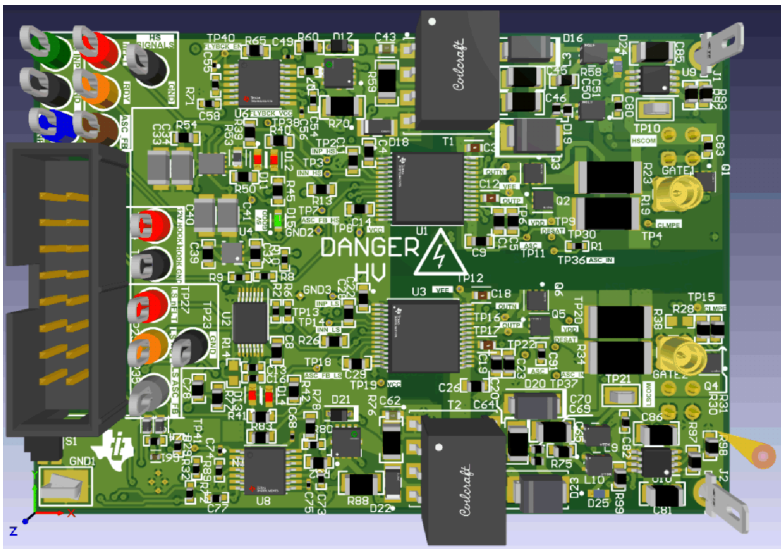
EVM User's Guide: UCC2189X5YQEVM-096

UCC2189X5Y Half-Bridge EVM User's Guide for Wolfspeed 1200V SiC Platforms

ABSTRACT

The UCC2189X5YQEVM-096 is a compact, half-bridge gate driver board consisting of two single-channel isolated gate drivers. It provides isolated bias supply, drive current and protection needed for driving several different models of Wolfspeed silicon-carbide (SiC) MOSFET modules and other IGBT or SiC MOSFET modules with a similar pinout. The on-board flyback converters can provide adjustable isolated voltage. The board's compact form factor, combined with UCC2189X5Y's 5.0kVrms reinforced isolation, makes it a good candidate for doing high voltage tests, such as double-pulse tests and short-circuit tests, with the Wolfspeed SiC modules.

This user's guide describes the characteristics, operation and use of the UCC2189X5Y Evaluation Module (EVM). It also includes instructions to adjust different gate driver parameters, such as voltage supply and soft turn-off strength. A complete schematic diagram, printed circuit board layouts, and bill of materials are included in this document.



UCC2189X5Y Hardware Board

1 General TI High Voltage Evaluation User Safety Guidelines

Always follow TI's set-up and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and the safety of those working around you. Contact TI's Product Information Center http://support/ti./com for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and/or burn hazards.

The term TI HV EVM refers to an electronic device typically provided as an open framed, unenclosed printed circuit board assembly. It is intended strictly for use in development laboratory environments, solely for qualified professional users having training, expertise, and knowledge of electrical safety risks in development and application of high-voltage electrical circuits. Any other use and/or application are strictly prohibited by Texas Instruments. If you are not suitably qualified, you must immediately stop from further use of the HV EVM.

- **Work Area Safety:**
  - Maintain a clean and orderly work area .
  - Qualified observer(s) must be present anytime circuits are energized.
  - Effective barriers and signage must be present in the area where the TI HV EVM and its interface electronics are energized, indicating operation of accessible high voltages may be present, for the purpose of protecting inadvertent access.
  - All interface circuits, power supplies, evaluation modules, instruments, meters, scopes and other related apparatus used in a development environment exceeding 50 V_{RMS}/75 VDC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
  - Use a stable and non-conductive work surface.
  - Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.
- **Electrical Safety:**

  As a precautionary measure, it is always a good engineering practice to assume that the entire EVM may have fully accessible and active high voltages.

  - De-energize the TI HV EVM and all its inputs, outputs, and electrical loads before performing any electrical or other diagnostic measurements. Confirm that TI HV EVM power has been safely de-energized.
  - With the EVM confirmed de-energized, proceed with required electrical circuit configurations, wiring, measurement equipment hook-ups and other application needs, while still assuming the EVM circuit and measuring instruments are electrically live.
  - When EVM readiness is complete, energize the EVM as intended.

  WARNING

  WARNING: While the EVM is energized, never touch the EVM or its electrical circuits as they could be at high voltages capable of causing electrical shock hazard.
- **Personal Safety:**
  - Wear personal protective equipment, for example, latex gloves and/or safety glasses with side shields or protect EVM in an adequate lucent plastic box with interlocks from accidental touch.
- **Limitation for Safe Use:**
  - EVMs are not to be used as all or part of a production unit.

Safety and Precautions

The EVM is designed for professionals who have received the appropriate technical training, and is designed to operate from an AC power supply or a high-voltage DC supply. Please read this user guide and the safety-related documents that come with the EVM package before operating this EVM.

CAUTION

Do not leave the EVM powered when unattended.

WARNING

High Voltage! Electric shock is possible when connecting board to live wire. Board must be handled with care by a professional.

For safety, use of isolated test equipment with overvoltage and overcurrent protection is highly recommended.

2 Module Compatibility

2.1 Supported Wolfspeed Modules and Evaluation Platforms

Below is a list of Wolfspeed evaluation platforms and SiC modules supported by the half-bridge gate driver board.

Table 2-1. Wolfspeed Evaluation Platforms and SiC Modules Supported

Wolfspeed Design	Wolfspeed Parts Supported	Description
SpeedVal Kit	650-1200V Discrete MOSFETs, FM Half-Bridge Modules	Dynamic Characterization and Power Testing Platform
KIT-CRD-CIL12N-XM3	1200V XM Power Modules	Dynamic Characterization Platform
KIT-CRD-CIL12N-GMA	1200V GM Half-Bridge Modules	Dynamic Characterization Platform
KIT-CRD-CIL12N-FMA	1200V Half-Bridge FM Power Modules	Dynamic Characterization Platform
KIT-CRD-CIL12N-FMB	1200V FM Full-Bridge Modules	Dynamic Characterization Platform
KIT-CRD-CIL12N-FMC	1200V 6-Pack FM Power Modules	Dynamic Characterization Platform

Other SiC MOSFET modules and IGBT modules with similar pinouts are directly supported as well.

3 System Overview and Functions

3.1 Features

- Directly compatible with Wolfspeed's FM3 and XM3 modules
- LM5185 flyback controllers supply positive and negative bias to the secondary side
  - Only a +12-V input voltage needed to generate the primary-side and secondary-side bias voltages
- Status LEDs indicate power-good and fault feedback from each driver
- Include protection features such as short-circuit detection and active short-circuit functionality
- Programmable soft turn-off current with resistor
- Test points for all critical nodes to expedite debugging

3.2 Specifications

Wide bandgap SiC-based power modules become popular in power electronics because of their excellent conduction and switching performance. Compact driver board UCC2189X5YQEVM-096 supports SiC modules by reducing parasitics, minimizing switching loss, and providing full required protection and diagnostics features. For the full elctrical specifications table, refer to the UCC2189X5Y-Q1 datasheet

Table 3-1. Electrical Specifications

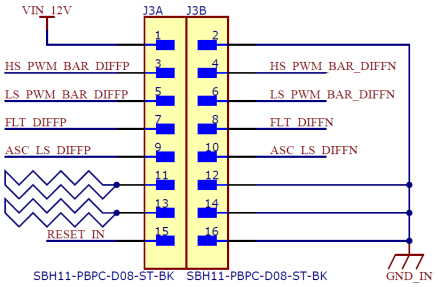
Parameter		Test Conditions	Min	Nom	Max	Unit
SUPPLY VOLTAGES AND CURRENTS						
Vcc	VCC supply voltage			5.0	5.5	V
Vdd2u, Vdd2l	VDD supply voltages	From transformer and LDO		20		V
Vee2u, Vee2l	VEE supply voltages	From transformer		-5.5		V
DRIVE CURRENT						
Ioutp	Peak source/sink current for OUTP	Cload = 100pF		2.8		A
Ioutn	Peak source/sink current for OUTN	Cload = 100pF		2.8		A
INPUT/OUTPUT SIGNALS						
Vinh	Input high threshold				0.7 x VCC	V
Vinl	Input low threshold		0.3 x VCC			V
Vinhys	Input threshold hysteresis			0.15 x VCC		V
TIMING PARAMETERS						
TPr	OUTP rise time	Cload = 1 nF		11		ns
TPf	OUTP fall time	Cload = 1 nF		10		ns
TNr	OUTN rise time	Cload = 1 nF		9		ns
TNf	OUTN fall time	Cload = 1 nF		5		ns
Tpd	Propagation delay	Cload = 1 nF		65		ns
PROTECTION - DESAT, ACTIVE SHORT CIRCUIT, EXTERNAL MILLER CLAMP						
Ichg	Blanking capacitor charging current	Vdesat = 2.0V		2000		uA
Tdesatleb	Leading edge blank time			200		ns
Tdesatfil	DESAT deglitch filter			125		ns
Vascl	ASC input low threshold referenced to COM			1.45		V
Vasch	ASC input high threshold referenced to COM			2.7		V
Tascfil	ASC deglitch filter time		400		700	ns
Vclmpth	Miller Clamp threshold	Reference to VEE	1.7	2	2.3	V

Table 3-1. Electrical Specifications (continued)

Parameter		Test Conditions	Min	Nom	Max	Unit
Iclmpe	Miller Clamp current	Cclmpe = 10nF		0.5		A
ISOLATION						
Viso	Withstand isolation voltage for gate driver	Reinforced, 60s	5			kVrms
Cio	Barrier capacitance for gate driver			1.2		pF
Tj	Operating Junction Temperature for gate driver		-40		150	°C

3.3 PCB Pinout

Table 3-2. PCB Pinout

Pinout	Location (top/bottom)	Function
J1	Top	HS DESAT drain connection
J2	Top	LS DESAT drain connection
J3	Top	16-pin connector, connection shown below 
J4	Bottom	HS gate/source connection
J5	Bottom	LS gate/source connection
TP10	Top	HS COM
TP21	Top	LS COM
TP23, TP24, TP25	Top, black	Primary side GND
TP26	Top, orange	HS RDY
TP27	Top, red	LS nFLT
TP28	Top, red	HS nFLT
TP29	Top, orange	LS RDY
TP32	Top, green	HS input PWM
TP33	Top, brown	HS ASC feedback
TP34	Top, blue	LS input PWM
TP35	Top, gray	LS ASC feedback
TP44	Top, red	+12V voltage hook input
TP45	Top, black	Primary side GND hook input
GATE1	Top	MMCX connector, HS gate
GATE2	Top	MMCX connector, LS gate
GND1, 2, 3	Top	Primary side GND

3.4 Device Information

3.4.1 Primary-Side Power

The primary-side power supply block fulfills the following functions:

- Provides +12-V input to the board via the connector or the test point hooks.
- Converts the +12-V input voltage to +5-V VCC for the gate drivers. This functionality is realized by a TPS7A25 LDO.
- Uses an ACM4520 common-mode choke to filter out common-mode noise.

  The +12-V power supply and the PWM signals should be connected to the same board, either the differential board or the EVM. Failure to do so might result in EVM component damage.

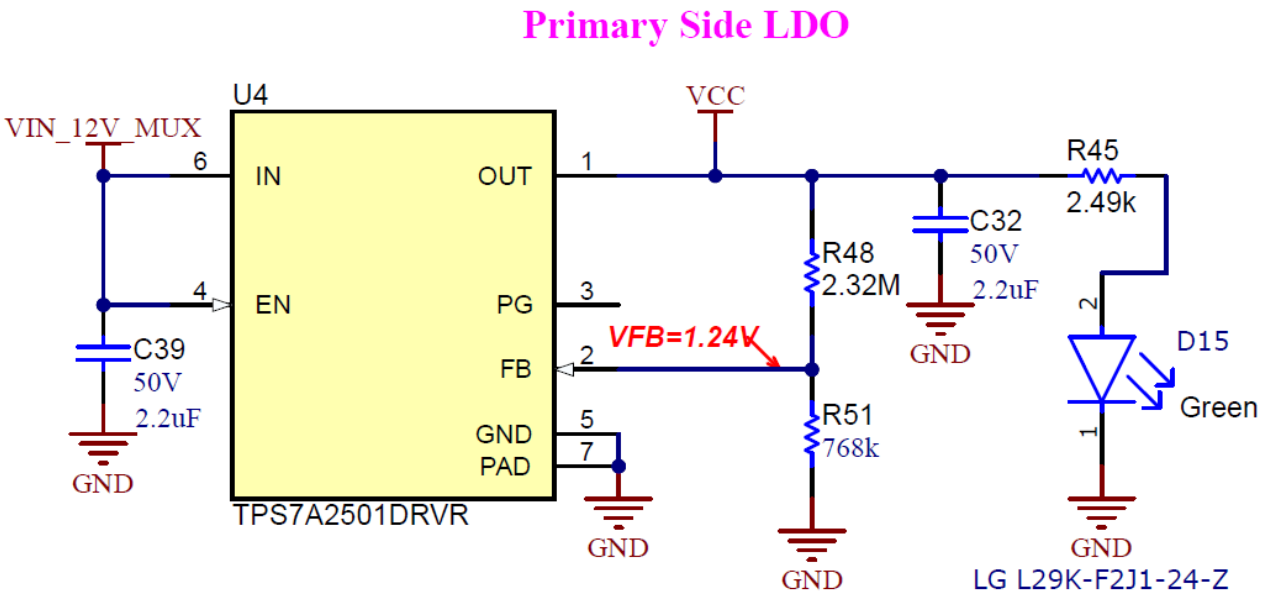


Figure 3-1. Primary-Side Power

3.4.2 Primary-Side I/O and Diagnostics

The primary-side I/O and diagnostic block fulfills the following functions:

- Provides signal input, including high-side and low-side PWM and RESET, as well as +12-V voltage input to the half-bridge board.
  - If the power and signal inputs are given via the differential board connector, the status output pin of a power MUX, TPS2121, is used to turn on the SN65C1167 dual differential driver and receiver. The dual differential driver and receiver then converts the differential gate driver inputs to single-ended gate driver inputs, and converts single-ended gate driver outputs to differential outputs that will be transmitted to the differential board.
  - If the power and signal inputs are given via the test point hooks on this EVM, the power MUX turns off the SN65C1167 dual differential driver and receiver. This protects the dual differential driver and receiver from damage.
- Filters out the high frequency noise in the high-side and low-side differential signals through RLC filters.
- Combines high-side and low-side RDY and nFLT signal into one FLT_OUT signal through an SN74LV21 AND gate.
- Combines the nRST signal coming from the differential board and the on-board reset button into one RESET signal through an SN74LV21 AND gate.

  The +12-V power supply and the PWM signals should be connected to the same board, either the differential board or the EVM. Failure to do so might result in EVM component damage.

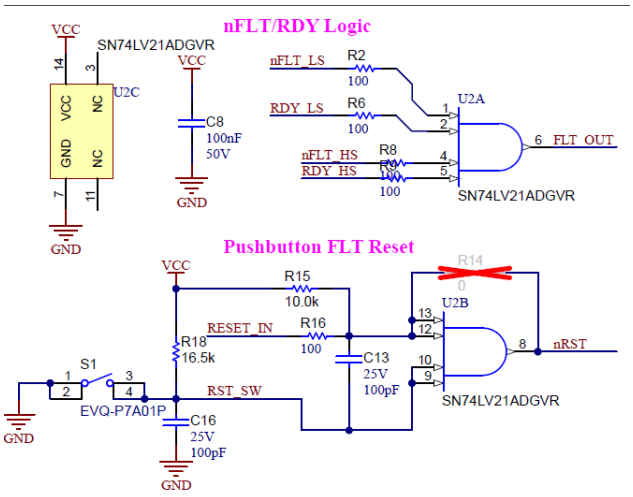


Figure 3-2. Primary Side nFLT/RDY/Reset Logic

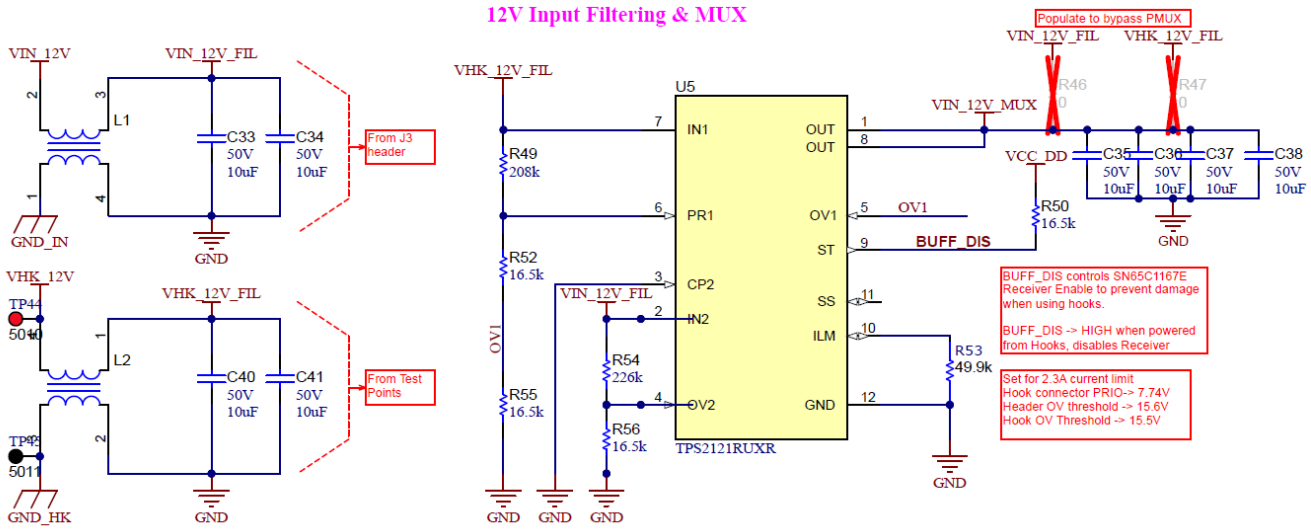


Figure 3-3. Primary Side Input Filtering and MUX

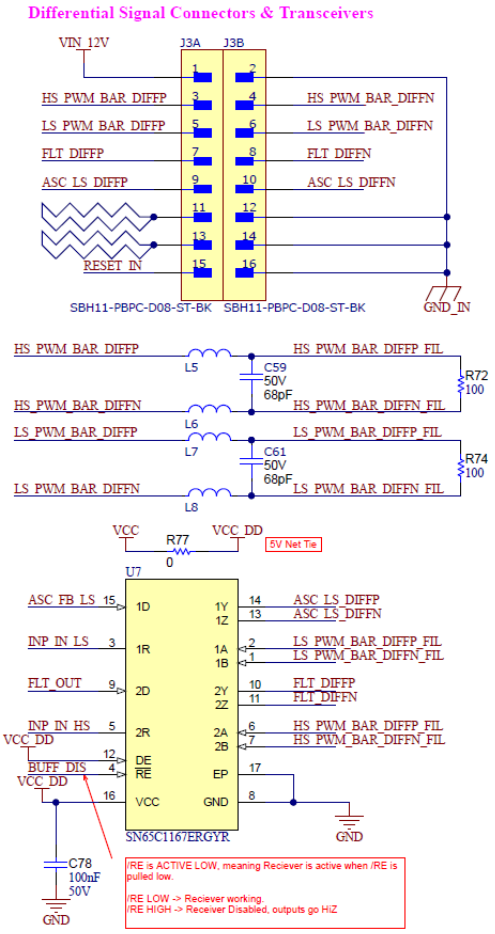


Figure 3-4. Primary Side Connectors and Transceiver

3.4.3 Secondary-Side Bias Supply

The secondary-side power supply block fulfills the following functions:

- Converts the +12-V input voltage to +20-V/-5.5-V bipolar bias voltage supply for the secondary side of the gate drivers. Each gate driver has its own bias supply. This is achieved by using one LM5185-Q1 flyback controller and one YA8864-BLD transformer for each gate driver.
  - The bias supply voltage can be adjusted by following the instructions in Section 6.1.1 and Section 6.1.2.
- Reduces the noise of the positive secondary side supply voltage by using a TPS7A4901 LDO.
  - This LDO can also be bypassed by following the instructions in Section 6.1.4

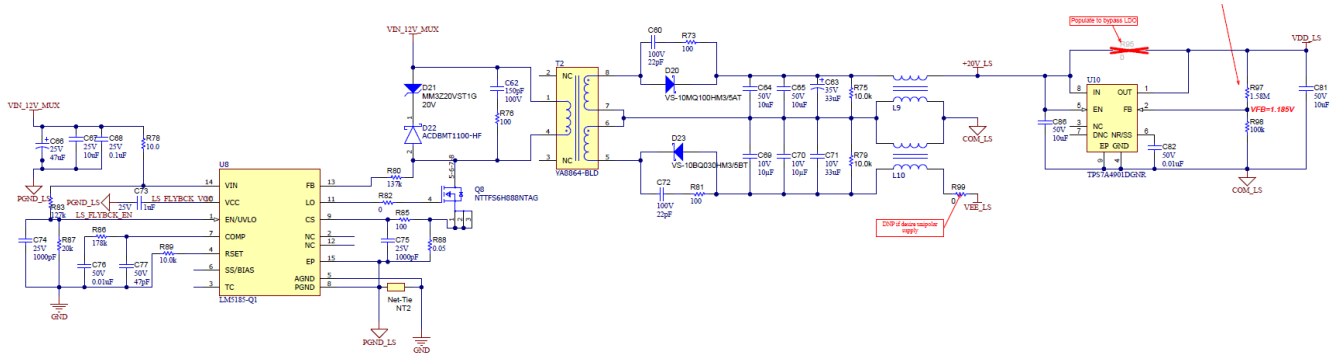


Figure 3-5. Secondary-Side Bias Supply

3.4.4 Output Stage Gate Loop

The gate driver output block consists of a pair of PMOS/NMOS buffer stage, the turn-on gate resistor, the turn-off gate resistor, and the connectors to the SiC MOSFET/IGBT module. Test points are also placed near the output pins for easy measurement of the gate voltage.

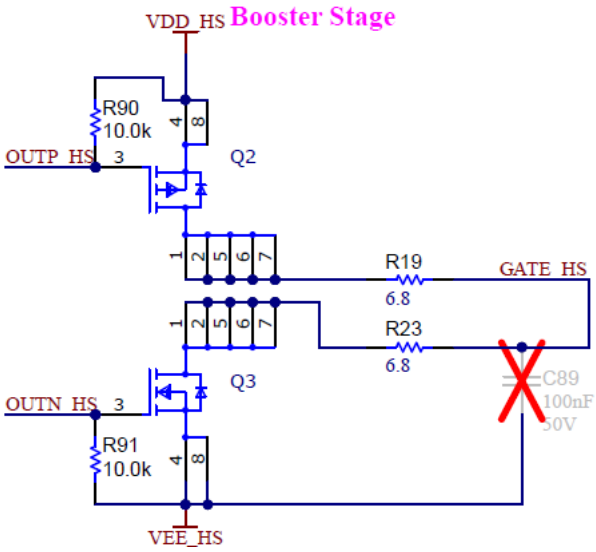


Figure 3-6. Output Stage Gate Loop

3.4.5 Short-Circuit Detection - DESAT

The short-circuit detection system on the board provides protection in case of a short-circuit event. When a short circuit is detected, the gate driver sinks a specified amount of current through the SSD pin, which is programmable by the SSD pin external resistor. The FLT flag will also be raised on the primary side. If the short-circuit detection system is not used or if an IGBT/MOSFET is not connected to the board, J1 and J2 should be shorted to high-side and low-side COM respectively to prevent false short-circuit triggering.

The Vds voltage detection threshold can be calculated with the equation below mentioned in this FAQ:

$$V_{DET} = V_{DESAT} - V_Z - n \times V_F - I_{chg} \times R_{lim} \quad (1)$$

With the 9V internal DESAT detection threshold, the two STTH122A diode with forward voltage of 0.6 V each, the 1kΩ limiting resistor, the Zener diode with 2.7-V Zener voltage, and the 2mA internal charging current, the Vds DESAT detection threshold is calculated to be 3.1V. If another Vds voltage detection threshold is desired, adjust the size of the current-limiting resistor and the Zener voltage of the Zener diode.

In this EVM, method mentioned in this FAQ is implemented to increase the DESAT charging current in case of a short-circuiting event. Increasing the DESAT charging current can decrease the blanking time of the capacitor and provide better protection for SiC MOSFETs. The blanking time for this circuit can be calculated by the equation mentioned in the same FAQ, which is calculated to be 115 ns. This blanking time calculation is valid for VDD = 20V; if another VDD value is used, the blanking time will vary.

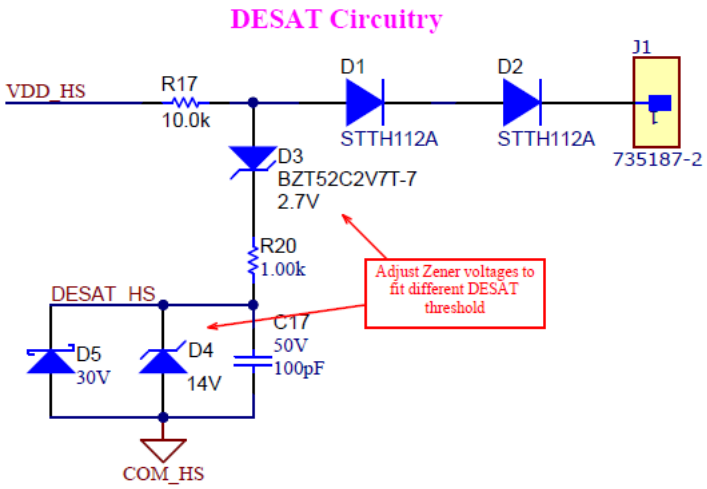


Figure 3-7. DESAT Circuit

4 Using the EVM

4.1 Equipment List

- Power Supplies
  - Need to provide at least 12 V and 1 A to power up the EVM
- Function Generator and Accessories
  - One 2-channel function generator
  - Two standard 50-Ω BNC coaxial cables
- Oscilloscope and Accessories
  - 500-MHz or higher bandwidth oscilloscope with at least four channels
  - Four passive voltage probes with at least 500-MHz bandwidth
- Digital Multimeters
  - Two digital multimeters
- Other
  - Connection wires of various length

4.2 Test Setups and Procedures

4.2.1 Power-On and Bias Supply Check

Note

This is a low voltage only test; do not attempt to manually probe the test points when a high bus voltage is applied to this EVM.

1. Power supply set at 12V, 0.5A. Connect power supply to TP44 (power) and TP45 (GND)
2. Tie J1 to HS COM, and J2 to LS COM. See Figure 4-1 for location of test points.
3. Probe the VCC-GND voltage between the VCC test via and GND1 TP (lower left of board) with a multimeter. This value should be 5V.
4. Probe the high side VDD-COM voltage by using the HS VDD test point and the HS COM test point. Probe the low side VDD-COM voltage by using the LS VDD test point and the LS COM test point. These values should be around 20V.
5. Probe the high side VEE-COM voltage by using the HS VEE test point and the HS COM test point. Probe the low side VEE-COM voltage by using the LS VEE test point and the LS COM test point. These values should be around -5.5V.
6. Make sure the four red indicator LEDs are off. Make sure the one green indicator LED and the two blue indicator LEDs are on.

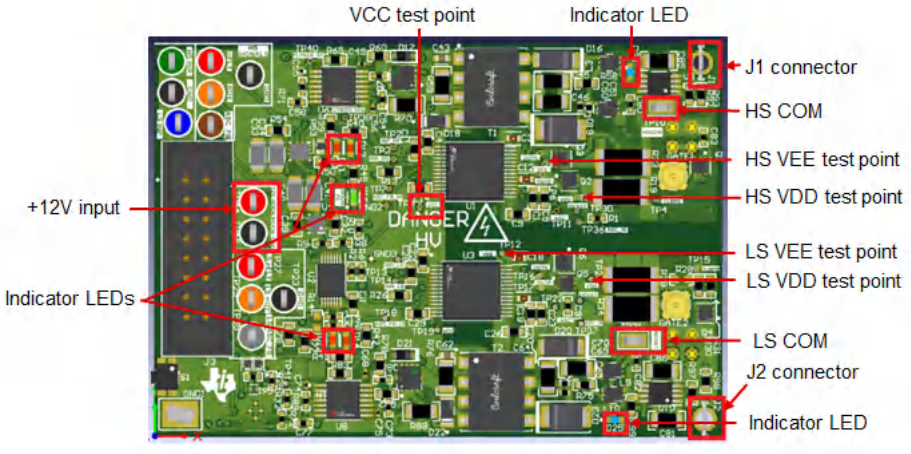


Figure 4-1. Test Point Locations for Power On Check

4.2.2 Output Switching

To perform this test, make sure tests in Section 4.2.1 has been performed and the gate drivers are powered up properly.

1. Generate two 10kHz 0V-5V complementary PWM waves on two function generator channels. Deadtime can be added between the two PWM waves.
2. Connect these channel probes to the test points on the EVM; connect the high-side PWM channel probe to HS INP and the low-side PWM channel probe to LS INP on top left of the board. Connect the function generator ground lead to either the black GND TP in between HS INP and LS INP, or to the GND1 TP on the bottom left of the board.
3. Measure the high-side gate voltage with the MMCX connector GATE1, and measure the low-side gate voltage with the MMCX connector GATE2.
4. GATE1 waveform should match high-side PWM input signal with a small delay (~100ns). GATE2 waveform should match low-side PWM input signal with a small delay (~100ns). Both waveforms should have high level of around +20V and low level of around -5.5V.

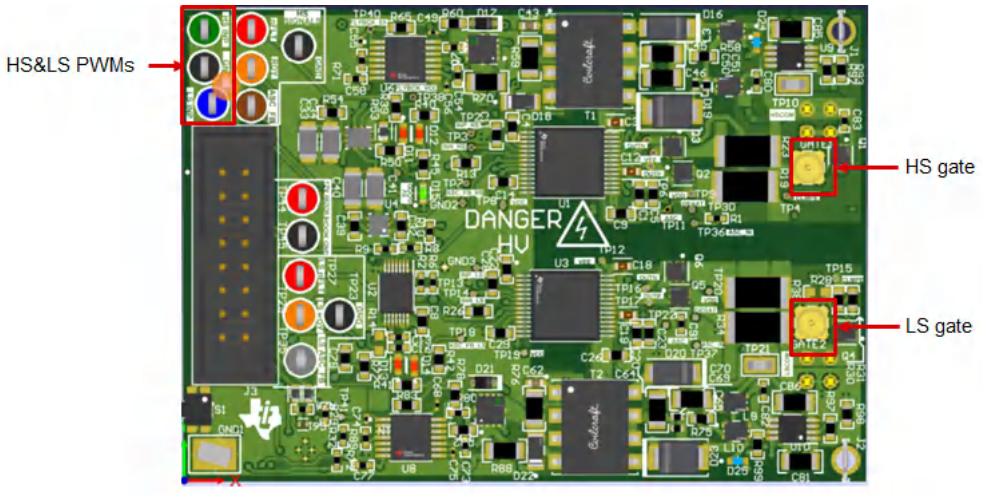


Figure 4-2. Test Point Locations for Output Switching Check

5 EVM Example Measurements

5.1 DESAT Functionality Testing

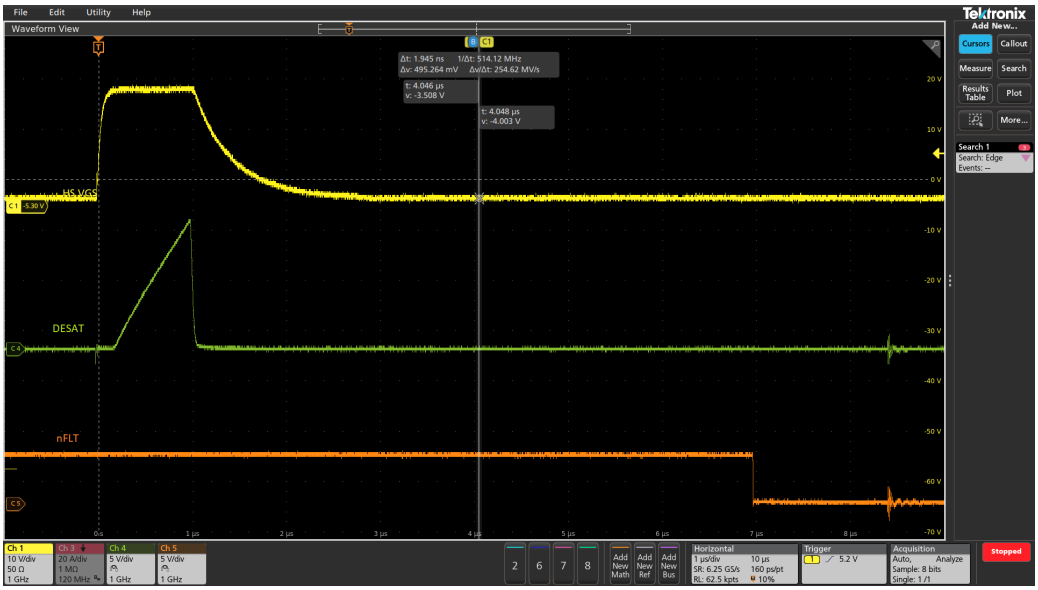


Figure 5-1. DESAT and Soft Turn-Off Waveform

This test is carried out without a bus voltage to test the functionality of DESAT pin, soft turn-off, and nFLT feedback.

The voltage on DESAT first reaches the detection threshold. After a short delay as specified in the UCC2189X5Y-Q1 data sheet, output experiences soft turn-off via the SSD pin. The soft turn-off current can be programmed by the resistor on SSD. On the primary side, nFLT also pulls low as a result of DESAT triggering, following a longer delay as specified in the datasheet.

6 EVM Tuning

6.1 Adjust Power Supplies

6.1.1 Adjust Only VDD Bias Supply

This section outlines steps to adjust only the VDD bias supply.

To decrease the VDD bias supply voltage, change the resistor divider connected to the FB pin of the TPS7A49 LDO. The resistors are R92/R93 for the high-side LDO, and R97/R98 for the low-side LDO. The equation below, mentioned in the TPS7A49 datasheet, can be used to select the resistors.

$$V_{DD} = V_{FB} \times \left(1 + \frac{R_{92}}{R_{93}}\right) = 1.185 \times \left(1 + \frac{R_{92}}{R_{93}}\right) \quad (2)$$

$$V_{DD} = V_{FB} \times \left(1 + \frac{R_{97}}{R_{98}}\right) = 1.185 \times \left(1 + \frac{R_{97}}{R_{98}}\right) \quad (3)$$

Equation 2 and Equation 3 are used for high-side and low-side VDD resistor selection, respectively.

It's not recommended to increase the VDD bias supply voltage as it might violate the maximum Vgs value of the power module. If VDD voltage needs to be increased, VEE voltage will increase accordingly as well. Refer to Section 6.1.2 to change VDD and VEE bias supplies simultaneously.

6.1.2 Adjust VDD and VEE Bias Supplies Simultaneously

VDD and VEE bias supplies can be adjusted simultaneously if desired. The bias supplies can be adjusted separately for high-side and low-side gate drivers. If VDD/VEE for the high-side gate driver needs to be adjusted, R62 should be changed; if VDD/VEE for the low-side gate driver needs to be adjusted, R80 should be changed.

The table below outlines the VDD/VEE bias supply voltage with corresponding resistor values.

Table 6-1. VEE Bias Supply Voltage and Recommended Resistor Values

R62/R80 Values (Ω)	VDD (V)	VEE (V)
100k	15	-4
120k	18	-4.8
137k (Original configuration)	20	-5.5

6.1.3 Switch to Unipolar Bias Supply

The secondary side bipolar power supply can be switched to a unipolar power supply. The high side and low side can be adjusted separately. To change the high-side gate driver to a unipolar power supply, short R43 and remove R94; to change the low-side gate driver to a unipolar power supply, short R44 and remove R99.

After the resistors adjustments, VDD would remain the same.

6.1.4 Bypass VDD LDO

The VDD LDO can be bypassed on either the high side gate driver or the low side. To bypass the VDD LDO on the high side gate driver, populate R66. To bypass the VDD LDO on the low side gate driver, populate R95.

6.2 Adjust Drive Strength

To adjust the drive strength, change the gate resistors. The gate resistors are placed after the booster stage. For high-side gate driver, the turn-on and turn-off gate resistors are R19 and R23. For low-side gate driver, the turn-on and turn-off gate resistors are R34 and R38. The default values of the gate resistors are 6.8Ω.

UCC2189X5Y-Q1 can provide peak source/sink current of 2.8A typical to drive the booster stage efficiently.

6.3 Adjust Soft Turn-off Strength

The soft turn-off functionality is realized by activating an internal pull-down FET for the SSD/GATE pin for UCC2189X5Y-Q1. The soft turn-off strength can be adjusted by changing the resistor connected to the SSD pin, and is inversely proportional to the resistor size. The resistors are R11 and R24 respectively for high-side and low-side gate driver.

7 Hardware Design Files

7.1 Schematics

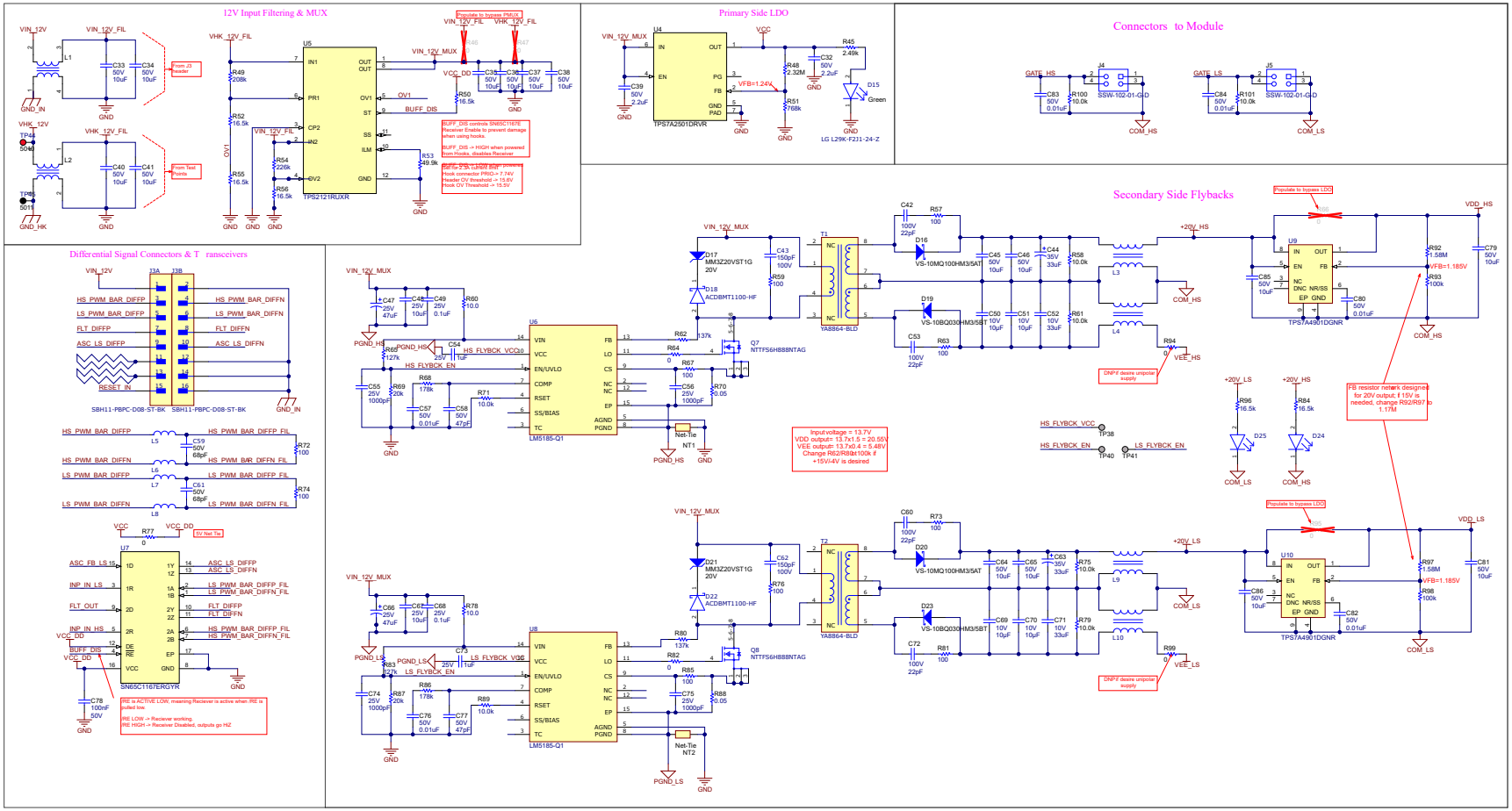


Figure 7-1. EVM Schematic

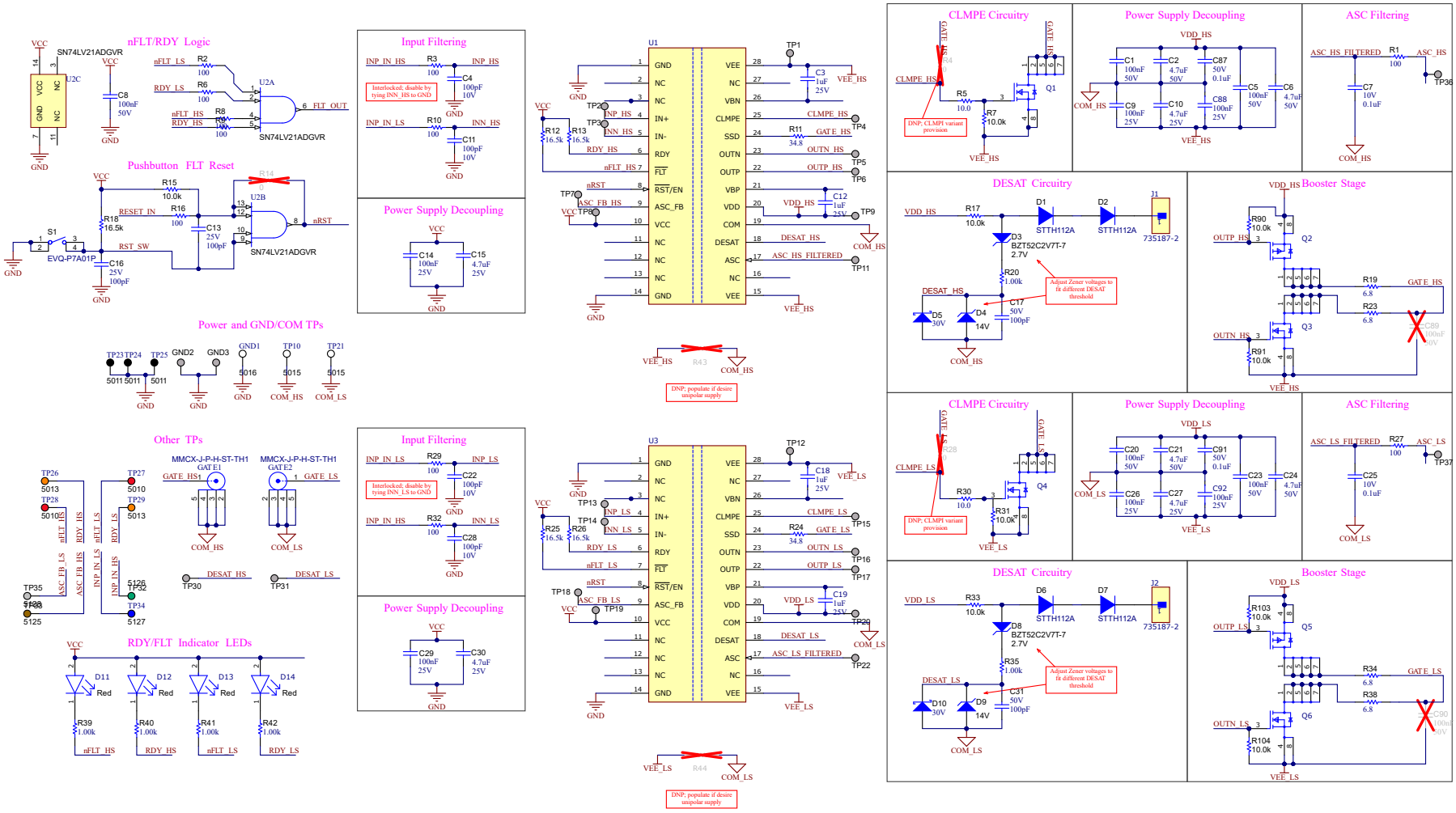


Figure 7-2. EVM Schematic

7.2 PCB Layouts

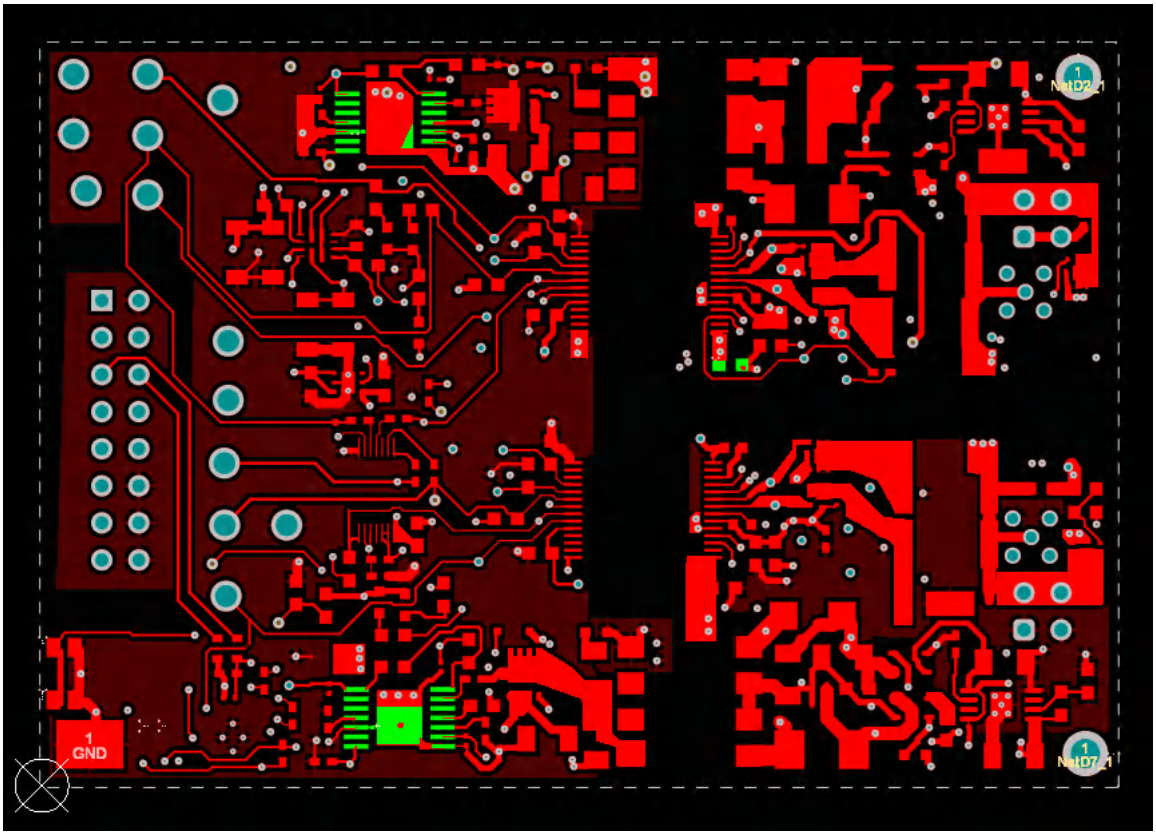


Figure 7-3. Top Layer

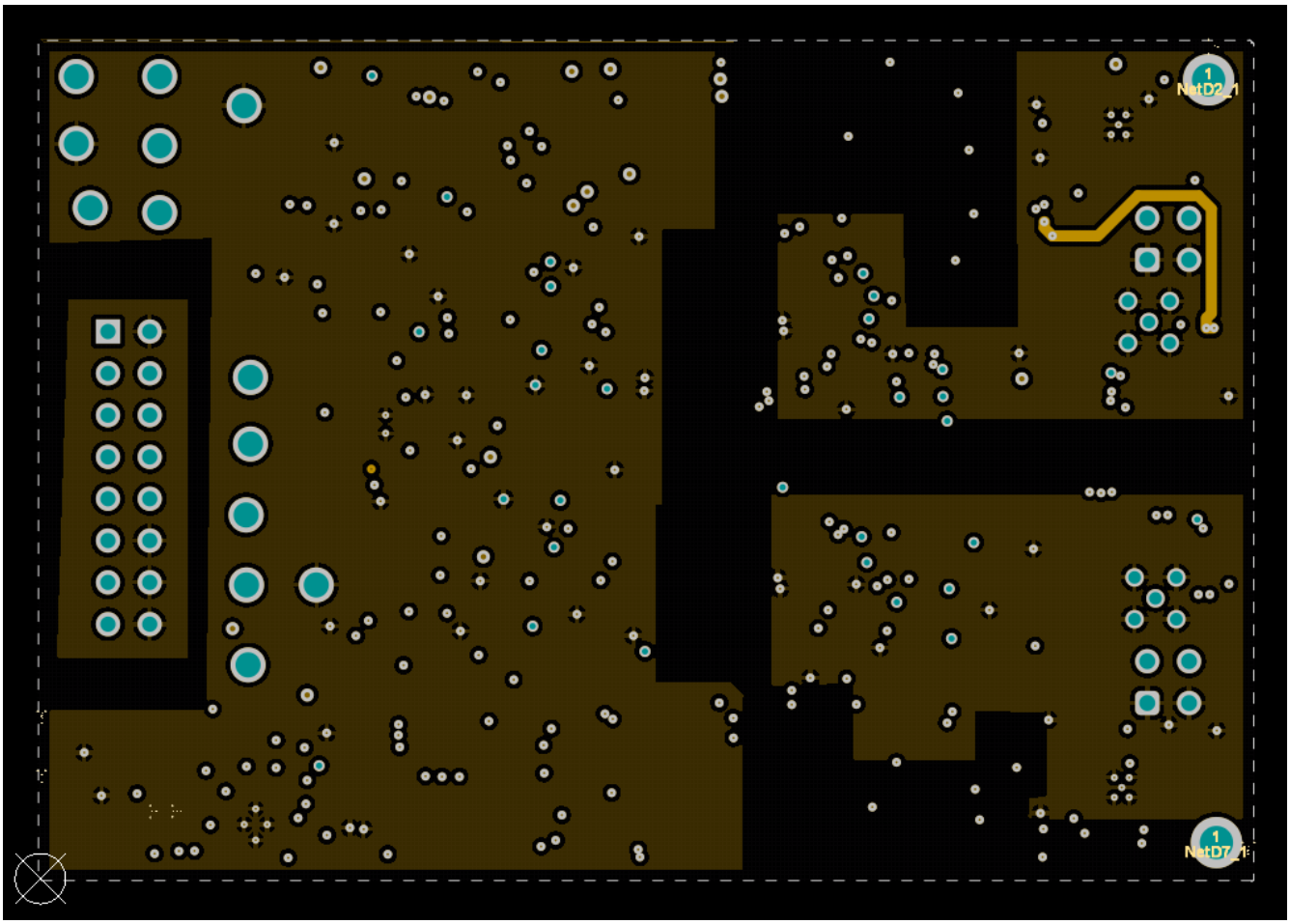


Figure 7-4. Signal Layer 1

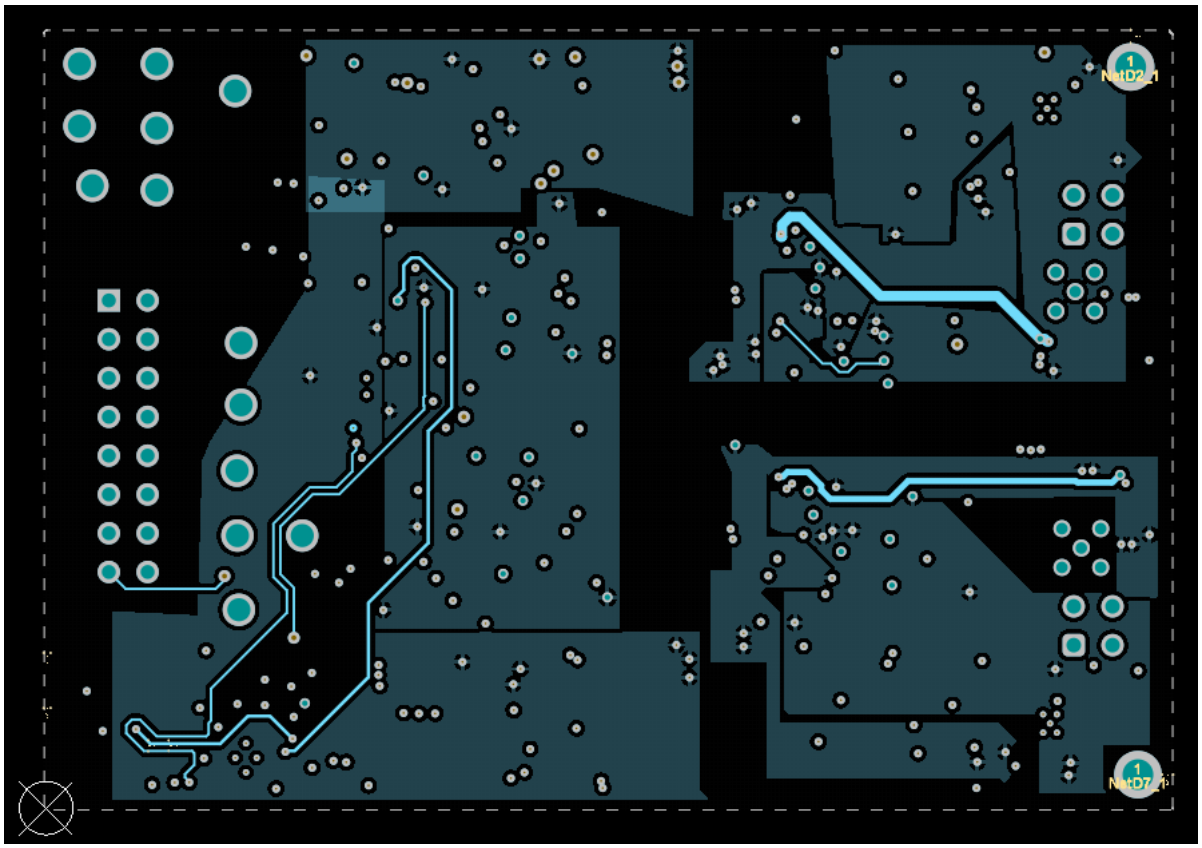


Figure 7-5. Signal Layer 2

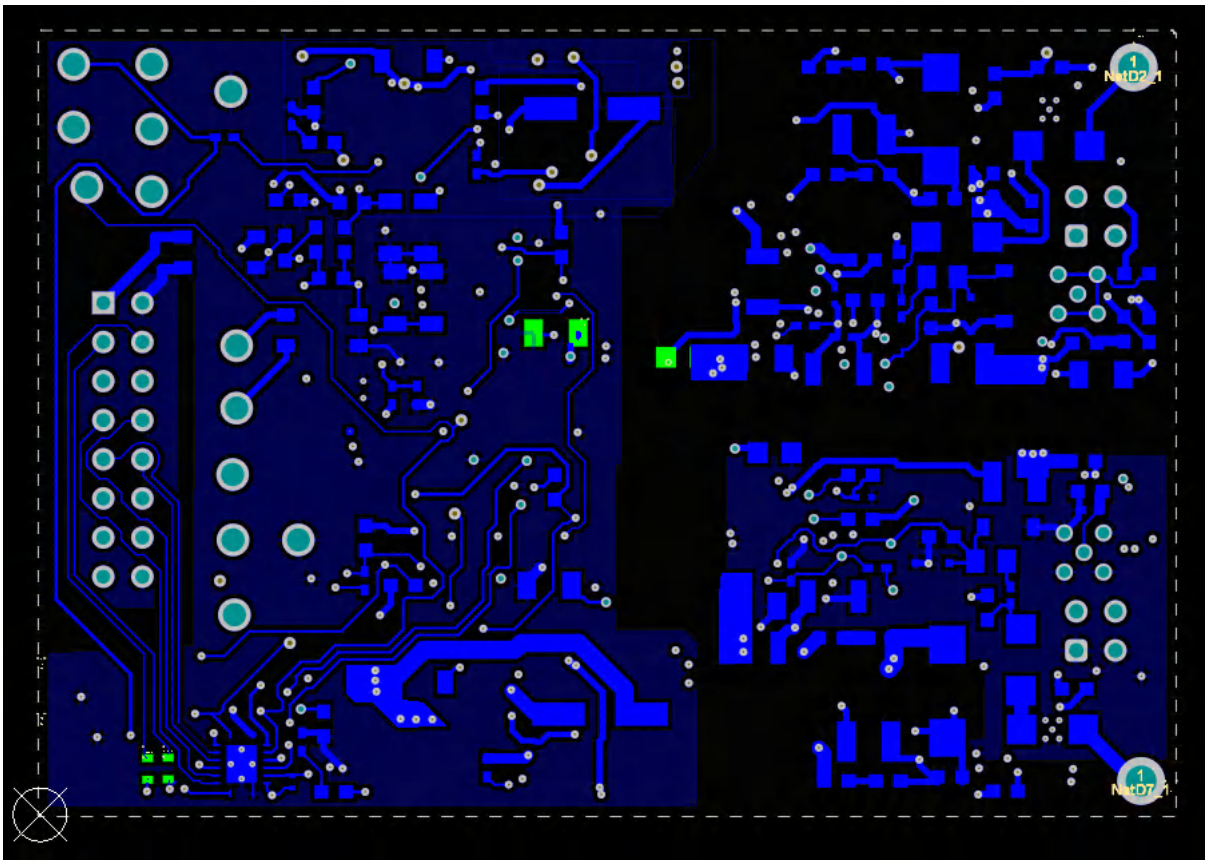


Figure 7-6. Bottom Layer

7.3 Bill of Materials (BOM)

Table 7-1. EVM BOM

Designator	Quantity	Value	Description	Part Number
!PCB	1		Printed Circuit Board	HVP-096
C1, C5, C20, C23	4	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	8.85012E+11
C2, C6, C21, C24	4	4.7uF	CAP, CERM, 4.7 uF, 50 V, +/- 10%, X7R, 1210	C3225X7R1H475K250AB
C3, C12, C18, C19	4	1µF	Cap Ceramic 1uF 25V X5R ±10% Pad SMD 0603 +85°C T/R	CL10A105KA8NNNC
C4, C11, C22, C28	4	100pF	CAP, CERM, 100 pF, 10 V, +/- 10%, X7R, 0603	0603ZC101KAT2A
C7, C25	2	0.1uF	CAP, CERM, 0.1 uF, 10 V,+/- 10%, X5R, 0402	LMK105BJ104KV-F
C8, C78	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	C0603C104K5RACTU
C9, C14, C26, C29	4	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	C0603X104K3RACTU
C10, C15, C27, C30	4	4.7uF	CAP, CERM, 4.7 uF, 25 V, +/- 20%, X5R, 1206	12063D475MAT2A
C13, C16	2	100pF	CAP, CERM, 100 pF, 25 V, +/- 5%, C0G/NP0, 0402	C0402C101J3GACTU

Table 7-1. EVM BOM (continued)

Designator	Quantity	Value	Description	Part Number
C17, C31	2	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 0, 0603	CGA3E2NP01H101J080AA
C32, C39	2	2.2uF	CAP, CERM, 2.2 uF, 50 V, +/- 10%, X5R, 0603	GRM188R61H225KE11D
C33, C34, C35, C36, C37, C38, C40, C41	8	10uF	CAP, CERM, 10 uF, 50 V, +/- 10%, X5R, 1206	C3216X5R1H106K160AB
C42, C53, C60, C72	4	22pF	CAP, CERM, 22 pF, 100 V, +/- 5%, C0G/NP0, 0603	GRM1885C2A220JA01D
C43, C62	2	150pF	0603 150 pF 100 V ±5 % Tolerance C0G/NP0 SMT Multilayer Ceramic Capacitor	06031A151JAT2A
C44, C63	2	33uF	CAP, TA, 33 uF, 35 V, +/- 10%, 0.1 ohm, SMD	TPSE336K035R0100
C45, C46, C64, C65, C79, C81, C85, C86	8	10uF	CAP, CERM, 10 uF, 50 V, +/- 20%, X5R, AEC-Q200 Grade 3, 1206	CGA5L3X5R1H106M160AB
C47, C66	2	47uF	CAP, AL, 47 uF, 25 V, +/- 20%, 0.44 ohm, SMD	UUD1E470MCL1GS
C48, C67	2	10uF	CAP, CERM, 10 uF, 25 V, +/- 10%, X7R, 1206	GRM31CR71E106KA12L
C49, C68	2	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X5R, 0201	GRM033R61E104KE14J
C50, C51, C69, C70	4	10uF	CAP, CERM, 10 µF, 10 V,+/- 20%, X5R, 0402	GRM155R61A106ME44
C52, C71	2	33uF	CAP, CERM, 33 uF, 10 V, +/- 20%, X5R, 1210	C3225X5R1A336M200AC
C54, C73	2	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X5R, 0402	C1005X5R1E105K050BC
C55, C56, C74, C75	4	1000pF	CAP, CERM, 1000 pF, 25 V, +/- 10%, X5R, 0201	C0603X5R1E102K030BA
C57, C76, C80, C82, C83, C84	6	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0402	GRM155R71H103KA88D
C58, C77	2	47pF	CAP, CERM, 47 pF, 50 V, +/- 5%, C0G/NP0, 0402	UMK105CG470JVHF
C59, C61	2	68pF	68pF ±5% 50V Ceramic Capacitor C0G, NP0 0402 (1005 Metric)	GCM1555C1H680JA16D
C87, C91	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	GCM155R71H104KE02D
C88, C92	2	100nF	CAP, CERAMIC, 0402, X7R, 100nF, 25V, ±15 %, SMD	8.85012E+11
D1, D2, D6, D7	4	1200V	Diode, Ultrafast, 1200 V, 1 A, SMA	STTH112A
D3, D8	2	2.7V	Diode, Zener, 2.7 V, 300 mW, SOD-523	BZT52C2V7T-7
D4, D9	2	14V	Diode, Zener, 14 V, 500 mW, SOD-123	DDZ14B-7

Table 7-1. EVM BOM (continued)

Designator	Quantity	Value	Description	Part Number
D5, D10	2	30V	Diode, Schottky, 30 V, 0.2 A, SOD-323	BAT54WS-7-F
D11, D12, D13, D14	4		Red 630nm LED Indication - Discrete 1.5V 0603 (1608 Metric)	LS L29K-G1J2-1-Z
D15	1		Green 570nm LED Indication - Discrete 1.7V 0603 (1608 Metric)	LG L29K-F2J1-24-Z
D16, D20	2	100V	Diode, Schottky, 100 V, 1 A, AEC-Q101, SMA	VS-10MQ100HM3/5AT
D17, D21	2	20V	Diode, Zener, 20 V, 300 mW, SOD-323	MM3Z20VST1G
D18, D22	2		Diode 100 V 1A Surface Mount SOD-123H	ACDBMT1100-HF
D19, D23	2	30V	Diode, Schottky, 30 V, 1 A, AEC-Q101, SMB	VS-10BQ030HM3/5BT
D24, D25	2		LED Uni-Color Blue 0.07lm 465nm Chip LED 2-Pin 0603 T/R	LB Q39G-L2OO-35-1
GATE1, GATE2	2		Connector, MMCX 50 ohm, TH	MMCX-J-P-H-ST-TH1
GND1	1		Test Point, Compact, SMT	5016
J1, J2	2		FASTON 110, PCB Terminals, Tab, Tab, PCB Terminal Mating Tab Width .11 in [2.8 mm], PCB Terminal Mating Tab Thickness .02 in [.51 mm]	735187-2
J3	1			SBH11-PBPC-D08-ST-BK
J4, J5	2		Receptacle, 2.54mm, 2x2, Gold, TH	SSW-102-01-G-D
L1, L2	2		Coupled inductor, 2.8 A, 0.055 ohm, SMD	ACM4520-421-2P-T000
L3, L4, L9, L10	4		2 Line Common Mode Choke Surface Mount 1 kOhms @ 100 MHz 200mA DCR 900mOhm	ACM2520-102-2P-T002
L5, L6, L7, L8	4		1µH Shielded Multilayer Inductor 600mA 150mOhm 0603 (1608 Metric)	MLZ1608A1R0WT000
LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10
Q1, Q3, Q4, Q6	4		N-Channel 40 V 8A (Ta), 19A (Tc) 2.3W (Ta), 15W (Tc) Surface Mount DFN2020MD-6	BUK6D23-40EX
Q2, Q5	2		P-Channel 40 V 6A (Ta) 15W (Tc) Surface Mount DFN2020MD-6	BUK6D43-40PX
Q7, Q8	2		N-Channel 80 V 4.7A (Ta), 12A (Tc) 2.9W (Ta), 18W (Tc) Surface Mount 8-WDFN (3.3x3.3)	NTTFS6H888NTAG

Table 7-1. EVM BOM (continued)

Designator	Quantity	Value	Description	Part Number
R1, R3, R10, R27, R29, R32	6	100	RES, 100, 1%, 0.125 W, AEC-Q200 Grade 1, 0402	ATC504L1000FTNCFT
R2, R6, R8, R9, R16, R72, R74	7	100	RES, 100, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402100RJNED
R5, R30	2	10	RES, 10.0, 1%, 0.25 W, AEC-Q200 Grade 0, 0603	CRCW060310R0FKEAHP
R7, R15, R17, R31, R33, R90, R91, R100, R101, R103, R104	11	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	RC0603FR-0710KL
R11, R24	2	34.8	RES, 34.8, 1%, 0.5 W, 1210	RC1210FR-0734R8L
R12, R13, R18, R25, R26, R50, R52, R55, R56, R84, R96	11	16.5k	RES, 16.5 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	ERJ-3EKF1652V
R19, R23, R34, R38	4	6.8	RES, 6.8, 5%, 1 W, AEC-Q200 Grade 0, 2512	CRCW25126R80JNEG
R20, R35	2	1.00k	RES, 1.00 k, 0.1%, 0.125 W, 0805	RT0805BRD071KL
R39, R40, R41, R42	4	1.00k	RES, 1.00 k, 1%, 0.1 W, 0603	ERJ-3EKF1001V
R45	1	2.49k	RES, 2.49 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW06032K49FKEA
R48	1	2.32Meg	RES, 2.32 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04022M32FKED
R49	1	208k	RES, 208 k, 0.5%, 0.1 W, 0603	RT0603DRE07208KL
R51	1	768k	RES, 768 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW0402768KFKED
R53	1		49.9 kOhms ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	CRCW060349K9FKEA
R54	1	226k	RES, 226 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW0603226KFKEA
R57, R63, R73, R81	4	100	RES, 100, 1%, 0.25 W, AEC-Q200 Grade 0, 0603	CRCW0603100RFKEAHP
R58, R61, R75, R79	4	10.0k	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW060310K0FKEA
R59, R76	2	100	RES, 100, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	ERJ-8ENF1000V
R60, R78	2	10	RES, 10.0, 1%, 0.1 W, 0603	RC0603FR-0710RL
R62, R80	2	137k	RES, 137 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	ERJ-2RKF1373X
R64, R82	2	0	RES, 0, 5%, 0.1 W, 0603	RC0603JR-070RL
R65, R83	2	127k	RES, 127 k, 1%, 0.1 W, 0603	RC0603FR-07127KL
R67, R85	2	100	RES, 100, 1%, 0.1 W, 0402	ERJ-2RKF1000X
R68, R86	2	178k	RES, 178 k, 1%, 0.1 W, 0603	RC0603FR-07178KL
R69, R87	2	20k	RES, 20 k, 5%, 0.1 W, 0603	RC0603JR-0720KL
R70, R88	2	0.05	RES, 0.05, 1%, 1 W, 1206	MCS1632R050FER

Table 7-1. EVM BOM (continued)

Designator	Quantity	Value	Description	Part Number
R71, R89	2	10.0k	RES, 10.0 k, 1%, 0.1 W, 0402	ERJ-2RKF1002X
R77, R94, R99	3	0	RES, 0, 5%, 0.125 W, 0603	MCT06030Z0000ZP500
R92, R97	2	1.58Meg	RES, 1.58 M, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	CRCW06031M58FKEA
R93, R98	2	100k	RES, 100 k, 1%, 0.1 W, 0603	RC0603FR-07100KL
S1	1		Switch, Tactile, SPST-NO, 0.05A, 12V , SMD	EVQ-P7A01P
T1, T2	2		Flyback Transformer, for TI LM5180-Q1, SMT, RoHS	YA8864-BLD
TP10, TP21	2		Test Point, Miniature, SMT	5015
TP23, TP24, TP25, TP45	4		Test Point, Multipurpose, Black, TH	5011
TP26, TP29	2		Test Point, Multipurpose, Orange, TH	5013
TP27, TP28, TP44	3		Test Point, Multipurpose, Red, TH	5010
TP32	1		Test Point, Multipurpose, Green, TH	5126
TP33	1		Test Point, Multipurpose, Brown, TH	5125
TP34	1		Test Point, Multipurpose, Blue, TH	5127
TP35	1		Test Point, Multipurpose, Grey, TH	5128
U1, U3	2		Single Channel Isolated Pre-Driver for SiC/IGBT with Active Protection	UCC218905BQDFPRQ1
U2	1		Dual 4-Input Positive-AND Gate, DGV0014A (TVSOP-14)	SN74LV21ADGVR
U4	1		300-mA, 18-V, Low IQ, Low Dropout Voltage Regulator with Power Good, DRV0006A (WSON-6)	TPS7A2501DRVR
U5	1		2.7V-22V, 4A, 50mohm Priority Power MUX, RUX0012A (VQFN-HR-12)	TPS2121RUXR
U6, U8	2		120-VIN PSR Flyback Automotive DC/DC Controller With Low IQ and Low EMI, HTSSOP14	LM5185-Q1
U7	1		Dual Differential Driver and Receiver with +/-15-kV IEC ESD Protection, 2 TX / 2 RX, 5V, -40 to 85 degC, 16-Pin VQFN(RGY), Green (RoHS & no Sb/Br)	SN65C1167ERGYR
U9, U10	2		Single Output High PSRR LDO, 150 mA, Adjustable 1.2 to 33 V Output, 3 to 36 V Input, with Ultra-Low Noise, 8-pin MSOP (DGN), -40 to 125 degC, Green (RoHS & no Sb/Br)	TPS7A4901DGNR

Table 7-1. EVM BOM (continued)

Designator	Quantity	Value	Description	Part Number
C89, C90	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	8.85012E+11
FID1, FID2, FID3	0		Fiducial mark. There is nothing to buy or mount.	N/A
R4, R14, R28, R46, R47, R66, R95	0	0	RES, 0, 5%, 0.125 W, 0603	MCT06030Z0000ZP500
R43, R44	0	0	0 Ohms Jumper 0.5W, 1/2W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200 Metal Foil	HCJ0805ZT0R00

8 Additional Information

8.1 Trademarks

All trademarks are the property of their respective owners.

9 Revision History

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

DATE	REVISION	NOTES
December 2024	*	Initial Release

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
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なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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