# LV MFM™ Filter

## MFM1714x50M50C5yzz

## Low Voltage MIL-COTS Input Filter Module

### Features & Benefits

- 28V Nominal input
- 99% efficiency
- EMI filtering
  - MIL-STD-461E/F, selected CE and CS tests
- Input Transient protection
  - MIL-STD-1275A/B/D/E
  - MIL-STD-704A/F (MIL-HDBK-704-8) Normal and Abnormal Transients
- Envronmental qualification
  - MIL-STD-810
  - MIL-STD-202
- Low M grade temperature rating, providing operation down to -55°C
- Output power up to 350W
- Available in chassis and PCB mount
- Small size
  - 1.76" x 1.40" x 0.36" (44.6mm x 35.5mm x 9.2mm)

### Typical Applications

- Defense
- Aerospace

### Compatible Products

- Low input voltage DCM in a VIA Package
- Low input voltage ChiP[1] DCM

### Product Description

The MFM DCM Filter is a DC front-end module that provides EMI filtering and transient protection. The MFM DCM Filter enables designers using Vicor's 28V nominal input voltage VIA or ChiP[1] modules to meet conducted emission/conducted susceptibility per MIL-STD-461E/F; and input transients per MIL-STD-704A/F, MIL-STD-1275A/B/D/E and DO-160E. The MFM DCM Filter accepts an input voltage of 16 – 50$V_{DC}$ (28V nominal input ) and delivers output power up to 350W.

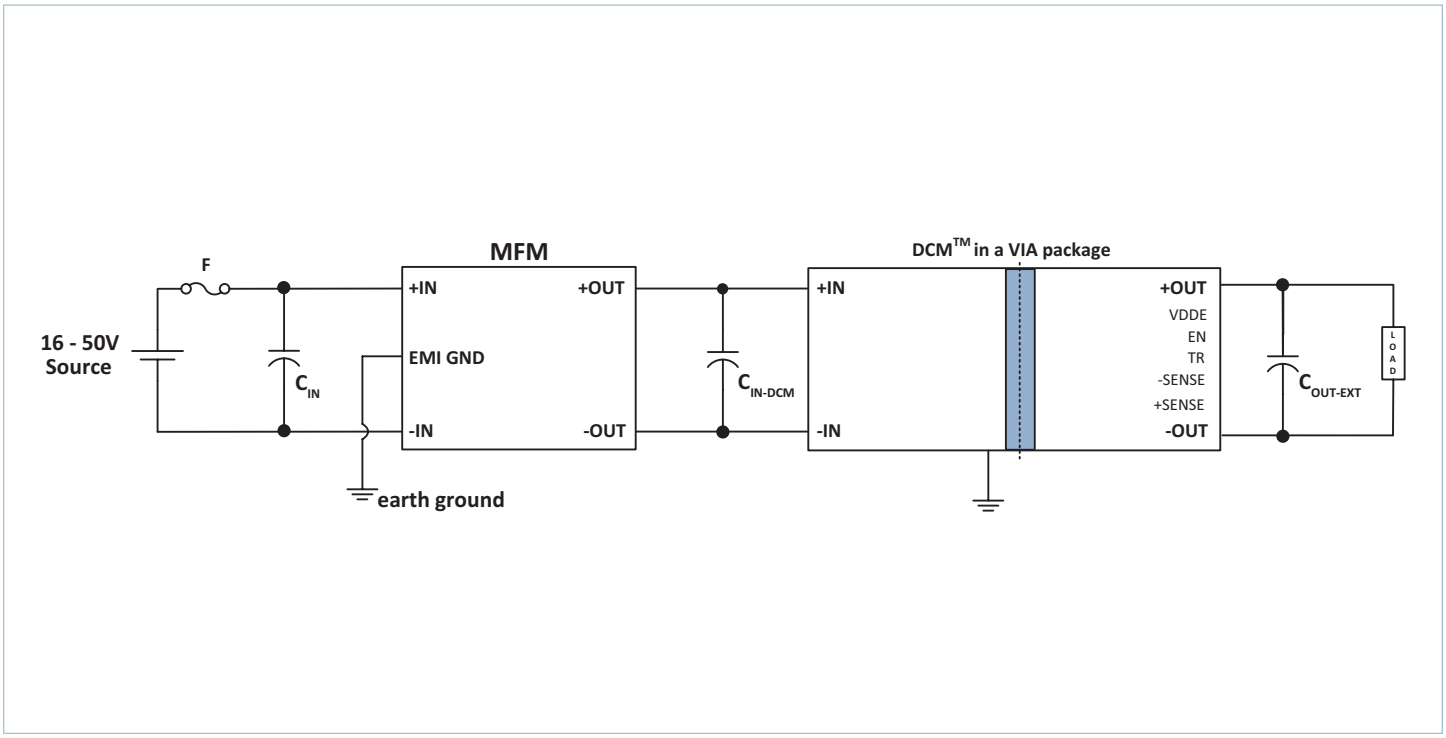
Size:
1.76 x 1.40 x 0.36in
44.6 x 35.5 x 9.2mm

[1] Additional components are required for EMI filtering and transient suppression, when used with ChiP modules.

### Part Ordering Information

| Product Function | Package Length | Package Width | Package Type | Max High Side Voltage | High Side Voltage Range Ratio | Max Low Side Voltage | Max Low Side Current | Product Grade (Case Temperature) | Option Field |
|---|---|---|---|---|---|---|---|---|---|
| MFM | 17 | 14 | x | 50 | M | 50 | C5 | y | zz |
| MFM = MIL-COTS Input Filter Module | Length in Inches x 10 | Width in Inches x 10 | B = Board VIA<br>V = Chassis VIA | Internal Reference | | | | M = -55 to 100°C | 00 = Chassis<br>04 = Short Pin<br>08 = Long Pin |

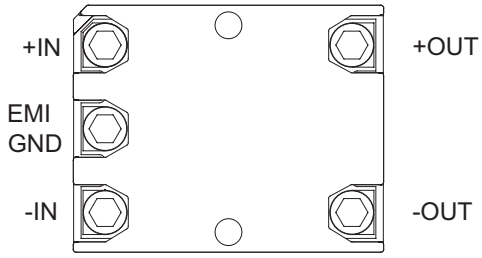
## Typical Application



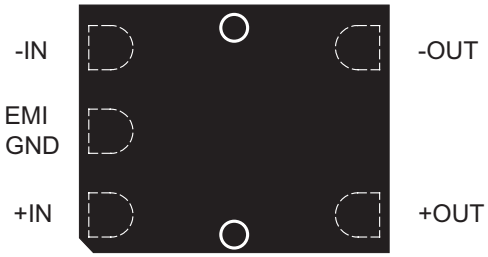

*M-Grade DCM in a VIA package with a MFM input filter, to meet the EMI and transient requirements*

| Parts List for Typical Applications | |
|---|---|
| F | **EATON (Cooper/Bussman)** ABC series, fast acting tube fuses rated 30A<br>**Littlefuse NANO2** 456 Series, surface mount fuses rated 30A |

## Pin Configuration




**MFM Filter in a VIA Package - Chassis (Lug) Mount - Terminals Up**




**MFM Filter in a VIA Package - PCB Mount - Pins Down**

**Note:** These Pin drawings are not to scale.

## Pin Descriptions

| Signal Name | Type | Function |
|---|---|---|
| +IN | INPUT POWER | Positive input power terminal |
| –IN | INPUT POWER RETURN | Negative input power terminal |
| EMI GND | EMI GROUND | EMI ground terminal |
| +OUT | OUTPUT POWER | Positive output power terminal |
| –OUT | OUTPUT POWER RETURN | Negative 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. Electrical specifications do not apply when operating beyond rated operating conditions.

| Parameter | Comments | Min | Max | Unit |
|---|---|---|---|---|
| Input Voltage (+IN to –IN) | Continuous | -0.5 | 65.0 | $V_{DC}$ |
| | Transient per MIL-STD-1275D/E, 50ms | | 100 | |
| | Transient per MIL-STD-1275A/B/D, 70µs | | 250 | |
| | Transient per DO-160E, 100ms | | 80 | |
| Output Voltage (+OUT to –OUT) | | -0.5 | 65.0 | $V_{DC}$ |
| Dielectric Withstand (Input/Output to EMI GND/Case) | | | 1500 | $V_{DC}$ |
| Storage Temperature | M-Grade | -65 | 125 | °C |
| Internal Operating Temperature | M-Grade | -55 | 125 | °C |
| Average Output Current | | | 22 | A |
| Input/Output Pin Torque and Mounting Torque | | | 4 (0.45) | in-lbs (N-m) |

## Electrical Specifications

Specifications apply over all line and load conditions, unless otherwise noted; **boldface** specifications apply over the temperature range of -55°C ≤ $T_{CASE}$ ≤100°C (M-Grade); all other specifications are at $T_{CASE}$ = 25°C unless otherwise noted.

| Attribute | Symbol | Conditions / Notes | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Power Input / Output Specification** | | | | | | |
| Input Voltage Range[2] | $V_{IN}$ | Continuous operation | 16 | 28 | 50 | V |
| | | Transient per MIL-STD-1275D/E, 50ms | | | 100 | |
| | | Transient per MIL-STD-1275A/B/D, 70µs | | | 250 | |
| | | Transient per DO-160E, 100ms | | | 80 | |
| Maximum Output Current[3] | $I_{OUT\_MAX}$ | Continuous, at $V_{OUT}$ = 16V ($I_{OUT} = P_{OUT}/V_{IN}$) | | | 22 | A |
| Rated Output Power[3] | $P_{OUT}$ | Continuous, over all line conditions | | | 350 | W |
| Internal Voltage Drop | | @16V, 22A, 100°C baseplate | | | **0.65** | $V_{DC}$ |
| Efficiency | η | Full load, low line, high temperature | **97.7** | 98 | 98.2 | % |
| | | Full load, nominal line, high temperature | **99.2** | 99.4 | | % |
| | | Full load, high line, high temperature | **99.7** | 99.8 | | % |

[2] Transient immunity specifications are met only when LV MFM is used with M-grade 16-50$V_{IN}$ DCM in a VIA package.
[3] One MFM for each DCM even if the total power of the DCM is below $P_{OUT}$ maximum value.

## EMI/EMC

| Standard | Test Procedure | Notes |
|---|---|---|
| | | |
| **MIL-STD-461E/F** | | |
| Conducted Emmisions | CE101 | Figure CE101-4, Navy ASW & Army Aircraft, Curve #2 ($28V_{DC}$ or below) |
| | CE102 | Figure CE102-1, Basic curve for all applications |
| Conducted Susceptibility | CS101 | Figure CS101, Curve #2, for all applications ($28V_{DC}$ or below) |
| | | |
| **MIL-STD-1275** | | |
| Transient Immunity[4] | MIL-STD-1275A/B/D/E | $100V_{DC}$ for 50ms duration |
| | | $250V_{DC}$ for 70µs |
| | | |
| **MIL-STD-704** | | |
| Transient Immunity[4] | MIL-STD-704A (MIL-HDBK-704-8) Normal Voltage Transients | From table LDC 105-II (A-J) overvoltage $70V_{DC}$ for 20ms duration; within the MIL-STD-1275 (100V for 50ms) transient condition |
| | MIL-STD-704B/C/D/E/F (MIL-HDBK-704-8) Normal Voltage Transients | From table LDC 105-III (AA-RR) overvoltage $50V_{DC}$ for 12.5ms duration, undervoltage $18V_{DC}$ for 15ms duration; within the normal operating input voltage range |
| | MIL-STD-704A (MIL-HDBK-704-8) Abnormal Voltage Transients | From table LDC 302-II (A-J) overvoltage $80V_{DC}$ for 50ms duration; within the MIL-STD-1275 (100V for 50ms) transient condition |
| | MIL-STD-704E/F (MIL-HDBK-704-8) Abnormal Voltage Transients | From Table LDC 302-IV (AAA-FFF), overvoltage test conditions; within the normal operating input voltage range |
| | | |
| **DO-160E** | | |
| Transient Immunity[4] | DO-160E sec. 16, cat. z | $80V_{DC}$ for 100ms |

[4] Transient immunity specifications are met only when LV MFM is used with M-grade 16-$50V_{IN}$ DCM in a VIA package.

## Typical Characteristics

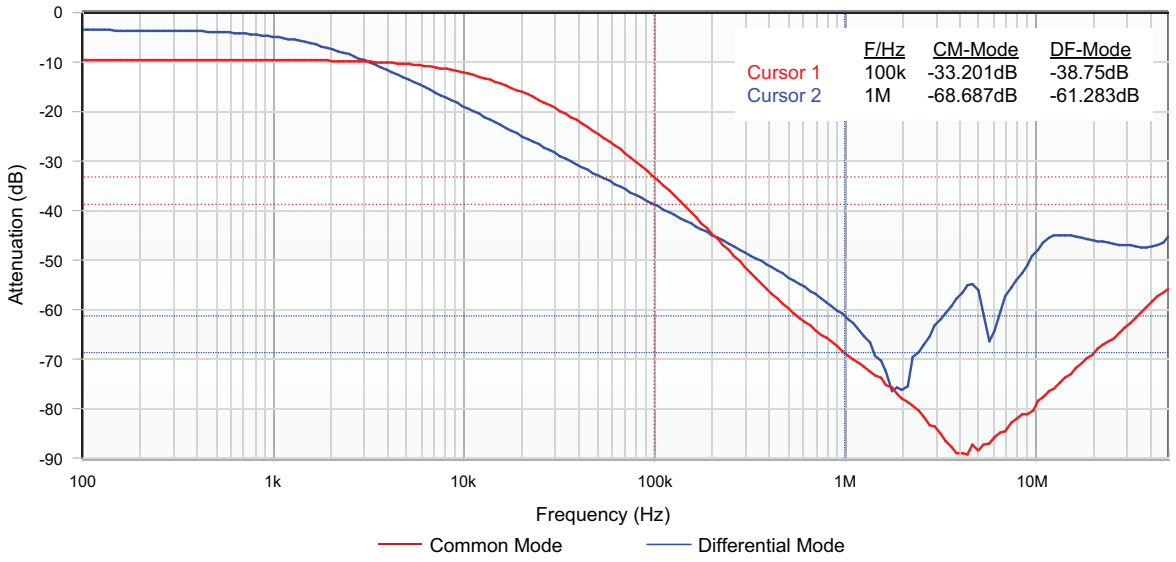



***Figure 1 —*** *Attenuation (dB) vs. Frequency (Hz), input leads are terminated with LISN impedances 25Ω for common mode, 100Ω for differential mode*

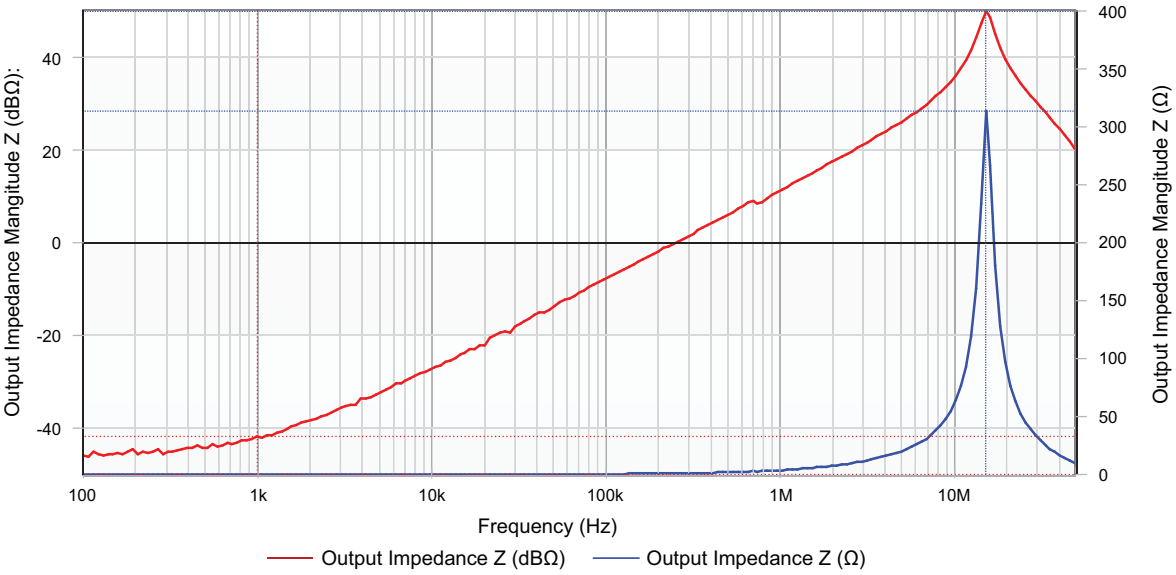



***Figure 2 —*** *Output Impedance vs. Frequency (Hz) plot looking back into the output terminals of the MFM with shorted input terminals*

## Typical Conducted Emissions

CE101 peak scans with MFM1714V50M50C5M00 and DCM3414V50M31C2T01, –OUT connected to GND, –OUT floating.

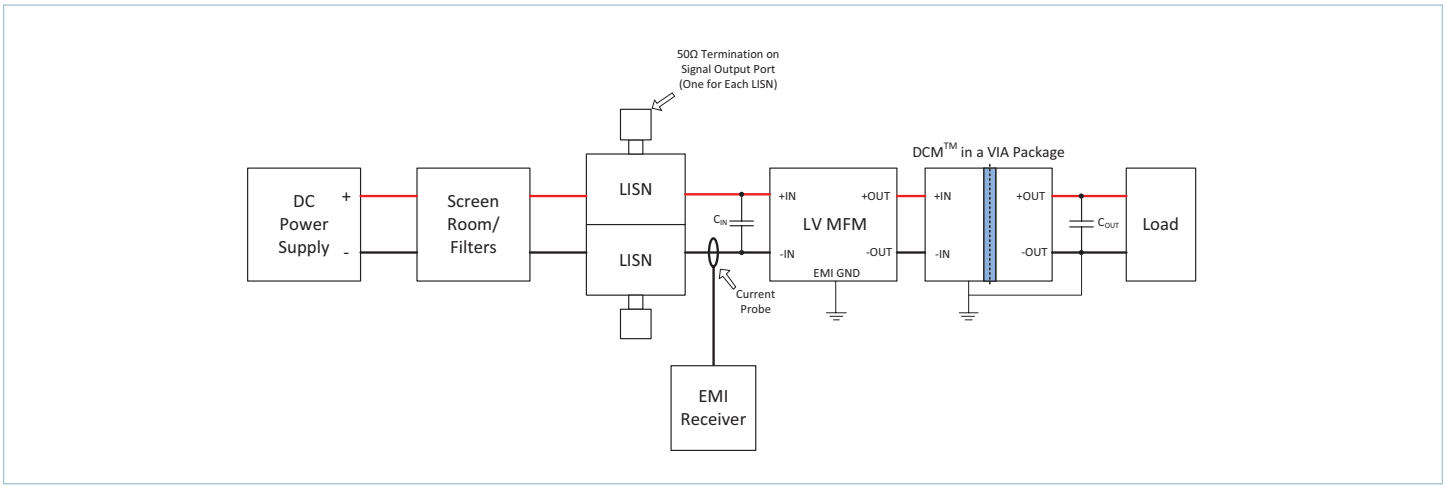



***Figure 3 —*** *A typical test setup for conducted emissions CE101 is shown above. A current probe is used to measure and plot the variations in the current through the RED and BLACK leads at various load conditions.*

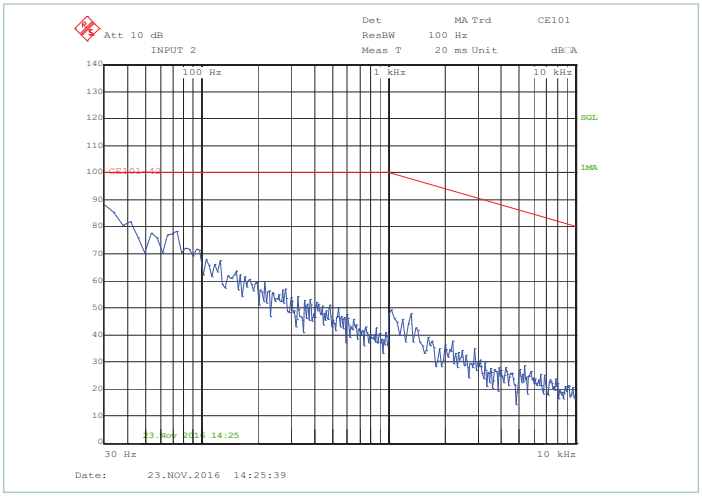



***Figure 4 —*** *Peak scan for the RED lead with $C_{IN}$ = 2200µF, $C_{OUT-EXT}$ = 1000µF, 0% load*

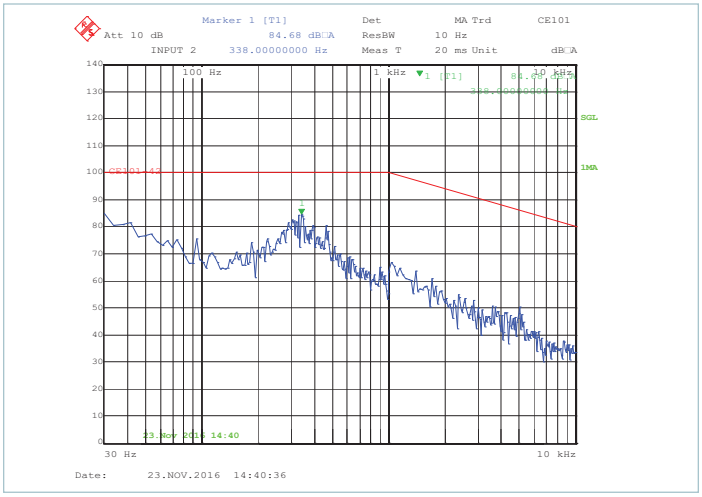



***Figure 5 —*** *Peak scan for the RED lead with $C_{IN}$ = 2200µF, $C_{OUT-EXT}$ = 1000µF, 100% load*

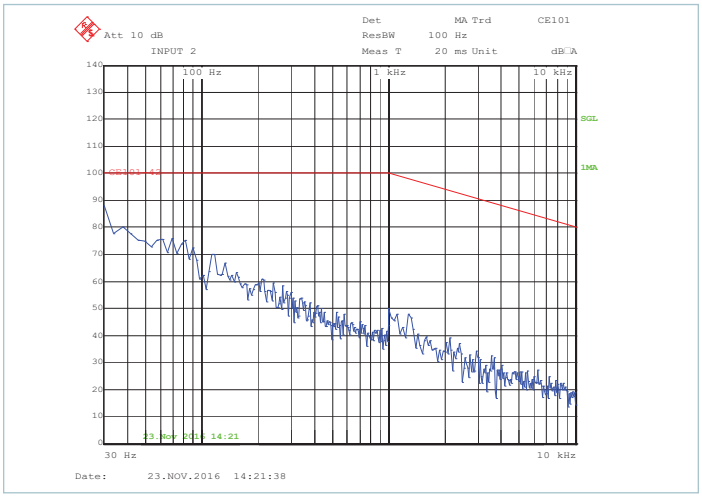



***Figure 6 —*** *Peak scan for the BLACK lead with $C_{IN}$ = 2200µF, $C_{OUT-EXT}$ = 1000µF, 0% load*

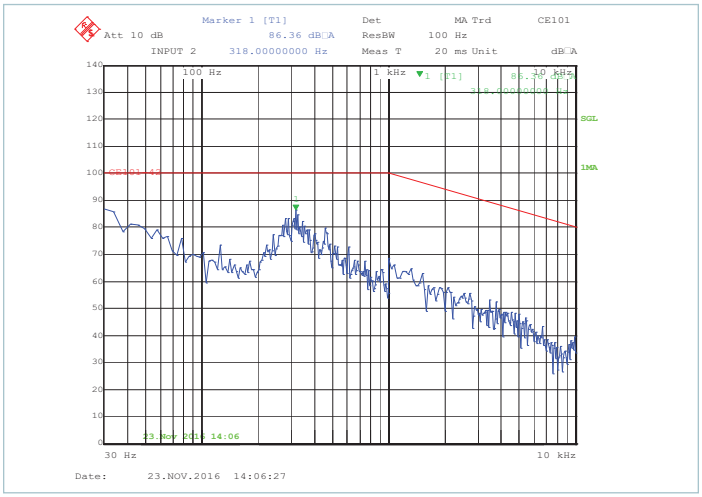



***Figure 7 —*** *Peak scan for the BLACK lead with $C_{IN}$ = 2200µF, $C_{OUT-EXT}$ = 1000µF, 100% load*

## Typical Conducted Emissions (Cont.)

CE102 peak scans with MFM1714V50M50C5M00 and DCM3414V50M31C2T01, –OUT connected to GND, –OUT floating.

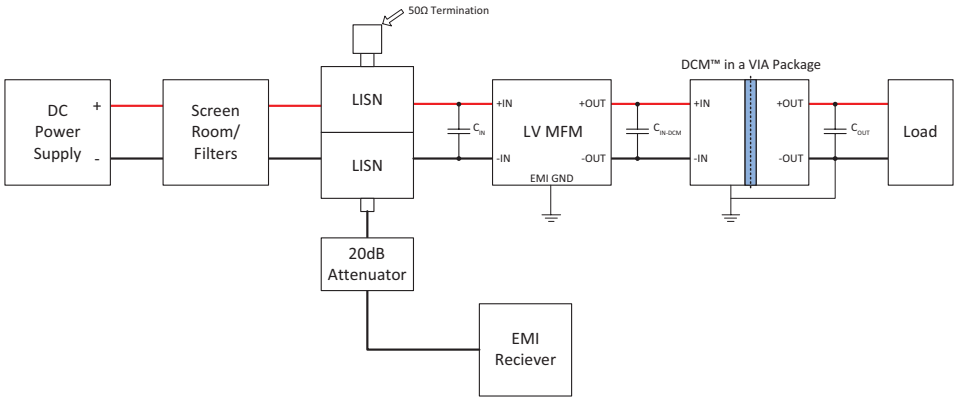



***Figure 8 —*** *A typical test setup for conducted emissions CE102 is shown above. A 50Ω termination is used for LISN and voltage across the RED and BLACK leads are measured at various load conditions.*

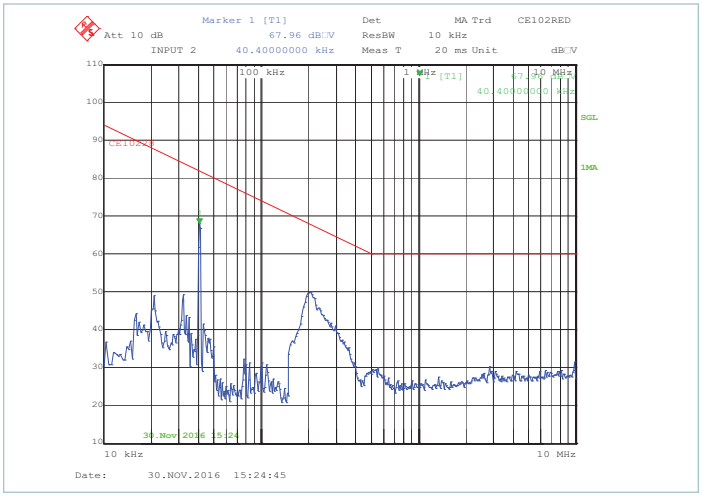



***Figure 9—*** *Peak scan for the RED lead with $C_{IN}$ = 2200µF, $C_{IN-DCM}$ = 1000µF, $C_{OUT-EXT}$ = 1000µF, 0% load*

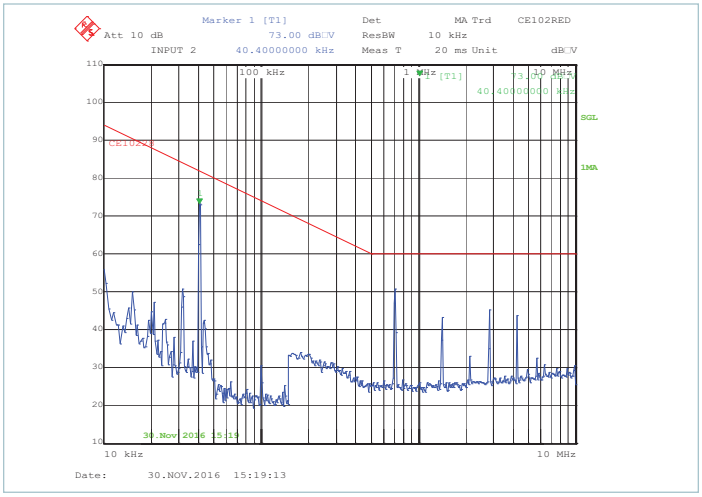



***Figure 10 —*** *Peak scan for the RED lead with $C_{IN}$ = 2200µF, $C_{IN-DCM}$ = 1000µF, $C_{OUT-EXT}$ = 1000µF, 100% load*

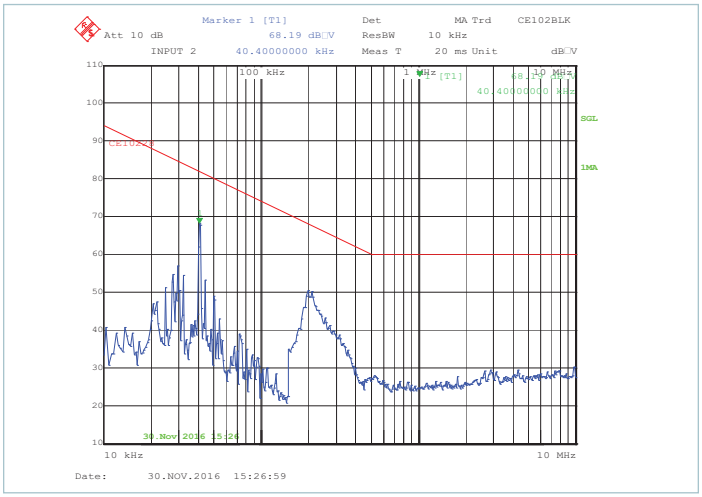



***Figure 11 —*** *Peak scan for the BLACK lead with $C_{IN}$ = 2200µF, $C_{IN-DCM}$ = 1000µF, $C_{OUT-EXT}$ = 1000µF, 0% load*

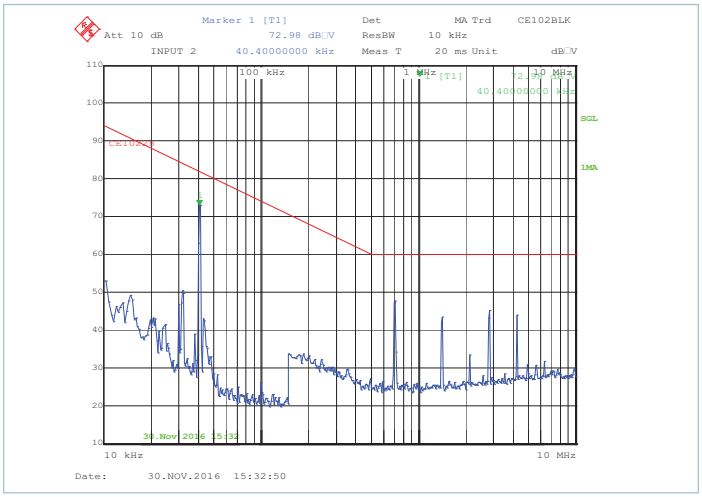



***Figure 12 —*** *Peak scan for the BLACK lead with $C_{IN}$ = 2200µF, $C_{IN-DCM}$ = 1000µF, $C_{OUT-EXT}$ = 1000µF, 100% load*

## Electrical Power Characteristics

Transient immunity with MFM1714V50M50C5M00 and DCM3414V50M13C2M01 per MIL-STD-1275D/E.

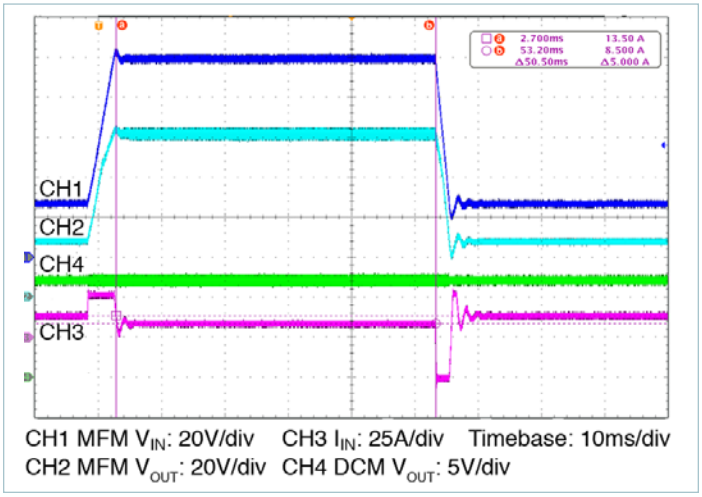



***Figure 13 —*** *Transient immunity; LV MFM and DCM 3414 VIA output response to an 100V, 50ms input transient*

## General Characteristics

Specifications apply over all line and load conditions, $T_J$ = 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 |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Mechanical** | | | | | | |
| Length | L | | | 44.6 / [1.76] | | mm / [in] |
| Width | W | | | 35.5 / [1.39] | | mm / [in] |
| Height | H | | | 9.22 / [0.36] | | mm / [in] |
| Volume | Vol | Without heatsink | | 14.5 / [0.88] | | $cm^3$/ [$in^3$] |
| Mass (Weight) | M | | | 30 / [1.06] | | g / [oz] |
| Pin Material | | C145 copper, 1/2 hard | | | | |
| Underplate | | Low stress ductile Nickel | 50 | | 100 | µin |
| Pin Finish | | Palladium | 0.8 | | 6 | µin |
| | | Soft Gold | 0.12 | | 2 | |
| Flatness | | | | | <0.25 / [0.010] | mm / [in] |
| | | | | | | |
| **Thermal** | | | | | | |
| Internal Operating Temperature | | M-Grade | -55 | | 125 | °C |
| Case Temperature | | M-Grade | -55 | | 100 | |
| Thermal Resistance, Junction to Case Bottom | $\theta_{INT\_BOT}$ | | | 14.29 | | °C/W |
| Thermal Resistance, Junction to Output Terminals | $\theta_{INT\_OUT\_TERMINALS}$ | | | 4.68 | | °C/W |
| | | | | | | |
| **Soldering** | | | | | | |
| Temperature | | See: AN:401 PCB Mount VIA Soldering Guidelines | | | | |
| | | | | | | |
| **Reliability** | | | | | | |
| MTBF | | MIL-HDBK-217FN2 Parts Count - 25°C Ground Benign, Stationary, Indoors / Computer | 6.6 | | | MHrs |
| | | | | | | |
| **Safety** | | | | | | |
| Dielectric Withstand | | Input / Output to EMI GND/Case | 1500 | | | $V_{DC}$ |
| Agency Approvals / Standards | | | | | | |
| | | | | | | |
| | | CE marked to the Low Voltage Directive (LVD) 2014/35/EU | | | | |

## Environmental Qualification

| Testing Activity | Reference Standard | Test Details |
|---|---|---|
| HTOB-HTOL High Temperature Operating Bias/Life | JESD22-A110-B | Duration of 1000 hrs, High Line, full load, max operating temperature, Power cycled per IPC9592 |
| TC (Temperature Cycling) | JESD22-A104D | 1000 cycles -55°C to 125°C |
| HALT (Highly Accelerated Life Test) | DP-0266 | Low Temp, High Temp, Rapid Thermal Cycling, Random Vibration Test, Combined Stress Test |
| THB (Temperature Humidity Bias) | JEDSD22-A101C | Duration of 1000hrs, Biased, 85°C, 85%RH. |
| HTS (High Temperature Storage) | JESD 22-A103-D | Duration 1000hrs, No Bias. Maximum storage temperature (125°C) |
| LTS (Low Temperature Storage) | JESD22–A119 | Duration 1000hrs, No Bias. Minimum storage temperature (-65°C) |
| Random Vibration | MIL-STD-810G | Method 514.6, Procedure I, Category 24, Mounted on QA |
| Mechanical Shock | MIL-STD-810G | Method 516.5, Procedure I, Environment: Functional shock 40G, Mounted on QA |
| Electro Static Discharge Human Body Model | JEDEC JS-001-2012 | Table 2B, Class 2, ±2000V minimum |
| Electro Static Discharge Device Charge Model | JESD22-C101-E | Class III ±500V minimum |
| Free Fall | IPC9592B | IEC 60068-2-32, Freefall procedure 1 |
| Term Strength | MIL-STD-202G | Method 211A,Test Condition A, Environment: Ambient Temperature & %Rh. |
| Through Hole Solderability | IPC-9592B | IPC/ECA J-STD-002 Test A (dip and look) |
| Salt Fog | MIL-STD-810G | Method 509.5 |
| Fungus | MIL-STD-810G | Method 508.6 |
| Resistance to solvents | MIL-STD-202G | Method 215K |
| Acceleration | MIL-STD-810G | Method 513.6 Procedure II |
| Altitude | MIL-STD-810G | Method 500.5 Procedure I & II |
| Explosive Atmosphere | MIL-STD-810G | Method 511.5 Procedure I, operational |

## Thermal Considerations

The customer needs to insure that the LV MFM is operated such that the internal components are kept within the maximum of the operating temperature range by monitoring/controlling the temperature of both the bottom plastic housing and the output terminals. To assist the customer, Vicor provides the simplified thermal circuit model of the LV MFM shown below in Figure 14. In this thermal circuit model, thermal resistance in units of °C/W is analogous to electrical resistance, temperature in °C is analogous to voltage, and the rate of heat transferred in W is analogous to current. The maximum internal temperature of the LV MFM can be estimated by the customer based on total power dissipated by the MFM, the temperature maintained on the bottom of the housing, and the temperature of the output terminals.

In the example shown in Figure 14, the bottom of the plastic housing is maintained by the customer at 70°C, the output terminals are measured to be about 100°C, and the LV MFM is dissipating 9W of heat. The resultant maximum internal temperature of the LV MFM can then be estimated at 124°C, which is close to the maximum in the operating temperature range. 4W of power is conducted through the lower housing, and the balance of 5W is conducted through the output terminals.

The LV MFM is best attached to a material with a high thermal conductivity (e.g., aluminum or copper) to maintain temperature uniformity across the bottom plastic housing.

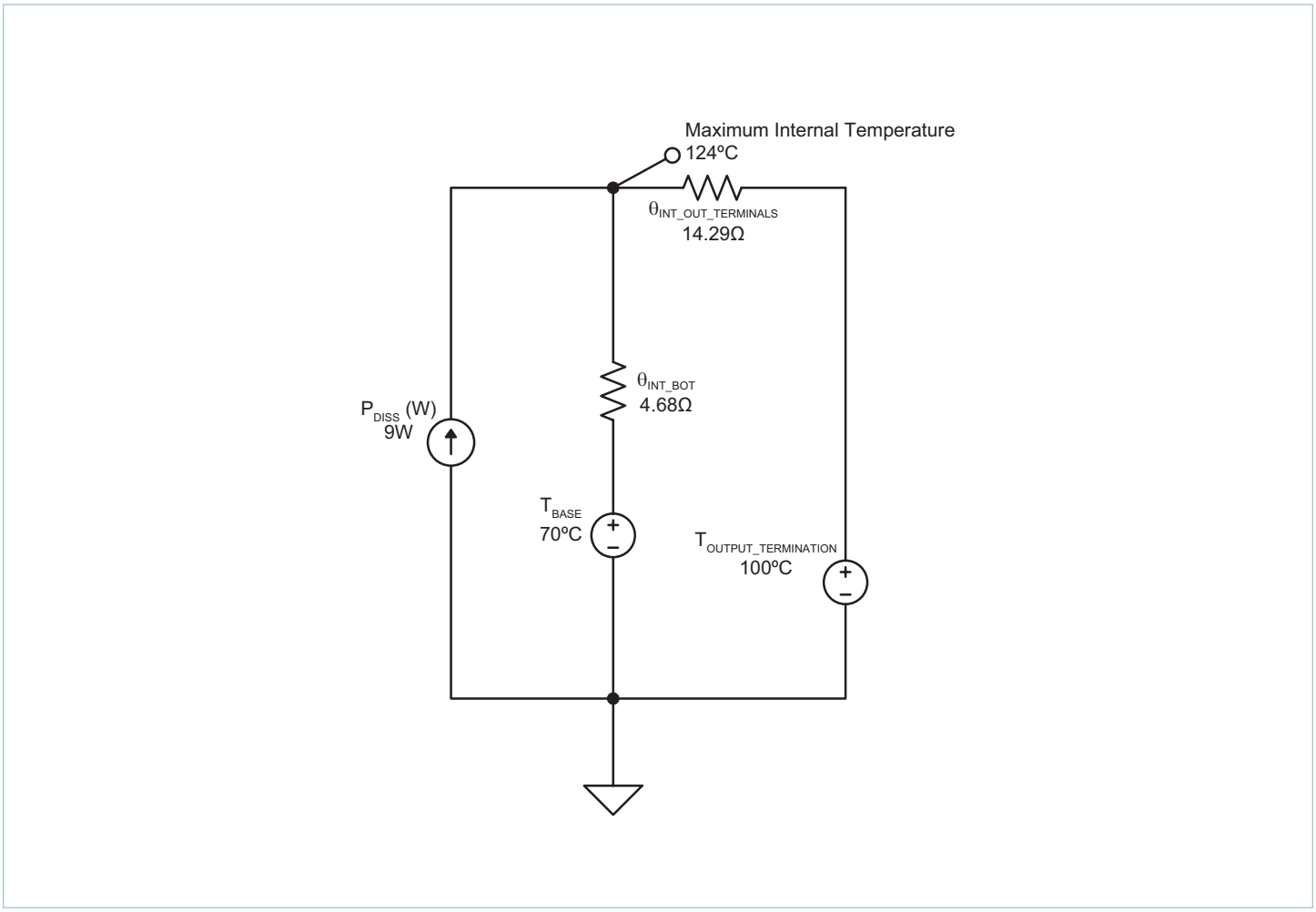
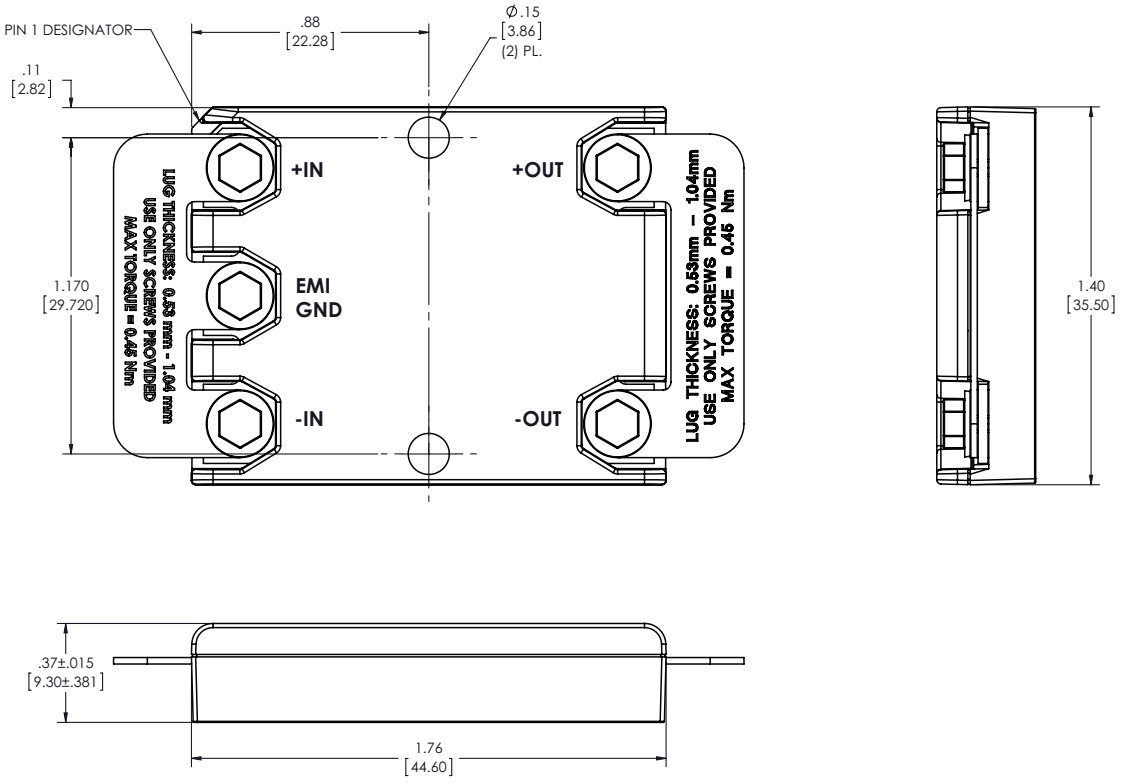



***Figure 14 —*** *LV MFM thermal model*

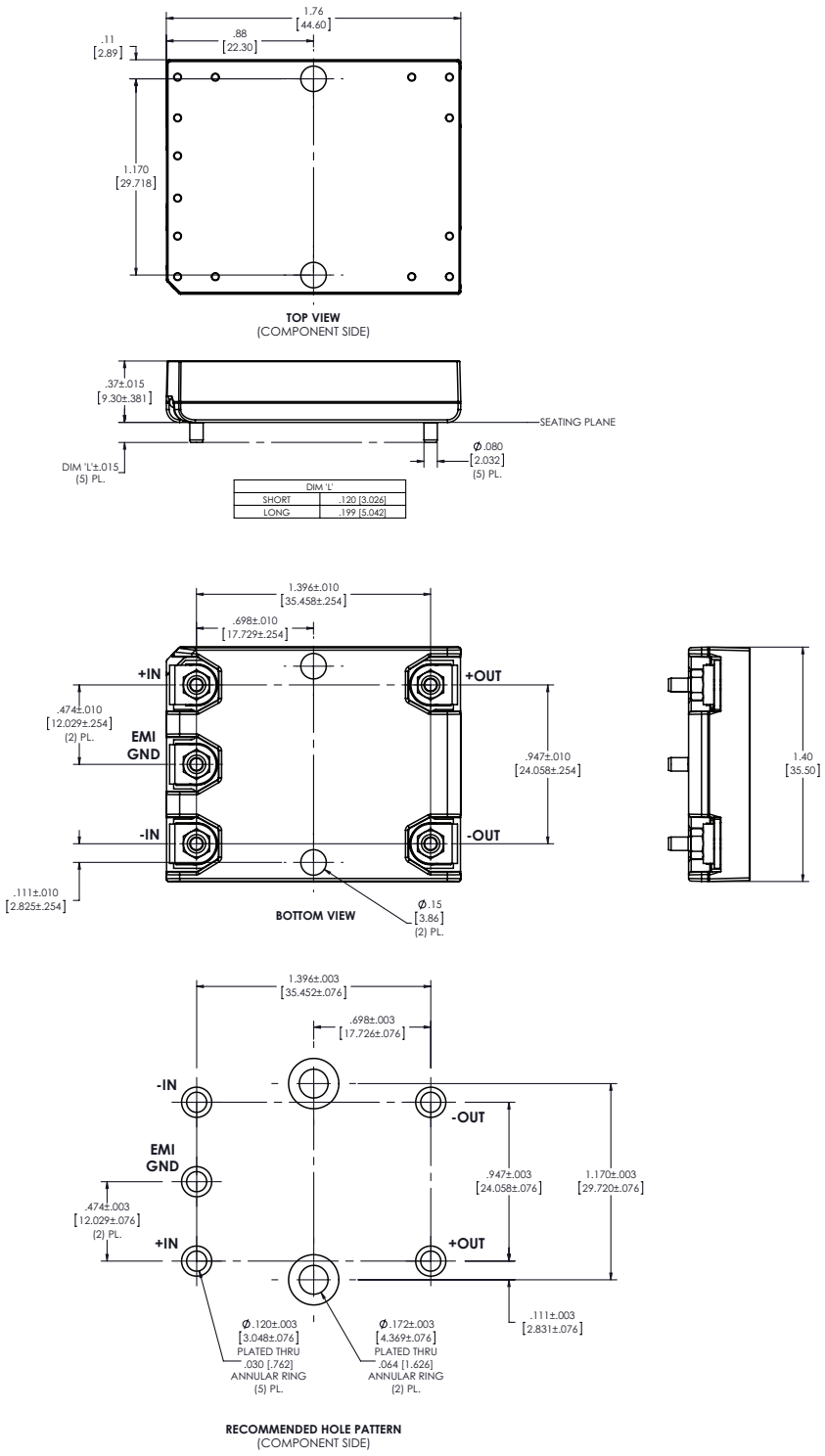
## Chassis Mount Outline Drawing




NOTE:

1. RoHS COMPLIANT PER CST-0001 LATEST REVISION

## Board Mount Outline Drawing




NOTE:
1. RoHS COMPLIANT PER CST-0001 LATEST REVISION

## Revision History

| Revision | Date | Description | Page Number(s) |
|---|---|---|---|
| 1.0 | 06/07/17 | Initial Release | n/a |
| 1.1 | 07/26/17 | Added fuse recommendation for typical application & remvoed MOV<br>Updated internal operting temperature<br>Updated note on CE scans for –OUT floating<br>Updated MTBF rating | 2<br>4<br>7, 8<br>10 |

**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 makes no representations or warranties with respect to the accuracy or completeness of the contents of this publication. Vicor reserves the right to make changes to any products, specifications, and product descriptions at any time without notice. Information published by Vicor has been checked and is believed to be accurate at the time it was printed; however, Vicor assumes no responsibility for inaccuracies. Testing and other quality controls are used to the extent Vicor deems necessary to support Vicor's product warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

**Specifications are subject to change without notice.**

Visit http://www.vicorpower.com/mil-cots-dc-dc/mfm-filter-module for the latest product information.

## Vicor's Standard Terms and Conditions and Product Warranty

All sales are subject to Vicor's Standard Terms and Conditions of Sale, and Product Warranty which are available on Vicor's webpage (http://www.vicorpower.com/termsconditionswarranty) or upon request.

## Life Support Policy

VICOR'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF VICOR CORPORATION. As used herein, life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness. Per Vicor Terms and Conditions of Sale, the user of Vicor products and components in life support applications assumes all risks of such use and indemnifies Vicor against all liability and damages.

### 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. No license, whether express, implied, or arising by estoppel or otherwise, to any intellectual property rights is granted by this document. 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:
Patents Pending.

Contact Us: http://www.vicorpower.com/contact-us

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

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