

## Three-Phase AC Input Module

### Features & Benefits

- Three-phase input
- 170 – 530V<sub>AC</sub> (line to line)
- 47 – 840Hz
- Chassis-Mount or PCB-Mount Form Factor
- Small robust package
- Low profile
- EMI filtering
- Meets EN61000-4-5 Class 3 surge protection at V<sub>IN</sub> = 208V<sub>AC</sub> when used with external surge trap and fuse, paired with Vicor BCM4414 VIA high-voltage products

### Typical Applications

- 3-Phase AC-DC Power Converters
- Test and Measurement Equipment
- Industrial Power Systems

| Product Ratings                      |                                |
|--------------------------------------|--------------------------------|
| V <sub>IN</sub> = 170 – 530V (L – L) | P <sub>OUT</sub> = up to 1650W |
| V <sub>OUT</sub> = Rectified AC      | I <sub>OUT</sub> = 2.3A        |

### Product Description

The TPM in a VIA Package (Three-Phase Module) is a front-end module designed to interface with worldwide three-phase AC mains and provide a rectified AC input to the Vicor family of BCM4414 VIA high-voltage and ultra-high-voltage products. The TPM combines a full-wave bridge rectifier, EMI filter and surge-protection circuitry in an easy-to-use VIA plastic housing. The TPM can be used with other power components (such as the ultra-high-voltage BCM®) to create a low profile, efficient, simple and cost-effective AC-DC solution for a broad range of end applications.

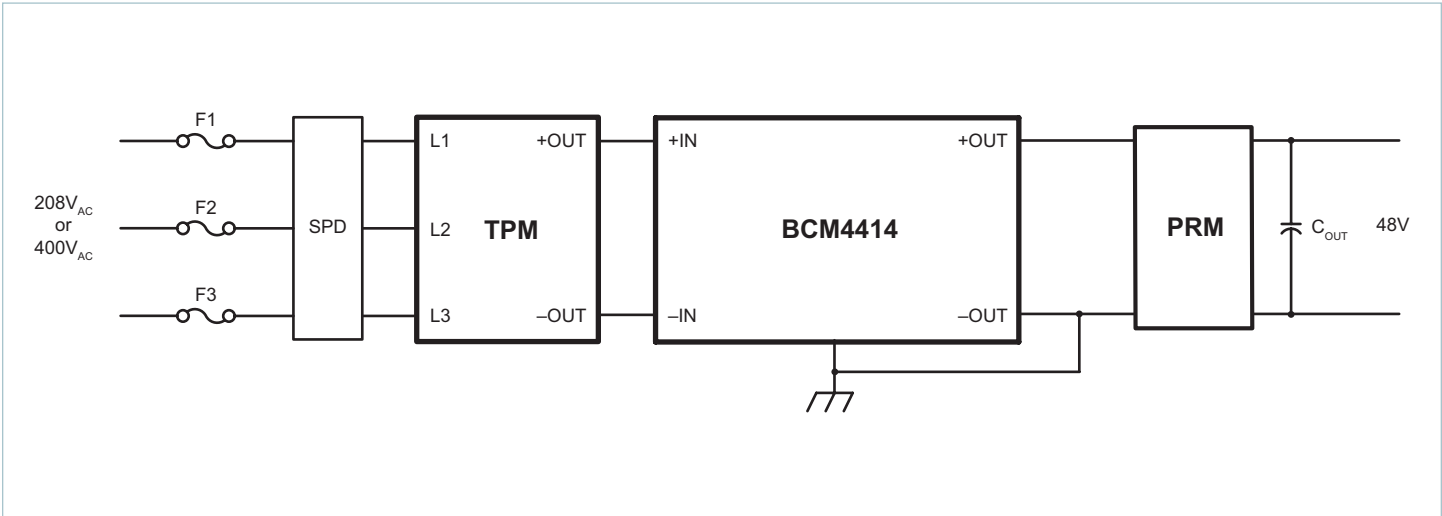


Size:  
1.76 x 1.40 x 0.37in  
[44.6 x 35.5 x 9.3mm]

### Part Ordering Information

| Product Function                  | Package Length        | Package Width        | Package Type                                   | Input Voltage      | Range Ratio | Output Voltage (Range) | Max Output Power                                   | Product Grade  | Option Field |   |
|-----------------------------------|-----------------------|----------------------|--|--------------------|-------------|------------------------|--|--|--------------|---|
| TPM                               | 17                    | 14                   | x  | E3                 | M           | G5                     | K7   | y  | z            | z |
| TPM = Three-Phase AC Input Module | Length in Inches x 10 | Width in Inches x 10 | <b>B</b> = Board VIA<br><b>V</b> = Chassis VIA | Internal Reference |             |                        | <b>C</b> = -20 to 100°C<br><b>T</b> = -40 to 100°C | <b>00</b> = Chassis/Always On<br><b>04</b> = Short Pin/Always On<br><b>08</b> = Long Pin/Always On |              |   |

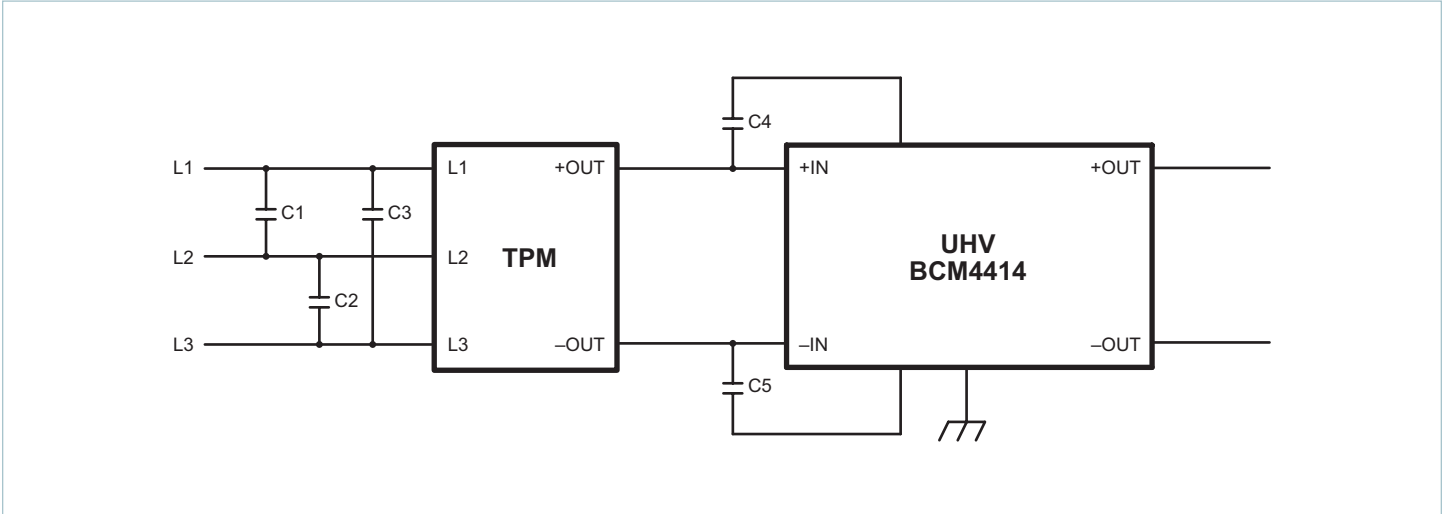
Typical Application



Typical Application: The PCB terminal option allows mounting on an industry standard printed circuit board, with two different pin lengths.

| Parts List for Typical PCB-Mount Applications |  |
|---|--|
| F1, F2, F3                                    | Eaton/Bussman 5A/600V <sub>AC</sub> , Class CC, KTK-R-5  |
| SPD   | Mersen Surge-Trap Model ST2083PYG rated 120/208V <sub>AC</sub> or ST4803PYG rated 277/480V <sub>AC</sub>   |
| TPM   | Vicor TPM TPM1714xE3MG5K7yzz   |
| BCM   | Vicor BCM <sup>®</sup> BCM4414xD1E5135yzz, or BCM4414xD1E13A3yzz, BCM4414xD1E2663yzz or BCM4414xG0F4440yzz |
| PRM   | Downstream PRM <sup>™</sup> regulator (optional)   |
| C <sub>OUT</sub>                              | Output hold-up capacitor (optional): must be located after regulator to avoid harmonics degradation        |

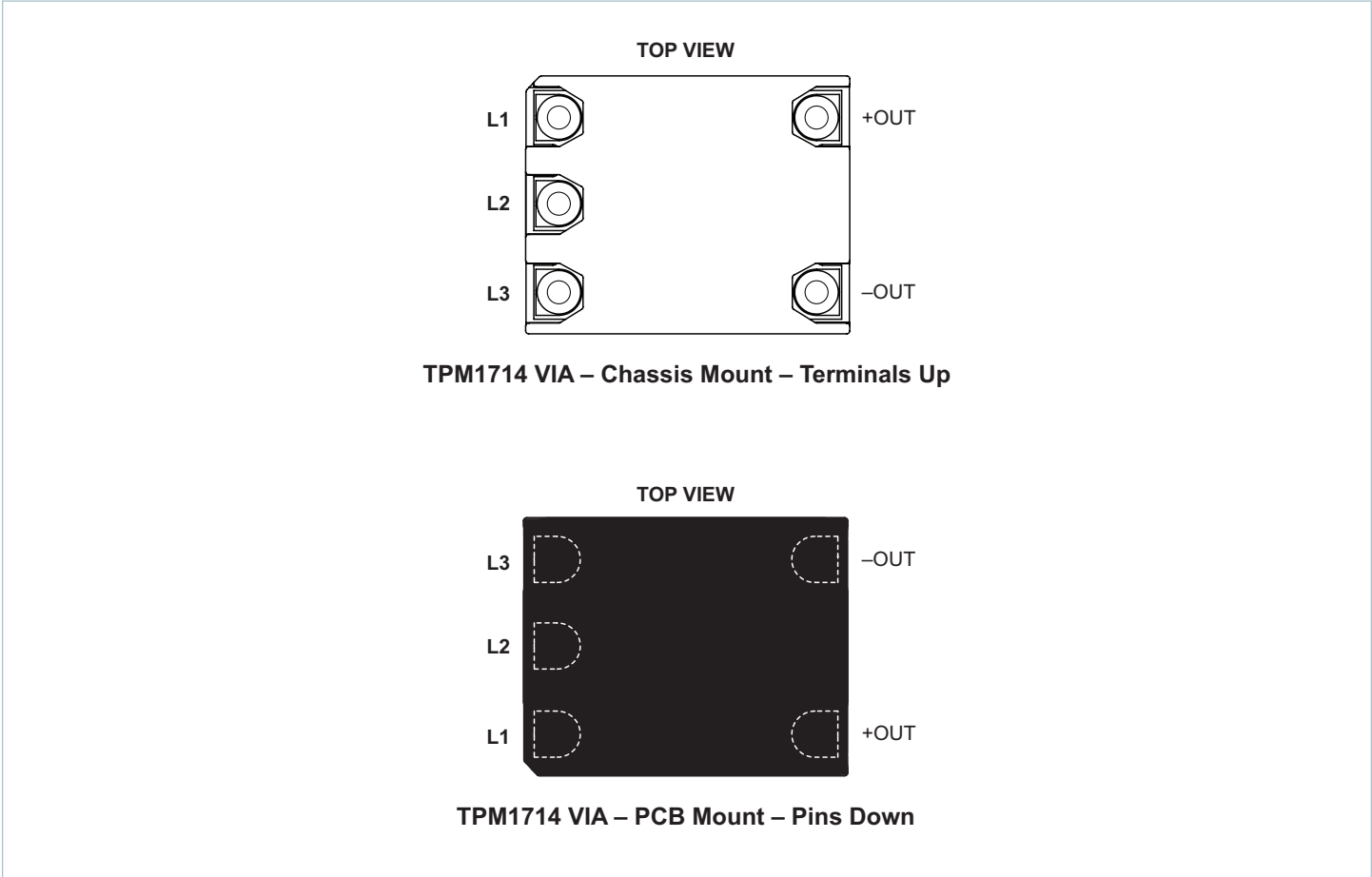
Typical Applications (Cont.)



Typical Application: TPM configuration and external components used for conducted-emission scan shown in Figure 2

| Parts List for Conducted-Emissions Scan |   |
|---|---|
| C1, C2, C3                              | X1 capacitors, 0.1µF, Kemet PHE844, rated 440V~ (ENEC) / 480V~ (UL/CSA)     |
| C4, C5                                  | Y1 capacitors, Vishay VY1472M61Y5UC63V0, rated 4.7nF/Y5U/500V <sub>AC</sub> |
| TPM                                     | TPM1714xE3MG5K7yzz  |
| BCM                                     | Ultra-High-Voltage BCM® BCM4414xG0F4440yzz                                  |

Pin Configuration



Please note that these pin drawings are not to scale.

Pin Descriptions

| Signal Name | Type                | Function                       |
|-------------|---------------------|--------------------------------|
| L1          | INPUT POWER         | AC Line 1 input                |
| L2          | INPUT POWER         | AC Line 2 input                |
| L3          | INPUT POWER         | AC Line 3 input                |
| -OUT        | OUTPUT POWER RETURN | Negative output power terminal |
| +OUT        | OUTPUT POWER        | Positive output power terminal |

## Absolute Maximum Ratings

The absolute maximum ratings below are stress ratings only. Operation at or beyond these maximum ratings can cause permanent damage to the device.

| Parameter                                     | Comments  | Min | Max      | Unit             |
|---|---|-----|----------|------------------|
| Peak Voltage at Input Terminals, 1ms Max      | Limits refer to TPM only. System limits (TPM + BCM4414) will vary based on absolute maximum ratings of BCM model selected | 0   | 800      | V <sub>PK</sub>  |
| Input Voltage (AC RMS) Continuous             |   | 0   | 530      | V <sub>RMS</sub> |
| Output Current (Continuous)                   |   | 0   | 2.3      | A <sub>RMS</sub> |
| Operating Internal Temperature                |   | -40 | 125      | °C               |
| Storage Temperature                           |   | -65 | 125      | °C               |
| Input / Output Pin Torque and Mounting Torque |   |     | 4 [0.45] | in-lbs [N·m]     |

## Electrical Specifications

Specifications apply over all line and load conditions, 50Hz and 60Hz line frequencies, T<sub>CASE</sub> = 25°C, unless otherwise noted.

**Boldface** specifications apply over the temperature range of the specified product grade.

| Attribute  | Symbol            | Conditions / Notes                   | Min        | Typ         | Max         | Unit             |
|--|-------------------|--------------------------------------|------------|-------------|-------------|------------------|
| <b>Input Specifications</b>  |                   |                                      |            |             |             |                  |
| Input Voltage Range, Continuous Operation                                    | V <sub>IN</sub>   | Line-to-line voltage                 | <b>170</b> |             | <b>530</b>  | V <sub>RMS</sub> |
| Input Voltage Range, Transient, Non-Operational (Peak), 30s Minimum Interval | V <sub>IN</sub>   |                                      |            |             | 800         | V <sub>PK</sub>  |
| Source Line Frequency Range  | f <sub>LINE</sub> |                                      | <b>47</b>  |             | <b>840</b>  | Hz               |
| Power Factor   | PF                | Full load, no external capacitance   |            | 0.95        |             | -                |
| <b>Output Specifications</b>   |                   |                                      |            |             |             |                  |
| Output Power   | P <sub>OUT</sub>  |                                      |            |             | <b>1650</b> | W                |
| Output Current (Continuous)  | I <sub>OUT</sub>  |                                      |            |             | <b>2.3</b>  | A                |
| Full-Load Efficiency   | η                 | V <sub>IN</sub> = 400V <sub>AC</sub> |            | 99.4        |             | %                |
|  |                   | Over line and temperature            |            | <b>98.7</b> |             |                  |
| Full-Load Efficiency, 800Hz  | η <sub>800</sub>  | V <sub>IN</sub> = 400V <sub>AC</sub> |            | 97.3        |             | %                |
|  |                   | Over line and temperature            |            | <b>97.0</b> |             |                  |

Application Characteristics

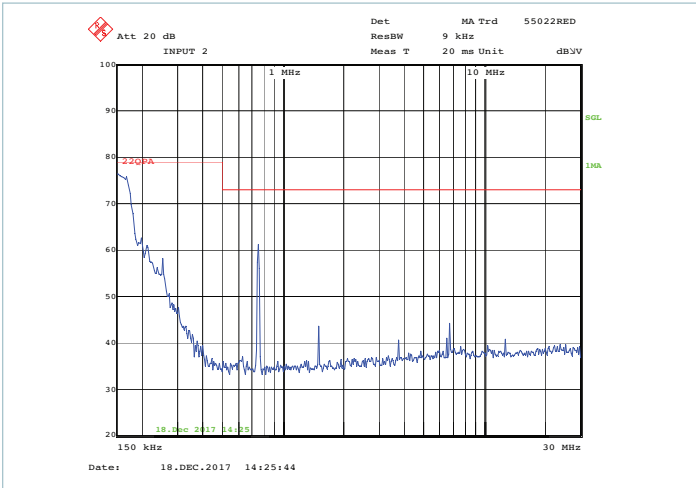


Figure 1 — Typical conducted emissions, peak scan, with BCM4414VGOF4440T02 VIA, 400V<sub>AC</sub>, 90% load, no external components

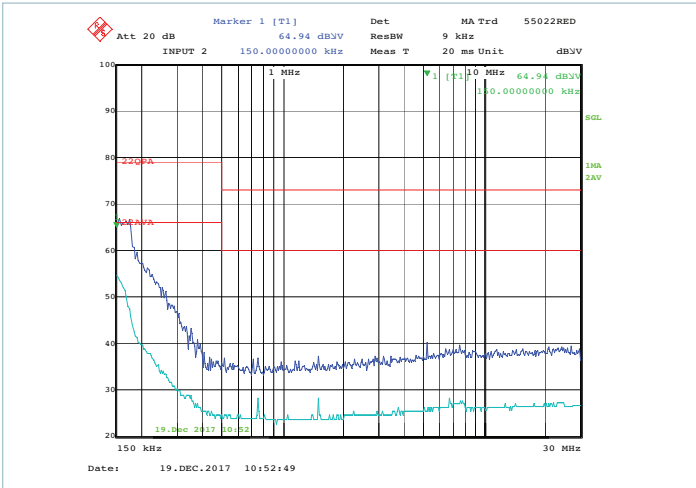


Figure 2 — Typical conducted emissions, peak and average scan, with external components as shown in typical application on page 3

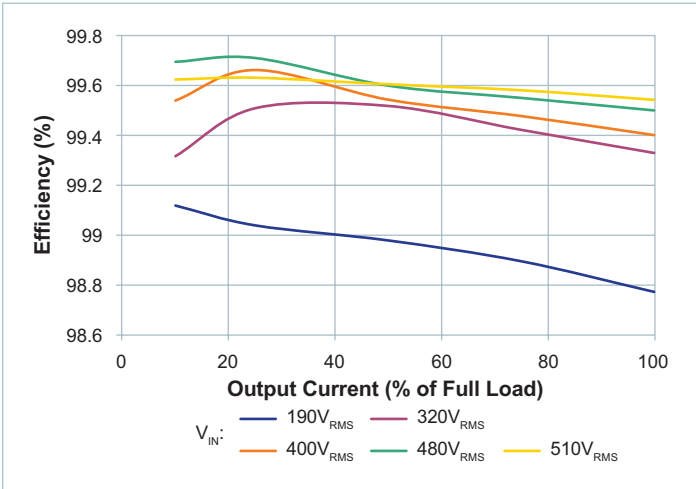


Figure 3 —  $V_{IN}$  to  $V_{OUT}$  efficiency vs.  $V_{IN}$  (line to line) and  $I_{OUT}$ ,  $T_{CASE} = 25^{\circ}C$

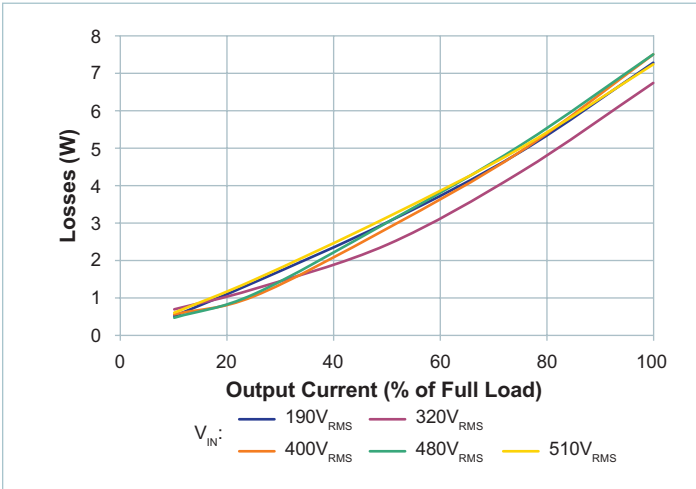


Figure 4 —  $V_{IN}$  to  $V_{OUT}$  power dissipation vs.  $V_{IN}$  (line to line) and  $I_{OUT}$ ,  $T_{CASE} = 25^{\circ}C$

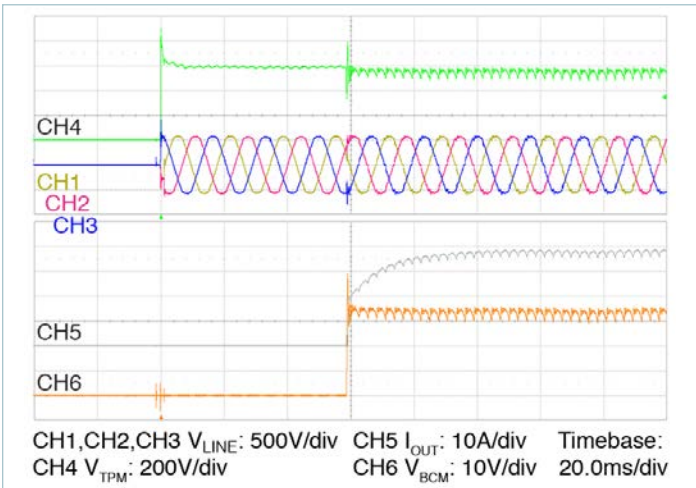


Figure 5 — Start up from  $V_{IN}$

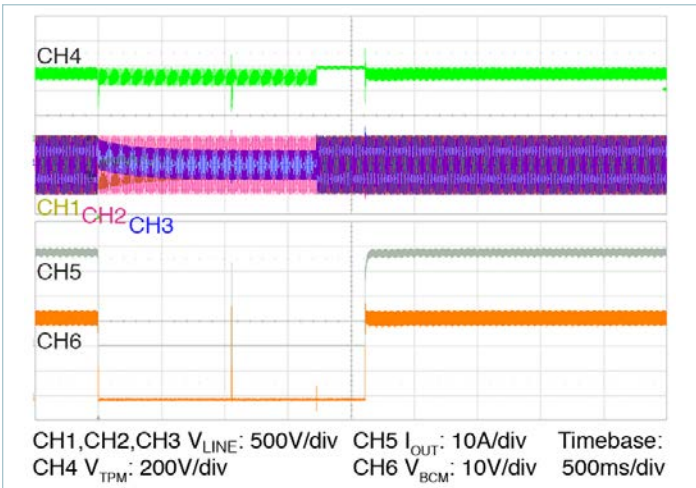


Figure 6 — Input line drop and recovery

General Characteristics

Specifications apply over all line and load conditions, 50Hz and 60Hz line frequencies,  $T_{CASE} = 25^{\circ}C$ , unless otherwise noted.

**Boldface** specifications apply over the temperature range of the specified Product Grade.

| Attribute   | Symbol                         | Conditions / Notes  | Min  | Typ         | Max | Unit                               |
|---|--------------------------------|---|------|-------------|-----|------------------------------------|
| <b>Mechanical</b>                                 |                                |   |      |             |     |                                    |
| Length  | L                              |   |      | 44.6 [1.76] |     | mm [in]                            |
| Width   | W                              |   |      | 35.5 [1.40] |     | mm [in]                            |
| Height  | H                              |   |      | 9.3 [0.37]  |     | mm [in]                            |
| Volume  | Vol                            | Without heat sink   |      | 14.5 [0.88] |     | cm <sup>3</sup> [in <sup>3</sup> ] |
| Mass (Weight)                                     | M                              |   |      | 35 [1.2]    |     | g [oz]                             |
| Pin Material                                      |                                | C145 copper, half hard  |      |             |     |                                    |
| Underplate  |                                | Low-stress, ductile nickel  | 50   |             | 100 | μin                                |
| Pin Finish  |                                | Palladium   | 0.8  |             | 6   | μin                                |
|   |                                | Soft Gold   | 0.12 |             | 2   | μin                                |
| <b>Thermal</b>                                    |                                |   |      |             |     |                                    |
| Operating Case Temperature                        | $T_{CASE}$                     | C-Grade   | -20  |             | 100 | °C                                 |
|   |                                | T-Grade   | -40  |             | 100 | °C                                 |
| Thermal Resistance, Internal to Case Non-Pin Side | $\theta_{INT\_NON\_PIN\_SIDE}$ |   |      | 2.2         |     | °C/W                               |
| Thermal Design                                    |                                | See Thermal Considerations on Page 9  |      |             |     |                                    |
| <b>Soldering</b>                                  |                                |   |      |             |     |                                    |
| Temperature                                       |                                | See: <a href="#">AN:401 PCB Mount VIA Soldering Guidelines</a>                          |      |             |     |                                    |
| <b>Reliability</b>                                |                                |   |      |             |     |                                    |
| MTBF  |                                | MIL-HDBK-217FN2 Parts Count - 25°C Ground Benign, Stationary, Indoors Computer          |      | 8.2         |     | MHrs                               |
|   |                                | Telcordia Issue 2 - Method I Case III; 25°C   |      | 28.6        |     |                                    |
|   |                                | MIL-HDBK-217FN2 - 25°C Ground Benign, Stationary, Indoors Computer                      |      | 7.4         |     |                                    |
| <b>Safety</b>                                     |                                |   |      |             |     |                                    |
| Agency Approvals Standards                        |                                | EN60950-1; CE marked for low voltage directive and RoHS recast directive, as applicable |      |             |     |                                    |
| Dielectric Withstand (Hipot)                      |                                | IN / OUT to Case  | 2200 |             |     | V <sub>AC</sub>                    |
| Leakage Current Touch Current                     |                                | No Y capacitor connection of GND connection within package                              |      | Negligible  |     |                                    |
| <b>EMI/EMC Compliance</b>                         |                                |   |      |             |     |                                    |
| FCC Part 15, EN55032 : 2015, Conducted Emissions  |                                | Class A Limits, with BCM4414xG0F4440yzz   |      |             |     |                                    |
| EN61000-4-5: 2015, Level 3 Surge Immunity         |                                | Performance Criteria B 208V, with BCM4414xG0F4440yzz                                    |      |             |     |                                    |

Environmental Qualification

| Testing Activity                                 | Reference Standard                 | Test Details   |
|--|------------------------------------|--|
| High Temperature Operating Bias/Life (HTOB/HTOL) | JESD22-A108D                       | 1000hrs, nominal full load at max operating temperature  |
| Temperature Cycling Test (TCT)                   | IPC-9592B                          | 125 to -40°C, 700 cycles   |
| Temperature Humidity Bias (THB)                  | JESD22-A101C                       | 1000hrs, Nominal input voltage, minimal load 85°C, 85% RH  |
| High Temperature Storage (HTS)                   | JESD22-A103D                       | 1000hrs, 125°C   |
| Low Temperature Storage (LTS)                    | JESD22-A119                        | 1000hrs, -65°C   |
| Random Vibration                                 | MIL-STD-810G                       | Method 514.6, Procedure I, Category 24, 20 – 2000Hz, @7.7g <sub>RMS</sub> , 1hour /axis for 3 axis. Product mounted on an evaluation board, nominal line 50% load. |
| Mechanical Shock                                 | MIL-STD-810G                       | Method 516.5, Procedure I, Functional shock 40G, total of 18 shocks. Product mounted on an evaluation board, nominal line 50% load.                                |
| Highly Accelerated Life Test (HALT)              | Internal Vicor Procedure - DP-0265 | Low and high temperature tests, rapid thermal cycling, random vibration testing, combined stress testing and destruct testing.                                     |
| Res. Solvents                                    | MIL-STD-202G                       | Method 215K, 3 minutes exposure  |
| ESD Human Body Model                             | JEDEC JS-001-2012                  | Class 1C (HBM) minimum   |
| ESD Charged Device Model                         | JESD22-C101E                       | Class II (CDM) minimum   |



## Thermal Considerations

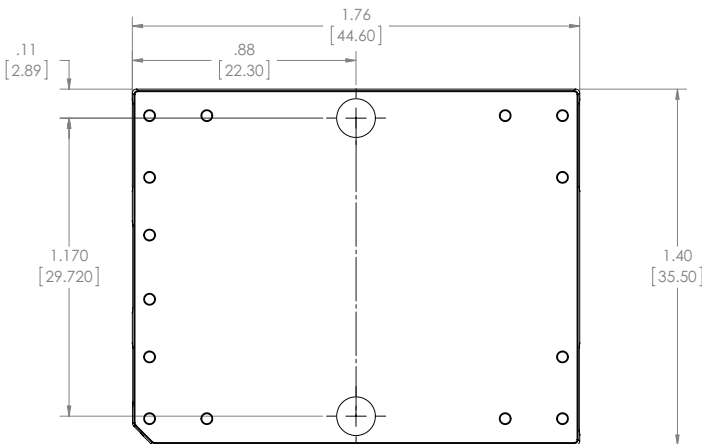
The TPM in a VIA package can be cooled using single side cooling from the non-pin side.

Internal operating temperatures will be kept to acceptable limits if the lower housing of the unit is mounted to a metal plate (coldplate or heatsink) with thermal grease that is kept to 100°C or less. If the unit is not mounted to a metal plate, then a thermocouple on the bottom housing located midway between the two mounting holes needs to be kept to 110°C or less.

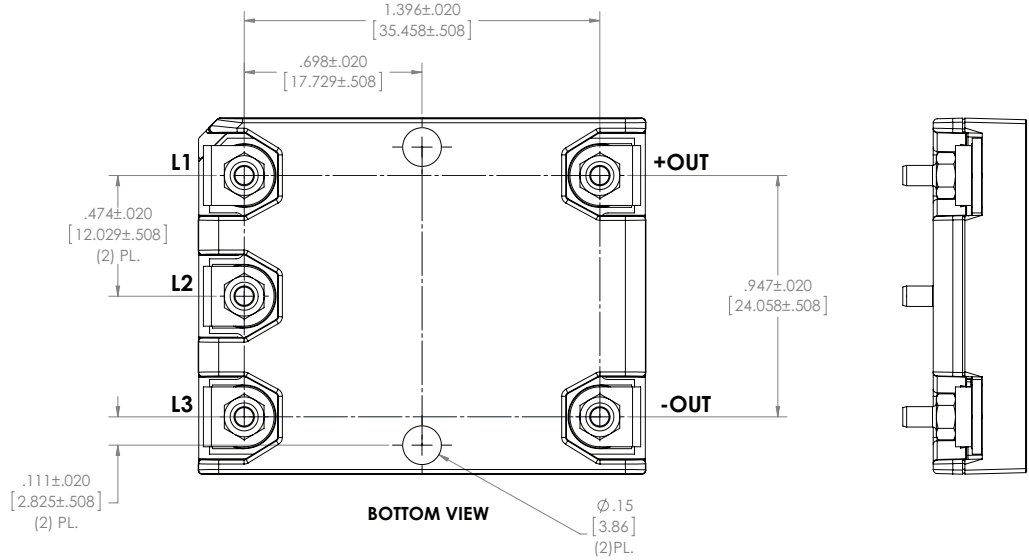
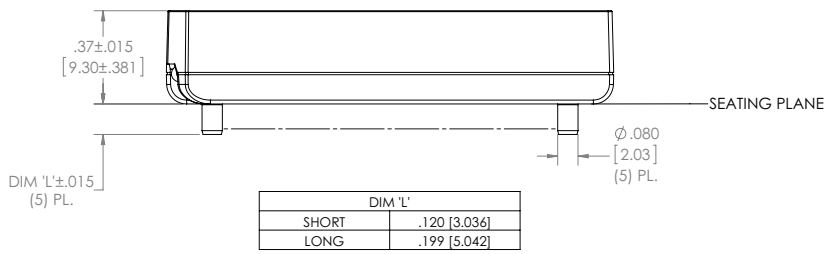
## Creepage

In chassis-mount applications a Gap Pad TIM is necessary to meet the creepage requirements from the Input/Output terminals to chassis. If a heat sink is used then it will need to be insulated or sized appropriately to satisfy the creepage requirements from the Input/Output terminals to the heatsink. Vicor Part Number 47591 shown on page 13 can be used to meet the required creepage distances.

TPM in a VIA Package Chassis-Mount Package Mechanical Drawing



TOP VIEW  
(COMPONENT SIDE)

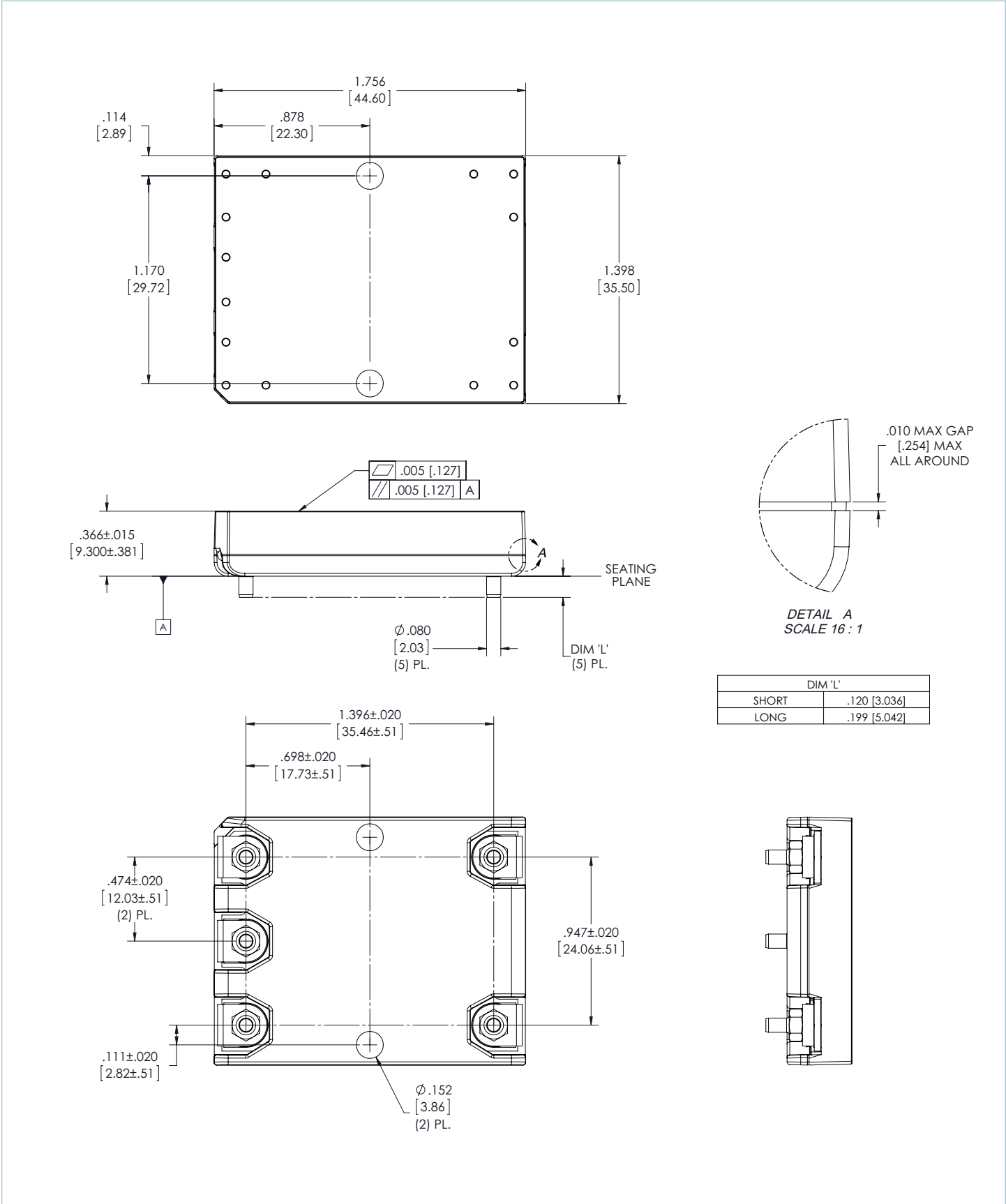


BOTTOM VIEW

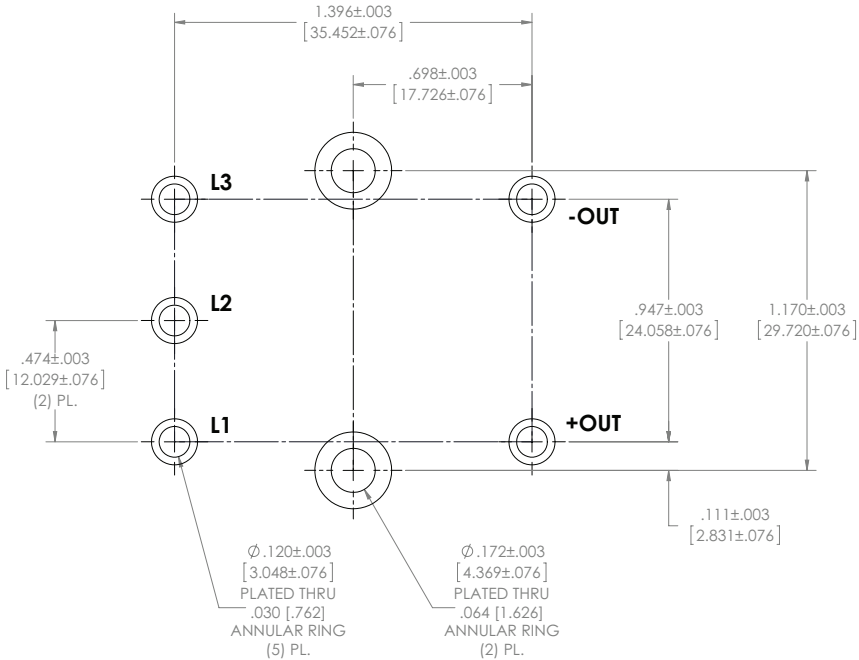
NOTES:  
1. UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE: INCH [MM]

Product outline drawing; product outline drawings are available in .pdf and .dxf formats.  
3D mechanical models are available in .pdf and .step formats.

TPM in a VIA Package PCB-Mount Package Mechanical Drawing

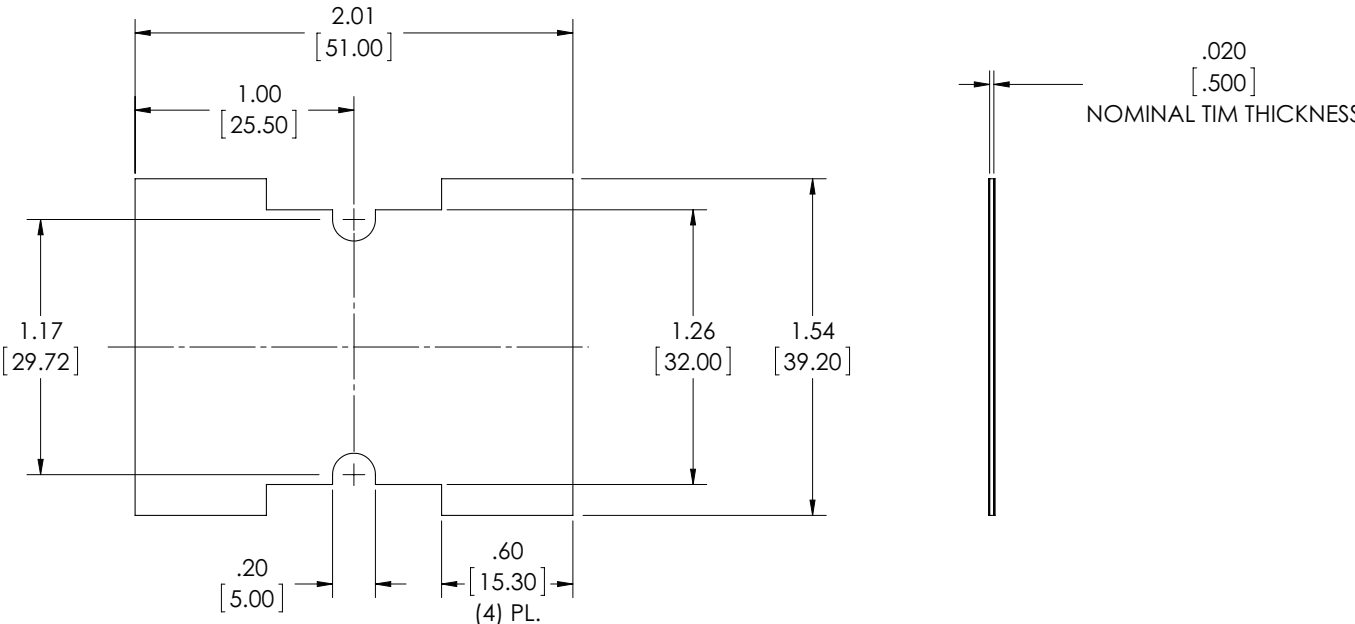


TPM in a VIA Package PCB-Mount Recommended Land Pattern



RECOMMENDED HOLE PATTERN (COMPONENT SIDE)

TPM1714 Thermal Interface Material (TIM) Pad Mechanical Drawing



- NOTES:
- 1. RoHS COMPLIANT PER CST-0001 LATEST REVISION
  - 2. MATERIAL: HENKEL BERGQUIST GAP PAD 5000 S35
  - 3. NOMINAL THICKNESS .020 [.50] EXCLUSIVE OF LINER
  - 4. PART IS KISS CUT AND SUPPLIED WITH A REMOVABLE PROTECTIVE LINER ON BOTH SIDES
  - 5. LINEAR TOLERANCE  $\pm 0.020$  [0.50]

Revision History

| Revision | Date     | Description                            | Page Number(s) |
|----------|----------|--|----------------|
| 1.0      | 07/10/18 | Intitial release                       | n/a            |
| 1.1      | 07/12/18 | Updated to include safe operating area | 5, 6           |
| 1.2      | 10/11/18 | Updated to remove SOA                  | 5              |

Note: page added in Rev 1.1, removed in Rev 1.2.

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