

PI354x-00 Evaluation Board User Guide

36 to 60V_{IN}, 2.5, 3.3, 5.0, and 12V_{OUT} ZVS Buck Regulator & LED Driver



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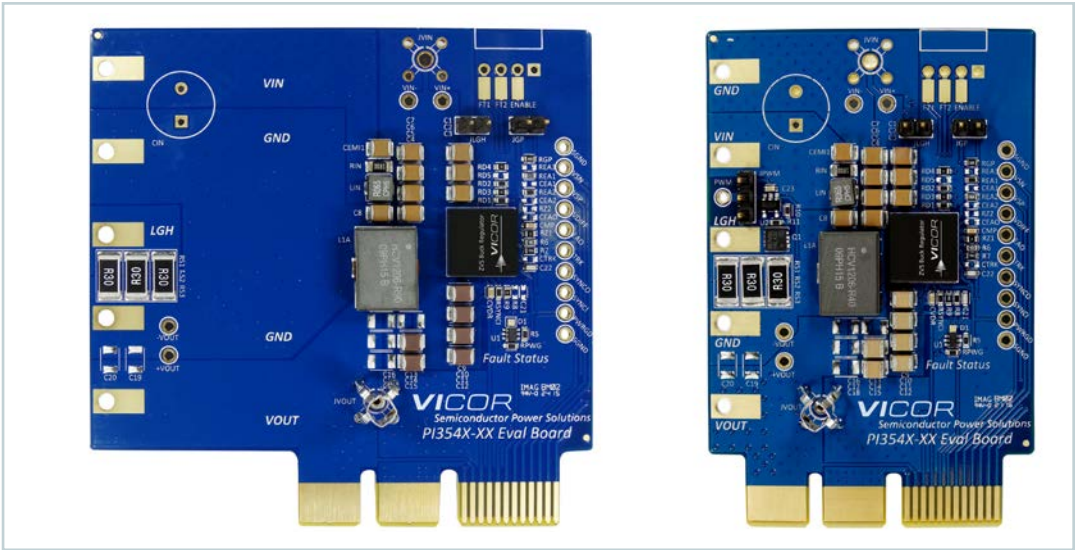
Introduction

The PI354x-00 evaluation board demonstrates the features and benefits of the Vicor ZVS high-voltage Buck Regulator family. There are four preconfigured evaluation boards available: PI3542-00-EVAL1 (2.5V), PI3543-00-EVAL1 (3.3V), PI3545-00-EVAL1 (5.0V) and PI3546-00-EVAL1 (12.0V). Please refer to the PI354x-00 data sheet for individual regulator’s specifications and design instructions.

The evaluation board provides several options for applying input power (VIN and GND) and output load (VOUT and GND). The user can solder tab style banana jacks or wire, use threaded connectors with retaining nuts, or solder turret pins for clip-on connections.

The evaluation board family can demonstrate all the PI354x-00’s features accessible to the user. The general-purpose amplifier (VDIFF) is preset with a gain of two, but can be easily reconfigured for differential measurements by adding extra 0603 resistors (RD1 – RD5). The lighting option (LGH) can be explored by ordering any of the evaluation boards. When using the lighting option, connections are made between the VIN (anode) and the LGH (cathode) terminals (see Figure 3). Three parallel shunt footprints (2512) are available to program a desired LED constant current. Each evaluation board is preset with a constant current of 1.0A implementing three 0.3Ω resistors in parallel (RS1 – RS3). R6, R7 and C22 are used to set the LGH compensation (please refer to the data sheet for design calculations, theory of operation, as well as maximum compliant voltage requirements). REA1 and REA2 are used to adjust the output voltage regulation. There are additional schematic features that allow a low-frequency dimming circuit (included on the PI3543-00-EVAL1-00 only) to be utilized. This consists of a MOSFET and driver circuit to allow the user to pulse the LED on and off using an external dimming PWM signal. This signal should be limited to less than 10kHz. Since dimming circuitry is only available on the PI3543-00-EVAL1, be sure to order that part number if LED dimming is to be explored.

Figure 1
Representative sample
(board layout and size will vary)



The I/O pins are brought out to the right edge of the evaluation board to allow for easy monitoring or for adding additional circuitry. The status of the Power Good pin is indicated by a dual colored LED; red indicates that the regulator is disabled ($EN = 0V$) or faulting and green indicates that the regulator is enabled ($EN > 1.1$ or floating) and operating correctly. The SYNC0 and SYNC1 pins are accessible to allow for paralleling modules or for synchronization to an external clock.

A footprint (CTRK) for an external capacitor (0603) is available to tailor the start-up profile of the converter. The error amplifier's output (EAO) is brought to a pin and in conjunction with the TRK pin, can be used for paralleling two converters.

The board was designed with an edge connector to facilitate in-house testing, but can be also used for evaluation purposes. The printed circuit board is four layers FR-4 170Tg material with 2oz copper layers, ENIG pad finish and a board thickness of 0.062.

Evaluation Board Supply & Load Connections

Figure 2

The recommended connections for input supply and output loading; all the I/O pins are brought out to the edge to allow for easy measurement and/or connection to the user's external circuitry

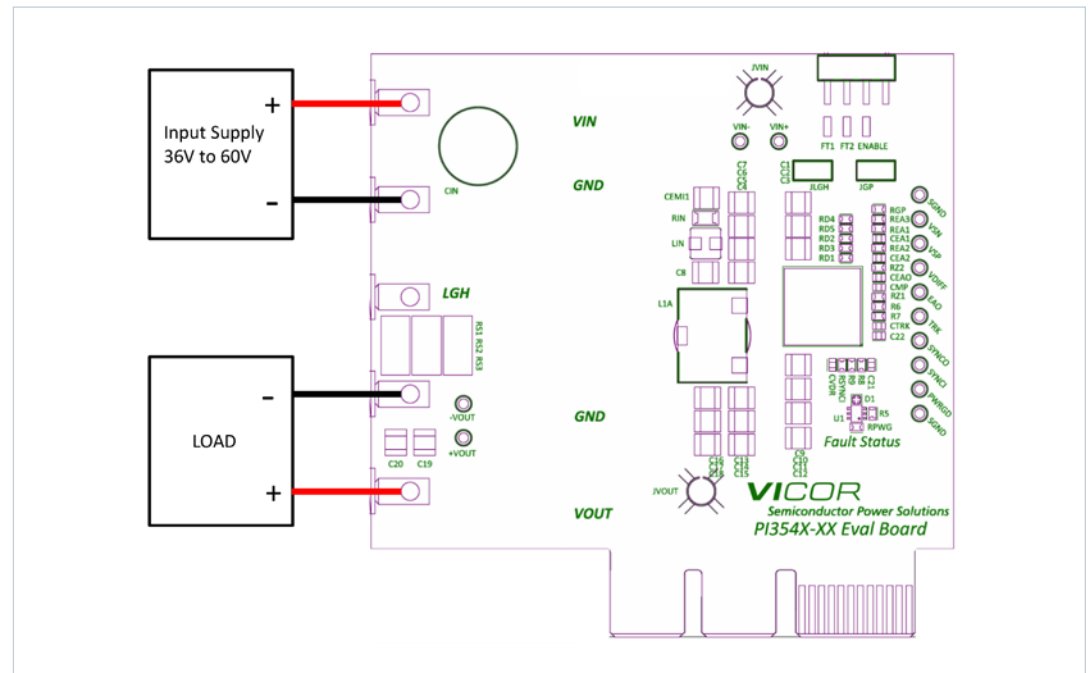
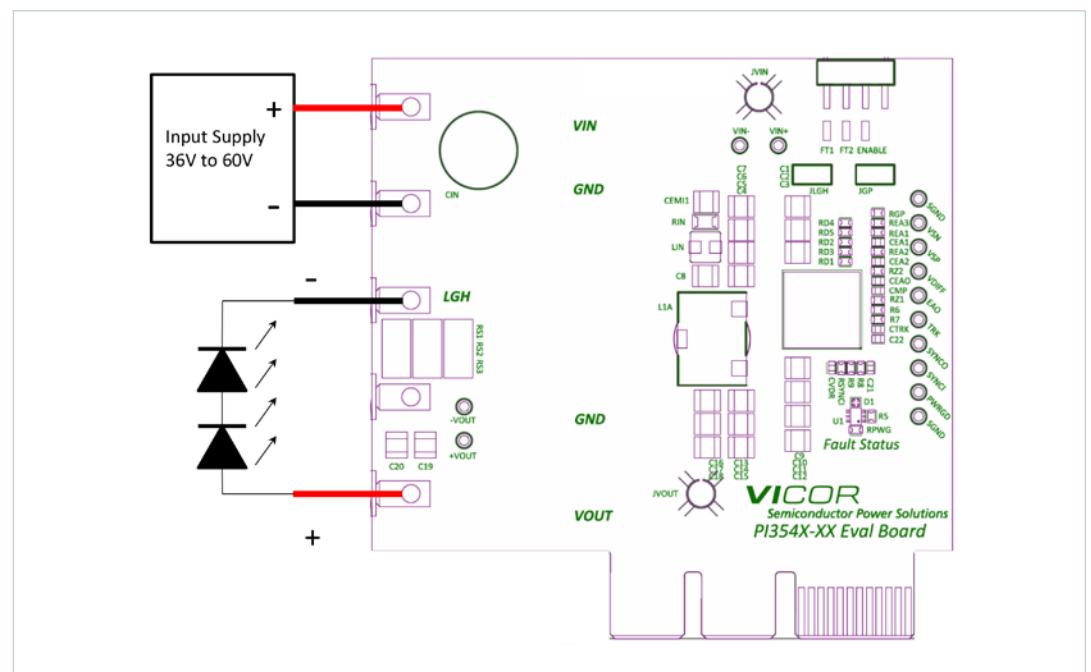


Figure 3

Lighting (LGH) external connections



Bill of Materials

Table 1
Bill of materials
PI3546-00-EVAL1

Qty	Reference Designator	Description	Vendor Name	Vendor Part Number
1	CVDR	Capacitor, X7R Ceramic, 0.1μF, 50V, 0603	Rohm	MCH185CN104KK
9	C1 – C8, CEM11	Capacitor, Ceramic, 2.2μF, 100V, 10%, X7R, 1210	Murata	GRM32ER72A225KA35
1	CMP	Capacitor, X7R, 4700pF, 50V, 0603	Murata	GRM188R71H472KA01D
6	C9 – C12, C14, C15	Capacitor, Ceramic, 10μF, 50V, 20%, X7S, 1210	TDK	C3225X7S1H106M250AB
1	C22	Capacitor, NPO, 270pF, 100V, 0603	Murata	GRM1885C2A271JA01D
1	D1	Diode, LED, Red/Green, 1 x 1mm	Rohm	SML-P24MUWT86
1	LIN	Inductor, 65nH, 20A, FP0404	EATON	FP0404R1-R065-R
1	L1A	Inductor, 0.90μH, 28A, HCV1206	EATON	HCV1206-R90-R
1	REA1	Resistor, 11kΩ, 5%, 0.1W, 0603	Panasonic	ERJ-3GEYJ113V
2	R5, REA2	Resistor, 1.00kΩ, 1%, 0.1W, 0603	Panasonic	ERJ-3EKF1001V
4	RD1 – RD2, RPWG, RSYNCl	Resistor, 10.0kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPF1002
4	R9, RD3 – RD4, RZ1	Resistor, 0Ω, 1%, 0.1W, 0603	Rohm	MCR03EZPJ000
1	R6	Resistor, 100kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPF1003
1	R7	Resistor, 4.99kΩ, 1%, 0.125W, 0603	Rohm	MCR03EZPF4991
1	RIN	Resistor, 1.0Ω, 1%, 0.25W, 1206	Rohm	MCR18ERTFL1R00
1	RGP	Resistor, 49.9Ω, 1%, 0.1W, 0603	Rohm	MCR03ERTF49R9
3	RS1 – RS3	Resistor, 0.30Ω, 1%, 1W	Panasonic	ERJ-1TRQFR30U
1	U1	Dual Schmitt Trigger Inverter, NC7WZ14, SC70-6	Fairchild	NC7WZ14EP6X
1	JVOUT	Connector, Johnson Jack	Tektronix	131503100
2	JGP, JLGH	Connector, Header Pins 0.1" pitch J, Header 0.1"	Samtec	TSW-148-07-F-S
1	SiP1	High Voltage ZVS Buck SiP, 60V _{IN} 10 x 10 x 2mm LGA SiP	Vicor	PI3546-00-LGiZ

Table 2
Bill of materials
PI3546-00-EVAL1
(non-populated components)

Qty	Reference Designator	Description
5	R5, RD5, R8, R22, REA3	Resistor, 1%, 0.1W, 0603
7	C13, C16 – C21	Capacitor, Ceramic, 50V, 20%, X7S, 1210
4	CEA1, CEA2, CEA0, CTRK	Capacitor, X7R, 50V, 0603
1	CIN	Electrolytic Capacitor, 100V
3	ENABLE, FT1, FT2	SM Test point, Keystone 5015
1	JIN	Johnson Jack, Tektronix 131503100
13	–VOUT, +VOUT, VIN+, VIN–, SYNCl, SYNCO, PWRGD, TRK, VSP, VSN, VDEFF, SGND1, SGND2	Thru-hole Test points, Vector K24C

Bill of Materials (Cont.)

Table 3
Bill of materials
PI3545-00-EVAL1

Qty	Reference Designator	Description	Vendor Name	Vendor Part Number
9	C1 – C8, CEMI1	Capacitor, Ceramic, 2.2μF, 100V, 10%, X7R, 1210	Murata	GRM32ER72A225KA35
6	C9 – C12, C14, C15	Capacitor, X7R, 47μF, 10V, 10%, 1210	Murata	GRM32ER71A476KE15L
1	C22	Capacitor, NPO, 270pF, 100V, 0603	Murata	GRM1885C2A271JA01D
1	CVDR	Capacitor, X7R Ceramic, 0.1μF, 50V, 0603	Rohm	MCH185CN104KK
1	CMP	Capacitor, X7R, 4700pF, 50V, 0603	Murata	GRM188R71H472KA01D
1	D1	Diode, LED, Red/Green, 1 x 1mm	Rohm	SML-P24MUWT86
2	JGP, JLGH	Connector, Header Pins 0.1 " pitch J, Header 0.1 "	Samtec	TSW-148-07-F-S
1	JVOUT	Connector, Johnson Jack	Tektronix	131503100
1	L1A	Inductor, 0.42μH, 42A, HCV1206	EATON	HCV1206-R42-R
1	LIN	Inductor, 65nH, 20A, FP0404	EATON	FP0404R1-R065-R
1	R5	Resistor, 1.00kΩ, 1%, 0.1W, 0603	Panasonic	ERJ-3EKF1001V
1	R6	Resistor, 100kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPFX1003
1	R7	Resistor, 4.99kΩ, 1%, 0.125W, 0603	Rohm	MCR03EZPFX4991
4	RD1 – RD2, RPWG, RSYNCI	Resistor, 10.0kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPFX1002
4	R9, RD3 – RD4, RZ1	Resistor, 0Ω, 1%, 0.1W, 0603	Rohm	MCR03EZPJ000
1	REA1	Resistor, 4.53kΩ, 1%, 0.1W, 0603	Yageo	RC0603FR-074K53L
1	REA2	Resistor, 1.13kΩ, 1%, 0.1W, 0603	Yageo	RC0603FR-071K13L
1	RGP	Resistor, 49.9Ω, 1%, 0.1W, 0603	Rohm	MCR03ERTF49R9
1	RIN	Resistor, 1.0Ω, 1%, 0.25W, 1206	Rohm	MCR18ERTFL1R00
3	RS1 – RS3	Resistor, 0.30Ω, 1%, 1W	Panasonic	ERJ-1TRQFR30U
1	SIP1	High Voltage ZVS Buck SiP, 60VIN 10 x 10 x 2mm LGA SiP	Vicor	PI3545-00-LGIZ
1	U1	Dual Schmitt Trigger Inverter, NC7WZ14, SC70-6	Fairchild	NC7WZ14EP6X

Table 4
Bill of materials
PI3545-00-EVAL1
(non-populated components)

Qty	Reference Designator	Description
5	R5, RD5, R8, R22, REA3	Resistor, 1%, 0.1W, 0603
7	C13, C16 - C21	Capacitor, Ceramic, 50V, 20%, X7S, 1210
4	CEA1, CEA2, CEA0, CTRK	Capacitor, X7R, 50V, 0603
1	CIN	Electrolytic Capacitor, 100V
3	ENABLE, FT1, FT2	SM Test point, Keystone 5015
1	JIN	Johnson Jack, Tektronix 131503100
13	–VOUT, +VOUT, VIN+, VIN–, SYNCI, SYNCO, PWRGD, TRK, VSP, VSN, VDEFF, SGND1, SGND2	Thru-hole Test points, Vector K24C

Bill of Materials (Cont.)

Table 5
Bill of materials
PI3543-00-EVAL1

Qty	Reference Designator	Description	Vendor Name	Vendor Part Number
9	C1 – C8, CEM11	Capacitor, Ceramic, 2.2μF, 100V,10%, X7R, 1210	Murata	GRM32ER72A225KA35
6	C9 – C12, C14, C15	Capacitor, X7S, 100μF, 6.3V, 20%,1210	Murata	GRM32EC70J107ME15L
1	C21	Capacitor, NPO, 2000pF, 50V, 0603	Murata	GRM1885C1H202JA01D
1	C22	Capacitor, NPO, 270pF, 100V, 0603	Murata	GRM1885C2A271JA01D
2	C23, CVDR	Capacitor, X7R Ceramic, 0.1μF, 50V ,0603	Rohm	MCH185CN104KK
1	CMP	Capacitor, X7R, 4700pF, 50V, 0603	Murata	GRM188R71H472KA01D
1	L1A	Inductor, 0.42μH, 42A, HCV1206	EATON	HCV1206-R42-R
1	LIN	Inductor, 65nH, 20A, FP0404	EATON	FP0404R1-R065-R
1	R5	Resistor, 1.00kΩ, 1%, 0.1W, 0603	Panasonic	ERJ-3EKF1001V
1	R6	Resistor, 100kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPFX1003
2	R7, R9	Resistor, 4.99kΩ, 1%, 0.125W, 0603	Rohm	MCR03EZPFX4991
1	R8	Resistor, 20.0kΩ, 1%, 0.1W, 0603	Panasonic	ERJ-3EKF2002V
1	R10	Resistor, 10.0Ω, 1%, 0.1W, 0603	Panasonic	ERJ-3EKF10R0V
5	R11, RD1 – RD2, RPWG, RSYNCI	Resistor, 10.0kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPFX1002
3	RD3 – RD4, RZ1	Resistor, 0Ω, 1%, 0.1W, 0603	Rohm	MCR03EZPJ000
1	REA1	Resistor, 2.61kΩ, 1%, 0.1W, 0603	Panasonic	ERJ-3EKF2611V
1	REA2	Resistor, 1.13kΩ, 1%, 0.1W, 0603	Yageo	RC0603FR-071K13L
1	RGP	Resistor, 49.9Ω, 1%, 0.1W, 0603	Rohm	MCR03ERTF49R9
1	RIN	Resistor, 1.0Ω, 1%, 0.25W, 1206	Rohm	MCR18ERTFL1R00
3	RS1 – RS3	Resistor, 0.30Ω, 1%, 1W	Panasonic	ERJ-1TRQFR30U
1	SIP1	High Voltage ZVS Buck SiP, 60VIN 10 x 10 x 2mm LGA SiP	Vicor	PI3543-00-LGIZ
3	JGP, JLGH, JPWM	Connector, Header Pins 0.1 " pitch J, Header 0.1 "	Samtec	TSW-148-07-F-S
1	JVOUT	Connector, Johnson Jack	Tektronix	131503100
1	D1	Diode, LED, Red/Green, 1 x 1mm	Rohm	SML-P24MUWT86
1	U1	Dual Schmitt Trigger Inverter, NC7WZ14, SC70-6	Fairchild	NC7WZ14EP6X
1	U2	Gate Driver, FAN3100TSX, SOT-23-5	Fairchild	FAN3100TSX
1	Q1	Transistor, N-Channel, 60V, 20A, 6.7mOhm, PG-TSDSON-8	Infineon Technologies	BSZ067N06LS3 G

Table 6
Bill of materials
PI3543-00-EVAL1
(non-populated components)

Qty	Reference Designator	Description
5	R5, RD5, R22, REA3	Resistor, 1%, 0.1W, 0603
7	C13, C16 – C20	Capacitor, Ceramic, 50V,20%, X7S, 1210
4	CEA1, CEA2, CEA0, CTRK	Capacitor, X7R, 50V, 0603
1	CIN	Electrolytic Capacitor, 100V
3	ENABLE, FT1, FT2	SM Test point, Keystone 5015
1	JIN	Johnson Jack, Tektronix 131503100
13	–VOUT, +VOUT, VIN+, VIN–,SYNCI, SYNCO, PWRGD, TRK, VSP, VSN, VDEFF, SGND1, SGND2	Thru-hole Test points, Vector K24C

Bill of Materials (Cont.)

Table 7
Bill of materials
PI3542-00-EVAL1

Qty	Reference Designator	Description	Vendor Name	Vendor Part Number
9	C1 – C8, CEMI1	Capacitor, Ceramic, 2.2μF, 100V, 10%, X7R, 1210	Murata	GRM32ER72A225KA35
6	C9 – C11, C13, C15, C17	Capacitor, X7S, 100μF, 6.3V, 20%, 1210	Murata	GRM32EC70J107ME15L
1	C22	Capacitor, NPO, 270pF, 100V, 0603	Murata	GRM1885C2A271JA01D
1	CVDR	Capacitor, X7R Ceramic, 0.1μF, 50V, 0603	Rohm	MCH185CN104KK
1	CMP	Capacitor, X7R, 4700pF, 50V, 0603	Murata	GRM188R71H472KA01D
1	L1A	Inductor, 340H, 40A, FP71006-340-R	EATON	FT1006-340-R
1	LIN	Inductor, 65nH, 20A, FP0404	EATON	FP0404R1-R065-R
2	R5, REA2	Resistor, 1.00kΩ, 1%, 0.1W, 0603	Panasonic	ERJ-3EKF1001V
1	R6	Resistor, 100kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPFX1003
1	R7	Resistor, 4.99kΩ, 1%, 0.125W, 0603	Rohm	MCR03EZPFX4991
4	RD1 – RD2, RPWG, RSYNCl	Resistor, 10.0kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPFX1002
4	R9, RD3 – RD4, RZ1	Resistor, 0Ω, 1%, 0.1W, 0603	Rohm	MCR03EZPJ000
1	REA1	Resistor, 1.5kΩ, 1%, 0.1W, 0603	Rohm	MCR03EZPFX1501
1	RGP	Resistor, 49.9Ω, 1%, 0.1W, 0603	Rohm	MCR03ERTF49R9
1	RIN	Resistor, 1.0Ω, 1%, 0.25W, 1206	Rohm	MCR18ERTFL1R00
3	RS1 – RS3	Resistor, 0.30Ω, 1%, 1W	Panasonic	ERJ-1TRQFR30U
1	SIP1	High Voltage ZVS Buck SiP, 60V _{IN} , 10 x 10 x 2mm LGA SiP	Vicor	PI3542-00-LGIZ
2	JGP, JLGH	Connector, Header Pins 0.1" pitch J, Header 0.1"	Samtec	TSW-148-07-F-S
1	JVOUT	Connector, Johnson Jack	Tektronix	131503100
1	U1	Dual Schmitt Trigger Inverter, NC7WZ14, SC70-6	Fairchild	NC7WZ14EP6X
1	D1	Diode, LED, Red/Green, 1 x 1mm	Rohm	SML-P24MUWT86

Table 8
Bill of materials
PI3542-00-EVAL1
(non-populated components)

Qty	Reference Designator	Description
5	R5, RD5, R8, R22, REA3	Resistor, 1 %, 0.1W, 0603
7	C13, C16 - C21	Capacitor, Ceramic, 50V, 20%, X7S, 1210
4	CEA1, CEA2, CEA0, CTRK	Capacitor, X7R, 50V, 0603
1	CIN	Electrolytic Capacitor, 100V
3	ENABLE, FT1, FT2	SM Test point, Keystone 5015
1	JIN	Johnson Jack, Tektronix 131503100
13	–VOUT, +VOUT, VIN+, VIN–, SYNCl, SYNCO, PWRGD, TRK, VSP, VSN, VDEFF, SGND1, SGND2	Thru-hole Test points, Vector K24C

Schematics

Figure 4
PI3543-00-EVAL1
schematic with dimming circuit

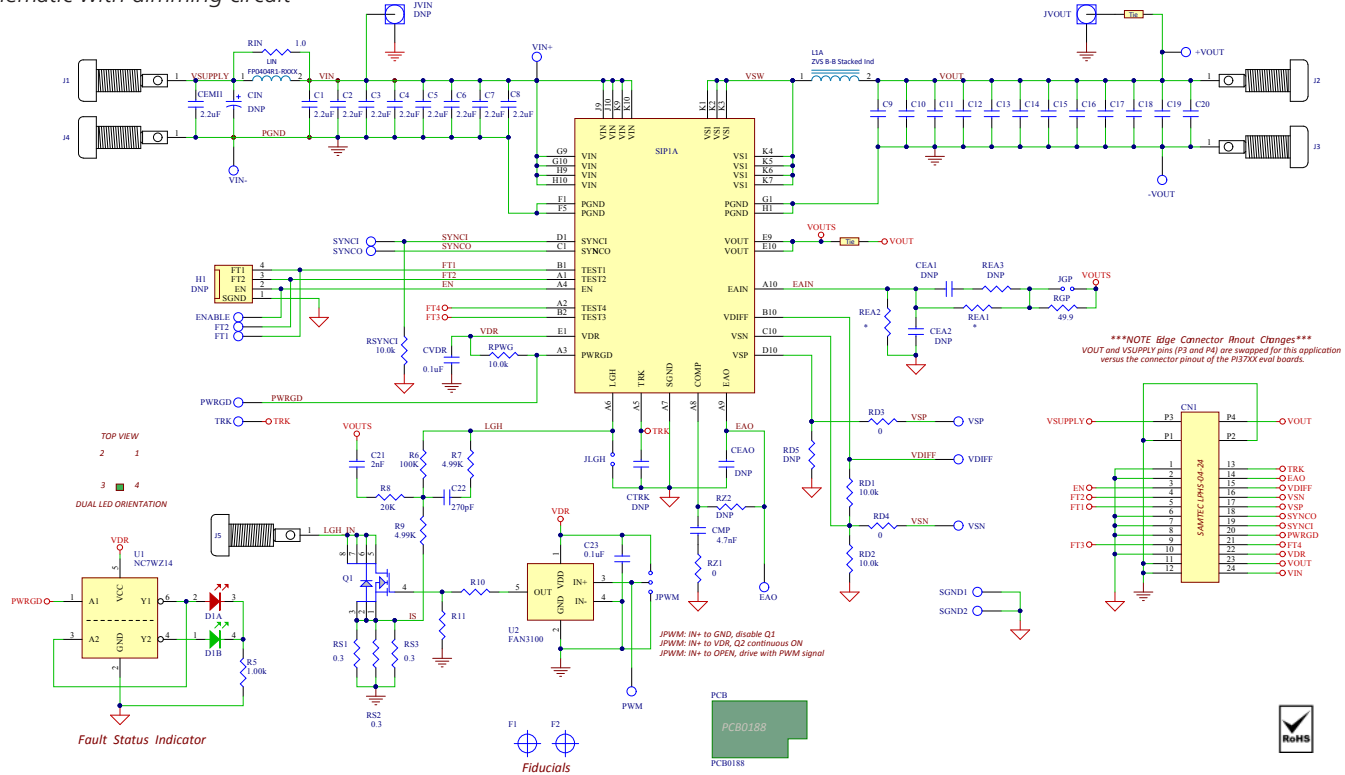
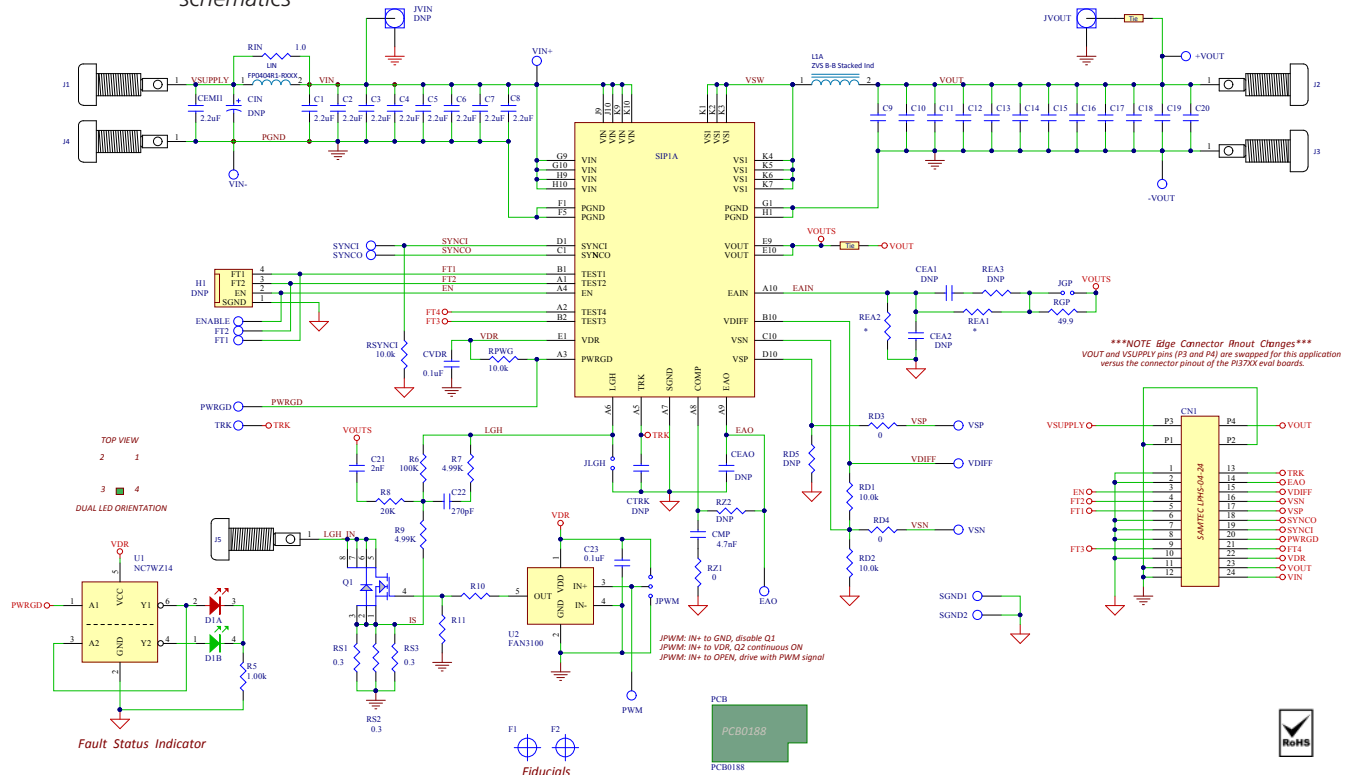


Figure 5
PI3542/45/46-00-EVAL1
schematics



Jumper Connection

To ensure proper device operation, the evaluation board jumpers must be fastened as shown in Table 9.

Table 9
Jumper connections

Op State	JGP	JLGH	JPWM	Device
Voltage Mode (CV)	short	short	short to GND	ALL
LGH (CC)	short	open	short to VDR	ALL
LGH (CC) with Dimming	short	open	open, connect Ext. Gen. to center pin and GND	PI3543-00-EVAL1 only
Frequency Response Measurement	Open, inject signal across pins	short	short to GND	ALL

Mechanical Drawings

Figure 6
PI3543/45/46-00-EVAL1
evaluation board dimensions

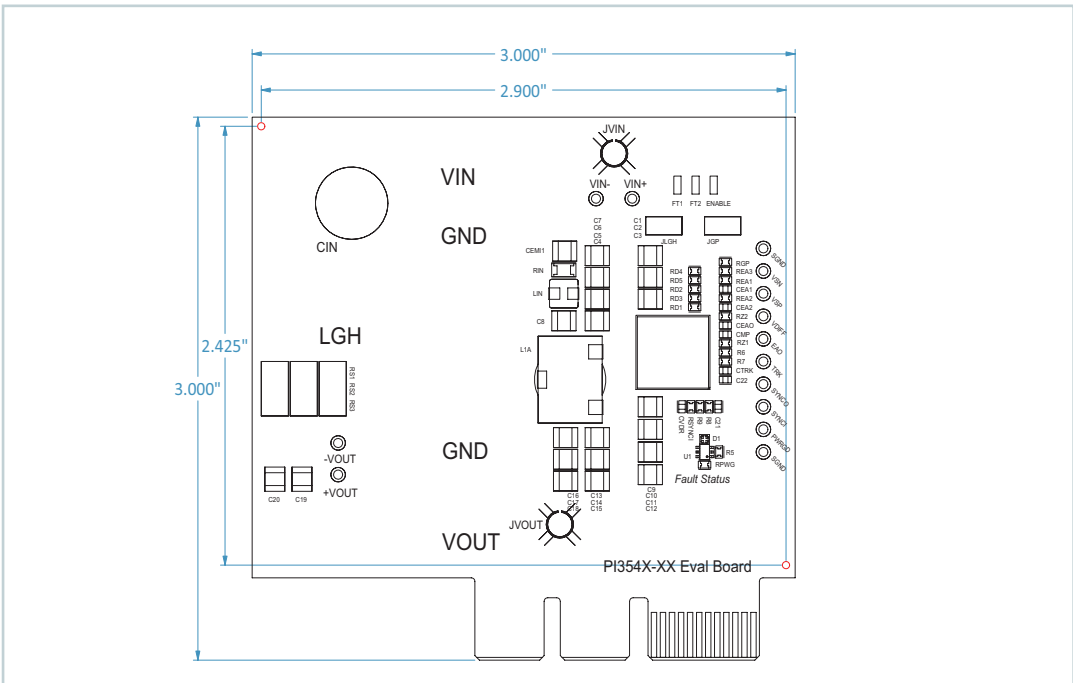
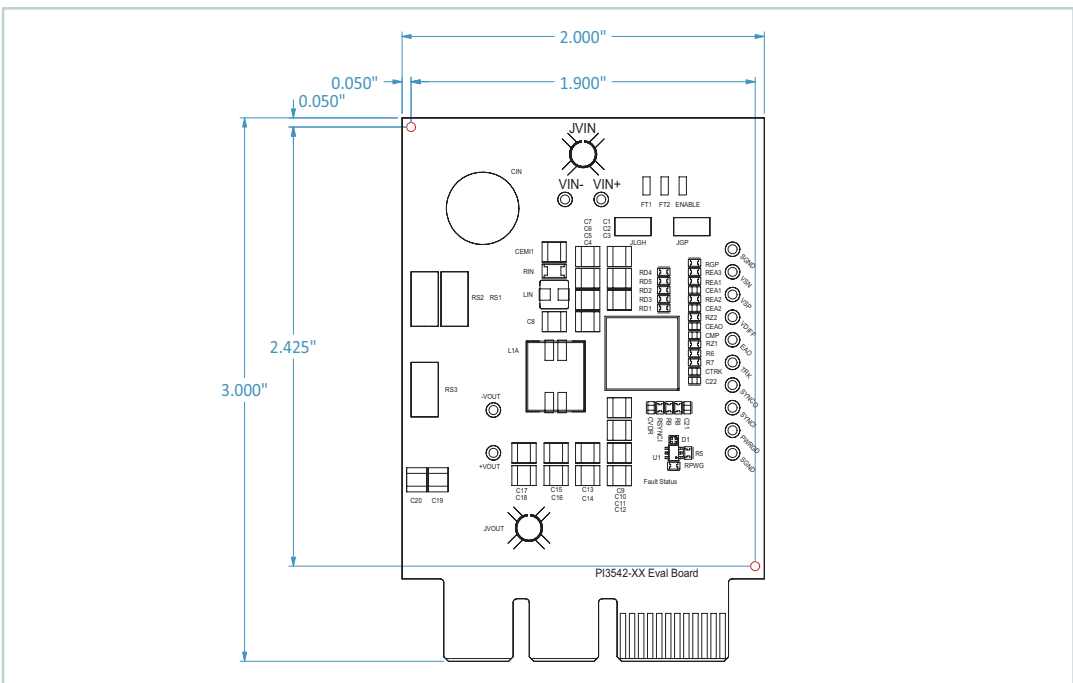


Figure 7
PI3542/43-00-EVAL1
evaluation board dimensions
PI3542-00-EVAL1 is shown,
PI3543-00-EVAL1 inductor
layout differs from that shown



Vicor PCB Edge Connector Description

SAMTEC reference mechanical drawings: based on EXTreme LPHPower™ Socket assembly series, available from Samtec's website PCB dimensions:

- Recommended PCB layout for LPHS-XX-XX-X-VXX-XX PCB Layout.pdf
- Right angle socket : LPHS-XX-XX-X-RTX-XX-MKT.pdf
- Vertical socket: LPHS-XX-XX-X-VXX-XX-MKT.pdf

Figure 8
Edge connector details

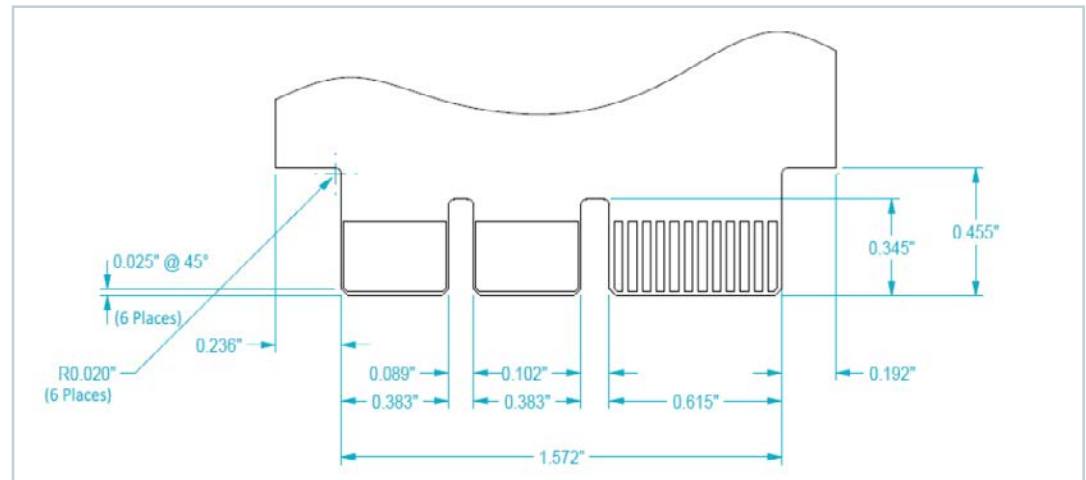


Figure 9
Top (component) view

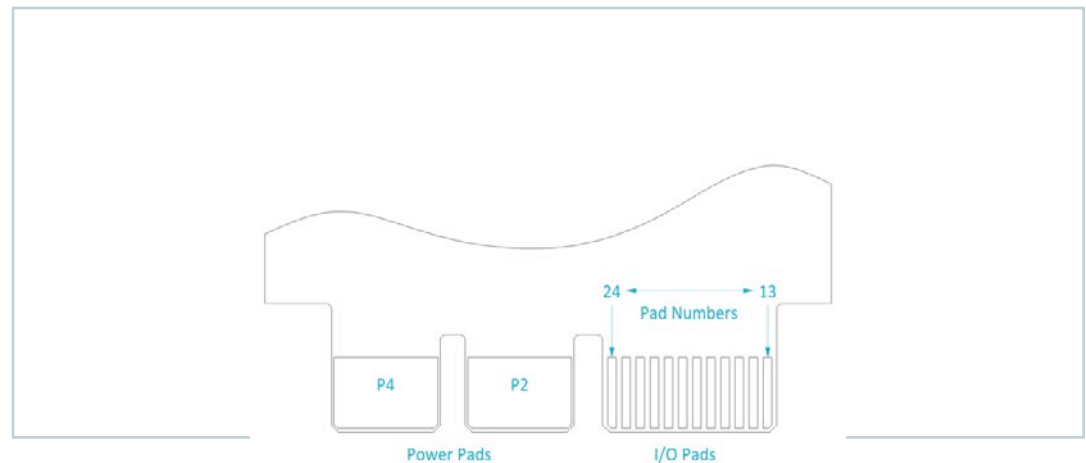
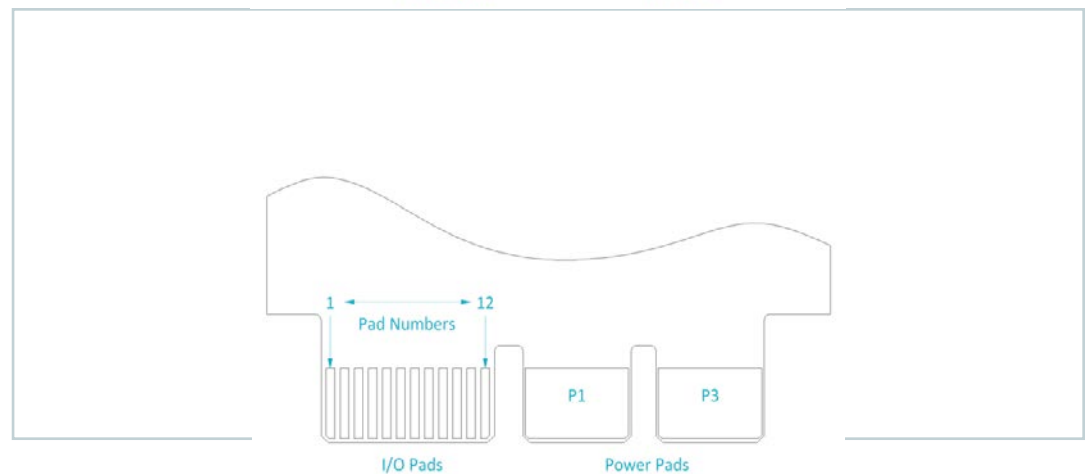


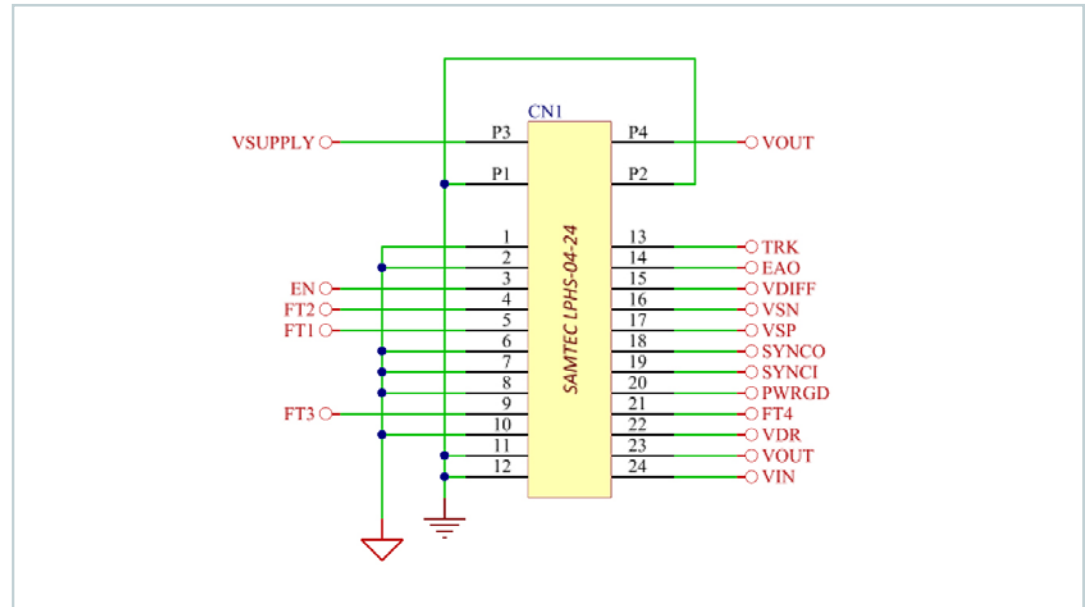
Figure 10
Bottom view



Vicor PCB Edge Connector Description (Cont.)

Schematic Symbol

Figure 11
Edge connector schematic



Pad Definitions

Table 10
PAD definitions

PAD	Name	Description
P1,P2	PGND	Power ground connection for the input supply and output load
P3	VSUPPLY	Output voltage connection
P4	VOUT	Input voltage connection
1, 2, 6, 7, 8, 10	SGND	Signal ground used as reference for I/O measurements
11, 12	PGND	Power ground used as reference for input and output voltage measurements
3	ENABLE	Enable input
4	FT1	Use only with factory guidance
5	FT2	Use only with factory guidance
9	FT3	Use only with factory guidance
13	TRK	Soft-start and track input
14	EAO	Error amplifier output
15	VDIFF	Differential amplifier output
16	VSN	Differential amplifier inverting input
17	VPN	Differential amplifier non-inverting input
18	SYNCO	Sync output pin
19	SYNCI	Sync input pin
20	PWRGD	Power Good
21	FT4	Use only with factory guidance
22	VDR	SiP's (internal or external) VDR voltage supply
23	VOUT	Output voltage measured at SiP's output
24	VIN	Input supply voltage measured at SiP's input

PCB Design Files

ODB++ evaluation board design files are available for download on the Vicor website.

Product	Design File Format	Link
PI3542-00-EVAL1	ODB++	http://www.vicorpower.com/files/live/sites/vicor/files/documents/pcb_files/PI31XX-XX Eval ODB++.zip
PI3543-00-EVAL1	ODB++	http://www.vicorpower.com/files/live/sites/vicor/files/documents/pcb_files/PI354X-XX Eval ODB++.zip
PI3545-00-EVAL1	ODB++	http://www.vicorpower.com/files/live/sites/vicor/files/documents/pcb_files/PI354X-XX Eval ODB++.zip
PI3546-00-EVAL1	ODB++	http://www.vicorpower.com/files/live/sites/vicor/files/documents/pcb_files/PI354X-XX Eval ODB++.zip

Important Errata

Evaluation board (PCB0191 rA) shown on the left in Figure 1 on page 1, has an incorrect industry standard footprint for the un-populated input electrolytic capacitor; CIN. Normally, this capacitor is not required unless the input leads are excessively long and as such, it is always un-populated by the factory. The industry standard footprint for this component should have a square pad indicating the (+) or positive terminal. The affected boards (PCB0191 rA) have the square pad wired to the (–) negative input. Users that wish to populate this component on an affected board will need to beware of this footprint error to avoid installing the component with the wrong polarity. All affected boards will be received with a sticker notice mounted on top of the CIN footprint with instructions to read this errata notice. Other than this one issue the form, fit and function of the affected evaluation boards are not impacted. Newer versions of the evaluation boards (PCB0191 rB) have been corrected and do not have this issue.

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