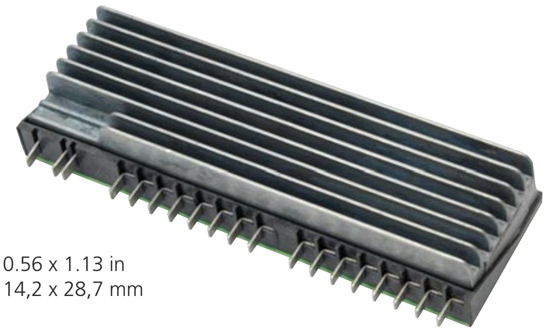
Features

- 384 Vdc – 48 Vdc 650 W VI BRICK™ BCM Array
- Integrated heatsink simplifies thermal management
- Vertical mount package reduces footprint
- High efficiency (>95%) reduces system power consumption
- High power density (>290 W/in^3)
- Contains built-in protection features: undervoltage, overvoltage lockout, over current protection, short circuit protection, overtemperature protection
- ZVS/ZCS Resonant Sine Amplitude Converter topology
- Can be paralleled to create multi-kW arrays
- Internal fuse and filter
- No output filtering required

TYPICAL APPLICATIONS

- High End Computing Systems
- Automated Test Equipment
- Telecom Base Stations
- High Density Power Supplies
- Communications Systems



Size:
3.54 x 0.56 x 1.13 in
89,9 x 14,2 x 28,7 mm

Vin = 360 – 400 V
Vout = 45 – 50 V (NO LOAD)
POUT = 650 W(NOM)
K = 1/8

Product Description

The VI BRICK™ BCM Array is a high efficiency (>95%) Sine Amplitude Converter (SAC) operating from a 360 to 400 Vdc primary bus to deliver an isolated 45-50 V nominal, unregulated secondary. The SAC offers a low AC impedance beyond the bandwidth of most downstream regulators, meaning that input capacitance normally located at the input of a regulator can be located at the input to the SAC. Since the K factor of the BC384R480T065VM-00 is 1/8, that capacitance value can be reduced by a factor of 64x, resulting in savings of board area, materials and total system cost.

Absolute Maximum Ratings

Parameter	Values	Unit	Notes
+In to -In	-1.0 to 440	Vdc	
PC to -In	-0.3 to +20	Vdc	
+In/–In to +Out/–Out	4242	V	Hi Pot
+In/–In to +Out/–Out	500	V	Working
+Out to -Out	-1.0 to +60	Vdc	

1.0 ELECTRICAL CHARACTERISTICS

Specifications apply over all line and load conditions unless otherwise noted; **Boldface** specifications apply over the temperature range of **-40°C < T_C < 100°C (T-Grade)**; All other specifications are at **T_C = 25°C** unless otherwise noted

ATTRIBUTE	SYMBOL	CONDITIONS / NOTES	MIN	TYP	MAX	UNIT
Voltage range	V_{IN}		**360**	**384**	**400**	Vdc
dV/dt	dV_{IN}/dt				**1**	V/µs
Quiescent power	P_Q	PC connected to -IN		790	**820**	mW
No load power dissipation	P_{NL}	V_{IN} = 384 V		13	20	W
		V_{IN} = 360 to 400 V			**27**	
Inrush Current Peak	I_{INR_P}	V_{IN} = 400 V C_{OUT} = 100 µF, P_{OUT} = 650 W		4	**8**	A
DC Input Current	I_{IN_DC}	P_{OUT} = 650 W			**2**	A
K Factor $\left(\frac{V_{OUT}}{V_{IN}}\right)$	K			1/8		
Output Power (Average)	P_{OUT}	V_{IN} = 384 V_{DC}; See Figure 11			**650**	W
		V_{IN} = 360 – 400 V_{DC}; See Figure 11			**600**	
Output Power (Peak)	P_{OUT_P}	V_{IN} = 384 V_{DC} Average P_{OUT} < = 650 W, Tpeak < 5 ms			**990**	W
Output Voltage	V_{OUT}	No load	**45**		**50**	V
Output Current (Average)	I_{OUT}	Pout < = 650 W			14.1	A
Efficiency (Ambient)	η	V_{IN} = 384 V, P_{OUT} = 650 W	94.2	95.5		%
		V_{IN} = 360 V to 400 V, P_{OUT} = 650 W	94.2			
Efficiency (Hot)	η	V_{IN} = 384 V, T_J = 100° C,P_{OUT} = 650 W	94	95		%
Minimum Efficiency (Over Load Range)	η	120 W < P_{OUT} < 650 W Max	**90**			%
Output Resistance (Ambient)	R_{OUT}	T_C = 25° C	50	85	100	mΩ
Output Resistance (Hot)	R_{OUT}	T_C = 100° C	75	118	135	mΩ
Output Resistance (Cold)	R_{OUT}	T_C = -40° C	30	65	90	mΩ
Load Capacitance	C_{OUT}				**200**	uF
Switching Frequency	F_{SW}		**1.66**	1.75	**1.83**	MHz
Ripple Frequency	F_{SW_RP}		**3.33**	3.5	**3.66**	MHz
Output Voltage Ripple	V_{OUT_PP}	C_{OUT} = 0 µF, P_{OUT} = 650 W, V_{IN} = 384 V		180	**450**	mV
V_{IN} to V_{OUT} (Application of V_{IN})	$T_{ON}1$	V_{IN} = 384 V, C_{PC} = 0	460	540	620	ms
CNTRL						
CNTRL Voltage (Operating)	V_{PC}		**4.7**	5	**5.3**	V
CNTRL Voltage (Enable)	V_{PC_EN}		**2**	2.5	**3**	V
CNTRL Voltage (Disable)	V_{PC_DIS}				**1.95**	V
CNTRL Source Current (Startup)	I_{PC_EN}		**100**	200	**600**	uA
CNTRL Source Current (Operating)	I_{PC_OP}		**4**	7	**10**	mA
CNTRL Internal Resistance	R_{PC_SNK}	Internal pull down resistor	**25**	75	**200**	kΩ
CNTRL Capacitance (Internal)	C_{PC_INT}				2000	pF
CNTRL Capacitance (External)	C_{PC_EXT}	External capacitance delays PC enable time			2000	pF
External CNTRL Resistance	R_{PC}	Connected to $-V_{IN}$	**25**			kΩ
CNTRL External Toggle Rate	F_{PC_TOG}				**1**	Hz
CNTRL to V_{OUT} with CNTRL Released	Ton2	V_{IN} = 384 V, Pre-applied C_{PC} = 0, C_{OUT} = 0	50	100	150	µs
CNTRL to V_{OUT}, Disable CNTRL	T_{PC_DIS}	V_{IN} = 384 V, Pre-applied C_{PC} = 0, C_{OUT} = 0		4	**10**	µs

1.0 ELECTRICAL CHARACTERISTICS (CONT.)

Specifications apply over all line and load conditions unless otherwise noted; **Boldface** specifications apply over the temperature range of **-40°C < T_C < 100°C (T-Grade)**; All other specifications are at **T_C = 25°C** unless otherwise noted

ATTRIBUTE	SYMBOL	CONDITIONS / NOTES	MIN	TYP	MAX	UNIT
PROTECTION						
Negative going OVLO	V_{IN_OVLO-}		**400**	420	**430**	V
Positive going OVLO	V_{IN_OVLO+}		**420**	430	**440**	V
Negative going UVLO	V_{IN_UVLO-}		**270**	285	**304**	V
Positive going UVLO	V_{IN_UVLO+}		**290**	310	**330**	V
Output Overcurrent Trip	I_{OCP}	V_{IN} = 384 V, 25°C	**18**	22	**28**	A
Short Circuit Protection Trip Current	I_{SCP}		**28**			A
Short Circuit Protection Response Time	T_{SCP}				**1.2**	µs
Thermal Shutdown Junction setpoint	T_{J_OTP}		**125**	130	**135**	°C
GENERAL SPECIFICATION						
Isolation Voltage (Hi-Pot)	V_{HIPOT}		**4242**			V
Working Voltage (IN – OUT)	$V_{WORKING}$				**500**	V
Isolation Capacitance	C_{IN_OUT}	Unpowered unit	**500**	660	**800**	pF
Isolation Resistance	R_{IN_OUT}		**5**			MΩ
MTBF		MIL HDBK 217F, 25° C, GB		2.1		Mhrs
Agency Approvals/Standards		cTUVus (Pending Approvals)				
		CE Mark				

SPECIFICATIONS

GENERAL

Parameter	Min	Typ	Max	Unit	Note
Mechanical					See Mechanical Drawings
Weight		3.2/92		oz/g	
Dimensions					
Length		3.54/89,9	3.55/90,1	in/mm	
Width		0.56/14,2	0.57/14,6	in/mm	
Height		1.13/28,7	1.18/30,0	in/mm	
Thermal					
Over temperature shutdown	125	130	135	°C	Junction temperature
Operating temperature - heatsink			100	°C	See thermal curve, Figure 14
Junction-to-heatsink thermal impedance ($R_{\theta JC}$)		0.50	0.65	°C/W	Heatsink temperature measured in location shown in Figure 15
Heatsink to ambient thermal impedance ($R_{\theta HA}$)		5.95	6.10	°C/W	Refer to http://www.vicorpower.com/technical_library/calculators/calc_t~1.xls

APPLICATION CHARACTERISTICS

All specifications are at **T_C = 25°** unless otherwise noted. See associated figures for general trend data.

ATTRIBUTE	SYMBOL	CONDITIONS / NOTES	TYP	UNIT
No Load Power	P_{NL}	V_{IN} = 384 V, PC enabled; See Figure 1	13	W
Inrush Current Peak	I_{NR_P}	C_{OUT} = 100 µF, P_{OUT} = 650 W	4	A
Efficiency (Ambient)	η	V_{IN} = 384 V, P_{OUT} = 650 W	95.5	%
Efficiency (Hot – 100°C)	η	V_{IN} = 384 V, P_{OUT} = 650 W	95	%
Output Voltage Ripple	V_{OUT_PP}	C_{OUT} = 0 uF, P_{OUT} = 650 W @ V_{IN} = 384, V_{IN} = 384 V	180	mV
Undervoltage Lockout Response Time Constant	T_{UVLO}		150	µs
Output Overcurrent Response Time Constant	T_{OCP}	18 < I_{OCP} < 28 A	5	ms
Overvoltage Lockout Response Time Constant	T_{OVLO}		120	µs

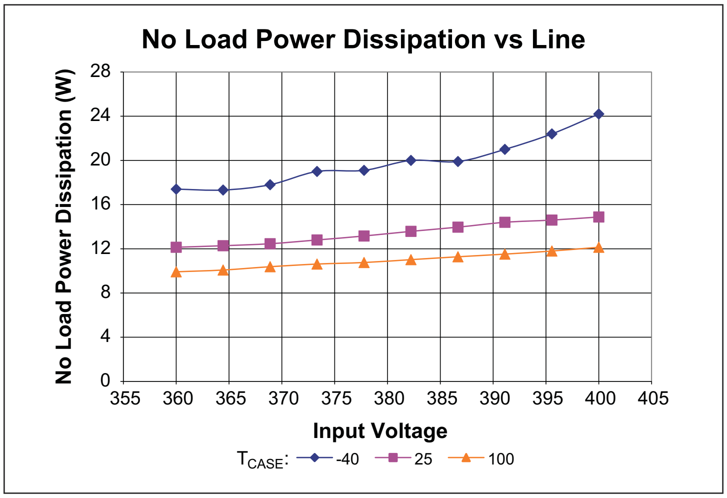


Figure 1 – No load power dissipation vs. V_{IN}; T_{CASE}

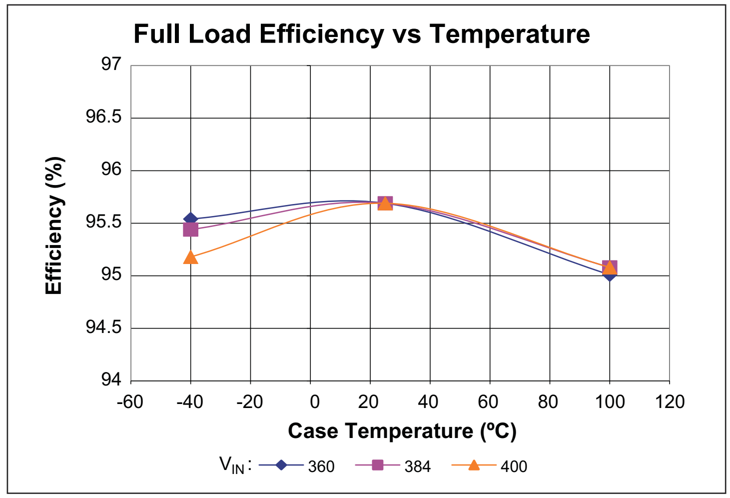


Figure 2 – Full load efficiency vs. temperature; V_{IN}

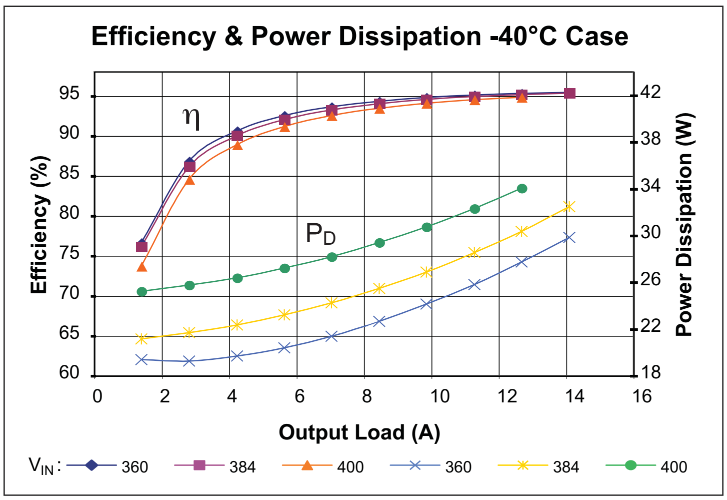


Figure 3 – Efficiency and power dissipation at -40°C (case); V_{IN}

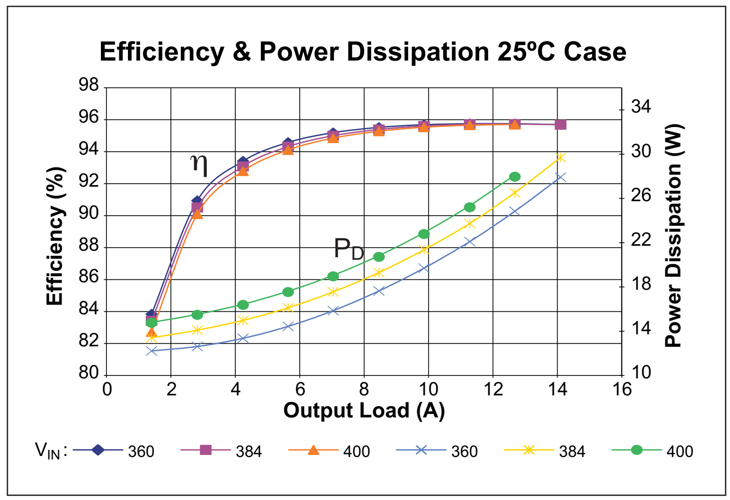


Figure 4 – Efficiency and power dissipation at 25°C (case); V_{IN}

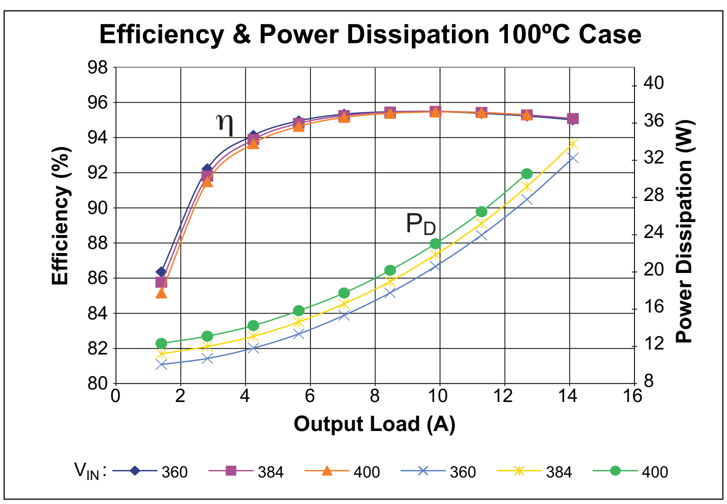


Figure 5 – Efficiency and power dissipation at 100°C (case); V_{IN}

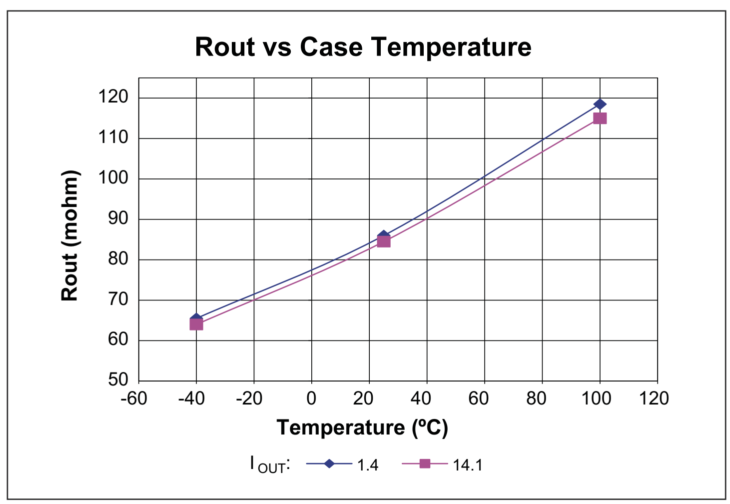


Figure 6 – R_{OUT} vs. temperature vs. I_{OUT}

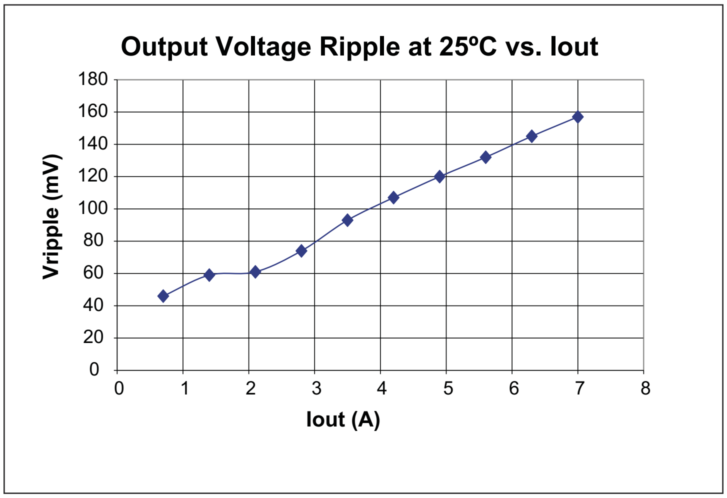


Figure 7 – *Typical Vripple vs. I_{OUT} ; 384 Vin, no external capacitance*

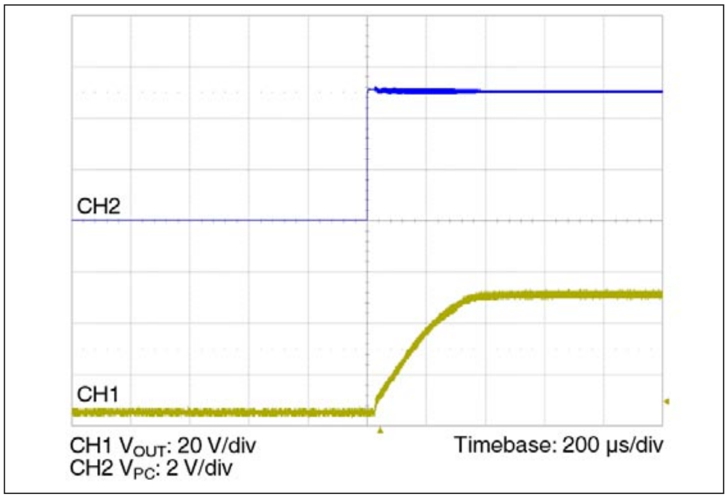


Figure 8 – *CNTRL to V_{OUT} startup waveform*

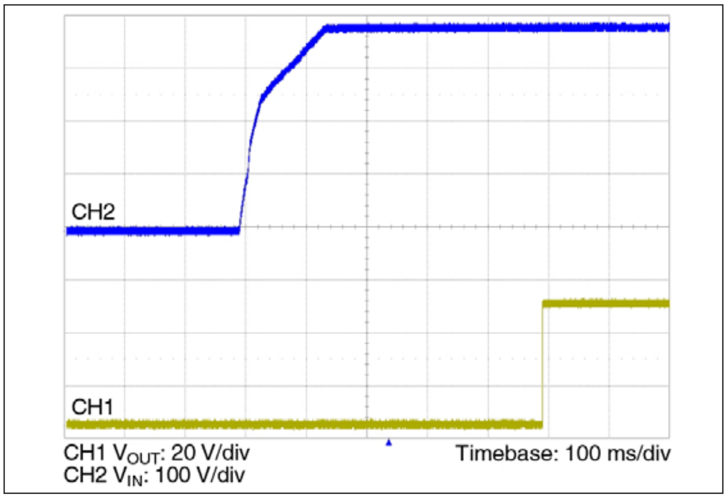


Figure 9 – *V_{IN} to V_{OUT} startup waveform*

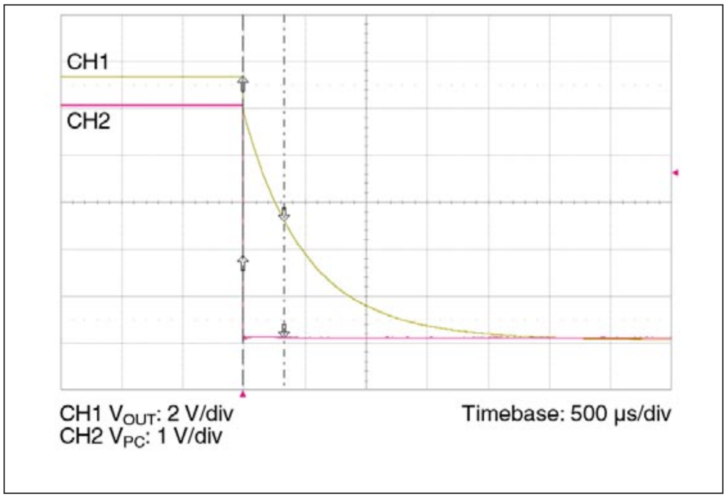


Figure 10 – *CNTRL disable waveform, 384 V_{IN}, 200 µF C_{OUT} full load*

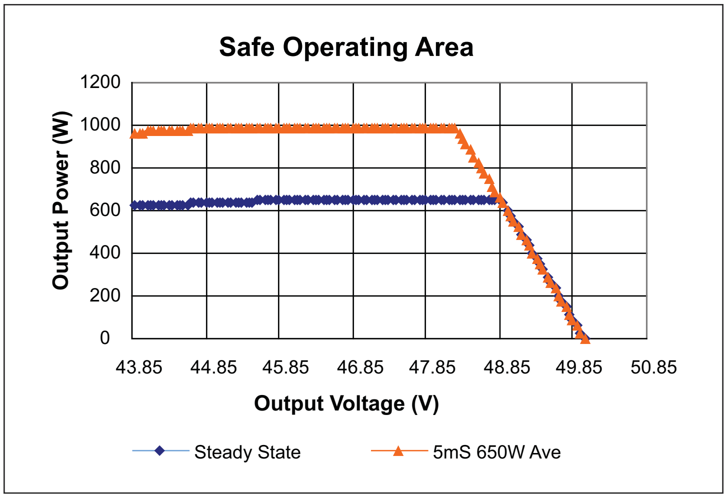


Figure 11 – *Safe Operating Area vs. V_{OUT}*

MECHANICAL DRAWING

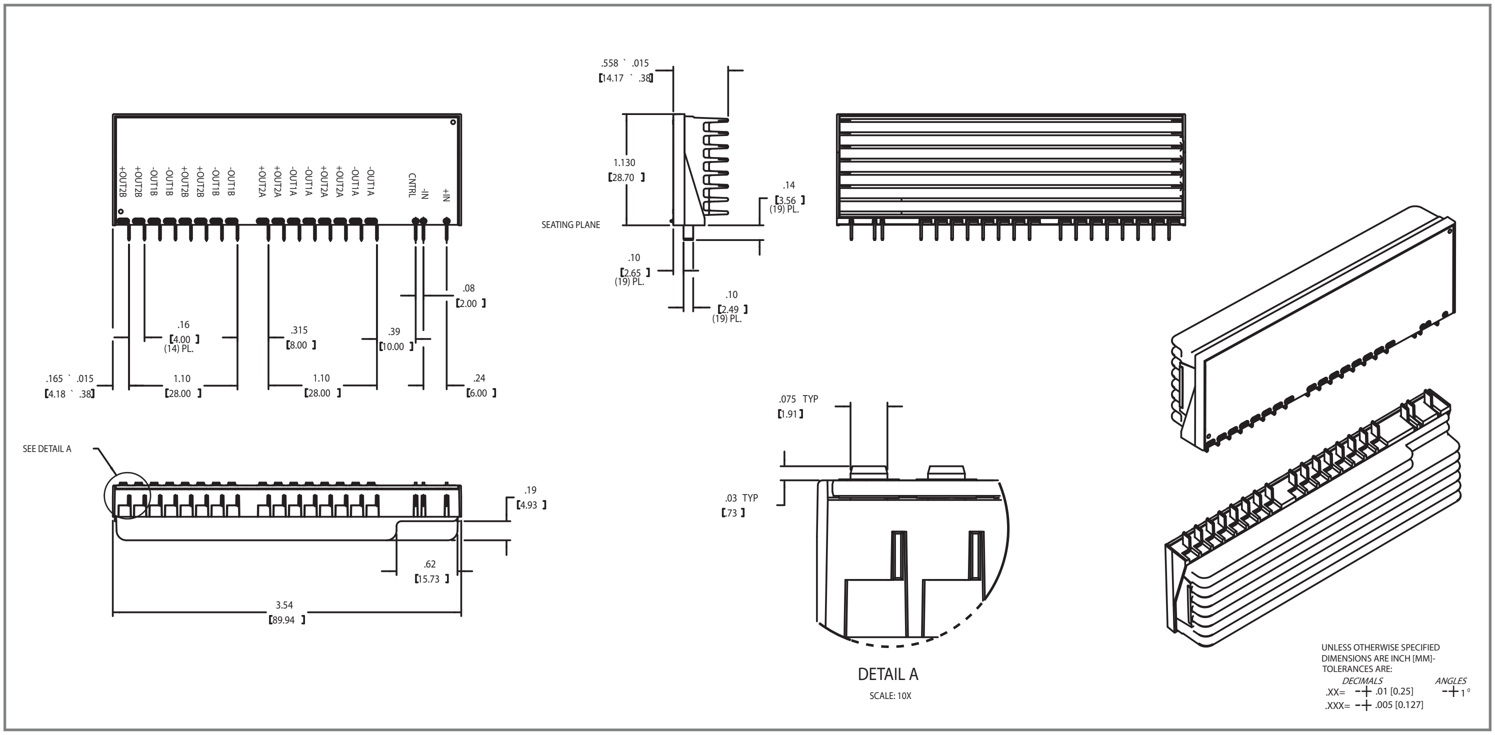


Figure 12 – *Outline Drawing*

RECOMMENDED PCB PATTERN

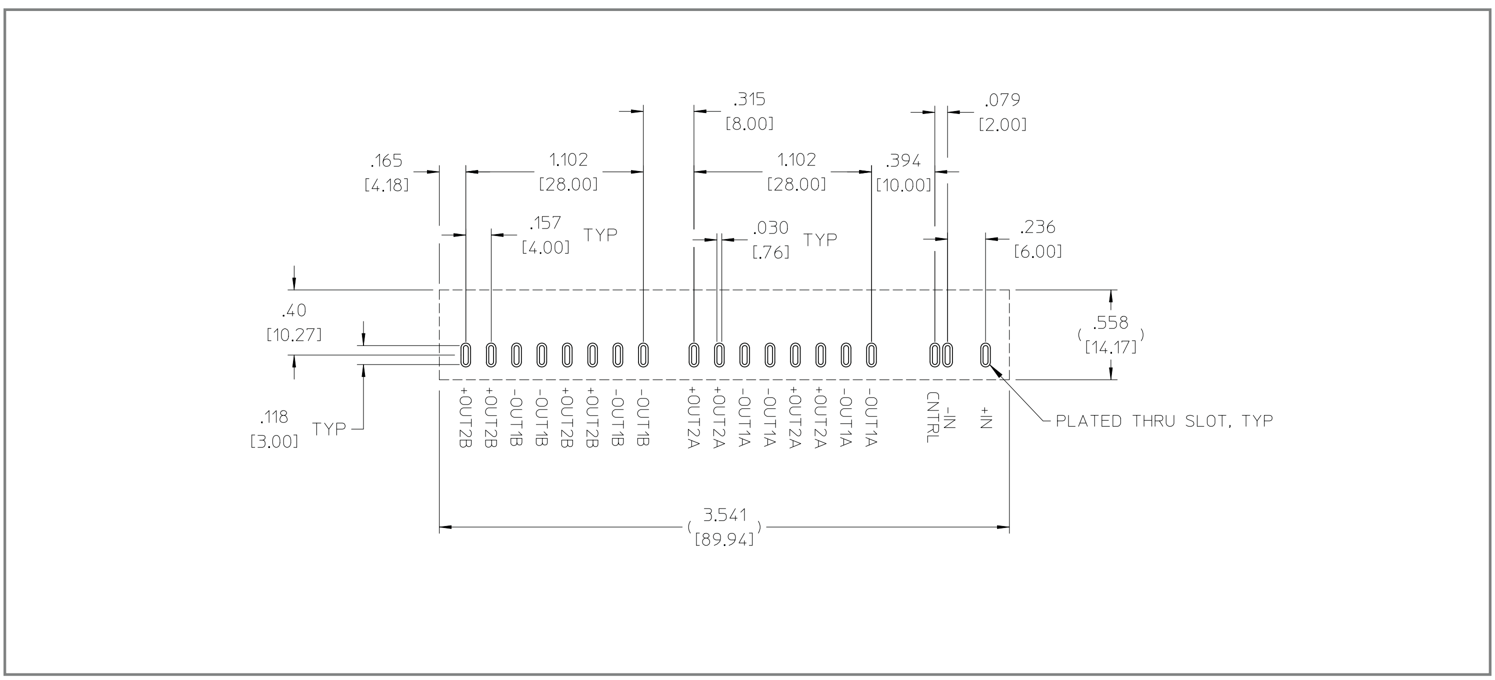


Figure 13 – *PCB Layout*

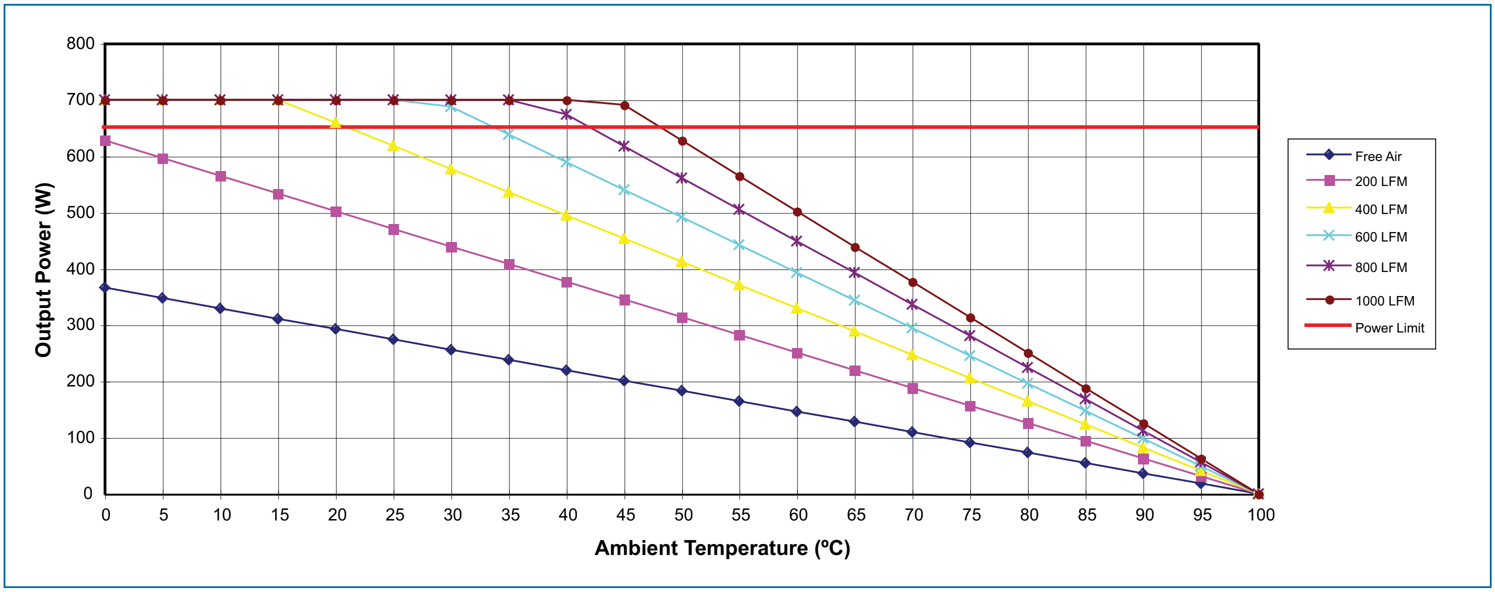


Figure 14 *– Typical thermal curve – verify all thermal management systems experimentally.*

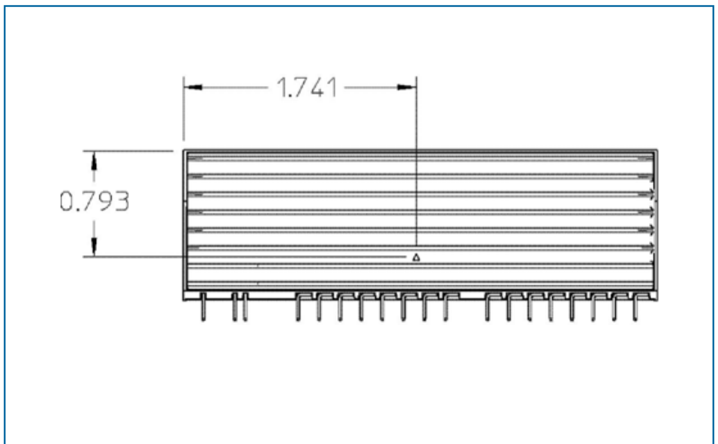


Figure 15 *— Temp measurement location*

+In / -In – DC Voltage Input Ports

The BCM Array input voltage range should not be exceeded. An internal under / over voltage lockout-function prevents operation outside of the normal operating input range. The module turns on within an input voltage window bounded by the "Input under-voltage turn-on" and "Input over-voltage turn-off" levels, as specified. The module may be protected against accidental application of a reverse input voltage by the addition of a rectifier in series with the positive input, or a reverse rectifier in shunt with the positive input located on the load side of the input fuse.

CNTRL – Enable / Disable

The Enable / Disable signal is a multifunction node that provides the following functions:

Enable / Disable – If CNTRL is left floating, the module output is enabled. Once this port is pulled lower than 1.95 Vdc with respect to –In, the output is disabled. This action can be realized by employing a relay, opto-coupler, or open collector transistor. This signal should not be toggled at a rate higher than 1 Hz. CNTRL should also not be driven by or pulled up to an external voltage source.

Primary Auxiliary Supply – CNTRL can source up to 10 mA at 5.0 Vdc. CNTRL should never be used to sink current.

Alarm – The module contains circuitry that monitors output overload, input over voltage or under voltage, and internal junction temperatures. In response to an abnormal condition in any of the monitored parameters, CNTRL will toggle.

+Out / -Out – DC Voltage Output Ports

Multiple pins are provided for the +Out and –Out connections. They **must** be connected in parallel with low interconnect resistance.

The low output impedance of the module reduces or eliminates the need for limited life aluminum electrolytic or tantalum capacitors at the input of POL converters.

Total load capacitance at the output of the device should not exceed the specified maximum. Owing to the wide bandwidth and low output impedance of the BCM Array, low frequency bypass capacitance and significant energy storage may be more densely and efficiently provided by adding capacitance at the input.

CURRENT SHARING

The SAC topology bases its performance on efficient transfer of energy through a transformer, without the need of closed loop control. For this reason, the transfer characteristic can be approximated by an ideal transformer with some resistive drop and positive temperature coefficient.

This type of characteristic is close to the impedance characteristic of a DC power distribution system, both in behavior (AC dynamic) and absolute value (DC dynamic).

When connected in an array (with same K factor), the BCM module will inherently share the load current with parallel units, according to the equivalent impedance divider that the system implements from the power source to the point of load.

It is important to notice that, when successfully started, BCMs are capable of bidirectional operations (reverse power transfer is enabled if the BCM input falls within its operating range and the BCM is otherwise enabled). In parallel arrays, because of the resistive behavior, circulating currents are never experienced, because of energy conservation law.

General recommendations to achieve matched array impedances are (see also AN016 for further details):

- to dedicate common copper planes within the PCB to deliver and return the current to the modules
- to make the PCB layout as symmetric as possible
- to apply same input/output filters (if present) to each unit

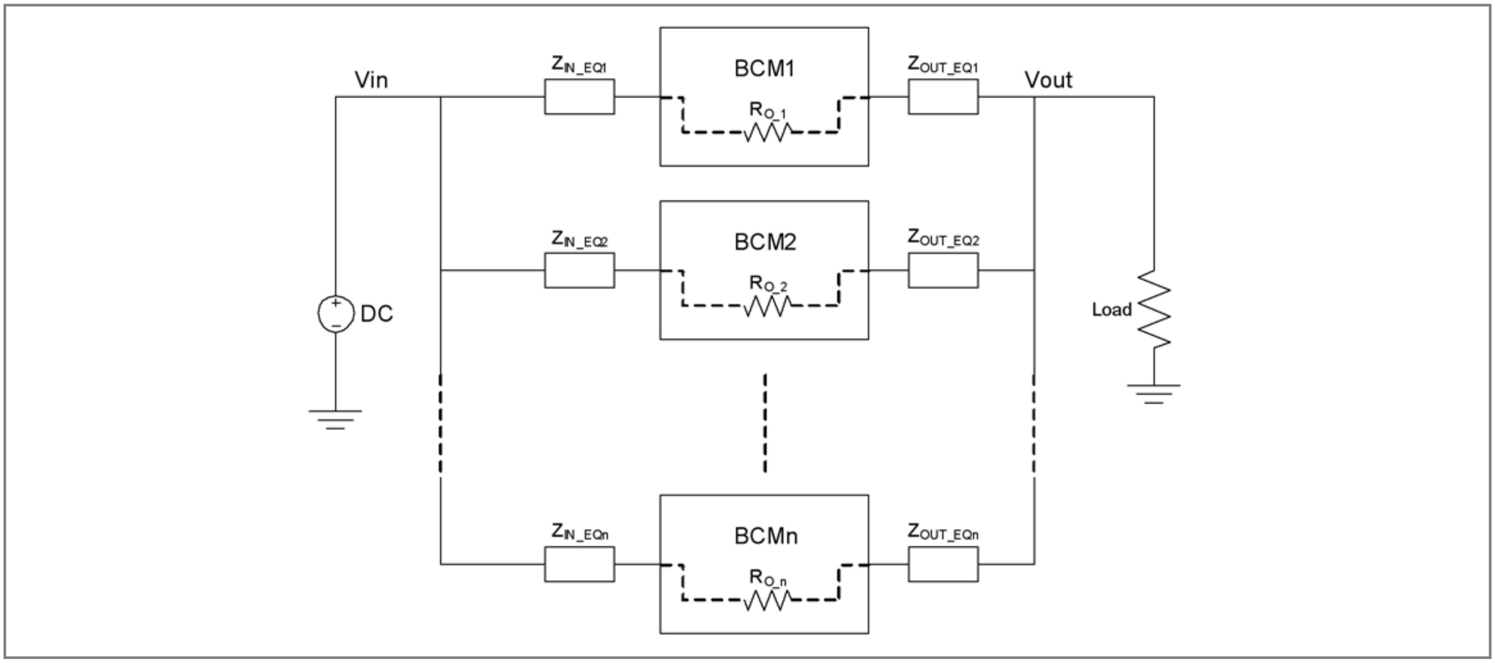


***Figure 16** – BCM Array*

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