



Size:  
1.91 x 1.09 x 0.37 in  
48,6 x 27,7 x 9,5 mm

## Applications

- Solid state lighting
- Stadium displays
- Industrial controls
- Avionics
- Underseas
- RF Amplifiers
- Microprocessor and DSP requiring fast response

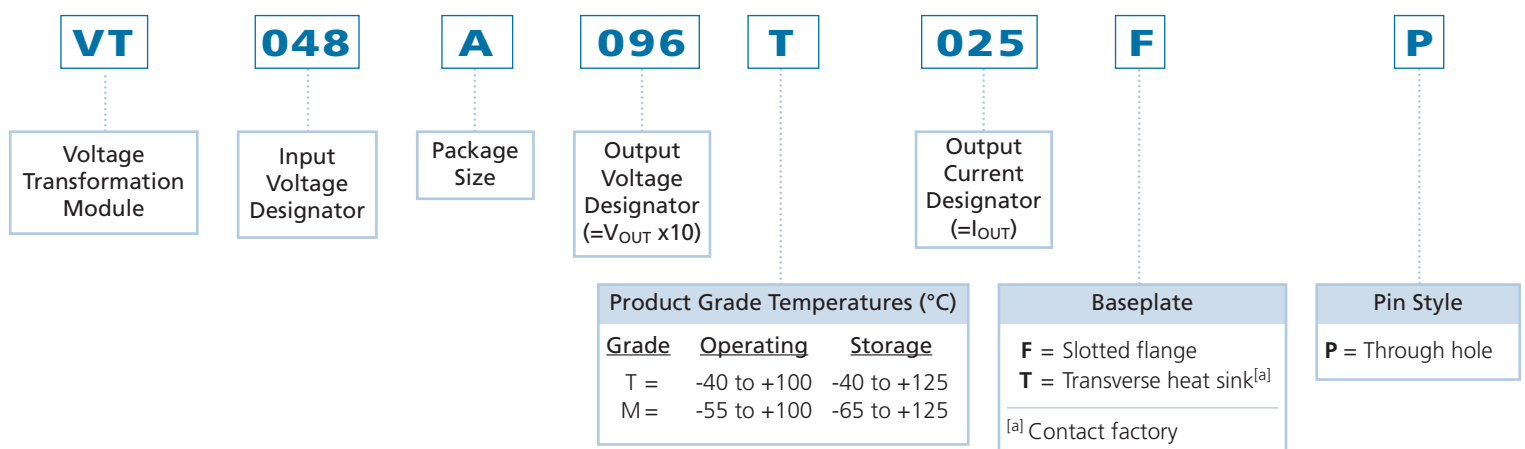
## Features

- 100°C baseplate operation
- 48 V to 9.6 V Converter
- 25 A (37.5 A for 1 ms)
- High density – up to 312 W/in<sup>3</sup>
- Small footprint – 1.64 and 2.08 in<sup>2</sup>
- Height above board – 0.37 in (9.5 mm)
- Low weight – 1.10 oz (31.3 g)
- ZVS / ZCS isolated sine amplitude converter
- Typical efficiency 96%
- <1 μs transient response
- Isolated output
- No output filtering required
- Lead free wave solder compatible
- Agency approvals

## Product Overview

The thermally enhanced VI BRICK VTM current multiplier excels at speed, density and efficiency to meet the demands of advanced power applications. Combined with the VI BRICK PRM regulator they create a DC-DC converter with flexibility to provide isolation and regulation where needed. The PRM can be located with the VTM at the point of load or remotely in the back plane or on a daughter card.

## Part Numbering



## SPECIFICATIONS

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.

### Absolute Maximum Ratings

| Parameter             | Values       | Unit | Notes              |
|-----------------------|--------------|------|--------------------|
| +In to -In            | -1.0 to 60   | Vdc  |                    |
| +In to -In            | 100          | Vdc  | For 100 ms         |
| PC to -In             | -0.3 to 7.0  | Vdc  |                    |
| VC to -In             | -0.3 to 19.0 | Vdc  |                    |
| +Out to -Out          | -0.5 to 16   | Vdc  |                    |
| Isolation voltage     | 2,250        | Vdc  | Input to output    |
| Output current        | 25           | A    | Continuous         |
| Peak output current   | 37.5         | A    | For 1 ms           |
| Output power          | 268          | W    | Continuous         |
| Peak output power     | 401          | W    | For 1 ms           |
| Operating temperature | -40 to +100  | °C   | T-Grade; baseplate |
|                       | -55 to +100  | °C   | M-Grade; baseplate |
| Storage temperature   | -40 to +125  | °C   | T-Grade            |
|                       | -65 to +125  | °C   | M-Grade            |

**Note:** Stresses in excess of the maximum ratings can cause permanent damage to the device. Operation of the device is not implied at these or any other conditions in excess of those given in the specification. Exposure to absolute maximum ratings can adversely affect device reliability.

### Input Specifications *(Conditions are at 48 Vin, full load, and 25°C ambient unless otherwise specified)*

| Parameter                      | Min  | Typ | Max  | Unit   | Notes  |
|--------------------------------|------|-----|------|--------|--|
| Input voltage range            | 32   | 48  | 55   | Vdc    | Max $V_{IN}$ = 53 V, operating from -55°C to -40°C |
| Input dV/dt                    |      |     | 1    | V/μs   |  |
| Input overvoltage turn-on      | 55.0 |     |      | Vdc    |  |
| Input overvoltage turn-off     |      |     | 59.5 | Vdc    |  |
| Input current                  |      |     | 5.4  | Adc    |  |
| Input reflected ripple current |      | 140 |      | mA p-p | Using test circuit in Figure 10; See Figure 1      |
| No load power dissipation      |      | 3.1 | 4.1  | W      |  |
| Internal input capacitance     |      | 4.0 |      | μF     |  |
| Internal input inductance      |      |     | 5    | nH     |  |

## SPECIFICATIONS (CONT.)

### Output Specifications *(Conditions are at 48 V<sub>in</sub>, full load, and 25°C ambient unless otherwise specified)*

| Parameter                          | Min    | Typ  | Max    | Unit  | Note   |
|------------------------------------|--------|------|--------|-------|--|
| Output voltage                     | 6.40   |      | 11.0   | Vdc   | No load  |
|                                    | 6.10   |      | 10.7   | Vdc   | Full load  |
| Rated DC current                   | 0      |      | 25     | Adc   | 32 - 55 V <sub>IN</sub>  |
| Peak repetitive current            |        |      | 37.5   | A     | Max pulse width 1ms, max duty cycle 10%, baseline power 50%      |
| Short circuit protection set point | 33.0   |      |        | Adc   | Module will shut down  |
| Current share accuracy             |        | 5    | 10     | %     | See Parallel Operation on Page 7                                 |
| Efficiency                         |        |      |        |       |  |
| Half load                          | 95.5   | 96.2 |        | %     | See Figure 3   |
| Full load                          | 95.5   | 96.2 |        | %     | See Figure 3   |
| Internal output inductance         |        | 1.6  |        | nH    |  |
| Internal output capacitance        |        | 55   |        | μF    | Effective value  |
| Output overvoltage setpoint        | 11.0   |      |        | Vdc   | Module will shut down  |
| Output ripple voltage              |        |      |        |       |  |
| No external bypass                 |        | 176  | 200    | mVp-p | See Figures 2 and 5  |
| 10 μF bypass capacitor             |        | 17   |        | mVp-p | See Figure 6   |
| Effective switching frequency      | 3.0    | 3.1  | 3.4    | MHz   | Fixed, 1.6 MHz per phase   |
| Line regulation                    |        |      |        |       |  |
| K                                  | 0.1980 | 1/5  | 0.2020 |       | V <sub>OUT</sub> = K•V <sub>IN</sub> at no load                  |
| Load regulation                    |        |      |        |       |  |
| R <sub>OUT</sub>                   |        | 8.9  | 12.0   | mΩ    | See Figure 13  |
| Transient response                 |        |      |        |       |  |
| Voltage overshoot                  |        | 92   |        | mV    | 25 A load step with 100 μF C <sub>IN</sub> ; See Figures 7 and 8 |
| Response time                      |        | 200  |        | ns    | See Figures 7 and 8  |
| Recovery time                      |        | 1    |        | μs    | See Figures 7 and 8  |

## WAVEFORMS

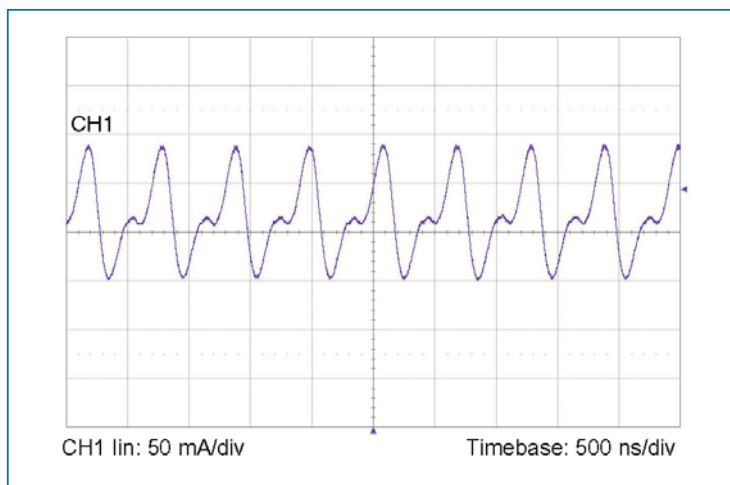


Figure 1 — Input reflected ripple current at full load and 48 Vf.

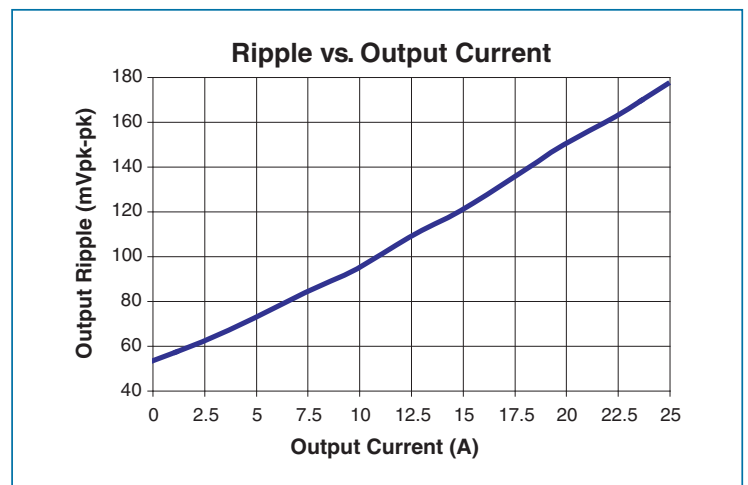


Figure 2 — Output voltage ripple vs. output current at 48 Vf with no POL bypass capacitance.

WAVEFORMS

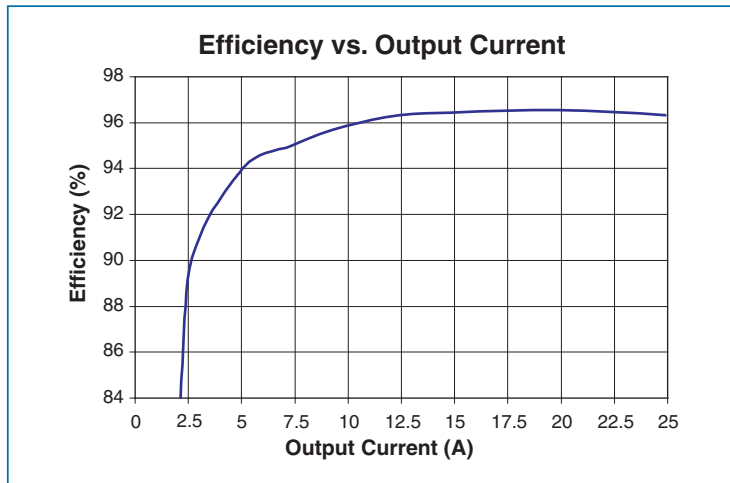


Figure 3 — Efficiency vs. output current.

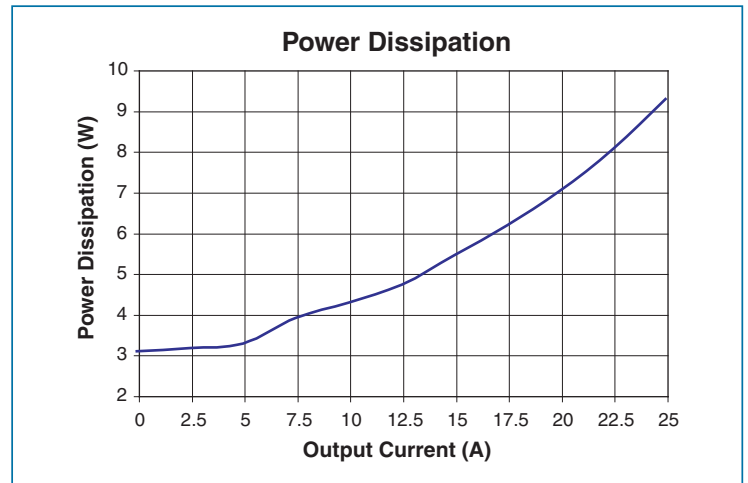


Figure 4 — Power dissipation vs. output current.

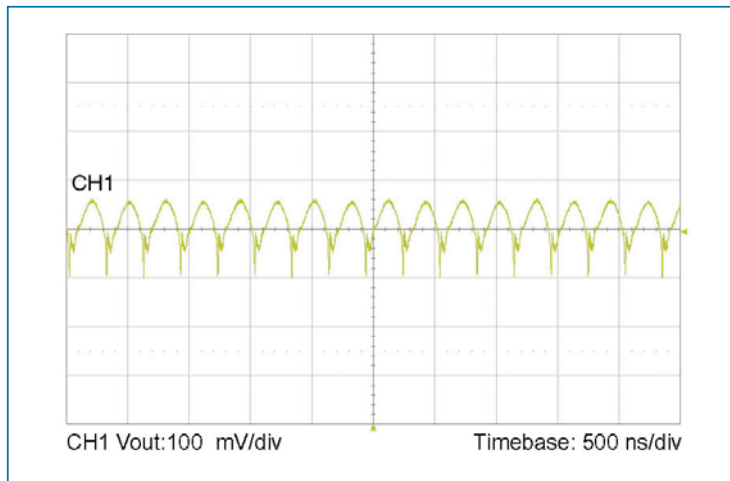


Figure 5 — Output voltage ripple at full load and 48 V<sub>f</sub> with no POL bypass capacitance.

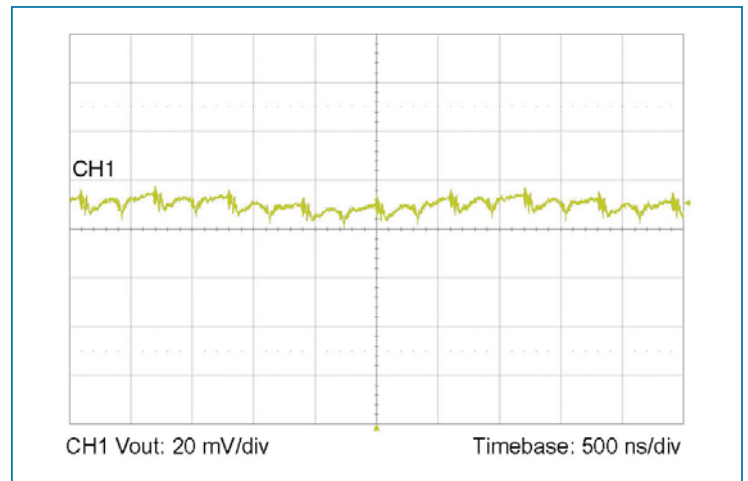


Figure 6 — Output voltage ripple at full load and 48 V<sub>f</sub> with 10 μF ceramic POL bypass capacitance and 20 nH distribution inductance.

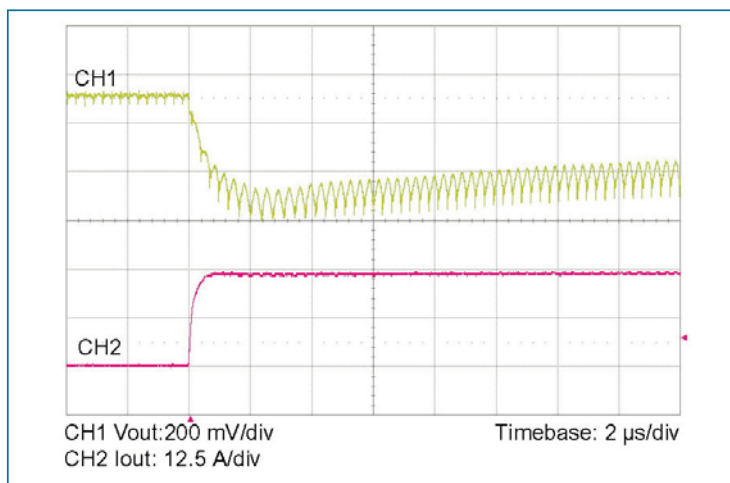


Figure 7 — 0-25 A load step with 100 μF input capacitance and no output capacitance.

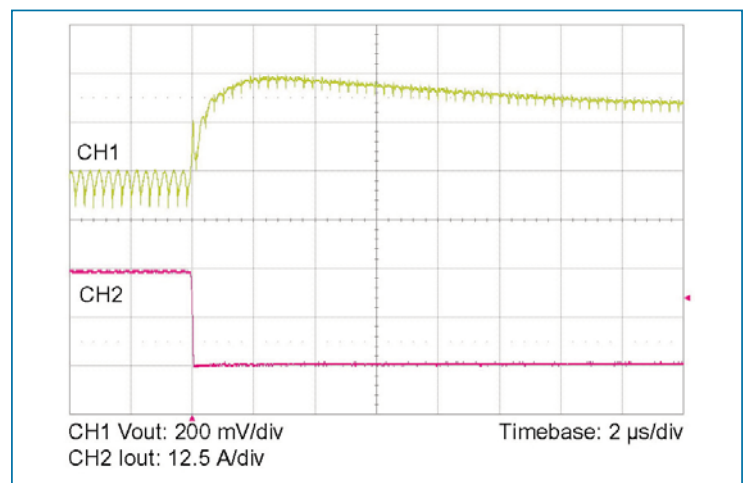


Figure 8 — 25-0 A load step with 100 μF input capacitance and no output capacitance.

## SPECIFICATIONS (CONT.)

### General Specifications

| Parameter                                | Min   | Typ       | Max | Unit  | Notes                                   |
|--|-------|-----------|-----|-------|---|
| MTBF                                     |       |           |     |       |   |
| MIL-HDBK-217F                            |       | 3.5       |     | Mhrs  | 25°C, GB                                |
| Isolation specifications                 |       |           |     |       |   |
| Voltage                                  | 2,250 |           |     | Vdc   | Input to output                         |
| Capacitance                              |       | 3,000     |     | pF    | Input to output                         |
| Resistance                               | 10    |           |     | MΩ    | Input to output                         |
| <a href="#">Agency approvals</a>         |       | cTÜVus    |     |       | UL/CSA 60950-1, EN 60950-1              |
|  |       | CE Mark   |     |       | Low voltage directive                   |
|  |       | RoHS      |     |       |   |
| Mechanical                               |       |           |     |       | See Mechanical Drawings, Figures 15, 16 |
| Weight                                   |       | 1.10/31.3 |     | oz/g  |   |
| Dimensions                               |       |           |     |       |   |
| Length                                   |       | 1.91/48,6 |     | in/mm | Baseplate model                         |
| Width                                    |       | 1.09/27,7 |     | in/mm | Baseplate model                         |
| Height                                   |       | 0.37/9,5  |     | in/mm | Baseplate model                         |
| Thermal                                  |       |           |     |       |   |
| Over temperature shutdown                | 125   | 130       | 135 | °C    | Junction temperature                    |
| Thermal capacity                         |       | 23.8      |     | Ws/°C |   |
| Baseplate-to-ambient                     |       | 7.7       |     | °C/W  |   |
| Baseplate-to-ambient; 1000 LFM           |       | 2.9       |     | °C/W  |   |
| Baseplate-to-sink; flat, greased surface |       | 0.40      |     | °C/W  |   |
| Baseplate-to-sink; thermal pad           |       | 0.36      |     | °C/W  |   |

### Auxiliary Pins

| Parameter               | Min | Typ | Max | Unit | Notes  |
|-------------------------|-----|-----|-----|------|--|
| Primary Control (PC)    |     |     |     |      |  |
| DC voltage              | 4.8 | 5.0 | 5.2 | Vdc  |  |
| Module disable voltage  | 2.4 | 2.5 |     | Vdc  |  |
| Module enable voltage   |     | 2.5 | 2.6 | Vdc  | VC voltage must be applied when module is enabled using PC     |
| Current limit           | 2.4 | 2.5 | 2.9 | mA   | Source only  |
| Disable delay time      |     | 20  |     | μs   | PC low to Vout low   |
| VTM Control (VC)        |     |     |     |      |  |
| External boost voltage  | 12  | 14  | 19  | Vdc  | Required for VTM start up without PRM                          |
| External boost duration |     | 10  |     | ms   | Vin > 32 Vdc. VC must be applied continuously if Vin < 32 Vdc. |

### +In / -In DC Voltage Ports

The VTM input should not exceed the maximum specified. Be aware of this limit in applications where the VTM is being driven above its nominal output voltage. If less than 32 Vdc is present at the +In and -In ports, a continuous VC voltage must be applied for the VTM to process power. Otherwise VC voltage need only be applied for 10 ms after the voltage at the +In and -In ports has reached or exceeded 32 Vdc. If the input voltage exceeds the overvoltage turn-off, the VTM will shutdown. The VTM does not have internal input reverse polarity protection. Adding a properly sized diode in series with the positive input or a fused reverse-shunt diode will provide reverse polarity protection.

### TM – For Factory Use Only

### VC – VTM Control

The VC port is multiplexed. It receives the initial  $V_{CC}$  voltage from an upstream PRM, synchronizing the output rise of the VTM with the output rise of the PRM. Additionally, the VC port provides feedback to the PRM to compensate for the VTM output resistance. In typical applications using VTMs powered from PRMs, the PRM's VC port should be connected to the VTM VC port.

In applications where a VTM is being used without a PRM, 14 V must be supplied to the VC port for as long as the input voltage is below 32 V and for 10 ms after the input voltage has reached or exceeded 32 V. The VTM is not designed for extended operation below 32 V. The VC port should only be used to provide  $V_{CC}$  voltage to the VTM during startup.

### PC – Primary Control

The Primary Control (PC) port is a multifunction port for controlling the VTM as follows:

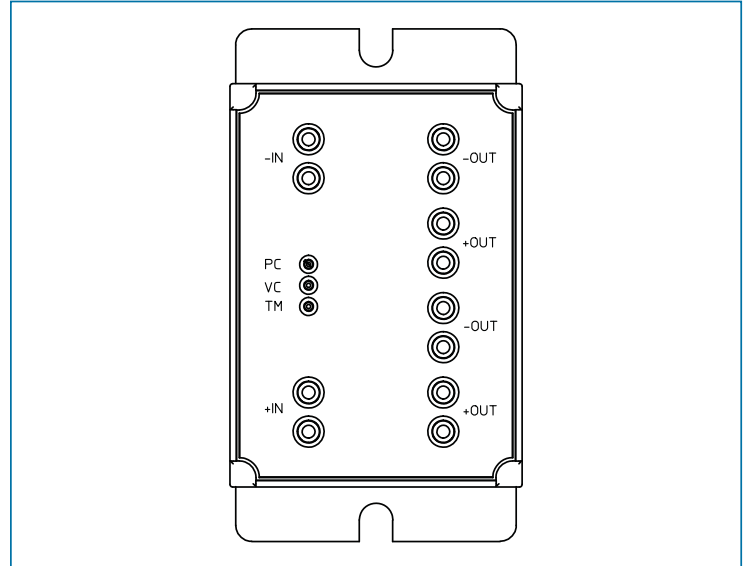
**Disable** – If PC is left floating, the VTM output is enabled. To disable the output, the PC port must be pulled lower than 2.4 V, referenced to -In. Optocouplers, open collector transistors or relays can be used to control the PC port. Once disabled, 14 V must be re-applied to the VC port to restart the VTM.

**Primary Auxiliary Supply** – The PC port can source up to 2.4 mA at 5 Vdc.

### +Out / -Out DC Voltage Output Ports

The output and output return are through two sets of contact locations. The respective +Out and -Out groups must be connected in parallel with as low an interconnect resistance as possible. Within the specified input voltage range, the Level 1 DC behavioral model shown in Figure 13 defines the output voltage of the VTM. The current source capability of the VTM is shown in the specification table.

To take full advantage of the VTM, the user should note the low output impedance of the device. The low output impedance provides fast transient response without the need for bulk POL capacitance. Limited-life electrolytic capacitors required with conventional converters can be reduced or even eliminated, saving cost and valuable board real estate.



**Figure 9** — VI BRICK VTM pin configuration (viewed from pin side)

## Parallel Operation

In applications requiring higher current or redundancy, VTM's can be operated in parallel without adding control circuitry or signal lines. To maximize current sharing accuracy, it is imperative that the source and load impedance on each VTM in a parallel array be equal. If VTM's are being fed by an upstream PRM, the VC nodes of all VTM's must be connected to the PRM VC.

To achieve matched impedances, dedicated power planes within the PC board should be used for the output and output return paths to the array of paralleled VTM's. This technique is preferable to using traces of varying size and length.

The VTM power train and control architecture allow bi-directional power transfer when the VTM is operating within its specified ranges. Bi-directional power processing improves transient response in the event of an output load dump. The VTM may operate in reverse, returning output power back to the input source. It does so efficiently.

## Input Impedance Recommendations

To take full advantage of the VTM's capabilities, the impedance of the source (input source plus the PC board impedance) must be low over a range from DC to 5 MHz. The input of the VTM (factorized bus) should be locally bypassed with a 8  $\mu\text{F}$  low Q aluminum electrolytic capacitor. Additional input capacitance may be added to improve transient performance or compensate for high source impedance. The VTM has extremely wide bandwidth so the source response to transients is usually the limiting factor in overall output response of the VTM.

Anomalies in the response of the source will appear at the output of the VTM, multiplied by its K factor of 1/5. The DC resistance of the source should be kept as low as possible to minimize voltage deviations on the input to the VTM. If the VTM is going to be operating close to the high limit of its input range, make sure input voltage deviations will not trigger the input overvoltage turn-off threshold.

## Input Fuse Recommendations

VI BRICKs are not internally fused in order to provide flexibility in configuring power systems. However, input line fusing of VI BRICKs must always be incorporated within the power system. A fast acting fuse is required to meet safety agency Conditions of Acceptability. The input line fuse should be placed in series with the +In port. For agency approvals and fusing conditions, click on the link below:

[http://www.vicorpower.com/technical\\_library/technical\\_documentation/quality\\_and\\_certification/safety\\_approvals/](http://www.vicorpower.com/technical_library/technical_documentation/quality_and_certification/safety_approvals/)

## Application Notes

For VTM and VI BRICK application notes on soldering, board layout, and system design please click on the link below:

[http://www.vicorpower.com/technical\\_library/application\\_information/](http://www.vicorpower.com/technical_library/application_information/)

## Applications Assistance

Please contact Vicor Applications Engineering for assistance, 1-800-927-9474, or email at [apps@vicorpower.com](mailto:apps@vicorpower.com).

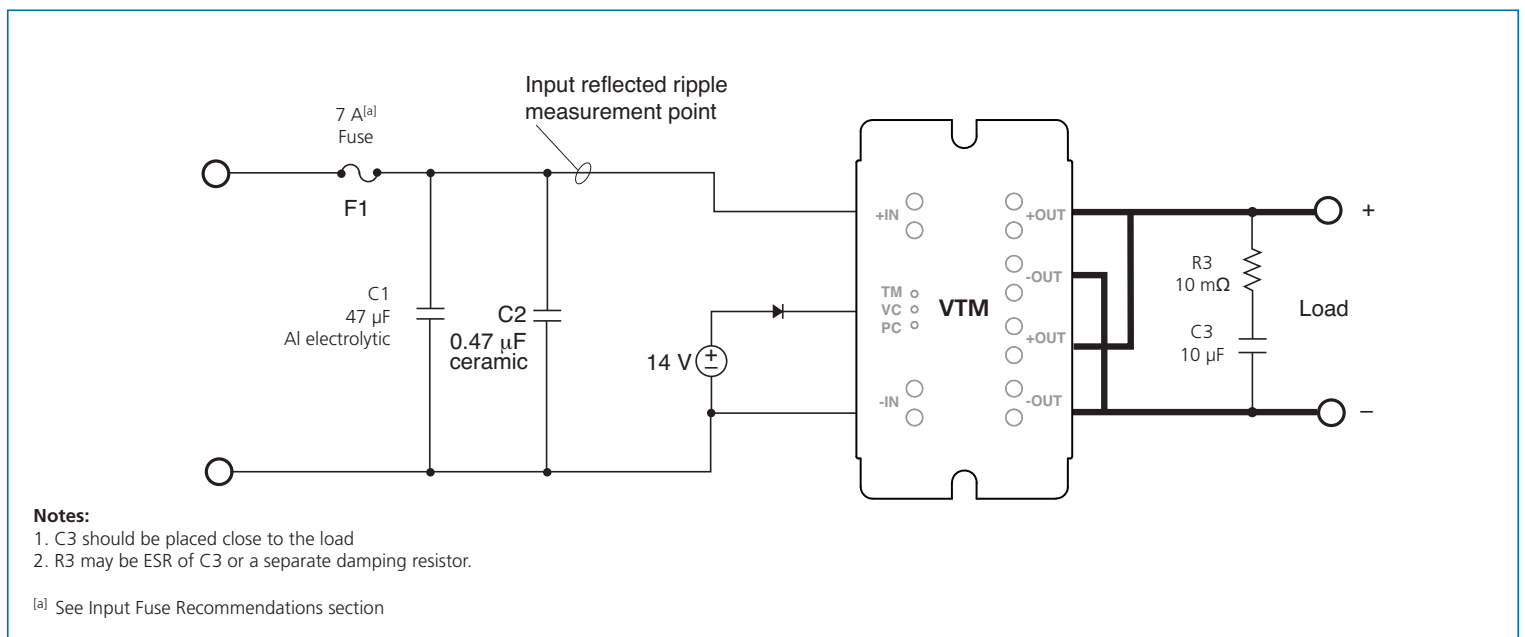


Figure 10 — VI BRICK VTM test circuit

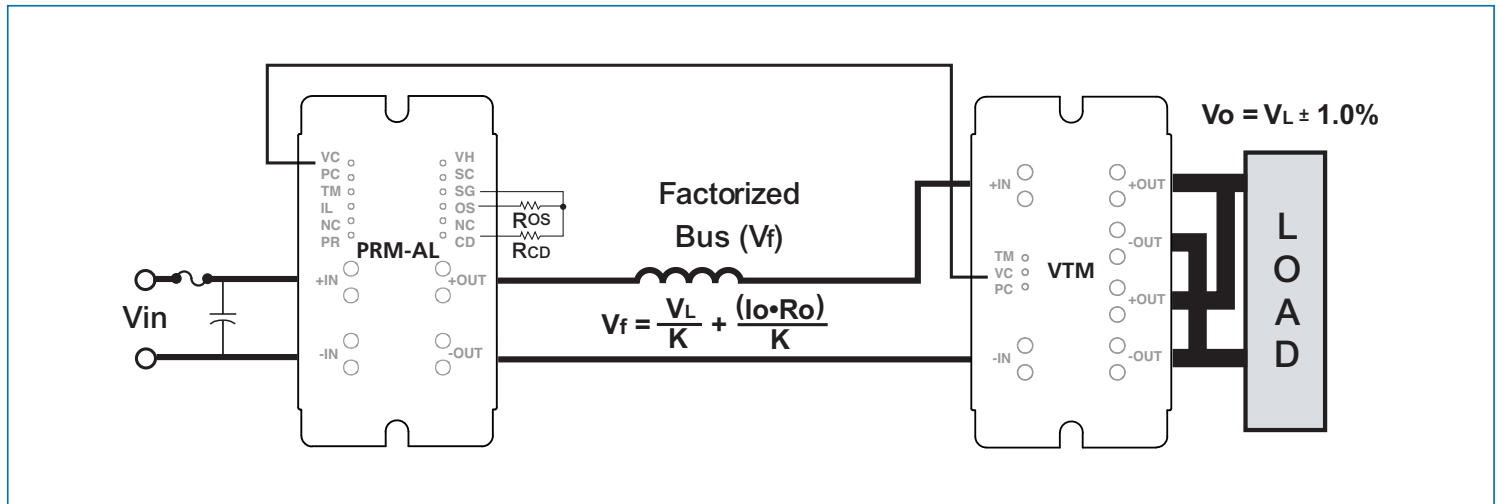
## APPLICATION NOTES (CONT.)

In figures below;

$K$  = VTM transformation ratio  
 $R_o$  = VTM output resistance

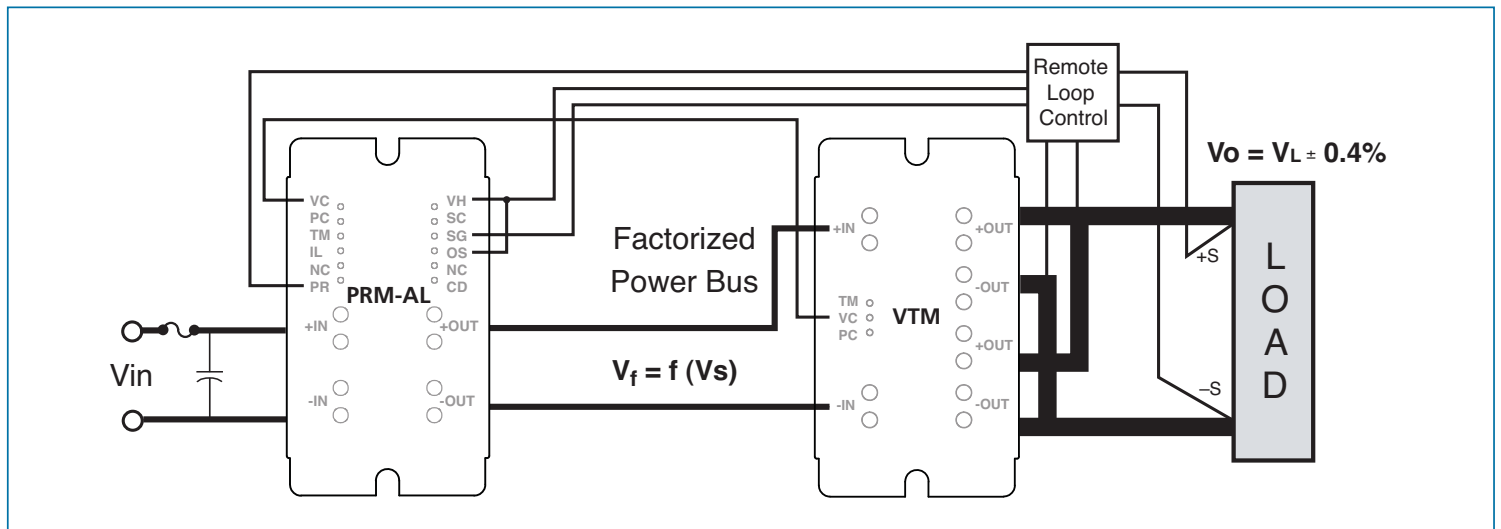
$V_f$  = PRM output (Factorized Bus Voltage)  
 $V_o$  = VTM output  
 $V_L$  = Desired load voltage

### FPA ADAPTIVE LOOP



**Figure 11** — The PRM controls the factorized bus voltage,  $V_f$ , in proportion to output current to compensate for the output resistance,  $R_o$ , of the VTM. The VTM output voltage is typically within 1% of the desired load voltage ( $V_L$ ) over all line and load conditions.

### FPA NON-ISOLATED REMOTE LOOP



**Figure 12** — An external error amplifier or Point-of-Load IC (POLIC) senses the load voltage and controls the PRM output – the Factorized Bus – as a function of output current, compensating for the output resistance of the VTM and for distribution resistance.

## BEHAVIORAL MODELS

### VI BRICK VTM LEVEL 1 DC BEHAVIORAL MODEL FOR 48 V TO 9.6 V, 25 A

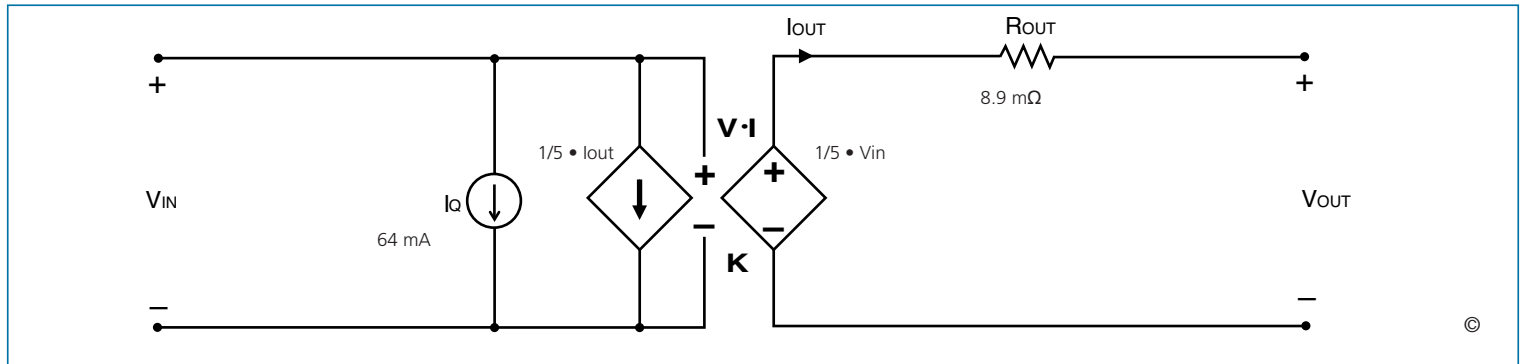


Figure 13 — This model characterizes the DC operation of the VI BRICK VTM, including the converter transfer function and its losses. The model enables estimates or simulations of output voltage as a function of input voltage and output load, as well as total converter power dissipation or heat generation.

### VI BRICK VTM LEVEL 2 TRANSIENT BEHAVIORAL MODEL FOR 48 V TO 9.6 V, 25 A

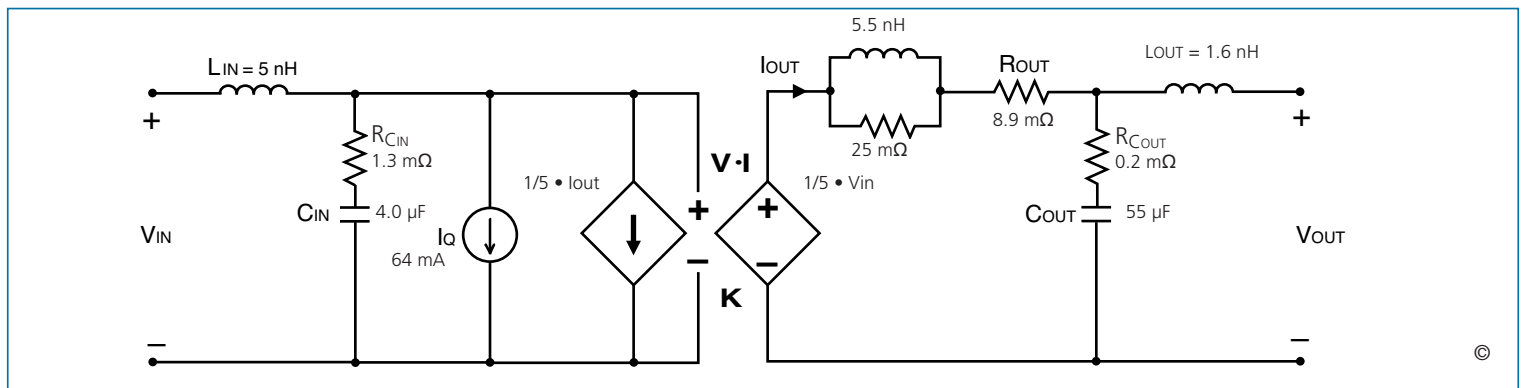


Figure 14 — This model characterizes the AC operation of the VI BRICK VTM including response to output load or input voltage transients or steady state modulations. The model enables estimates or simulations of input and output voltages under transient conditions, including response to a stepped load with or without external filtering elements.

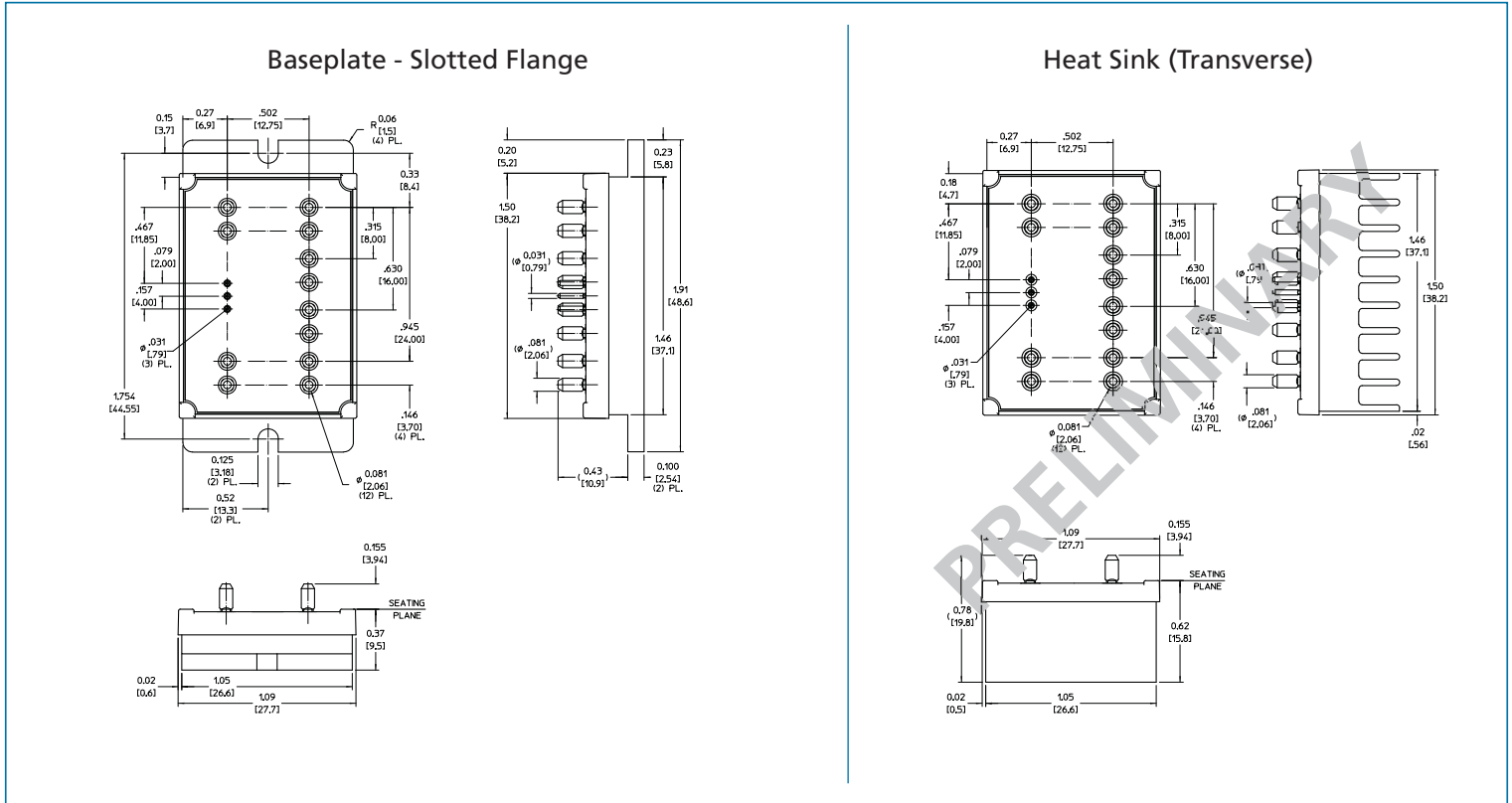


Figure 15 — Module outline

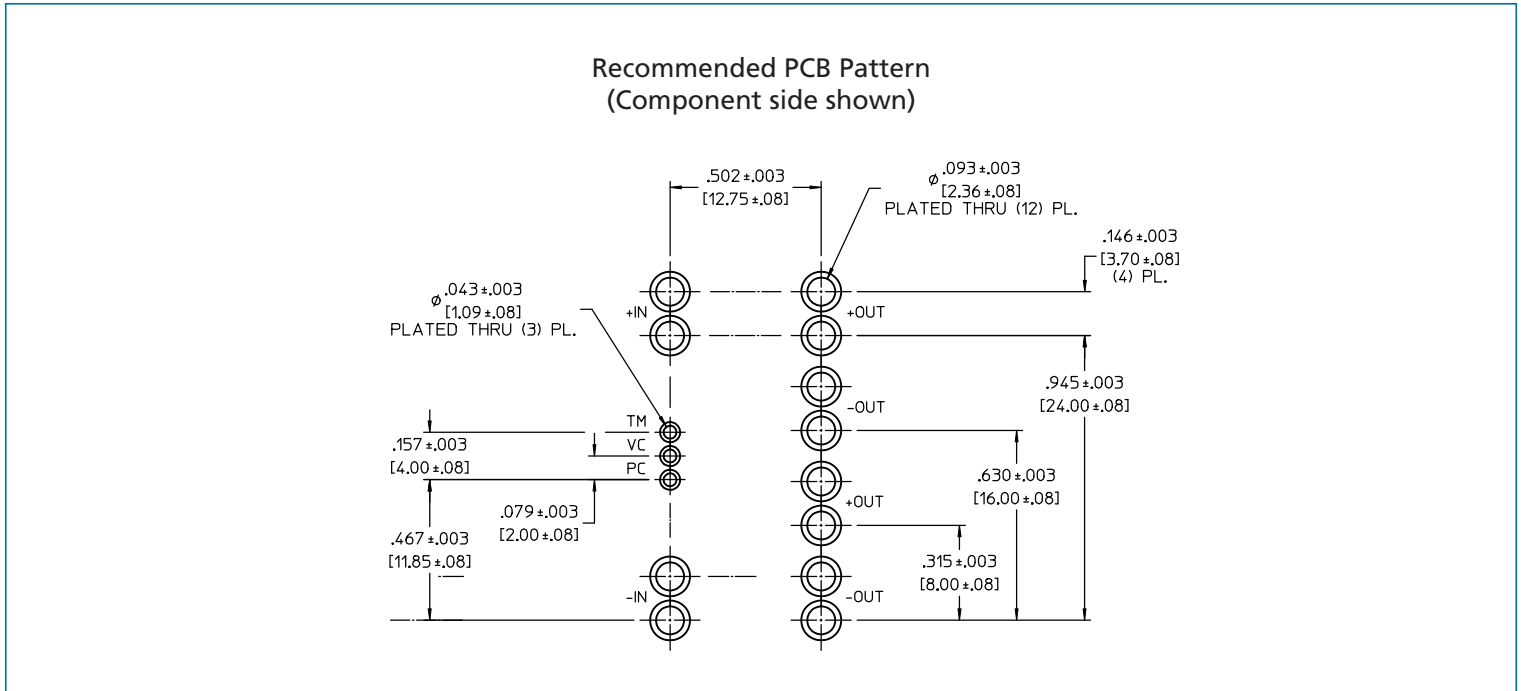


Figure 16 — PCB mounting specifications

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7,166,898; 7,187,263; D496,906; D505,114; D506,438; D509,472

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