



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

Features

- -55°C to 100°C baseplate operation
- Isolated 1 to 50 Vout
- High density
- Small footprint
- ZVS / ZCS Sine Amplitude Converter
- 3 MHz effective switching frequency
- Low weight – 1.10 oz (31.3 g)
- 1 μ s transient response
- Up to 96.5% efficiency

Product Overview

The VI BRICK VTM Current Multiplier provides extremely fast, efficient, and quiet fixed ratio voltage division (or current multiplication). With twelve voltage division ratios from 1:1 to 1:32, the isolated VI BRICK VTM provides the user with the flexibility to supply up to 100 A or 120 W at any output voltage from 1 to 50 Vdc in a package occupying ~ 2 square inches.

The Military COTS VI BRICK VTMs are optimized for use with the Military Pre-Regulator Module to implement a Factorized Power Architecture (FPA).

Together, the PRM™ + VTM set provides the full functionality of a DC-DC converter, but with breakthrough performance and flexibility in a rugged, miniature package. The companion VI BRICK PRM for the MT036 family of VI BRICK VTMs is the 28 Vdc input MR028A036M012FP, which operates from an input range of 16-50 Vdc (the data sheet is available at vicorpower.com). The VTM can also be used as a standalone POL product.

By factorizing the DC-DC power conversion into its essential elements – isolation and transformation on the one hand, and the

output voltage control and regulation on the other – and arranging those functions in a sequence that maximizes system performance, FPA offers a fundamentally new and significantly improved approach to power conversion.

The VI BRICK VTM's fast dynamic response and low noise eliminate the need for bulk capacitance at the load, substantially increasing the POL density while improving reliability and decreasing cost.

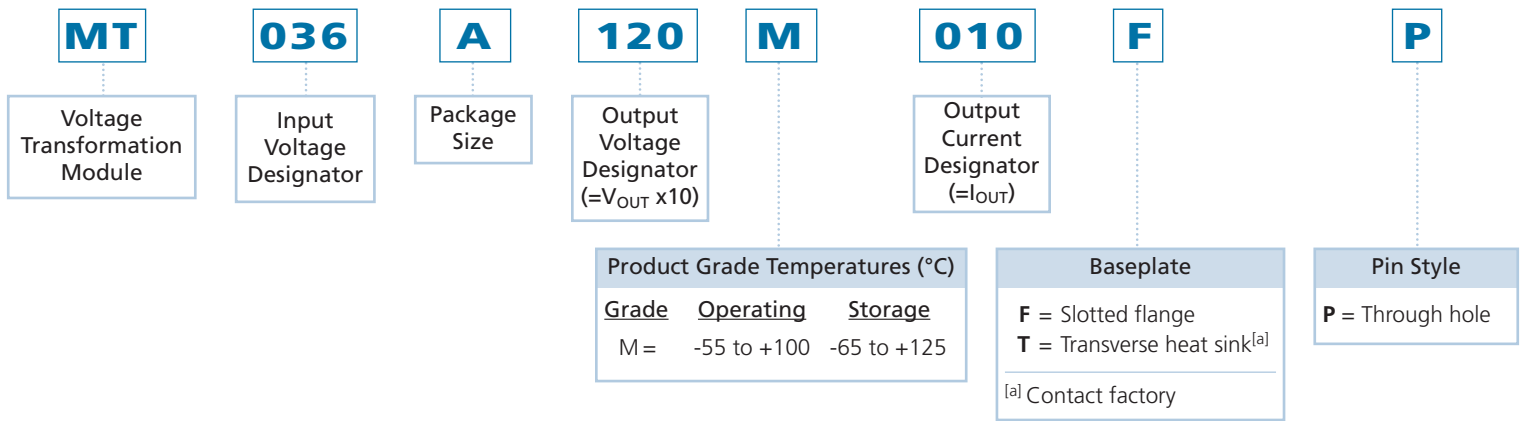
Absolute Maximum Ratings

| 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 | Model specific | Vdc | |
| Isolation voltage | 2,250 | Vdc | Input to output |
| Output current | Model specific | A | Continuous |
| Peak output current | 1.5 • Iout | A | For 1 ms |
| Output power | 120 | W | Continuous |
| Peak output power | 180 | W | For 1 ms |
| Operating temperature | -55 to +100 | °C | M-Grade; baseplate |
| Storage temperature | -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.

SPECIFICATIONS

PART NUMBERING



Input Specifications *(Conditions are at 36 Vin, full load, and 25°C baseplate unless otherwise specified)*

| Parameter | Min | Typ | Max | Unit | Notes |
|----------------------------|------|------|------|------------------|---|
| Input voltage range | 26 | 36 | 50 | Vdc | Operable down to zero V with VC voltage applied |
| Input dV/dt | | | 1 | V/ μs | |
| Input overvoltage turn-on | 50.5 | 54.5 | | Vdc | |
| Input overvoltage turn-off | | 55.5 | 57.5 | Vdc | |
| Input current | | | 3.5 | Adc | Continuous |
| No load power dissipation | 1.5 | 3.0 | 6.0 | W | Low line to high line |

Output Specifications *(Conditions are at 36 Vin, full load, and 25°C baseplate unless otherwise specified)*

| Parameter | Min | Typ | Max | Unit | Note |
|------------------------------------|---|------|----------------|------------------|---|
| Output voltage | See Table 1 | | | Vdc | No load |
| | $K \cdot V_{IN} - I_O \cdot R_{OUT\ NOM}$ | | | Vdc | Full load |
| Rated DC current | 0 | | 100 | Adc | 26 – 50 V_{IN} See Table 1, Page 5 |
| Peak repetitive current | | | 150% | $I_{MAX}(A)$ | Max pulse width 1ms, max duty cycle 10%, baseline power 50% |
| DC current limit | | 160% | | $I_{NOM}(A)$ | Module will shut down when current limit is reached or exceeded |
| Short circuit protection set point | 47.4 | | | Adc | Module will shut down |
| Current share accuracy | | 5 | 10 | % | See Parallel Operation on Page 8 |
| Efficiency | | | | | See Table 2, Page 5 |
| Load capacitance | | | | | See Table 2 when used with PRM |
| Output overvoltage setpoint | | 110% | 115% | $V_{OUT\ MAX}$ | |
| Output ripple voltage (Typ) | | | | | |
| No external bypass | 50 | | 250 | mV | See Figures 2 and 5 |
| 10 μF bypass capacitor | 2 | | 20 | mV | See Figure 6 |
| Effective switching frequency | 2.5 | 3.0 | 3.6 | MHz | Model dependent |
| Line regulation | 0.99K | K | 101K | | $V_{OUT} = K \cdot V_{IN}$ at no load, See Table 1 |
| Load regulation | $R_{OUT\ MIN}$ | | $R_{OUT\ MAX}$ | $\text{m}\Omega$ | See Table 1 |
| Transient response | | | | | |
| Response time | | 200 | | ns | See Figures 7 and 8 |
| Recovery time | | 1 | | μs | See Figures 7 and 8 |

TYPICAL WAVEFORMS & PLOTS

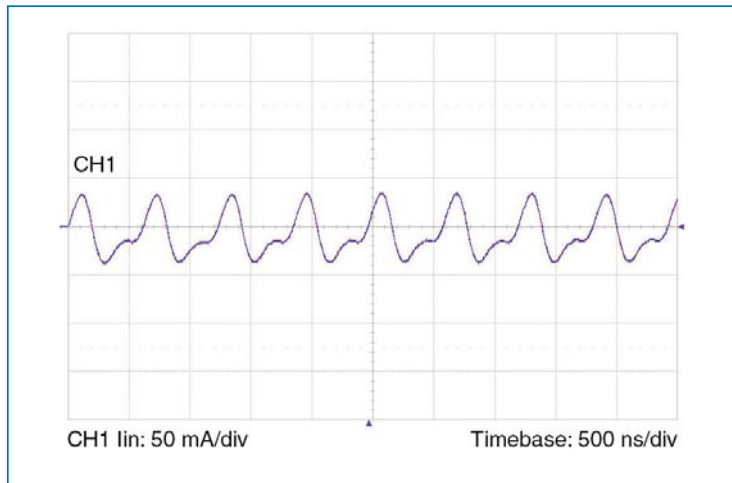


Figure 1 — Representative input reflected ripple current at full load (MT036A120M010FP)

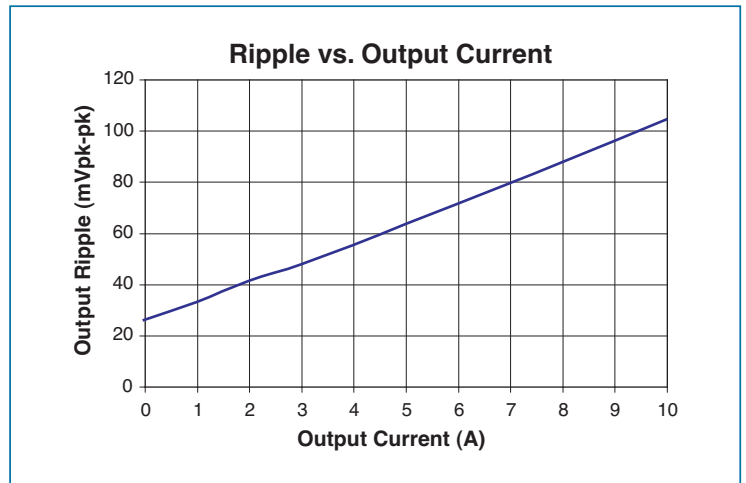


Figure 2 — Sample output voltage ripple vs. output current with no POL bypass capacitance. (MT036A120M010FP)

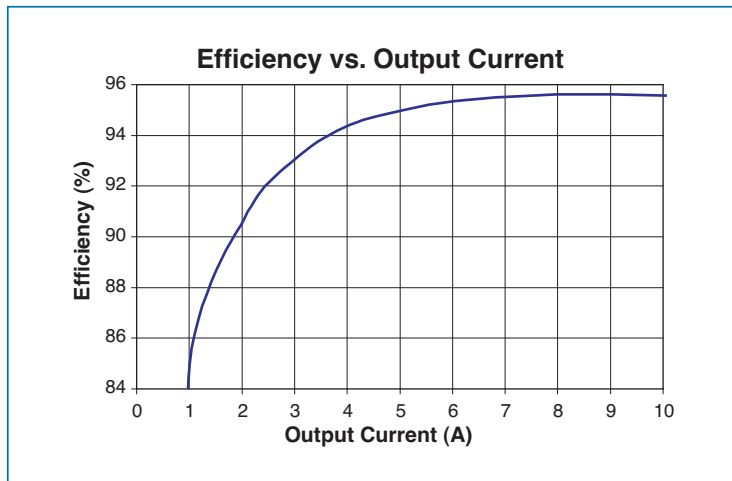


Figure 3 — Representative efficiency vs. output current. (MT036A120M010FP)

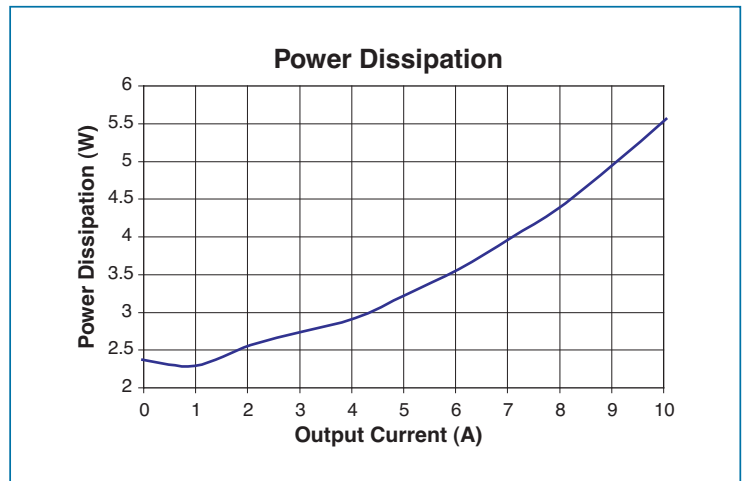


Figure 4 — Example power dissipation vs. output current. (MT036A120M010FP)

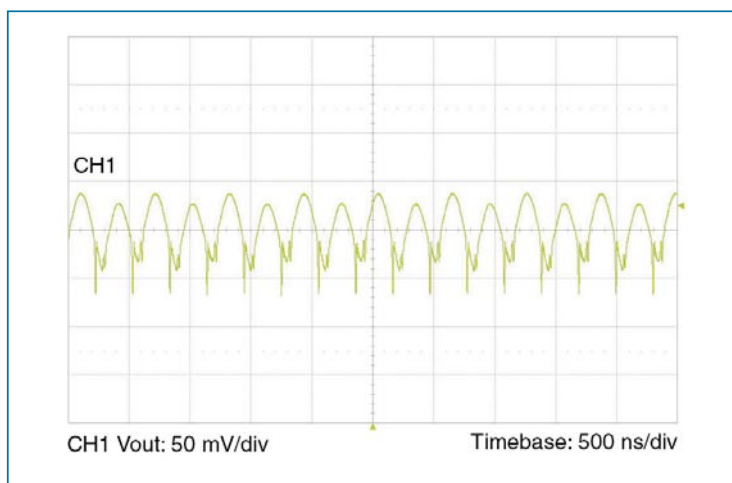


Figure 5 — Sample output voltage ripple at full load; with no POL bypass capacitance. (MT036A120M010FP)

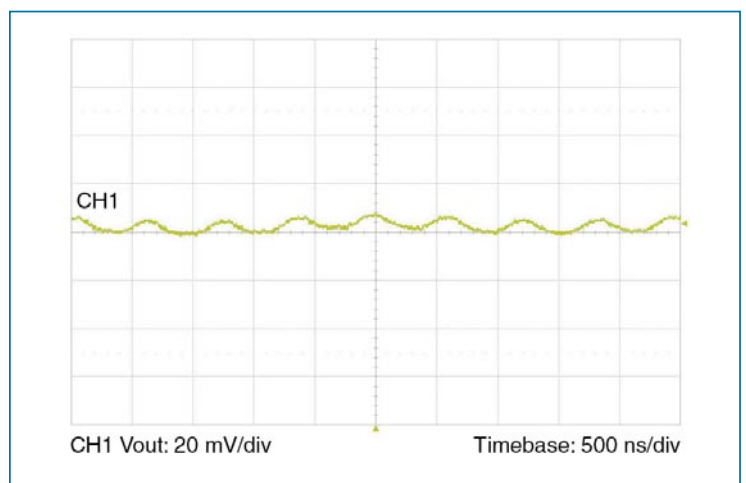


Figure 6 — Sample output voltage ripple at full load with 4.7 μ F ceramic POL bypass capacitance and 20 nH distribution inductance. (MT036A120M010FP)

TYPICAL WAVEFORMS

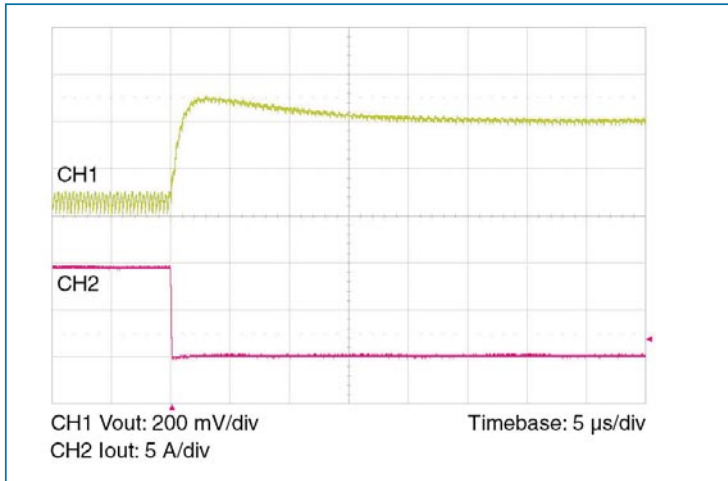


Figure 7 — Example load step with 100 μ F input capacitance and no output capacitance. (MT036A120M010FP)

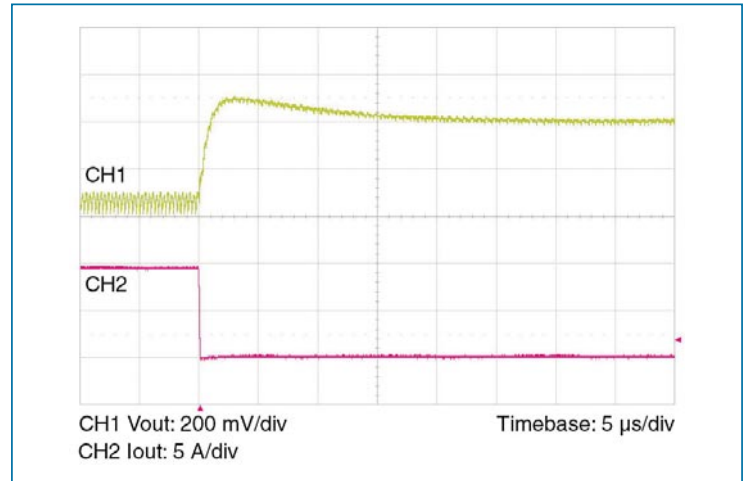


Figure 8 — Example load step with 100 μ F input capacitance and no output capacitance. (MT036A120M010FP)

Military Cots VTM Family Part Numbers and Ranges

| Part Number | K-Factor | Rated Output Current (A) | No Load Output Voltage (Vdc) | | Rout (mΩ) | | |
|-----------------|----------|--------------------------|------------------------------|----------|-----------|------|------|
| | | | @26 Vin | @ 50 Vin | Min | Nom | Max |
| MT036A011M100FP | 1/32 | 100 | 0.82 | 1.55 | 0.5 | 0.85 | 1.3 |
| MT036A015M080FP | 1/24 | 80 | 1.1 | 2.0 | 1.0 | 1.25 | 1.5 |
| MT036A022M055FP | 1/16 | 55 | 1.63 | 3.1 | 1.4 | 1.75 | 2.0 |
| MT036A030M040FP | 1/12 | 40 | 2.2 | 4.1 | 1.45 | 2.4 | 3.4 |
| MT036A045M027FP | 1/8 | 27 | 3.3 | 6.2 | 3.5 | 5.1 | 6.6 |
| MT036A060M020FP | 1/6 | 20 | 4.3 | 8.3 | 5.0 | 8.0 | 10 |
| MT036A072M017FP | 1/5 | 16.6 | 6.4 ^[a] | 10 | 6.0 | 9.6 | 12 |
| MT036A090M013FP | 1/4 | 13.3 | 6.5 | 12.5 | 6.9 | 9.3 | 11.6 |
| MT036A120M010FP | 1/3 | 10.0 | 8.7 | 16.6 | 25 | 31 | 35 |
| MT036A180M007FP | 1/2 | 6.7 | 13 | 25 | 27.5 | 35.7 | 46.4 |
| MT036A240M005FP | 2/3 | 5.0 | 17.4 | 33 | 49.3 | 70.6 | 91.8 |
| MT036A360M003FP | 1 | 3.3 | 26 | 50 | 140 | 170 | 200 |

Table 1 — VTM part numbers

^[a] Low line input voltage 32 V

| Part Number | Typical Full Load Efficiency at nom Vout (%) | Typical Half Load Efficiency at nom Vout (%) | Maximum Load Capacitance (μF) |
|-----------------|--|--|-------------------------------|
| MT036A011M100FP | 89.5 | 91.5 | 48128 |
| MT036A015M080FP | 92 | 94 | 27072 |
| MT036A022M055FP | 94 | 94.5 | 12032 |
| MT036A030M040FP | 94 | 95.0 | 6768 |
| MT036A045M027FP | 95.3 | 96.5 | 3008 |
| MT036A060M020FP | 95.3 | 96.8 | 1692 |
| MT036A072M017FP | 96.5 | 96.5 | 1175 |
| MT036A090M013FP | 96.3 | 95.5 | 752 |
| MT036A120M010FP | 95.5 | 95.5 | 423 |
| MT036A180M007FP | 96.0 | 95.2 | 188 |
| MT036A240M005FP | 95.0 | 94.8 | 106 |
| MT036A360M003FP | 96 | 96 | 47 |

Table 2 — Typical efficiency and maximum load capacitance, by part number

Control Pin Functions

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 26 V and for 10 ms after the input voltage has reached or exceeded 26 V. The VTM is not designed for extended operation below 26 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.

SPECIFICATIONS (CONT.)

General Specifications

| Parameter | Min | Typ | Max | Unit | Notes |
|--|-------|-----------|-----|-------|---|
| MTBF (MT036A120M010FP) | | | | | |
| MIL-HDBK-217F | | 5,046,701 | | Hours | 25°C, GB |
| | | 908,153 | | | 50°C NS |
| | | 711,584 | | | 65°C AIC |
| Isolation specifications | | | | | |
| Voltage | 2,250 | | | Vdc | Input to output |
| Capacitance | | 3,000 | | pF | Input to output |
| Resistance | 10 | | | MΩ | Input to output |
| Agency approvals | | cTÜVus | | | UL/CSA 60950-1, EN 60950-1 |
| | | CE Mark | | | Low voltage directive |
| Mechanical | | | | | |
| Weight | | 1.10/31.3 | | oz/g | See Mechanical Drawings, Figures 15, 16 |
| 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 | | 10 | | μs | PC low to Vout low |
| VTM Control (VC) | | | | | |
| External boost voltage | 12 | 6 | 19 | Vdc | Required for VTM start up without PRM |
| External boost duration | | 10 | | ms | Vin > 26 Vdc. VC must be applied continuously if Vin < 26 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 26 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 26 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 26 V and for 10 ms after the input voltage has reached or exceeded 26 V. The VTM is not designed for extended operation below 26 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.

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.

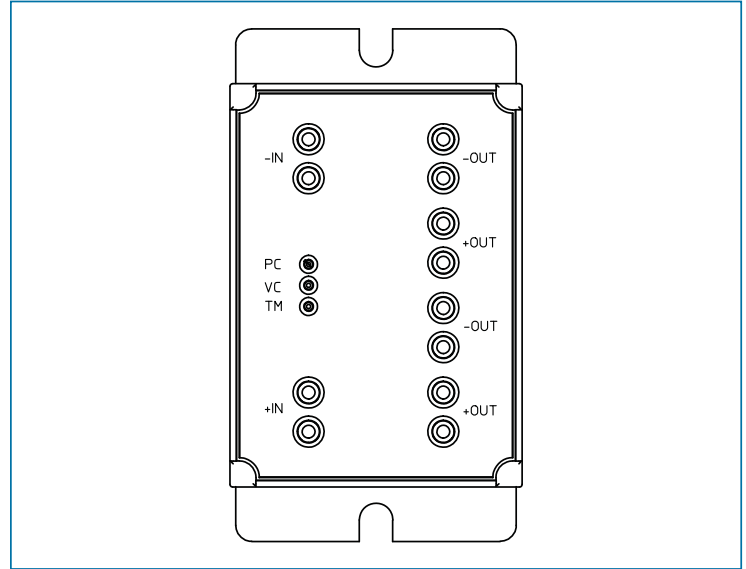


Figure 9 — VI BRICK VTM pin configuration (viewed from pin side)

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 μF 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 1/8. 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/

Application Notes

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

http://www.vicorpower.com/technical_library/application_information/

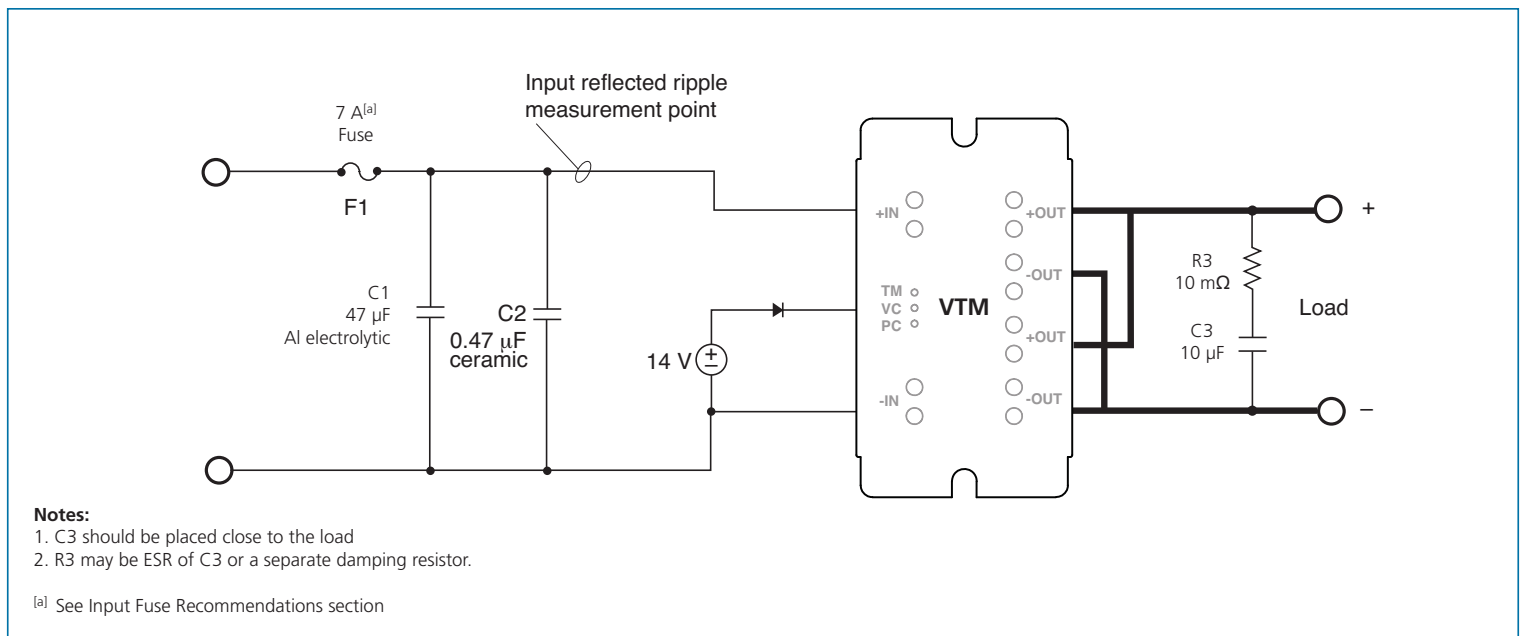


Figure 10 — VI BRICK VTM test circuit

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

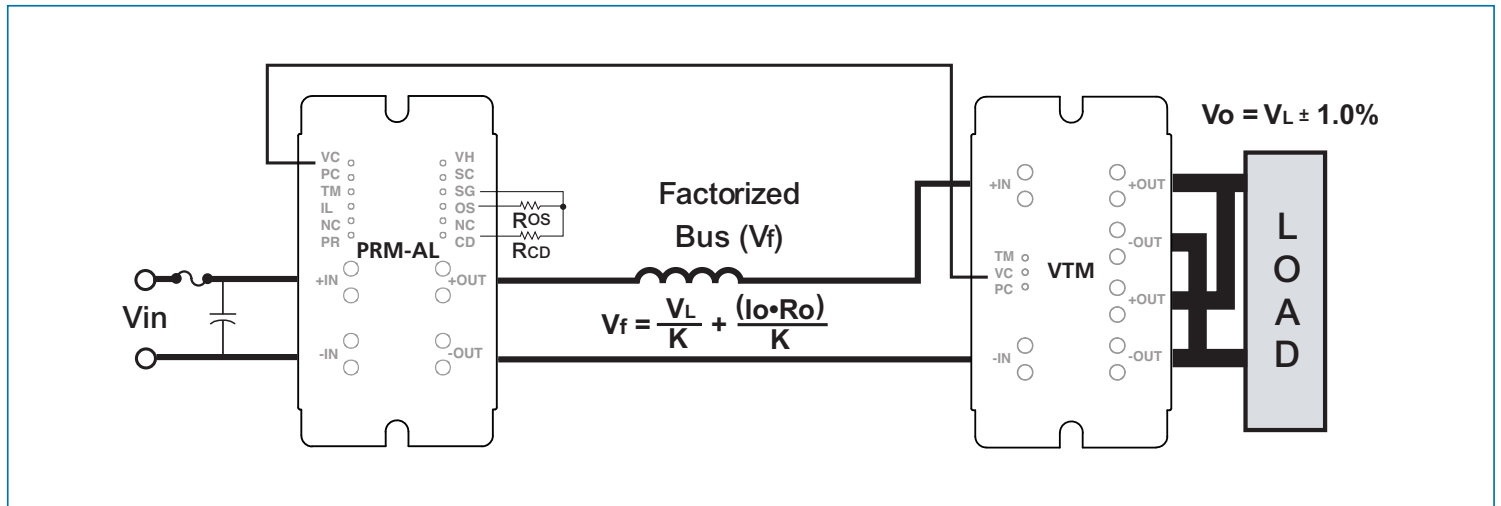


Figure 11 — The PRM controls the factorized bus voltage, V_f , in proportion to output current to compensate for the output resistance, R_o , of the VTM. The VTM output voltage is typically within 1% of the desired load voltage (V_L) over all line and load conditions.

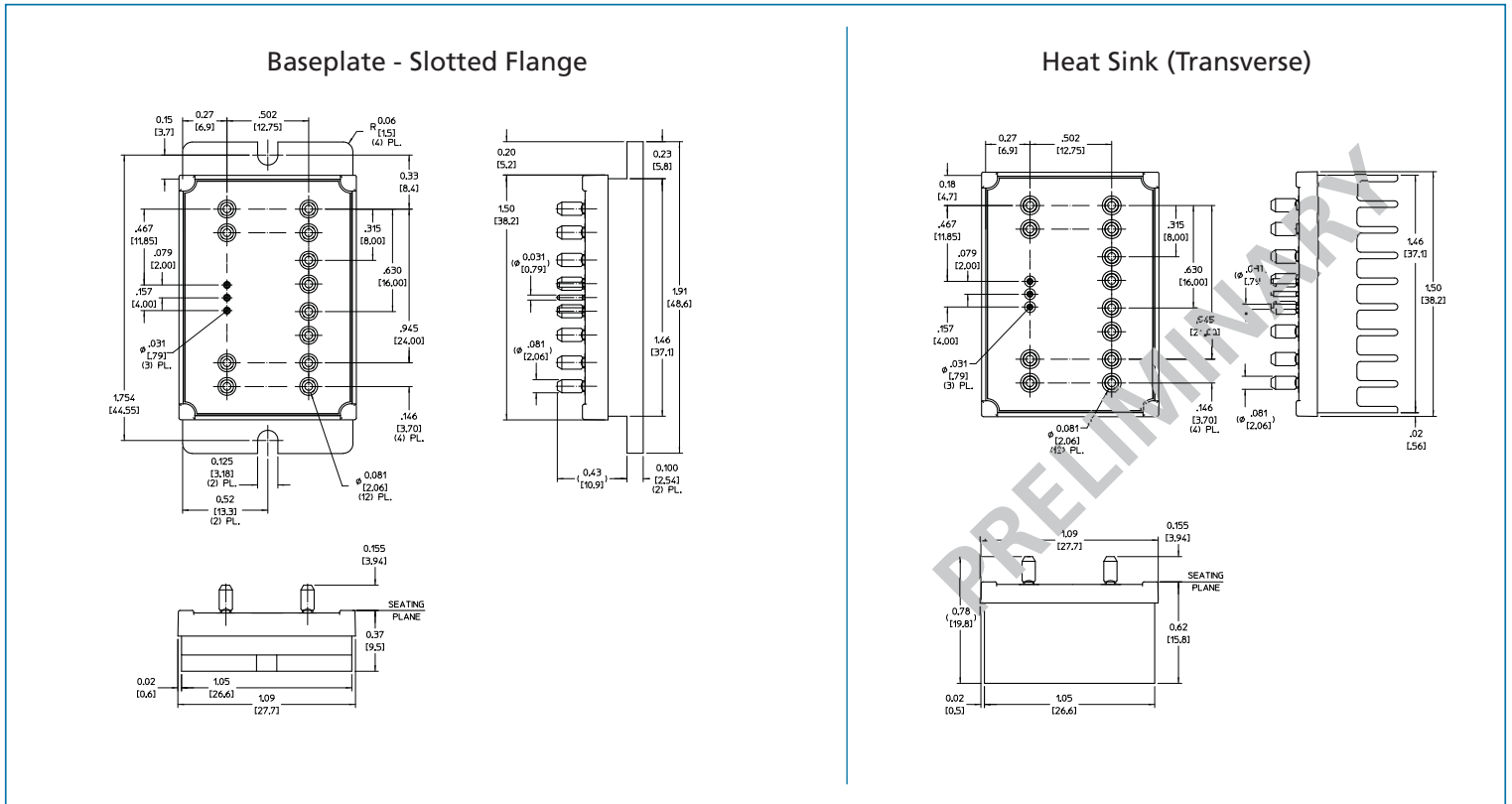


Figure 15 — Module outline

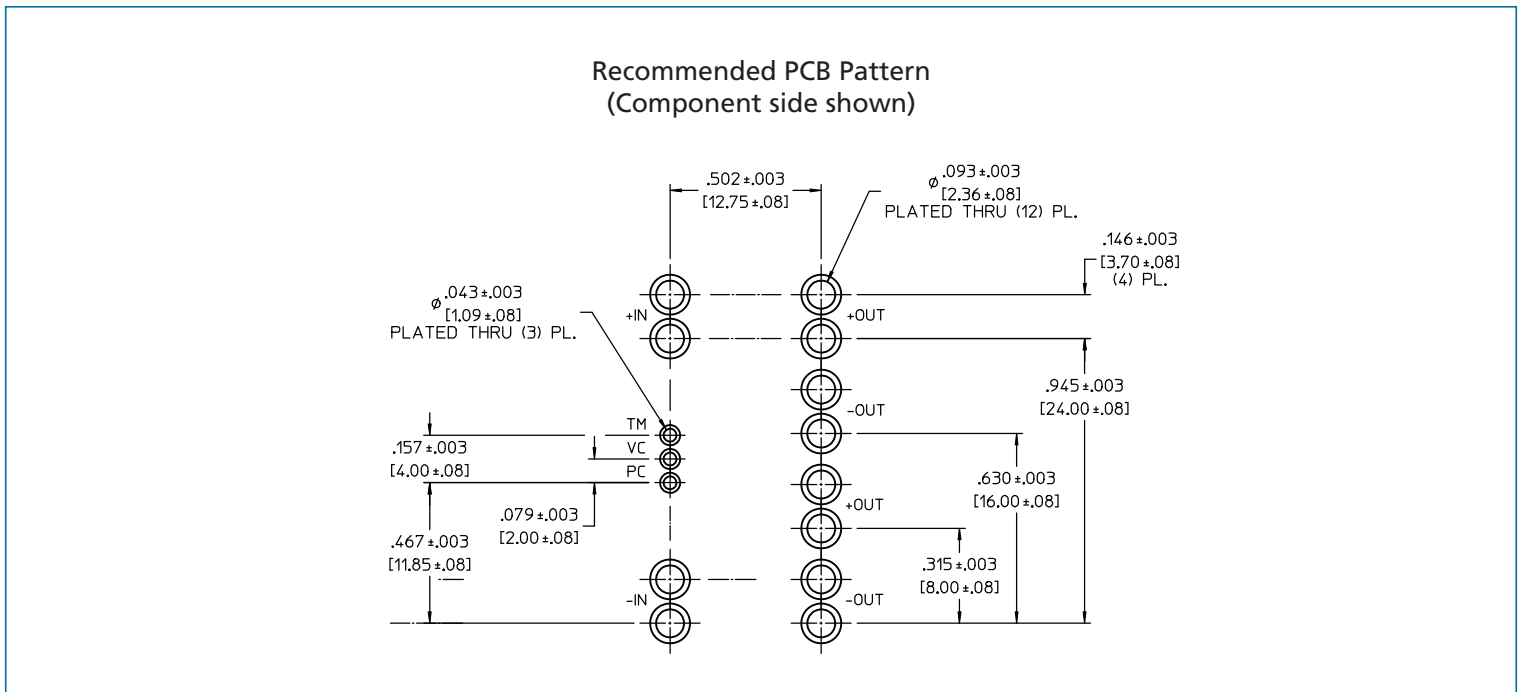


Figure 16 — PCB mounting specifications

Warranty

Vicor products are guaranteed for two years from date of shipment against defects in material or workmanship when in normal use and service. This warranty does not extend to products subjected to misuse, accident, or improper application or maintenance. Vicor shall not be liable for collateral or consequential damage. This warranty is extended to the original purchaser only.

EXCEPT FOR THE FOREGOING EXPRESS WARRANTY, VICOR MAKES NO WARRANTY, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

Vicor will repair or replace defective products in accordance with its own best judgement. For service under this warranty, the buyer must contact Vicor to obtain a Return Material Authorization (RMA) number and shipping instructions. Products returned without prior authorization will be returned to the buyer. The buyer will pay all charges incurred in returning the product to the factory. Vicor will pay all reshipment charges if the product was defective within the terms of this warranty.

Information published by Vicor has been carefully checked and is believed to be accurate; however, no responsibility is assumed for inaccuracies. Vicor reserves the right to make changes to any products without further notice to improve reliability, function, or design. Vicor does not assume any liability arising out of the application or use of any product or circuit; neither does it convey any license under its patent rights nor the rights of others. Vicor general policy does not recommend the use of its components in life support applications wherein a failure or malfunction may directly threaten life or injury. Per Vicor Terms and Conditions of Sale, the user of Vicor components in life support applications assumes all risks of such use and indemnifies Vicor against all damages.

Vicor's comprehensive line of power solutions includes high density AC-DC and DC-DC modules and accessory components, fully configurable AC-DC and DC-DC power supplies, and complete custom power systems.

Information furnished by Vicor is believed to be accurate and reliable. However, no responsibility is assumed by Vicor for its use. Vicor components are not designed to be used in applications, such as life support systems, wherein a failure or malfunction could result in injury or death. All sales are subject to Vicor's Terms and Conditions of Sale, which are available upon request.

Specifications are subject to change without notice.

Intellectual Property Notice

Vicor and its subsidiaries own Intellectual Property (including issued U.S. and Foreign Patents and pending patent applications) relating to the products described in this data sheet. Interested parties should contact Vicor's Intellectual Property Department.

The products described on this data sheet are protected by the following U.S. Patents Numbers:
5,945,130; 6,403,009; 6,710,257; 6,911,848; 6,930,893; 6,934,166; 6,940,013; 6,969,909; 7,038,917;
7,166,898; 7,187,263; D496,906; D505,114; D506,438; D509,472

Vicor Corporation
25 Frontage Road
Andover, MA, USA 01810
Tel: 800-735-6200
Fax: 978-475-6715

email

Customer Service: custserv@vicorpower.com
Technical Support: apps@vicorpower.com