ROHM SEMICONDUCTOR

Three-phase Brushless DC Motor Driver Series

Drive Board for Three-phase Brushless Motor using Three Hall Sensors (Pre-driver BM64300MUV)

User's Guide

＜High Voltage Safety Precautions＞

◇ Read all safety precautions before use

Please note that this document covers only the BM64300MUV evaluation board (BM64300MUV-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.

Three-phase Brushless DC Motor Driver Series

Drive Board for Three-phase Brushless Motor using Three Hall Sensors (Pre-driver BM64300MUV)

BM64300MUV-EVK-001

1. Product summary

1.1. Features

This product is an evaluation board for driving three-phase brushless DC motors using three Hall sensors with a power supply voltage of 48 V (typ) and a motor current between 1 and 8 A.

This board is composed of the BM64300MUV, which is a pre-driver for a three-phase brushless DC motor using three Hall sensors, and 6 units of the Nch MOSFET RD3P175SN.

The rotor position is detected with the three Hall sensors. Low noise and low vibration are achieved with sine wave drive. Automatic lead angle control enables highly efficient motor drive.

For the output MOSFETs, products of a TO252 and HSOP8 package can be mounted. On this board, products of a TO252 package are mounted.

1.2. Supply voltage range and output current

Item	Symbol	Minimum	Standard	Maximum	Unit	Conditions
Power supply voltage range	VCC	28	48	63	V	
Output current	I_O	-	-	8	A	Output MOS: RD3P175SN

1.3 Supported applications

Fan motors and other general consumer equipment

No. 62UG023E Rev.001
JUN.2020

1.4 External design of circuit board

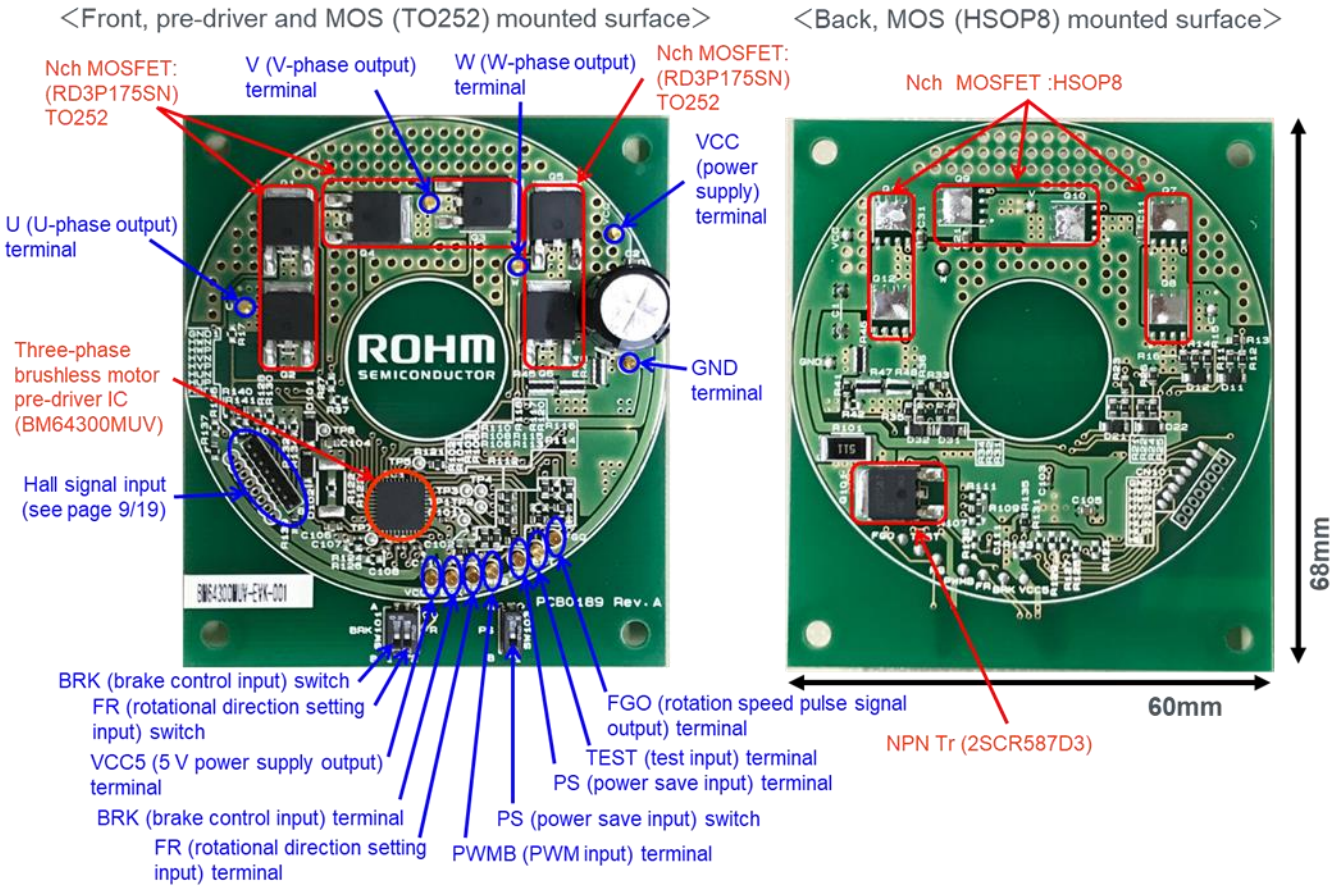

Figure 1.1 BM64300MUV-EVK-001 board

Contents

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2. Product details

2.1 Evaluation board: block diagram

The area within the dotted square is the evaluation board block.

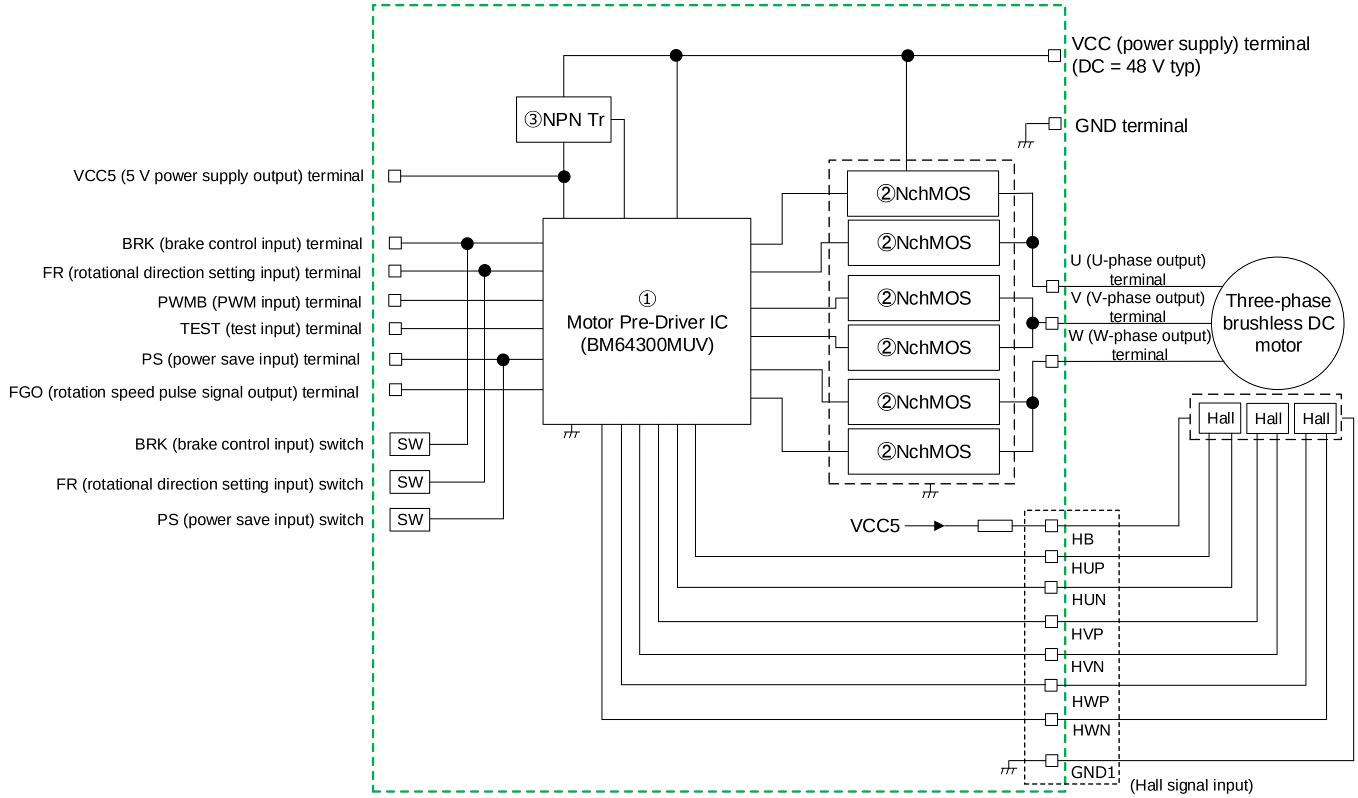

Figure 2.1 BM64300MUV-EVK-001 board: block diagram

	① Motor Pre-Driver	② NchMOS		③ NPN Tr
Parts included	**BM64300MUV (Package: VQFN040V6060)**	**RD3P175SN (Package: TO252)**	(Package: HSOP8)	**2SCR587D3 (Package: TO252)**
Features	Sine wave current drive	V_{DSS}=100 V $R_{DS\ (on)\ (Max.)}$ = 105mΩ I_D = ±17.5 A	-	V_{CEO}=120 V I_C=3 A

(Bold characters represent the name of products included in this EVK.)

Table 2.1 Parts included

2.2 Terminal function

Terminal name	Function	Terminal name	Function
GND1	Ground for Hall element and Hall IC	FR	Rotational direction setting input (H: U → V → W. L: U → W → V)
HWN	W-phase Hall input, negative side	PWMB	PWM input (negative logic)
HWP	W-phase Hall input, positive side	PS	Power save input (H: power save. L: operation)
HVN	V-phase Hall input, negative side	TEST	Input for testing (not used, always OPEN)
HVP	V-phase Hall input, positive side	FGO	Rotation speed pulse signal output
HUN	U-phase Hall input, negative side	GND	Ground
HUP	U-phase Hall input, positive side	VCC	Power supply
HB	Power supply output for Hall element and Hall IC	U	U-phase output
VCC5	5.0 V power supply output	V	V-phase output
BRK	Brake control input (H: short brake, L: operation)	W	W-phase output

Table 2.2 List of terminal functions

2.3 Switch functions

Switch name	Function	External design of switch
BRK	A side: Brake operation B side: Rotation operation	
FR	A side: Rotation in the sequence of U-phase → V-phase → W-phase B side: Rotation in the sequence of U-phase → W-phase → V-phase	
PS	A side: Rotation operation B side: Power save	

Table 2.3 List of switch functions

2.4 Evaluation board: circuit diagram

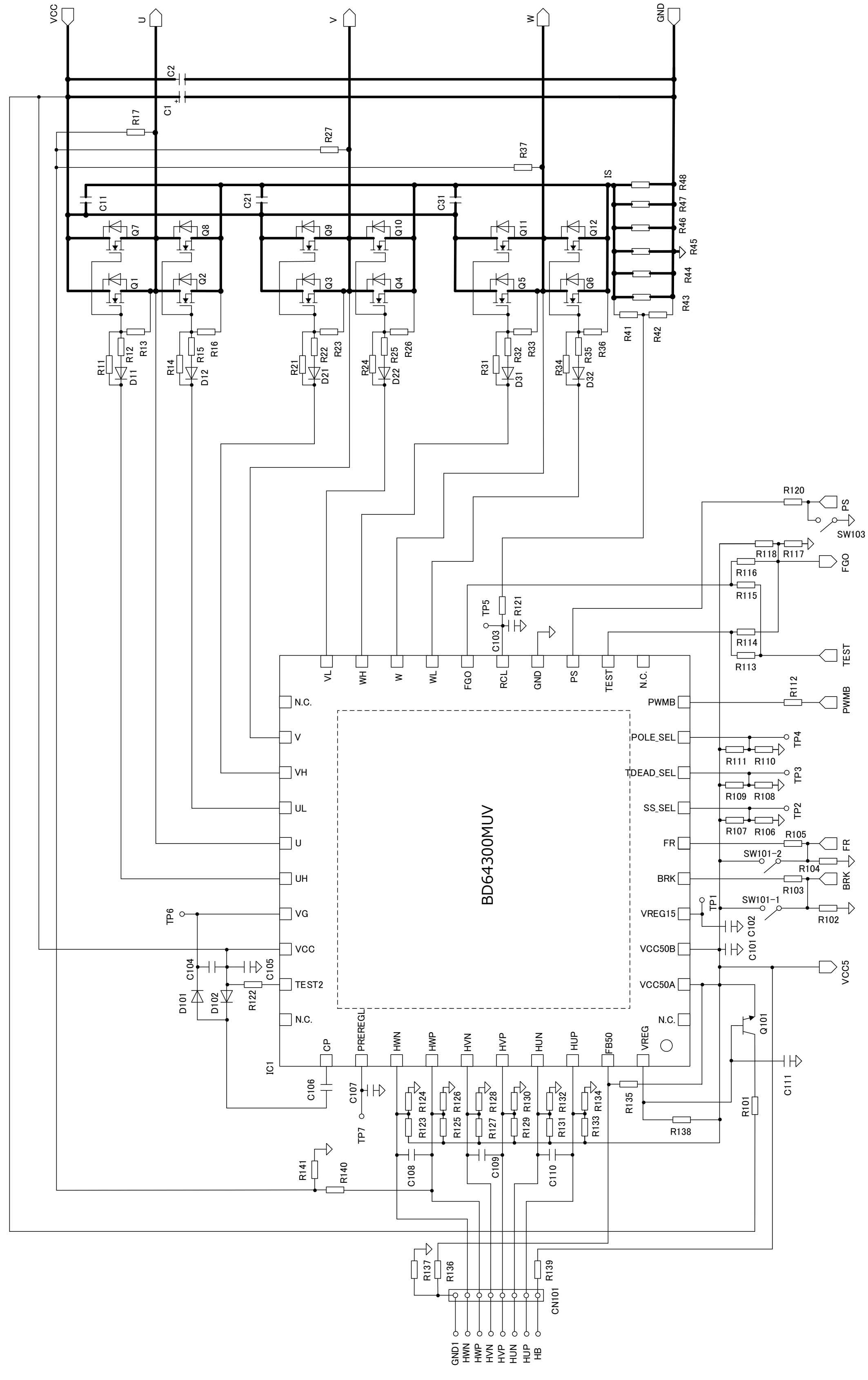

Figure 2.2 Circuit diagram

2.5 Parts list

Part Reference	Part Description	Value	Manufacturer	Parts Number	Quantity
IC1	Motor Pre-Driver	–	Rohm	BM64300MUV-E2	1
Q1,Q2,Q3,Q4,Q5,Q6	NchMOS (100V/17.5A/85mΩ/TO252)	–	Rohm	RD3P175SNFRATL	6
Q7,Q8,Q9,Q10,Q11,Q12	NchMOS(100VHSOP8)	NI	Rohm	–	0
Q101	NPN(120V/3A)	–	Rohm	2SCR587D3TL1	1
D11,D21,D31	Schottky Barrier Diode (40V/0.5A)	–	Rohm	RB160VAM-40TR	3
D12,D22,D32	Schottky Barrier Diode (40V/0.5A)	–	Rohm	RB160VAM-40TR	3
D101,D102	First Recovery Diode (200V/0.8A)	–	Rohm	RF081MM 2 STF	2
C1	Electrolytic Capacitor	47uF/100V	Nichicon	UVR2A470MPD	1
C2	Ceramic Capacitor	0.1μF/100V	Murata	GRM188R72A104KA35D	1
C11,C21,C31	Ceramic Capacitor	0.1μF/100V	Murata	GRM188R72A104KA35D	3
C101	Ceramic Capacitor	1.0μF/25V	Murata	GRM155R61E105KA12D	1
C102,C107	Ceramic Capacitor	0.1μF/25V	Murata	GRM155R71E104KE14D	2
C103	Ceramic Capacitor	0.1μF/25V	Murata	GRM155R71E104KE14D	1
C105	Ceramic Capacitor	0.1μF/100V	Murata	GRM188R72A104KA35D	1
C104,C106	Ceramic Capacitor	0.1μF/100V	Murata	GRM188R72A104KA35D	2
C108,C109,C110	Ceramic Capacitor	0.01μF	Murata	GRM155R71H103KA88D	3
C111	Ceramic Capacitor	1.0μF/25V	Murata	GRM155R61E105KA12D	1
R11,R21,R31	Resistor	470Ω	Rohm	MCR03EZPFX4700	3
R12,R22,R32	Resistor	0Ω	Rohm	MCR03EZPJ000	3
R14,R24,R34	Resistor	470Ω	Rohm	MCR03EZPFX4700	3
R15,R25,R35	Resistor	0Ω	Rohm	MCR03EZPJ000	3
R13,R23,R33	Resistor	10kΩ	Rohm	MCR03EZPFX1002	3
R16,R26,R36	Resistor	10kΩ	Rohm	MCR03EZPFX1002	3
R17,R27,R37	Resistor	NI	Rohm	MCR03EZPFX4301	0
R41	Resistor	0Ω	Rohm	MCR03EZPJ000	1
R42	Resistor	NI	Rohm	MCR03EZPFX1002	0
R43,R44,R45,R46,R47	Resistor	100mΩ	Rohm	LTR18EZPFLR100	5
R48	Resistor	NI	Rohm	LTR18EZPFLR100	0
R101	Resistor	510Ω	Rohm	MCR100JZHF5100	1
R102,R104	Resistor	10kΩ	Rohm	MCR03EZPFX1002	2
R103,R105,R112,R120	Resistor	100Ω	Rohm	MCR03EZPFX1000	4
R106,R110	Resistor	10kΩ	Rohm	MCR03EZPFX1002	2
R107,R111	Resistor	NI	Rohm	MCR03EZPFX1002	0
R108	Resistor	10kΩ	Rohm	MCR03EZPFX1002	1
R109	Resistor	20kΩ	Rohm	MCR03EZPFX2002	1
R113,R116	Resistor	0Ω	Rohm	MCR03EZPJ000	2
R114,R115	Resistor	NI	Rohm	MCR03EZPJ000	0
R117	Resistor	NI	Rohm	MCR03EZPJ000	0
R118	Resistor	10kΩ	Rohm	MCR03EZPFX1002	1
R121	Resistor	10Ω	Rohm	MCR03EZPFX10R0	1
R122	Resistor	NI	Rohm	MCR03EZPFX1001/ MCR100JZHF1001	0
R123,R124,R125,R126, R127,R128,R129,R130, R131R132,R133,R134,	Resistor	NI	Rohm	MCR03EZPFX1002	0
R136,R138	Resistor	NI	Rohm	MCR03EZPJ000	0
R135,R137	Resistor	0Ω	Rohm	MCR03EZPJ000	2
R139	Resistor	200Ω	Rohm	MCR03EZPFX2000	1
R140	Resistor	NI	Rohm	MCR03EZPJ000	0
R141	Resistor	0Ω	Rohm	MCR03EZPJ000	1
SW101	DIP Switch	–	Nidec copal electronics	CHS-02A1	1
SW103	DIP Switch	–	Nidec copal electronics	CHS-01A1	1
CN101	Pin Header	–	Hirosugi-keiki	PSS-710102-08	1
VCC5,BRK,FR,PWMB, TEST,FGO,PS,GND, VCC,U,V,W	Terminal	–	Hirosugi-keiki	HT0810-3	12

NI:Not Implemented

Table 2.2 Parts list

2.6 Input and output specifications (unless specified otherwise, VCC = 48 V and Ta = 25°C)

Item	Symbol	Minimum	Standard	Maximum	Unit	Conditions
VCC50 voltage	V_{VCC50}	4.5	5.0	5.5	V	
Hall input						
Input common-mode range	V_{HALLCM}	0	-	V_{VCC50}-1.7	V	Hall element
Input voltage range	$V_{HALLRNG}$	0	-	V_{VCC50}	V	Hall IC
Minimum input voltage	$V_{HALLMIN}$	50	-	-	mV_{P-P}	
PS						
Pull-up resistance	R_{PS}	-	101	-	kΩ	Pre-driver built-in value
Input High voltage	V_{STBY}	3.8	-	5.0	V	Power save
Input Low voltage	V_{ENA}	0	-	0.5	V	Drive
FR						
Pull-down resistance	R_{FR}	-	9.1	-	kΩ	Parallel value of pre-driver built-in resistance and R104
Input High voltage	V_{FRH}	V_{VCC50}-1.2	-	V_{VCC50}	V	U → V → W
Input Low voltage	V_{FRL}	0	-	0.8	V	U → W → V
BRK						
Pull-down resistance	R_{BRK}	-	9.1	-	kΩ	Parallel value of pre-driver built-in resistance and R102
Input High voltage	V_{BRKH}	V_{VCC50}-1.2	-	V_{VCC50}	V	Short brake
Input Low voltage	V_{BRKL}	0	-	0.8	V	Drive
Velocity command: PWMB						
Input High voltage	V_{PWMBH}	V_{VCC50}-1.2	-	V_{VCC50}	V	
Input Low voltage	V_{PWMBL}	0	-	0.8	V	
Input frequency range	f_{PWMB}	1	-	50	kHz	
FGO output						
Output Low voltage	V_{FGOL}	0	0.1	0.3	V	I_{FGO}=+3 mA
Pull-up resistance	R_{FGO}	-	10	-	kΩ	R118 value, pulled up to VCC50

3. Device connection and method of operation

3.1 Necessary devices

- Main power supply: 28 to 63 V output stabilizing DC power supply (power supply with a capacity exceeding the motor driving current).

• Oscillator for the PWMB terminal input signal: Oscillator that can output a square wave at an output frequency of 1 to 50 kHz with an output amplitude of 5 $V_{0\text{-}P}$.

• Three-phase brushless DC motor using three Hall elements, or three-phase brushless DC motor using three Hall ICs (The board settings must be changed according to the motor specifications. To change the settings, refer to "4. Settings for each function" on page 14/19 and "5. Changing Output MOS" on page 16/19).

3.2 Board connection for motors using Hall elements

This board is mounted with parts for motors using Hall elements. To connect a motor using Hall elements to the board, follow the procedure below.

To connect a motor using Hall ICs to the board, refer to "3.3 Board connection for motors using Hall ICs" on page 10/19.

1. Connect a DC power supply between the VCC and GND terminals. Set the voltage to be applied to the motor (28 to 63 V). Leave the output switch of DC power supply OFF, and don't supply a power supply.
2. Connect an oscillator to the PWMB terminal and set the waveform to a square wave. Set the output amplitude to 5 $V_{0\text{-}P}$. Fix the frequency between 1 kHz to 50 kHz. Set the low side duty between 10% and 30%. Leave the output switch of oscillator OFF, and don't input a signal.
3. Connect the power supply for the Hall elements of the motor to HB (5 V typ) of the board, and connect GND of the Hall elements of the motor to GND1 of the board.
4. Connect U+ and U-, which are the U-phase Hall element outputs of the motor, to HUP and HUN of the board. Connect V+ and V-, which are the V-phase Hall element outputs of the motor, to HVP and HVN of the board. Connect W+ and W-, which are the W-phase Hall element outputs of the motor, to HWP and HWN of the board. For more details on the connections, refer to Section 1 on pages 14/28 and 15/28 of the BM64300MUV Datasheet. Use R139 to adjust the current to the Hall elements. The value is set to 200Ω on this board. Confirm that the output voltage and the differential amplitude of the Hall element output satisfy the input and output specifications of the board.
5. Connect the U, V, and W outputs of the motor to the U, V, and W terminals of the board, respectively.

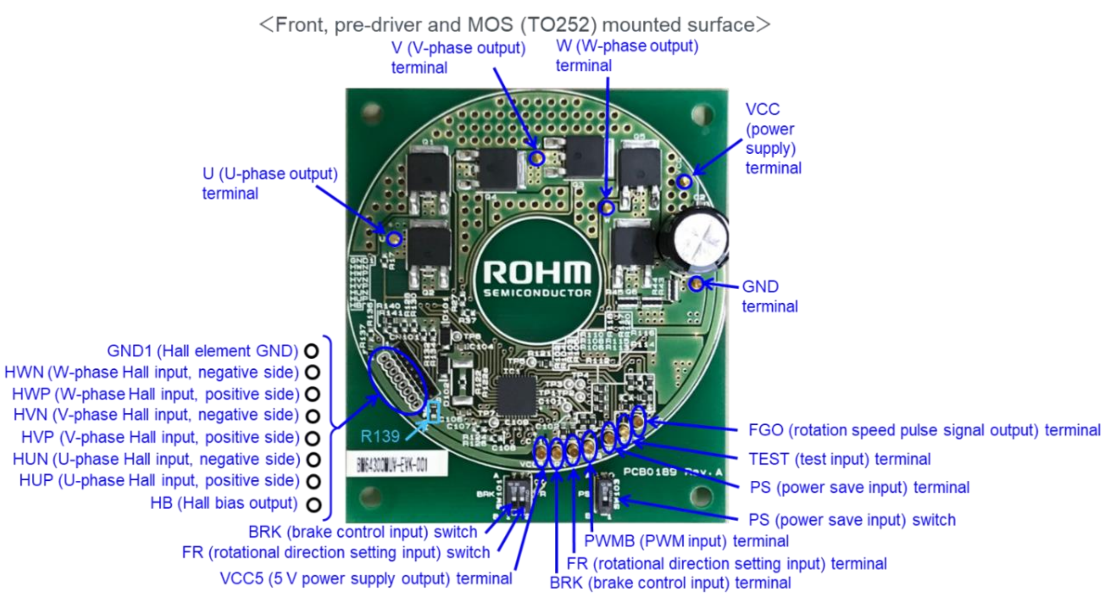

Figure 3.1 Circuit board connection diagram (Hall elements)

3.3 Board connection for motors using Hall ICs

3.3.1 Changes in board

The settings in the parts list for this board are compatible with the Hall elements. When a motor with built-in Hall ICs is used, change the parts on the board as follows.

- Remove capacitors C108, C109, and C110.
- Remove resistor R139 and install a 0Ω resistor.
- When the Hall IC output is CMOS or has a built-in pull-up resistance, install 10kΩ resistors for R123, R124, R127, R128, R131, and R132. When the Hall IC output is an open-collector, install 10kΩ resistors for R125, R129, and R133 as well.

3.3.2 Board connection

1. Connect a DC power supply between the VCC and GND terminals. Set the voltage to be applied to the motor (28 to 63 V). Leave the output switch of DC power supply OFF, and don't supply a power supply.
2. Connect an oscillator to the PWMB terminal and set the waveform to a square wave. Set the output amplitude to 5 $V_{0\text{-}P}$. Fix the frequency between 1 and 50 kHz. Set the low side duty range between 10% and 30%. Leave the output switch of oscillator OFF, and don't input a signal.
3. Connect the power supply for the Hall ICs to HB of the board, and connect GND of the Hall ICs to GND1 of the board.
4. Connect the U-, V-, and W-phase outputs of the Hall ICs to HUP, HVP, and HWP of the board, respectively.
5. Connect the U, V, and W outputs of the motor to the U, V, and W terminals of the board, respectively.

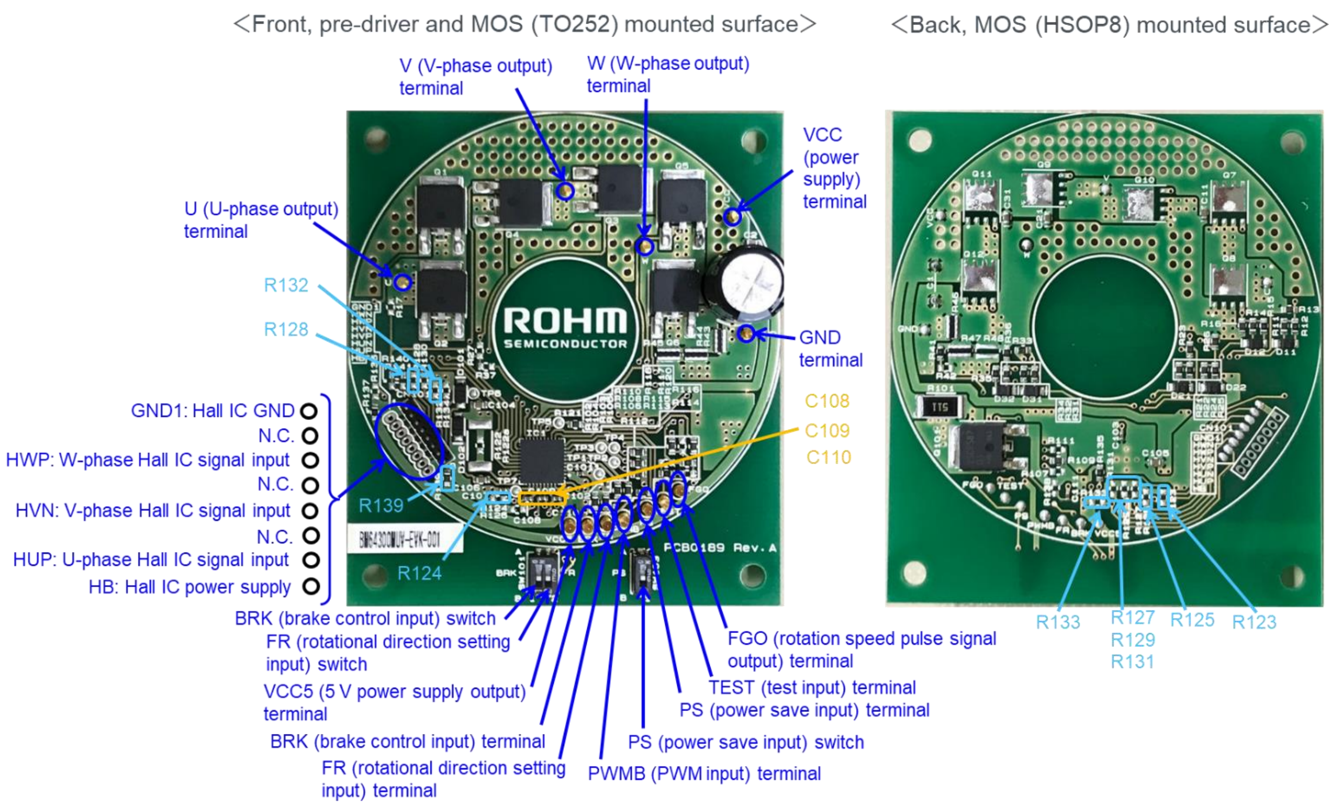

Figure 3.2 Circuit board connection diagram (Hall IC)

3.4 Motor operation

Figure 3.3 Switch A/B

1. Turn the BRK switch to the B side, the FR switch to the B side, and the PS switch to the B side (see Figure 3.3).
2. Turn ON the output switch of the DC power supply. Turn the PS switch to the A side.
3. Turn ON the output switch of the oscillator. Confirm that the motor is rotating.
   The initial value of the low side duty range of the square wave when the motor starts to rotate depends on the motor to be used. Calibrate the value experimentally. Increasing the low side duty range increases the rotation speed. Adjust the low side duty range so that the target rotation speed can be obtained.
4. When the FR switch is turned to the B side, the output is switched with a phase difference of 120 degrees in the sequence of U-phase → W-phase → V-phase.
   To switch over the rotational directions, put the motor in the stop state and then turn the FR switch to the A side.
   The output is now switched with a phase difference of 120 degrees in the sequence of U-phase → V-phase → W-phase.
   Although this is not recommended, when the rotational direction is switched while the motor is rotating, the motor enters the short brake mode until the rotation speed is decreased below 500 rpm (4-pole setting) before the rotational direction is changed.
5. When the BRK switch is turned to the A side, the external output upper side MOS is turned OFF and the external output low side MOS is turned ON, and then the short brake operation is performed.
   When the BRK switch is turned to the B side, the short brake operation is released.
6. The rotation speed can be measured using the FGO terminal waveform.

4. Settings for each function

4.1 Motor pre-driver settings

4.1.1 Current limit settings

Connecting low resistances (R43 to R48) between the source of the low side output MOS and GND enables the motor current to be detected and the current limit operation is performed.

On this evaluation board, a 100mΩ resistor is installed on each of R43 to R47. Since V_{CL}, the current limit detection voltage of the motor pre-driver, is 0.2 V (typ), current limit value I_L = (0.2 V/100mΩ) × 5 = 10 A (typ).

For more details on the settings, refer to Section 3 on page 17/28 of the BM64300MUV Datasheet.

4.1.2 Soft start time setting

The soft start time can be set using the voltage to be applied to the SS_SEL terminal of the BM64300MUV.

The soft start function gradually increases the coil current to restrain the inrush current during startup from the motor stop state.

Depending on the motor specifications, the inrush current may not be sufficiently restrained if the time setting is too short.

Also, it may take a long time until a desired rotation speed is reached if the time setting is too long.

On this evaluation board, the SS_SEL terminal of the motor pre-driver is set to 0 V. Therefore,

Soft start time = 49 ms × (200 mV - 51.6 mV)/5.16 mV = 1.4 s (typ),

requiring the shortest time setting.

To change the soft start time, change the SS_SEL terminal voltage using R106 and R107, which are the soft start time setting resistors.

For more details on the settings, refer to Section 4 on page 18/28 of the BM64300MUV Datasheet.

4.1.3 Output dead time setting

The output dead time can be set using the voltage to be applied to the TDEAD_SEL terminal of the BM64300MUV.

To prevent the upper and lower output MOSs in the same phase from being turned ON simultaneously, you can set the output dead time, which is a delay time after the upper (or lower) pre-driver output in the same phase is switched from High to Low until the lower (or upper) pre-driver output is switched from Low to High.

Depending on the output MOS, the upper output MOS and the lower output MOS may be turned ON simultaneously if the output dead time is too short. In addition, the phase current wave form becomes more distorted if the output dead time is too long. Accordingly, the output dead time is set to 1.0 μs (typ) on this board.

This is achieved by setting the TDEAD_SEL terminal voltage of the motor pre-driver as follows: using dead time setting resistors R108 = 10kΩ and R109 = 20kΩ,

TDEAD_SEL terminal voltage = R108/(R108 + R109) × V_{VCC50} = 10kΩ/(10kΩ + 20kΩ) × V_{VCC50} = 0.333 × V_{VCC50}

To change the output dead time, change the TDEAD_SEL terminal voltage by changing R108 and R109.

For more details on the settings, refer to Section 5 on page 19/28 of the BM64300MUV Datasheet.

4.1.4 Setting of number of motor poles

The number of motor poles can be set using the voltage to be applied to the POLE_SEL terminal of the BM64300MUV.

Set the number of motor poles according to the number of poles of the motor to be used.

On this evaluation board, the POLE_SEL terminal of the motor pre-driver is set to 0 V. This sets the number of motor poles to 4.

To change the number of motor poles, change the POLE_SEL terminal voltage using R110 and R111, which are the resistors for setting the number of motor poles.

For more details on the settings, refer to Section 6 on page 19/28 of the BM64300MUV Datasheet.

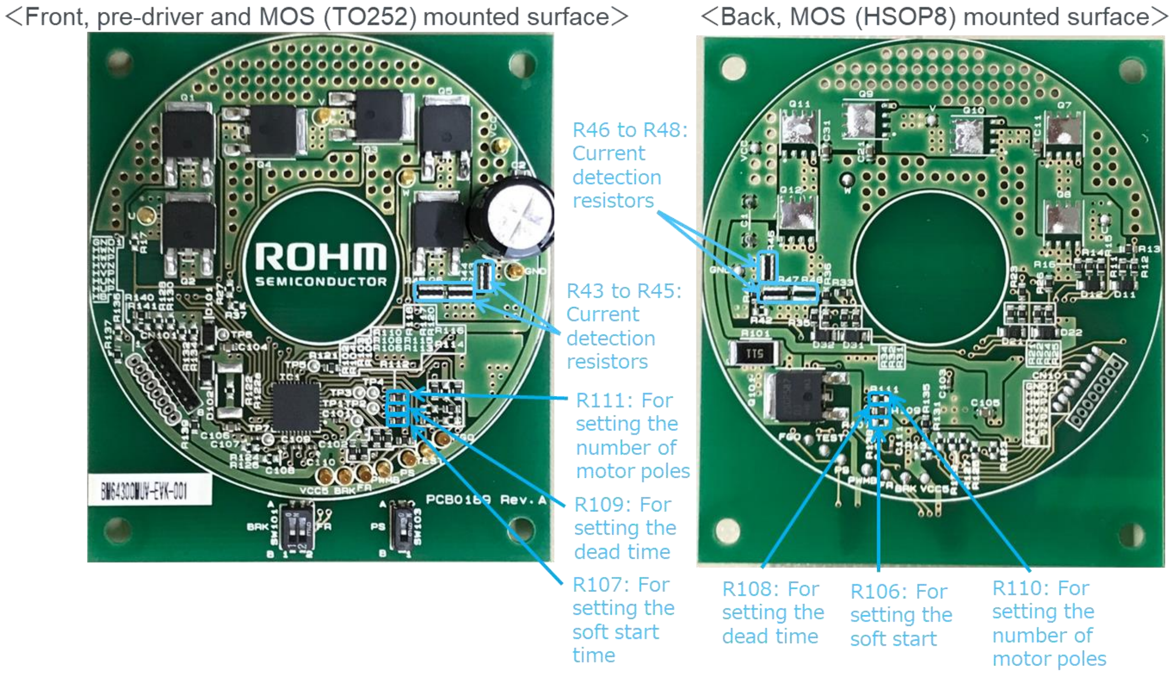

Figure 4.1 Diagram of motor pre-driver setting parts

4.2 Smoothing capacitor settings for the power supply

Change the capacitance of the electrolytic capacitor (C1) for the power supply according to the specifications of the motor to be used.

On the current evaluation board, a capacitor with 47 μF/100 V is mounted.

4.3 Fuse

No fuse is mounted on this evaluation board. Use fuses as necessary.

Note:

For more details on other settings that are not described above, refer to the BM64300MUV Datasheet.

5. Changing output MOS

5.1 To change output MOS

If necessary, change the MOS according to the specifications of the motor output current.

The pattern designing allows either the TO252 package or the HSOP8 package to be mounted on this board.

Remove the MOS of the TO252 package that is currently mounted, and then mount a desired MOS.

5.2 Changing gate constants

When the MOS is changed, change the gate constants (R11, R12, R14, R15, R21, R22, R24, R25, R31, R32, R34, and R35). On this board, 470Ω resistors are mounted for R11, R14, R21, R24, R31, and R34, and 0Ω resistors are mounted for R12, R15, R22, R25, R32, and R35.

Increasing R11, R14, R21, R24, R31, or R34 increases the time until the MOS is turned ON and also decreases the slew rate when the MOS output is ON. Decreasing R11, R14, R21, R24, R31, or R34 decreases the time until the MOS is turned ON and also increases the slew rate when the MOS output is ON.

In addition, increasing R12, R15, R22, R25, R32, or R35 increases the time until the MOS is turned OFF and also decreases the slew rate when the MOS output is OFF. Decreasing R12, R15, R22, R25, R32, or R35 decreases the time until the MOS is turned OFF and also increases the slew rate when the MOS output is OFF.

Decreasing the slew rate may increase the loss during switching, reducing the efficiency. In addition, increasing the slew rate may cause a ringing in the output voltage, generating noise.

When the time until the output MOS is turned ON is set too short and the time until the output MOS is turned OFF is set too long, the upper and lower MOSs may be turned ON simultaneously, causing a shoot-through current to flow. In addition, when the time until the output MOS is turned ON is set too long and the time until the output MOS is turned OFF is set too short, the current in each phase may be distorted. Set the gate constants so that the desired characteristics can be obtained.

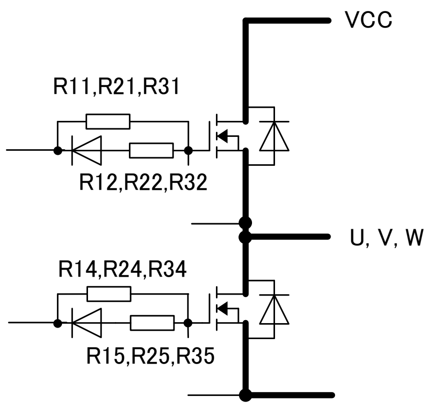

Figure 5.1 Gate constants: circuit diagram

<Back, MOS (HSOP8) mounted surface>

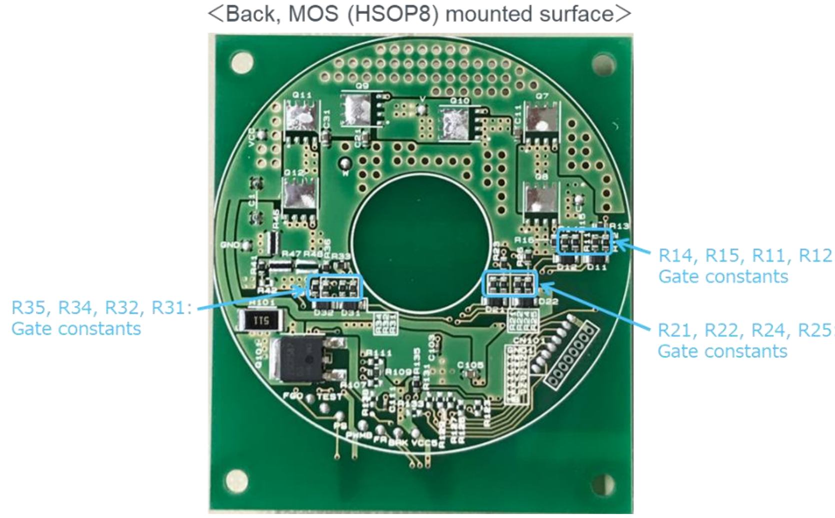

Figure 5.2 Gate constants: parts diagram

6. Board layout

Circuit board size: 60 mm × 68 mm × 1.6 mm (double-sided), FR-4 material, copper foil thickness of 35 µm

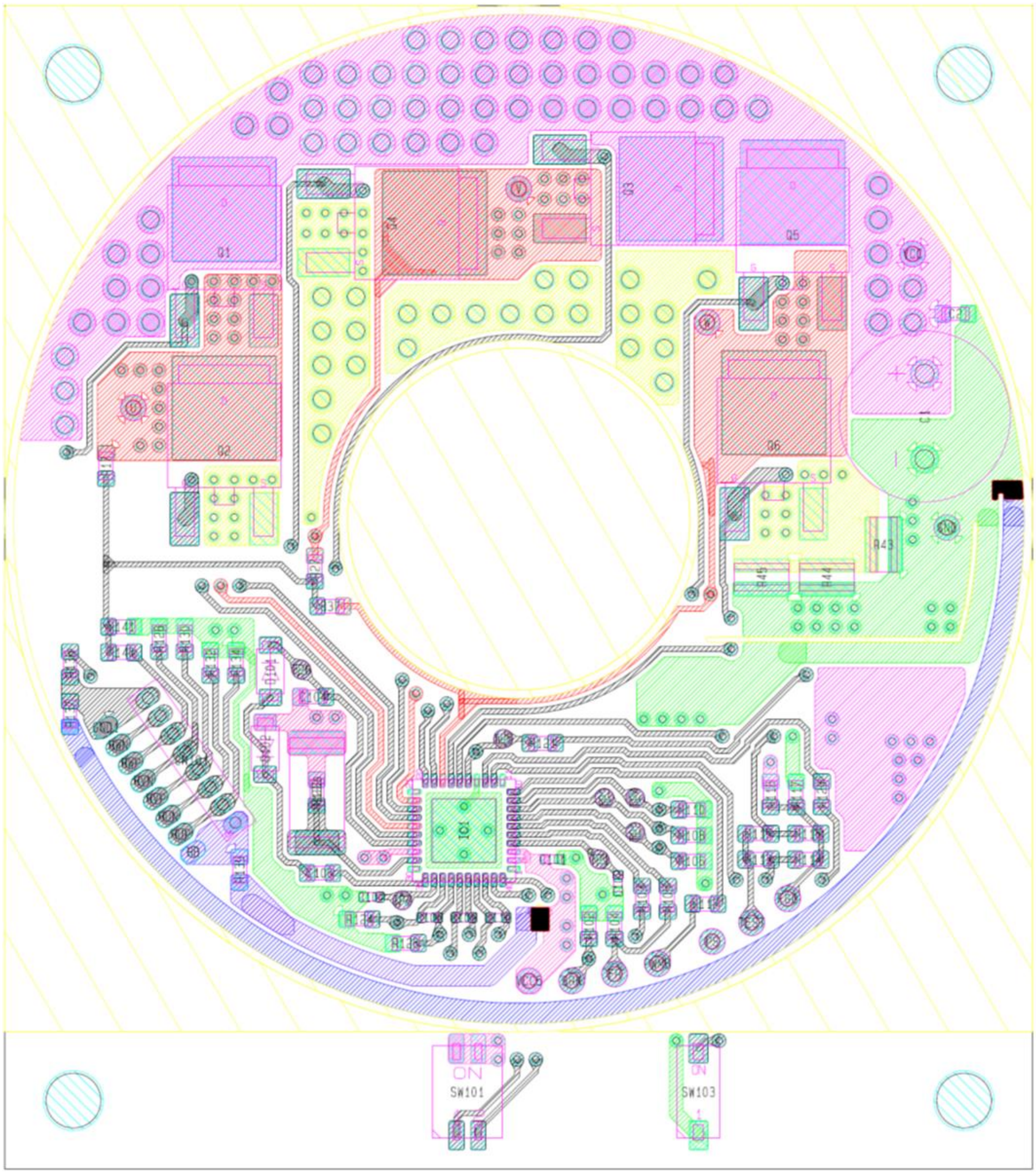

Figure 6.1 Evaluation board (pattern, front, motor pre-driver IC and MOSFET TO252 mounted surface)

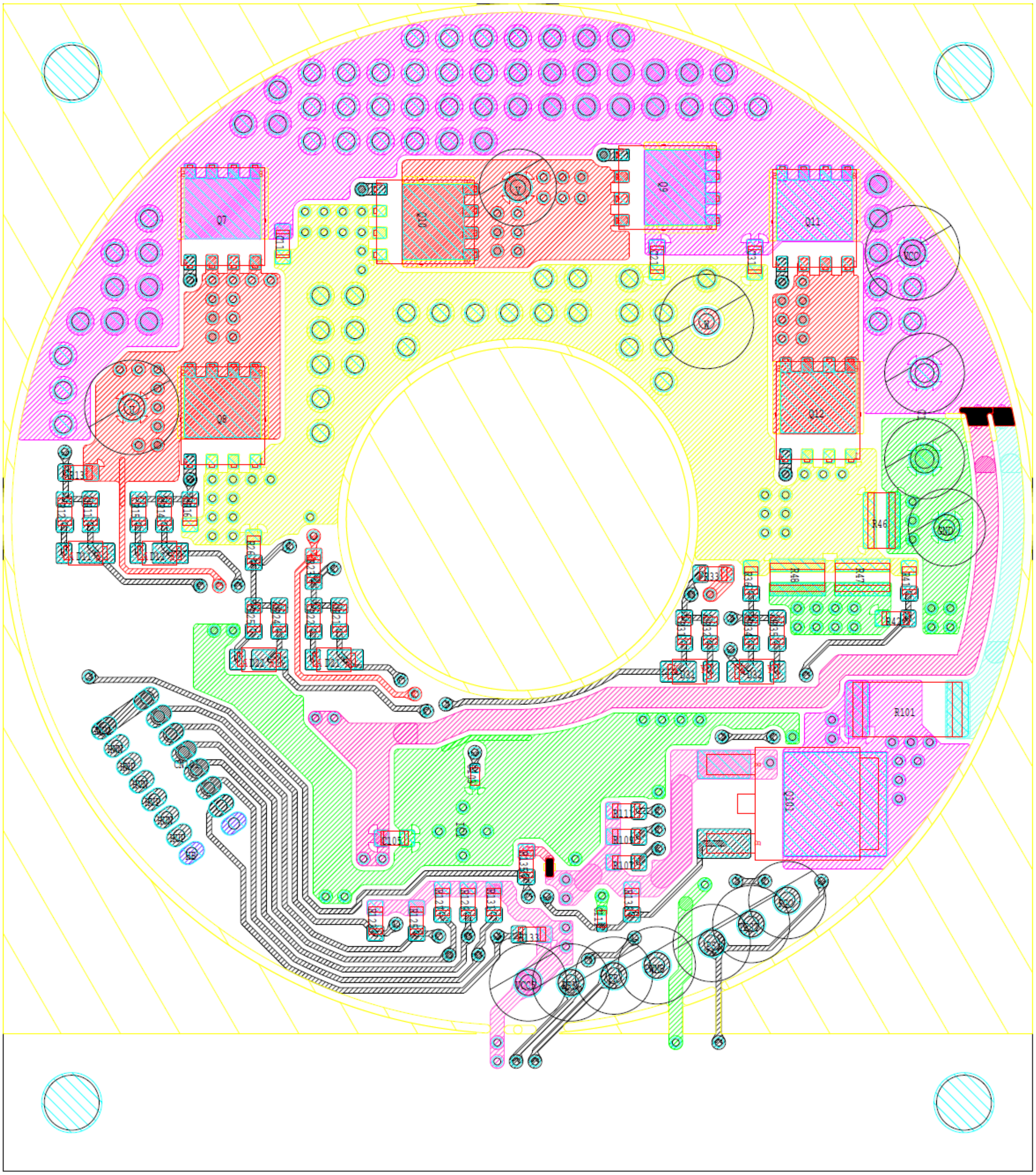

Figure 6.2 Evaluation board (pattern, back, MOSFET HSOP8 mounted surface: transparent view)

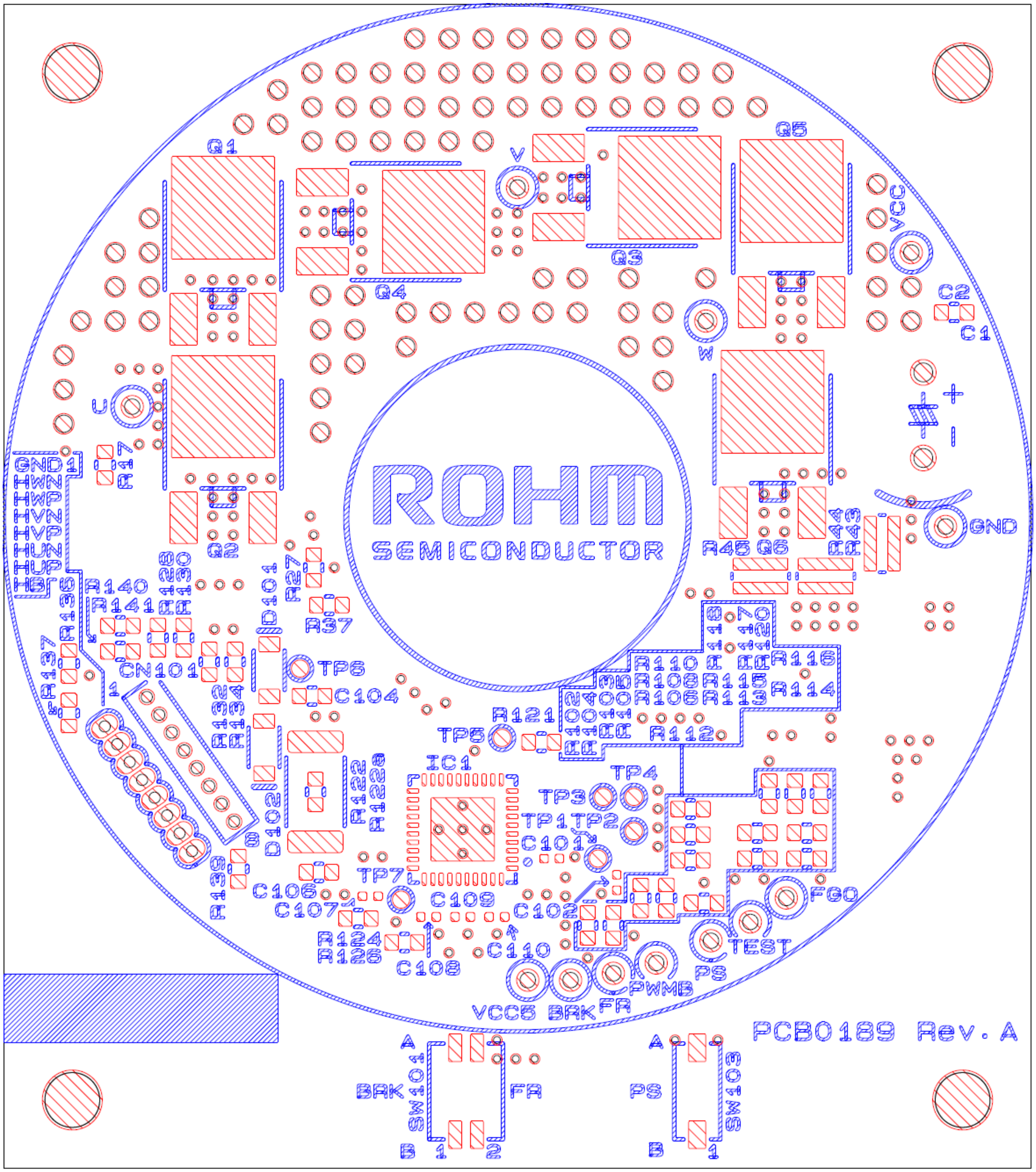

Figure 6.3 Evaluation board (silkscreen print, front, motor pre-driver IC and MOSFET TO252 mounted surface)

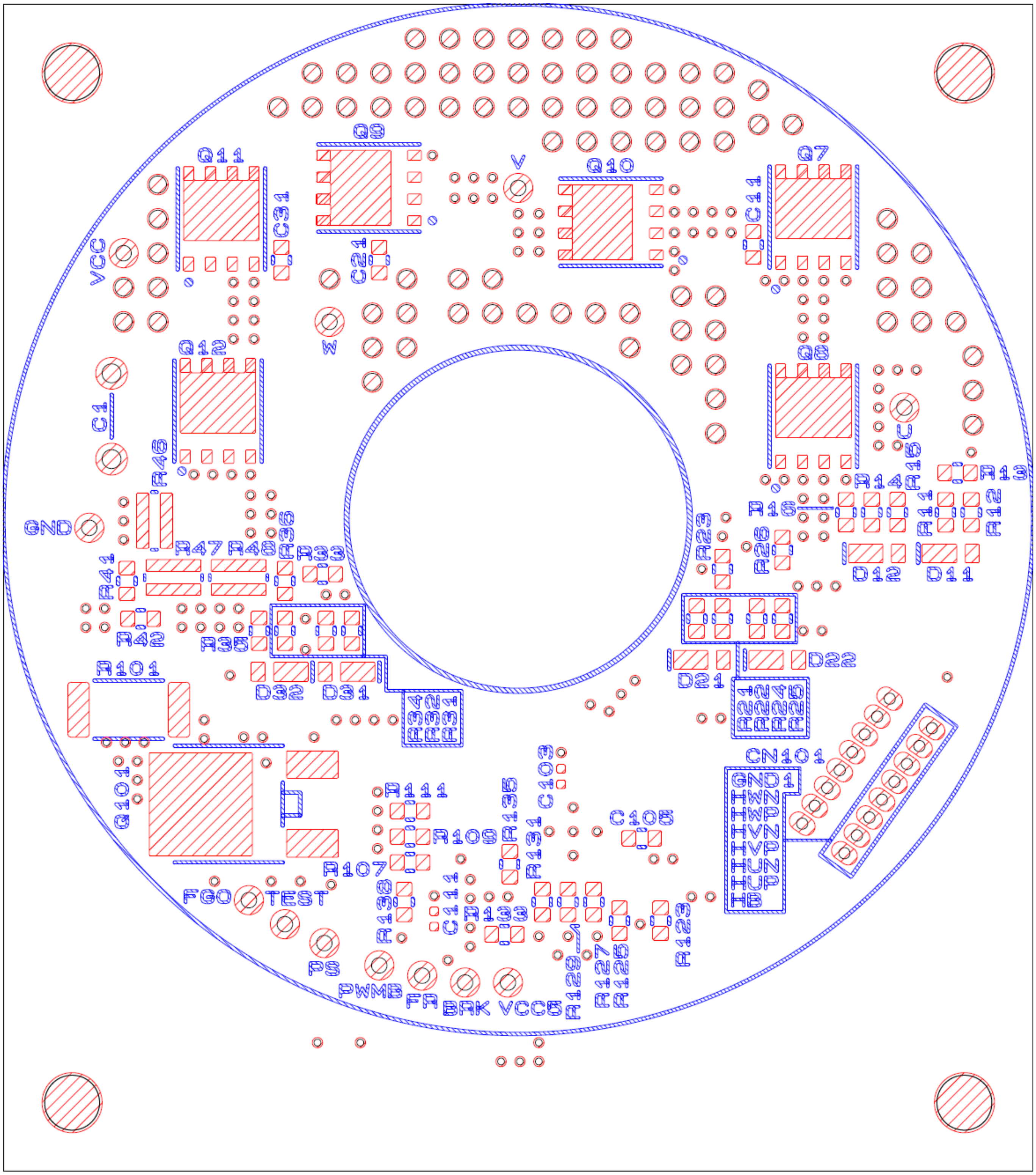

Figure 6.4 Evaluation board (silkscreen print, back, MOSFET HSOP8 mounted surface)

● Revision history

Date	Revision	Revised content
2020.6.26	001	Newly created

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.
Therefore, in order to prevent personal injury or fire arising from failure, please take safety measures such as complying with the derating characteristics, implementing redundant and fire prevention designs, and utilizing backups and fail-safe procedures. ROHM shall have no responsibility for any damages arising out of the use of our Poducts beyond the rating specified by ROHM.

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.

6) The Products specified in this document are not designed to be radiation tolerant.

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.

8) Do not use our Products in applications requiring extremely high reliability, such as aerospace equipment, nuclear power control systems, and submarine repeaters.

9) ROHM shall have no responsibility for any damages or injury arising from non-compliance with the recommended usage conditions and specifications contained herein.

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