EVM User's Guide: TRKRLDOEVM-119

TRKRLDOEVM-119 General-Purpose Tracker LDO Evaluation Module

Description

The TRKRLDOEVM-119 evaluation module (EVM) helps design engineers evaluate the operation and performance of TI's tracker low-dropout (LDO) linear regulators for use in their own circuit application. The configuration of the TRKRLDOEVM-119 contains pads for external components for correct functionality of the tracker LDOs and test points for easy testing. An added high-performance load transient circuit is included to improve the measurement capability of the low-dropout LDO regulator.

Get Started

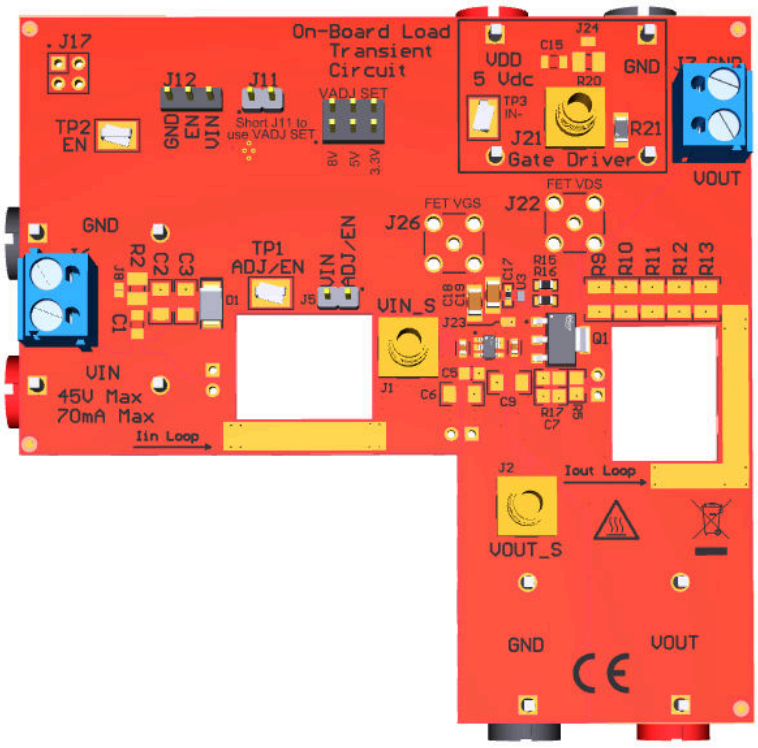
1. Order the TRKRLDOEVM-119 Evaluation Module
2. Download the TRKRLDOEVM-119 User's Guide

Features

- Qualified for automotive applications
- On-board load transient circuit
- Fits SOT-23 (DDA) and SOIC-8 (D) packages

Applications

- Powertrain pressure sensors
- Powertrain temperature sensors
- Powertrain exhaust sensors
- Body control module (BCM)



TRKRLDOEVM-119 Hardware Board

1 Evaluation Module Overview

1.1 Introduction

This evaluation board contains a DDA (SOT-23) footprint to fit TI's modern tracker LDO devices in the DDA package as well as the D (SOIC-8) package, as well as pads for input and output capacitors and feedback resistors.

This user's guide describes the operational use of the TRKRLDOEVM-119 evaluation module (EVM) as a reference design for engineering demonstration and evaluation of TI's tracker low-dropout linear regulators (LDOs). Included in this user's guide are setup and operating instructions, thermal and layout guidelines, a printed-circuit board (PCB) layout, a schematic diagram, and a bill of materials (BOM).

Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the TRKRLDOEVM-119.

1.2 Kit Contents

This EVM kit includes:

- TRKRLDOEVM-119 evaluation module (EVM) version 1.0
- EVM Disclaimer Read Me
- Antistatic foam

What is Not Included

This is a general-purpose tracker LDO EVM, and the board comes with the main IC unpopulated. Populate one of TI's tracker LDO devices in a SOT-23 or SOIC-8 package to use this board.

1.3 Specification

In addition, there is a TPS7B84-Q1 device on-board to provide a reference voltage to the tracker LDO, and other connectors if the user wants to supply the reference voltage externally. There is also an optional on-board load transient circuit as well as current loops that fit most current probes to make fast and accurate load transient measurements.

Figure 1-1 shows a functional block diagram for the TRKRLDOEVM-119 with the optional load transient circuit.

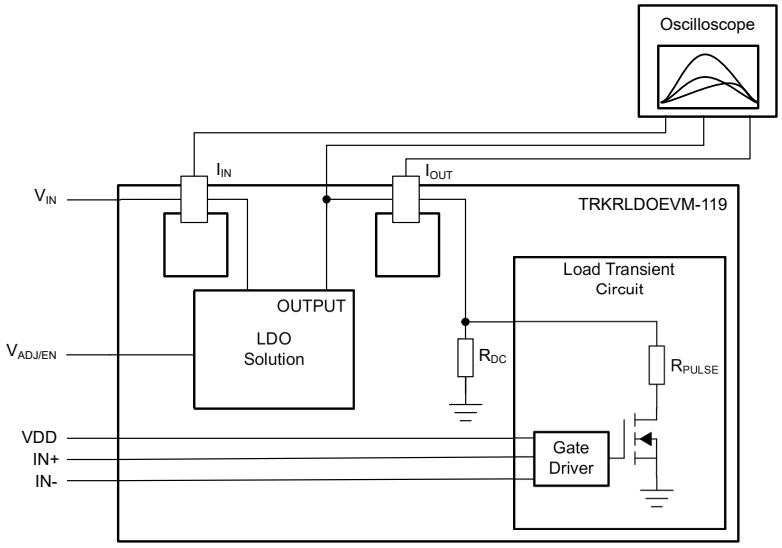


Figure 1-1. TRKRLDOEVM-119 Functional Block Diagram

1.4 Device Information

Table 1-1. Device Information

EVM ORDERABLE NUMBER	V_{OUT}	PART NAME	PACKAGE
TRKRLDOEVM-119	Tracking	Unpopulated	SOT-23 or SOIC-8

2 Hardware

2.1 Power Requirements

This EVM comes populated with a TPS7B84-Q1 LDO to provide a DC reference voltage to the tracker LDO if the user does not have an external supply to provide the reference voltage. The power supply requirement for the TPS7B84-Q1 depends on the output voltage setting chosen with J15; a 10-V, 100-mA current limit supply covers all of the default output voltage settings for the on-board TPS7B84-Q1. This supply is the same as the input supply for the tracker LDO.

This EVM also includes an on-board load transient circuit that is driven by the LM1020 gate driver. The LM1020 requires a nominal 5 V supply that must not exceed 5.4V and must be no less than 4.75V.

2.2 Setup

This section describes the jumpers and connectors on the EVM, and how to properly connect, set up, and use the TRKRLDOEVM-119.

2.3 Connector Information

2.3.1 VIN and GND

VIN and GND are the connection terminals for the input supply. The VIN terminal is the positive connection, and the GND terminal is the negative (that is, ground) connection.

2.3.2 VOUT and GND

VOUT and GND are the connection terminals for the output load. The VOUT terminal is the positive connection, and the GND terminal is the negative (that is, ground) connection.

2.4 Jumper Information

2.4.1 J13 EN

EN is a 3-pin header used to enable or disable the TPS7B84-Q1, which in turn enables the populated tracker LDO.

The center pin of the 3-pin header is tied to the TPS7B84-Q1 EN input. When the 2-pin shunt is placed across the right two pins of the header, VIN is shorted to EN and the TPS7B84-Q1 is enabled. When the 2-pin shunt is placed across the left two pins of the header, GND is shorted to EN and the TPS7B84-Q1 is disabled.

If the TPS7B84-Q1 is not to be used to supply the ADJ/EN signal for the populated tracker, remove jumper J13 and use TP1 to drive ADJ/EN directly, or a combination of J5, R2, R5, C11 to configure ADJ/EN to be a function of the input voltage.

2.4.2 J16

J16 is an optional connection for the user to make measurements or apply loads to the output of the LDO.

2.4.3 J19

J19 is an optional connection to insert a damping circuit across the load transient MOSFET drain to source voltage.

2.4.4 J20

J20 is an optional connection to insert capacitance or additional load across the drain to source of the load transient MOSFET.

2.4.5 J22

J22 is the connection for the function generator to drive the gate driver device. J21 is terminated by the 50-Ω resistor, R21.

2.4.6 J23

J23 is a high-frequency kelvin connection that allows accurate measurements of the load transient MOSFET drain to source voltage.

2.4.7 J24

Short J24 to enable the gate driver.

2.4.8 J27

J27 is a high-frequency kelvin connection that allows accurate measurements of the load transient MOSFET gate to source voltage.

2.5 Test Points

2.5.1 TP1

TP1 along with TP2 can be used to ADJ/EN with an external supply. Disconnect jumper J12 if TP1 is used.

2.5.2 TP3

TP3 along with TP2 can be used to enable the TPS7B84-Q1 with an external signal.

2.6 TRKRLDOEVM-119 Operation and Component Selection

The TRKRLDOEVM-119 evaluation module contains a SOT-23 footprint that also fits an SOIC-8 package, and pads for input and output capacitors. The prepopulated capacitors are sized to verify the minimum capacitance requirements are maintained under all normal operating conditions. Optional pads are available to test the LDO with additional setpoint options, as well as input and output capacitors beyond what is already installed on the EVM.

Setpoint resistors are prepopulated on the TRKRLDOEVM-119 to configure the TPS7B84-Q1 LDO with an output voltage of 3.3 V, 5 V, or 8 V. With a shunt placed across the pins of jumper J12, the output of the TPS7B84-Q1 supplies the ADJ/EN pin of the populated tracker LDO. If a different voltage than the TPS7B84-Q1 output is desired to drive the ADJ/EN pin, remove the shunt from jumper J12 and use a combination of J5, R2, R5, and C11 to configure the ADJ/EN pin to be a function of the input voltage. Alternatively, TP1 and TP2 can be used to directly drive ADJ/EN with an external voltage source.

The TPS7B84-Q1 LDO can be enabled or disabled by using the J13 3-pin header:

- Place a 2-pin shunt across the header to tie VIN to EN to enable the device
- Place a 2-pin shunt across the header to tie GND to EN to disable the device

Alternatively, by connecting an external function generator to TP3 (EN) and TP2 (GND), the user can enable or disable the TPS7B84-Q1 LDO after VIN is applied.

If desired, a current probe can be inserted in the EVM as illustrated in Figure 2-1 to measure the input and output current. The slots were sized to fit most current probes, such as the LeCroy™ AP015 or CP031 current probes.

The board layout is designed such that the I_{in} current probe slot does not detect any current that goes to the TPS7B84-Q1 circuit or the peripherals during start up or during any other operational mode. Thus, the I_{in} current probe slot can be used to isolate and accurately measure current into the tracker LDO device.

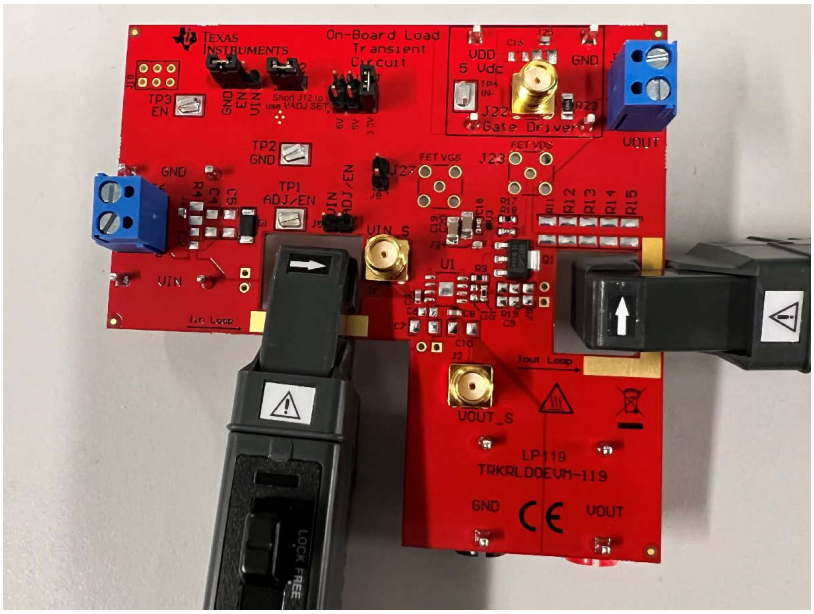


Figure 2-1. TRKRLDOEVM-119 With Current Probes Attached

The user has two options for providing a DC load on the output of the tracker LDO. J7 can be used to place a DC load that flows through the current sense path on the output of the LDO. Alternatively, the J4 (VOUT) and J11 (GND) banana connectors can be used for external measurements and loading; however, the I_{OUT} loop does not sense current flowing through these connectors. In cases where very fast transient tests are performed, ringing can occur on VIN or VOUT as a result of the PCB parasitic inductance. Placing a strip of wire on the exposed copper in the current path can reduce this ringing. 10 AWG wire can be used as needed. If ringing persists, install damping networks by adding a series resistor and capacitor in parallel with VIN. Locations where damping can be installed include C2 and R4, and C16 and R22.

WARNING

Current probe sensors can be tied to GND and must not come into contact with energized conductors. See the user manual of your current probe for details. If your current probe has this limitation, use a thin strip of electrical or Kapton® tape to isolate the current sense path from the current probe.

Optional kelvin sense points are provided using the SMA connectors J1 (VIN) and J2 (VOUT).

2.7 Optional Load Transient Circuit Operation

The TRKRLDOEVM-119 evaluation module contains an optional high-performance load transient circuit to allow efficient testing of the tracker LDO load transient performance. To use the optional load transient circuit, install the correct components in accordance with the application. Modify the input and output capacitance connected to the tracker LDO to match the expected operating conditions. Determine the desired peak current to test and modify the parallel resistor combination of R11, R12, R13, R14, R15 as shown:

$$I_{Peak} = \frac{V_{OUT}}{R_{11}|R_{12}|R_{13}|R_{14}|R_{15}} + I_{DC} \quad (1)$$

The slew rate of the load step can be adjusted by C21, R17, R18, and R20. In this section, only R17 and R18 are adjusted to set the slew rate. Use Table 2-1 to select a value of R15 and R16 that results in the desired rise or fall time.

Table 2-1. Suggested Ramp Rate Resistor Values

R17	R18	Rise, Fall Time
3.4 kΩ	2.1 kΩ	700 ns
1.69 kΩ	1.1 kΩ	350 ns
604 Ω	383 Ω	140 ns
332 Ω	169 Ω	70 ns
121 Ω	69.8 Ω	35 ns
37.4 Ω	0 Ω	14 ns

After the EVM is modified (if needed), connect a power supply to banana connectors J21 (VDD) and J26 (GND) with a 5-V DC supply and a 1-A DC current limit. Use a pulse-duration limit of 1 ms to prevent excessive heating of the pulsed resistors (R11, R12, R13, R14, and R15). Configure a function generator for the 50-Ω output, in a 0-V DC to 5-V DC square pulse. If necessary, then burst mode can be configured in the function generator for repetitive, low duty cycle, load transient testing.

3 Hardware Design Files

3.1 Schematic

Figure 3-1 shows the schematic for the TRKRLDOEVM-119. The optional load transient circuit is enclosed in the red box.

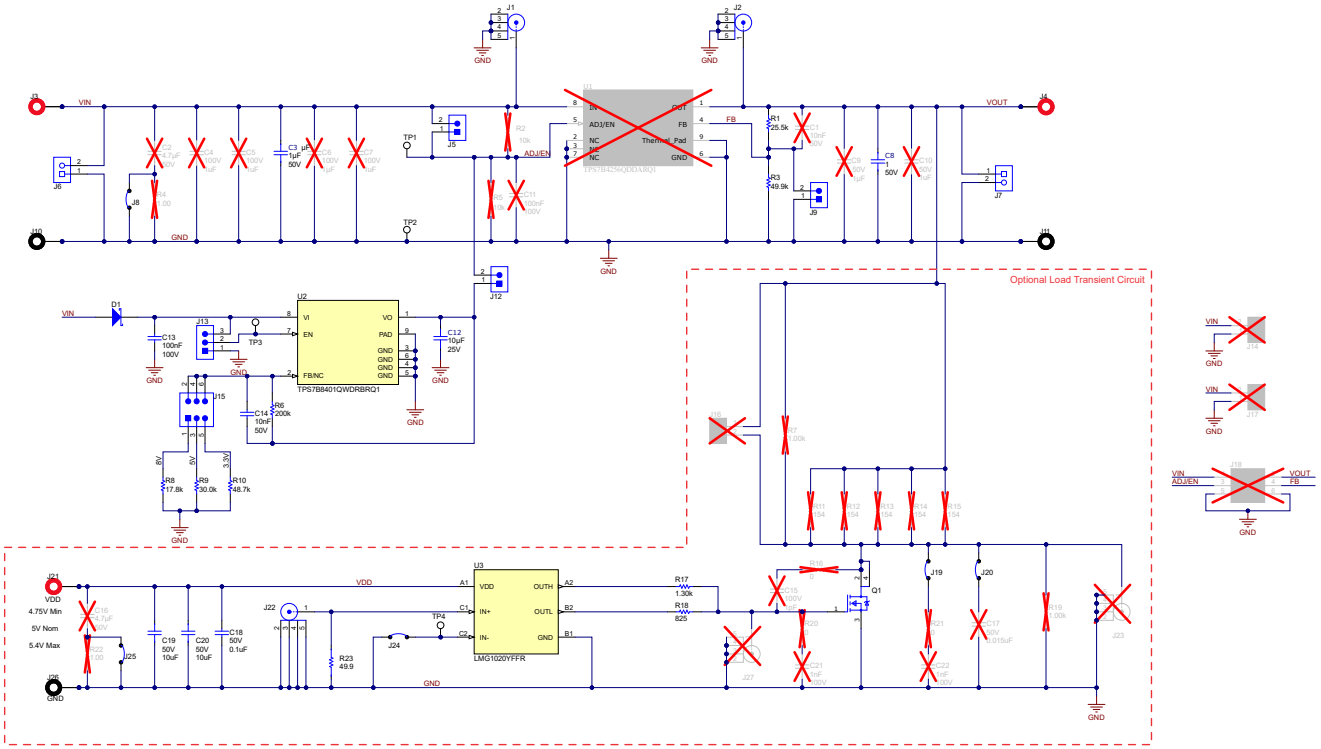


Figure 3-1. TRKRLDOEVM-119

3.2 Board Layout

Figure 3-2 through Figure 3-9 illustrate the board layout for the TRKRLDOEVM-119 PCB.

The TRKRLDOEVM-119 dissipates power, which can cause some components to experience an increase in temperature. The populated tracker LDO and pulsed resistors R11, R12, R13, R14, and R15 are most at risk of raising the junction temperature during normal operation. The LDO can become hot to the touch during normal operation; see the thermal impedance discussion in the populated tracker LDO data sheet.

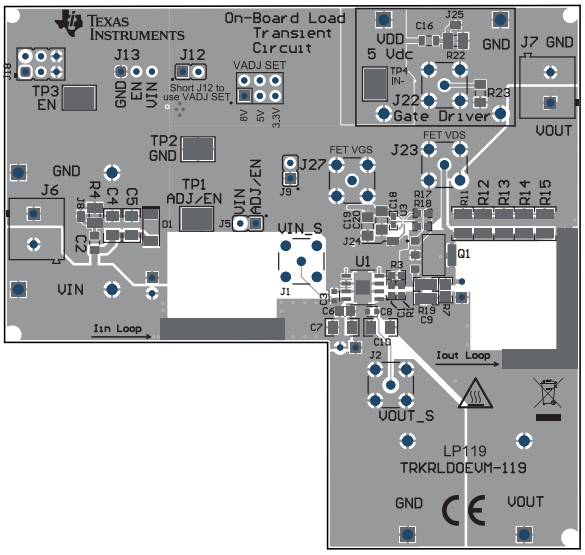


Figure 3-2. Top Assembly Layer and Silkscreen

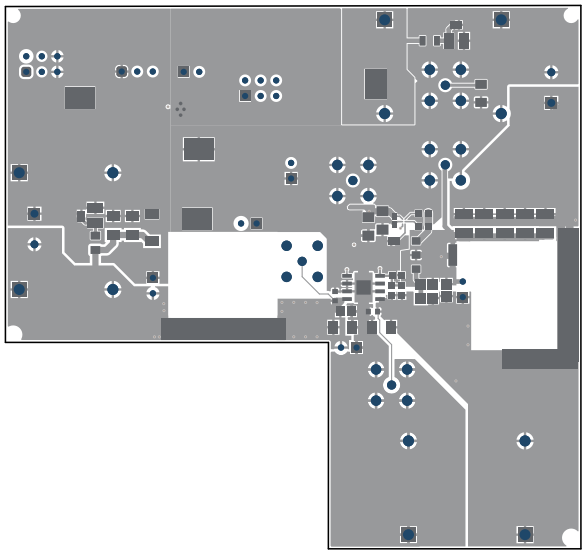


Figure 3-3. Top Layer Routing

Figure 3-4. Internal Layer 1

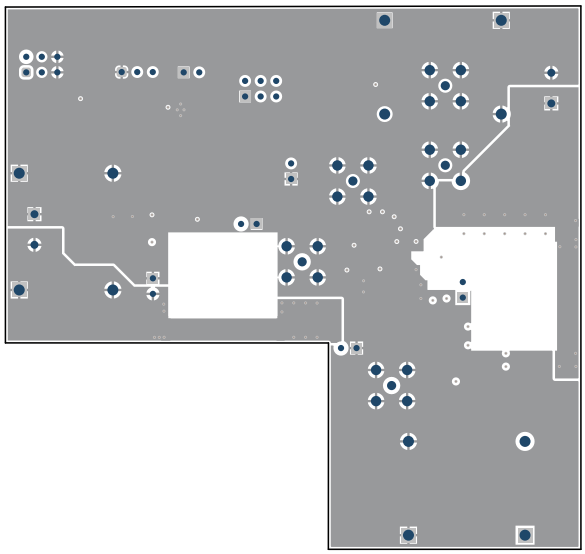


Figure 3-5. Internal Layer 2

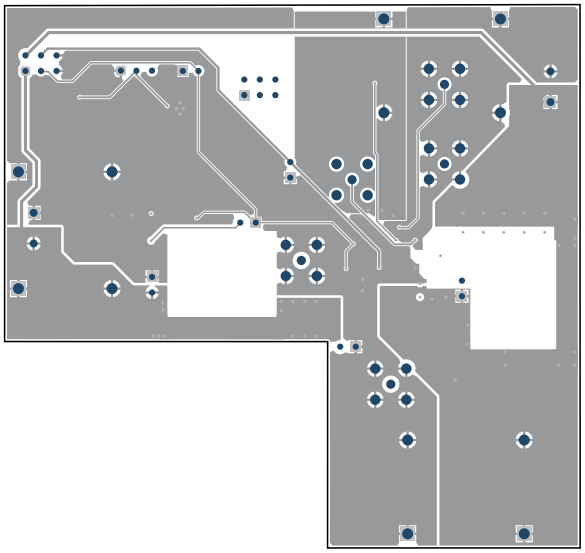


Figure 3-6. Internal Layer 3

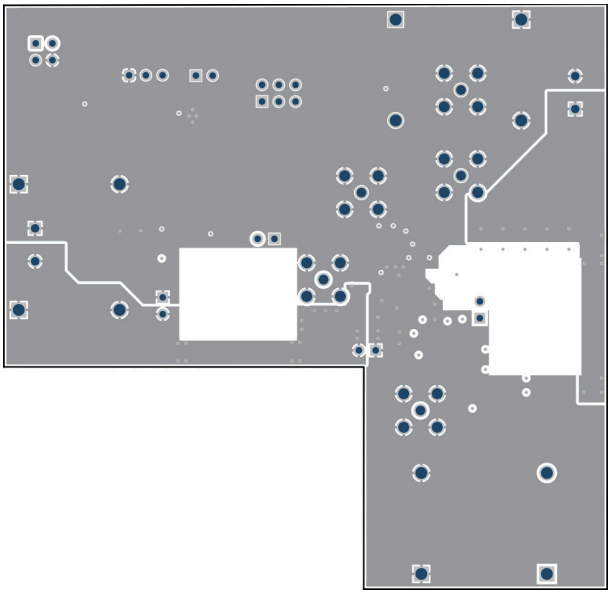


Figure 3-7. Internal Layer 4

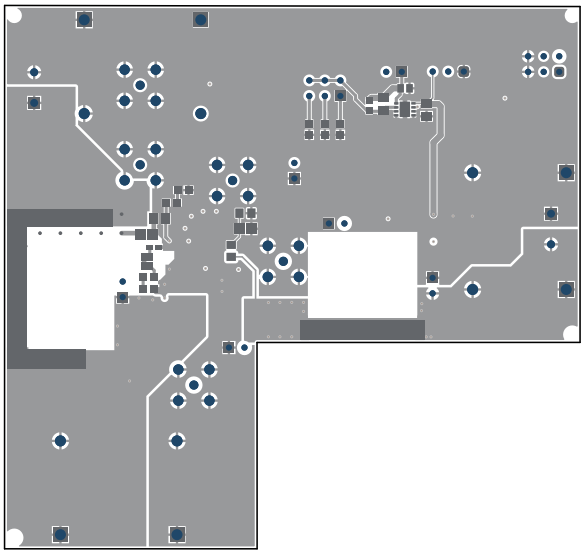


Figure 3-8. Bottom Layer Routing

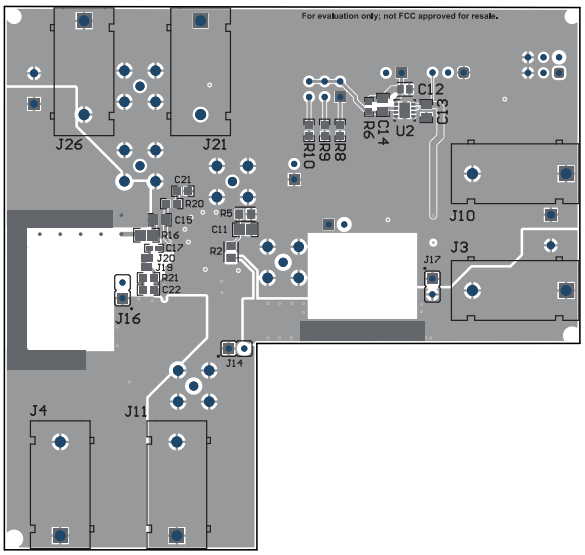


Figure 3-9. Bottom Assembly Layer and Silkscreen

3.3 Bill of Materials (BOM)

Table 3-1 lists the bill of materials for TRKRLDOEVM-119.

Table 3-1. Bill of Materials

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
!PCB1	1		Printed Circuit Board		LP119	Any		
C3, C8	2	1 µF	1 µF ±10% 50 V Ceramic Capacitor X7R 0603 (1608 Metric)	603	CC0603KRX7R9BB105	YAGEO		
C12	1	10 µF	CL21 Series 0805 10uF 25 V ±10% Tolerance X7R Multilayer Ceramic Chip Capacitor	805	CL21B106KAYQNNE	Samsung		
C13	1	0.1uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, 0805	805	HMK212B7104KG-T	Taiyo Yuden		
C14	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0805	805	08055C103KAT2A	AVX		
C15	1	100 pF	CAP, CERM, 100 pF, 100 V, +/- 5%, X7R, 0805	805	C0805C101J1RACTU	Kemet		
C18	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0402	402	C1005X7R1H104K050BB	TDK		
C19, C20	2	10 µF	10 µF ±10% 50 V Ceramic Capacitor X7R 1206 (3216 Metric)	1206	GMC31X7R106K50NT	Cal-Chip Electronics		
D1	1	60 V	Diode, Schottky, 60 V, 3 A, SOD-128	SOD-128	PMEG6030EP,115	Nexperia		
FID1, FID2, FID3, FID4, FID8	5		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
J1, J2, J22	3		SMA Straight Jack, Gold, 50 Ohm, TH	SMA Straight Jack, TH	901-144-8RFX	Amphenol RF		
J3, J4, J21	3		Standard Banana Jack, insulated, 10 A, red	571-0500	571-0500	DEM Manufacturing		
J5, J9, J12	3		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
J6, J7	2		Terminal Block, 5 mm, 2x1, Tin, TH	Terminal Block, 5 mm, 2x1, TH	691 101 710 002	Wurth Elektronik		
J8, J19, J20, J24, J25	5		Jumper, SMT	shorting jumper, SMT	JMP-36-30X40SMT	Any		
J10, J11, J26	3		Standard Banana Jack, insulated, 10 A, black	571-0100	571-0100	DEM Manufacturing		
J13	1		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec		

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
J15	1		Header, 100mil, 3x2, Gold, TH	3x2 Header	TSW-103-07-G-D	Samtec		
Q1	1		N-Channel 100 V 1.2A (Ta) 1.8W (Ta) Surface Mount PG-SOT223-4	SOT223	BSP296NH6327XTSA1	Infineon		
R1	1	25.5k	RES, 25.5 k, 1%, 0.1 W, 0603	603	RC0603FR-0725K5L	Yageo		
R3	1	49.9k	RES, 49.9 k, 1%, 0.1 W, 0603	603	RC0603FR-0749K9L	Yageo		
R6	1	200k	RES, 200 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603200KFKEA	Vishay-Dale		
R8	1	17.8k	RES, 17.8 k, 1%, 0.1 W, 0603	603	RC0603FR-0717K8L	Yageo		
R9	1	30.0k	RES, 30.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	ERJ-3EKF3002V	Panasonic		
R10	1	48.7k	RES, 48.7 k, 1%, 0.1 W, 0603	603	RC0603FR-0748K7L	Yageo		
R17	1	1.30k	RES, 1.30 k, 1%, 0.1 W, 0603	603	RC0603FR-071K3L	Yageo		
R18	1	825	RES, 825, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603825RFKEA	Vishay-Dale		
R23	1	49.9	RES Thick Film, 49.9Ω, 1%, 0.75W, 100 ppm/°C, 1206	1206	CRCW120649R9FKEAHP	Vishay Dale		
TP1, TP2, TP3, TP4	4		Test Point, Compact, SMT	Testpoint_Keystone_Compact	5016	Keystone, Keystone Electronics		
U2	1		150-mA, wide VIN, low IQ, low-dropout regulator, DRB0008F (VSON-8)	DRB0008F	TPS7B8401QWDRBRQ1	Texas Instruments		Texas Instruments
U3	1		5 V, 7 A/5 A Low Side GaN Driver With 60 MHz/1ns Speed, YFF0006AEAE (DSBGA-6)	YFF0006AEAE	LMG1020YFFR	Texas Instruments	LMG1020YFFT	Texas Instruments
C1	0	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/-10%, X7R, 0603	603	C1608X7R1H103K080AA	TDK		
C2, C16	0	4.7µF	Cap Ceramic 4.7 uF 50 V X7R 10% Pad SMD 0805 +125°C Automotive T/R	805	CGA4J1X7R1H475K125AC	TDK Corporation		
C4, C5, C7	0	1uF	CAP, CERM, 1 uF, 100 V, +/-10%, X7R, 1206	1206	C3216X7R2A105K160AA	TDK		
C6	0	1uF	CAP, CERM, 1 µF, 100 V,+/-10%, X7R, AEC-Q200 Grade 1, 0805	805	08051C105K4Z2A	AVX		
C9	0	1uF	CAP, CERM, 1 uF, 50 V, +/-10%, X7R, 0805	805	C2012X7R1H105K085AC	TDK		

Table 3-1. Bill of Materials (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer	Alternate PartNumber	Alternate Manufacturer
C10	0	1uF	CAP, CERM, 1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 1206	1206	CGA5L3X7R1H105K160AB	TDK		
C11	0	0.1uF	CAP, CERM, 0.1 uF, 100 V, +/- 10%, X7R, 0805	805	C2012X7R2A104K125AA	TDK		
C17	0	0.015uF	CAP, CERM, 0.015 uF, 50 V, +/- 10%, X7R, 0402	402	GRM155R71H153KA12D	MuRata		
C21, C22	0	1000 pF	CAP, CERM, 1000 pF, 100 V, +/- 5%, X7R, 0603	603	06031C102JAT2A	AVX		
FID5, FID6, FID7	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
J14, J16, J17	0		Header, 100mil, 2x1, Gold, TH	Sullins 100mil, 1x2, 230 mil above insulator	PBC02SAAN	Sullins Connector Solutions		
J18	0		Header, 2.54mm, 3x2, Gold, TH	Header, 2.54mm, 3x2, Gold, TH	HTSW-103-07-G-D	Samtec		
J23, J27	0		SMA Straight Jack, Gold, 50 Ohm, TH	SMA Straight Jack, TH	901-144-8RFX	Amphenol RF		
R2, R5	0		10 kOhms ±1% 0.333W, 1/3W Chip Resistor 0805 (2012 Metric) Thick Film	805	CRGH0805F10K	TE Connectivity		
R4, R22	0	1	RES, 1.00, 1%, 0.333 W, AEC-Q200 Grade 1, 0805	805	RL1220S-1R0-F	Susumu Co Ltd		
R7, R19	0	1.00k	RES, 1.00 k, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6ENF1001V	Panasonic		
R11, R12, R13, R14, R15	0	154	RES, 154, 1%, 0.5 W, 1210	1210	RC1210FR-07154RL	Yageo		
R16	0	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6GEY0R00V	Panasonic		
R20, R21	0	0	RES, 0, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	RMCF0603ZT0R00	Stackpole Electronics Inc		
U1	0		70-mA, 40-V, Voltage-Tracking LDO With 3-mV Tracking Tolerance	SOIC8	TPS7B4256QDDARQ1	Texas Instruments		

4 Additional Information

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