

# Analog HV and LV 6123 ChiP™ BCM® Bus Converter Evaluation Board User Guide

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## Introduction

The 6123 Converter housed in a Package (ChiP) Bus Converter Module (BCM) evaluation board described in this document is designed to be used with the BCM family of isolated, DC-DC Bus converters. The Evaluation board is used for both the analog-control and digital-control BCM products.

The focus of this document is to assist the user in evaluating the analog-control version of the BCM family.

The BCM evaluation board can be configured for various enabling and fault-monitoring schemes, as well as to exercise various loading conditions depending on the application requirements. The evaluation board can be used to evaluate BCMs in either a stand-alone configuration, or as an array of modules.

It is important to remember the fast response of BCMs can readily show the limitations of the source, load and associated wiring connected to the evaluation board. Care should be exercised to minimize the stray source and load impedance in order to fully exercise the BCM.

Refer to the appropriate data sheet for performance and operating limits. Data sheets are available at [www.vicorpower.com](http://www.vicorpower.com).

### Enable Options:

1. Apply input voltage greater than the BCM undervoltage lockout (Default)
2. On-board mechanical switch
3. External control using available test point

### Fault Monitor Options:

1. On-board LED: the VAUX pin drives a visible LED for visual feedback on the BCM status such as enabled or fault condition.



## IMPORTANT NOTICE:

**Hazardous voltages are present on the HV BCM® Evaluation Board under power.**

**PERSONAL CONTACT WITH LINE VOLTAGE MAY RESULT IN SEVERE INJURY, DISABILITY, OR DEATH. IMPROPER OR UNSAFE HANDLING OF THIS BOARD MAY RESULT IN SERIOUS INJURY OR DEATH.**

Read the precautions below entirely BEFORE using the BCM evaluation board. Do not operate the evaluation board unless appropriate bench safety precautions are in place to guarantee safety.

The list below is not comprehensive and is not a substitute for common sense and good practice.

- During operation, the power devices and surrounding structures can be operated safely at high temperatures.
- Remove power and use caution when connecting and disconnecting test probes and interface lines to avoid inadvertent short circuits and contact with hot surfaces.
- Never use a jumper in place of the fuse.
- When testing electronic products always use approved safety glasses. Follow good laboratory practice and procedures.
- Avoid creating ground loops when making measurements of the isolated input or output voltage.
- Care should be taken to protect the user from accidental contact when under power.
- Care should be taken to avoid reversing polarities if connecting to the opposite (solder) side of the board.
- The product evaluation boards described in this document are designed for general laboratory evaluation and are not suitable for installation in end user equipment.
- Refer to the specific BCM module data sheet for electrical, thermal, and mechanical product details.

These boards provide a convenient way to evaluate / demonstrate the performance of the Vicor BCM products. Kelvin connections are provided for accurate voltage measurements on power nodes. Sockets are provided to permit quick installation and changing of bulk-filtering capacitors. The evaluation board also provides lugs for Input / output connections, test points and sockets for easy connection to standard test equipment and a high performance air-cooled heat sink assembly.

## Contents

The evaluation board arrives with the following contents:

- 1 x BCM evaluation board
- 1 x Top heat sink pre-installed as well as a bottom of the ChiP™ heat sink when applicable
- 1 x Hardware kit:
  - 1 x through hole aluminum-electrolytic output capacitor (C121)
  - 3 x Connector receptacle 8 position
  - 2 x Connector socket 2 position
  - 5 x Size 10 screws, lugs and washers

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## Features

The BCM® evaluation board has the following features:

1. Input and output lugs for source and load connections
2. Appropriately rated input fuse
3. Input aluminum electrolytic capacitor for additional source decoupling
4. Basic output filtering footprint, including sockets to add through hole output aluminum electrolytic capacitors
5. Toggle switch for enabling and disabling the BCM via the enable (EN) pin
6. Oscilloscope probe jack for accurate, high-frequency output voltage measurements
7. Connectors for BCM signal pins (TM, EN, and VAUX) and temperature monitor filtered signal
8. Kelvin voltage test points for all power pins
9. Top and bottom heat sink assembly for the BCM where applicable

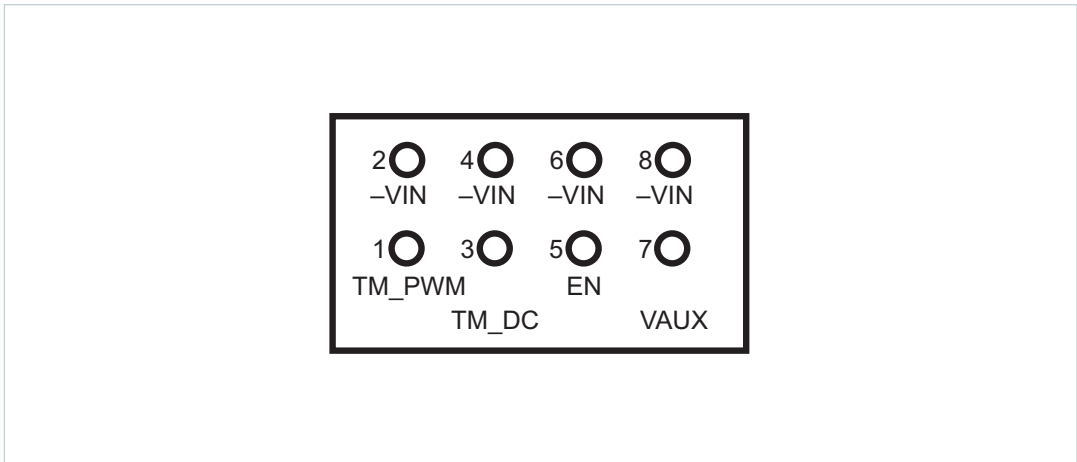
## Board Description

The following section provides a detailed description of the evaluation board components, test points and sockets.

## General Components

1. BCM (PS01)
2. Input lugs: Sized for #10 hardware. Use for making connection to the input source. This board does not contain reverse polarity protection. Check for proper polarity before applying the power. It is important to remember that noise from the source and voltage drops will appear at the output of the bus converter multiplied by transformation ratio (K). The K factor is the ratio of the output voltage to the input voltage ( $V_{OUT} / V_{IN}$ ).
3. Input fuse (F101 & F102): Appropriately rated for the BCM model installed on the board. The fuse is not meant to protect the module.
4. Input filtering: aluminum electrolytic input capacitor (C101).
5. Enable / Disable switch (SW101): When actuator is in top position towards "ON" text on the board, the (EN) pin will be open and the BCM will be enabled. When actuator is in bottom position towards "OFF" text on the board, the (EN) pin will be connected to (-IN) pin and the BCM will be disabled. When switch (SW101) is "ON", an external voltage source can control the EN pin state.
6. Signal connector (J102): provides access to the bus converter signal pins (TM, EN, and VAUX) as well as (TM\_DC) externally filtered signal. All signal pins are reference to the primary non-isolated voltage return (-IN) pin.
  - Temperature Monitor (TM): The BCM (TM) pin outputs a 250kHz PWM signal. A 1k $\Omega$  and a 10nF is the recommended low-pass filtering solution. (TM\_PWM) and filtered (TM\_DC) are both accessible on (J102) connector header. (TM\_DC) measures 1.27V for a 27°C internal temperature corresponding to a (TM\_PWM) duty cycle of 38.48%.
  - Enable Control (EN): Connecting the BCM (EN) pin to (-IN) will disable the module. (SW101) can be used to turn off the power train and disable the module. The (EN) pin is internally pulled up. This connector can be used to bus the (EN) pin in an array allowing array synchronous start up.
  - Auxiliary Voltage Source (VAUX): The BCM (VAUX) can be used as a fault flag it is internally driven low during a fault condition. The (VAUX) pin can also be used as a ready-to-process full-power flag. A 2ms delay from power train active is introduced on this pin signaling the end of soft start. During normal operation this pin can be used as an auxiliary supply up to 4mA max load.

**Figure 1**  
BCM® Signal Connector (J102)



7. Output lugs: Sized for #10 hardware. Use these lugs to connect the output directly to the load.
8. Output oscilloscope probe Jack (J101): Used for making accurate scope measurements of the output voltage (e.g., ripple). The jack is directly compatible with many common passive voltage probes models. Remove the grounding lead and insulating barrel of the probe and insert the probe tip and barrel directly into the jack, ensuring that the probe tip sits in the center socket of the jack. To avoid the risk of an inadvertent short circuit, do not attempt to install while power is applied. This Johnson Jack is Kelvin connected to the module output pins. The effect of the output capacitors will not be noticeable.
9. Output filter: 10x output ceramic capacitors 1206 footprint provision (C103, C104, C113, C114, C115, C116, C117, C118, C119, and C120). In addition to socket (C121) that can be used for easy installation of an aluminum electrolytic output capacitor included with in hardware kit of the evaluation board.
10. Isolation barrier: R106, R107, R108 each are a 2010 package. The footprint can be used to provide a convenient means to short the isolation barrier or provided an additional AC path using capacitors.

**Figure 2**  
PCB#42030 Evaluation Board  
Photo, Top Side



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## Test Points Description

Test nodes are labeled and include an SMT test point for attaching miniature probes, clips or hooks.

**Table 1**  
*Primary-Referenced  
Test Point Descriptions*

Name	Description
+V <sub>IN</sub> , -V <sub>IN</sub>	Provide measurement test points for the input voltage of the BCM® module. Test points are Kelvin connected to the module input pins.
EN	Used to measure the BCM EN pin relative to -V <sub>IN</sub> .
TM_DC	Used to measure the filtered BCM TM signal using a recommended low-pass filter relative to -V <sub>IN</sub> .
TM_PWM	Used to measure the BCM TM pin which is a pulse width modulated output signal relative to -V <sub>IN</sub> .
VAUX	Used to measure the BCM VAUX pin output signal relative to -V <sub>IN</sub> .

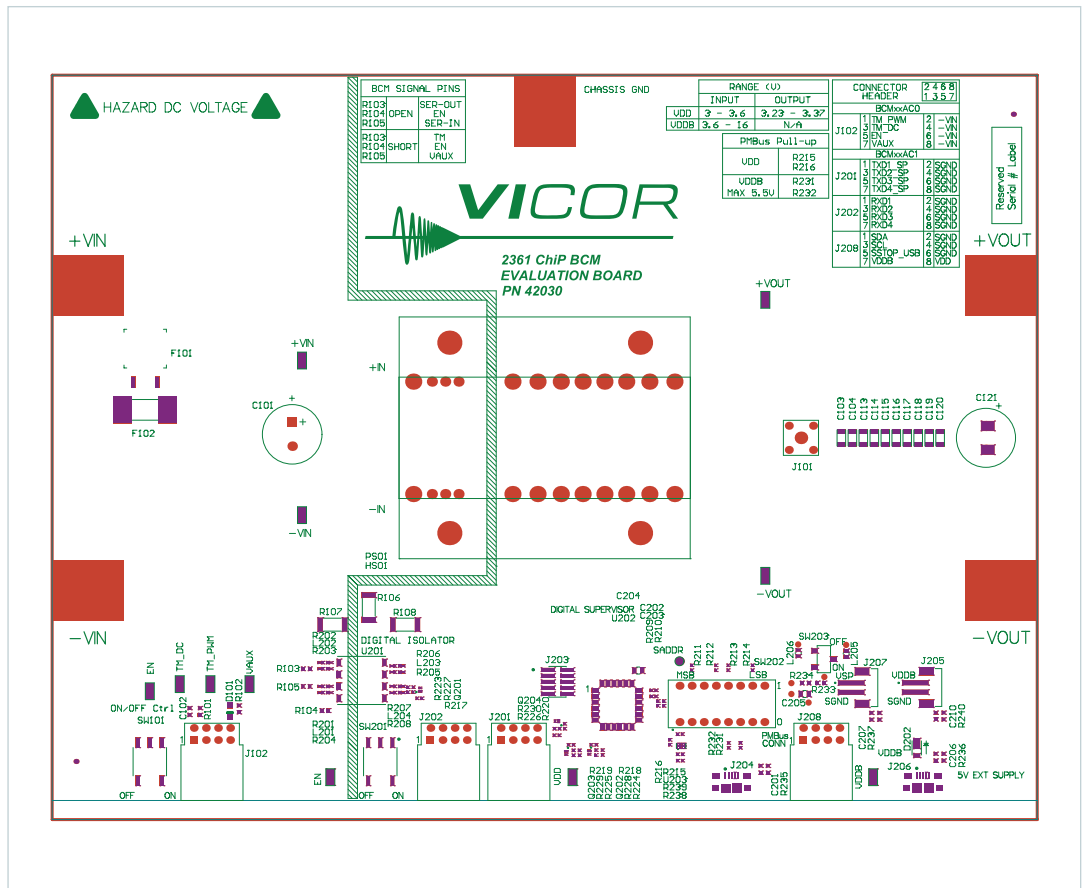
**Table 2**  
*Secondary-Referenced  
Test Point Descriptions*

Name	Description
+V <sub>OUT</sub> , -V <sub>OUT</sub>	Provide measurement test points for the output voltage of the BCM module. Test points are Kelvin connected to the module output pins.

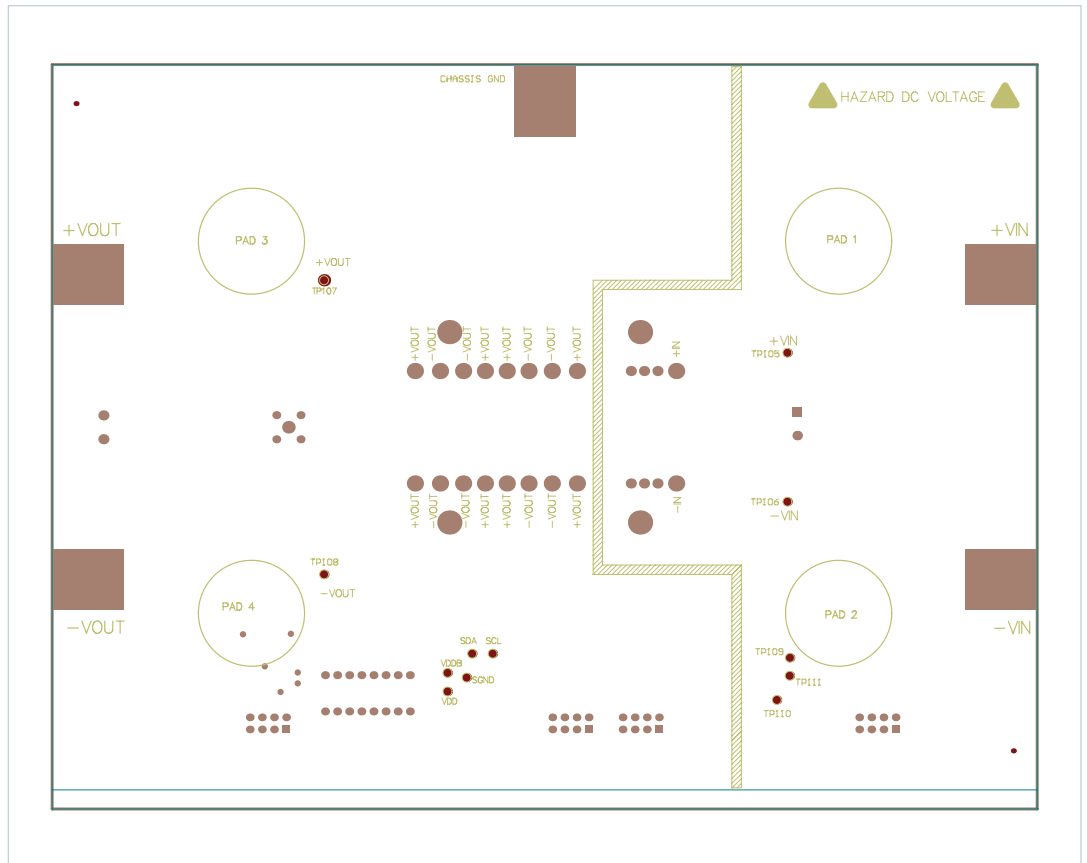




**Figure 5**  
PCB#42030 Evaluation Board



**Figure 6**  
BPCB#42030 Evaluation Board







## Bill of Materials

Following table describes the design specific components of all 6123 BCM® evaluation boards.

**Table 3**  
BCM Evaluation Board  
Components Common  
to all Boards

Reference Designator	Description	Manufacturer	Manufacturer Part Number
C101	CAP ALEL 10µF 20% 450V RAD	United Chemi-Con	EKXG451ELL100MK20S
C102	CAP X7R .010µF 10% 50V 0603	Murata Manufacturing	GRM188R71H103KA01D
D101	DLED RED 0805	Rohm	SML-211UTT86
F101	Design specific - See Table 4		
F102			
J101	JACK VERTICAL MECH THRU HOLE	Tektronix	131-5031-00
J102	CONN HEADER R/A .100 8POS 30AU	TE Connectivity Ltd	5-103166-2
HS01	Design specific - See Table 4		
PCB Part Number	Design specific - See Table 4		
R103, R104, R105	RES 0Ω JUMPER 1A 0603	KOA Speer Electronics	RK73Z1JTTD
R102	RES 750Ω 1/10W 5% 0603	KOA Speer Electronics	RK73B1JTTD751J
R101	RES 1kΩ 1/10W 1% 0603	KOA Speer Electronics	RK73H1JTTD1001F
SW101	SW Horizontal SPDT 1 POS SMD	C&K Components	GT11MSABETR

**Table 4**  
BOM Additions, Components  
which are BCM® Model Specific

Reference Designator	Description	Manufacturer	Manufacturer Part Number
<b>Evaluation board numbers: BCM6123E60E15A3T00; BCM6123E60E10A5T00</b>			
PS01	LV BCM	Vicor Corporation	BCM6123T60E15A3T00; BCM6123T60E10A5T00
PCB Part Number	BCM Evaluation Board	Vicor Corporation	42030
F102	FUSE 40A 60VAC FAST 4.5X12.5 SMD	Littelfuse	0456040.DR
HS01	BOM HEAT SINK, TOP	Vicor Corporation	42676
<b>Evaluation board numbers: BCM6123ED1E13A3T00; BCM6123ED1E1368T00; BCM6123ED1E13A3T0R; BCM6123ED1E1368T0R; BCM6123ED1E2663T00</b>			
PS01	HV BCM	Vicor Corporation	BCM6123TD1E13A3T00; BCM6123TD1E1368T00; BCM6123TD1E13A3T0R; BCM6123TD1E1368T0R; BCM6123TD1E2663T00
PCB Part Number	BCM Evaluation Board	Vicor Corporation	42030
F101	FUSE PC-TRON PCI 5A	Cooper Industries	PCI-5-R
HS01	BOM HEAT SINK, TOP	Vicor Corporation	42676
<b>Evaluation board numbers: BCM6123ED1E5135T00; BCM6123ED1E5126T00; BCM6123ED1E5117T00; BCM6123ED1E5135T0R; BCM6123ED1E5126T0R; BCM6123ED1E5117T0R</b>			
PS01	HV BCM	Vicor Corporation	BCM6123TD1E5135T00; BCM6123TD1E5126T00; BCM6123TD1E5117T00; BCM6123TD1E5135T0R; BCM6123TD1E5126T0R; BCM6123TD1E5117T0R
PCB Part Number	BCM Evaluation Board	Vicor Corporation	42143
F101	FUSE PC-TRON PCI 5A	Cooper Industries	PCI-5-R
HS01	BOM ASSY 6123 DUAL HTSNK NO TIM FOR 11mm	Vicor Corporation	40528

## Recommended Test Equipment

The following is a list of recommended test equipment.

1. Safety glasses
2. DC power supply: Refer to the specific BCM model datasheet to ensure the supply has sufficient power and current capability
3. Electronic load: Refer to the specific BCM model datasheet to ensure the load has sufficient power handling and current capability for testing
4. Cooling fan
5. Digital multi-meters (DMMs)
6. Oscilloscope and probes
7. Interconnect wires, cables and fastening hardware

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## Basic Connections

- Confirm bench equipment is powered off.
- Connect the input DC power supply positive lead to the +IN input lug of the evaluation board, connect the input power supply negative lead to the –IN input lug of the evaluation board.
- Connect the CHASSIS\_GND lug of the evaluation board to a safety “green wire” earth ground.
- Connect the +OUT lug of the evaluation board to the electronic load positive input, connect the –OUT lug of the evaluation board to the electronic load negative input.
- Verify proper polarity of the connections.
- Verify (SW101) desired actuator position.
- Direct airflow from the cooling fan through the BCM® heat sink fins.
- Have the latest BCM datasheet on hand for reference.

## Board Operation Details

- SW01 provides control over enable.
- In the “OFF” position, the switch will connect –IN pin to the EN net, which disables the BCM.
- In the “ON” position, the EN net is allowed to float.
- External connection to EN is permitted using the EN test point. (SW01) should be set to “ON” to allow external control.
- The (J102) paralleling connectors can be used to connect EN nets across different boards.  
**Note:** to enable the BCMs in a parallel array, all boards need (SW01) set to “ON” to avoid pulling the EN node low.
- The heat sink assembly of the BCM is connected to the CHASSIS\_GND lug. A connection from the CHASSIS\_GND lug to earth ground is required for safety as the heat sink will be floating otherwise.
- The visible LED at D101 and its bias resistor network (R102 & R105) are connected to the VAUX pin. LED turns “ON” when VAUX is high signaling that the BCM is ready to process full power.
- Primary input voltage greater than the undervoltage lockout must be applied to enable the BCM power train. This applies to all products listed in this document which includes reversible products.

## Thermal Considerations

The evaluation board is supplied with a pre-installed 11mm double-sided heat sink assembly for PCB#42143 and a 27mm top only for PCB#42030. A fan blowing across the evaluation board and heat sink assembly is required during operation at load. The fan should be placed about four inches away from the evaluation board facing the output voltage side. A typical bench top fan is recommended providing about 1000LFM. Using the supplied rubber feet is also required in order to elevate the board about 0.4 inches off a flat surface and enable air flow underneath the PCB.

The PCB top layer used for the 42676 heat sink ChiP™ is required to be of the same potential of the heat sink. This is to allow heat transfer from the bottom of the ChiP and leads to the heat sink. CHOMERICS GEL-8010 is used on both top and bottom surface of the ChiP. (Between the ChiP top and heat sink as well as the ChiP bottom and the PCB). It is also required to apply to the heat sink extended surface resting on the PCB.

## Paralleling

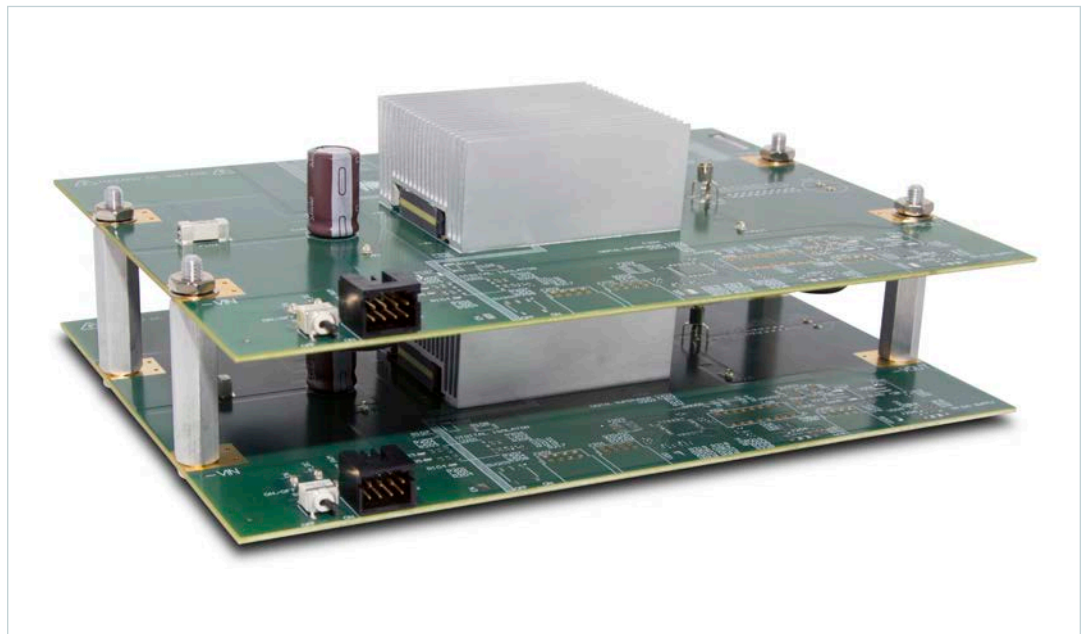
The paralleling and sharing performance of multiple BCMs can be easily demonstrated by stacking multiple evaluation boards and interconnecting the inputs and outputs with standoffs to create a parallel array. Each BCM<sup>®</sup> in an array operates in the same way as it does as a stand-alone unit. With equal impedance, the load is effectively shared across multiple BCMs. Mismatches in this case are modest and are further canceled by an effective-negative voltage vs. temperature coefficient.

The following connections and settings should be used for an array of BCM evaluation boards:

- All BCMs in a parallel array must be the same model.
- The boards should be physically stacked using metal standoffs at the +IN & -IN lugs, the +OUT & -OUT lugs and the CHASSIS\_GND lug. This also connects these nodes electrically so that a single source, single load and earth-ground connection can be made to the system.
- The +IN lugs are required to be connected together for an array of BCMs.
- Standoffs must be sufficient in length to avoid contact between boards and to permit airflow to all BCMs in the system.
- If coordinated enable control then the paralleling connectors (J102) can be used to easily interconnect the EN pin across boards.
- The paralleling connector receptacle (J102) is provided to daisy chain EN signal and  $-V_{IN}$ . The will accept a wire size range 26 – 22AWG, 0.12 – 0.3mm<sup>2</sup> wires.

The paralleling and current sharing capability of the devices can be demonstrated by stacking multiple evaluation boards and interconnecting the inputs and outputs with standoffs of sufficient current rating to create a parallel array. If synchronous start up is desired, connect EN pin 5 and  $-V_{IN}$  pin 6 in (J102) using a twisted pair to all respective pins in different paralleled units.

**Figure 9**  
BCM Evaluation Boards Stacked  
to Form a High-Power Parallel  
Array, Using Common -IN and  
the Paralleling Connectors.  
Paralleling of  
BCM Evaluation Board.



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