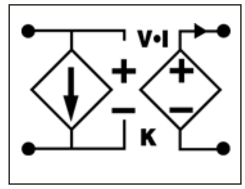
VTM™ Transformer

- Isolated 1-50 Vout
- High density
- Small footprint
- ZVS / ZCS Sine Amplitude Converter™
- 3 MHz effective switching frequency
- Surface-mount package
- Low weight
- -55°C to 125°C operation
- 1 µs transient response
- 4.5 million hours MTBF
- Up to 96.5% efficiency



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Product Description

The VTM Transformer is a V•I Chip™ product that 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 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 surface mount package occupying ~1 square inch.

The Military VTMs are optimized for use with the Military PRM™ Regulator to implement a Factorized Power Architecture™ (FPA™). Together, the PRM + VTM chip set provides the full functionality of a DC-DC converter, but with breakthrough performance and flexibility in a rugged, miniature package. The companion PRM for the MV036 family of VTMs is the 28 Vdc input MP028F036M12AL, 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 – the VTM's isolation and transformation on the one hand, and the PRM's 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 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. The low profile VTM (0.265 inches, 6,73 mm) is available with J-leads for surface mount or pins for through hole applications.

Absolute Maximum Ratings

Parameter	Values	Unit	Notes
+In to -In	-1.0 to 60	Vdc	
	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	Contact factory
Isolation voltage	2,250	Vdc	Input to Output
Output current	Model specific	A	See Table 1
Peak output current	1.5 • Iout	A	For 1 ms
Output power	120	W	
Peak output power	180	W	For 1 ms
Case temperature	225	°C	MSL 5
	245	°C	MSL 6
Operating junction temperature[a]	-55 to 125	°C	M - Grade
Storage temperature	-65 to 125	°C	M - Grade

Note:

[a] The referenced junction is defined as the semiconductor having the highest temperature. This temperature is monitored by a shutdown comparator.

Part Numbering Format

MV | 036 | F | 120 | M | 010

- MV: Voltage Transformation Module
- 036: Input Voltage Designator
- F: Configuration — F = J-lead, T = Through hole
- 120: Output Voltage Designator (=VOUT x10)
- M: Product Grade Temperatures (°C)

Grade	Storage	Operating (TJ)
M	-65 to125	-55 to125

- 010: Output Current Designator (=IOUT)

Electrical Specifications

Input Specs (Conditions are at 36 Vin, full load, and 25°C ambient unless otherwise specified)

Parameter	Min	Typ	Max	Unit	Note
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	54.4		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 Specs (Conditions are at 36 Vin, full load, and 25°C ambient 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
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
Current share accuracy		5	10	%	
Efficiency					See Table 2, Page 3
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	1.01K		$V_{OUT} = K \cdot V_{IN}$ at no load, See Table 1
Load regulation	R_{OUTMIN}		R_{OUTMAX}	mΩ	See Table 1
Transient response					
Response time		200		ns	See Figures 7 and 8
Recovery time		1		µs	See Figures 7 and 8

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
MV036F011M100	1/32	100	**0.82**	**1.55**	0.5	0.85	1.3
MV036F015M080	1/24	80	**1.1**	**2.0**	1.0	1.25	1.5
MV036F022M055	1/16	55	**1.63**	**3.1**	1.4	1.75	2.0
MV036F030M040	1/12	40	**2.2**	**4.1**	1.45	2.4	3.4
MV036F045M027	1/8	27	**3.3**	**6.2**	3.5	5.1	6.6
MV036F060M020	1/6	20	**4.3**	**8.3**	5.0	8.0	10
MV036F072M017*	1/5	16.6	**6.4***	**10**	6.0	9.6	12
MV036F090M013	1/4	13.3	**6.5**	**12.5**	6.9	9.3	11.6
MV036F120M010	1/3	10.0	**8.7**	**16.6**	25	31	35
MV036F180M007	1/2	6.7	**13**	**25**	27.5	35.7	46.4
MV036F240M005	2/3	5.0	**17.4**	**33**	49.3	70.6	91.8
MV036F360M003	1	3.3	**26**	**50**	140	170	200

Table 1 *— VTM part numbers*

* 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)
MV036F011M100	89.5	91.5	48128
MV036F015M080	92	94	27072
MV036F022M055	94	94.5	12032
MV036F030M040	94	95.0	6768
MV036F045M027	95.3	96.5	3008
MV036F060M020	95.3	96.8	1692
MV036F072M017	96.5	96.5	1175
MV036F090M013	96.3	95.5	752
MV036F120M010	95.5	95.5	423
MV036F180M007	96.0	95.2	188
MV036F240M005	95.0	94.8	106
MV036F360M003	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.

Waveforms

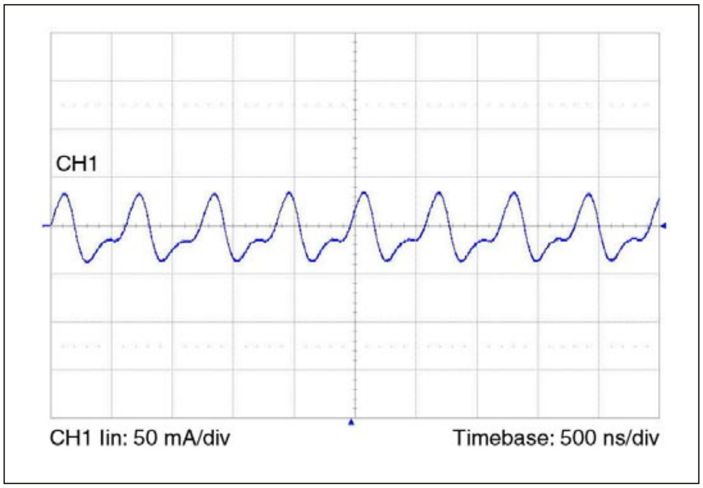


Figure 1 *— Representative input reflected ripple current at full load (MV036F120M010).*

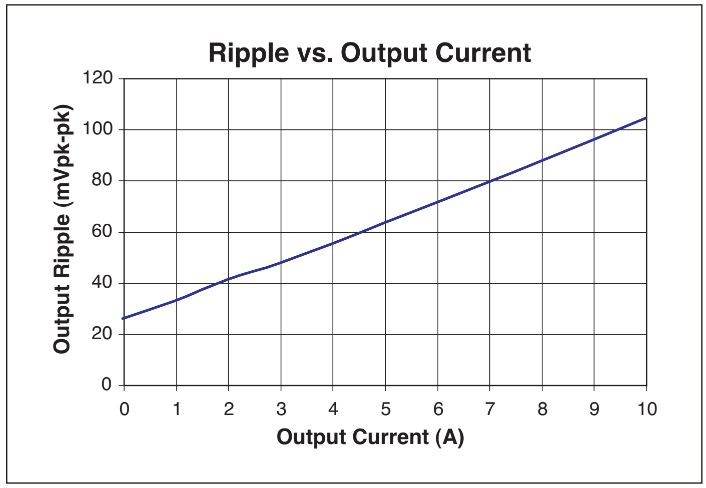


Figure 2 *— Sample output voltage ripple vs. output current with no POL bypass capacitance (MV036F120M010).*

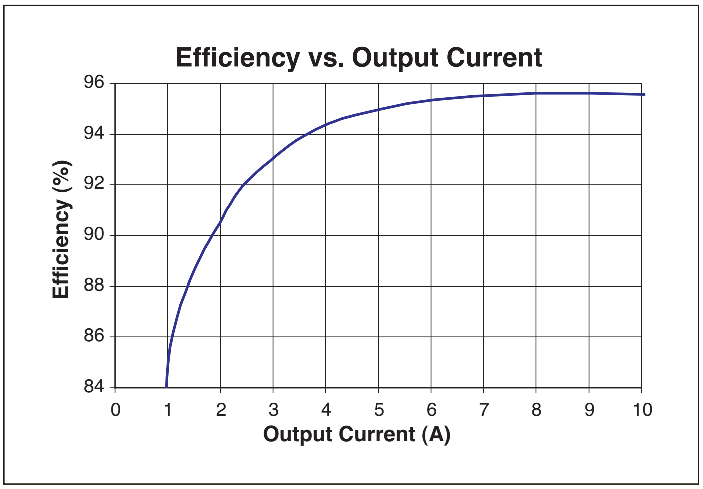


Figure 3 *— Representative efficiency vs. output current (MV036F120M010).*

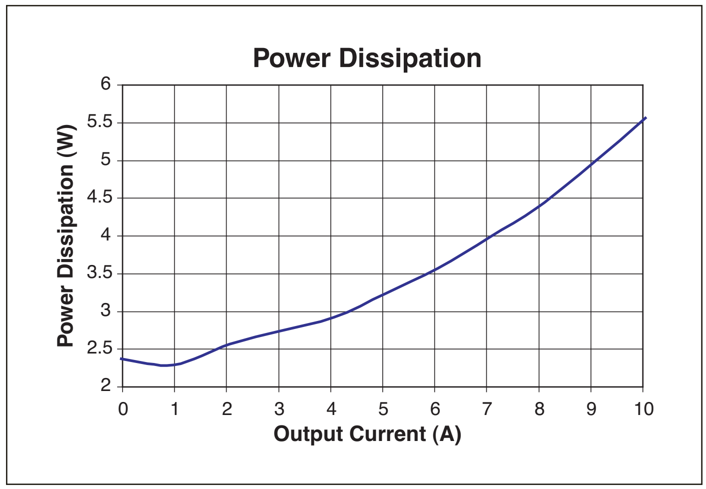


Figure 4 *— Example power dissipation vs. output current (MV036F120M010).*

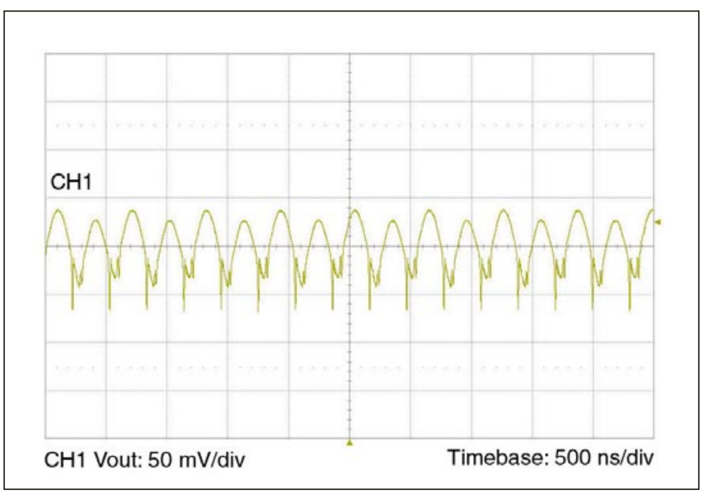


Figure 5 *— Sample output voltage ripple at full load; with no POL bypass capacitance (MV036F120M010).*

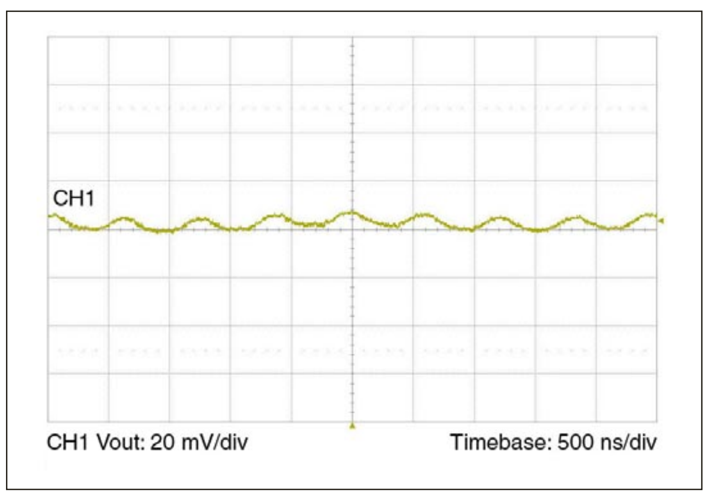


Figure 6 *— Sample output voltage ripple at full load with 4.7 µF ceramic POL bypass capacitance and 20 nH distribution inductance (MV036F120M010).*

Electrical Specifications (continued)

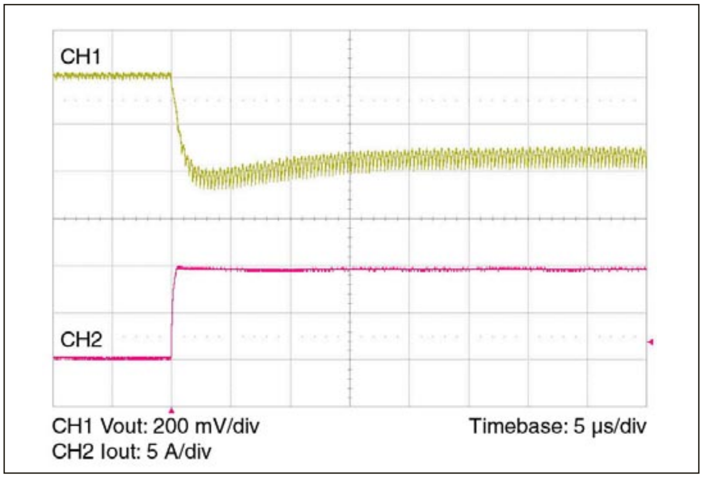


***Figure 7** — Example load step with 100 µF input capacitance and no output capacitance (MV036F120M010).*

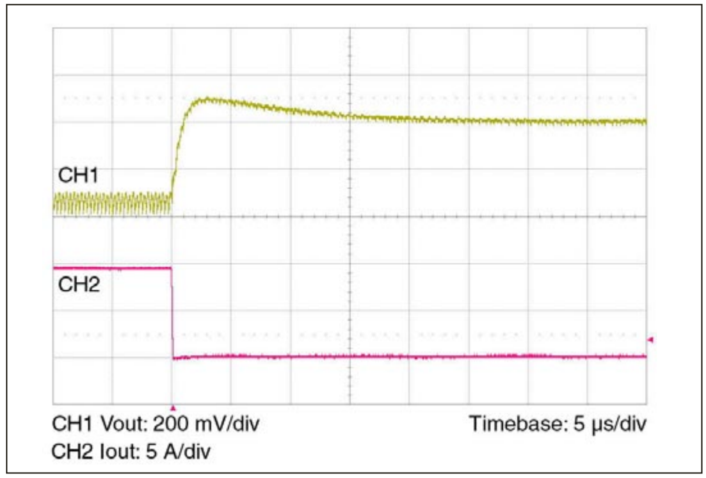


***Figure 8** — Example load step with 100 µF input capacitance and no output capacitance (MV036F120M010).*

General

Parameter	Min	Typ	Max	Unit	Note
MTBF (MV036F030M040)					
MIL-HDBK-217F		4,480,000		Hours	25°C, GB
		806,000			50°C NS
		631,000			65°C AIC
Isolation specifications					
Voltage	2,250			Vdc	Input to Output
Capacitance		3000		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					See Mechanical Drawings, Figures 10 & 11
Weight		0.53/15		oz /g	
Dimensions					
Length		1.28/32,5		in/mm	
Width		0.87/22		in/mm	
Height		0.265/6,73		in/mm	
Thermal					
Over temperature shutdown	125	130	135	°C	Junction temperature
Thermal capacity		9.3		Ws/°C	
Junction-to-case thermal impedance ($R_{\theta JC}$)		1.1		°C/W	
Junction-to-ambient		5.0		°C/W	With 0.25" heat sink^
Junction-to-board thermal impedance ($R_{\theta JB}$)		2.1		°C/W	

Auxiliary Pins (Conditions are at 36 Vin, full load, and 25°C ambient unless otherwise specified)

Parameter	Min	Typ	Max	Unit	Note
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		6		µs	PC low to Vout low
VTM Control (VC)					
External boost voltage	12	14	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:

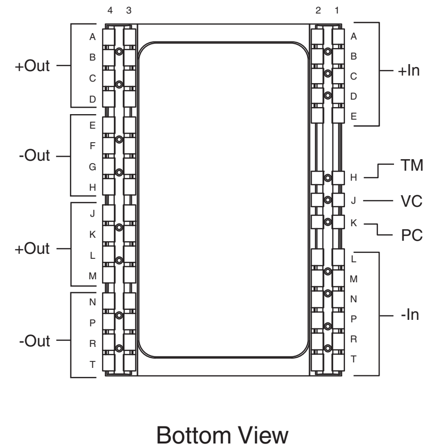
Disable – If PC is left floating, the VTM output is enabled. To disable the output, the PC port must be pulled lower than 2.4 V, referenced to -In. Optocouplers, open collector transistors or relays can be used to control the PC port. Once disabled, 14 V must be re-applied to the VC port to restart the 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.



Signal Name	Pin Designation
+In	A1-E1, A2-E2
–In	L1-T1, L2-T2
TM	H1, H2
VC	J1, J2
PC	K1, K2
+Out	A3-D3, A4-D4, J3-M3, J4-M4
–Out	E3-H3, E4-H4, N3-T3, N4-T4

Figure 9 *— VTM pin configuration*

Mechanical Drawings

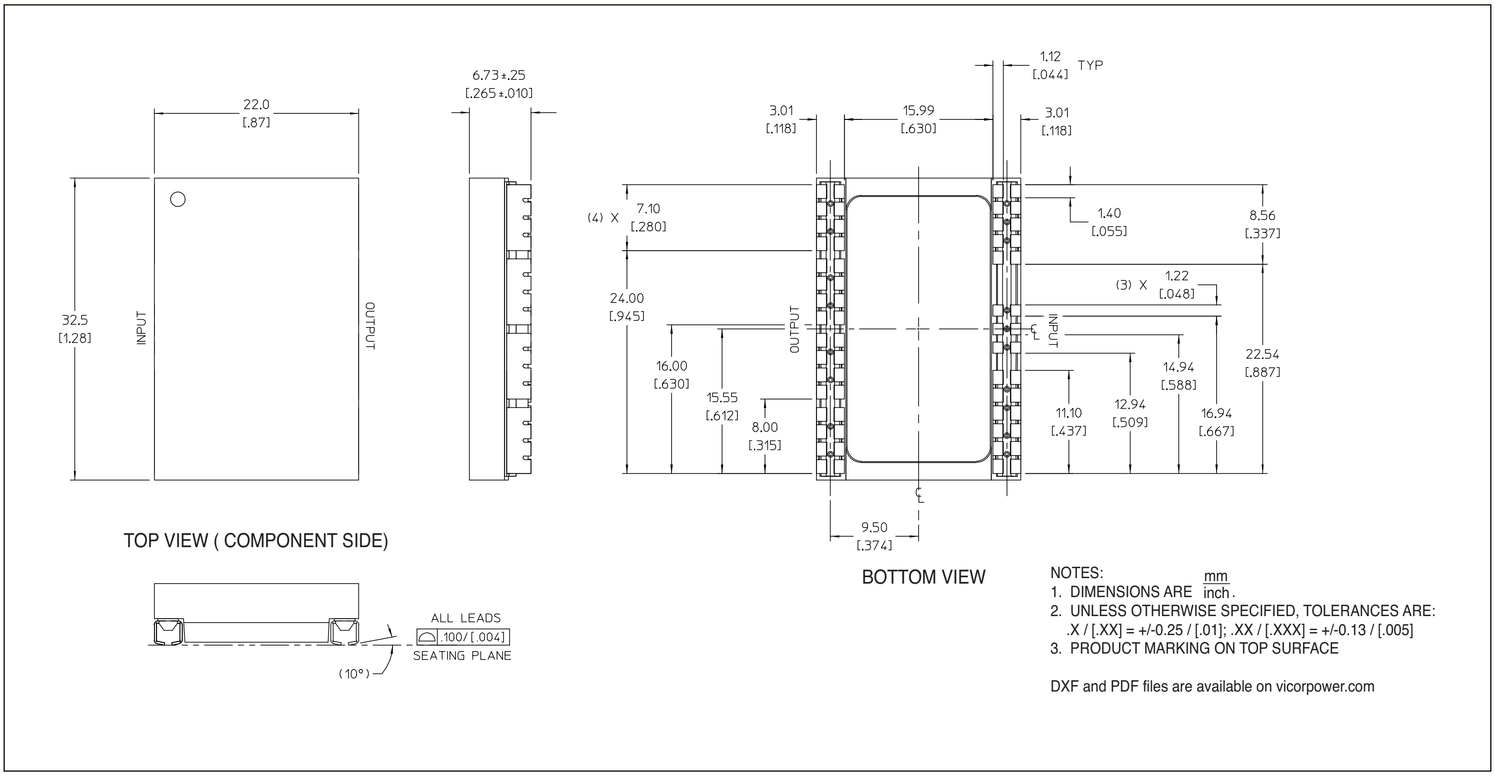


Figure 10 *— VTM mechanical outline*

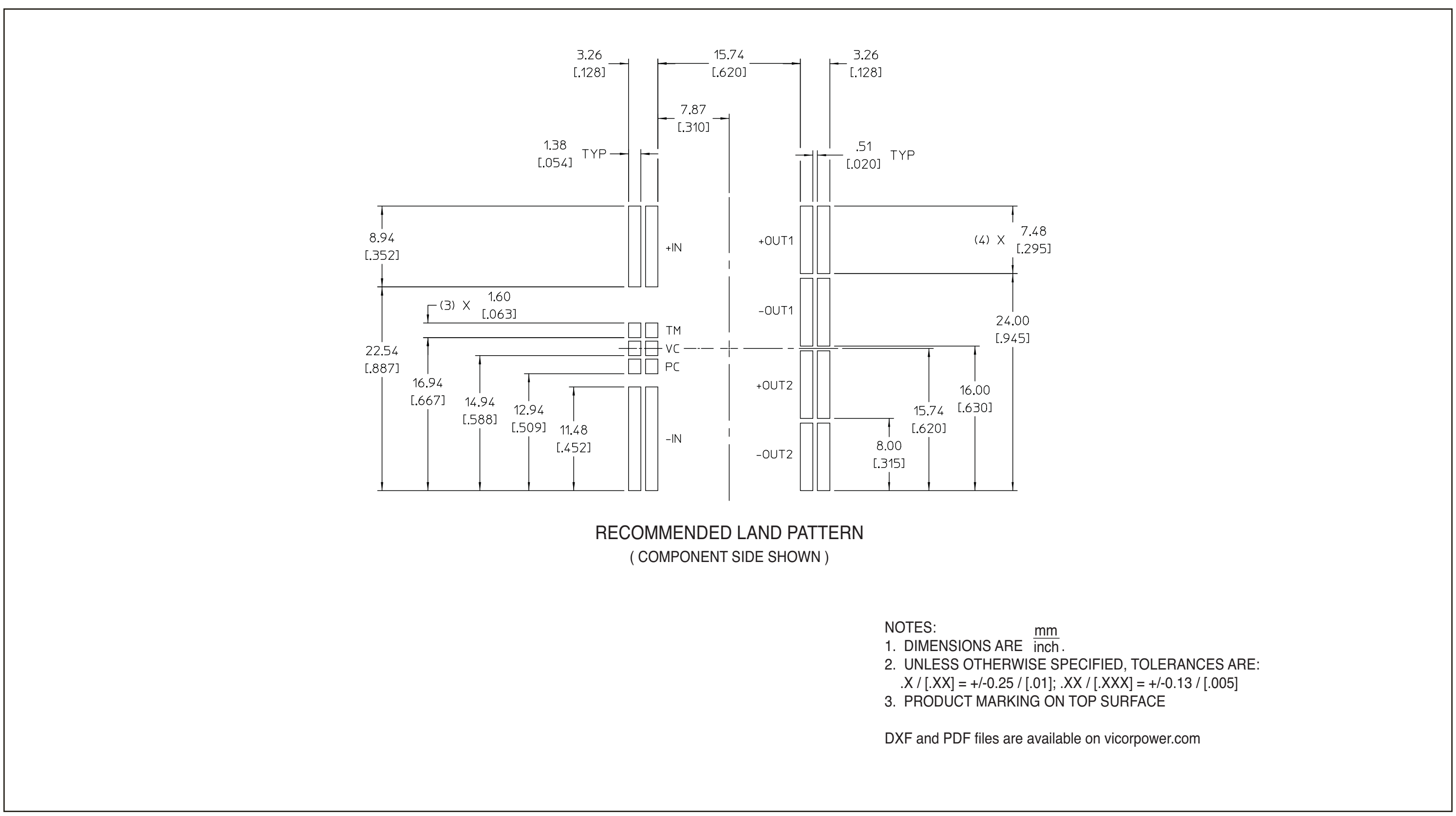
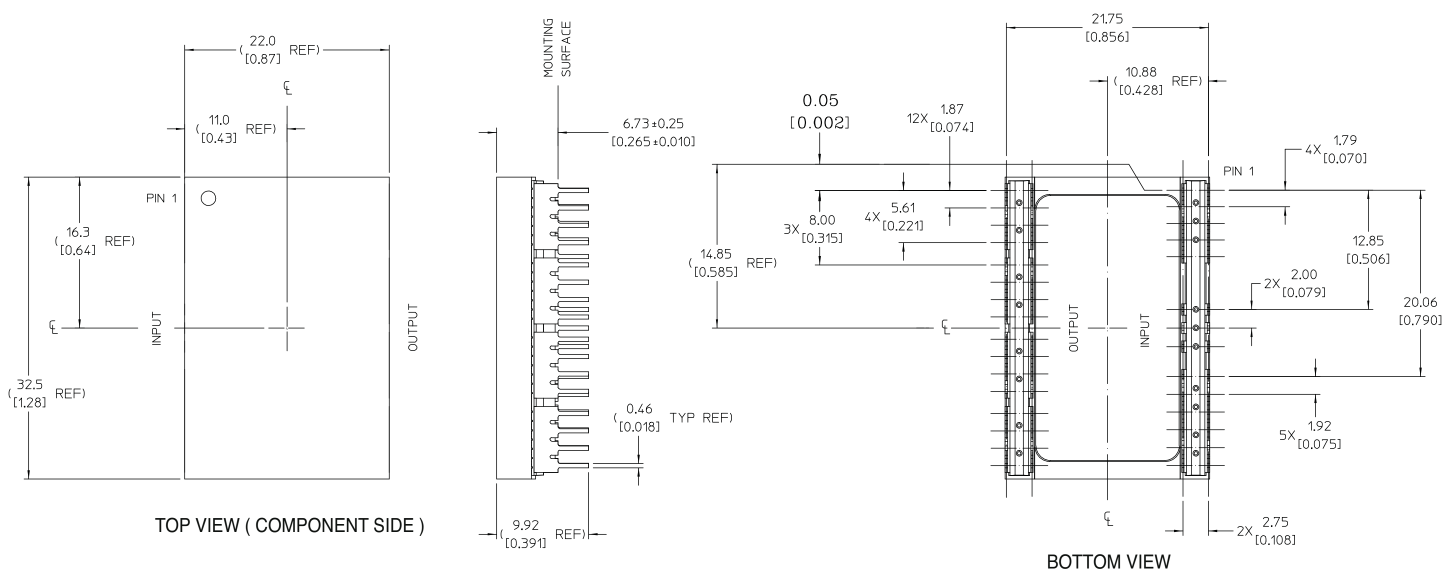


Figure 11 *— VTM PCB land layout information*

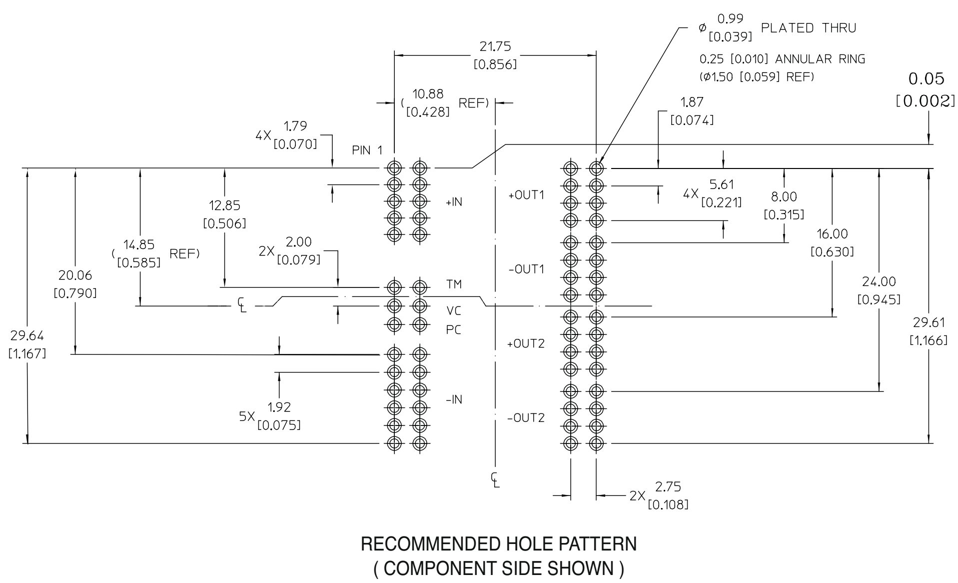


NOTES:

1. DIMENSIONS ARE $\frac{\text{(mm)}}{\text{inch}}$.
2. UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:
   X.X [X.XX] = ±0.25 [0.01]; X.XX [X.XXX] = ±0.13 [0.005]
3. RoHS COMPLIANT PER CST-0001 LATEST REVISION

DXF and PDF files are available on vicorpower.com

Figure 12 *— VTM through-hole mechanical outline*



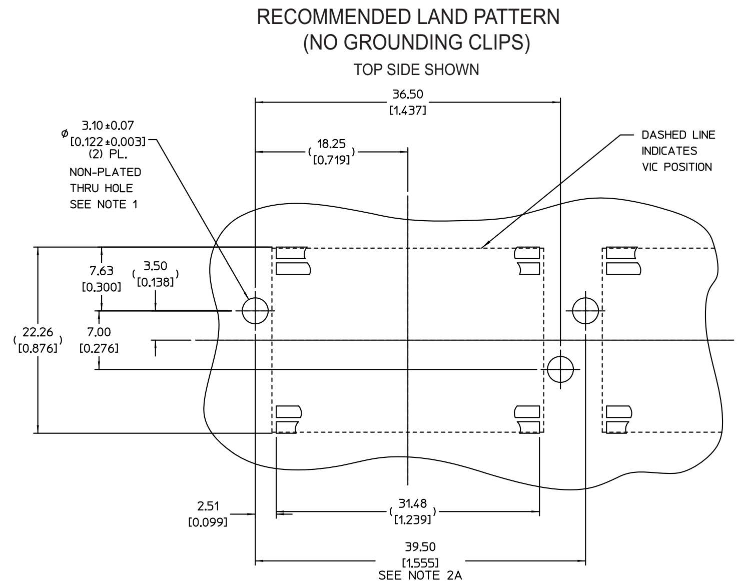
RECOMMENDED HOLE PATTERN
(COMPONENT SIDE SHOWN)

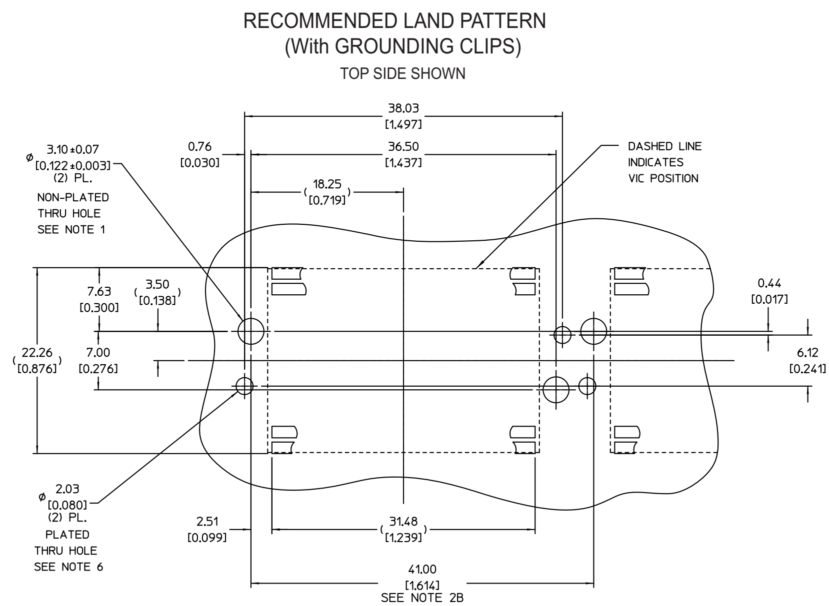
NOTES:

1. DIMENSIONS ARE $\frac{\text{(mm)}}{\text{inch}}$.
2. UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:
   X.X [X.XX] = ±0.25 [0.01]; X.XX [X.XXX] = ±0.13 [0.005]
3. RoHS COMPLIANT PER CST-0001 LATEST REVISION

DXF and PDF files are available on vicorpower.com

Figure 13 *— VTM through-hole PCB layout information*





NOTES:

1. MAINTAIN 3.50 [0.138] DIA. KEEP-OUT ZONE FREE OF COPPER, ALL PCB LAYERS.
2. (A) MINIMUM RECOMMENDED PITCH IS 39.50 [1.555], THIS PROVIDES 7.00 [0.275] COMPONENT EDGE-TO-EDGE SPACING, AND 0.50 [0.020] CLEARANCE BETWEEN VICOR HEAT SINKS.

   (B) MINIMUM RECOMMENDED PITCH IS 41.00 [1.614], THIS PROVIDES 8.50 [0.334] COMPONENT EDGE-TO-EDGE SPACING, AND 2.00 [0.079] CLEARANCE BETWEEN VICOR HEAT SINKS.
3. V•I CHIP LAND PATTERN SHOWN FOR REFERENCE ONLY; ACTUAL LAND PATTERN MAY DIFFER. DIMENSIONS FROM EDGES OF LAND PATTERN TO PUSH-PIN HOLES WILL BE THE SAME FOR ALL FULL SIZE V•ICHIP PRODUCTS.
4. UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE MM [INCH]. TOLERANCES ARE:
   X.X [X.XX] = ±0.3 [0.01]
   X.XX [X.XXX] = ±0.13 [0.005]
5. PLATED THROUGH HOLES FOR GROUNDING CLIPS (33855) SHOWN FOR REFERENCE. HEATSINK ORIENTATION AND DEVICE PITCH WILL DICTATE FINAL GROUNDING SOLUTION.

Figure 14 *— Hole location for push pin heat sink relative to V•I Chip*

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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; 7,145,186; 7,166,898; 7,187,263; D496,906; D505,114; D506,438; D509,472; and for use under 6,975,098 and 6,984,965

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