EVM User's Guide: LM654B0EVM-1PH

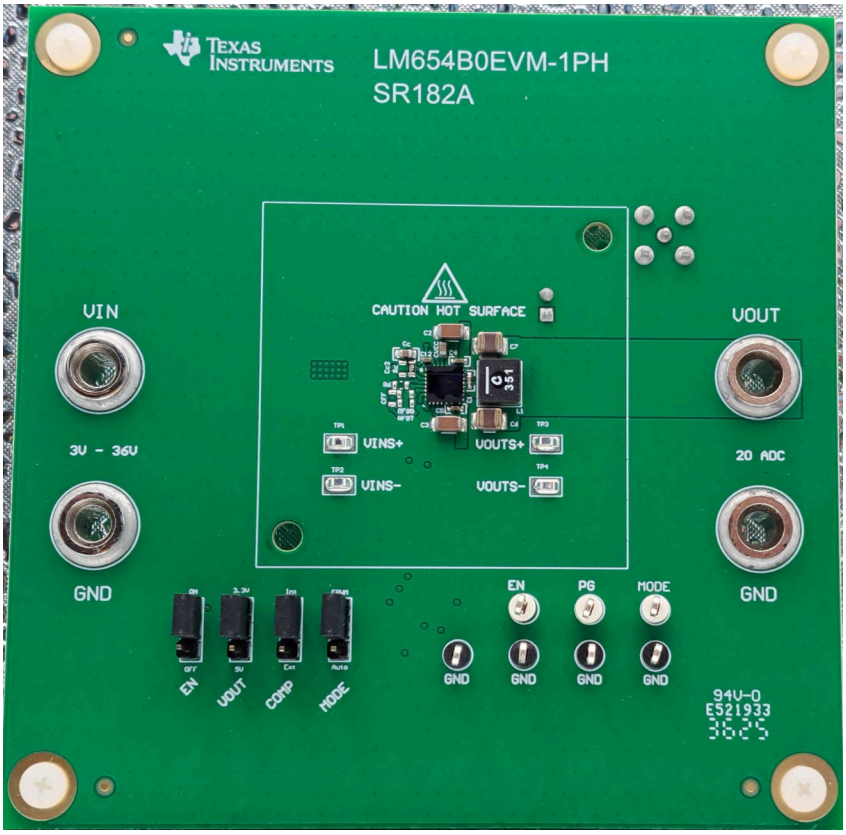
LM654B0 Evaluation Module

Description

The Texas Instruments LM654B0EVM-1PH evaluation module (EVM) helps designers evaluate the operation and performance of the LM654xx family of wide input voltage buck converters.

Features

- 3V to 36V wide-input voltage range
- 5V, 3.3V, and ADJ voltage
- Up to 25A peak output current
- 300kHz to 2.2MHz switching frequency
- Minimized switch node ringing to reduce electromagnetic interference (EMI)



LM654B0EVM-1PH Board Image

1 Evaluation Module Overview

1.1 Introduction

The LM654B0EVM-1PH is configured to deliver a 5V output to a load requiring 15A or less. The LM654B0EVM-1PH can be used in many different configurations by substituting other versions of the LM654xx and re-configuring the board components and jumpers. See also *Device Information*.

1.2 Kit Contents

This kit includes one LM654B0EVM-1PH and one heat-sink.

1.3 Specification

Performance characteristics for the LM654B0EVM-1PH, with LM654B0, are found in Table 1-1.

Unless otherwise stated: V_{IN} = 12V, V_{OUT} = 5V, T_A = 25ºC, no heatsink.

Table 1-1. LM654B0EVM-1PH Electrical Performance Characteristics

Parameter	Test Conditions		Min	Typ	Max	Units
INPUT CHARACTERISTICS						
Input voltage range, V_{VIN}	EVM input voltage operating range		6	12	36	V
Input current, no load, $I_{IN(NL)}$	I_{OUT} = 0A	AUTO mode		23		µA
Input current, disabled, $I_{IN(OFF)}$	$V_{EN/UVLO}$ = 0V, no EN divider	V_{IN} = 12V		1.2		µA
OUTPUT CHARACTERISTICS						
Output voltage, V_O	I_{OUT} = 0A, AUTO mode			5.022		V
	I_{OUT} = 15A			5.002		V
Output voltage regulation, ΔV_{OUT}	Load regulation, AUTO mode	I_{OUT} = 0A to 15A		20		mV
Output voltage regulation, ΔV_{OUT}	Load regulation, FPWM mode	I_{OUT} = 0A to 15A		10		
Output voltage regulation, ΔV_{OUT}	Line regulation, V_{IN} = 9V to 36V	I_{OUT} = 15A		3.8		
Maximum output current	V_{IN} = 12V			20		A
SYSTEM CHARACTERISTICS						
Switching frequency	I_{OUT} = 1A			2100		kHz
Peak efficiency	I_{OUT} = 8A	V_{IN} = 12V		94.5%		
Full load efficiency	I_{OUT} = 15A	V_{IN} = 12V		93.1%		

1.4 Device Information

The default EVM incorporates the LM654B0. Table 1-2 provides a list of additional devices that can be used with theLM654B0VM. Appropriate passive component changes must be made to use another device in the EVM.

Table 1-2. LM654B0EVM-1PH Device Options

Device GPN	Peak Output Current
LM654A0	10A
LM654A2	12A
LM654A5	15A
LM654B0	20A

2 Hardware

2.1 Additional Images

Figure 2-1 and Figure 2-2 show the front and back of the LM654B0EVM-1PH respectively.

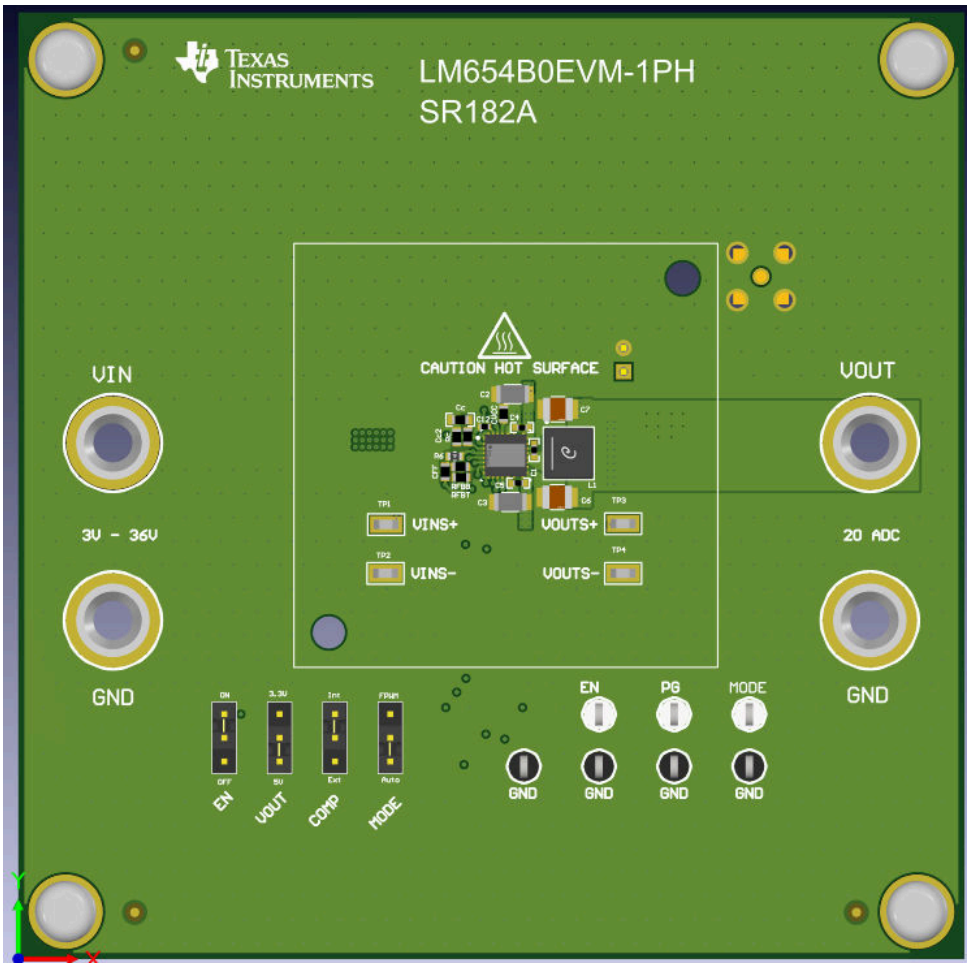


Figure 2-1. LM654B0EVM-1PH Top Side

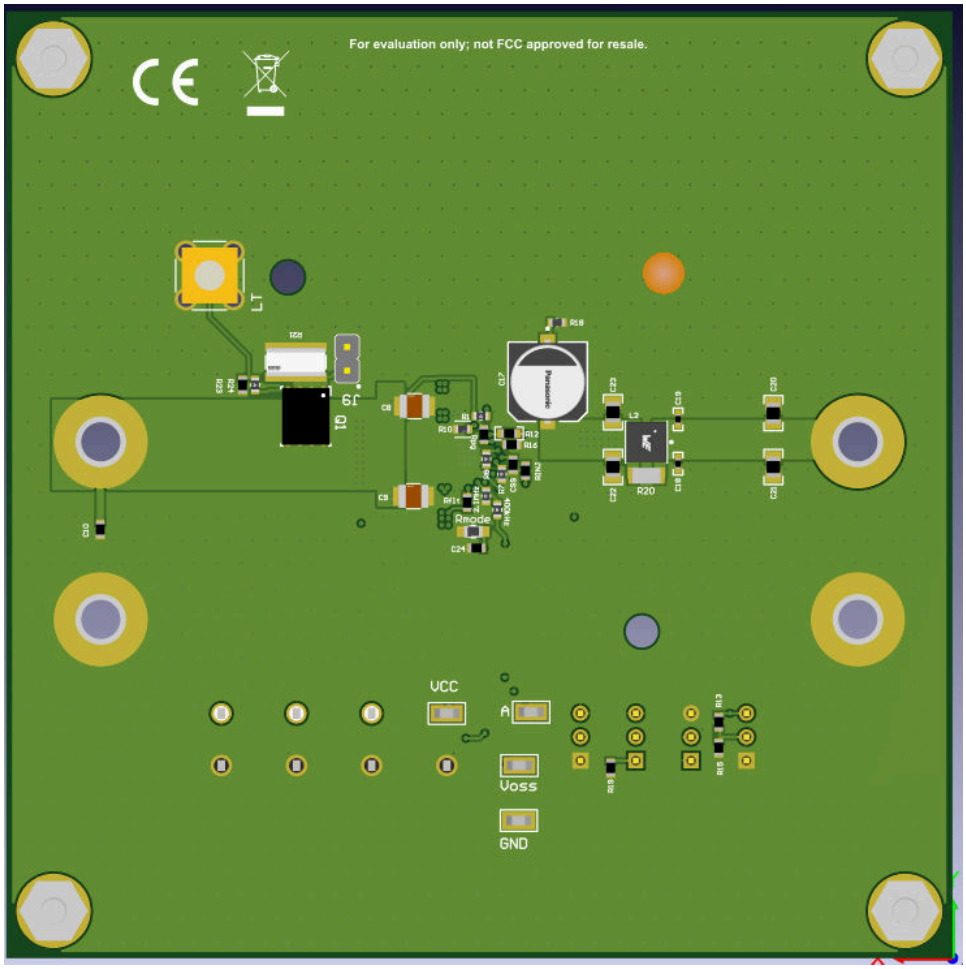


Figure 2-2. LM654B0EVM-1PH Bottom Side

2.2 Power Requirements

Any power source in the range of 6V to 36V, and capable of delivering 15A, can be used to evaluate the LM654B0EVM-1PH.

2.3 Setup

This section describes the connectors, test points, and jumpers on the EVM and how to properly connect, set up, and use the LM654B0EVM-1PH See Figure 2-3 for location of connectors and jumpers and typical setup.

The EVM is setup up to operate with a single phase at 2.1MHz and provide an output voltage of either 5V or 3.3V. A heat-sink is provided in the kit to help reduce the device temperature when operating with large load currents. Note that a thermal pad is required between the regulator and the heat-sink and is not provided in the kit. See the BOM for more details.

A load transient generator is provided on the EVM. Connect a suitable pulse generator to the "LT" SMB connector and adjust the load current pulse amplitude and duration as desired. The pulse duty cycle must be kept low to avoid damaging the MOSFET. The current pulse is monitored across the "Isense" jumper (J9), while the output voltage must be monitored directly across the output capacitors. TI recommends use of a high speed differential probe. See also Figure 2-5.

The typical current rating of ordinary banana type cables is about 5A. If larger load currents are tested with this EVM, several cables must be stacked together. The jacks on the EVM are rated for 15A.

VOUT	Output voltage of the converter. VOUT banana post. Apply load to this connector.

VIN	Input voltage to the converter. VIN banana post. Apply input voltage to this connector.
GND	Ground of the converter GND banana posts. Apply load ground and input voltage ground to these connectors. The various GND test point are used as ground sense for input voltage and output voltage measurements.
VOUTS+	The VOUTS+ test point is used as the positive DMM connection for VOUT sensing.
VOUTS-	The VOUTS- test point is used as the negative DMM connection for VOUT sensing.
VINS+	The VINS+ test point is used as the positive DMM connection for VOUT sensing.
VINS-	The VINS- test point is used as the negative DMM connection for VOUT sensing.
EN	The use of the EN jumper is self-explanatory. To supply an external signal to the EN input of the device, remove the EN jumper shunt and apply the signal to the EN test point. To use the external UVLO feature, populate Rent (R13) and Renb (R15) as desired and remove the EN jumper shunt. Note that for accurate shutdown current measurement, these resistors must be removed (if used) and the EN jumper shunt moved to "OFF".
VOUT	This jumper selects the default output voltage to either 5V or 3.3V. See Feed-back Connections for more information.
COMP	This jumper selects the use of either internal or external frequency compensation for the regulator loop. With the jumper in the "Int" position, the internal loop compensation is active; this is the default case. With the jumper in the "Ext" position, the user must supply compensation components Rc, Cc, and Cc2 to provide loop compensation. See the LM654B0 data sheet for more details.
MODE	MODE jumper is used to select the operating mode of the device. With MODE in the AUTO position, the device operates in automatic PFM/FPWM mode depending on load current. With the MODE in the FPWM position, the device operates at fixed frequency at all load currents. The MODE pin is also the frequency synchronization input. To synchronize the device to an external clock, remove the MODE jumper shunt and apply the clock to the MODE test point.
Feed-back Connections	The default EVM is set for either a 5V or 3.3V output using the "VOUT" jumper, with R8 populated at 0Ω and R6 open. To use the adjustable output voltage option, populate R6 with a 0Ω, open R8, and populate RFBT (R4) and RFBB (R9) with the appropriate value resistors. The reference voltage is 0.8V. See the LM654B0 data sheet for appropriate values of feed-back resistors. When using the adjustable output voltage mode, a Bode plot can be taken using the Rinj (R2) resistor. This resistor becomes the injection point for the frequency response analyzer, allowing the loop frequency response to be taken in the usual way. In the fixed output voltage mode, a Bode plot cannot be taken.
RT	The default EVM is set for 2.1MHz operation, with a 0Ω resistor placed in the "2.1MHz" position. To set the frequency to 400kHz, place a 0Ω in the "400kHz" position and remove the 0Ω in the "2.1MHz" position. To use the adjustable frequency option, populate the "2.1MHz" position with the appropriate resistor value. See the LM654B0 data sheet for frequency vs. RT values.
PGOOD	The PGOOD test point is used to monitor the power-good indicator. This flag indicates whether the output voltage has reached the regulation level. PGOOD is an open-drain output that is tied to VOUT through a 100kΩ, resistor, Rpg (R3).
VCC	VCC Test point The VCC pin is the output of the internal LDO. The VCC voltage is typically 3.3V. This point can be used for logic inputs and pullup. Do not connect to external loads.
BIAS	Auxiliary input to LDO

	Connected to VOUT through 0Ω Rbias (R1) on EVM. To change the input supply of the LDO, remove Rbias (R1) and connect external supply to BIAS pin, or ground BIAS pin as required. Populate Cbias (C12) when using an external bias supply. See the LM654B0 data sheet for more information.
PHASE	Rph (R7) is populated with a 0Ω resistor for single phase operation. See LM654B0 data sheet for more information.
DRSS	Rdrss (R10) is populated with a 150kΩ. See LM654B0 data sheet for more information.
Css	Css (C14) is open. See LM654B0 data sheet for more information.
Bode Plot	When using the adjustable output voltage mode, a Bode plot can be taken using the connection shown in Figure 2-4. Rinj (R2) must be populated.
EMI Filter	The EMI filter is populated on the EVM, but shorted out with R20. To test with the EMI filter, remove R20.

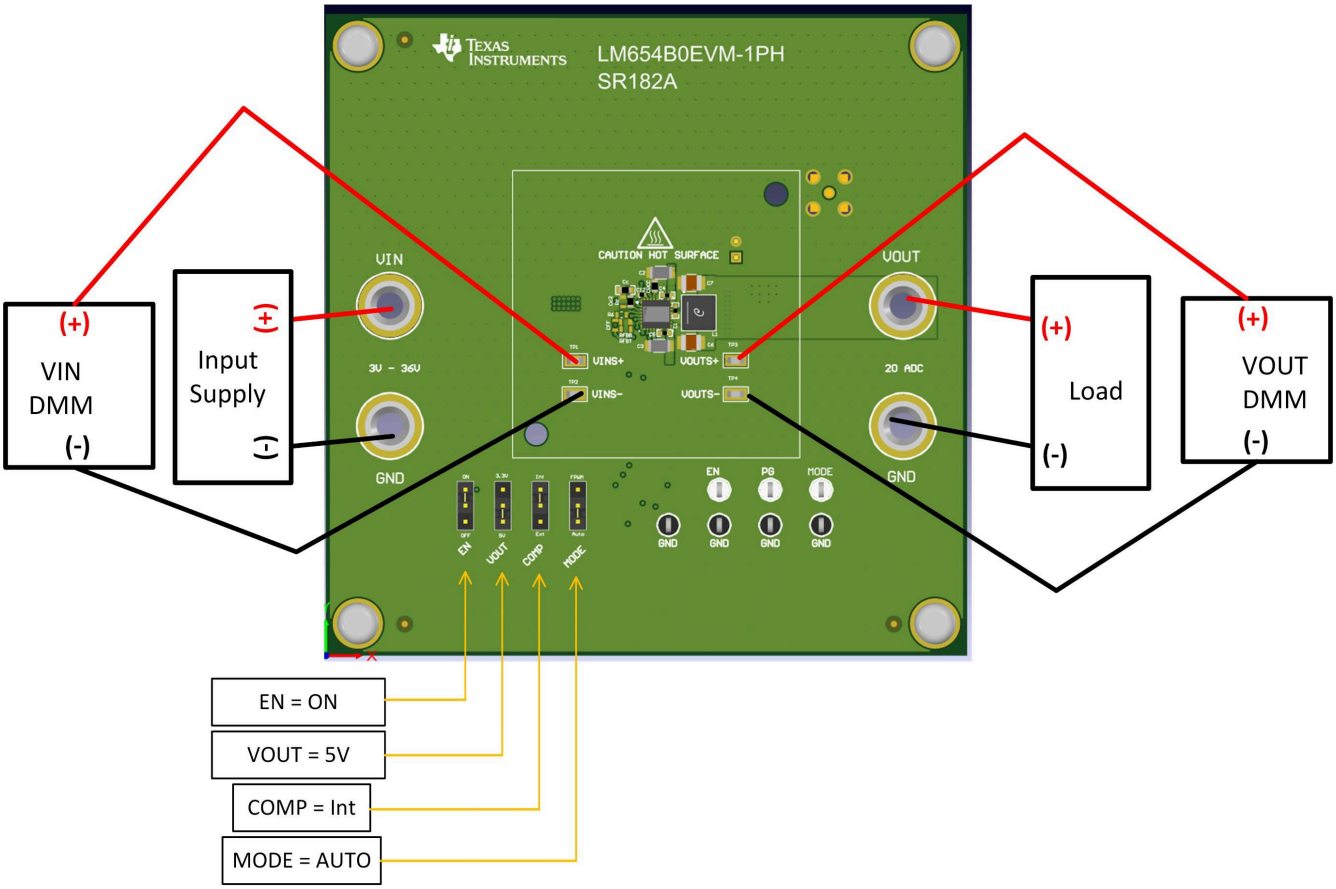


Figure 2-3. LM654B0 Set-up and Test Connections

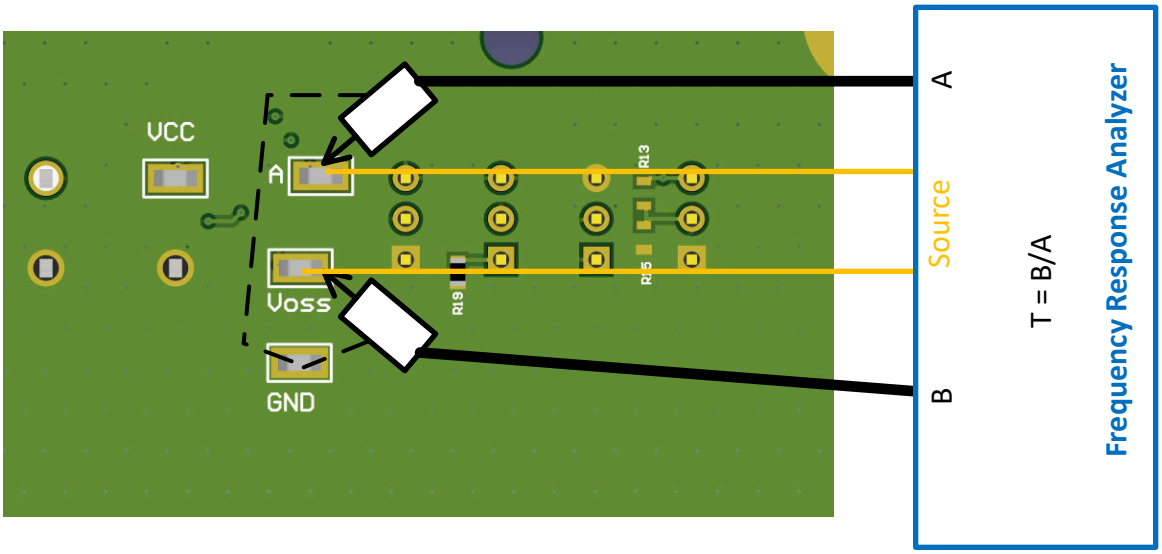


Figure 2-4. LM654B0 Loop Response Connections

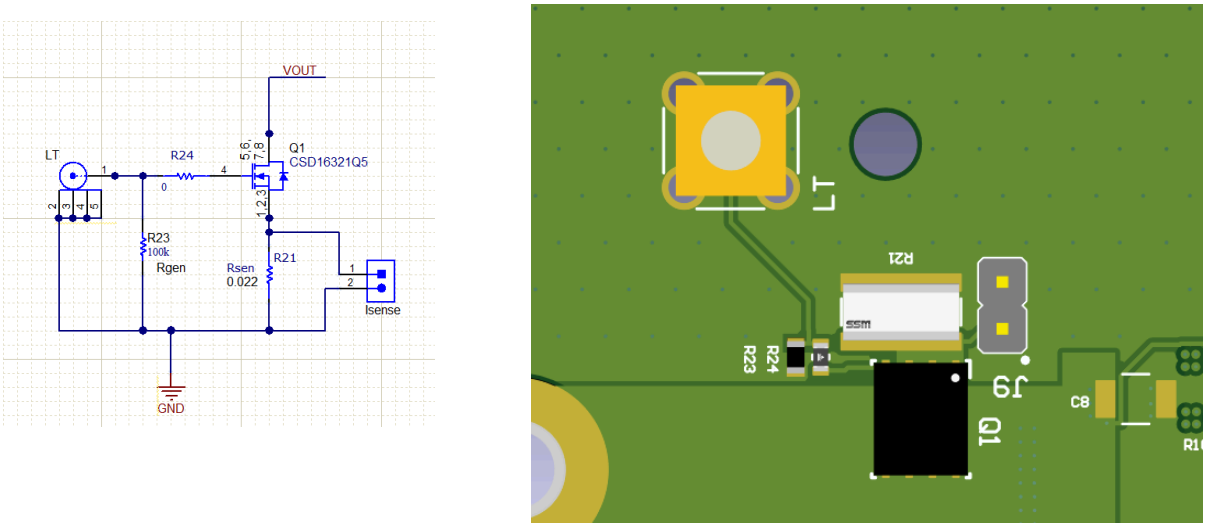
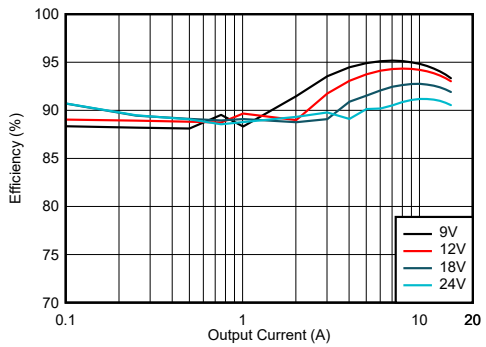


Figure 2-5. Load Transient Generator

3 Implementation Results

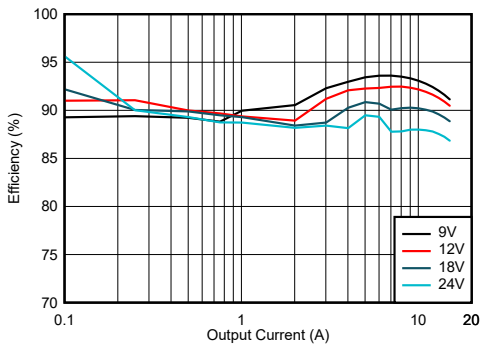
3.1 Performance Data and Results

Unless otherwise specified the following condition apply: T_A = 25ºC, V_{IN} = 12V, F_{SW} = 2100kHz. No heat-sink.



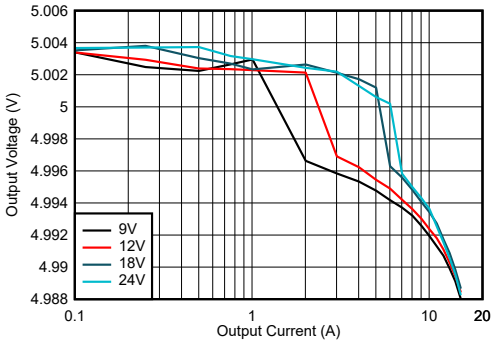
V_{OUT} = 5V 2100kHz, Auto Mode

Figure 3-1. Efficiency



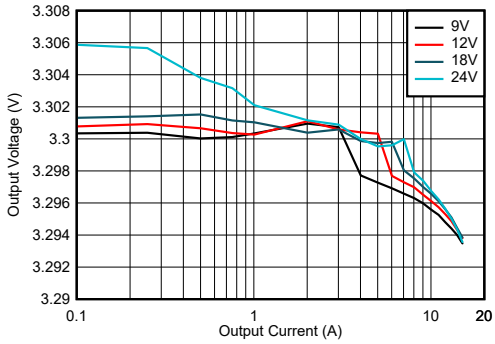
V_{OUT} = 3.3V 2100kHz, Auto Mode

Figure 3-2. Efficiency



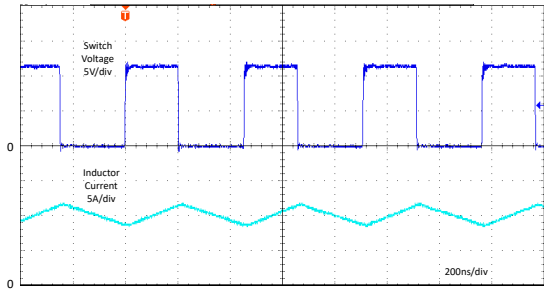
V_{OUT} = 5V 2200kHz, Auto Mode

Figure 3-3. Line and Load Regulation



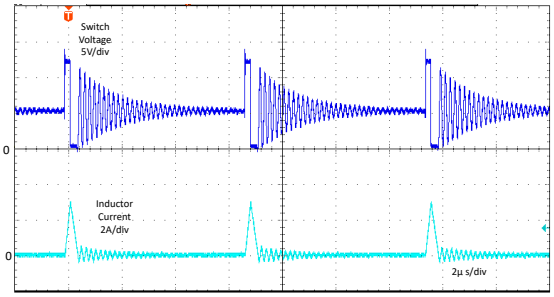
V_{OUT} = 3.3V 2200kHz, Auto Mode

Figure 3-4. Line and Load Regulation



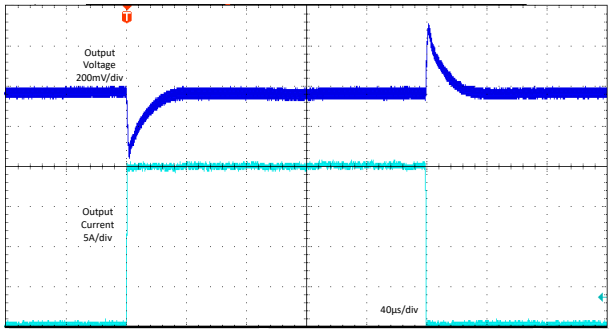
I_{OUT} = 10A V_{IN} = 12V V_{OUT} = 5V

Figure 3-5. Typical Switching Waveform in PWM



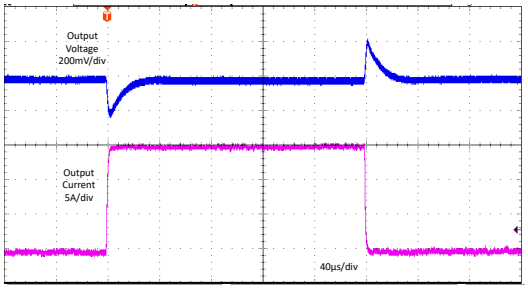
I_{OUT} = 100mA V_{IN} = 12V V_{OUT} = 5V

Figure 3-6. Typical Switching Waveform in PFM



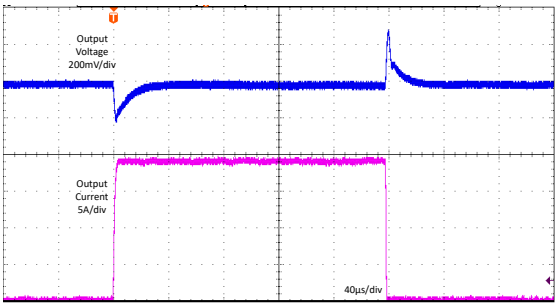
I_{OUT} = 0A to 20A V_{IN} = 12V FPWM Mode

Figure 3-7. Load Transient



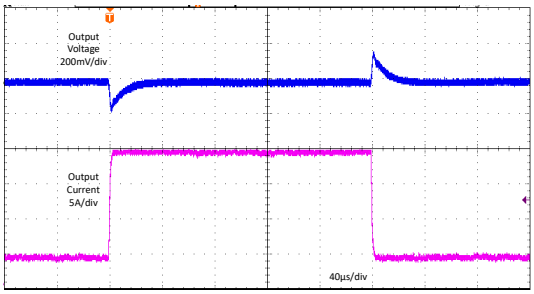
I_{OUT} =5A to 20A V_{IN} = 12V FPWM Mode
V_{OUT} = 5V

Figure 3-8. Load Transient



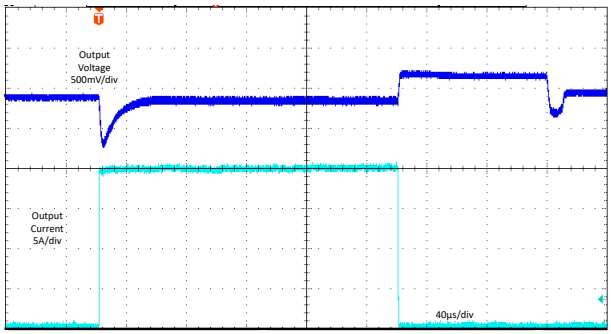
I_{OUT} = 0A to 20A V_{IN} = 12V FPWM Mode
V_{OUT} = 3.3V

Figure 3-9. Load Transient



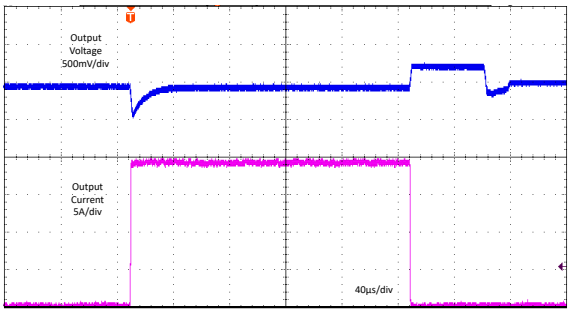
I_{OUT} = 5A to 20A V_{IN} = 12V FPWM Mode
V_{OUT} = 3.3V

Figure 3-10. Load Transient



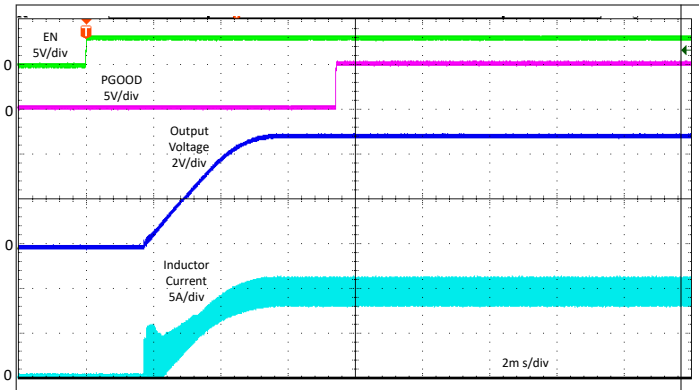
I_{OUT} = 0A to 20A V_{IN} = 12V AUTO Mode
V_{OUT} = 5V

Figure 3-11. Load Transient



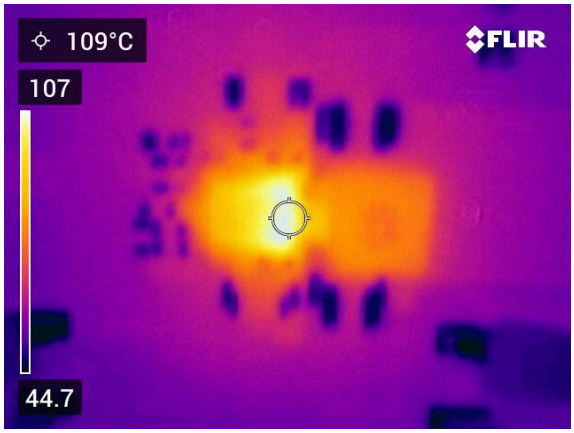
I_{OUT} = 0A to 20A V_{IN} = 12V AUTO Mode
V_{OUT} = 3.3V

Figure 3-12. Load Transient



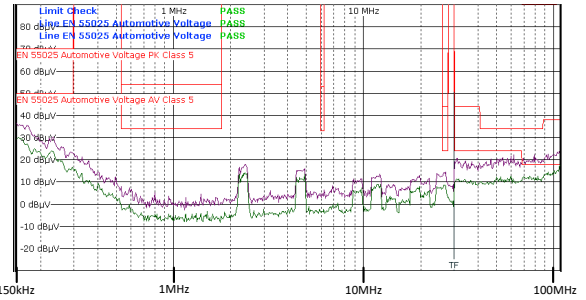
I_{OUT} = 10A V_{IN} = 12V FPWM Mode V_{OUT} = 5V

Figure 3-13. Start Up



V_{OUT} = 5V V_{IN} = 12V I_{OUT} = 15A

Figure 3-14. Thermal Image



V_{OUT} = 3.3V V_{IN} = 12V I_{OUT} = 13A

Figure 3-15. Conducted EMI

4 Hardware Design Files

4.1 Schematics

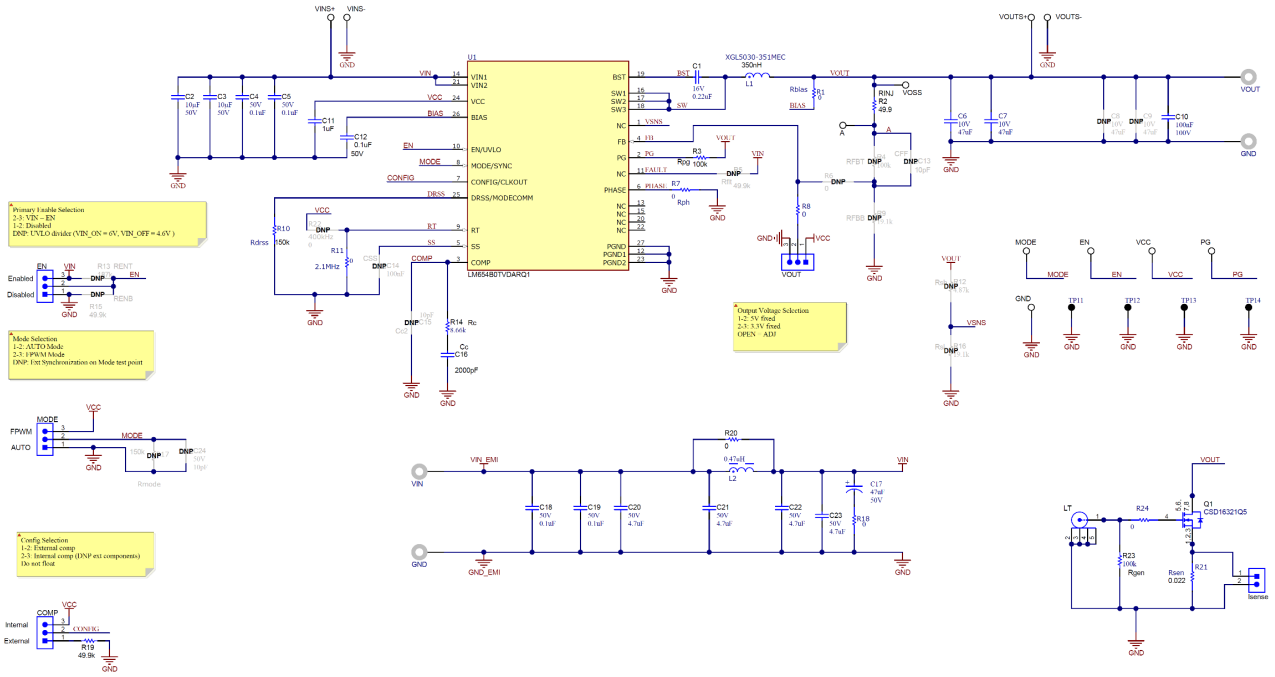


Figure 4-1. LM654B0EVM-1PH Schematic

4.2 PCB Layouts

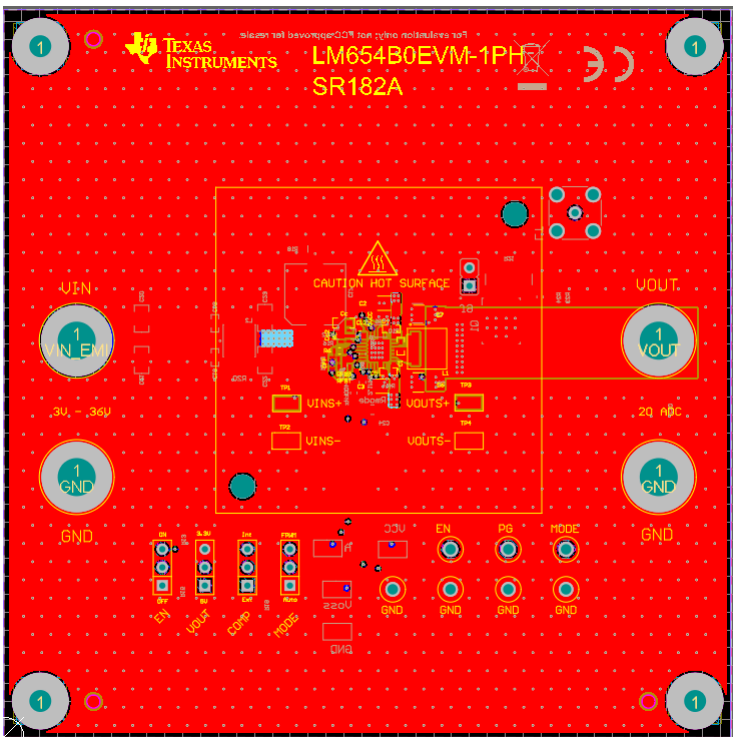


Figure 4-2. PCB Top Silk

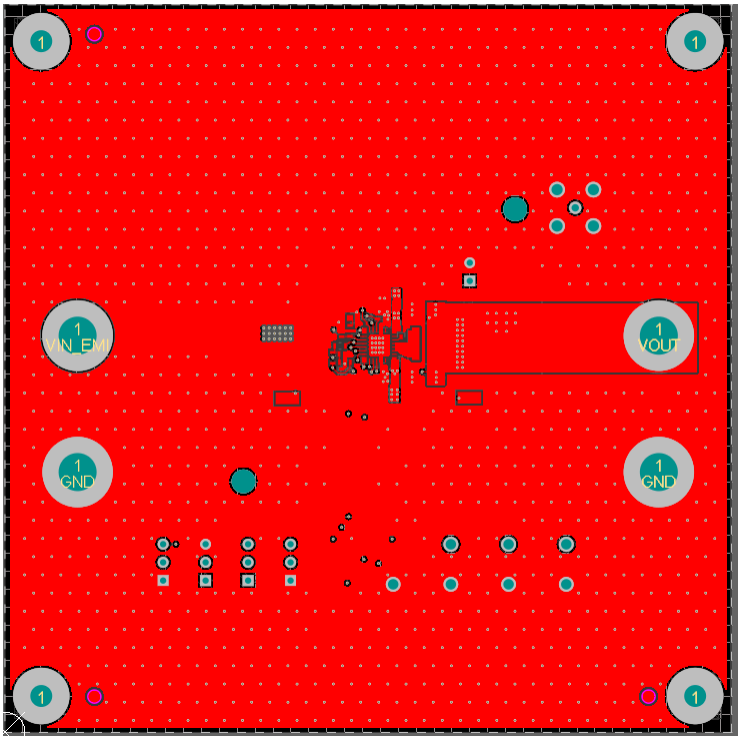


Figure 4-3. PCB Top

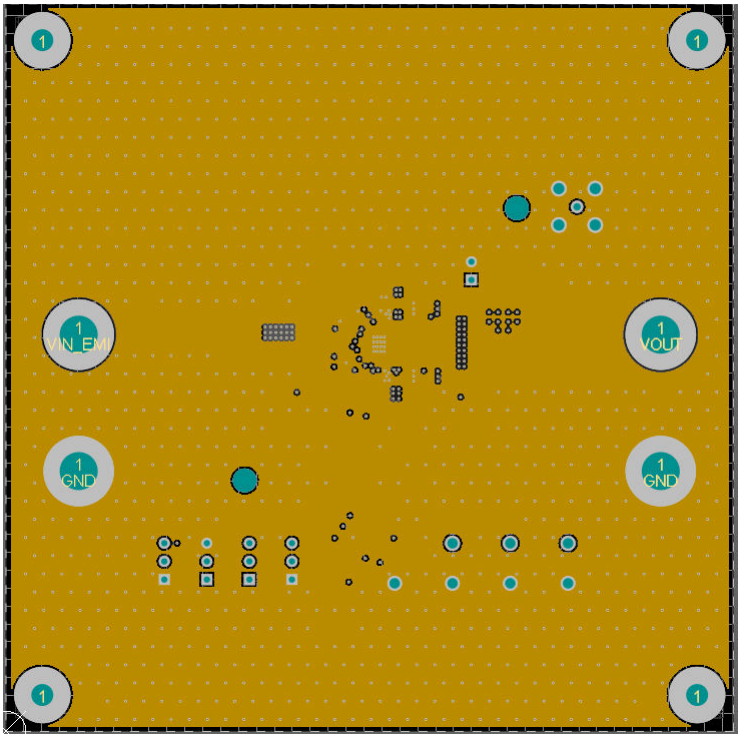


Figure 4-4. PCB First Ground Layer

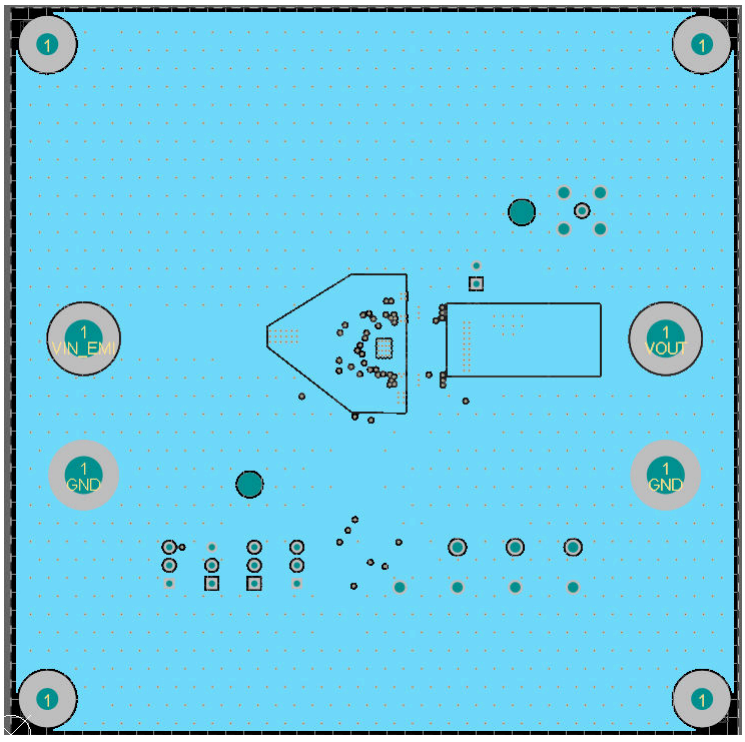


Figure 4-5. PCB First Signal Layer

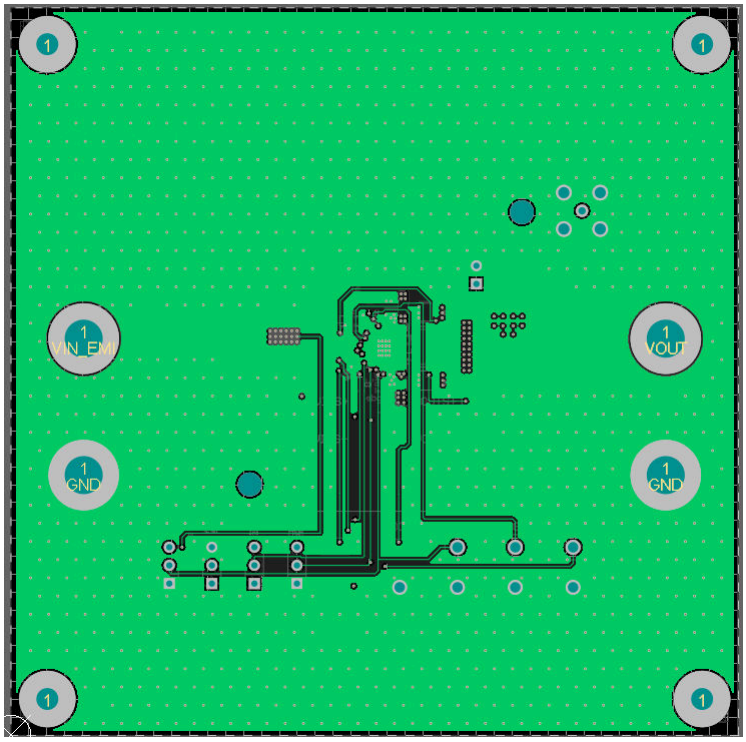


Figure 4-6. PCB Second Signal Layer

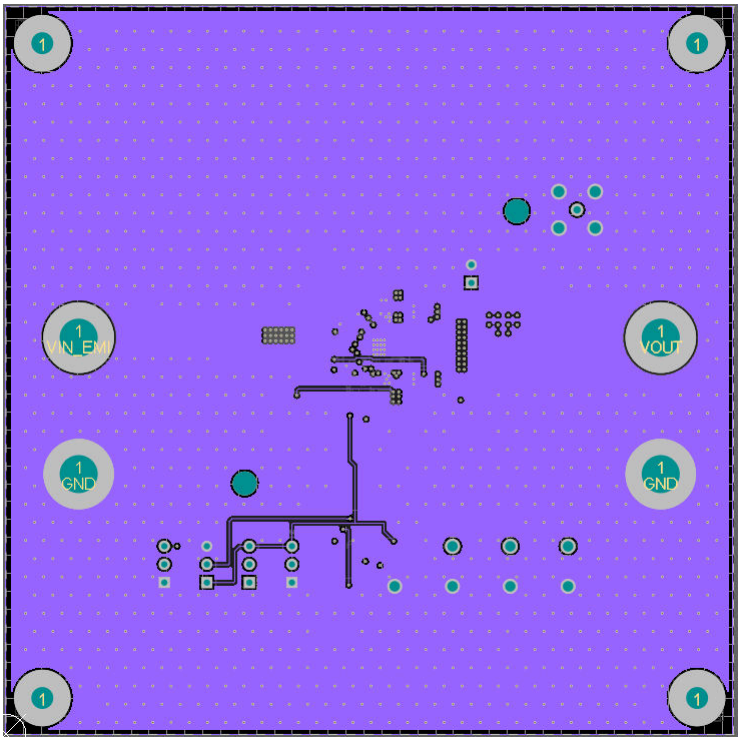


Figure 4-7. PCB Third Signal Layer

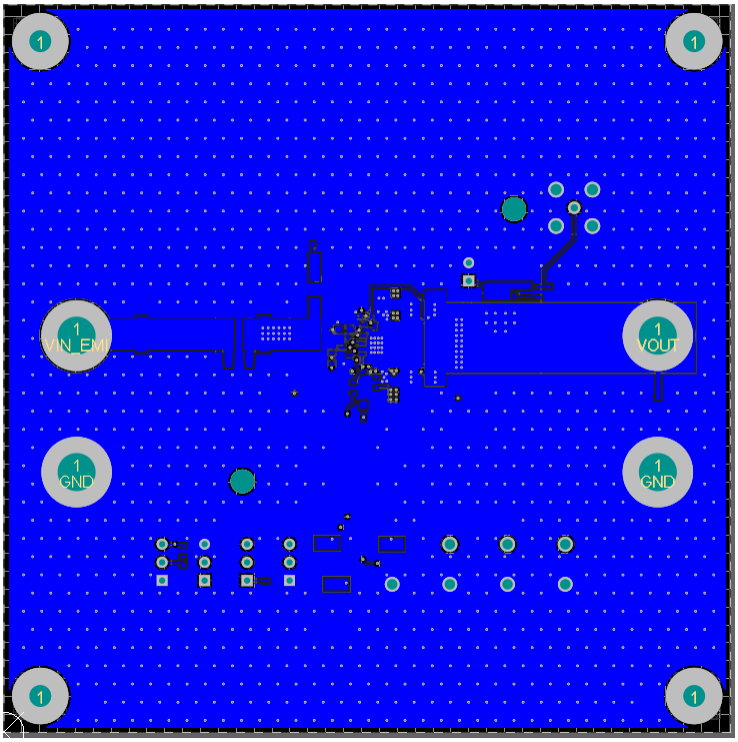


Figure 4-8. PCB Bottom Layer

4.3 Bill of Materials (BOM)

Table 4-1. LM654B0EVM-1PH BOM (With Options)

Designator	Alias	QTY	Value	Description	Part Number
C1		1	0.22uF	CAP, CERM, 0.22uF, 16V, +/- 10%, X7R, 0402	GRM155R71C224KA12D
C2, C3		2	10uF	CAP, CERM, 10µF, 50V,+/- 10%, X7R, AEC-Q200 Grade 1, 1206	CGA5L1X7R1H106K160AC
C4, C5, C12, C18, C19		5	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	CGA2B3X7R1H104K050BB
C6, C7		2	47µF	Ceramic Capacitor for Automotive 47uF ±10% 10VDC X7S 1210 Embossed T/R	GCM32EC71A476KE02K
C10		1	0.1uF	CAP, CERM, 0.1uF, 100V,+/- 10%, X7R, AEC-Q200 Grade 1, 0603	GCJ188R72A104KA01D
C11	CVCC	1	1uF	CAP, CERM, 1uF, 16V, +/- 20%, X7R, AEC-Q200 Grade 1, 0603	GCM188R71C105MA64D
C16	Cc	1	2000pF	CAP, CERM, 2000pF, 50V, +/- 5%, C0G/NP0, 0603	GRM1885C1H202JA01D
C17		1		CAP ALUM 47UF 20% 50V SMD	EEEFK1H470P
C20, C21, C22, C23		4	4.7uF	CAP, CERM, 4.7uF, 50V, +/- 20%, X5R, AEC-Q200 Grade 3, 0805	CGA4J3X5R1H475M125AB
J1, J2, J3, J4		4		Standard Banana Jack, Uninsulated, 8.9mm	575-8
J5, J6, J7, J8		4		Header, 100mil, 3x1, Gold, TH	PCC03SAAN
J9		1		Header, 100mil, 2x1, Gold, TH	PBC02SAAN
J10		1		Connector, SMB,Vertical RCP 0-4GHz, 50ohm, TH	131-3701-261
L1		1	0.35uH	350nH Shielded Molded Inductor 22.8A 2.2mOhm Max Nonstandard	XGL5030-351MEC
L2		1	0.47uH	470nH Shielded Molded Inductor 17.1A 4.5mOhm Max Nonstandard	744393240047
Q1		1	25V	MOSFET, N-CH, 25V, 100A, DQH0008A (VSON-CLIP-8)	CSD16321Q5
R1	Rbias	1	0	CRCW Series 0603 0.1W 0Ohm Jumper Surface Mount Thick Film Chip Resistor	CRCW06030000Z0EAC
R7, R8, R24		3	0	CRCW Series 0603 0.1W 0Ohm Jumper Surface Mount Thick Film Chip Resistor	CRCW06030000Z0EAC
R2	Rinj	1	49.9	RES, 49.9, 1%, 0.1W, AEC-Q200 Grade 0, 0603	CRCW060349R9FKEA
R3	Rpg	1	100k	RES, 100 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	CRCW0603100KFKEA
R23		1	100k	RES, 100k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	CRCW0603100KFKEA
R10		1	150k	150kΩ ±1% 0.1W 0603 Thick Film Chip Resistor AEC-Q200 compliant	RMCF0603FT150K
R11	2.1MHz	1	0	CRCW Series 0603 0.1W 0Ohm Jumper Surface Mount Thick Film Chip Resistor	CRCW06030000Z0EAC
R14	Rc	1	8.66k	RES, 8.66k, 1%, 0.1W, 0603	RC0603FR-078K66L
R18		1	0	0Ohms ±1% Chip Resistor 0603 (1608 Metric) Thick Film	CR160000F
R19		1	49.9k	RES, 49.9k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	CRCW060349K9FKEA
R20		1	0	RES, 0, 1%, 0.5W, 1206	5108
R21		1	0.022	22mOhms ±1% 3W Chip Resistor Wide 2512 (6432 Metric), 1225 Automotive AEC-Q200, Current Sense Metal Foil	KRL6432E-M-R022-F-T1
SH-J1, SH-J2, SH-J3, SH-J4		4		Single Operation 2.54mm Pitch Open Top Jumper Socket	M7582-05

Table 4-1. LM654B0EVM-1PH BOM (With Options) (continued)

Designator	Alias	QTY	Value	Description	Part Number
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP16		8		Test Point, Miniature, SMT	5015
TP8, TP9, TP15		3		Test Point, Multipurpose, White, TH	5012
TP11, TP12, TP13, TP14		4		Test Point, Multipurpose, Black, TH	5011
U1		1		LM654B0 20A Stackable Buck Converter	LM654B0TVDARQ1
C8, C9		0	47µF	Ceramic Capacitor for Automotive 47uF ±10% 10VDC X7S 1210 Embossed T/R	GCM32EC71A476KE02K
C13		0	10pF	CAP, CERM, 10pF, 50V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	CGA3E2C0G1H100D080AA
C14		0	0.1uF	CAP, CERM, 0.1uF, 50V, +/- 10%, X7R, 0603	GCM188R71H104KA57D
C15, C24		0	10pF	CAP, CERM, 10pF, 50V, +/- 5%, C0G/NP0, 0603	GRM1885C1H100JA01D
MP1		0		Heat Sink BGA Aluminum Alloy 9.7W at 75°C Top Mount	HSB43-454515P
R4		0	100k	RES, 100 k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	CRCW0603100KFKEA
R5, R15		0	49.9k	RES, 49.9k, 1%, 0.1W, AEC-Q200 Grade 0, 0603	CRCW060349K9FKEA
R6, R22		0	0	CRCW Series 0603 0.1W 0Ohm Jumper Surface Mount Thick Film Chip Resistor	CRCW06030000Z0EAC
R9, R16		0	19.1k	RES, 19.1k, 1%, 0.1W, 0603	RC0603FR-0719K1L
R12		0	4.87k	RES, 4.87k, 1%, 0.1W, 0603	RC0603FR-074K87L
R13		0	187k	RES, 187k, 1%, 0.1W, 0603	RC0603FR-07187KL
R17		0	150k	Res Thin Film 0805 150KOhm 0.1% 1/8W ±25ppm/°C Molded SMD SMD Punched Carrier T/R	ERA-6AEB154V

5 Additional Information

5.1 Trademarks

All trademarks are the property of their respective owners.

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (October 2025) to Revision A (July 2026)	Page
• First public release of the EVM user's guide	1
• Updated board description verbiage	1
• Updated the hardware figure title	1
• Updated reconfiguring board verbiage in *Introduction*	2
• Updated verbiage to reflect LM654B0EVM-1PH GPN throughout the document	4
• Updated VCC connection verbiage in *Setup*	4
• Added data test conditions to figures in *Performance Data and Results*	8

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2 *Limited Warranty and Related Remedies/Disclaimers*:

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   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI’s recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI’s recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI’s instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGREDATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 *Regulatory Notices:*

3.1 *United States*

3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

3.2 *Canada*

3.2.1 *For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247*

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 *Japan*

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive)*:

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

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