specifications

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Primary Side (PC = Primary Control; PR = Parallel)** | | | | | |
| PC bias voltage<br>current limit | 5.50<br>1.5 | 5.75<br>2.1 | 6.00<br>3.0 | $V_{DC}$<br>mA | PC current = 1.0mA<br>PC voltage = 5.5V<br>During normal operation |
| PC module disable | 2.3 | 2.6 | 2.9 | $V_{DC}$ | Switch must be able to sink ≥4mA. See Figure 2 |
| PC module enable delay | | 4 | 7 | ms | |
| PC module alarm | | | 0.5 | $V_{AVG}$ | UV, OV, OT, module fault. See Figures 3 and 5 |
| PC resistance | 0.9 | 1.0 | 1.1 | MΩ | See Figure 3, converter off or fault mode |
| PR emitter amplitude | 5.7 | 5.9 | 6.1 | Volts | PR load >30Ω, <30pF |
| PR emitter current | 150 | | | mA | |
| PR receiver impedance | 375 | 500 | 625 | Ω | 25°C |
| PR receiver threshold | 2.4 | 2.5 | 2.6 | Volts | Minimum pulse width: 20ns |
| PR drive capability | | | 12 | modules | Without PR buffer amplifier |
| **Secondary Side (SC = Secondary Control)** | | | | | |
| SC bandgap voltage | 1.21 | 1.23 | 1.25 | $V_{DC}$ | Referenced to –Sense |
| SC resistance | 990 | 1000 | 1010 | Ω | |
| SC capacitance | | 0.033 | | µF | |
| SC module alarm | | 0 | | $V_{DC}$ | With open trim; referenced to –Sense. See Figure 7 |

### Module General Specifications

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Remote sense (total drop) | | | 0.5 | $V_{DC}$ | 0.25V per leg (sense leads must be connected to respective, output terminals) |
| Isolation test voltage (IN to OUT)* | 3000 | | | $V_{RMS}$ | Complies with reinforced insulation requirements |
| Isolation test voltage (IN to base)* | 1500 | | | $V_{RMS}$ | Complies with basic insulation requirements |
| Isolation test voltage (OUT to base)* | 500 | | | $V_{RMS}$ | Complies with operational insulation requirements |
| Isolation resistance | | 10 | | MΩ | IN to OUT, IN to baseplate, OUT to baseplate |
| Weight (E, C, T grade) | 3.1<br>[89.3] | 3.5<br>[100.3] | 3.9<br>[111.3] | ounces<br>[grams] | |
| Weight (H, M grade) | 3.5<br>[99.6] | 3.9<br>[110.6] | 4.3<br>[121.6] | ounces<br>[grams] | |
| Temperature limiting | 100 | 115 | | °C | See Figures 3 and 5. Do not operate coverter >100°C. |
| Agency approvals | | cURus, cTÜVus, CE<br>UKCA | | | UL60950-1, EN60950-1, CSA60950-1, IEC60950-1.<br>With appropriate fuse in series with the +Input<br>Electrical equipment (safety) regulations |

* Isolation test voltage, 1 minute or less.

**Note:** Specifications are subject to change without notice.

## Module-Specific Operating Specifications

### 3.3$V_{OUT}$, 150W (e.g. S24B3V3C150BL, V24B3V3C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B3V3C150BL (enhanced efficiency) | 84.0 | 86.5 | | % | Nominal input; 75% load; 25°C |
| V24B3V3C150BL (standard efficiency) | 80.0 | 81.4 | | | |
| Ripple and noise | | 160 | 200 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 4.14 | 4.3 | 4.46 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 5 | 6 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 45.45 | Amps | |
| Current limit | 46.4 | 52.3 | 61.5 | Amps | Output voltage 95% of nominal |
| Short circuit current | 31.8 | 52.3 | 61.5 | Amps | Output voltage <250mV |

### 3.3$V_{OUT}$, 100W (e.g. S24B3V3C100BL, V24B3V3C100BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B3V3C100BL (enhanced efficiency) | 83.5 | 85.1 | | % | Nominal input; 75% load; 25°C |
| V24B3V3C100BL (standard efficiency) | 80.4 | 81.4 | | | |
| Ripple and noise | | 71 | 89 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 4.14 | 4.3 | 4.46 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 2.5 | 3 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 30.3 | Amps | |
| Current limit | 30.9 | 34.8 | 41 | Amps | Output voltage 95% of nominal |
| Short circuit current | 21.2 | 34.8 | 41 | Amps | Output voltage <250mV |

### 5$V_{OUT}$, 200W (e.g. S24B5C200BL, V24B5C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B5C200BL (enhanced efficiency) | 85.9 | 87.0 | | % | Nominal input; 75% load; 25°C |
| V24B5C200BL (standard efficiency) | 80.5 | 84.9 | | | |
| Ripple and noise | | 95 | 119 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 6.07 | 6.3 | 6.53 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 5.1 | 5.5 | Watts | No load |
| Load regulation | | ±0.02 | ±0.45 | % | No load to full load; nominal input |
| Load current | 0 | | 40 | Amps | |
| Current limit | 40.8 | 52 | 54.5 | Amps | Output voltage 95% of nominal |
| Short circuit current | 28 | 52 | 62 | Amps | Output voltage <250mV |

### 5$V_{OUT}$, 150W (e.g. S24B5C150BL, V24B5C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B5C150BL (enhanced efficiency) | 86.0 | 87.2 | | % | Nominal input; 75% load; 25°C |
| V24B5C150BL (standard efficiency) | 83.5 | 84.8 | | | |
| Ripple and noise | | 50 | 63 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 6.03 | 6.25 | 6.47 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 3.7 | 4.5 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 30 | Amps | |
| Current limit | 30.6 | 34.5 | 40.5 | Amps | Output voltage 95% of nominal |
| Short circuit current | 5 | 34.5 | 40.5 | Amps | Output voltage <250mV |

## Module-Specific Operating Specifications (Cont.)

### 6.5$V_{OUT}$, 200W (e.g. S24B6V5C200BL, V24B6V5C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B6V5C200BL (enhanced efficiency) | 84.5 | 87.5 | | % | Nominal input; 75% load; 25°C |
| V24B6V5C200BL (standard efficiency) | 83.2 | 84.6 | | | |
| Ripple and noise | | 182 | 230 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 7.7 | 8.0 | 8.3 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 5.3 | 6.2 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 30.8 | Amps | |
| Current limit | 31.4 | 35.4 | 41.5 | Amps | Output voltage 95% of nominal |
| Short circuit current | 21.5 | 35.4 | 41.5 | Amps | Output voltage <250mV |

### 8$V_{OUT}$, 200W (e.g. S24B8C200BL, V24B8C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B8C200BL (enhanced efficiency) | 87.0 | 89.0 | | % | Nominal input; 75% load; 25°C |
| V24B8C200BL (standard efficiency) | 85.0 | 86.4 | | | |
| Ripple and noise | | 310 | 390 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 9.36 | 9.7 | 10.1 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 5 | 6 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 25 | Amps | |
| Current limit | 25.5 | 28.8 | 33.8 | Amps | Output voltage 95% of nominal |
| Short circuit current | 17.5 | 28.8 | 33.8 | Amps | Output voltage <250mV |

### 12$V_{OUT}$, 250W (e.g. S24B12C250BL, V24B12C250BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B12C250BL (enhanced efficiency) | 87.0 | 89.0 | | % | Nominal input; 75% load; 25°C |
| V24B12C250BL (standard efficiency) | 86.0 | 87.4 | | | |
| Ripple and noise | | 172 | 215 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 13.8 | 14.3 | 14.8 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 6.5 | 7.6 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 20.8 | Amps | |
| Current limit | 21.3 | 24.0 | 28.1 | Amps | Output voltage 95% of nominal |
| Short circuit current | 14.6 | 24.0 | 28.1 | Amps | Output voltage <250mV |

### 12$V_{OUT}$, 200W (e.g. S24B12C200BL, V24B12C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B12C200BL (enhanced efficiency) | 87.0 | 90.0 | | % | Nominal input; 75% load; 25°C |
| V24B12C200BL (standard efficiency) | 87.0 | 88.0 | | | |
| Ripple and noise | | 360 | 450 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 13.8 | 14.4 | 15 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.6 | 7.4 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 16.67 | Amps | |
| Current limit | 17 | 19.2 | 22.6 | Amps | Output voltage 95% of nominal |
| Short circuit current | 11.6 | 19.2 | 22.6 | Amps | Output voltage <250mV |

## Module-Specific Operating Specifications (Cont.)

### $12V_{OUT}$, 150W (e.g. S24B12C150BL, V24B12C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| **Efficiency** | | | | | |
| S24B12C150BL (enhanced efficiency) | 87.5 | 90.0 | | % | Nominal input; 75% load; 25°C |
| V24B12C150BL (standard efficiency) | 87.0 | 88.6 | | | |
| Ripple and noise | | 200 | 250 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 13.7 | 14.3 | 14.9 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.5 | 5.4 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 12.5 | Amps | |
| Current limit | 12.7 | 14.4 | 16.9 | Amps | Output voltage 95% of nominal |
| Short circuit current | 8.75 | 14.4 | 16.9 | Amps | Output voltage <250mV |

### $15V_{OUT}$, 200W (e.g. V24B15C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 88.0 | 88.9 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 250 | 313 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 17.1 | 17.8 | 18.5 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 3.4 | 3.8 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 13.33 | Amps | |
| Current limit | 13.5 | 15.9 | 17.3 | Amps | Output voltage 95% of nominal |
| Short circuit current | 13.5 | 16.1 | 17.3 | Amps | Output voltage <250mV |

### $15V_{OUT}$, 150W (e.g. V24B15C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 88.0 | 88.9 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 200 | 250 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 17.1 | 17.8 | 18.5 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.4 | 5.4 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 10 | Amps | |
| Current limit | 10.2 | 11.5 | 13.5 | Amps | Output voltage 95% of nominal |
| Short circuit current | 7 | 11.5 | 13.5 | Amps | Output voltage <250mV |

### $24V_{OUT}$, 250W (e.g. V24B24C250BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 86.0 | 87.0 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 300 | 360 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 27.1 | 28.1 | 29.1 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 7.7 | 9.0 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 10.4 | Amps | |
| Current limit | 10.6 | 12.0 | 14.1 | Amps | Output voltage 95% of nominal |
| Short circuit current | 7.3 | 12.0 | 14.1 | Amps | Output voltage <250mV |

## Module-Specific Operating Specifications (Cont.)

### $24V_{OUT}$, 200W (e.g. V24B24C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 85.4 | 87.0 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 260 | 325 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 27.5 | 28.5 | 29.5 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 5.1 | 6.2 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 8.33 | Amps | |
| Current limit | 8.46 | 9.8 | 11.5 | Amps | Output voltage 95% of nominal |
| Short circuit current | 5.81 | 9.8 | 11.5 | Amps | Output voltage <250mV |

### $24V_{OUT}$, 150W (e.g. V24B24C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 86.5 | 87.7 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 200 | 250 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 27.1 | 28.1 | 29.1 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.7 | 5.1 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 6.25 | Amps | |
| Current limit | 6.37 | 7.19 | 8.44 | Amps | Output voltage 95% of nominal |
| Short circuit current | 3 | 7.19 | 8.44 | Amps | Output voltage <250mV |

### $28V_{OUT}$, 250W (e.g. V24B28C250BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 87.2 | 88.7 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 133 | 166 | mV | P-P Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 31.5 | 32.7 | 33.8 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 9.6 | 10.5 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 8.9 | Amps | |
| Current limit | 9.1 | 10.3 | 12.1 | Amps | Output voltage 95% of nominal |
| Short circuit current | 6.3 | 10.3 | 12.1 | Amps | Output voltage <250mV |

### $28V_{OUT}$, 200W (e.g. V24B28C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 85.0 | 87.0 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 180 | 225 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 31.6 | 32.8 | 34 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.5 | 5.5 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 7.14 | Amps | |
| Current limit | 7.29 | 8.22 | 9.66 | Amps | Output voltage 95% of nominal |
| Short circuit current | 5 | 8.22 | 9.66 | Amps | Output voltage <250mV |

## Module-Specific Operating Specifications (Cont.)

### 28$V_{OUT}$, 150W (e.g. V24B28C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 86.5 | 87.8 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 200 | 250 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 31.5 | 32.7 | 33.9 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.3 | 5.2 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 5.36 | Amps | |
| Current limit | 5.46 | 6.16 | 7.24 | Amps | Output voltage 95% of nominal |
| Short circuit current | 3.75 | 6.16 | 7.24 | Amps | Output voltage <250mV |

### 36$V_{OUT}$, 200W (e.g. V24B36C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 87.0 | 88.0 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 200 | 250 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 40.4 | 41.9 | 43.4 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.5 | 5.3 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 5.55 | Amps | |
| Current limit | 5.67 | 6.39 | 7.51 | Amps | Output voltage 95% of nominal |
| Short circuit current | 3.89 | 6.39 | 7.51 | Amps | Output voltage <250mV |

### 36$V_{OUT}$, 150W (e.g. V24B36C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 86.7 | 88.0 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 200 | 250 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 40.4 | 41.9 | 43.4 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 4.2 | 5 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 4.17 | Amps | |
| Current limit | 4.25 | 4.8 | 5.63 | Amps | Output voltage 95% of nominal |
| Short circuit current | 2.91 | 4.8 | 5.63 | Amps | Output voltage <250mV |

### 48$V_{OUT}$, 250W (e.g. V24B48C250BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 87.6 | 89.1 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 182.0 | 228.0 | mV | P-P Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 53.8 | 55.7 | 57.6 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 7.4 | 8.5 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 5.2 | Amps | |
| Current limit | 5.3 | 6.0 | 7.0 | Amps | Output voltage 95% of nominal |
| Short circuit current | 3.6 | 6.0 | 7.0 | Amps | Output voltage <250mV |

## Module-Specific Operating Specifications (Cont.)

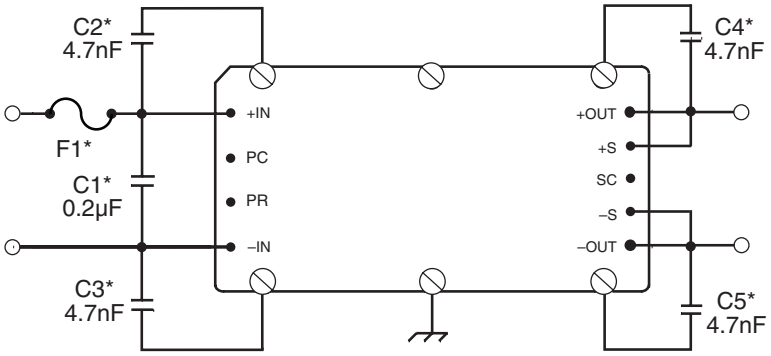
### $48V_{OUT}$, 200W (e.g. V24B48C200BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 86.0 | 87.5 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 225 | 282 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 53.8 | 55.8 | 57.8 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 5.4 | 5.8 | Watts | No load |
| Load regulation | | ±0.02 | ±0.5 | % | No load to full load; nominal input |
| Load current | 0 | | 4.17 | Amps | |
| Current limit | 4.25 | 4.8 | 5.63 | Amps | Output voltage 95% of nominal |
| Short circuit current | 2.91 | 4.8 | 5.63 | Amps | Output voltage <250mV |

### $48V_{OUT}$, 150W (e.g. V24B48C150BL)

| Parameter | Min | Typ | Max | Unit | Notes |
|---|---|---|---|---|---|
| Efficiency | 87.9 | 88.9 | | % | Nominal input; 75% load; 25°C |
| Ripple and noise | | 125 | 157 | mV | P-P; Nominal input; full load; 20MHz bandwidth |
| Output OVP set point | 53.7 | 55.7 | 57.7 | Volts | 25°C; recycle input voltage or PC to restart (>100ms off) |
| Dissipation, standby | | 3.7 | 4.2 | Watts | No load |
| Load regulation | | ±0.02 | ±0.2 | % | No load to full load; nominal input |
| Load current | 0 | | 3.13 | Amps | |
| Current limit | 3.19 | 3.6 | 4.23 | Amps | Output voltage 95% of nominal |
| Short circuit current | 2.19 | 3.6 | 4.33 | Amps | Output voltage <250mV |

## Basic Module Operation




*For C1 – C5, keep leads and connections short.*

***Figure 1 —*** *Basic module operation requires fusing, grounding, bypassing capacitors.* See Maxi, Mini, Micro Design Guide.*

### Output Connections and Considerations

The permissible load current must never be exceeded during normal, abnormal or test conditions. Converters subject to dynamic loading exceeding 25% of rated current must be reviewed by Vicor Applications Engineering to ensure that the converter will operate properly.

Under dynamic-load, light-load or no-load conditions, the converter may emit audible noise. Converters that utilize remote sense may require compensation circuitry to offset the phase lag caused by the external output leads and load impedance. Remote-Sense leads must be protected for conditions such as lead reversal, noise pickup, open circuit or excessive output lead resistance between the sense point and the converters output terminals. For applications that may draw more than the rated current, a fast-acting electronic circuit breaker must be utilized to protect the converter. Under no circumstance should the rated current be exceeded. Utilizing or testing of current limit or short-circuit current will damage the converter. Ensure that the total output capacitance connected to the converter does not exceed the limits on Page 16, "Maximum Output Capacitance", of the design guide.

### Comprehensive Online Application Information




**The Design Guide and Applications Manual includes:**

- Application circuits
- Design requirements
- EMC considerations
- Current sharing in power arrays
- Thermal performance information
- Recommended soldering methods
- Accessory modules – filtering, rectification, front-ends
- Mounting options
- ...and more.

CLICK HERE TO VIEW DESIGN GUIDE

*Also at vicorpower.com*

- PowerBench online configurators
- Over 20 Application Notes
- Online calculators – thermal, trimming, hold-up
- PDF data sheets for ALL Vicor products

## Primary Control – PC Pin

### Module Enable/Disable

The module may be disabled by pulling PC to 0V (2.3V max) with respect to the –Input. This may be done with an open collector transistor, relay or optocoupler. Converters may be disabled with a single transistor or relay either directly or via "OR'ing" diodes for two or more converters. See Figure 2.

### Primary Auxiliary Supply

During normal operation only, the PC Pin can source 5.7V @ 1.5mA. In the example shown in Figure 4, PC powers a module enabled LED.

### Module Alarm

The module contains "watchdog" circuitry which monitors input voltage, operating temperature and internal operating parameters. In the event that any of these parameters are outside of their allowable operating range, the module will shut down and PC will go low. PC will periodically go high and the module will check to see if the fault (as an example, Input Undervoltage) has cleared. If the fault has not been cleared, PC will go low again and the cycle will restart. The SC pin will go low in the event of a fault and return to its normal state after the fault has been cleared. See Figures 3 and 5.

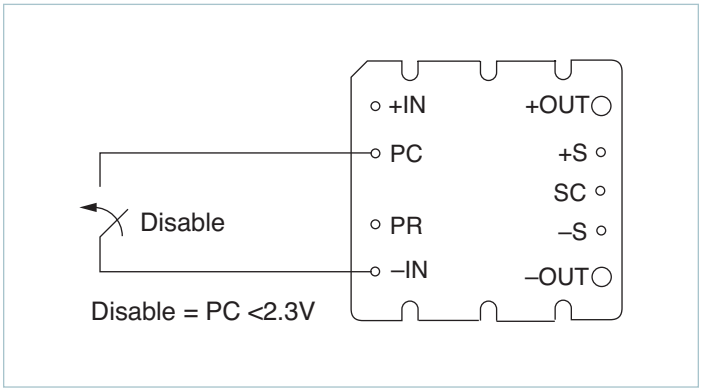



***Figure 2 —*** *Module enable/disable*

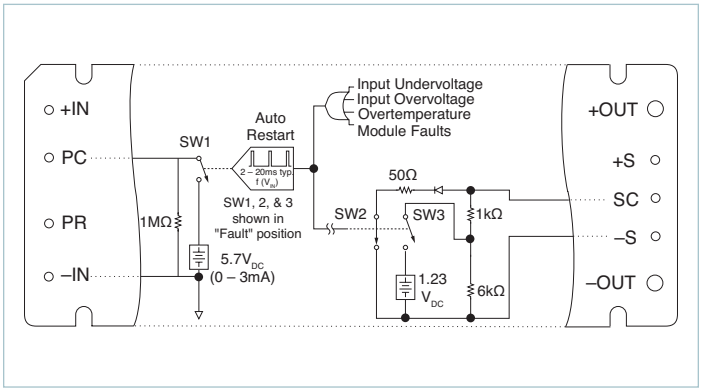



***Figure 3 —*** *PC/SC module alarm logic*

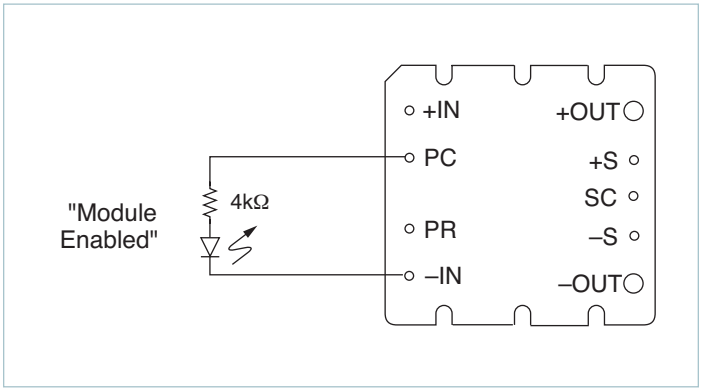



***Figure 4 —*** *LED on-state indicator*

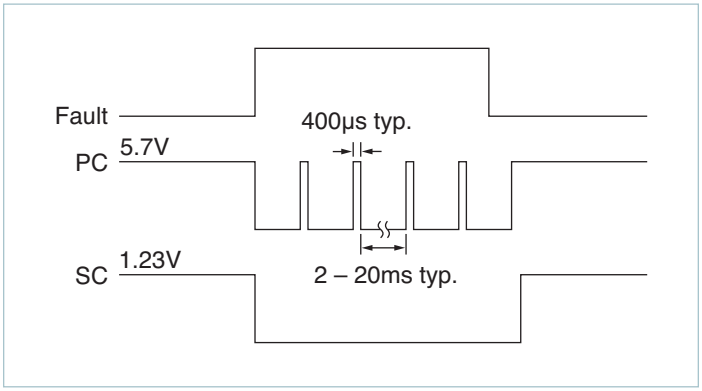



***Figure 5 —*** *PC/SC module alarm timing*

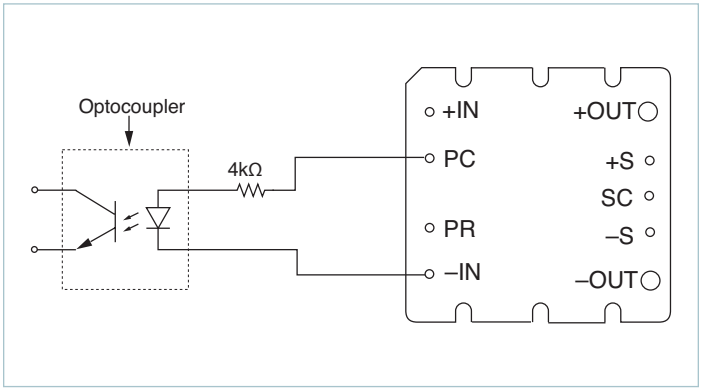



***Figure 6 —*** *Isolated on-state indicator*

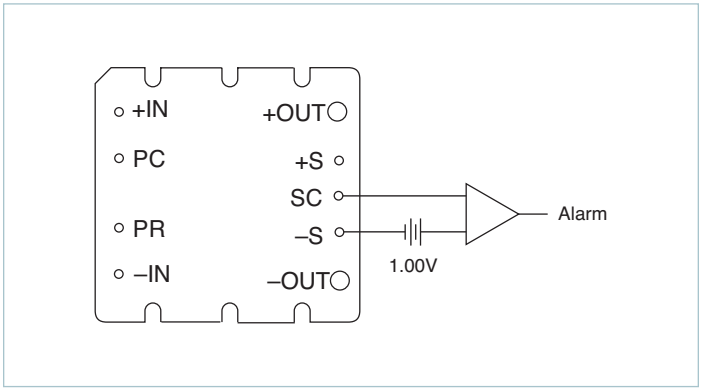



***Figure 7 —*** *Secondary-side on-state indicator*

## Secondary Control – SC Pin

### Output Voltage Programming

The output voltage of the converter can be adjusted or programmed via fixed resistors, potentiometers or voltage DACs. See Figure 8.

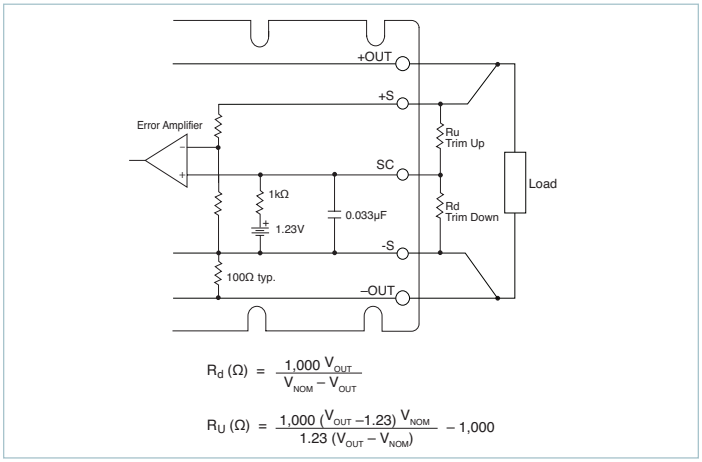



***Figure 8 —*** *Output voltage trim-down and trim-up circuit*

### Trim Down

1. This converter is not a constant-power device – it has a constant current limit. Hence, available output power is reduced by the same percentage that output voltage is trimmed down. Do not exceed maximum rated output current.
2. The trim-down resistor must be connected between the SC and –S pins. Do not bypass the SC pin directly with a capacitor.

### Trim Up

1. The converter is rated for a maximum delivered power. To ensure that maximum rated power is not exceeded, reduce maximum output current by the same percentage increase in output voltage.
2. The trim-up resistor must be connected between the SC and +S pins. Do not bypass the SC pin directly with a capacitor.
3. Do not trim the converter above maximum trim range (typically +10%) or the output over voltage protection circuitry may be activated.

**Trim resistor values calculated automatically:**

On-line calculators for trim resistor values are available on the vicor website at:
asp.vicorpower.com/calculators/calculators.asp?calc=1
Resistor values can be calculated for fixed trim up, fixed trim down and for variable trim up or down.

## Parallel Bus – PR Pin

### Parallel Operation

The PR pin supports paralleling for increased power with N+1 (N+M) redundancy. Modules of the same input voltage, output voltage, and power level will current share if all PR pins are suitably interfaced.

Compatible interface architectures include the following:

***AC-coupled single-wire interface.*** All PR pins are connected to a single communication bus through 0.001µF (500V) capacitors. This interface supports current sharing and is fault tolerant except for the communication bus. Up to three converters may be paralleled by this method. See Figure 9.

***Transformer-coupled interface.*** For paralleling four or more converters a transformer coupled interface is required, and under certain conditions a PR buffer circuit.

For details on parallel operation please refer to the Design Guide & Applications Manual for Maxi, Mini, Micro Family.

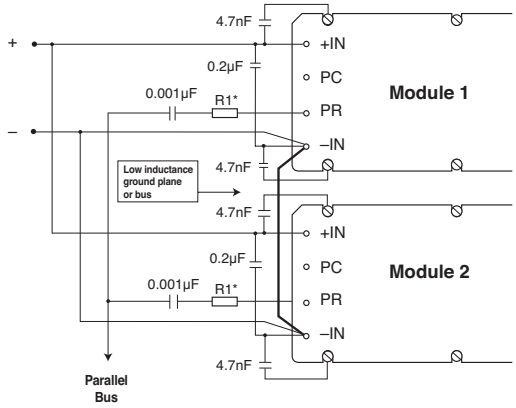



***Figure 9 —*** *AC-coupled single-wire interface*
** See Maxi, Mini, Micro Design Guide*

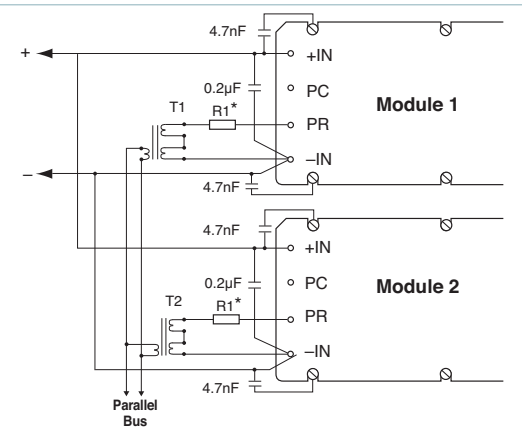
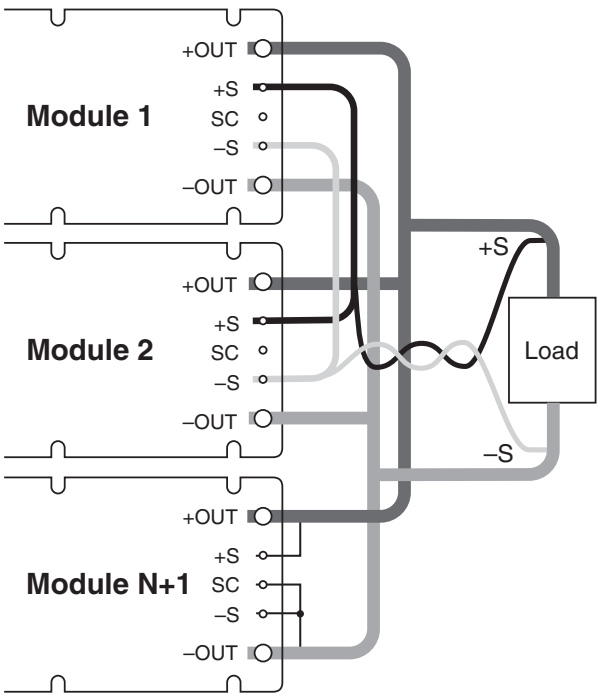



***Figure 10 —*** *Transformer-coupled interface*

| Number of Converters in Parallel | *R1 value Ω |
|---|---|
| 2 | 75 |
| 3 | 50 |
| 4 | 33 |
| 5 or more | refer to application note: Designing High-Power Arrays using Maxi, Mini, Micro Family DC-DC Converters |

## Parallel Bus Output




- The +OUT and –OUT power buses should be designed to minimize and balance parasitic impedance from each module output to the load.
- The +Sense pins must be tied together to form a +Sense bus. This must be Kelvin connected to +OUT at a single point. The –Sense pins should be tied together to form a –Sense bus. This must be Kelvin connected to –OUT at a single point.
- At the discretion of the power system designer, a subset of all modules within an array may be configured as children by connecting SC to –S.
- OR'ing diodes may be inserted in series with the +OUT pins of each module to provide module output fault tolerance.
- The +Sense and –Sense leads should be routed in close proximity to each other on the printed circuit board. If wires are used to connect the converters on a PCB to an external load, the Sense leads should be twisted together to reduce noise pickup.

***Figure 11 —*** *N+1 module array output connections*

### Pin Styles*

| Designator | Description | Finish | Notes |
|---|---|---|---|
| (None) | Short | Tin/Lead | Requires inboard mounting |
| L | Long | Tin/Lead | Onboard mounting for 0.065in boards |
| S | Short ModuMate | Gold | SurfMate or inboard socket mounting |
| N | Long ModuMate | Gold | Onboard socket mounting |
| F | Short RoHS | Gold | Select for RoHS-compliant inboard solder, socket or SurfMate mounting |
| G | Long RoHS | Gold | Select for RoHS-compliant onboard solder or socket mounting |
| K | Extra Long RoHS | Gold | Select for RoHS compliance onboard mounting for thicker PCBs (not intended for socket or Surfmate mounting) |

* Pin style designator follows the "B" after the output power and precedes the baseplate designator.
Ex. V24B12T250B**N**2 — Long ModuMate Pins

## Storage

Vicor products, when not installed in customer units, should be stored in ESD safe packaging in accordance with ANSI/ESD S20.20, "Protection of Electrical and Electronic Parts, Assemblies and Equipment" and should be maintained in a temperature controlled factory/ warehouse environment not exposed to outside elements controlled between the temperature ranges of 15°C and 38°C. Humidity shall not be condensing, no minimum humidity when stored in an ESD compliant package.

## Mechanical Drawings

| Converter Pins | | |
|---|---|---|
| **No.** | **Function** | **Label** |
| 1 | +IN | + |
| 2 | Primary Control | PC |
| 3 | Parallel | PR |
| 4 | –IN | – |
| 5 | –OUT | – |
| 6 | –Sense | –S |
| 7 | Secondary Control | SC |
| 8 | +Sense | +S |
| 9 | +OUT | + |

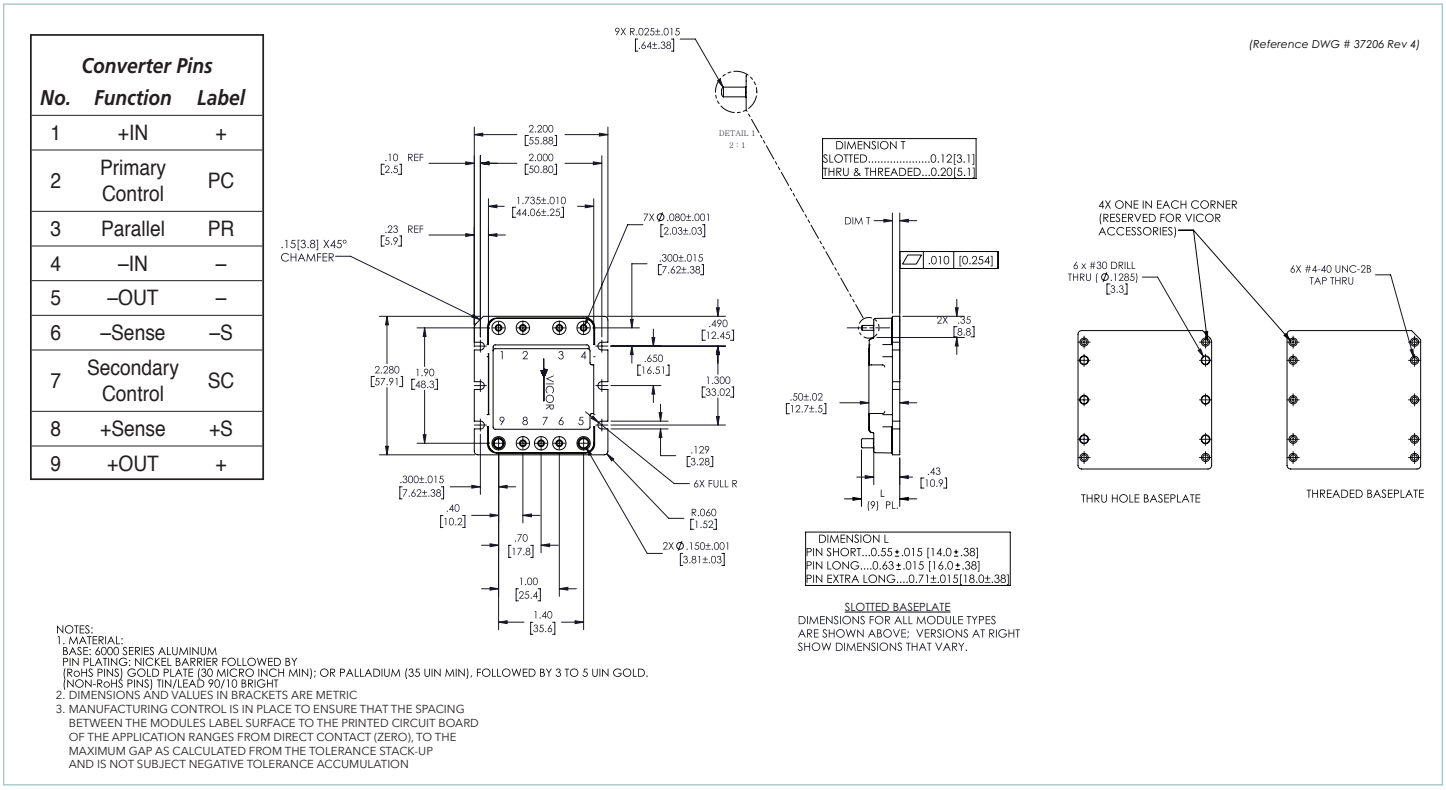



***Figure 12 —*** *Module outline*

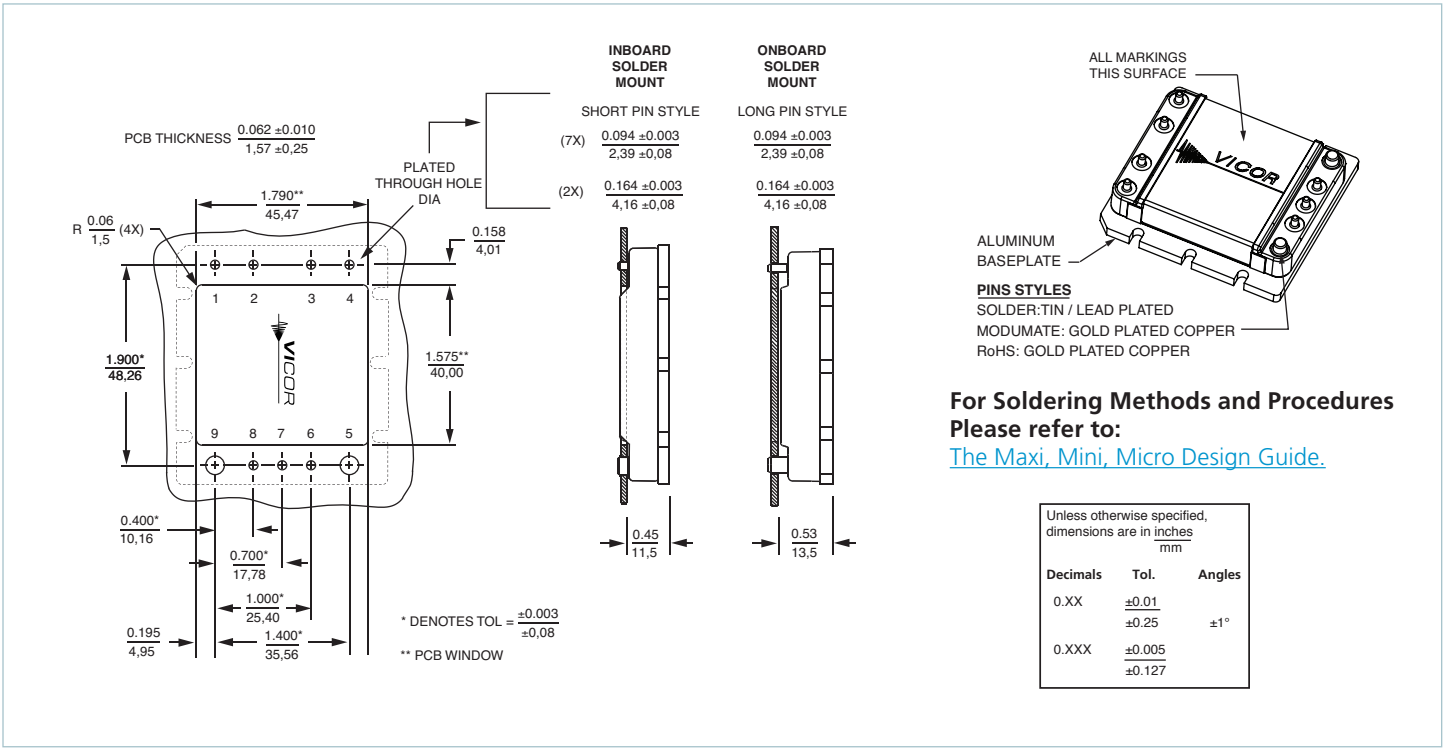



***Figure 13 —*** *PCB mounting specifications*

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