4th Generation SiC MOSFET
Half Bridge Evaluation Board
Product Specifications

User's Guide

<High Voltage Precautions>

◇Before you start operation!

This document describes only the circuits, BOM, electrical characteristics, and board layouts of evaluation boards for **SiC MOSFETs** (**P04SCT4018KE-EVK-001, P05SCT4018KR-EVK-001**). Please refer to the User's Manual for more detailed information on handling.

In order to ensure safe operation, please read this document thoroughly before using the evaluation board!

Also, depending on the voltage used and the structure of the board,
life-threatening voltages may be generated.
Be sure to strictly observe the precautions in the box below.

<Before Use>

① Make sure that no parts are damaged or missing, for example because the board has been dropped.

② Make sure that no conductive objects have fallen on the board.

③ When soldering the module to the evaluation board, be careful of solder splattering.

④ Make sure that there is no condensation or water droplets on the board.

<During Energization>

⑤ Make sure that no conductive objects come into contact with the board.

⑥ During operation, even a brief accidental contact or discharge due to bringing your hand near the board may result in serious or life-threatening injury.
Never touch the board with bare hands or bring it too close to your hand.
Also, be careful when working with conductive instruments such as tweezers or screwdrivers, as described above.

⑦ If a higher voltage than the rated voltage is applied, the parts may explode depending on the specification conditions such as short circuit. Also consider the danger of parts scattering.

⑧ During operation, be careful of discoloration of the board and components due to heat, liquid leakage, etc., and condensation when evaluating at low temperature.

<After Use>

⑨ The evaluation board may contain a circuit that stores high voltage. Even if the connected power supply circuit is disconnected, it still stores electric charge, so be sure to discharge it after use and confirm that it is discharged before handling.

⑩ Be careful of burns, etc. caused by contact with overheated components.

This evaluation board is to be used in research and development facilities and **can only be used by persons who are authorized to handle high voltage in each facility.** When working with high voltages, it is recommended to install signage such as "high voltage work underway," to use a cover with interlocks, etc., and to wear protective goggles to ensure a safe working environment. Please read the cautionary note on **short circuit protection** for this board at the beginning of this document.

SiC MOSFET Evaluation Board

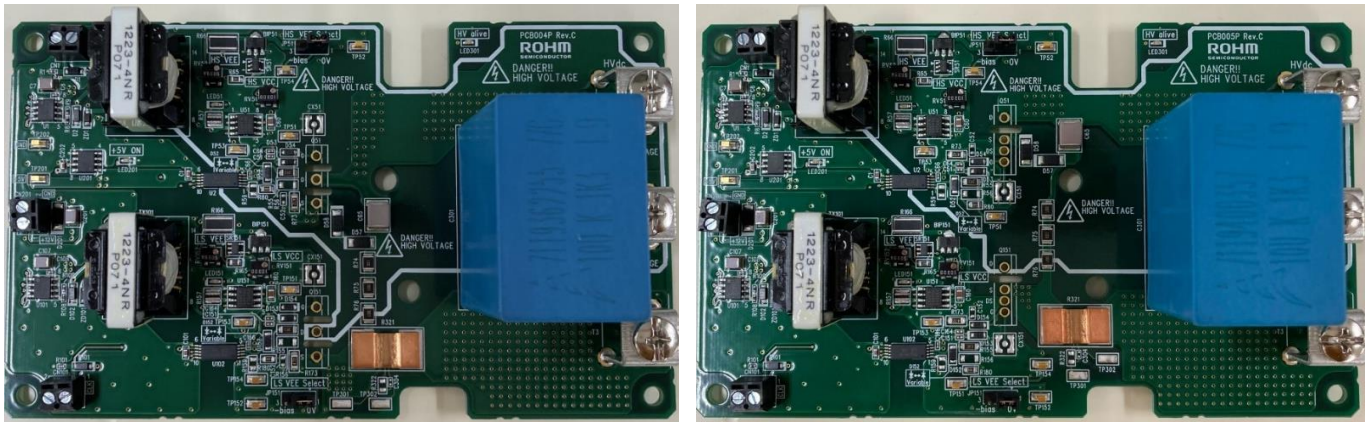
4th Generation MOSFET Evaluation Board Product Specifications

Since power devices such as SiC MOSFETs generally handle high voltages and currents, to evaluate them it is necessary to create an appropriate evaluation environment. However, when considering a new package, it is often difficult to immediately obtain an optimal evaluation board. Therefore, ROHM provides the optimal evaluation environment by offering an evaluation board that employs a half-bridge circuit, which is a common circuit configuration, and that includes features such as a drive circuit, drive power supply, and gate signal protection circuit. With this evaluation board, users can easily and simply prepare the appropriate evaluation conditions. This user guide describes the product specifications. For detailed information on handling, please refer to the "4th Generation MOSFET Evaluation Board User's Manual" .

This evaluation board does not have a short circuit protection function for the evaluation device.
Therefore, even with the normal evaluation method, if the usage deviates from the electrical specifications (maximum current, etc.) of the evaluation device selected by the customer, the device may be severely damaged with a popping sound. Therefore, never use the evaluation board in a way that deviates from the specifications of the evaluation device. Also, take precautions to prevent fragments from scattering and use protective equipment in case severe damage occurs.

1. Appearance

Figure 1 shows the appearance of the evaluation board, and Table 1 shows the dimensions and weight.



(a) For TO-247N (b) For TO-247-4L

Figure 1. Top view

Table 1 Dimensions and weight

Length	90	mm
Width	150	
Height	65	
Weight	0.2	kg

2. Features

The main features are as follows:

- TO-247-4L and TO-247N can be evaluated
- Operates on a single power supply (+12 V)
- Double pulse test up to 250 A
- Switching operation up to 500 kHz
- Supports various power supply topologies (Buck, Boost, Half-Bridge)
- Built-in adjustable gate drive isolated power supply (positive and negative) (+12 V to +25 V, -4.5 V to -2 V)
- Active mirror clamp circuit (driver IC built-in type)
- Gate surge clamp circuit

3. Arrangement Specifications

The specifications of the evaluation board arrangement are as follows, and Table 2 shows the list of specifications that can be arranged.

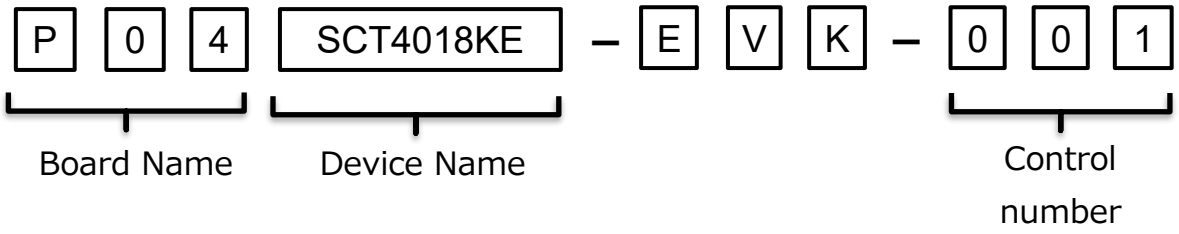


Table 2 List of specifications that can be arranged

Device	Package	Arrangement specifications
SCT4018KE	TO-247N	P04SCT4018KE-EVK-001
SCT4018KR	TO-247-4L	P05SCT4018KR-EVK-001

In addition, this board is designed with the optimum gate drive circuit for "SCT4018KE" or "SCT4018KR" as a default setting, surely other devices in "TO-247N" or "TO-247-4L" packages can also be mounted and evaluated. In this case, change the gate drive circuit constants according to the characteristics of each device, referring to "4. How to set the gate drive voltage" and "5. How to set the gate resistance"

Table.3 shows the lineup and specifications of the 4th generation SiC MOSFET series.

Product Name	V_{DSS}(V)	R_{ON}(Typ.) (mΩ)	I_D (A)	P_D (W)	Tj(Max) (℃)	Package
SCT4045DE	750	45	34	115	175	TO-247N 
SCT4026DE		26	56	176		
SCT4013DE		13	105	312		
SCT4062KE	1200	62	26	115		
SCT4036KE		36	43	176		
SCT4018KE		18	81	312		
SCT4045DR	750	45	34	115		TO-247-4L 
SCT4026DR		26	56	176		
SCT4013DR		13	105	312		
SCT4062KR	1200	62	26	115		
SCT4036KR		36	43	176		
SCT4018KR		18	81	312		

4. Functional Block Diagram

Figure 2 shows the functional block diagram. This evaluation board has four major functions.

- Drive system ... Circuit for switching power components
- Control system ... Circuit to control input signals
- Protection system ... Circuit to prevent damage to power components
- Power component system ... Components that control high voltages and currents such as SiC MOSFETs and snubber circuits.

Table 4 shows the details of each function, and Table 5. shows the definitions of the I/O signal lines. HS and LS in the figure mean for upper arm and for lower arm respectively, so they are omitted from Symbol.

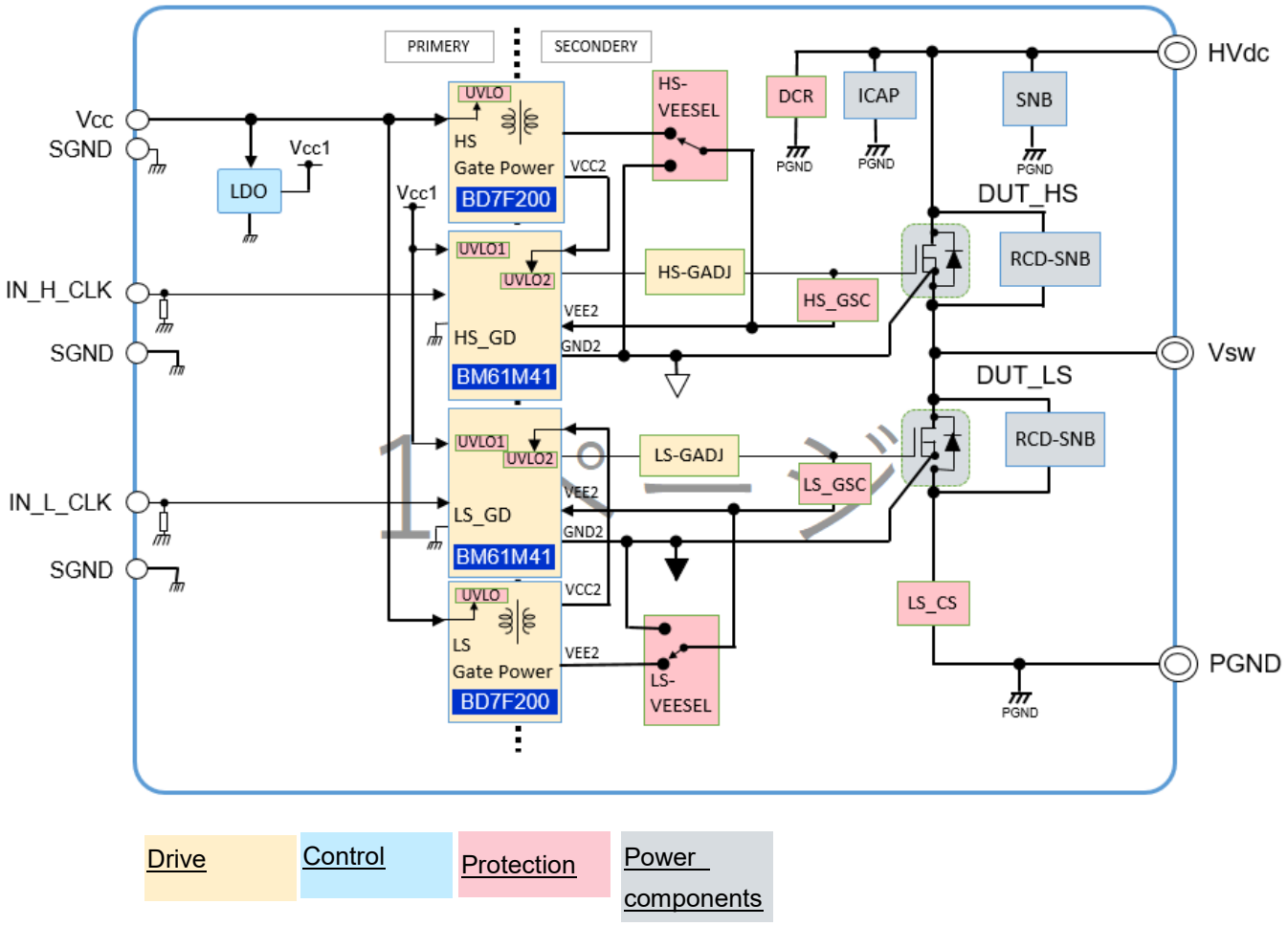


Figure 2 Functional block diagram

Table 4 Details of each function

	Function	Symbol	Detail
Drive	Gate Driver	GD	Gate drive IC (BM61M41RFV-C)
	Gate Power	GP	Power supply circuit for gate drive circuit (BD7F200EFJ-BE2)
	Gate Adjust	GADJ	Adjustment circuit for adjusting the switching speed of the MOSFET Turn-on and turn-off can be adjusted individually.
	VEE2 Select	VEESEL	VEE2 voltage setting circuit. 0 V/-2 V is selected by the setting pin
Control	Low Drop-Out regulator	LDO	Power supply for control circuits (BD450M2WEFJ) Power supply for circuits that control logic level input signals
Protection	Gate Surge Clamp	GSC	Gate-source surge voltage clamp circuits. Positive and negative surges are clamped by SBD
	Current Sense	CS	Current sensing circuit (0.1 mΩ sensing resistor)
	Discharge Resistor	DCR	Discharge resistor circuit (68 kΩ × 5 in series) Discharges the charge of the input capacitor when HVdc is turned off.
Power components	Input Capacitor	ICAP	Input smoothing capacitor
	Snubber Capacitor	C-SNB	Bypass capacitor connected to the upper and lower arms collectively
	RDC Snubber Circuit	RCD_SNB	Non-discharge type RCD snubber circuit connected to each of the upper and lower arms
	Device Under Test	DUT	MOSFET and SBD for evaluation

Table 5 Definition of input/output signal lines

Connector	Pin	signal	I/O	Details
CN1	01	IN_H_CLK	I	Signal to turn on/off the upper arm MOSFET
	02	SGND	--	Input signal side GND
CN101	01	IN_L_CLK	I	Signal to turn on/off the lower arm MOSFET
	02	SGND	--	Input signal side GND
CN201	01	Vcc	--	Power supply pin for driver IC and internal control
	02	SGND	--	Input signal side GND
JP51 JP151	01	GND2	I	Driver IC(U2,U102) GND2 signal
	02	SOURCE	--	DUT Source signal (In the case of TO-247-4L, Driver Source signal)
	03	VEE2	I	VEE2 power supply
T1	--	HVdc	--	High-voltage input/output pins
T2	--	Vsw	--	Source pin of upper arm MOSFET and drain pin of lower arm MOSFET
T3	--	PGND	--	Power GND pin

5. Electrical Characteristics

Table 6 shows the maximum ratings and Table 7 shows the recommended operating conditions.

Table 6 Maximum ratings

Parameter	Symbol	Min.	Max.	Unit	Remarks
Input Voltage DC	V_{HVdc}		1200	V	
Input Voltage slew rate	SR_{HVdc}		50	V/μs	Limited by input film capacitor
Output Voltage	V_{OUT}		1200	V	
Vcc Supply Voltage	V_{CC}	9.0	18	V	for isolated gate power and internal logic
Input Signal Voltage	$V_{IN\_H\_CLK}$ $V_{IN\_L\_CLK}$	- 0.3	7.0	V	
Storage Temperature	T_{STG}	-10	40	ºC	Limited by input film capacitor

Table 7 Recommended operating conditions

Parameter	Symbol	Min.	TYP.	Max.	Unit	Remarks
Input Voltage DC	V_{HVdc}			900	V	
Output Voltage	V_{OUT}			900	V	
Vcc Supply Voltage	V_{CC}	10	12	15	V	
Output Current	I_{OUT}			30	A	
Double Pulse Current	I_{DP}			250	A	
CLK Signal frequency	$f_{IN\_xx\_CLK}$			500	kHz	
Gate positive supplied voltage	VG+	12		23	V	
Gate negative supplied voltage	VG-	-4.5		-2.0	V	0 V and VG- selectable
VG+ UVLO	V_{UVLO_VG+}		7.8 – VG-		V	
Input signal Low level voltage	$V_{IN\_H\_CLK}$ $V_{IN\_L\_CLK}$	0		0.8	V	
Input signal High Level voltage		2.4		5.25	V	
Operating Temperature	T_{OPR}	-25		85	ºC	
Cumulative operating Time	t_{CUM}		100		Hrs.	

6. Circuit Diagram

Figures 3(a) and (b) show the circuit diagrams when SCT4018KE and SCT4018KR are mounted, respectively.

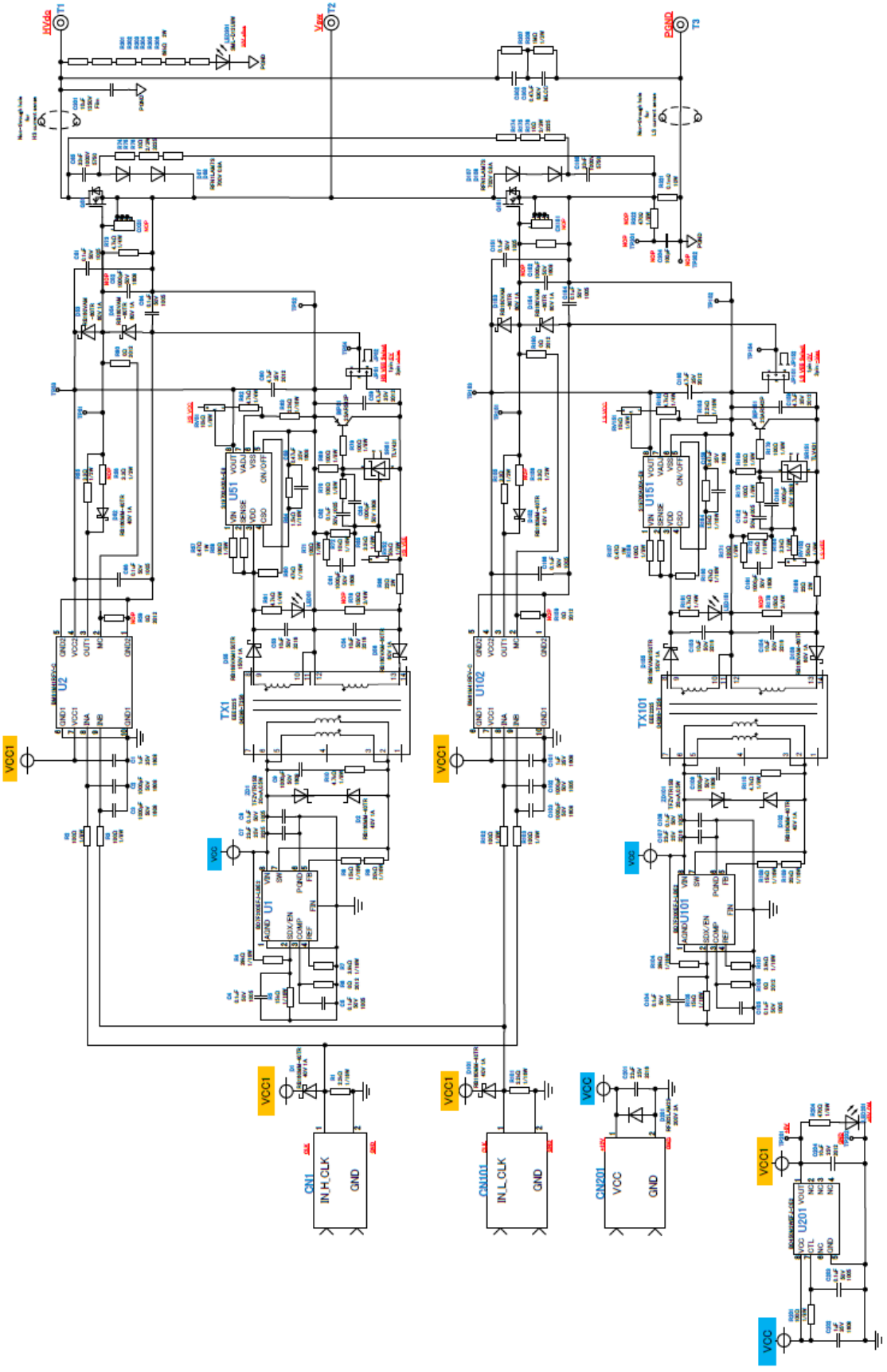


Figure 3. (a) P04SCT4018KE-EVK-001 Schematics

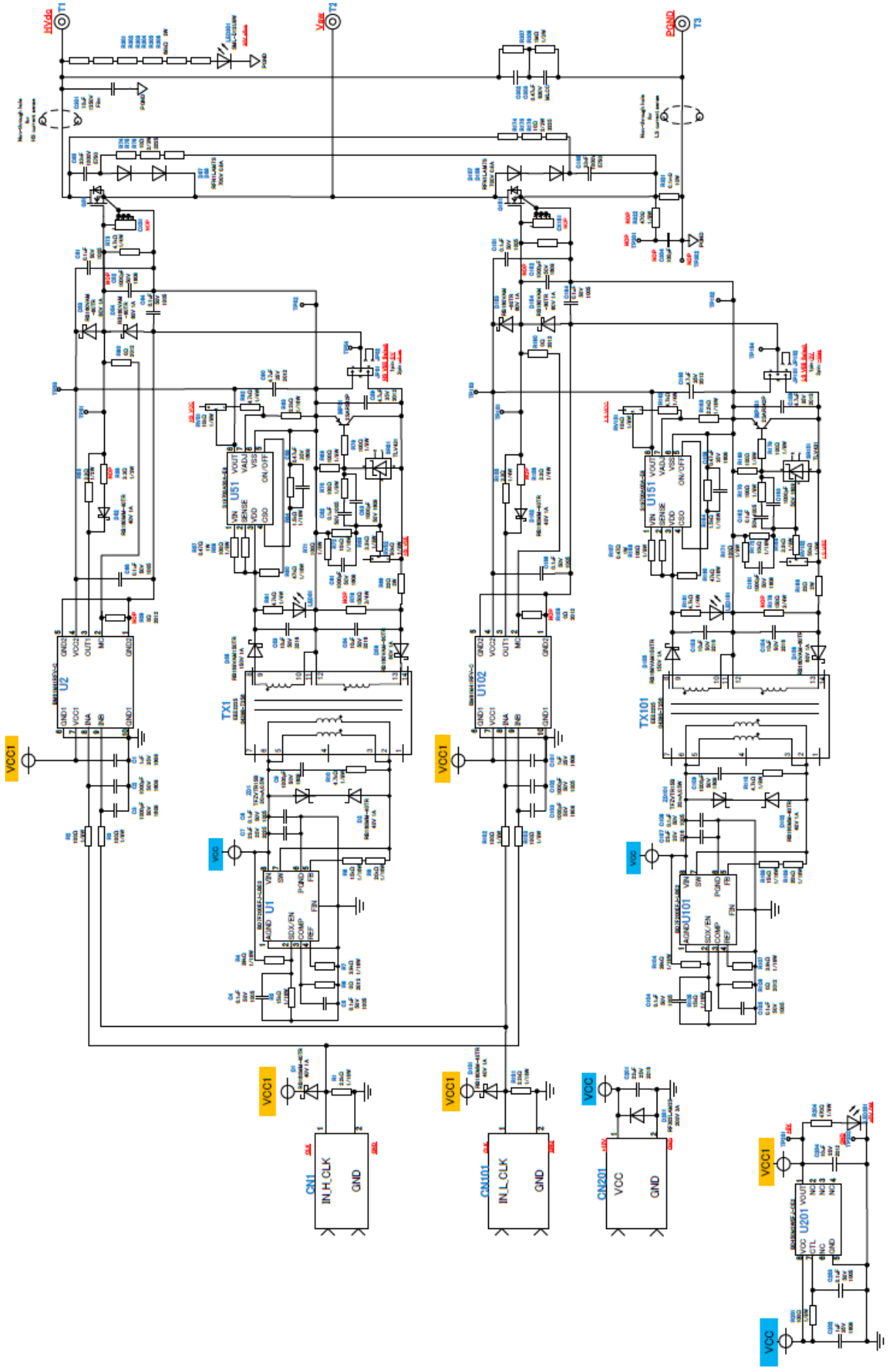


Figure 3. (b) P05SCT4018KR-EVK-001 Schematics

7.BOM

Table 8. Bills of Materials

Device	Mounted	Symbol	Parts Number	Values	Manufacture	Package Size [mm]
PCB	--	--	PCB004 Rev.0.1 PCB005 Rev.0.1	RF4, 4layer, 2.0mm Thickness		90 x 150
Heatsink	NOP	--	33BS136 or equivalent	1.16K/W, 477g	SANKYO	137x33x100
IC		U1,U101	BD7F200EFJ-LB2	PWM IC	ROHM	HTSOP-J8
IC		U2,U102	BM61M41RFV-C	Driver IC	ROHM	SSOP-B10W
IC		U201	BD450M2WEFJ-CE2	LDO(5V,0.2A)	ROHM	HTSOP-J8
IC		U51,U151	S-19700A00A-E8	LDO(20V,0.4A)	ABLIC	HSOP-8A
Shunt Regulator		SR51,SR151	TLV431AQDBVRQ1	6V,20mA	TI	SOT23-5
Bipolar		BIP51,BIP151	2SAR542P	PNP(-30V,-6A)	ROHM	SOT-89
Diode		D1,D101,D2,D102 D52,D152	RB160MM-40TR	40V,1A	ROHM	PMDU
Diode						
Diode		D55,D155	RB168VAM150TR	150V,1A	ROHM	TUMD2M
Diode		D53,D54,D153,D154,D56,D156	RB160VAM-60TR	60V,1A	ROHM	TUMD2M
Diode		D57,D58,D157,D158	RFN1LAM7STR	700V,0.8A	ROHM	PMDTM
Diode		D201	RF302LAM2STR	200V,3A	ROHM	PMDTM
MOSFET	NOP	Q51,Q151	SCT4018KE SCT4018KR	1200 V, 18mΩ	ROHM	TO247N TO-247-4L
Zener Diode		ZD1,ZD101	TFZVTR15B	15V, 20mA	ROHM	TUMD2M
LED		LED201,LED51,LED151	SML-D12P8WT86L	Green, 20mA	ROHM	1608
LED		LED301	SML-D12U8WT86Q	Red, 20mA	ROHM	1608
Jumper pin		JP51,JP151	929647-09-03-EU	Male,3-pin	3M	3.68mm
Jumper pin shunt	NOP	JP52,JP152	QPC02SXGN-RC	2-pin, black	Sullins	2.54x5x6
Terminal		T1,T2,T3	7808	M5, 30A, 6P	Keystone	12 x 12
Terminal		CN1,CN101,CN201	OSTTE020104	2pin, black	ON-SHORE	8 x 7
Test Pin		TP51,TP52,TP53,TP54	HK-2-G	SMD	Mac8	3.2 x 1.6
Test Pin		TP151,TP152,TP153				
Test Pin		TP154,TP201,TP202				
Test Pin	NOP	TP301,TP302				
Connector	NOP	CX51,CX151	73415-2061	Jack, SMD mount	Molex	ø3.45 × 3.45
Transformer		TX1,TX101	EE2225-1223-4NR	2-output	SUMIDA	20 x 18 (3.5mm)
Trimmer		RV51,RV151	SM-3TW10kohm(103)	10k,1/8W,11turns	Copal	3.9 x 3.5
Trimmer		RV52,RV152	SM-3TW50kohm(503)	50k,1/8W,11turns	Copal	3.9 x 3.5
Resistor	Mounted	R1,R101,R63,R163	MCR01MZPF2201	2.2k,1/16W	ROHM	1.0 x 0.5
Resistor	Mounted	R4,R104	MCR01MZPF3902	39k,1%,1/16W	ROHM	1.0 x 0.5
Resistor	Mounted	R5,R105,R8,R108	MCR01MZPF1502	15k,1%,1/16W	ROHM	1.0 x 0.5
Resistor	Mounted	R9,R109	MCR01MZPF2002	20k,1%,1/16W	ROHM	1.0 x 0.5
Resistor	Mounted	R10,R110	MCR10EZPF4701	4.7k,1%,1/8W	ROHM	2.0 x 1.25
Resistor	Mounted	R7,R107	MCR01MZPF3901	3.9k,1%,1/16W	ROHM	1.0 x 0.5
Resistor	Mounted	R6,R106,R80,R180	MCR10EZPJ000	0ohm	ROHM	2.0 x 1.25
Resistor	Mounted	R204	MCR10EZPF4700	470,1%,1/8W	ROHM	2.0 x 1.25
Resistor	Mounted	R60,R160	MCR01MZPF4702	47k,1%,1/16W	ROHM	1.0 x 0.5
Resistor	Mounted	R64,R164	MCR01MZPF1501	1.5k,1%,1/16W	ROHM	1.0 x 0.5

Table 8. Bills of Materials

Device	Mounted	Symbol	Parts Number	Values	Manufacture	Package Size [mm]
Resistor	Mounted	R72,R172	MCR01MZPF1002	10k,1%,1/16W	ROHM	1.0 x 0.5
Resistor	Mounted	R65,R165	MCR10EZPF3301	3.3k,1%,1/8W	ROHM	2.0 x 1.25
Resistor	Mounted	R2,R102,R3,R103,R58	MCR10EZPJ101	100,5%,1/8W	ROHM	2.0 x 1.25
Resistor	Mounted	R158,R69,R169,R70,R170				
Resistor	Mounted	R71,R171,R79,R179,R201				
Resistor	Mounted	R74,R174,R75,R175	ESR25JZPJ100	10, 5%, 2/3W	ROHM	3.2 x 2.5
Resistor	Mounted	R76,R176			ROHM	3.2 x 2.5
Resistor	Mounted	R66,R166,	LTR100JZPF22R0	22, 1%,2W	ROHM	6.4 x 3.2
Resistor	Mounted	R57,R157	LTR18EZPFLR470	0.47,1%,1W	ROHM	1.6 x 3.2
Resistor	Mounted	R321	PSR500HTQFB0L10	0.1m,1%,10W	ROHM	5.9 x 3.1
Resistor	Mounted	R61,R161,R62,R162	MCR18EZPJ472	4.7k,5%,1/4W	ROHM	3.2 x 1.6
Resistor	Mounted	R73,R173				
Resistor	Mounted	R55,R155	ESR18EZPJ3R3	3.3,5%,1/2W	ROHM	3.2 x 1.6
Resistor	Mounted	R307,R308	KTR25JZPJ105	1M,5%,1/3W	ROHM	3.2 x 2.5
Resistor	Mounted	R301,R302,R303,R304	LTR100JZPJ683	68k,5%,2W	ROHM	3.2 x 6.4
Resistor	Mounted	R305,R306				
Resistor	NOP	R56,R156	ESR18EZPJ3R3	3.3,5%,1/2W	ROHM	3.2 x 1.6
Resistor	NOP	R59,R159	MCR10MZPJ000	0ohm	ROHM	2.0 x 1.25
Resistor	NOP	R78,R178	LTR18EZPF1500	150,1%,3/4W	ROHM	1.6 x 3.2
Resistor	NOP	R322	MCR10EZPF4700	2.2k,1/16W	ROHM	2.0 x 1.25
Capacitor	Mounted	C4,C104	CGA2B3X7R1H104K050BB	0.1u,50V,X7R	TDK	1.0 x 0.5
Capacitor	Mounted	C5,C105,C8,C108				
Capacitor	Mounted	C51,C151,C62,C162				
Capacitor	Mounted	C64,C164,C66,C166,C203				
Capacitor	Mounted	C1,C101,C202	CGA3E1X7R1V105K080AC	1u,35V,X7R	TDK	1.6 x 0.8
Capacitor	Mounted	C2,C102,C3,C103,C9	CGA3E2C0G1H102J080AA	1000p,50V,X7R	TDK	1.6 x 0.8
Capacitor	Mounted	C109,C61,C161,C63,C163				
Capacitor	Mounted	C58,C158	CGA3E1X7R1V474K	0.47u,35V,X7R	TDK	1.6 x 0.8
Capacitor	Mounted	C59,C159,C60,C160	CGA4J1X7R1V475K125AC	4.7u,35V,X7R	TDK	2.0 x 1.25
Capacitor	Mounted	C204	CGA4J1X7S1E106KT0Y0N	10uF,25V,X7S	TDK	2.0 x 1.25
Capacitor	Mounted	C53,C153,C54,C154	CGA5L1X7R1H106K160AC	10uF,50V,X7R	TDK	3.2 x 1.6
Capacitor	Mounted	C7,C107,C201	CGA6P3X7R1E226M250AB	22uF,25V,X7R	TDK	3.2 x 2.5
Capacitor	Mounted	C302,C303	CGA9P1X7T2J474M250KC	0.47u,630V,X7T	TDK	5.7 x 5.0
Capacitor	Mounted	C301	B32776G1106K000	10uF,1250V	TDK	42 x 28
Capacitor	Mounted	C65,C165	CGA9Q1C0G3A333J280KC	33000pF,1000V	TDK	5.7 x 5.0
Capacitor	NOP	C52,C152	CGA3E2C0G1H102J080AA	1000p,50V,X7R	TDK	1.6 x 0.8
Capacitor	NOP	C304	CGA2B2C0G1H101J050BA	100p,50V,C0G	TDK	1.0 x 0.5

8. PCB Layout

This evaluation board has four layers. (A) to (d) show the pattern layout of each layer, and (e) and (f) show the silkscreen printing. Figure 4 is for TO-247N and Figure 5 is for TO-247-4L.

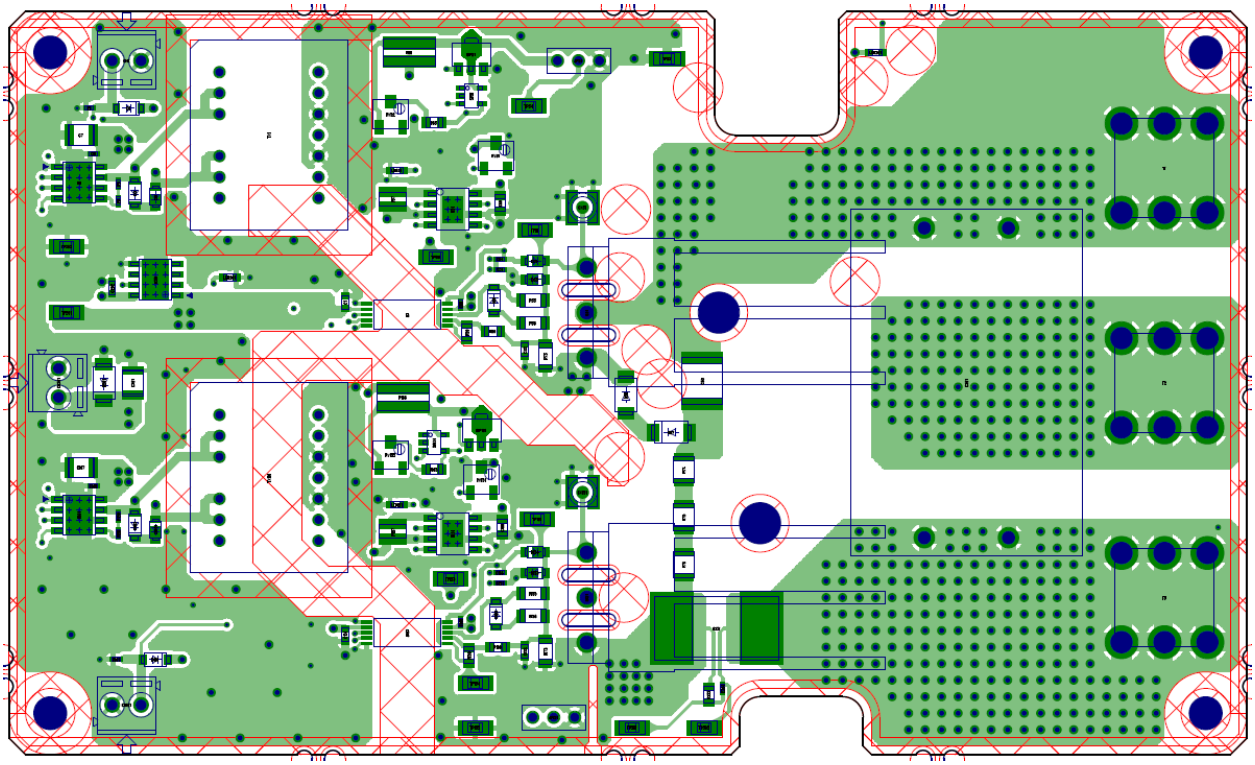


Figure 4. (a) Top Layer (Top view)

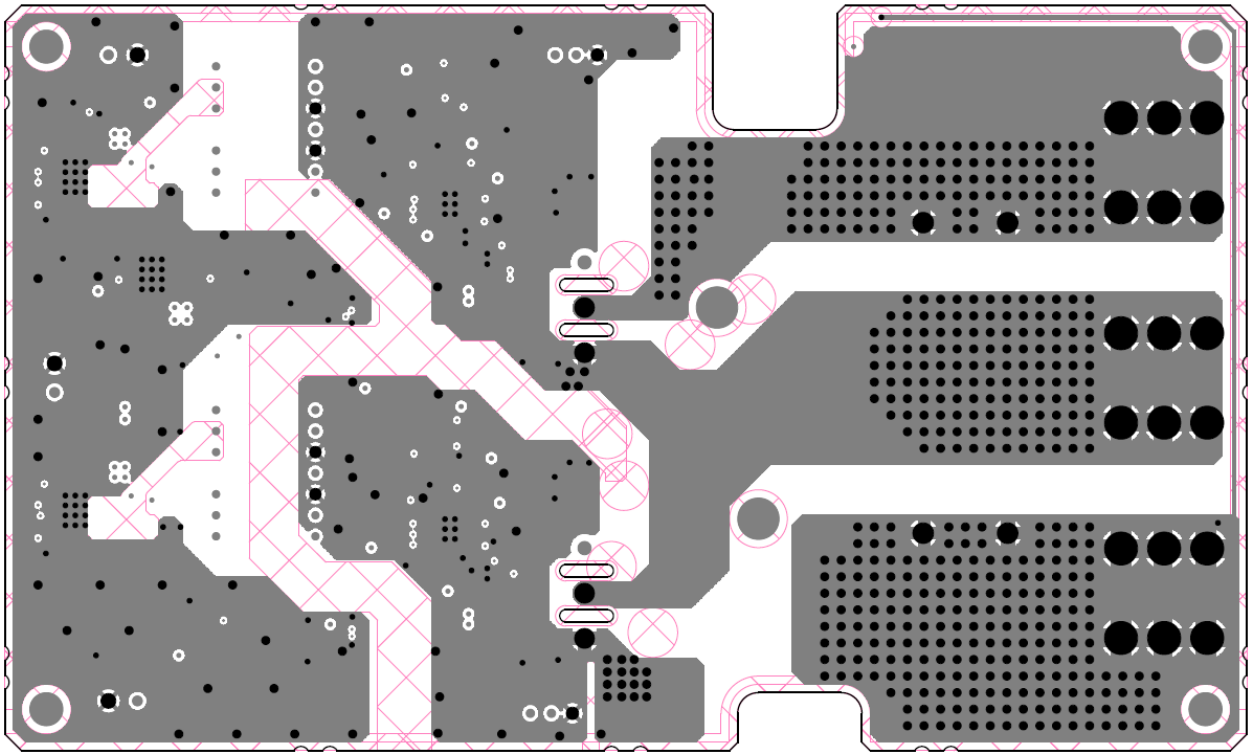


Figure 4. (b) Layer 2 (Top view)

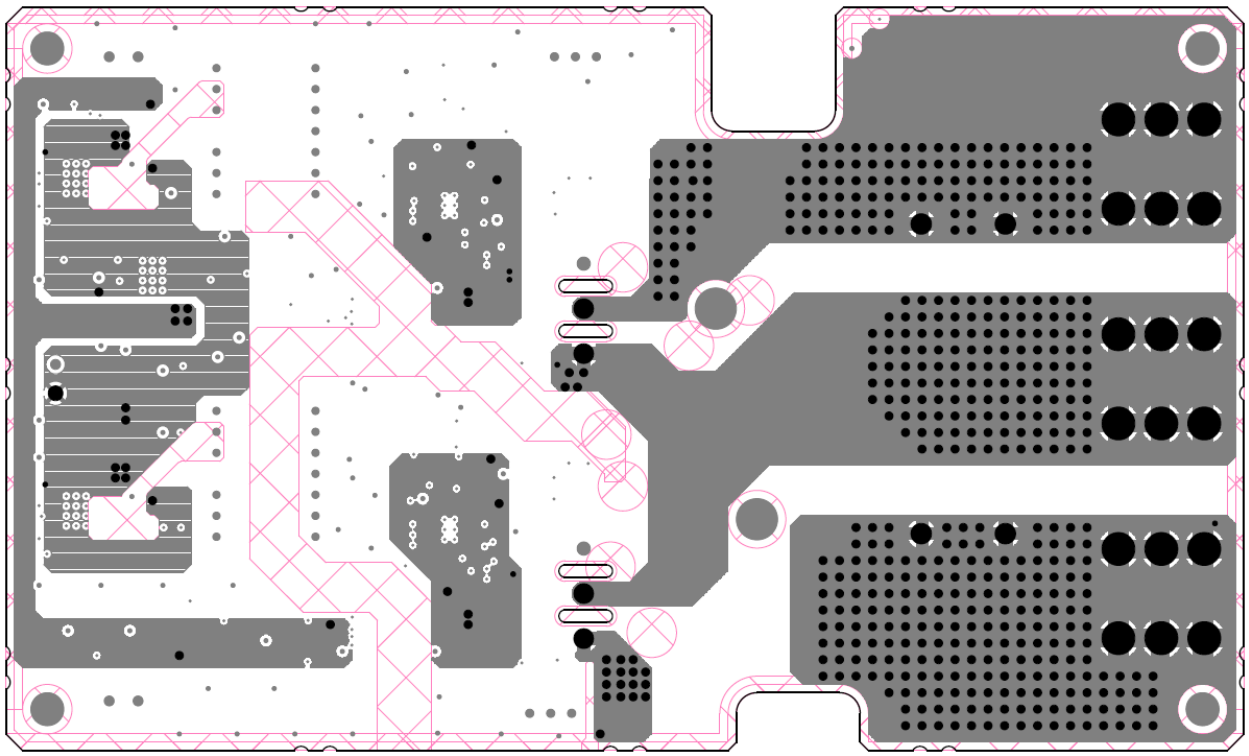


Figure 4. (c) Layer 3 (Top view)

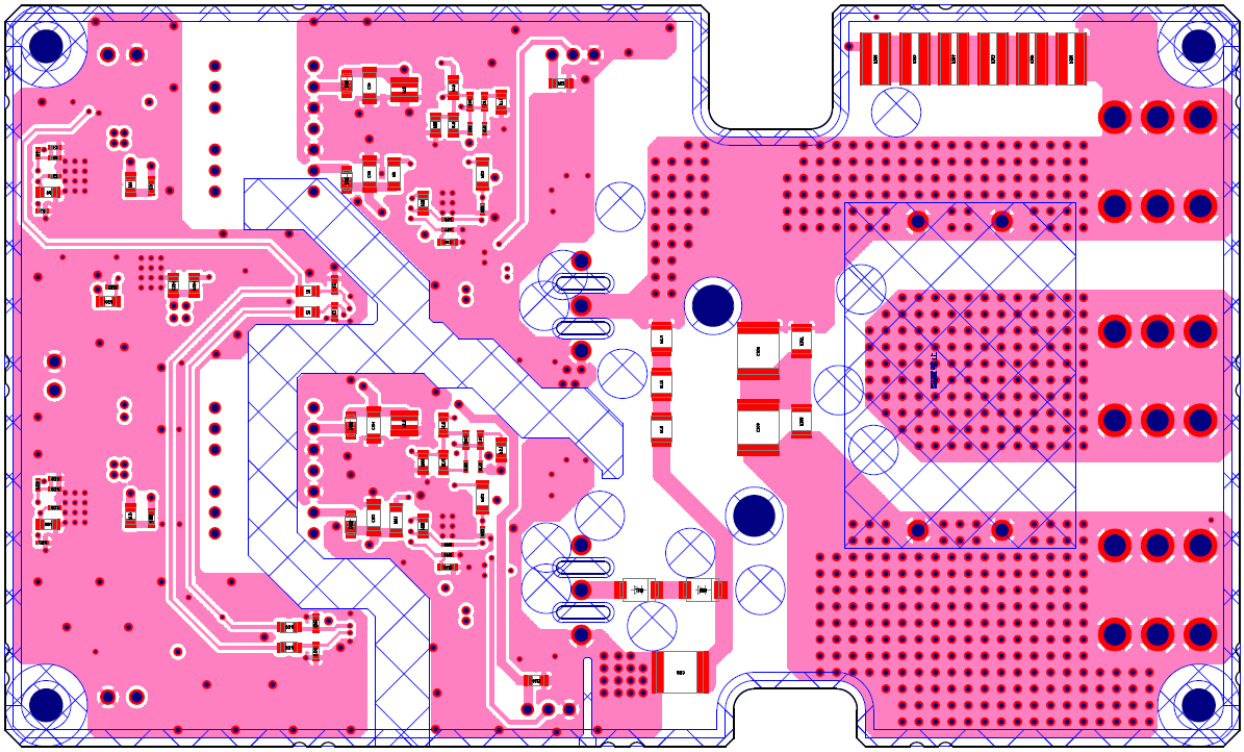


Figure 4. (d) Bottom Layer (Top view)

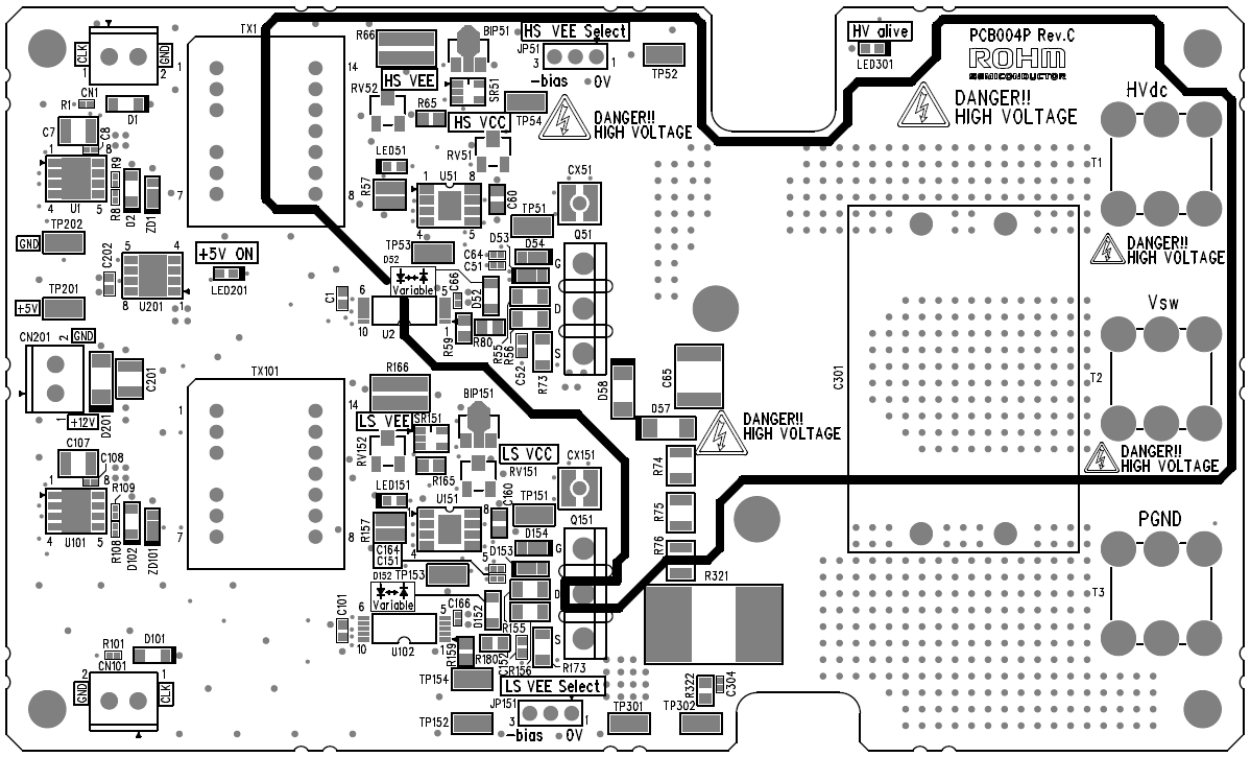


Figure 4. (e) TOP Silkscreen

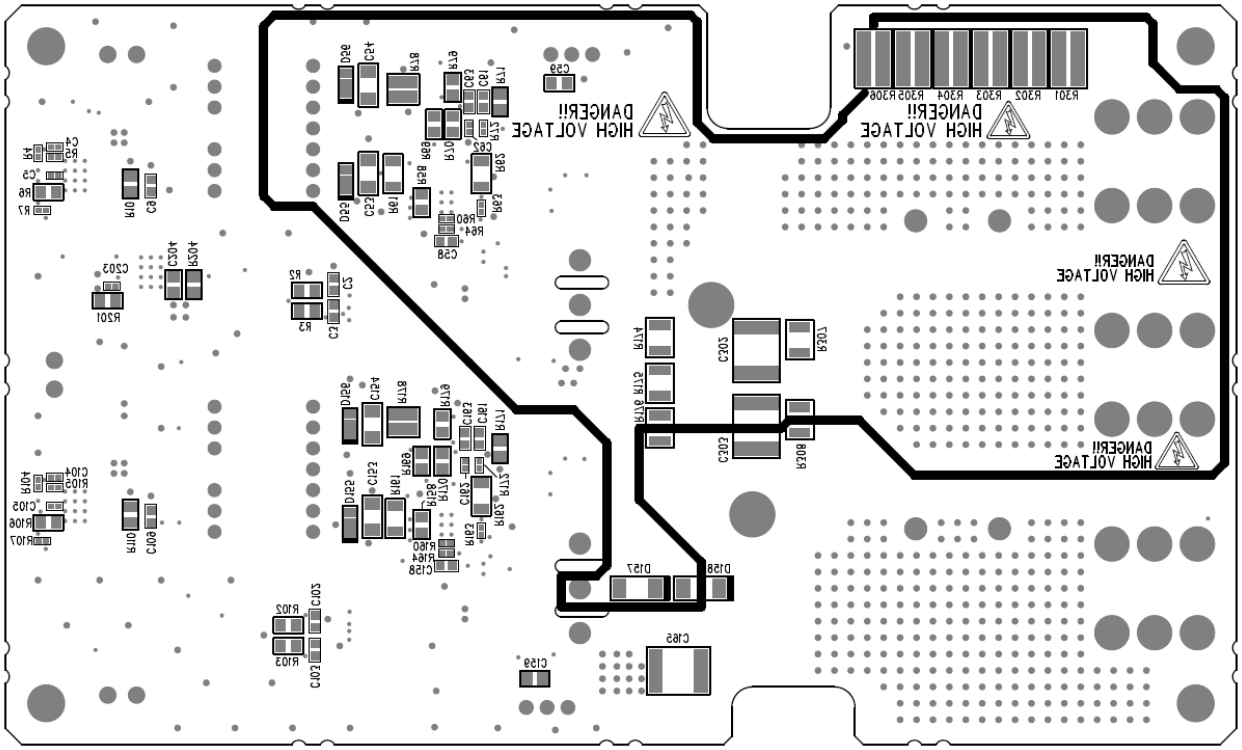


Figure 4. (f) Bottom Silkscreen

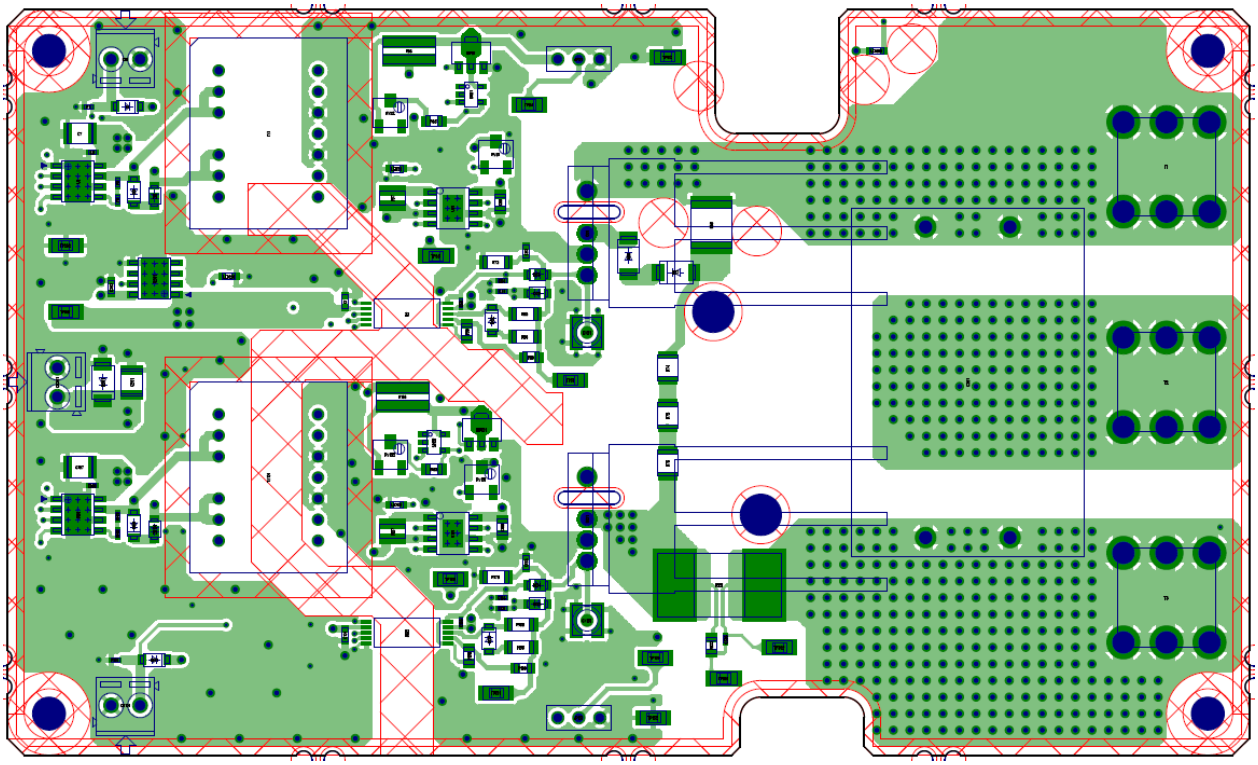


Figure 5. (a) Top Layer (Top view)

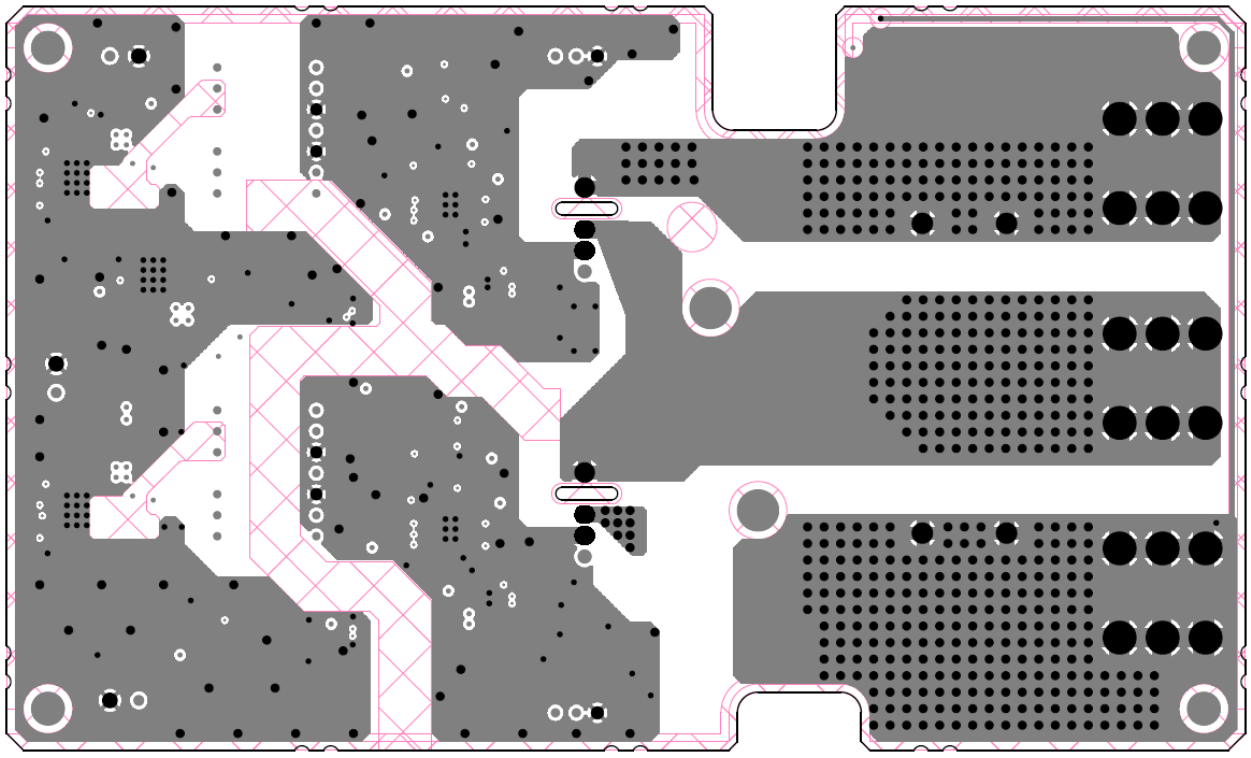


Figure 5. (b) Layer 2 (Top view)

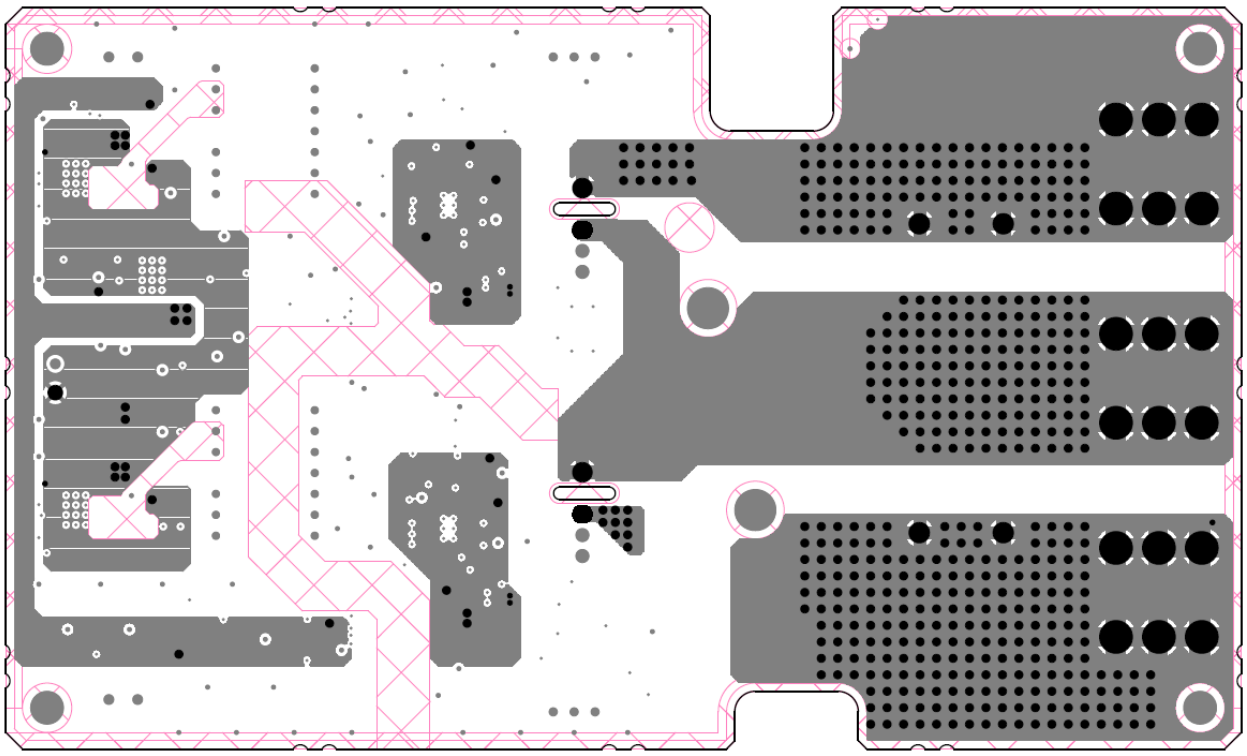


Figure 5. (c) Layer 3 (Top view)

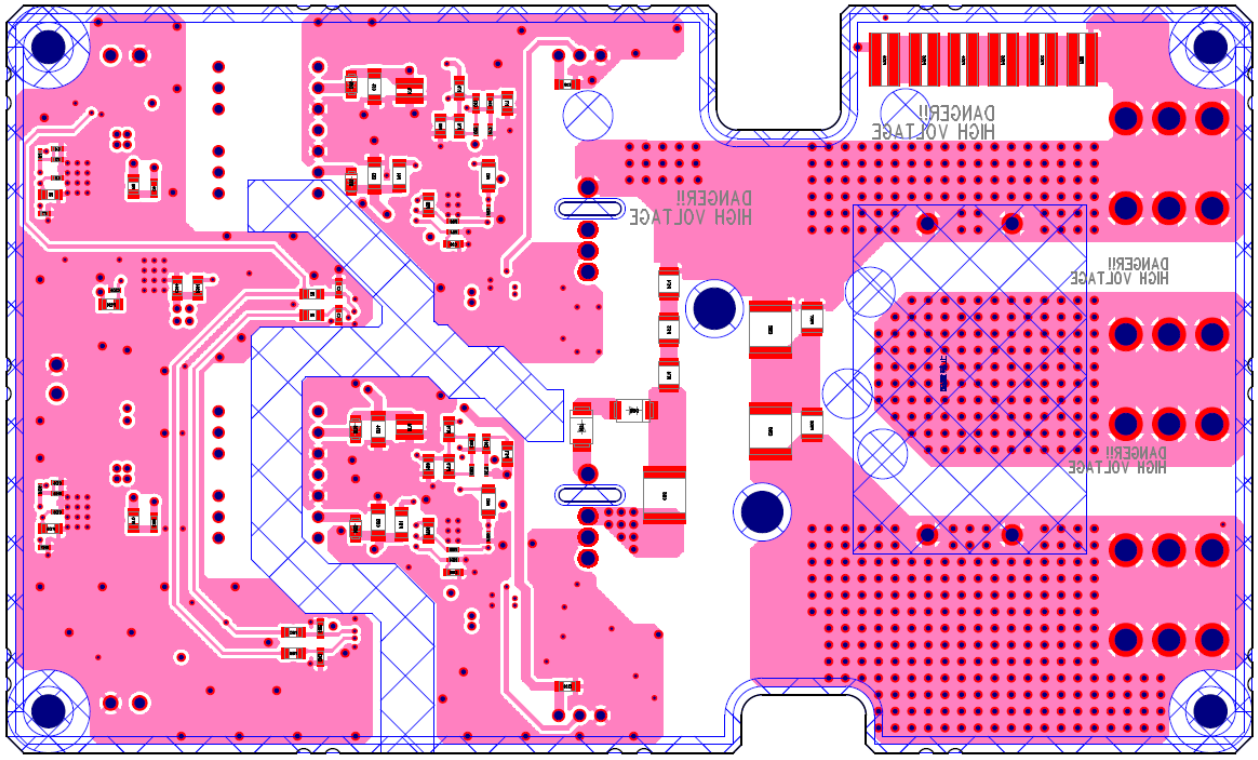


Figure 5. (d) Bottom Layer (Top view)

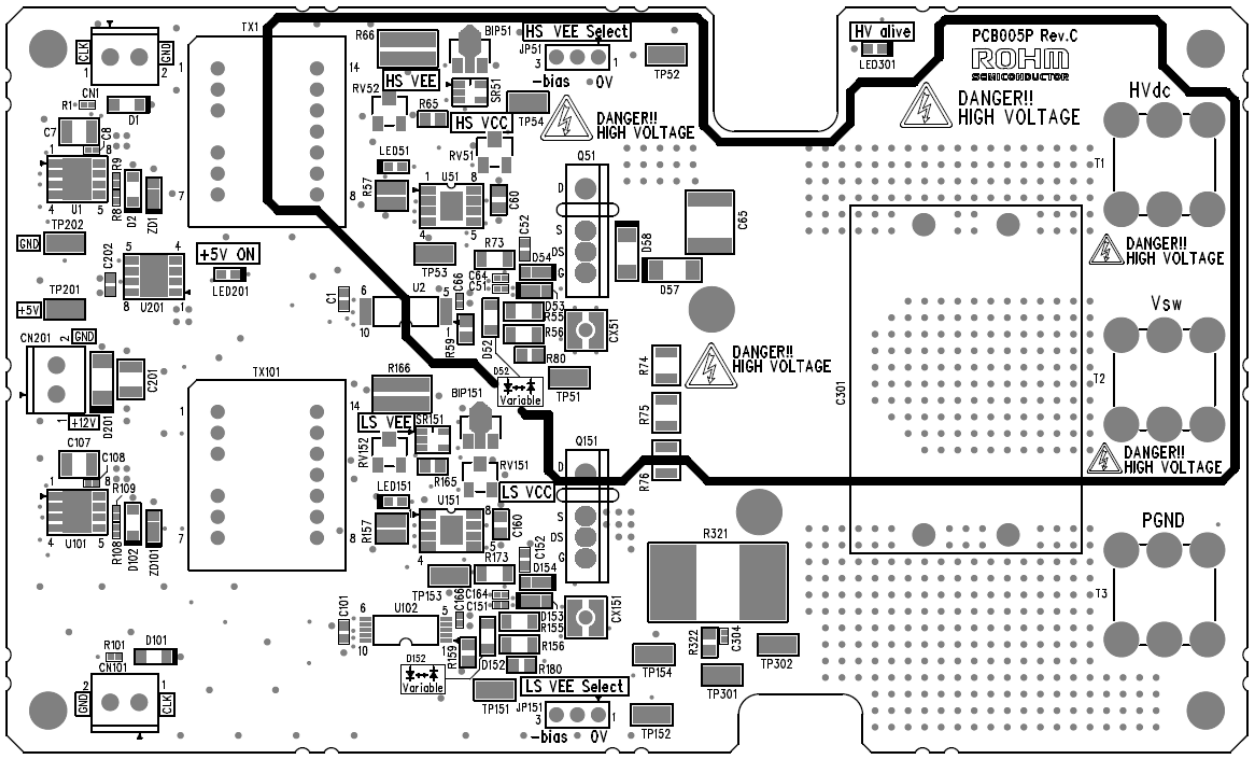


Figure 5. (e) TOP Silkscreen

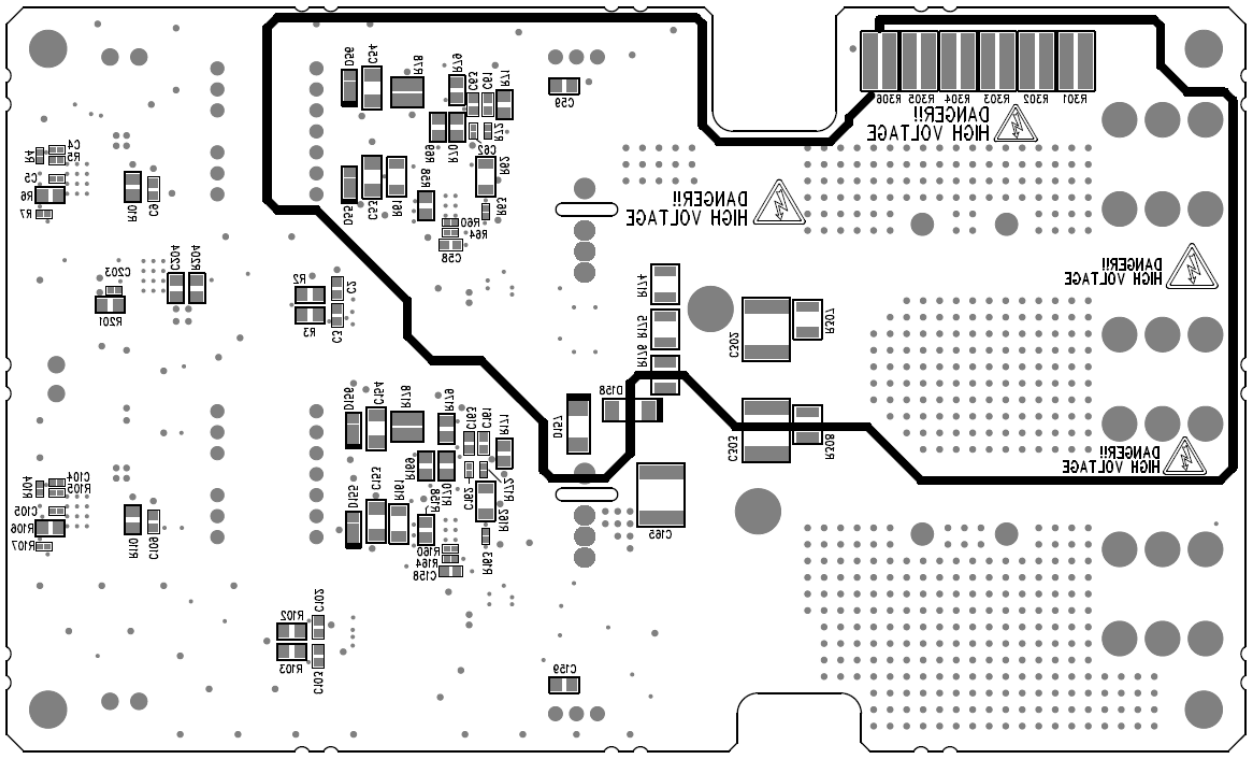


Figure 5. (f) Bottom Silkscreen

9. Precautions

Since this evaluation board handles voltages of several hundred volts, care must be taken at all times to avoid dangerous situations due to malfunctions. Defects may occur not only in this board, but also due to incorrect handling, such as misconnection of wiring or application of out-of-specification voltages.

Table 9 shows the points to pay attention to, but please take all possible measures to prevent other problems before using the product.

Table 9 List of typical faults

Function	Items	Details
DCR	LED does not light up	When voltage is applied to the HVdc-PGND pins, check that LED301 (red) is lit. If the LED does not light up, check the applied voltage source and wiring. The LED lights up when the input/output voltage is approximately 20 V or more.
HVdc Vsw	Misconnection of wiring Application of out-of-specification voltage	It is strictly prohibited to apply a voltage higher than the specified value (1200 V), and care must be taken to ensure that there is no misconnection of wiring, etc. Also, never touch the product while it is in operation.
Vcc	Misconnection of wiring Application of out-of-specification voltage	Check the wiring of Vcc before use to prevent the application of positive and negative reverse voltages. However, since a diode for reverse connection is included, the OCP setting of the Vcc power supply should be set to 1 A to 3 A. (To protect the diode for reverse connection). Also, applying a voltage other than the specified voltage may cause a failure, so operate the circuit only after thorough confirmation.
SNB RDC_SNB	MLCC burnout	An MLCC, that is prone to cracks and other short-circuit failures due to mechanical stress, is used. Therefore, handle the board with care to avoid excessive shocks. If you have even the slightest concern when voltage is applied, immediately take measures to avoid danger, such as cutting off the applied voltage.
IN_H_CLK IN_L_CLK	Continuous pulse application	Continuous application of the CLK signal to drive the DUT may cause a current exceeding the specified value to flow and may damage the DUT. Therefore, always use the DUT within the range that satisfies its electrical characteristics.
DUT	Driver IC damage	If the gate-source of the DUT is short-circuited and the CLK signal to be driven is turned on, a short-circuit current will flow from Vcc2 through the OUT pin to GND2, which may destroy the OUT pin of the driver IC if the external resistance is small. Therefore, be sure to check the gate-source short circuit conditions before operation.

END

Notes

1) The information contained herein is subject to change without notice.

2) Before you use our Products, please contact our sales representative and verify the latest specifications :

3) Although ROHM is continuously working to improve product reliability and quality, semiconductors can break down and malfunction due to various factors.
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4) Examples of application circuits, circuit constants and any other information contained herein are provided only to illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

5) The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. ROHM does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by ROHM or any other parties. ROHM shall have no responsibility whatsoever for any dispute arising out of the use of such technical information.

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7) For use of our Products in applications requiring a high degree of reliability (as exemplified below), please contact and consult with a ROHM representative : transportation equipment (i.e. cars, ships, trains), primary communication equipment, traffic lights, fire/crime prevention, safety equipment, medical systems, servers, solar cells, and power transmission systems.

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