

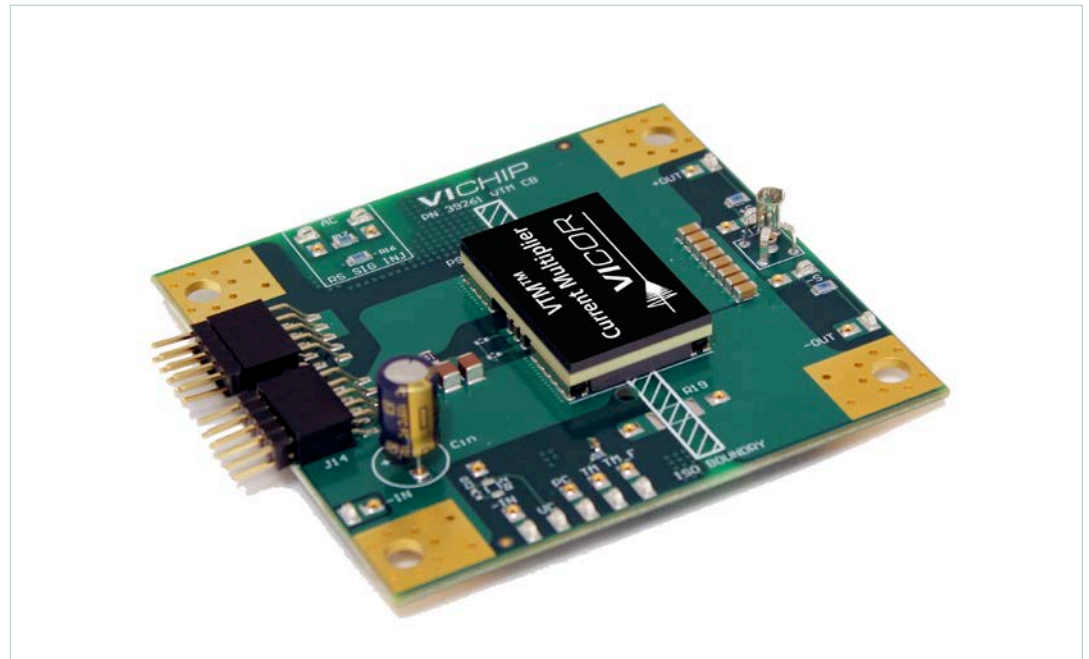
# VI Chip® VTM™ Evaluation Board



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## Introduction

This evaluation board offers a convenient means to evaluate the performance of the Vicor VTM current multiplier. All evaluation boards include sockets for easy plug-and-play insertion and removal of through-hole components and wires. The board provides lugs for power connections, connectors for easy PRM-VTM evaluation board interconnects and Kelvin voltage-measurement test points of all pins of the VTM. Please refer to the appropriate VTM data sheet for performance and operating limits, available for downloading at [www.vicorpower.com](http://www.vicorpower.com).



### IMPORTANT NOTICE:

Please read this document before setting up a VTM evaluation board.

This user guide is not comprehensive and the operator should not substitute it for common sense and good practice. The following procedures should be followed during operation:

- Wear approved safety glasses when testing electronic product.
- Provide strain relief for wires and secure the board on the test bench to avoid displacement.
- Remove the power and use caution when connecting and disconnecting all test probes and interface lines to avoid unintentional short circuits and contact with hot surfaces.
- Never attempt to disconnect the evaluation board from a PRM™ evaluation board while power is applied. This system is not designed to demonstrate the hot-plug capability.

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## Contents

All VTM™ evaluation boards arrive with the following contents.  
(The user guide can be downloaded from [www.vicorpower.com](http://www.vicorpower.com).)

- 1 x VTM Evaluation board
- 1 x VI Chip® push-pin heat sink
- 2 x VI Chip push pins for heat-sink installation
- 1 x Hardware kit
- 2 x Through-hole mating connectors
- 1 x Through-hole 22µF input capacitor

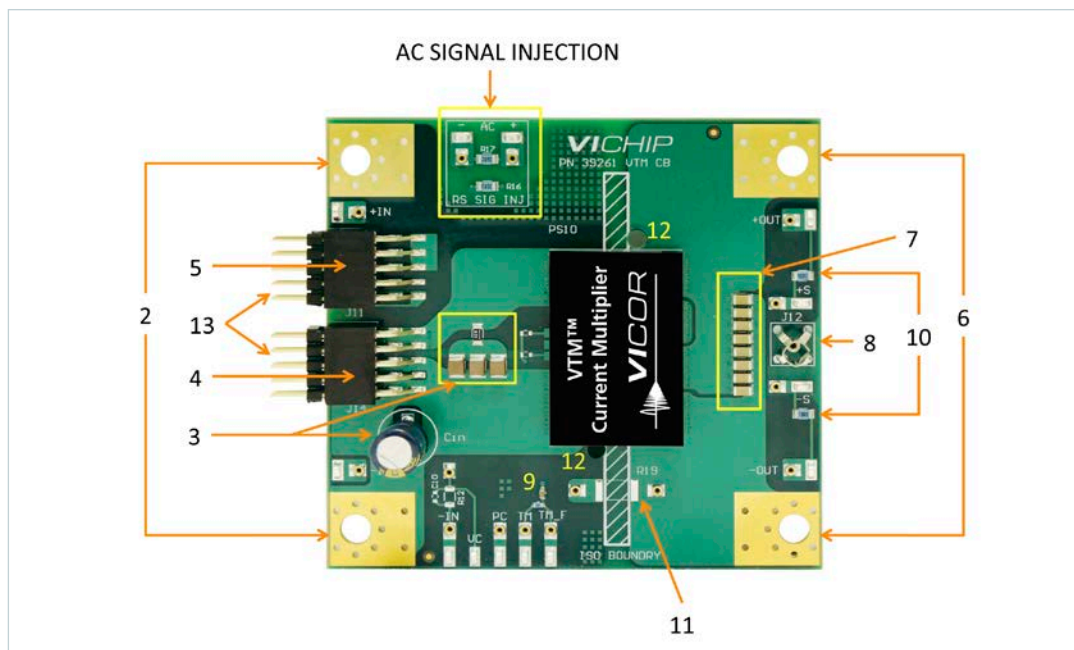
## Features

1. Input filtering: ceramic capacitors and sockets for installation of through-hole aluminum electrolytic capacitor
2. Output filtering: ceramic capacitors
3. Oscilloscope probe jack for output voltage signal measurement
4. Kelvin test points for measurement of input voltage, output voltage and all signal pins of the VTM
5. Sockets for each test point for easy installation of through-hole components and solid wires to facilitate wiring to external circuitry and test equipment
6. Input and output lugs for power supply and load connections
7. Input power and signal connectors for testing with PRM™ module
8. Provisions for non-isolated remote-sense operation with PRM evaluation board
  - a. Provision to inject network analyzer signals
  - b. 2512 resistor footprint for installation of zero-ohm resistor to break the VTM isolation for non-isolated remote-sense operation
  - c. Sense pins with local-sense resistors to +OUT and –OUT

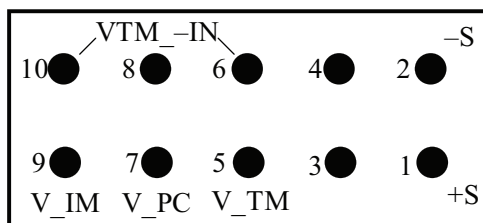
## Board Description

The following section provides a detailed description of the evaluation board components, test points and sockets.

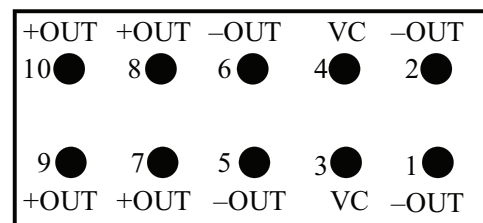
**Figure 1**  
Board description



**Figure 2**  
Power/signal connectors pinout  
(front view)



**J11**  
Signal Connector



**J14**  
Power/Signal Connector

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## General Components

1. **VTM™ (PS10).**
2. **Input lugs (+IN and –IN):** Sized for #10 hardware. Use these for making connection to the input source. This board does not contain reverse-polarity protection. Check for proper polarity before applying power.
3. **Input filtering:** Input capacitor (CIN) and filtering (ceramic capacitors) allows for stable operation with most input sources. Sockets can be used for easy installation of aluminum-electrolytic input capacitor.
4. **Power/Signal connector (J14):** Used to receive the power (+OUT/–OUT) and VC from upstream PRM™ board when used.
5. **Signal connector (J11):** Used to transfer VTM PC, IM, TM, –IN and output sense signals between the VTM and PRM boards. TM pin of the VTM provides feedback to the VT pin of the PRM in adaptive-loop operation of PRM and VTM. +S and –S signals provide voltage sensing to the PRM remote-sense circuitry for non-isolated remote-sense operation.
6. **Output lugs (+OUT, –OUT):** Sized for #10 hardware. Use these lugs to connect the output directly to the load.
7. **Output filtering (ceramic capacitors):** Helps to minimize switching ripple of the output voltage.
8. **Output oscilloscope probe jack (J12):** Used for making accurate scope measurements of the output voltage (i.e., ripple). Remove scope grounding lead and insert probe directly into jack ensuring a good connection between the jack and the probe ground barrel. Do not attempt to install while power is applied. May not be compatible with all scope probes.
9. **TM filtering:** Filters the TM signal noise. Corner frequency of the filter is set well below the VTM switching frequency.
10. **Sense pins and local-sense resistors:** Used to sense the output voltage of the VTM for non-isolated remote-sense operation. Local sense resistors can be bypassed by connecting twisted pair from the sense test points directly to the load.
11. **VTM isolation boundary:** Zero-ohm shunt can be soldered or use sockets to break the isolation for non-isolated remote-sense operation of VTM board and PRM board.
12. **Heat-sink push pins:** Secure the heat sink to the board using these pins. Use of a fan across the heat sink is highly recommended for proper cooling.
13. **Mating connectors:** Connect the PRM and VTM with the connectors to share power and signal connection.

## Test Points and Sockets Description

Each test-point socket accepts 0.015 – 0.025 inch diameter leads of solid wires and through-hole components for use with external circuitry and test equipment. All test points are aligned on the board's edge for easy access, measurement and external circuitry connections. Each point is labeled and is accompanied by an additional adjacent socket.

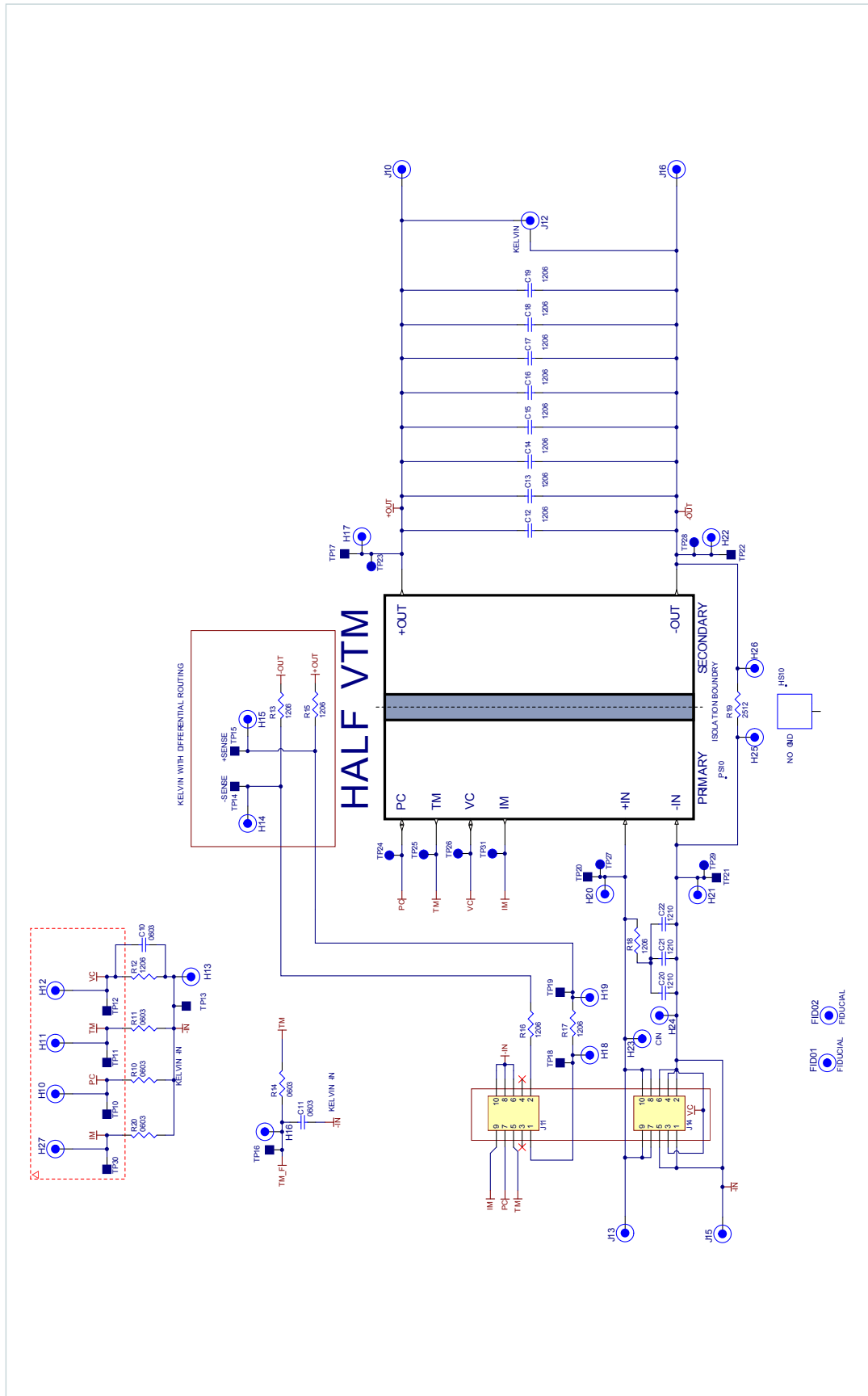
**Table 1**  
Test points and sockets description

| Reference Designator | Functional Name | Functional Description   |
|----------------------|-----------------|--|
| TP20<br>TP21         | +IN<br>-IN      | Input voltage test points provide Kelvin connection to input pins of the VTM™. Use these test points for measuring the input voltage of the VTM to avoid error due to interconnect losses.   |
| H20<br>H21           | +IN<br>-IN      | Sockets for +IN and -IN test points. Kelvin connected to the VTM input pins.   |
| TP17<br>TP22         | +OUT<br>-OUT    | Output voltage test points provide Kelvin connection to output pins of the VTM. Use these test points for measuring the output voltage of the VTM to avoid error due to interconnect losses.   |
| H17<br>H22           | +OUT<br>-OUT    | Sockets for +OUT and -OUT test points. Kelvin connected to the VTM output pins.  |
| TP12                 | VC              | VC test point provides Kelvin connection to VC pin of the VTM. Can be used to apply and measure the VC signal with reference to -IN signal. VC is used to enable the VTM. Apply 14V to VC to enable the VTM, when not using PRM.               |
| H12                  | VC              | Socket for VC test point. Kelvin connected to VC pin of the VTM. Aligned with -IN socket for placing through hole resistor from VC to -IN.   |
| TP10                 | PC              | PC test point provides Kelvin connection to PC pin of the VTM. Can be used to measure the PC signal with reference to -IN signal. PC can be used to disable the VTM in the presence of input power. Connecting PC to -IN will disable the VTM. |
| H10                  | PC              | Socket for PC test point. Kelvin connected to PC pin of the VTM.   |
| TP11                 | TM              | TM test point provides Kelvin connection to TM pin of the VTM. Can be used to measure and monitor the TM signal with reference to -IN signal.  |
| H11                  | TM              | Socket for TM test point. Kelvin connected to TM signal of the VTM   |
| TP16                 | FILTERED<br>TM  | Provides the low noise measurement of TM signal. Output of the TM RC filter can be measured using this testpoint with reference to -IN.  |
| H15                  | FILTERED<br>TM  | Socket for TP16 test point.  |
| TP13                 | -IN             | -IN test point provides Kelvin connection to -IN pin of the VTM. All signals on input side of the VTM are measured with reference to -IN signal of the VTM.  |
| H13                  | -IN             | Socket for -IN test point.   |
| TP15<br>TP14         | +S<br>-S        | Output sense test points provide connection to the output pins of VTM through local-sense resistors. Routed to connector J11 for use in differential non-isolated remote-sense circuitry for remote-sense operation of VTM and PRM™.           |
| H15<br>H14           | +S<br>-S        | Sockets for +S and -S test points.   |
| TP18<br>TP19         | AC SIG INJ      | Can be used to inject the isolated signal of network analyzer for bode plot measurement to measure the stability in remote-sense operation using VTM and PRM   |
| H18<br>H19           | AC SIG INJ      | Sockets for AC +/- test points.  |
| TP30                 | IM              | IM test point provides the Kelvin connection to IM pin. Can be used to measure the IM signal of the half VTM. IM can be used to monitor the output current of the VTM. Available on half-VTM boards only.                                      |
| H27                  | IM              | Socket for IM test point.  |



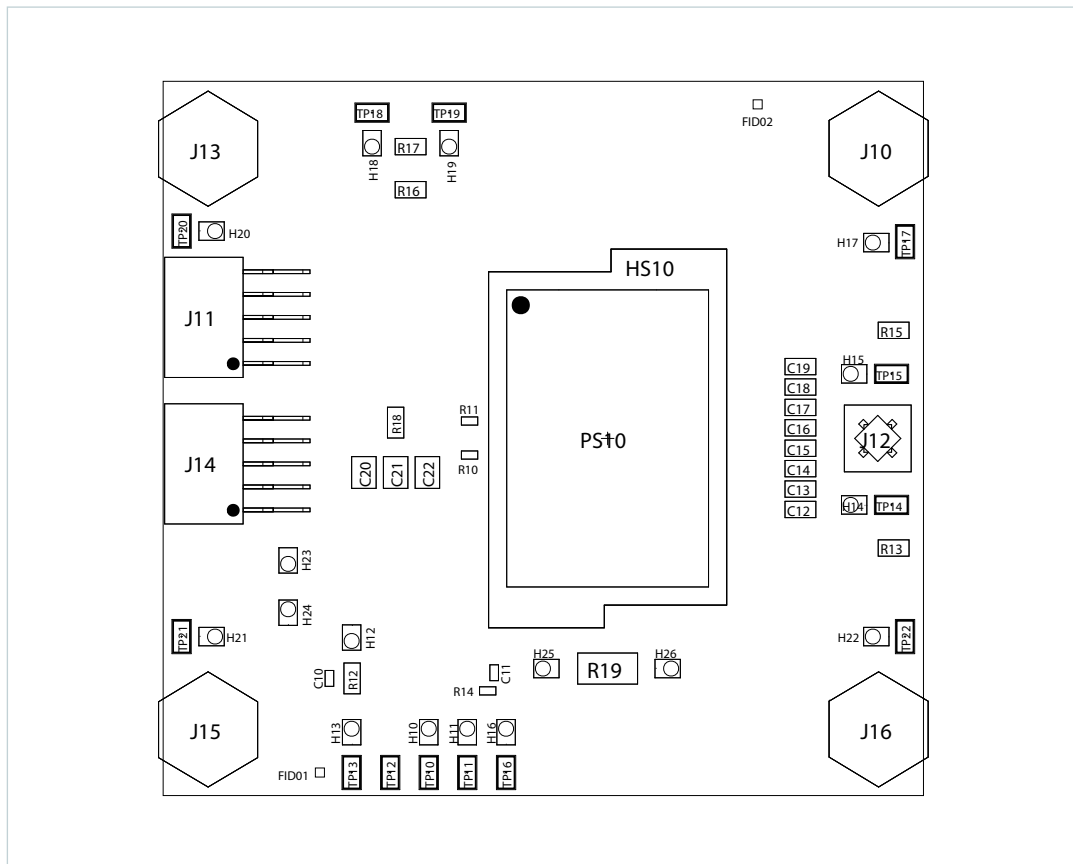
Schematic (Cont.)

Figure 3b  
Half-chip VTM™  
evaluation board

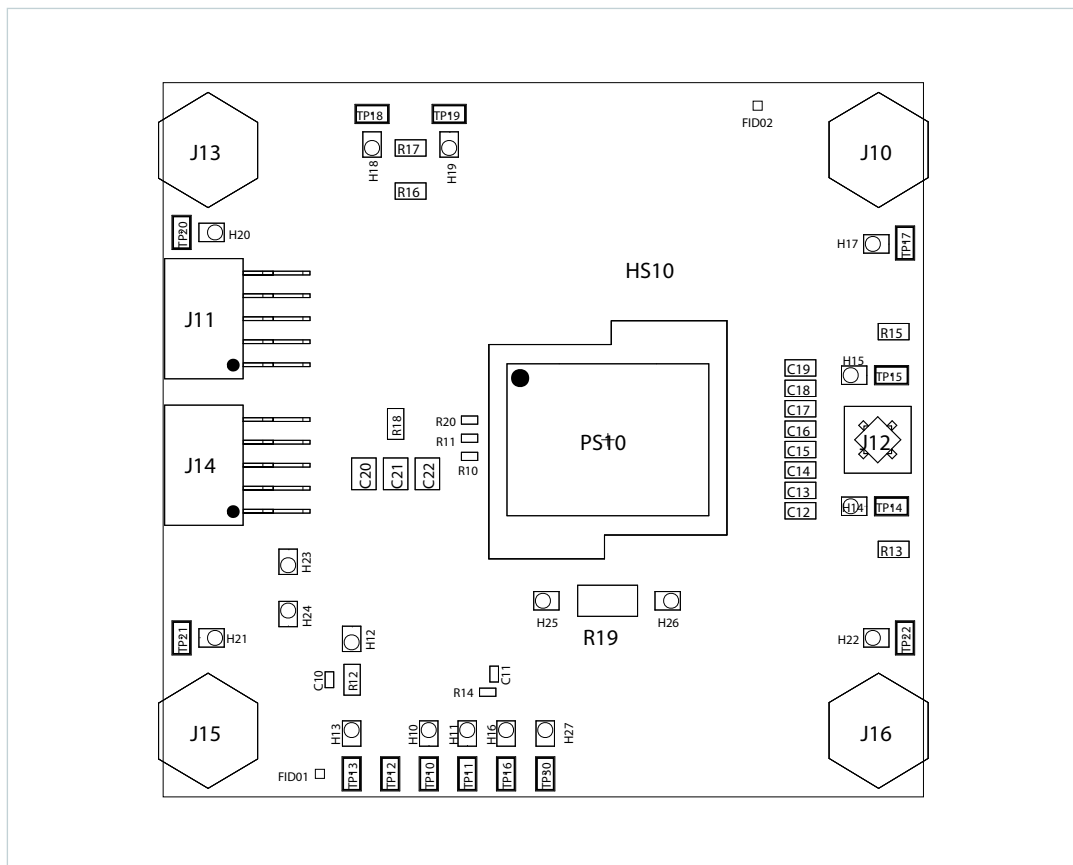


## Assembly Drawings

**Figure 4a**  
Top view: full-chip VTM™  
evaluation board



**Figure 4b**  
Top view: half-chip VTM  
evaluation board





## Bill of Materials

Following table describes the common components of all VTM™ evaluation boards.

**Table 2**  
Common components

| Reference Designator | Description                              | Manufacturer                | Manufacturer Part Number |
|----------------------|--|-----------------------------|--------------------------|
| C10                  | Not applied                              |                             |                          |
| C11                  | CAP X7R 0.1μF 10% 100V 0603              | Murata Manufacturing        | GRM188R72A104KA35D       |
| C12 – C19            | Design specific – see Table 3            |                             |                          |
| C20 – C22            | CAP X7R 2.2μF 10% 100V 1210 0.102 MAX HT | TDK Corp. Of America        | C3225X7R2A225KT5LOU      |
| CIN_PUT_IN_BOX       | CAP ALEL 22μF 20% 100V RADIAL 8 x 11.5   | Panasonic                   | EEUFC2A220               |
| H10 – H27            | PIN RECPT 0.015/0.025 DIA 0667 SER TH    | Mill-Max                    | 0667-0-57-15-30-27-1     |
| HEADER_IN_BOX        | CONN 10POS HEADER STR M-M 3A/0.100       | Sullins                     | PEC05DABN                |
| J11<br>J14           | CONN 10 PINS 2.54MM PITCH DUAL ROW SM HO | Global Connector Technology | BG225-10-A-N-A           |
| J12                  | JACK VERTICAL MECH THRU HOLE             | Tektronix                   | 131-5031-00              |
| PCB                  | Design specific – see Table 3            |                             |                          |
| PS10                 | Design specific – see Table 3            |                             |                          |
| R10                  | Not applied                              |                             |                          |
| R11                  | Not applied                              |                             |                          |
| R12                  | Not applied                              |                             |                          |
| R13, R15             | RES 10Ω 1/4W 1% 1206                     | KOA Speer Electronics       | RK73H2BTDD10R0F          |
| R14                  | RES 1kΩ 1/10W 1% 0603                    | KOA Speer Electronics       | RK73H1JTDD1001F          |
| R16, R17             | RES 20Ω 1/4W 1% 1206                     | KOA Speer Electronics       | RK73H2BTDD20R0F          |
| R18                  | RES 10mΩ 1/4W 1% 1206                    | Vishay                      | WSL1206R0100FEA          |
| R19                  | Not applied                              |                             |                          |
| TP10 – TP22, TP30    | TEST POINT, SURFACE MOUNT                | Keystone Electronics        | 5017                     |

Following table describes the design-specific components of all VTM evaluation boards.

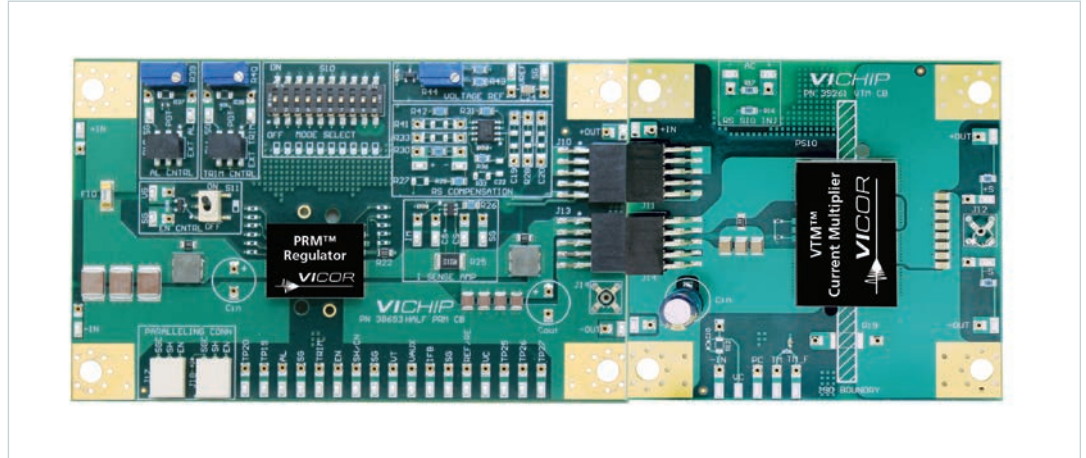
**Table 3**  
Design-specific components

| Reference Designator | Description  | Manufacturer         | Manufacturer Part Number | Evaluation Board                 |
|----------------------|--|----------------------|--------------------------|----------------------------------|
| C12 – C19            | CAP X5R 47μF 20% 6.3V 1206                                 | Murata Manufacturing | GRM31CR60J476ME19K       | K = 1/12, 1/16, 1/24, 1/32 VTMs  |
| C12 – C19            | CAP X5R 10μF 10% 25V 1206                                  | Murata Manufacturing | GRM31CR61E106KA12L       | K = 1/3, 1/4, 1/5, 1/6, 1/8 VTMs |
| C12 – C19            | CAP X7R 1.0μF 10% 100V 1206                                | Murata Manufacturing | GRM31CR72A105KA01L       | K = 1, 2/3, 1/2, VTMs            |
| PCB                  | SNGLTD PCB FULL CHIP VTM CB                                | Vicor                | 39261                    | Full-chip VTM boards             |
| PCB                  | SNGLTD PCB HALF CHIP VTM CB                                | Vicor                | 39262                    | Half-chip VTM boards             |
| PS10                 | Full-chip / half-chip VTM, Part Number refer to data sheet |                      |                          |                                  |

## PRM™ & VTM™ Evaluation Boards

The VTM evaluation board has been designed for compatibility with all PRM evaluation boards to accommodate any PRM-VTM combination. The VTM evaluation board contains dual connectors designed to mate with J10 and J13 on PRM board. An additional signal connector shares VTM signal pins along with TM, S+ and S- to the PRM board. When connected to a PRM evaluation board the TM signal provides feedback to the VT pin of the PRM enabling temperature compensation in adaptive-loop configuration.

**Figure 5**  
PRM evaluation board  
connection to  
VTM evaluation board



### Stand-Alone Operation vs. PRM-VTM Operation

In standalone VTM operation, the VTM cannot self-start with only an input voltage applied. A voltage of 14V must be applied to its VC pin or test point for it to become active. Ensure that the applied VC slew rate is within the specified limits of the device. The VC voltage may be removed once the VTM has started and the input voltage has reached 26V or VC can be applied continuously to allow operation down below 26V input voltage. When connected together, the PRM provides power and the VC pulse via the J14 connector to the VTM. A 22 $\mu$ F, 100V electrolytic input capacitor is provided with the board and is recommended in stand-alone VTM operation.

Refer to the VI Chip® PRM evaluation board [UG:013](#) for more information on various modes of PRM+VTM operation.

### PRM-VTM Non-Isolated Remote Sense

To demonstrate non-isolated remote sense with a PRM evaluation board, the VTM isolation must be broken by tying VTM –IN to –OUT. This can be done using sockets on both side of R19 resistor footprint or by soldering a 2512 zero-ohm resistor at the R19 location. Output sense test points are routed to connector J11 and provide feedback to the PRM remote-sense circuitry. By default, the +S and –S pins are connected to the output pins of VTM through local-sense resistors. To demonstrate sensing at a remote point-of-load, the local-sense resistors can be bypassed by connecting the +S and –S test points to the desired sense location. Use a twisted pair to avoid noise pickup.

It is recommended to use a network analyzer to measure the closed-loop frequency response when adjusting compensation. The VTM boards provide test points which can be used to inject the network analyzer AC signal and measure the closed-loop response. For PRM-VTM remote-sense mode, test points are provided on the VTM board in series with the +S connections (Labeled “RS SIG INJ +/-”) and should be used.

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## Paralleling

The paralleling and current sharing capability of the devices can be demonstrated by stacking multiple evaluation boards and interconnecting the inputs and outputs with standoffs of sufficient current rating to create a parallel array. When paralleling VTMs, in standalone VTM™ operation, VC pins should be connected together to enable the synchronized start up.

PRM™ boards can also be connected in parallel to create high-power PRM-VTM arrays. PRM input, outputs and interconnect signals need to be connected in parallel using same-size standoffs. Each VTM requires a VC signal from a PRM in order to start and it is recommended to connect one PRM VC to one VTM VC using the connector J13 on PRM board and J14 on VTM board when possible. If needed a single PRM VC can be used to drive up to two VTMs (will require additional off-board connections).

## Push-Pin Heat Sink Installation

Each VTM demonstration board comes with its own heat sink and push pins for installation. Before testing, it is highly recommended that the heat sink be installed in the appropriate location for each board. When installing the push-pin heat sink, use caution not to exceed the maximum compression on the device listed in the data sheet. For most lab environments a fan blowing across the evaluation board is recommended.

## Using the VTM Evaluation Board for Reverse Operation

VTMs are capable of bidirectional power transfer between the primary and secondary power terminals. Certain VTMs such as VTM48EF040T050B0R and VTM48EF120T025A0R are qualified for continuous operation in reverse (power transfer from secondary to primary).

Reversible VTMs are usually designated with an R as the last character of the part number, however, refer to the data sheet to determine if a particular VTM is qualified for continuous reverse operation.

Reverse operation with a PRM-VTM configuration is beyond the scope of this document. In stand-alone operation, the applied VC voltage must be referenced to –PRI (–IN). VC can be applied before or after the secondary (source) voltage. Applying VC after the secondary voltage will result in a non-negligible amount secondary inrush current as described in the data sheet. Refer to the data sheet for the peak secondary inrush value and ensure the source is rated appropriately. Fusing for the evaluation board is located on the primary side. If fusing on the secondary (source) side is required, then it should be added externally based on the device ratings.

In order to test a qualified VTM in the reverse direction, follow the the procedure for VTM stand-alone operation and make the following changes:

1. Connect the voltage source to the secondary (output) lugs.
2. Connect the load to the primary (input) lugs.

Ensure the applied source voltage has the correct polarity and is within the secondary voltage ratings of the VTM. It may be necessary to install an input capacitor across the secondary terminals to decouple the input source.

## Part Ordering Information

The VTM evaluation boards can be ordered from the Vicor [website](#). To order the demo boards, substitute VTM with VTD in VTM part number.

See <http://www.vicorpower.com/dc-dc-converters-board-mount/vtm> for part number listing.

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