

## 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

- 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 directly 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 bridge rectifier, EMI filter and surge-protection circuitry in an easy-to-use VIA plastic housing. Together, the TPM and ultra-high-voltage BCM® in a VIA Package realize a small, efficient, simple and cost-effective EMI Class A AC-DC solution for a broad range of end applications.

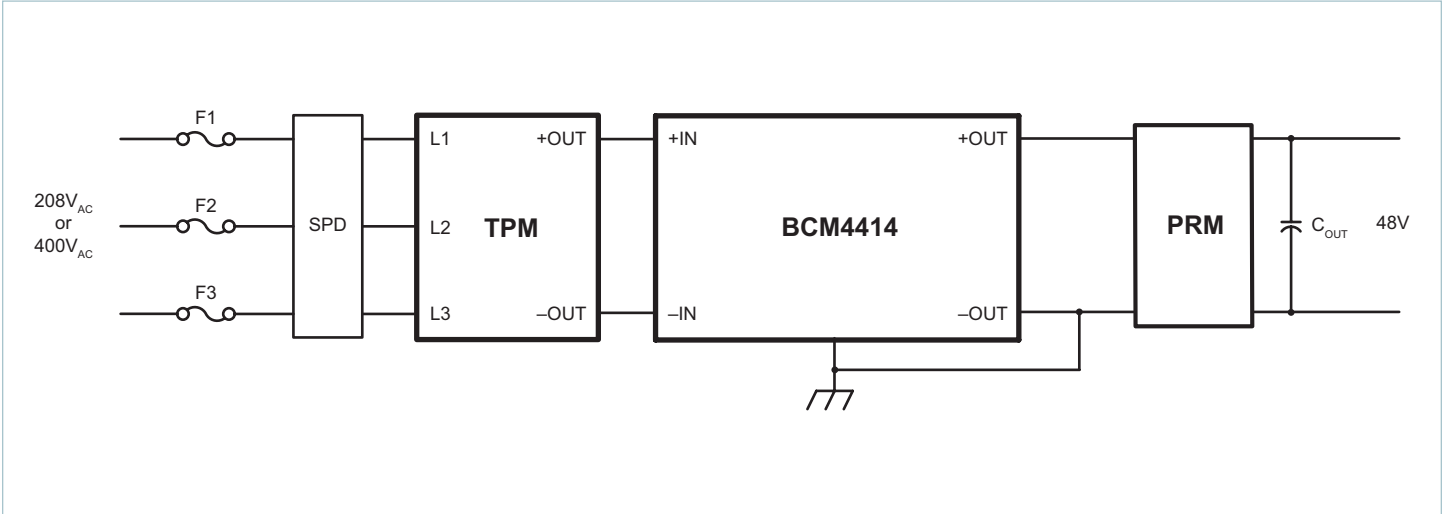


Size:  
1.76 x 1.40 x 0.37in  
[44.6 x 35.5 x 9.3mm]

### 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 = Board VIA V = Chassis VIA	Internal Reference			C = -20 to 100°C T = -40 to 100°C	00 = Chassis/Always On 04 = Short Pin/Always On 08 = Long Pin/Always On		

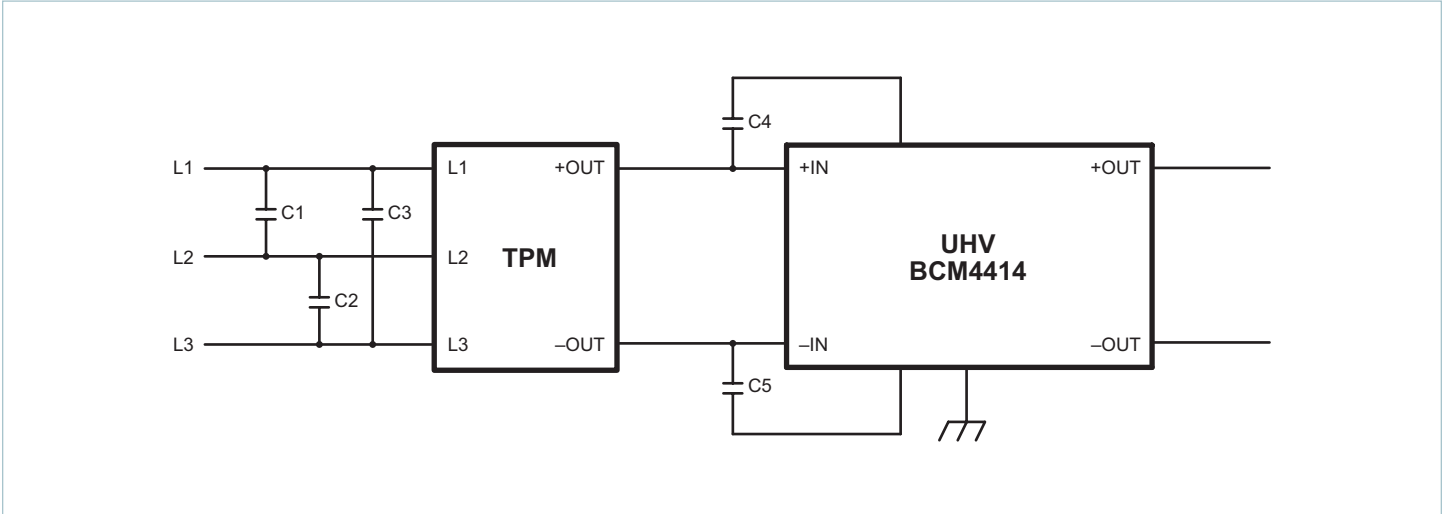
Typical Application



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

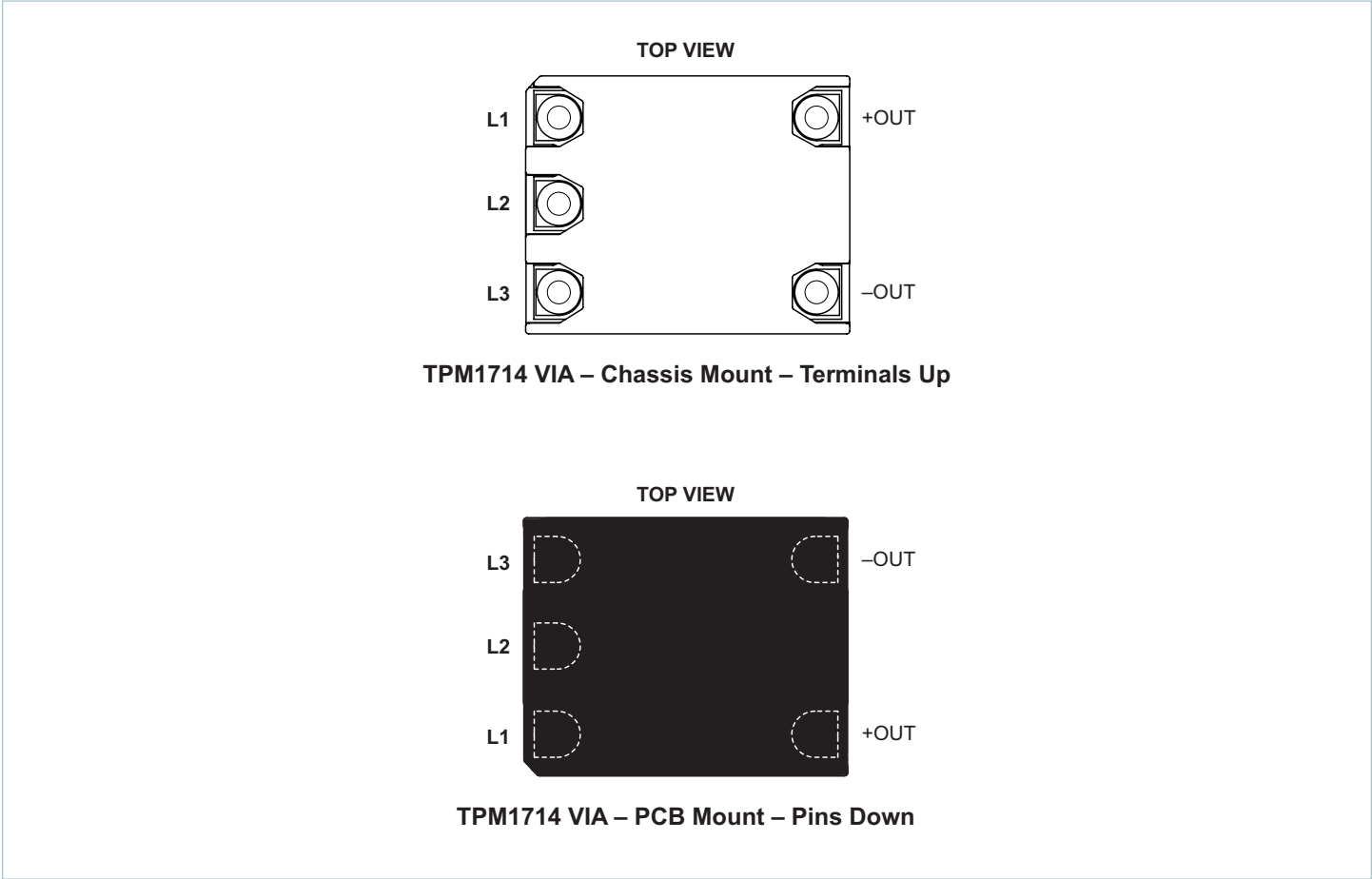
Typical Applications (Cont.)



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 Junction Temperature		-40	125	°C
Storage Temperature		-65	125	°C
Input / Output Pin Torque and Mounting Torque			4 [0.45]	in·lbs [N·m]

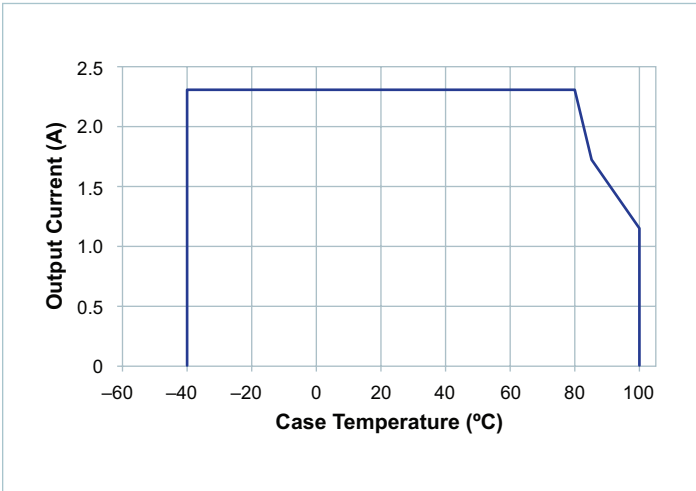


Figure 1 — Thermal safe operating area

## Electrical Specifications

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>Input Specifications</b>						
Input Voltage Range, Continuous Operation	$V_{IN}$	Line-to-line voltage	<b>170</b>		<b>530</b>	$V_{RMS}$
Input Voltage Range, Transient, Non-Operational (Peak), 30s Minimum Interval	$V_{IN}$				800	$V_{PK}$
Source Line Frequency Range	$f_{LINE}$		<b>47</b>		<b>840</b>	Hz
Power Factor	PF	Full load, no external capacitance		0.95		-
<b>Output Specifications</b>						
Output Power	$P_{OUT}$	For high-temperature operation and de-rating, see Figure 1			<b>1650</b>	W
Output Current (Continuous)	$I_{OUT}$	Refer to SOA on page 5			<b>2.3</b>	A
Full-Load Efficiency	$\eta$	$V_{IN} = 400V_{AC}$		99.4		%
		Over line and temperature		<b>98.7</b>		
Full-Load Efficiency, 800Hz	$\eta_{800}$	$V_{IN} = 400V_{AC}$		97.3		%
		Over line and temperature		<b>97.0</b>		

Application Characteristics

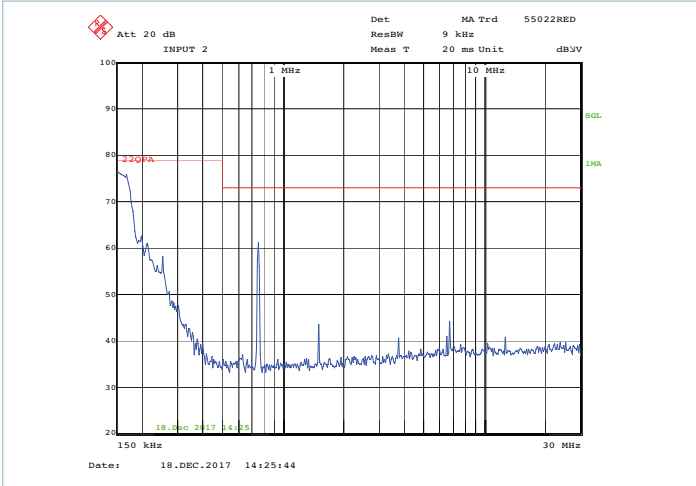


Figure 2 — Typical conducted emissions, peak scan, with BCM4414VGOF4440T02 VIA, 400V<sub>AC</sub> 90% load, no external components

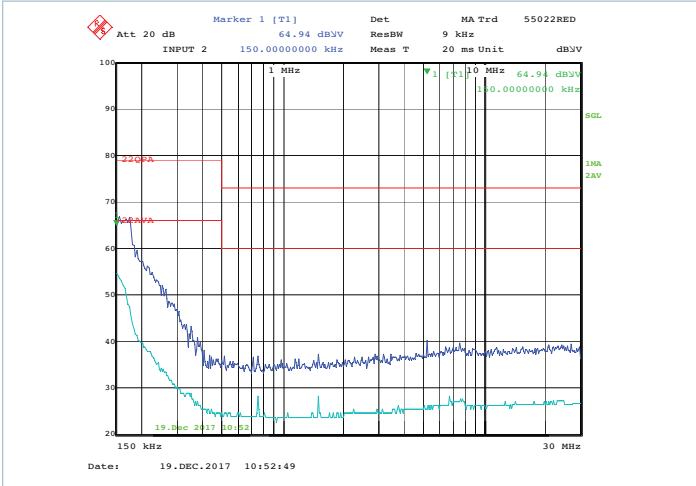


Figure 3 — Typical conducted emissions, peak and average scan, with BCM4414VGOF4440T02 VIA, 400V<sub>AC</sub> 90% load, with external components as shown in typical application on page 3

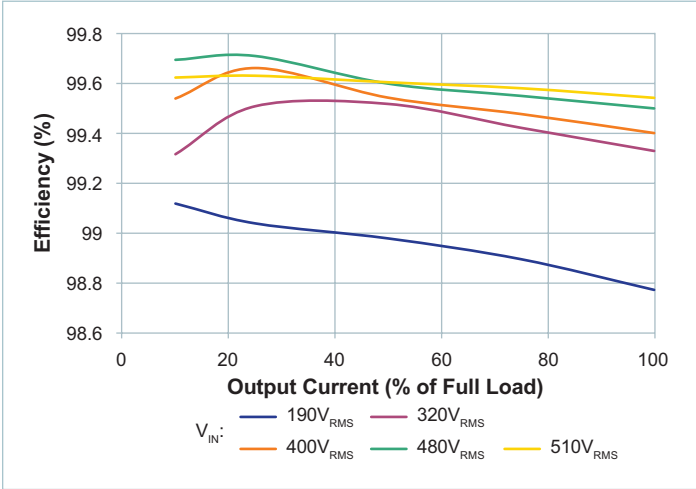


Figure 4 —  $V_{IN}$  to  $V_{OUT}$  efficiency vs.  $V_{IN}$  (line to line) and  $I_{OUT}$ ,  $T_{CASE} = 25^{\circ}C$

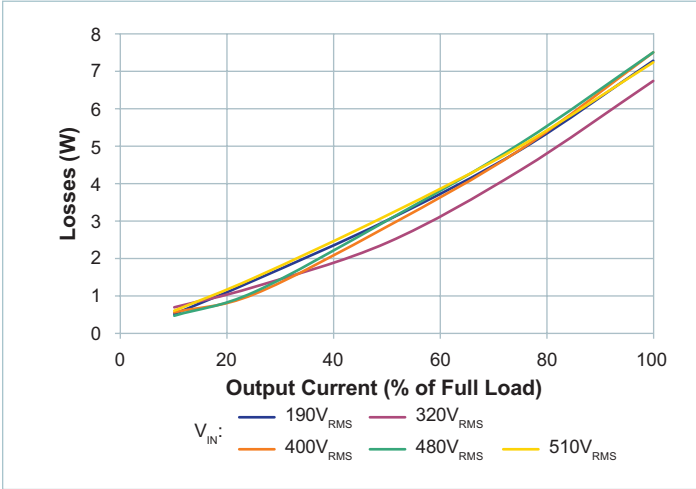


Figure 5 —  $V_{IN}$  to  $V_{OUT}$  power dissipation vs.  $V_{IN}$  (line to line) and  $I_{OUT}$ ,  $T_{CASE} = 25^{\circ}C$

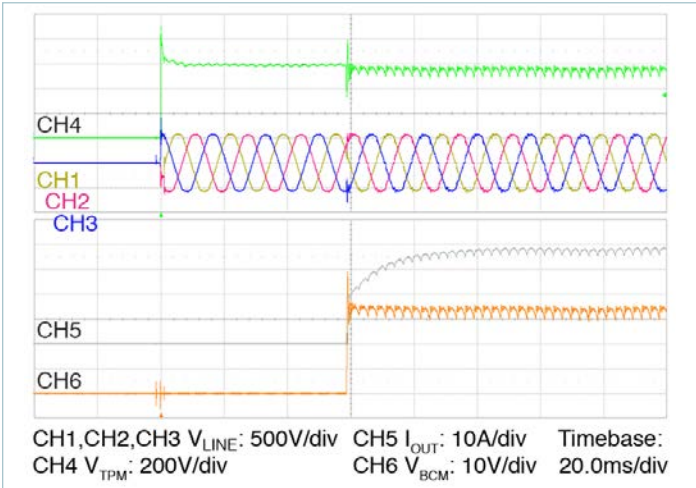


Figure 6 — Start up from  $V_{IN}$

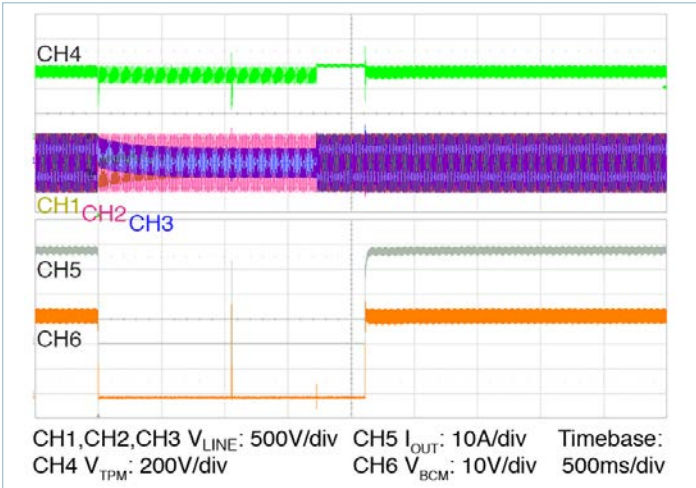


Figure 7 — Input line drop and recovery

## 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 heatsink		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	$T_C$	C-Grade	-20		100	°C
		T-Grade	-40		100	°C
Thermal Resistance, Junction to Case Bottom	$R_{JC\_BOT}$			2.2		°C/W
Thermal Design		See Thermal Considerations on Page 10				
<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

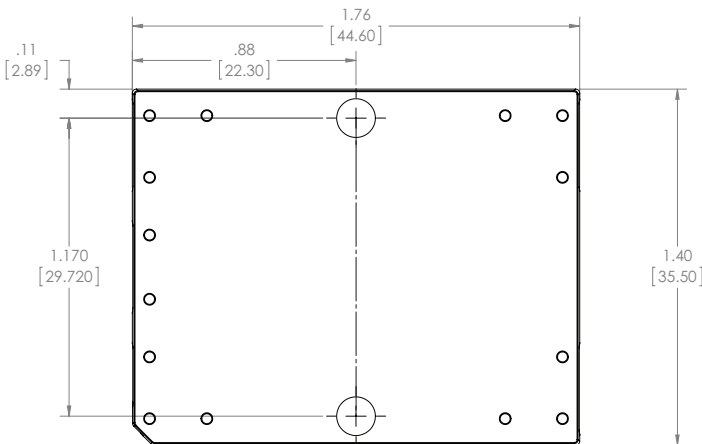
The TPM in a VIA package can be cooled using single side cooling from the bottom side (i.e., facing opposite the screws of PCB pins).

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.

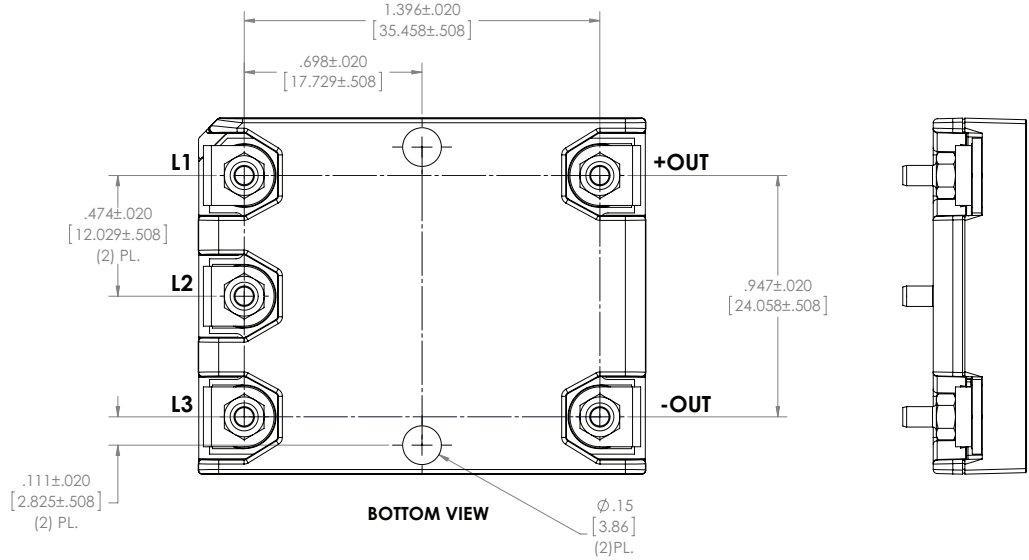
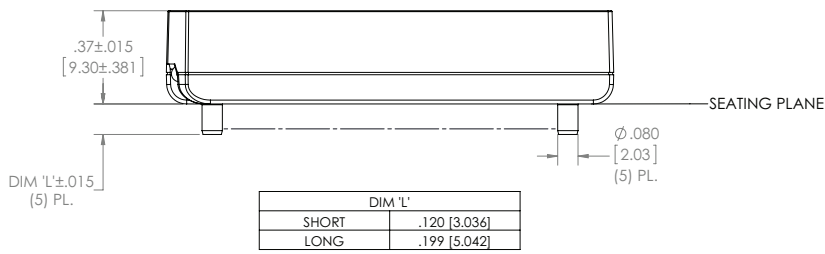
## Creepage

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 14 can be used to meet the required creepage distances.

TPM in a VIA Package Chassis-Mount Package Mechanical Drawing



TOP VIEW  
(COMPONENT SIDE)

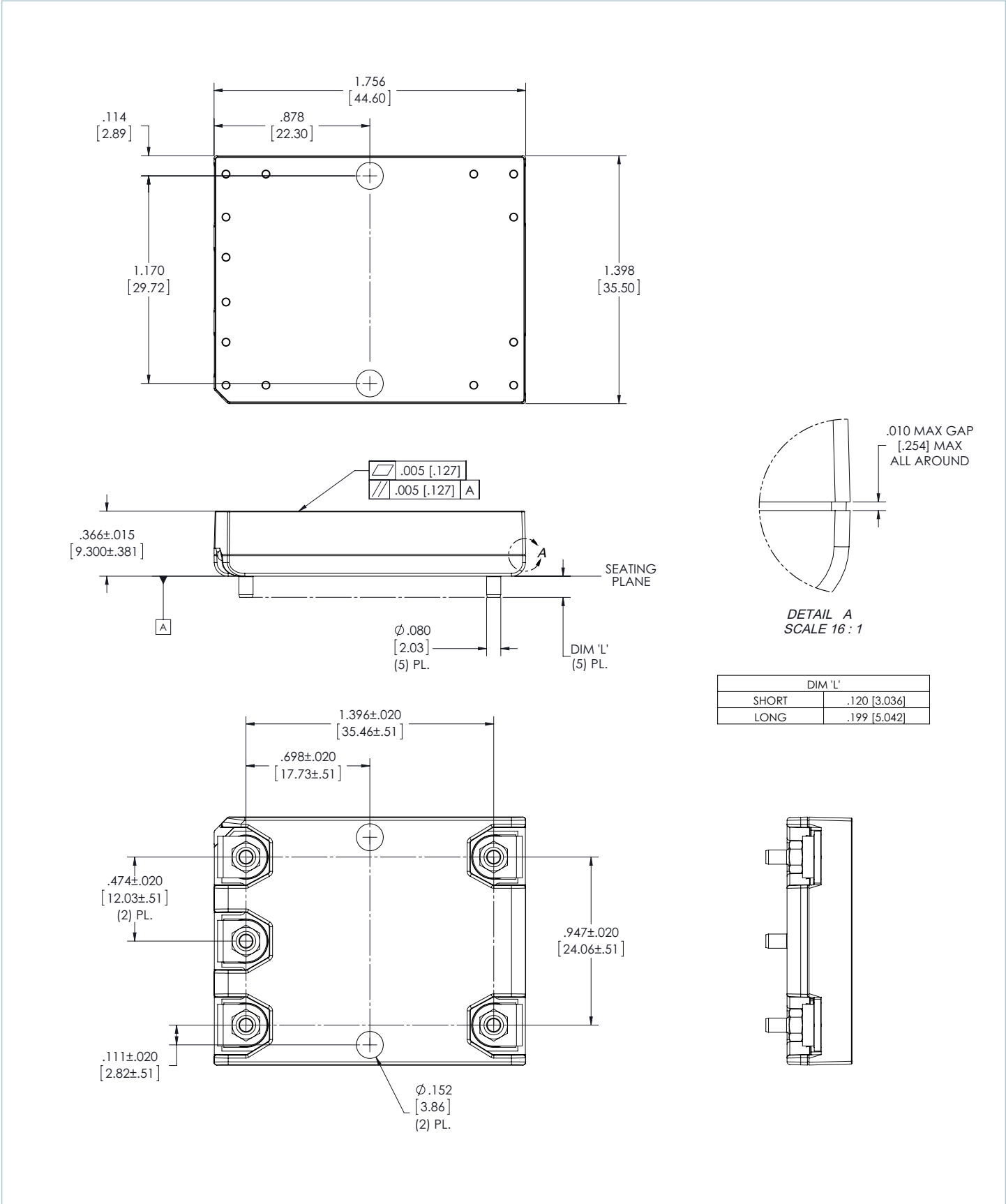


BOTTOM VIEW

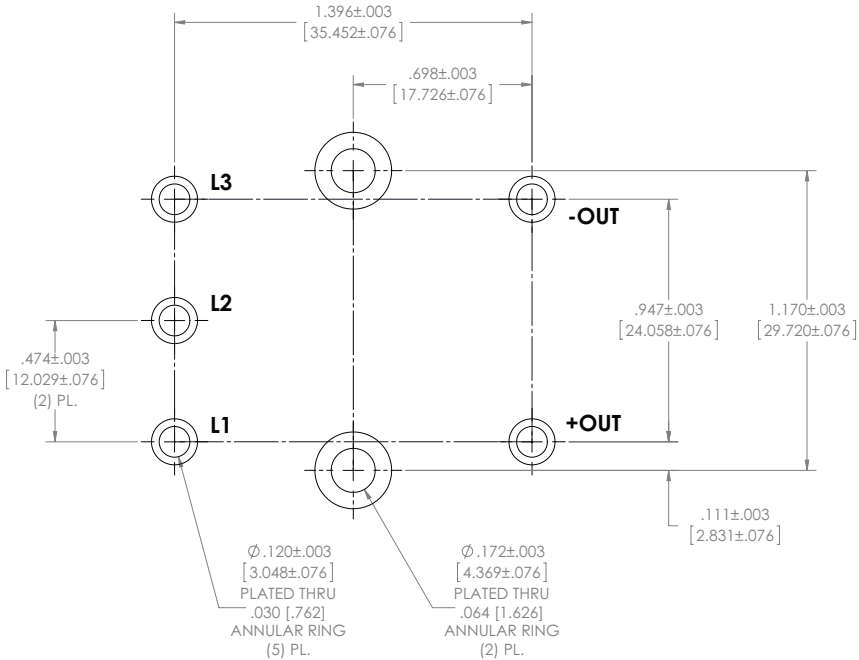
NOTES:  
1. UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE: INCH [MM]

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

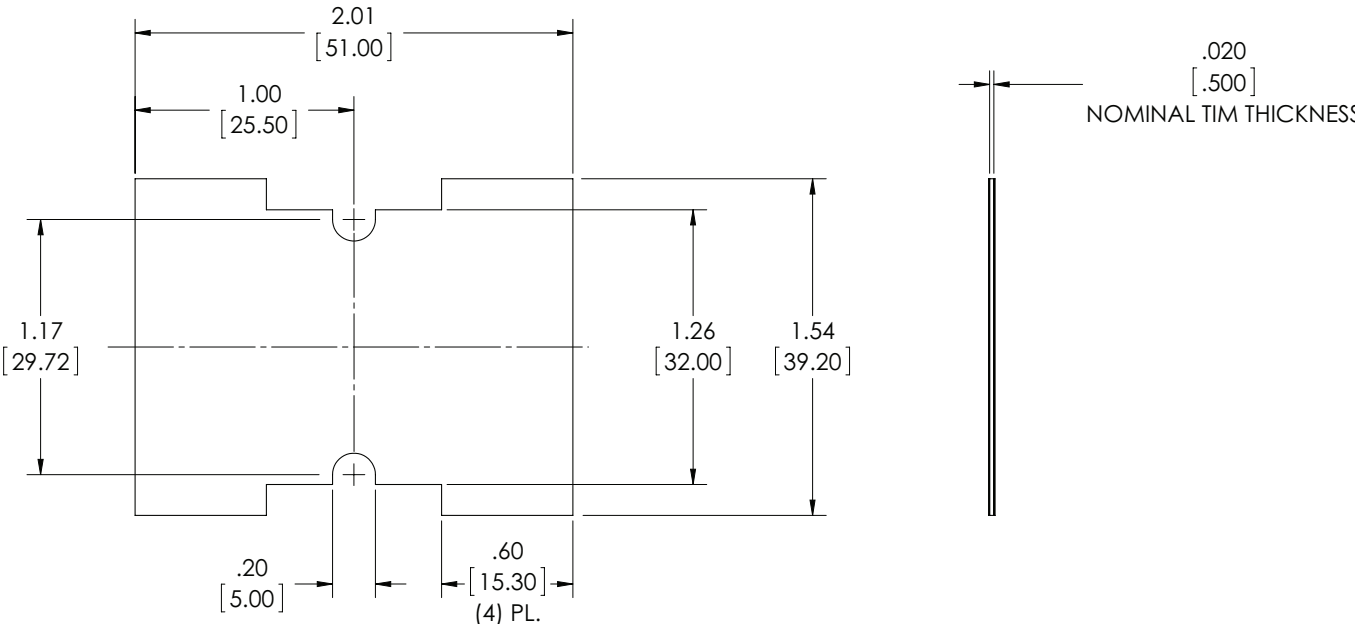


TPM in a VIA Package PCB-Mount Recommended Land Pattern



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 ± 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

Note: page added in Rev 1.1

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