ROHM SEMICONDUCTOR

High Power Density SiC Module HSDIP20:

3-Phase Inverter Evaluation Board

(BST70T2P4K01-EVK-001)

User’s Manual

User’s Guide

Contents

＜High Voltage Safety Precautions＞

◇ Read all safety precautions before use

Please note that this document covers only the HSDIP20 3-phase Inverter evaluation board (BST70T2P4K01-EVK-001) and its functions. For additional information, please refer to the datasheet.

To ensure safe operation, please carefully read all precautions before handling the evaluation board

Depending on the configuration of the board and voltages used,

Potentially lethal voltages may be generated.

Therefore, please make sure to read and observe all safety precautions described in the red box below.

Before Use

[1] Verify that the parts/components are not damaged or missing (i.e. due to the drops).
[2] Check that there are no conductive foreign objects on the board.
[3] Be careful when performing soldering on the module and/or evaluation board to ensure that solder splash does not occur.
[4] Check that there is no condensation or water droplets on the circuit board.

During Use

[5] Be careful to not allow conductive objects to come into contact with the board.
[6] **Brief accidental contact or even bringing your hand close to the board may result in discharge and lead to severe injury or death.**
Therefore, DO NOT touch the board with your bare hands or bring them too close to the board.
In addition, as mentioned above please exercise extreme caution when using conductive tools such as tweezers and screwdrivers.
[7] If used under conditions beyond its rated voltage, it may cause defects such as short-circuit or, depending on the circumstances, explosion or other permanent damages.
[8] Be sure to wear insulated gloves when handling is required during operation.

After Use

[9] The ROHM Evaluation Board contains the circuits which store the high voltage. Since it stores the charges even after the connected power circuits are cut, please discharge the electricity after using it, and please deal with it after confirming such electric discharge.
[10] Protect against electric shocks by wearing insulated gloves when handling.

This evaluation board is intended for use only in research and development facilities and should by handled **only by qualified personnel familiar with all safety and operating procedures.**
We recommend carrying out operation in a safe environment that includes the use of high voltage signage at all entrances, safety interlocks, and protective glasses.

High Power Density SiC Module HSDIP20: 3-Phase Inverter Evaluation Board (BST70T2P4K01-EVK-001)

User's Manual

This user guide describes how to use the 3-phase inverter evaluation board (BST70T2P4K01-EVK-001) consisting of the high-density SiC power module HSDIP20 (six-in-one type). Be careful that this is not a 4-in-1 type module evaluation board.

To use the board safely, be sure to observe the precautions in this document even though the board is designed to allow customers to easily create their own evaluation environments.

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 and emit a popping sound. Therefore, never use the evaluation board in a way that deviates from the specifications of the evaluation device. In addition, take precautions to prevent fragments from scattering and use protective equipment in case severe damage occurs.

To evaluate the operation conditions of a SiC module and its effects on applications, it is necessary to create an evaluation environment. However, this is not an easy task. To solve this problem, we have prepared an evaluation board that allows you to easily create an evaluation environment for the HSDIP20, so that you can efficiently conduct an evaluation. Furthermore, the board is designed in a modular manner in which functions are divided and arranged to improve the usefulness of evaluation testing.

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2026.1

0.Summary

This evaluation board is configured with three types of boards. The main board equipped with the power device and peripherals has connectors for two types of daughterboards: gate driver boards operating the power device and sensing boards obtaining voltages and currents applied to devices. Use the included gate driver boards.

Figure A shows the appearance and functions of the evaluation board (main board), Figure B shows the appearance of the gate driver board, and Figure C shows a diagram of the system configuration. Note that no sensing boards are included. However, the main board can obtain analog signals, so connect any sensing board prepared by yourself.

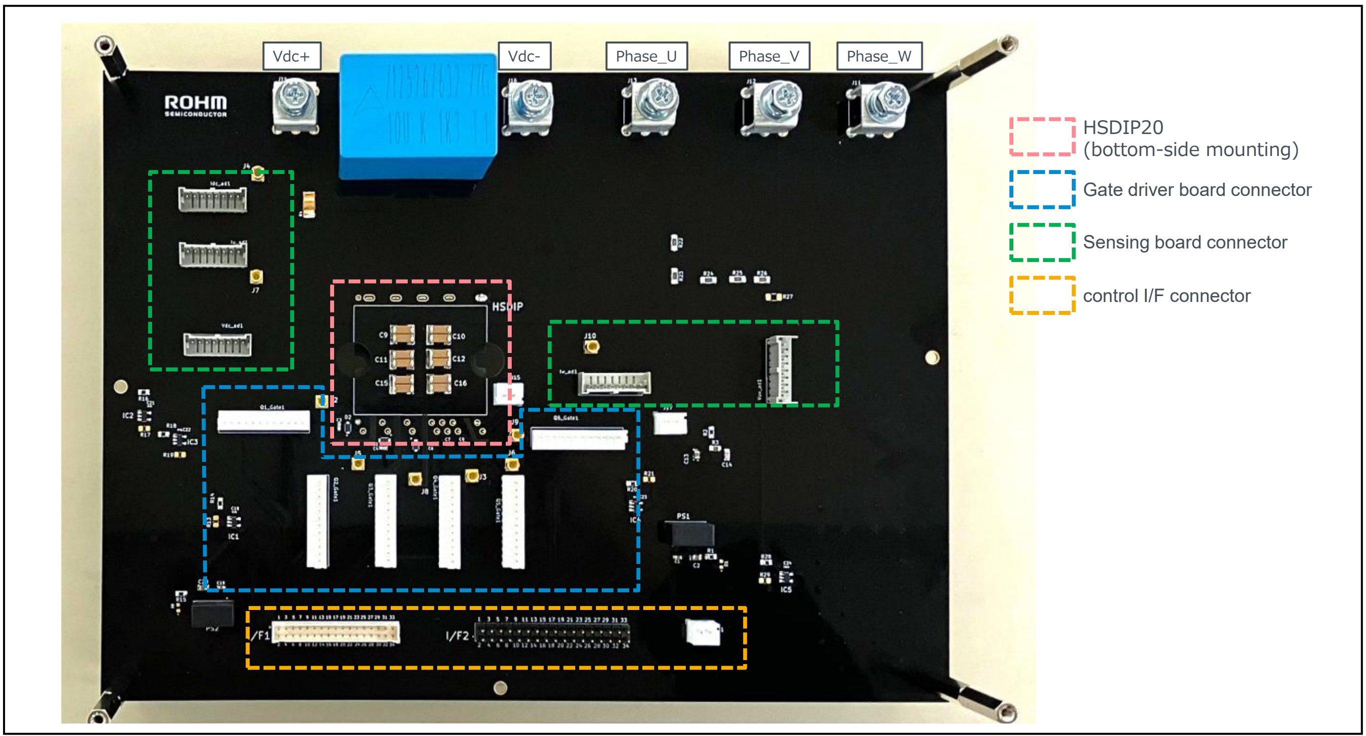


Figure A. Appearance and functions of the evaluation board

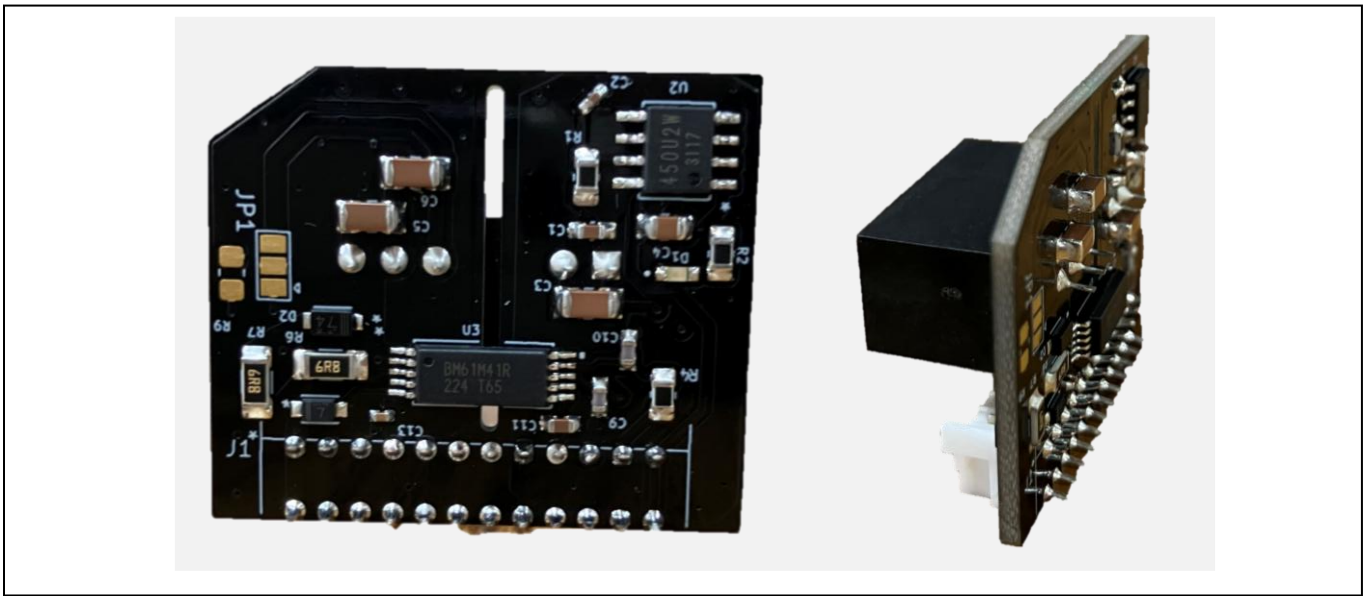


Figure B. Appearance of the gate driver board

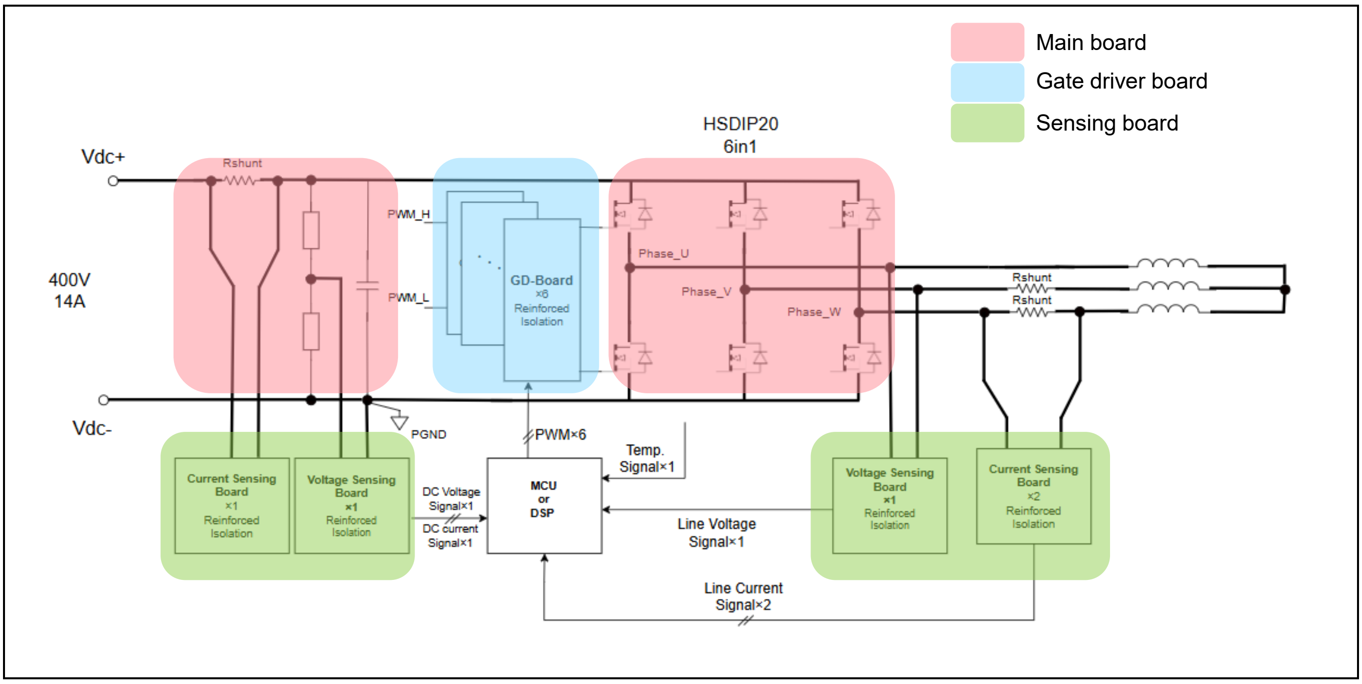


Figure C. Diagram of the system configuration. Sensing boards shall output analog signals only.

List of core parts

Table A. Core parts

Product	Model	Feature	Data sheet
Power module	BST70T2P4K01-VC	Small and low-loss SiC MOSFET, 6-in-1, Rthj-c 0.28°C/W, built-in thermistor	URL
Gate driver IC	BM61M41RFV-C	Breakdown voltage of 3750 Vrms, I/O delay time of 65 ns, and minimum input pulse width of 60 ns.	URL
Chip resistor for current sensing	PSR100KTQFH1L00	6432 (2512) size, 8W, 1mΩ, High Power Type Metal Plate Shunt Resistor	URL
Op-amp	LMR1802G-LB	High precision, low noise, low input offset, low input bias current	URL

1. Introduction

Since this board has multiple voltage and signal sources supplied from external sources, be sure to follow the on/off sequence specified below to avoid problems, such as destruction.

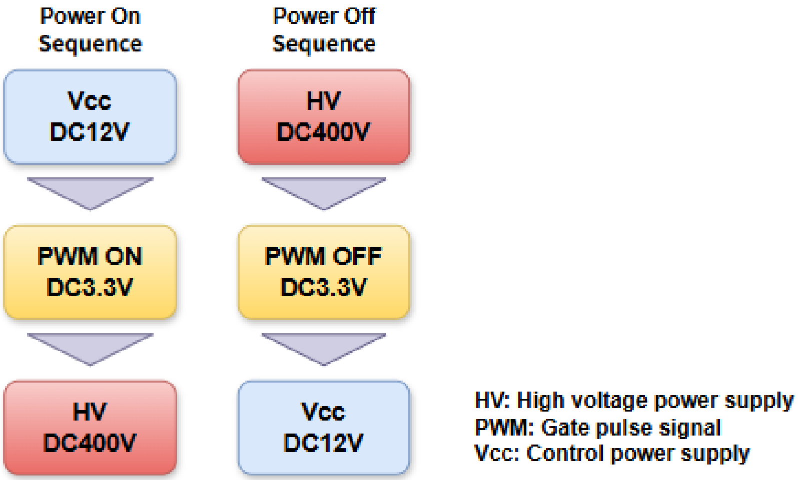


Figure 1-1. On/Off sequence

The specifications of the evaluation board are shown in Table 1-1. Refer to the datasheet of HSDIP20 for the detailed specifications and electrical characteristics of HSDIP20 and refer to the datasheet of the BM61M41RFV-C for the detailed specifications of the gate driver IC (BM61M41RFV-C).

Table 1-1. Specifications and electrical characteristics of the evaluation board

Item	Parameter	Spec.	Remarks
Inverter (Board)	DC-link Voltage	400VDC	Max 600VDC
	Output Current(continuous)	14Arms (max30A_peak)	Rated output 5 kVA Depends on switching frequency
	Switching Frequency	50 - 70kHz	-
	Power Device	HSDIP20	6-in-1, 1200 V, 18 mΩ
	Size	178.8mm * 240.0mm	-
Protection	UVLO	input-side Typ 4.0 V output-side Typ 7.4 V	-
	Gate Driver	Input Simultaneous ON Prevention	-
	Power Device	Embedded Thermistor	-
	Isolation	Basic Insulation	Isolated Gate Driver
Power Supply	-	DC12V	±10%, 10.8 V to 13.2 V, 1 A
Control	PWM Voltage	0~5V	-

2. LED Display

The board is equipped with LEDs showing the status of the control power supply. These LEDs are mounted on the upper side of control power supply terminal J1 and on the gate driver boards. The detailed locations of the LEDs are shown in Figures 2-1 and 2-2, and their details are shown in Table 2-1.

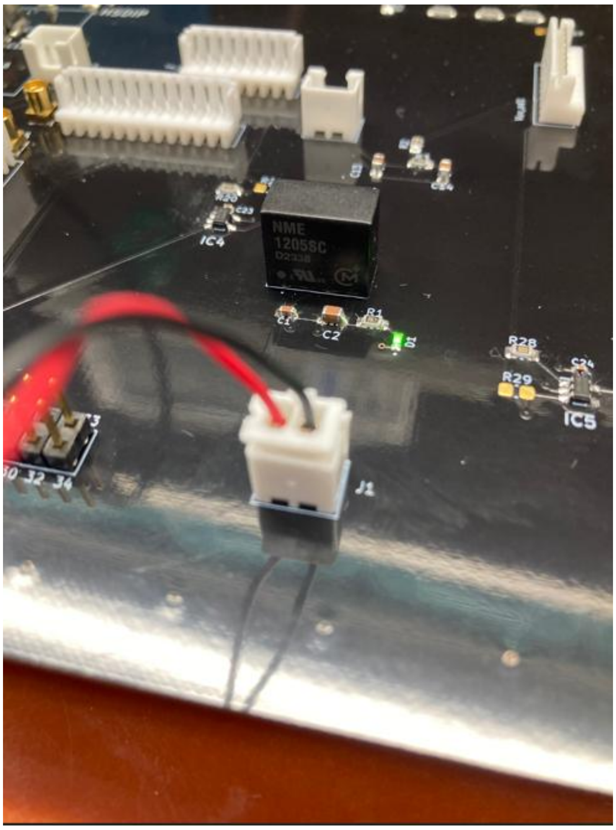


Figure 2-1. Control power supply LED

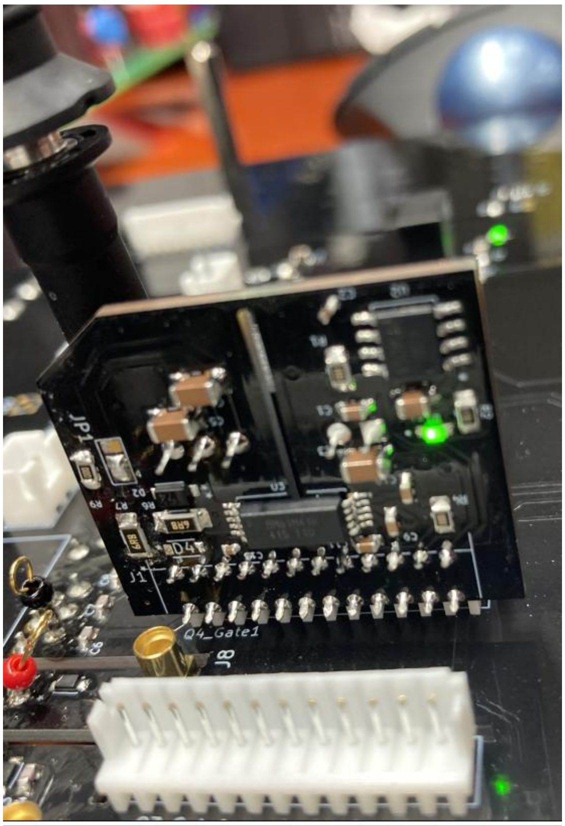


Figure 2-2. Gate driver power supply LED

Table 2-1. LED lights and their meanings

Designator	Color	Lighting status	Details
D1	Green	On	Normal operation (DC 10.8 V to 13.2 V). Testing can be performed.
		Off	Error condition. Please verify that the control power supply is within the normal operating range.
D8	Green	On	Normal operation (DC 10.8 V to 13.2 V). Testing can be performed.
		Off	Error condition. Please verify that the control power supply is within the normal operating range.
D1 (GD)*	Green	On	Normal operation (DC 10.8 V to 13.2 V). Testing can be performed.
		Off	Interrupt the control power supply, insert the gate driver board again, and apply the control power supply again.

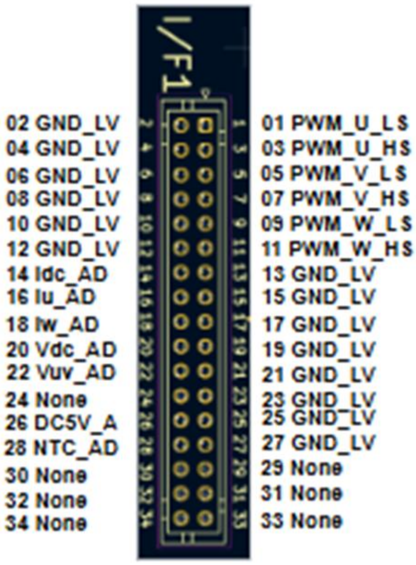
*An LED on the gate driver board.

3. Connector pin assignment

The pin assignment of the control power supply input connector (J1) and the control signal interface connectors (I/F1, I/F2) are shown in Figure 3-1. Use one of the control signal interface connectors. In addition, the definitions of the power supply pins and signals are shown in Tables 3-1 and 3-2.

1) J1 Control power supply connector (Part Number : XH_B2B)

2) I/F1 Control signal I/O connector (Part Number : B34B-PHDSS)



3) I/F2 Control signal I/O connector (Part Number : 2.54㎜ pitch Pin header)

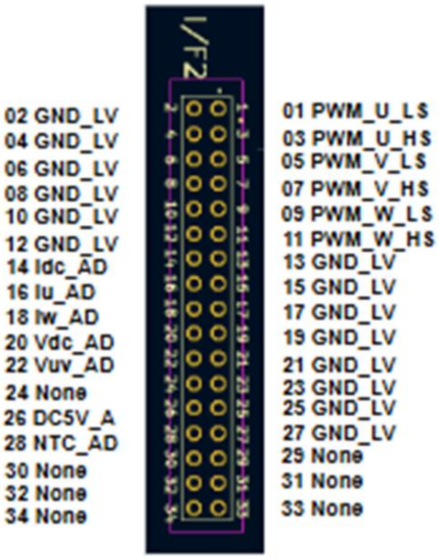


Figure 3-1. Connector pin assignment (top view)

Table 3-1. Definitions of power supply pins

Designator	Signal	Description
J14	HV_P	Connect it to the P side of inverter DC voltage (M5 screws included).
J16	HV_N	Connect it to the N side of inverter DC voltage (M5 screws included). This is separated from GND of the control circuit.
J13	HV_U	Connect it to the U-phase of the 3-phase load (M5 screws included).
J12	HV_V	Connect it to the V-phase of the 3-phase load (M5 screws included).
J11	HV_W	Connect it to the W-phase of the 3-phase load (M5 screws included).

Table 3-2. Definitions of control signals

Signal name	I/O	Description
PWM_U_LS	I	Gate signal of the inverter U-phase low-side (3.3 to 5.0 V). Turns on the power element at the "H" level. Pull it down when open.
PWM_U_HS	I	Gate signal of the inverter U-phase high-side (3.3 to 5.0 V). Turns on the power element at the "H" level. Pull it down when open.
PWM_V_LS	I	Gate signal of the inverter V-phase low-side (3.3 to 5.0 V). Turns on the power element at the "H" level. Pull it down when open.
PWM_V_HS	I	Gate signal of the inverter V-phase high-side (3.3 to 5.0 V). Turns on the power element at the "H" level. Pull it down when open.
PWM_W_LS	I	Gate signal of the inverter W-phase low-side (3.3 to 5.0 V). Turns on the power element at the "H" level. Pull it down when open.
PWM_W_HS	I	Gate signal of the inverter W-phase high-side (3.3 to 5.0 V). Turns on the power element at the "H" level. Pull it down when open.
Idc_AD	O	Analog signals can be acquired. When not in use, leave it in an open (floating) state.
Iu_AD	O	Analog signals can be acquired. When not in use, leave it in an open (floating) state.
Iw_AD	O	Analog signals can be acquired. When not in use, leave it in an open (floating) state.
Vdc_AD	O	Analog signals can be acquired. When not in use, leave it in an open (floating) state.
Vuv_AD	O	Analog signals can be acquired. When not in use, leave it in an open (floating) state.
DC5V_A	O	5 V power supply for externally additional contacts and other purposes. Use it with a load current of 80 mA or less.
NTC_AD	O	Thermistor signal can be acquired. When not in use, leave it in an open (floating) state.

The HSDIP20 module has a built-in thermistor. It can be used for reference values in temperature measurement. Information on the connector of the thermistor is shown in Figure 3-2.

Figure 3-2. Built-in thermistor connector (top view)

For the details of the built-in thermistor, refer to its product datasheet.

Product web page

4. Gate driver board

4.1 How to insert a gate driver board

In this section, the correct insertion direction of the gate driver board is explained. Figure 4-1. shows the appearance of the inserted gate driver board. In addition, the positions of the gate driver board connectors for phase devices are shown in Figure 4-2. In this step, follow the precautions below:

- Be sure to turn off the control power supply before inserting or removing a daughterboard.
- Insert the gate driver board vertically as much as possible into a connector until the connector completely locks the board.
- If a gate driver board is not completely inserted or it is inserted obliquely, a faulty contact and failure may occur. So, pay attention to this.

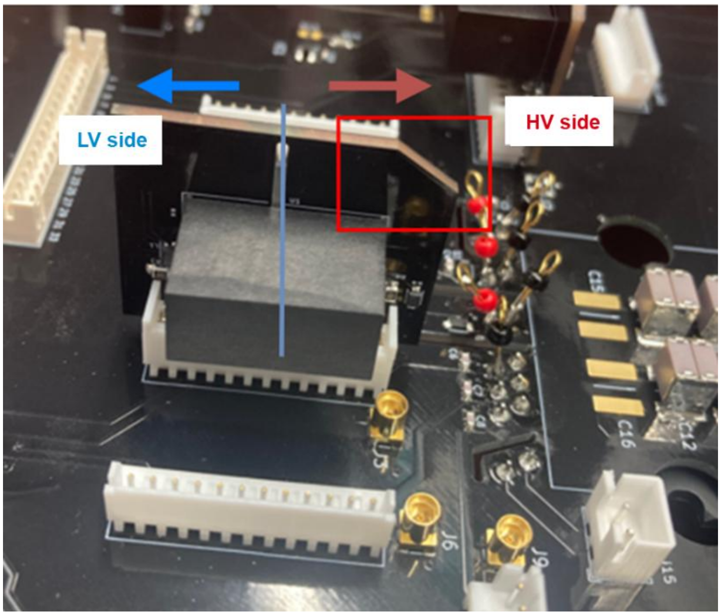


Figure 4-1. Direction of the gate driver board (the chamfer framed in red is to be placed on the HV side)

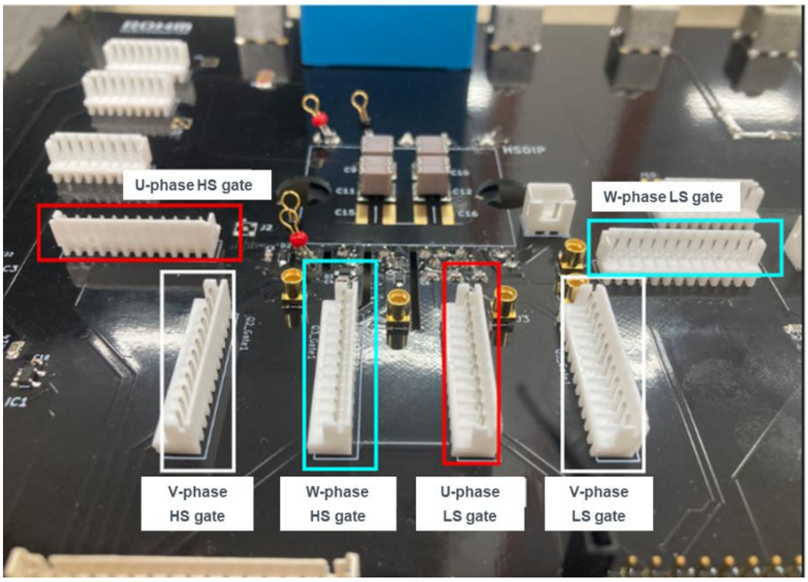


Figure 4-2. Arrangement of gate driver board connectors

4.2. How to set gate resistor

Gate resistors for adjusting the switching speed are mounted on the gate driver board. This allows you to change gate resistors without breaking the test environment. In addition, a diode (D2) is provided to set the gate resistance on the turn-off side low, so that the switching speeds of turn-on and turn-off can be adjusted separately. The initial gate resistances are set to R6 = R7 = 6.8Ω.

Turn-on: R6

Turn-off: R6 and R7 in parallel

The initial mounted resistors are the ESR18EZPJ6R8 model (size 1206). Figure 4-3 shows the appearance of the gate driver board with components mounted, and Figure 4-4 shows its schematic. The output signal of the ROHM MOSFET driver IC (BM61M41RFV-C) drives HSDIP20 via gate resistors.

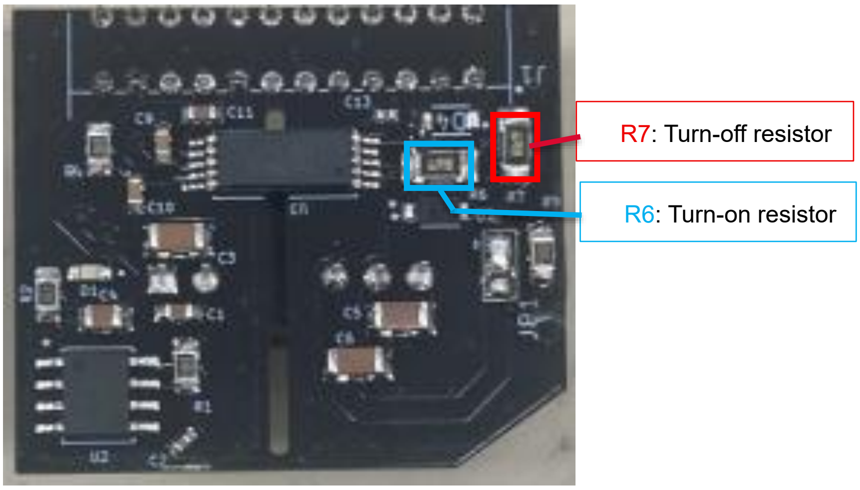


Figure 4-3. Appearance of the gate driver board with components mounted

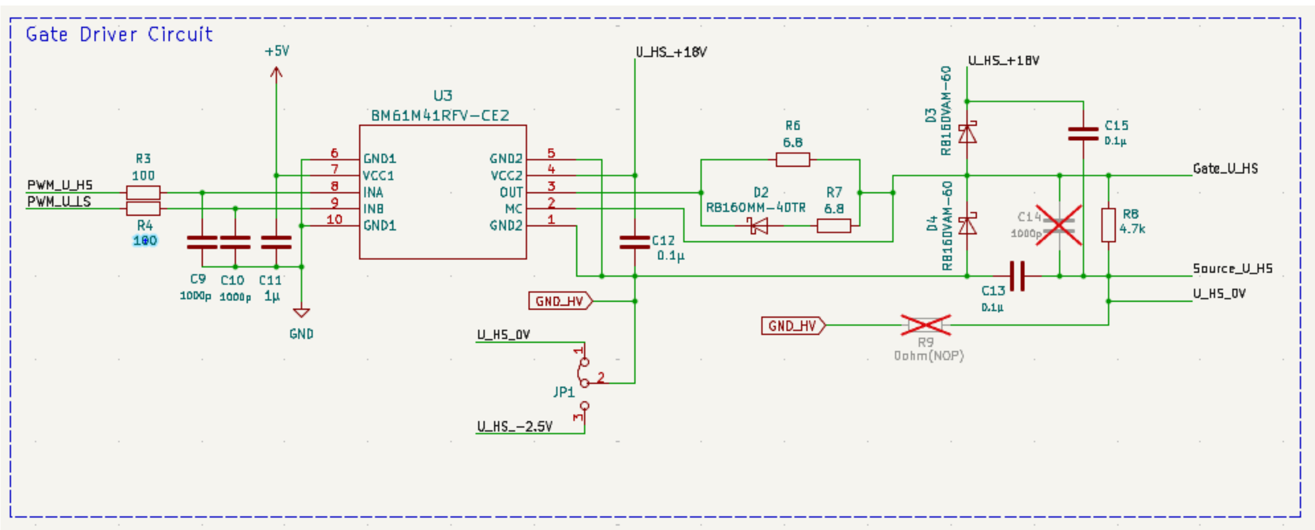


Figure 4-4. Schematic of the gate driver circuit

5. Evaluation method

5.1. How to measure a device current

To measure a drain current (Id) of a device, use a Rogowski coil.

We recommend that the wire size of a Rogowski coil is 3 mm or less, and the diameter of the coil is 25 to 30 mm.

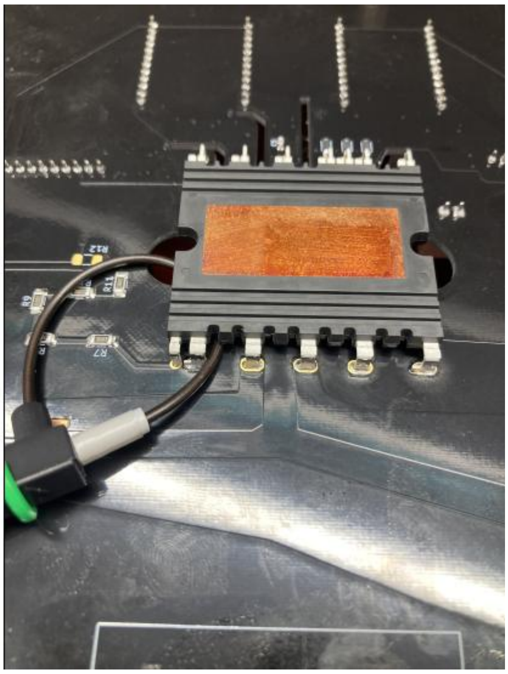


Figure 5-1. Example of the connection of a Rogowski coil

5.2 Example of connection for a double pulse test (DPT)

Figure 5-2. shows an example of connection for a DPT (Double Pulse Test) for a V-phase device.

To check that no self-turn-on phenomenon occurs on the low-side, the gate pulse is set on the High-side, and the LOW command is always set to the low-side. For the detailed pin assignment of the interface connectors, refer to chapter 3. In addition, an example of results of a DPT is shown in Figure 5-3. Note that this is just an example and results depend on measurement environments.

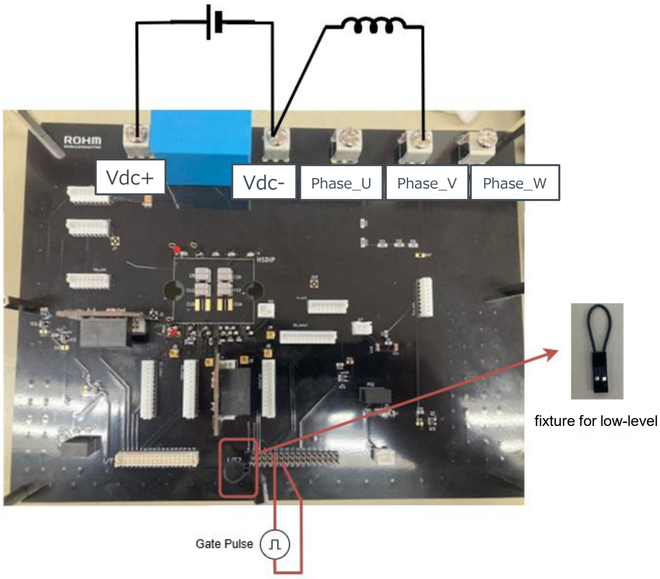


Figure 5-1. Configuration diagram for a double pulse test

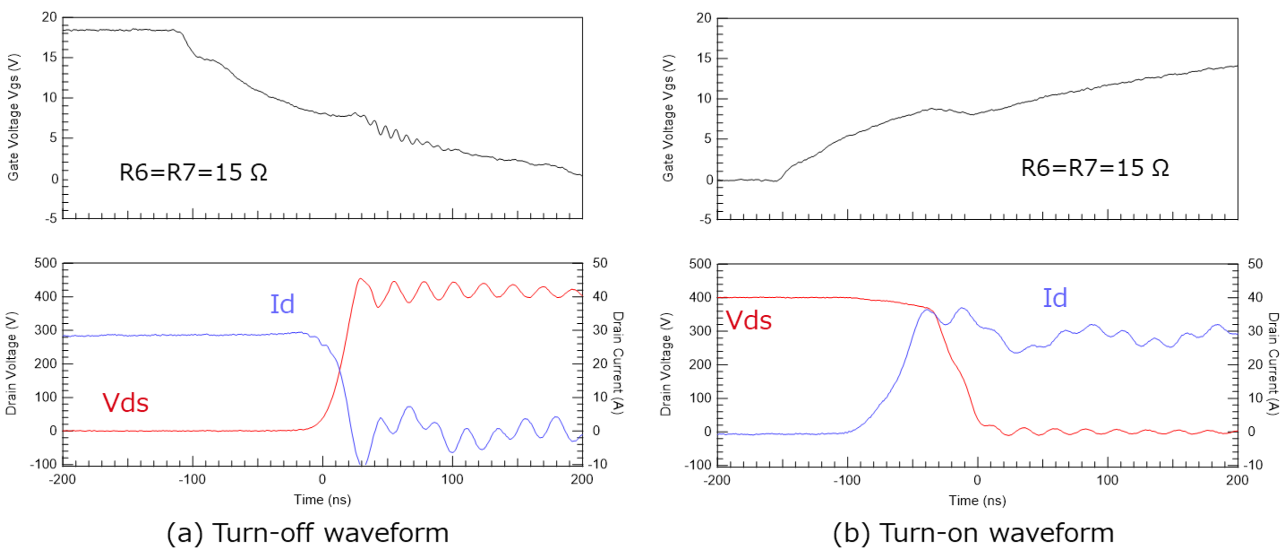


Figure 5-2. Example of measured waveforms of a double pulse test

6. Example of connection for a continuous driving test

Figure 6-1. shows an example of connection for a 3-phase inverter continuous driving test. Before conducting a test, be sure to check the screws for tightening. Pay attention to contact resistance that may increase measurement errors and may cause accidents.

This evaluation board is not designed to evaluate sudden change of the power supply and loads. To evaluate such sudden change, add a capacitor between the Vdc+ and Vdc- terminals at your own risk. To prevent inrush current, slowly increase a DC voltage or use the soft start function of the DC power supply.

In addition, before removing wiring, be sure to check that no electric charges remain in the capacitor. We recommend using a regenerative DC power supply or a DC power supply with a discharge resistor.

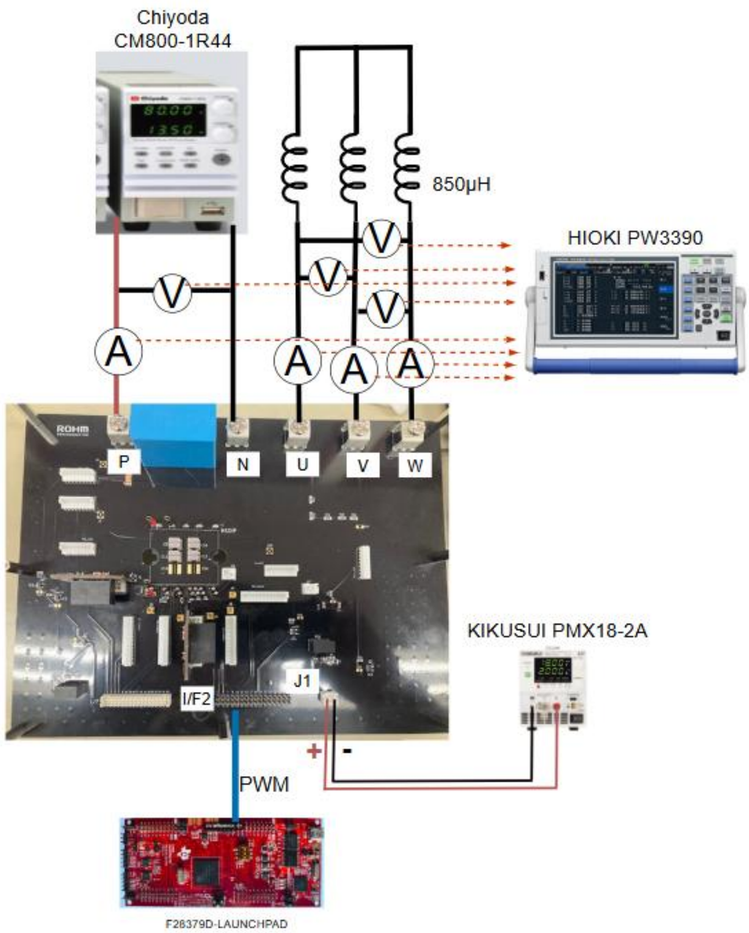


Figure 6-1. Example of configuration diagram for a continuous driving test

The HSDIP20 package has a high heat dissipation capacity, and its case temperature can be easily measured. Though thermocouples are typically placed on the heat dissipation pads of the elements to measure the temperatures of the power elements of the 3-phase inverter, the approximate temperature of the HSDIP20 in a steady state can be obtained from a measurement of one point. An example of the placement of a thermocouple is shown in Figure 6-2.

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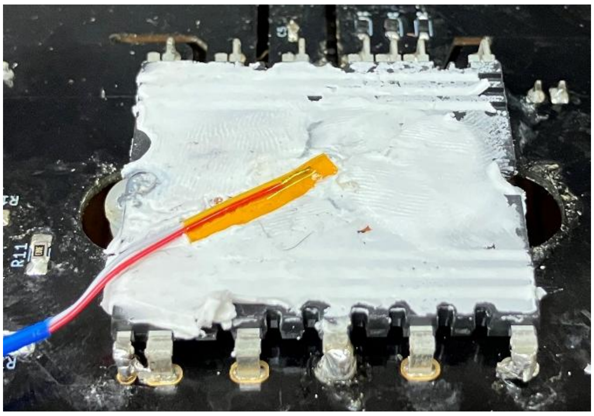


Figure 6-2. Example of the placement of a thermocouple (with a wire size of AWG36)

Though the heat dissipation pad of the HSDIP20 is insulated from high-voltage terminals, insulate the tip of a thermocouple with Kapton tape for additional safety. In addition, the HSDIP20 can be directly fixed on a metal surface of a heat sink or a frame, but to additionally improve the heat dissipation capacity, insulated heat-dissipation clay (CL28, from NOK CORPORATION) is used in experiment. However, consider thermal resistance due to the thickness of a TIM material in thermal design because a measurement method in which the above thermocouple is inserted between a heat dissipation pad, and a heat sink adversely affects the heat dissipation capacity (in this example, Rth_TIM = 0.54 K/W is added). In addition, be sure to provide a safety margin because the thermal resistance of Kapton tape tends to lower the measured temperature. If precise solution and measurement are necessary, contact us.

To more accurately measure temperature rises of the chips in the transient state, refer to Figure 6-3 "Arrangement diagram of chips in the package" to place thermocouples in the proper positions.

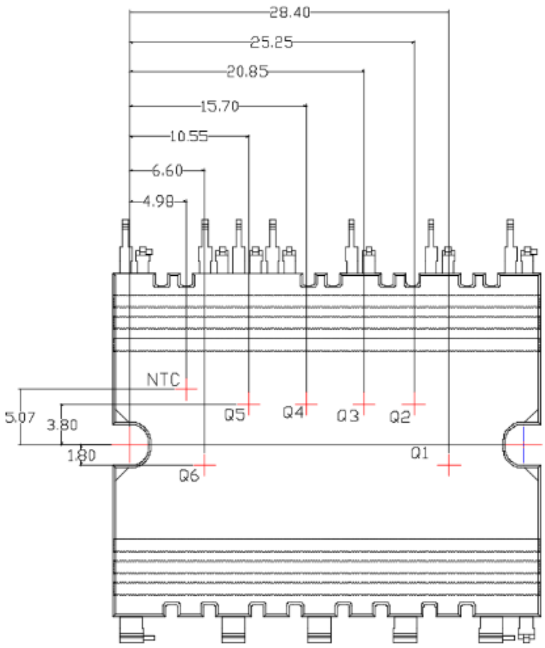


Figure 6-3. Arrangement diagram of chips in the package (top view)

In addition, follow the procedure below to mount a heat sink.

Step (1): Apply grease* 0.5 mm or more in thickness or heat dissipation clay to the heat dissipation pad of the HSDIP20.

*This is not recommended. In this design, it is necessary to consider the increase of thermal resistance due to the increase in the thickness of the TIM material. In this section, we describe the simplest measurement method with a sufficient safety margin. If precise analysis is necessary, contact us.

Step (2): Put the evaluation board onto a heat sink with tapped holes and align them such that the tapped holes (M3) can be seen. Refer to Figure 6-4 "Alignment of a heat sink."

Step (3): Insert two M3 screws (flathead, 10 mm or more in length) and tighten them temporarily for positioning. When doing so, use 8 mm washers.

Step (4): Tighten those two screws evenly, and finish tightening them with the specified torque of 0.69 N·m or more and up to the limited torque of 0.78 N·m. To avoid insufficient or excessive tightening torque, we recommend using a torque driver.

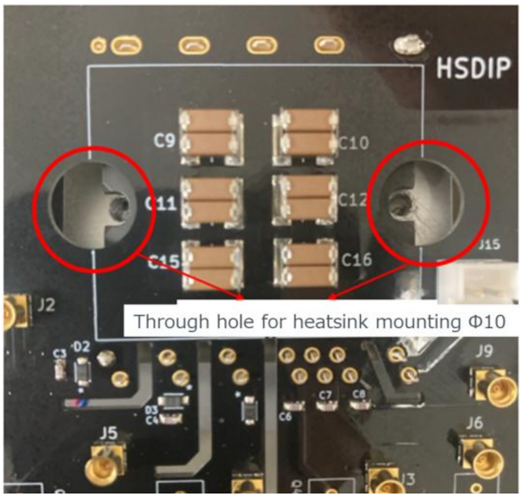


Figure 6-4. Alignment of a heat sink

Figure 6-5 shows an example of measured waveforms from a continuous driving test, and Table 6-1 shows an example of results from a continuous driving test*.

*Note that this is just an example and results depend on measurement environments.

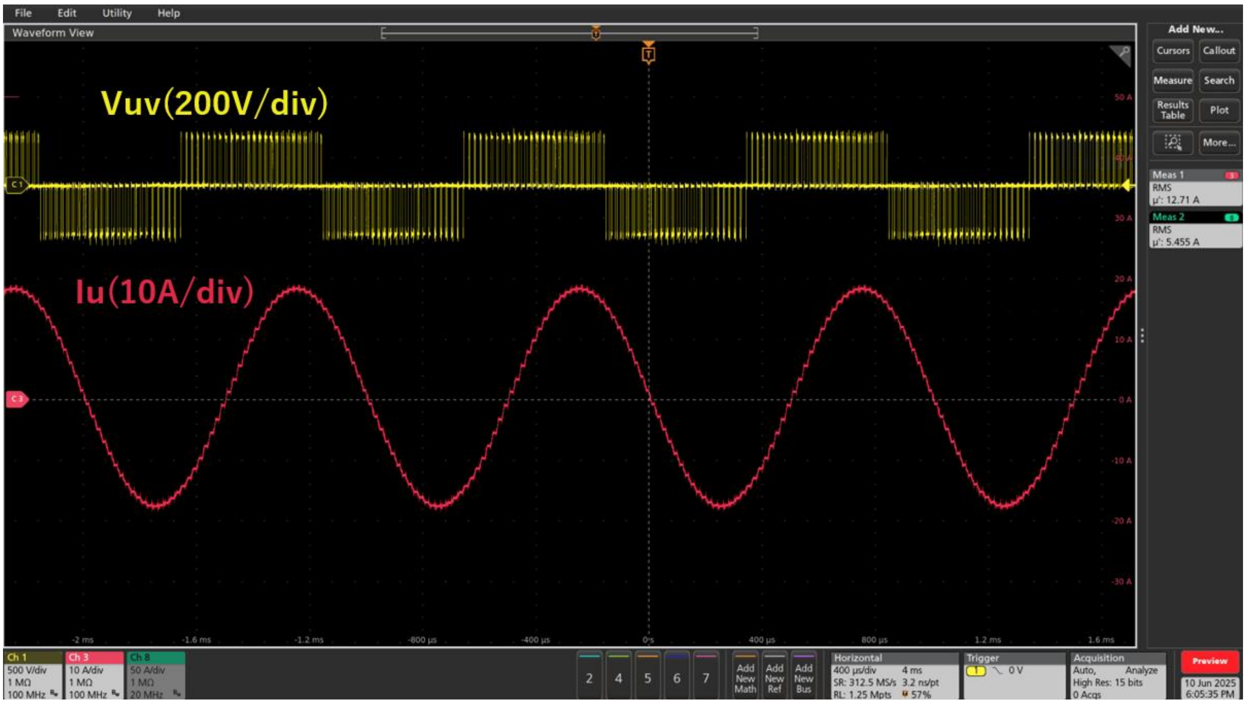


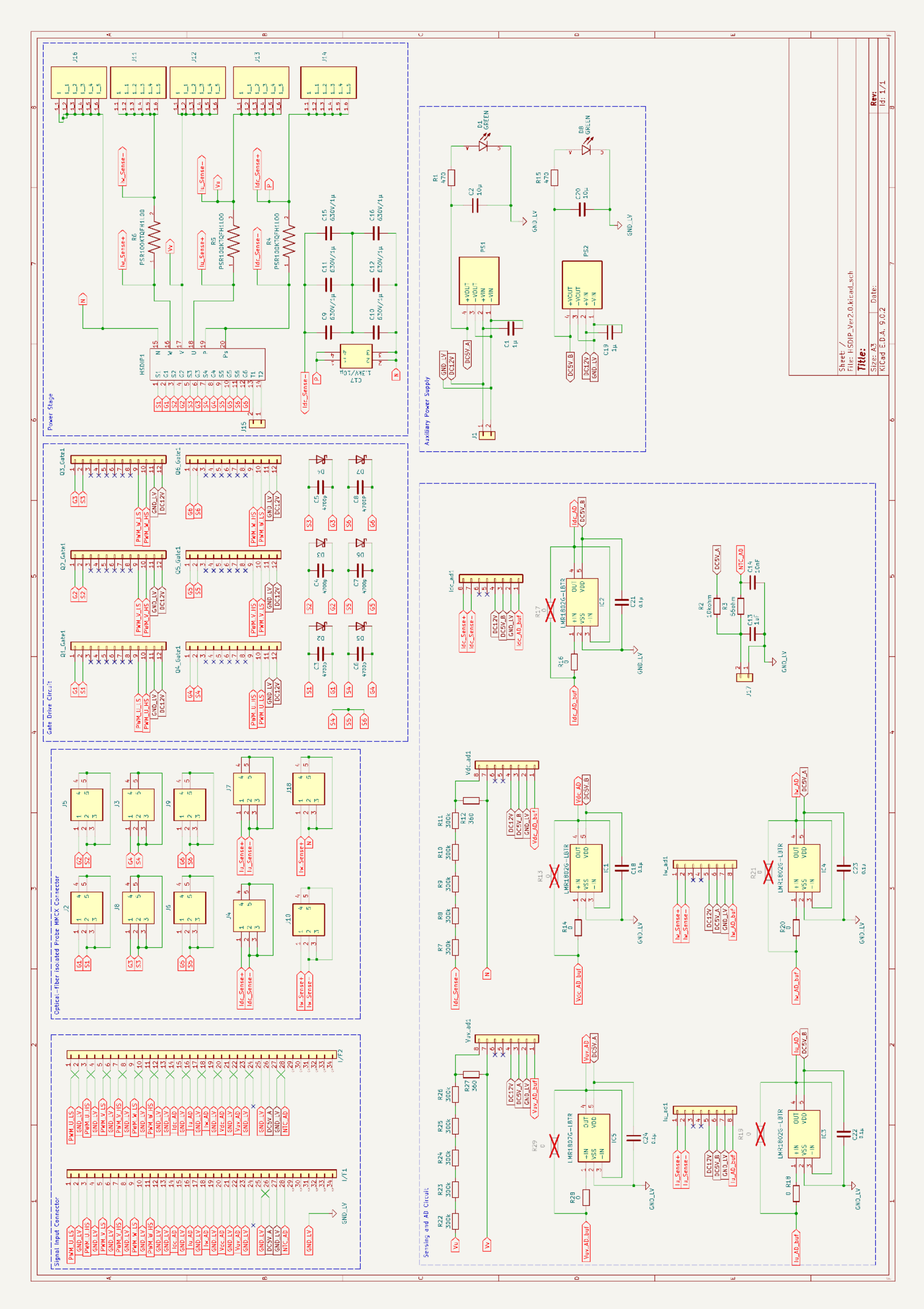
Figure 6-5. Phase-to-phase voltage waveform (yellow) and phase current waveform (red) of a continuous driving test

Table 6-1. Example of data of a continuous load test (a switching frequency of 50 kHz, R6 = R7 = 6.8Ω)

Load factor	%	0	80	90	100
Input voltage	%	Rated	Rated	Rated	Rated
line-to-line voltage U-V		200.3	193.2	200.4	209.5
V-W	Vrms	200.2	192.8	199.8	209.5
W-U		201.2	193.5	200.5	210.6
Phase current U		-	12.09	13.05	14.10
V	Arms	-	12.01	12.92	13.98
W		-	12.11	12.99	14.14
AC apparent power	VA	-	4039	4504	5115
DC voltage	V	400.2	400.3	400.2	400.1
DC current	A	0.05	0.20	0.22	0.25
Output frequency	Hz	-	1000	1000	1000
AC reactive power	Var	-	4039	4503	5115
DC power	W	21.2	80.0	88.9	101.0
Snubber capacitor ripple current	Arms	1.14	5.09	5.56	5.98
Power element temperature Tc*	℃	42.8	69.1	71.3	76.2
Snubber capacitor top temperature	℃	38.9	58.2	59.1	60.3
Atmosphere temperature	℃	25.6	25.3	24.3	24.2
Power element ΔK	℃	17.1	43.8	47.1	52.0

*This is not a precise case temperature but is used as a guide for safety in testing.

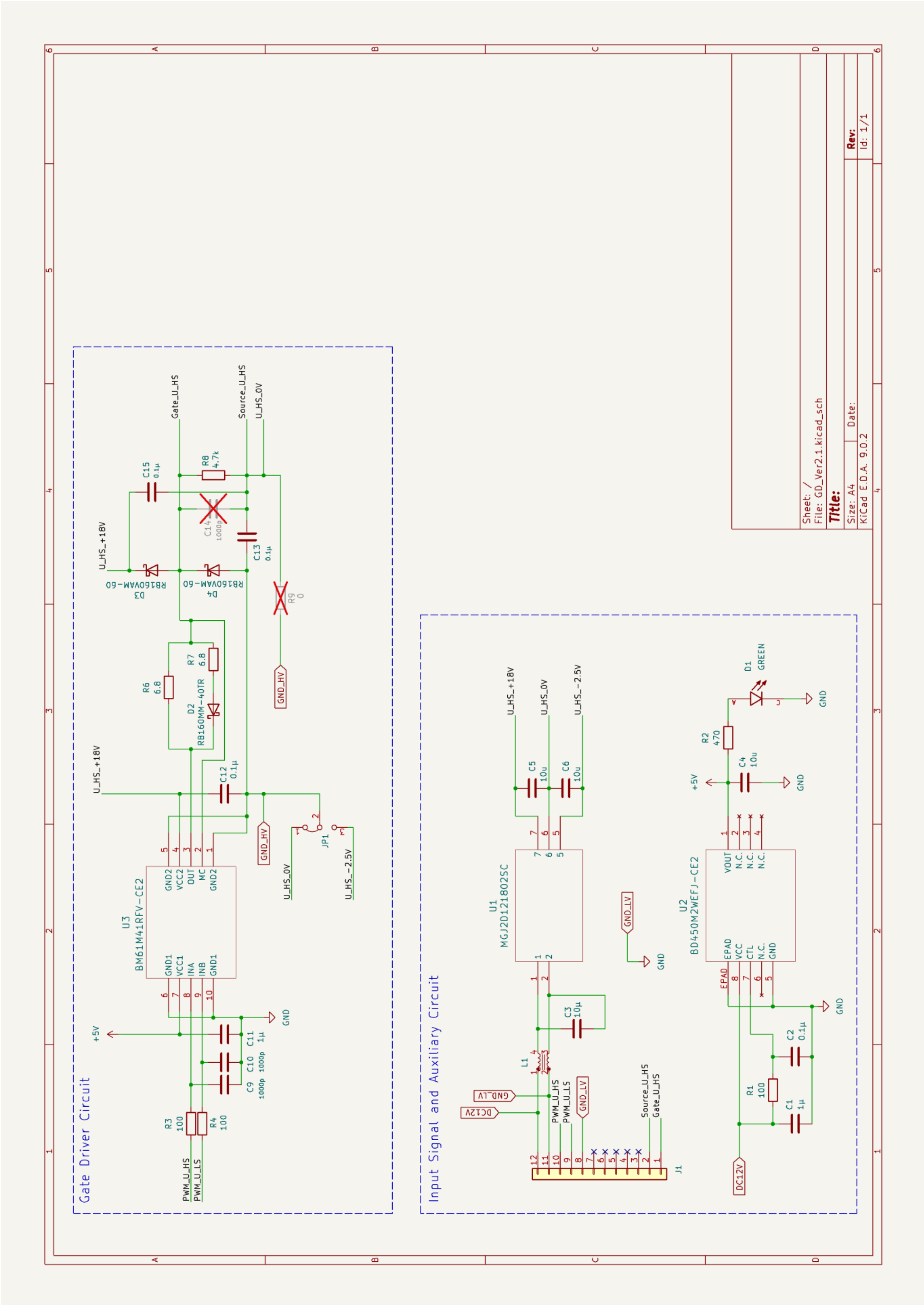
Appendix 1. Main board Schematics



Appendix 2. Main board BOM

No.	Device	Designator	Value	Description	Part Number	Manufacture	Quantity	DNP
1	Capacitor	C1,C19,	35V/1µ	CAP CER 1µF 35V X7R 0603	CGA3E1X7R1V105K080AC	TDK	2	
2	Capacitor	C2,C20,	10V/10µ	CAP CER 10µF 10V X7R 0805	C2012X7R1A106K125AC	TDK	2	
3	Capacitor	C3,C4,C5,C6,C7,C8,	50V/4700p	CAP CER 4700PF 50V C0G 0603	CGA3E2C0G1H472J080AA	TDK	6	
4	Capacitor	C9,C10,C11,C12,C15,C16,	630V/1µ	CAP STACKED 1µF 630V MLCC 2220	CAA572X7T2J105M640LH	TDK	4	
5	Capacitor	C13,	24V/1µ	CAP CER 1µF 25V X7R 0805	C2012X7R1E105K125AB	TDK	1	
6	Capacitor	C14,	50V/10n	CAP CER 10000PF 50V C0G 0805	C2012C0G1H103J060AA	TDK	1	
7	Capacitor	C17,	1.3KV/10µ	CAP FILM 10µF 1.3KVDC	B32776G1106K000	TDK	1	
8	Capacitor	C18,C21,C22,C23,C24,	50V/0.1µ	CAP CER 0.1µF 50V X7R 0402	CGA2B3X7R1H104K050BB	TDK	5	
9	LED	D1,D8,	GREEN	LED GREEN DIFFUSED 1608 SMD	SML-D12P8WT86	ROHM Semiconductor	2	
10	Diode	D2,D3,D4,D5,D6,D7,	60V/1A	DIODE SCHOTTKY 60V 1A TUMD2M	RB160VAM-60	ROHM Semiconductor	6	
11	SiC Power Module	HSDIP1,	1200V/70A	HSDIP20, 1200V, 70A, 3-Phase-bridge,	BST70T2P4K01-VC	ROHM Semiconductor	1	
12	Connector	I/F1,	B34B-PHDSS	CONN HEADER VERT 34POS 2MM	B34B-PHDSS	JST	1	
13	Connector	I/F2,	TSW-117-07-S-D	CONN HEADER VERT 34POS 2.54MM	TSW-117-07-S-D	SAMTEC	1	
14	Connector	Q1_Gate1,Q2_Gate1,Q3_Gate1,Q4_Gate1,Q5_Gate1,Q6_Gate1,	B12P-MQ	CONN RCPT 12POS 0.098 TIN PCB	B12P-MQ	JST	6	
15	Connector	Idc_ad1,Iu_ad1,Iw_ad1,Vdc_ad1,Vuv_ad1,	B8P-MQ-C	CONN RCPT 8POS 0.098 TIN PCB	B8P-MQ-C	JST	5	
16	Connector	J1,J15,J17,	B2B-XH-A	CONN HEADER VERT 2POS 2.5MM	B2B-XH-A	JST	3	
17	Connector	J2,J3,J4,J5,J6,J7,J8,J9,J10	73415-2061	CONN MMCX JACK STR 50 OHM SMD	73415-2061	Molex	9	
18	Terminal	J11,J12,J13,J14,J16,	7808	TERM SCREW M5 6PIN PCB	7808	Keystone Electronics	5	
19	IC	IC1,IC2,IC3,IC4,IC5,	LMR1802G-LBTR	IC CMOS 1 CIRCUIT 5SSOP	LMR1802G-LBTR	ROHM Semiconductor	5	
20	IC	PS1,PS2,	NME1205SC	DC DC CONVERTER 5V 1W	NME1205SC	Murata Electronics	2	
21	Resistor	R1,R15,	470	RES SMD 470 OHM 1% 1/8W 0805	MCR10EZPF4700	ROHM Semiconductor	2	
22	Resistor	R2,	10k	RES SMD 10K OHM 1% 1/8W 0805	MCR10ERTF1002	ROHM Semiconductor	1	
23	Resistor	R3,	56	RES SMD 56 OHM 1% 1/8W 0805	MCR10ERTF56R0	ROHM Semiconductor	1	
24	Resistor	R4,R5,R6,	1m	RES SMD 1m OHM 1% 8W 2512	PSR100KTQFH1L00	ROHM Semiconductor	3	
25	Resistor	R7,R8,R9,R10,R11,R22,R23,R24,R25,R26,	300k	RES SMD 300K OHM 1% 1/4W 1206	MCR18ERTF3003	ROHM Semiconductor	10	
26	Resistor	R12,R27,	360	RES SMD 360 OHM 1% 1/4W 1206	MCR18ERTF3600	ROHM Semiconductor	2	DNP
27	Resistor	R13,R17,R19,R21,R29,	0	RES SMD 0 OHM JUMPER 1/8W 0805	MCR10ERTJ000	ROHM Semiconductor	5	DNP
28	Resistor	R14,R16,R18,R20,R28,	0	RES SMD 0 OHM JUMPER 1/8W 0805	MCR10ERTJ000	ROHM Semiconductor	5	

Appendix 3. Gate driver board Schematics

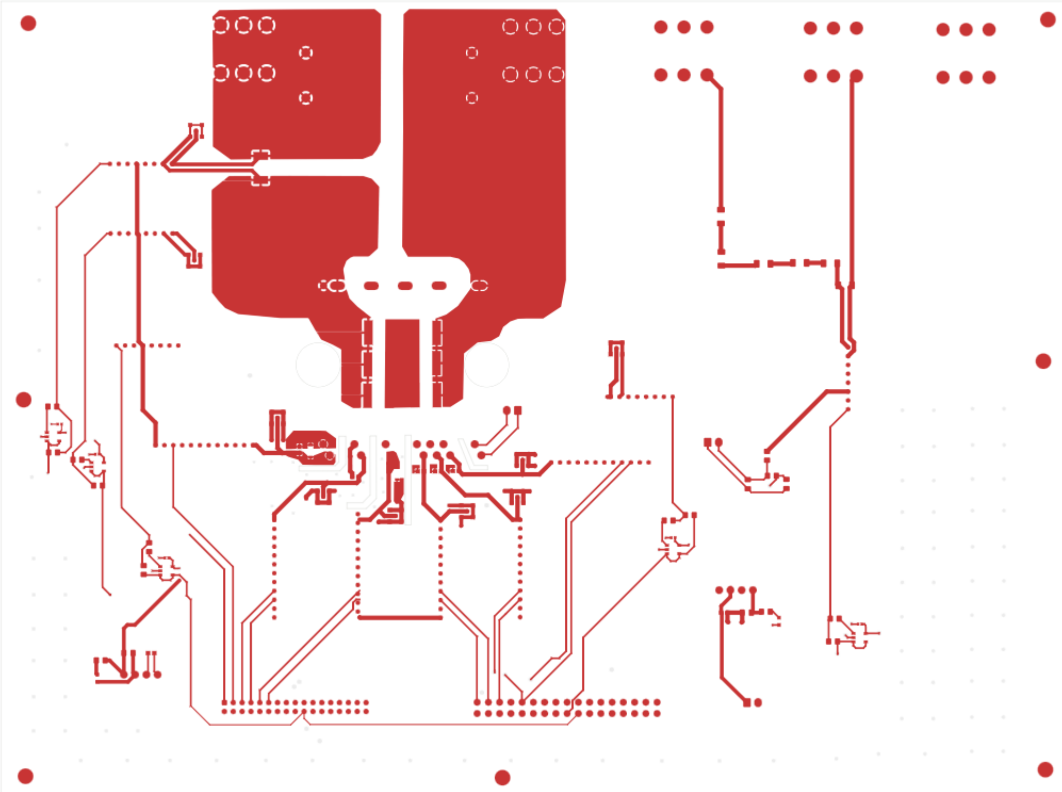


Appendix 4. Gate driver board BOM

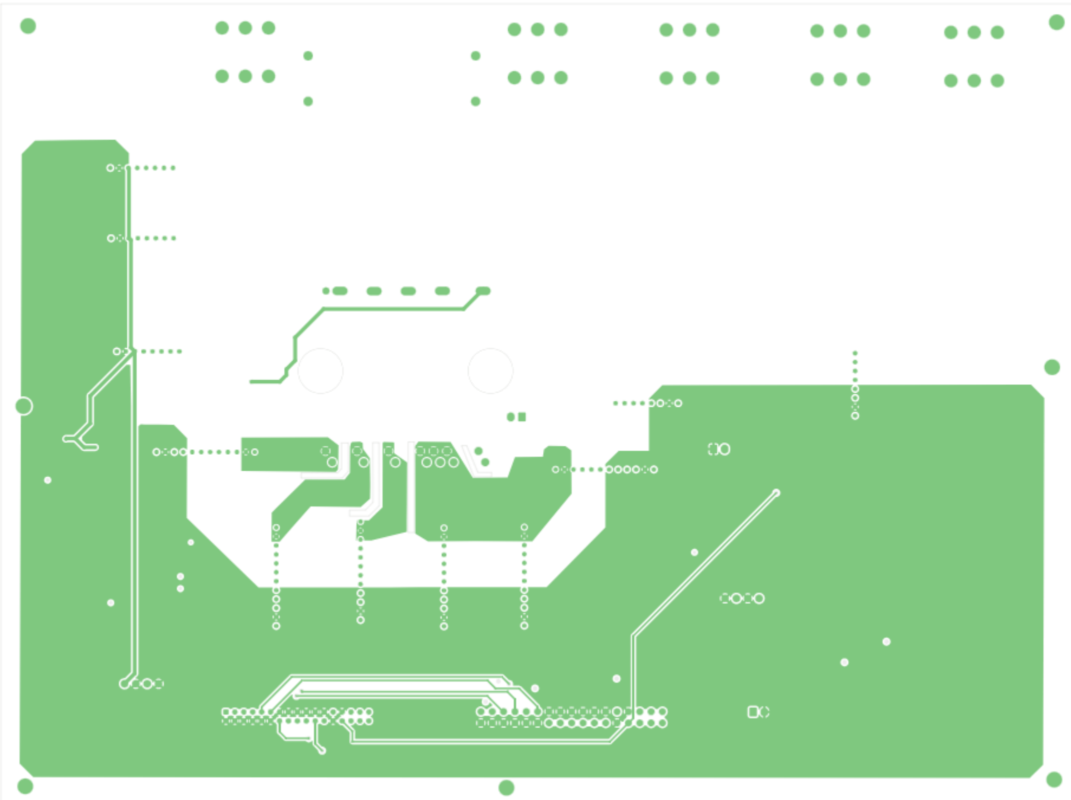
No.	Device	Designator	Value	Description	Part Name	Manufacture	Quantity	DNP
1	Capacitor	C1,C11,	35V/1µ	CAP CER 1µF 35V X7R 0603	CGA3E1X7R1V105K080AC	TDK	2	
2	Capacitor	C2,C12,C13,C15,	50V/0.1µ	CAP CER 0.1µF 50V X7R 0402	CGA2B3X7R1H104K050BB	TDK	4	
3	Capacitor	C3,C5,C6,	35V/10µ	CAP CER 10µF 35V X7R 1206	CGA5L1X7R1V106M160AC	TDK	3	
4	Capacitor	C4,	25V/10µ	CAP CER 10µF 25V X7S 0805	CGA4J1X7S1E106K125AC	TDK	1	
5	Capacitor	C9,C10,	50V/1000p	CAP CER 1000PF 50V C0G 0603	CGA3E2C0G1H102J080AA	TDK	2	
6	Capacitor	C14,	50V/1000p	CAP CER 1000PF 50V C0G 0603	CGA3E2C0G1H102J080AA	TDK	1	DNP
7	LED	D1,	GREEN	LED GREEN DIFFUSED 1608 SMD	SML-D12P8W	ROHM Semiconductor	1	
8	Diode	D2,	40V/1A	DIODE SCHOTTKY 40V 1A PMDU	RB160MM-40TR	ROHM Semiconductor	1	
9	Diode	D3,D4,	60V/1A	DIODE SCHOTTKY 60V 1A TUMD2M	RB160VAM-60TR	ROHM Semiconductor	2	
10	Connector	J1,	12MQ-ST	CONN RCPT 12P 0.098 TIN PCB R/A	12MQ-ST	JST	1	
11	Resistor	JP1,	-	–	–	–	1	DNP
12	Filter	L1,	DLW21PH201XQ2L	CMC 500MA 2LN 200 OHM SMD AECQ200	DLW21PH201XQ2L	Murata Electronics	1	
13	Resistor	R1,R3,R4,	100	RES SMD 100 OHM 5% 1/8W 0805	MCR10EZPJ101	ROHM Semiconductor	3	
14	Resistor	R2,	470	RES SMD 470 OHM 1% 1/8W 0805	MCR10EZPF4700	ROHM Semiconductor	1	
15	Resistor	R6,	6.8	RES SMD 6.8 OHM 5% 3/4W 1206	ESR18EZPJ6R8	ROHM Semiconductor	1	
16	Resistor	R7,	6.8	RES SMD 6.8 OHM 5% 3/4W 1206	ESR18EZPJ6R8	ROHM Semiconductor	1	
17	Resistor	R8,	4.7k	RES SMD 4.7K OHM 5% 1/8W 0805	MCR10EZPJ472	ROHM Semiconductor	1	
18	Resistor	R9,	0	RES SMD 0 OHM JUMPER 1/8W 0805	MCR10ERTJ000	ROHM Semiconductor	1	DNP
19	IC	U1,	18V/-2.5V, 80mA/80mA	DC DC CONVERTER 18V -2.5V 2W	MGJ2D121802SC	Murata Electronics	1	
20	IC	U2,	200mA/5.0V	IC REG LINEAR 5V 200MA 8HTSOP	BD450M2WEFJ-CE2	ROHM Semiconductor	1	
21	IC	U3,	BM61M41RFV-CE2	DGT ISO 3.75KV 1CH GT DVR 10SSOP	BM61M41RFV-CE2	ROHM Semiconductor	1	

Appendix 5. Main board Gerber

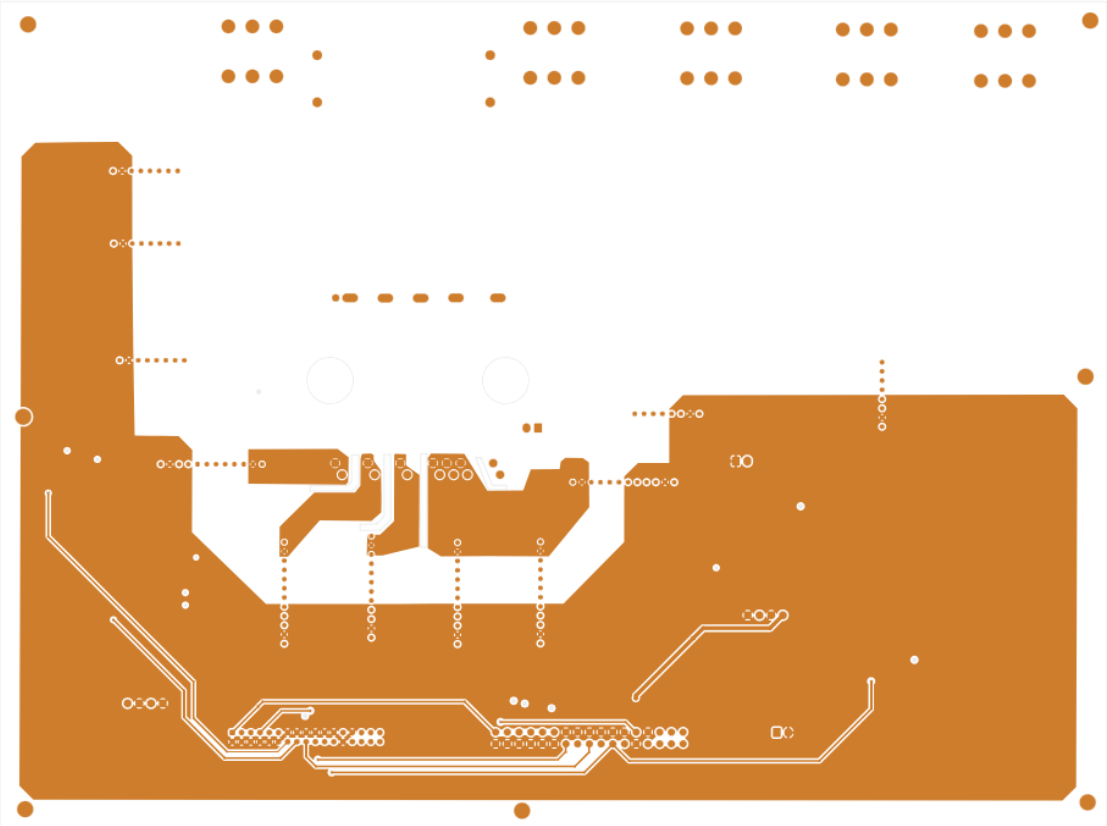
[Top layer](Top View)



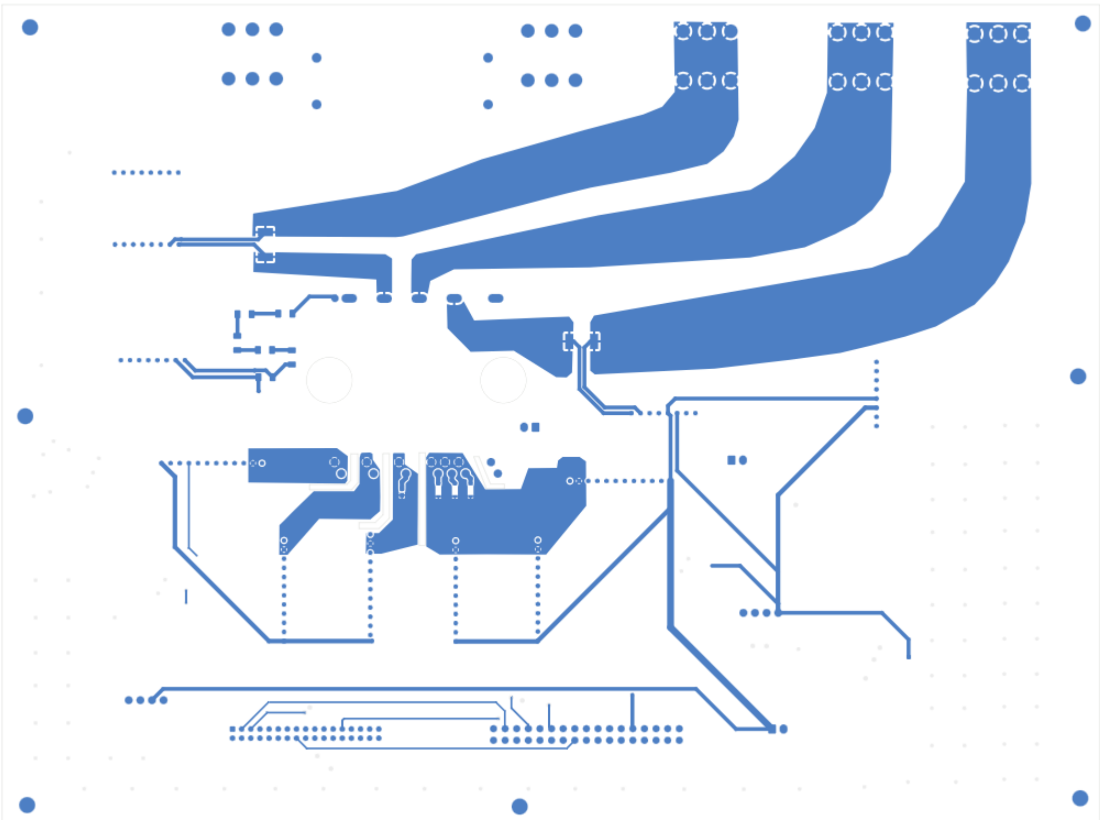
[2nd layer](Top View)



[3rd layer](Top View)

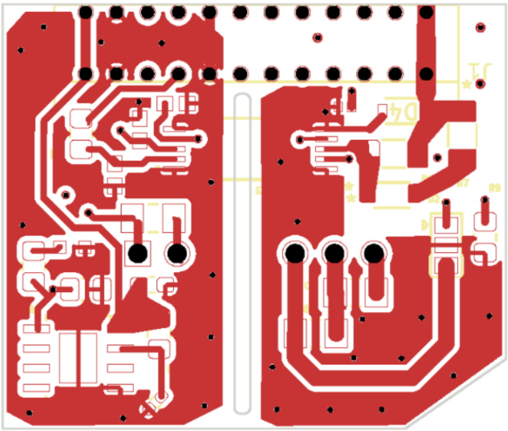


[Bottom layer](Top View)



Appendix 6. Gate driver board Gerber

[Top layer](Top View)



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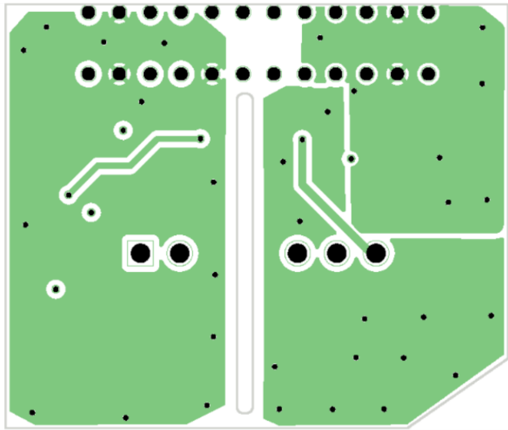
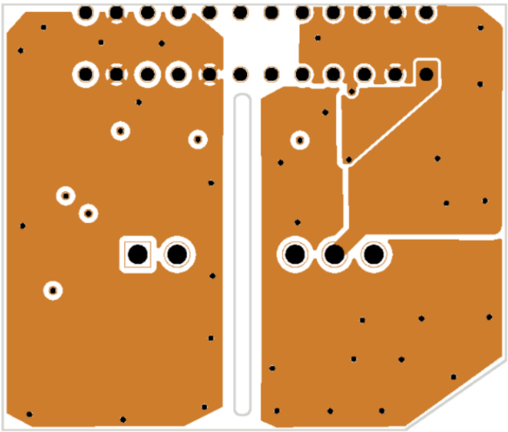
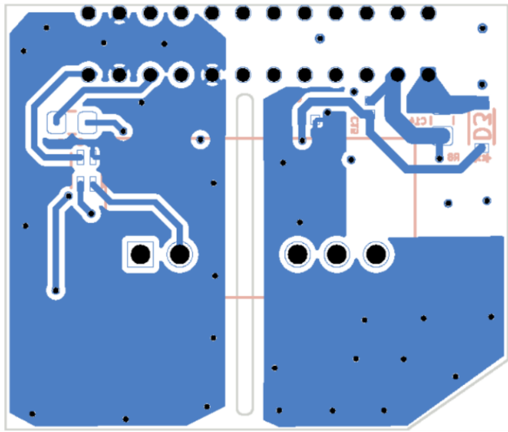


[3rd layer](Top View)



[Bottom layer](Top View)



Revision history

Version	Date	Description
1.0	2026/1/21	Originally issued.
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