Gate Driver IC for IGBTs and SiC MOSFETs

Gate Driver Evaluation Board for Inverter EV-GDIS16 User Guide

Introduction

This user guide describes the configuration and usage of the EV-GDIS16 evaluation board for Renesas's Gate Driver products in SOP-16 package.

The EV-GDIS16 board is designed for quick evaluation of Renesas Gate Drivers and is not intended to evaluate or guarantee all the characteristics of the Gate Driver products it is equipped with.

Target Device

Renesas Electronics Gate Driver series

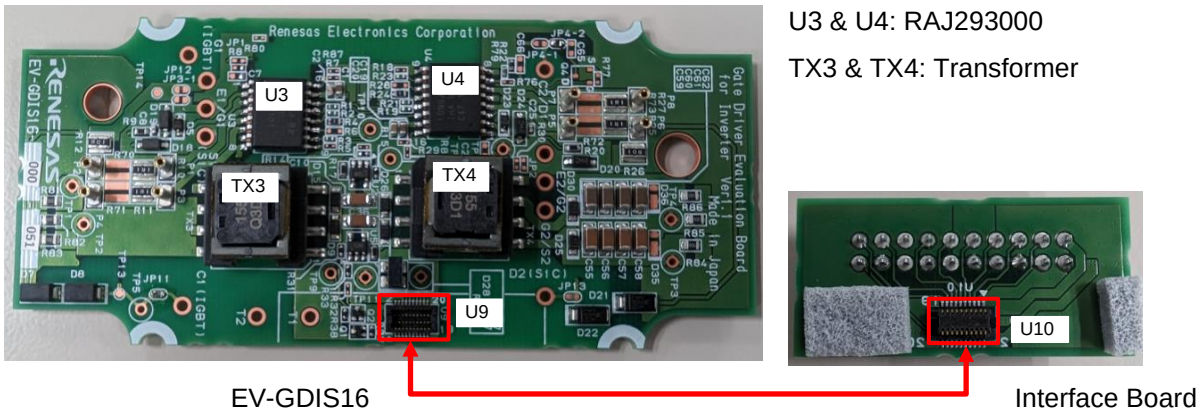
RAJ293000 and other future products

Contents

1. Getting Start

1.1 EV-GDIS and Interface board connection method and external view

Connect U9 on EV-GDIS to U10 on the interface board as shown in Figure 1 to connect EV-GDIS and interface board. Figure 2 shows the overall appearance of the connected EV-GDIS and interface board.



U3 & U4: RAJ293000

TX3 & TX4: Transformer

Figure 1. How to connect EV-GDIS16 and Interface board

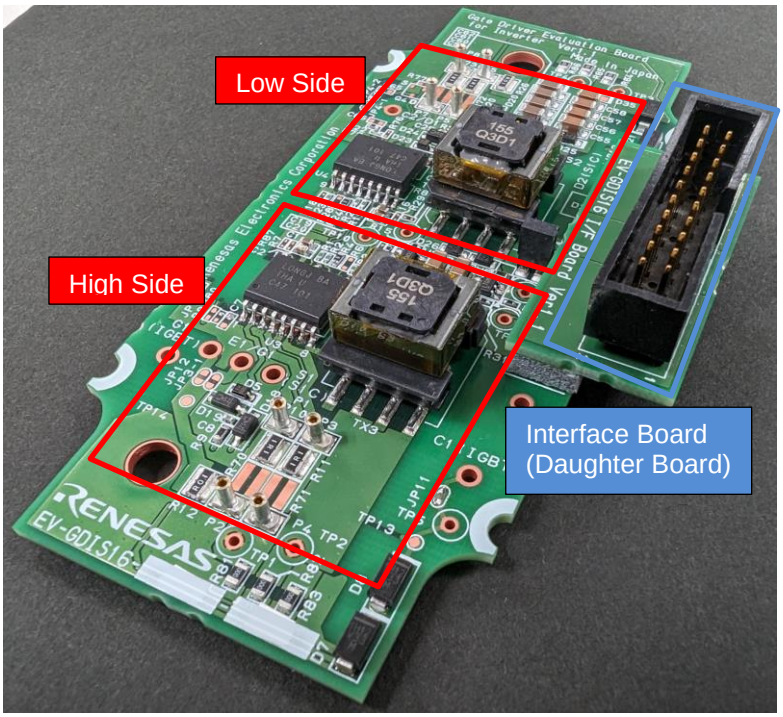


Figure 2. Overall appearance of board

1.2 How to switch IGBT/SiC modules

EV-GDIS supports IGBT and SiC modules. By default, EV-GDIS supports IGBT modules, which is realized by soldering the jumpers in red frame as shown in Figure 3.

To switch to SiC module, remove the jumpers in the red frame in Figure 3 and solder the jumpers in the yellow frame. Refer Chapter 7 for details.

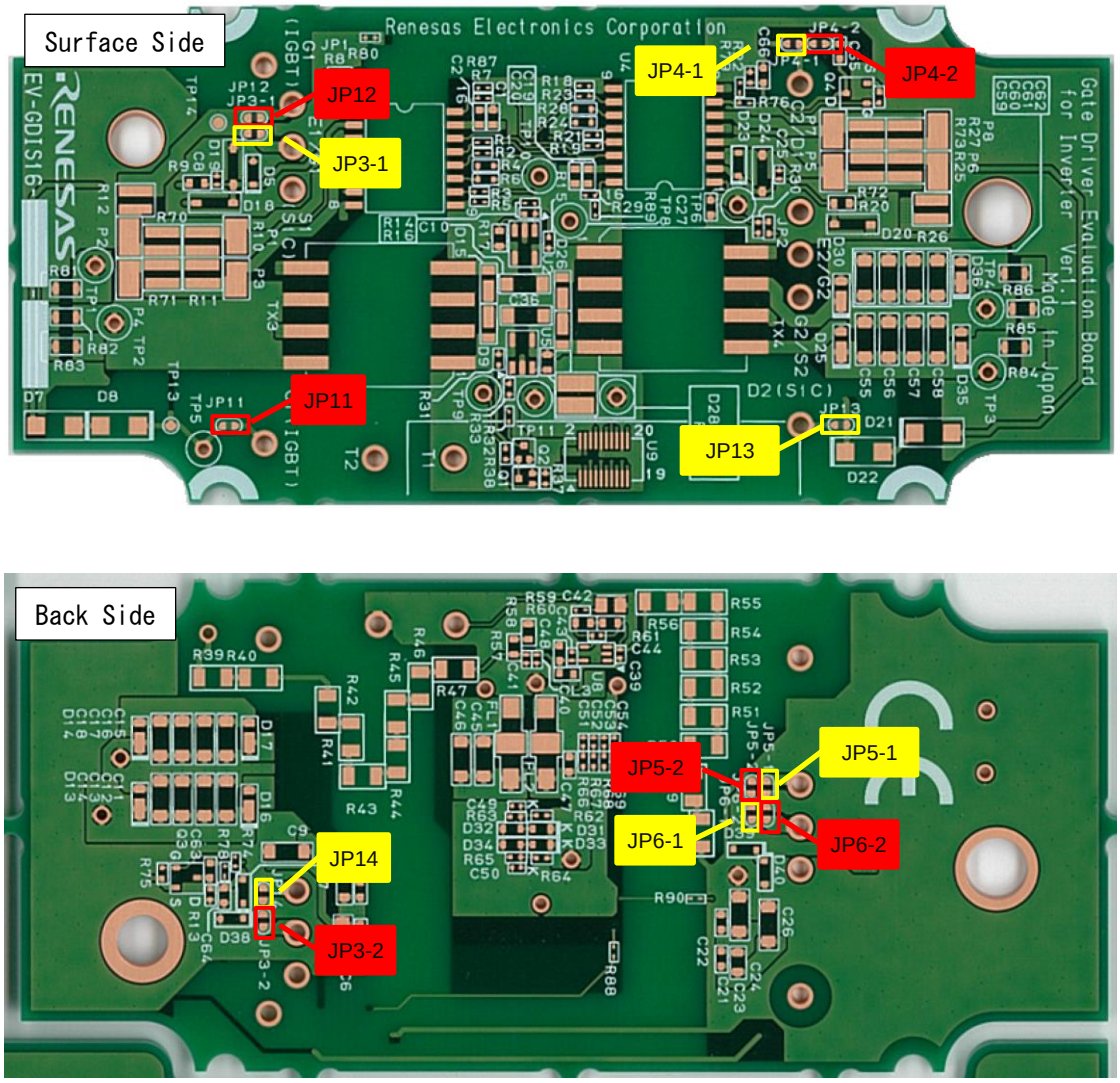


Figure 3. Jumper switching positions for IGBT and SiC

1.3 Simple operation method

Figure 4 shows a schematic diagram of a simple operation method of EV-GDIS. First, connect EV-GDIS and Interface board as shown in Figure 1. Apply voltage in the following order when connecting to the module and evaluating.

① Apply 12V to pin1 of I/F Board

② Apply 5V to pin2 of I/F Board

③ Apply a square wave of 0V-5V to each of the pin8 (UH_H) and pin4 (UL_H) of the I/F Board

Please set to prevent High side and Low side from being ON at the same time.

Refer Chapter 3 for pinout and connector details.

The output pin leading to the gate of the module is different when using the IGBT module and the SiC module. Figure 4 shows the position of the IGBT output pin with a red frame, and the position of the SiC output pin with a yellow frame.

When evaluating by connecting to a module, voltage is applied to the DESATpin internally and the board operates, but when evaluating the board alone,

DESATpin needs an externally applied power supply (eg. 1V) as indicated by dotted line in Figure 4.

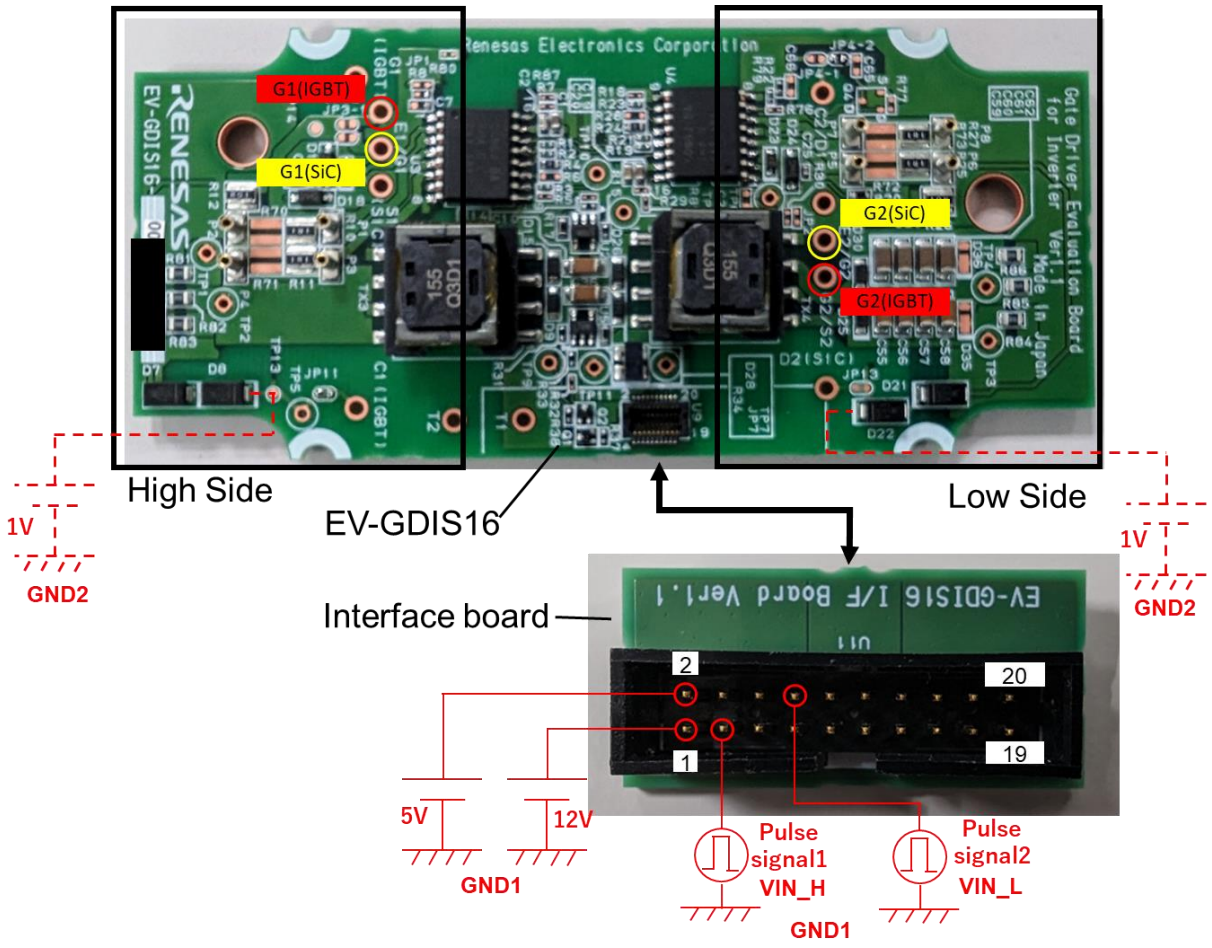


Figure 4. EV-GDIS Simple Operation Method

2. EV-GDIS16 Evaluation Board overview

EV-GDIS16 is a board for quick evaluation of Renesas' Gate Driver products in SOP-16 package. The boards are equipped with the necessary connectors and jumpers for evaluation, allowing customers to start evaluation early, before developing their own boards for target products. The Gate Driver products mounted on this evaluation board are working samples and the quality is not guaranteed.
The EV-GDIS16 board consists of a main board and an interface board, which has user-friendly pin-pitch connectors and components for double-pulse testing.

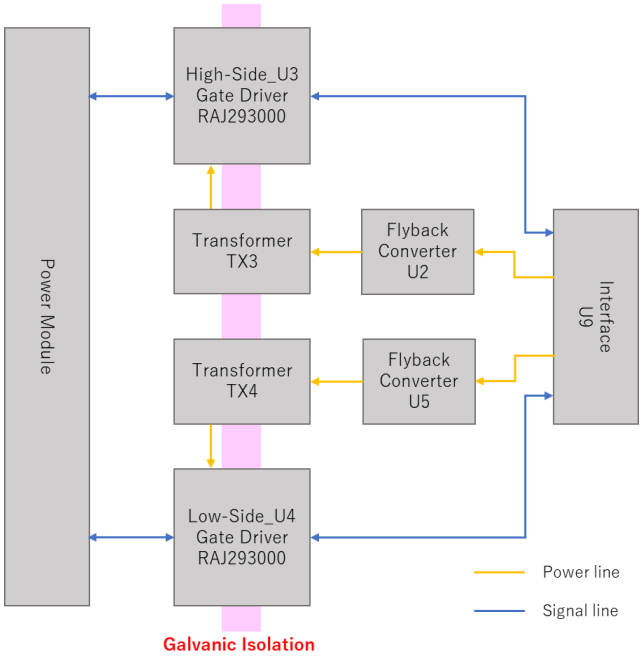
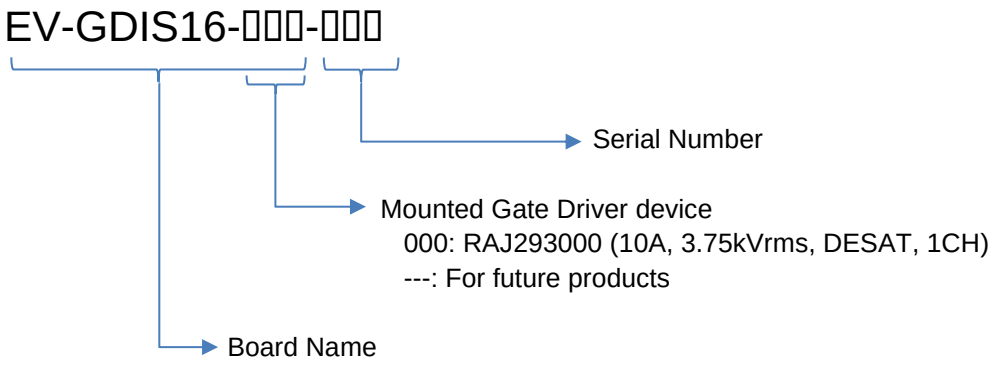


Figure 5. EV-GDIS16 block diagram

2.1 Board Name

The board name is marked on the board to identify the device it is equipped with.



3. PCB specification

The EV-GDIS16 uses an automotive grade PCB. The board size and number of layers are as below.

Table 1. PCB specification

Parameter	Value
Board size	104.5 mm x 47.0 mm
Thickness of PCB	1.6 mm
Thickness of Cu layer	20 µm
Cu layer numbers	6 layer, 1-4-1 build-up
Board material	FR4

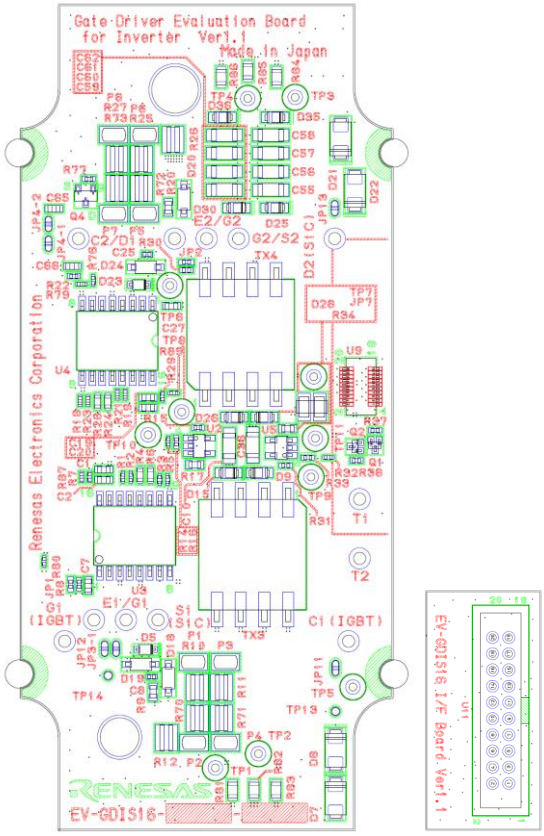


Figure 6. Layout of EV-GDIS16 (Main / Interface board)

4. Connectors

EV-GDIS16 is equipped with a connector and test pins to evaluate the on-board Gate Driver. Please refer to the following table for the description of each and precautions for use.

Table 2. Connectors

Connector	Pin count	Function
U9	20	U9 is a fine pitch connector mounted on EV-GDIS16. It is connected to U10 on the I/F Board.
U10	20	U10 is a fine pitch connector mounted on I/F board. It is connected to U9 on the EV-GDIS16.
U11	20	U11 is a connector on the I/F Board that allows signal input/output to/from the EV-GDIS16 Board. Please refer to Chapter 4 for U11 signal details.
C2/D1[*1]	1	This is the terminal to be connected to C2 on the IGBT module or D1 on the SiC module.
G2/S2[*1]	1	This is the terminal to be connected to G2 on the IGBT module or S2 on the SiC module.
E2/G2[*1]	1	This is the terminal to be connected to E2 on the IGBT module or G2 on the SiC module.
D2(SiC)	1	This is the terminal to be connected to D2 on the SiC module.
S1(SiC)	1	This is the terminal to be connected to S1 on the SiC module.
E1/G1[*1]	1	This is the terminal to be connected to E1 on the IGBT module or G1 on the SiC module.
G1(IGBT)	1	This is the terminal to be connected to G1 on the IGBT module.
C1(IGBT)	1	This is the terminal to be connected to C1 on the IGBT module.
T1	1	The T1 terminal is connected to the T1 of the Integrated NTC temperature of the IGBT/SiC module.
T2	1	The T2 terminal is connected to the T2 of the Integrated NTC temperature of the IGBT/SiC module.

Note1: The signal numbering depends on where the board is mounted in the 6pack module.

5. MCU Interface – U11

U11 on the I/F Board is an input/output interface to external MCUs and/or measuring equipment.

Table 3. Pin assignment of MCU Interface U11

Pin	Name	I/O	Description	Pin	Name	I/O	Description
1	+12V	-	+12V power supply	11	FLYBKEN_MCU	I	Flyback enable
2	+5V	-	+5V power supply	12	TP10	-	Optional I/O
3	UL_H	I	Gate driver input	13	TEMP_U	O	Module Temperature
4	FOBL	O	Low side FOB	14	RDY	O	RDY from Gate Driver
5	VSENS	O	Voltage sense	15	N.C.	-	N.C.
6	AGND	-	Analog ground	16	APWMH	O	Future option
7	FOBH	O	High side FOB	17	APWML	O	Future option
8	UH_H	I	Gate driver input	18	GND	-	Digital ground
9	RSTB	I	Reset input	19	ASCH	O	Future option
10	GND	-	Digital ground	20	ASCL	O	Future option

6. Test pins

EV-GDIS16 board has test pins (TP) to monitor signals. Please refer to Table 4 below for details.

Table 4. Test Pin list and assignment

TP	Description	TP	Description
1	Flyback for Gate Driver IC U3 VCC2	8	+5V
2	Flyback for Gate Driver IC U3 GND2	9	Flyback enable from MCU
3	Flyback for Gate Driver IC U4 VCC2	11	Analog GND
4	Flyback for Gate Driver IC U4 GND2	12	DESAT_CS
5	UH_C	13	UH_C
6	UH_E	14	UH_G
7	Digital GND		

P9 on the I/F Board is the input signal for double pulse testing. Please refer to chapter “9. Optional Setting” for details.

7. Gate resistor adjustment

EV-GDIS16 board provides a pattern for adjusting and evaluating Gate resistors. The gate resistor connected to the output pin of the Gate Driver can control the peak current and power dissipation of the Gate Driver as well as suppress ringing.
The EV-GDIS16 board has one 1.1ohm SMD resistor as default, with options for SMD and leaded resistors to be added for adjustment.

The following figure shows the schematic of the Gate resistor connected to pin 4 of Gate Driver IC U4. R25 is the SMD resistor mounted as default, and an SMD resistor can be added in parallel with R72. Additionally, lead resistors can be attached to P5 and P6.

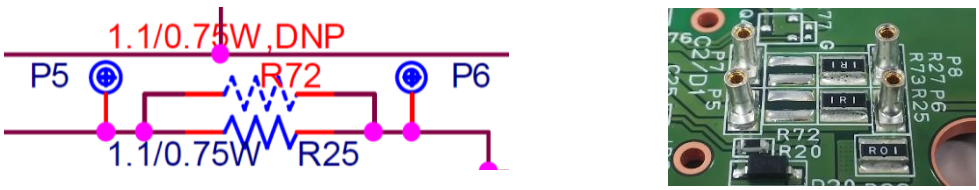


Figure 7. Gate resistor adjustable options

8. Target Modules

The EV-GDIS16 evaluation board is designed to be combined with a general IGBT/SiC power module to evaluate the on-board Renesas Gate Driver IC. The EV-GDIS16 is designed to allow three boards to be mounted side-by-side on these target modules. These IGBT/SiC modules are subject to change in the future.

Table 5. Target Modules

Module Type	Part Number	Description
IGBT	FS950R08A6P2B	HybridPACK Drive module with Trench/Fieldstop IGBT4 and Emitter Controlled 4 diode
SiC	FS03MR12A6MA1B	HybridPACK Drive module with CoolSiC Automotive MOSFET

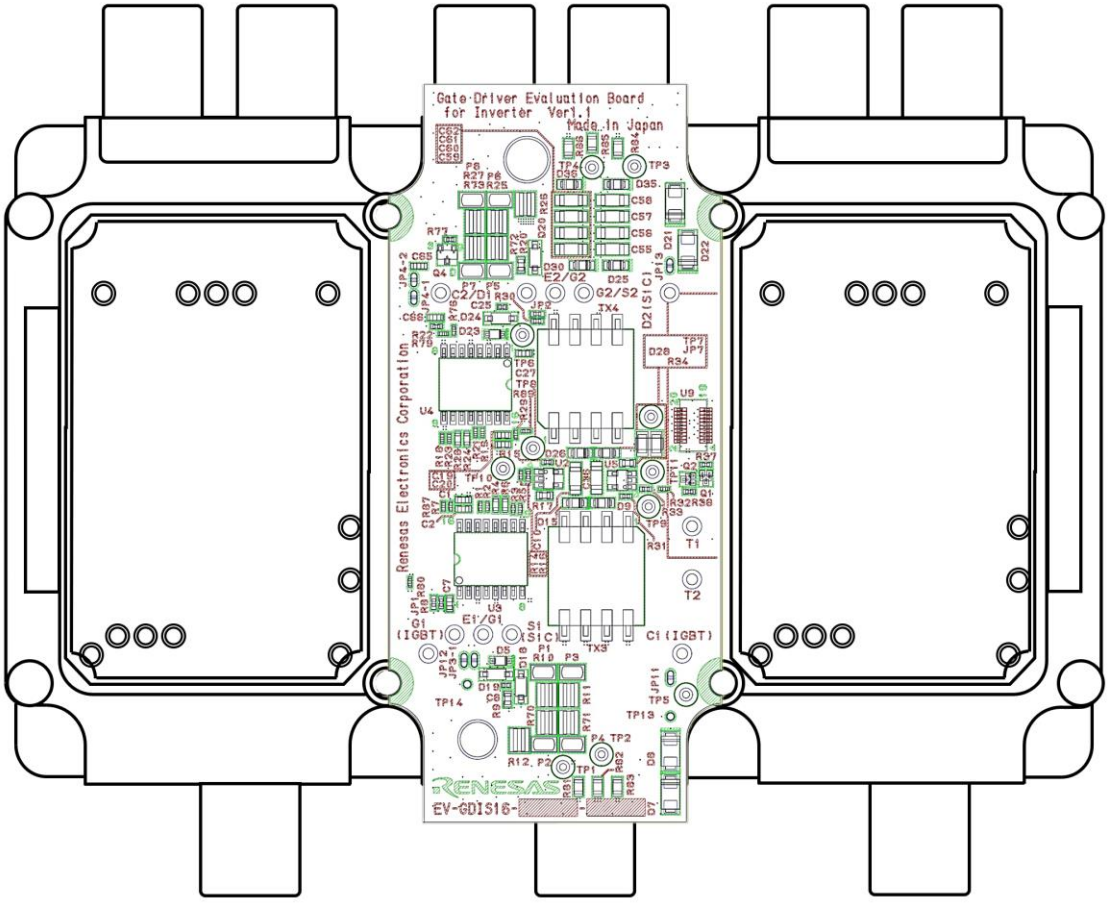


Figure 8. Image of EV-GDIS16 board with target module

Figure 3 shows the pinouts for mounting the EV-GDIS16 board on an IBGT/SiC module. The pin numbers depend on where the EV-GDIS16 board is mounted on the 6pack module.

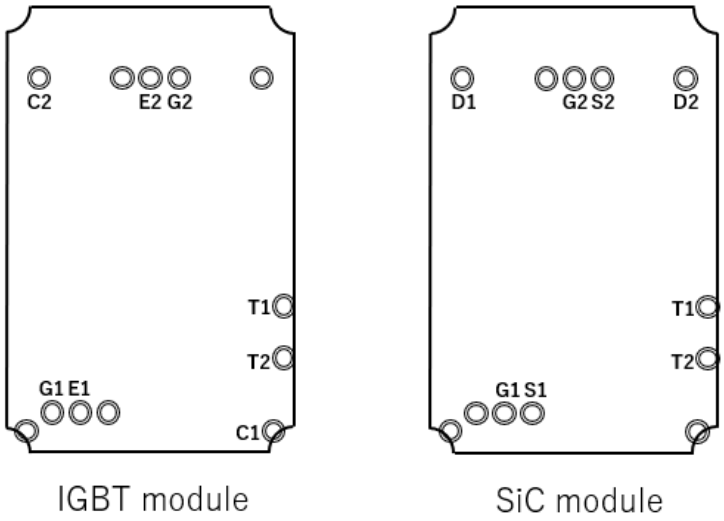


Figure 9. Connections with IGBT/SiC modules

To support both IGBT/SiC modules on a single board, the EV-GDIS16 board provides pin assignments for the target module with solder-short jumpers (Refer to Table 4).

Table 6. Solder-short jumper settings for target module

Jumper name	For IGBT module	For SiC module
JP3-1	-	Short
JP3-2	Short	-
JP4-1	-	Short
JP4-2	Short	-
JP5-1	-	Short
JP5-2	Short	-
JP6-1	-	Short
JP6-2	Short	-
JP11	Short	-
JP12	Short	-
JP13	-	Short
JP14	-	Short

If your target IGBT/SiC module has a different pin layout than these modules, connect this board to your target module with the shortest wires.

9. EV-GDIS16 interface board

The Interface board contains easy-to-use standard pitch connectors for signal input/output to MCU board and measuring equipment. The Interface board is attached to the U9 connector on the EV-GDIS16 board. Refer to Chapter 4 for details on input/output connector U11.

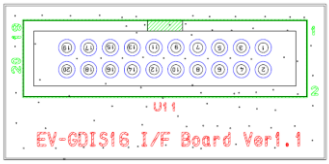


Figure 10. Interface Board

10. Optional settings

The EV-GDIS16 has an optional setting for a variety of evaluations. 0 ohm resistors and jumpers on the board can be used to change the connections to achieve the target evaluation purpose.

Table 7. Setting for target evaluation (e.g. For RAJ293000)

Evaluation	Parts setting	Description
Double Pulse Test (GDU 1pc)	(e.g. the case of IGBT) No set: R24,R84,R85,R86,JP3-2,JP9,JP10,JP11,JP12. Set: R28,R29,JP4-2,JP5-2,JP6-2	Use only Low side. Put in R=47kohm between VCC2-GND2 & GND2-VEE of Flyback Converter is recommended. It is recommended to apply supply voltage VCC1=5V, VCC2=15V, VEE=-5V as the input voltage*, and apply pulse signal in INA. The ON & OFF times of the pulse signal are the most important points. (*When using Flyback, set R84,R85,R86 and apply VCC1=5V, VCC2(Pin 1 of U11)=12V)
Flyback external control	R14, R32	This option is used to externally control the LT8301 flyback converter for U2 and U5. The EV/UVLO pin of the LT8301 on the board is always asserted by voltage divider with a resistor from +12V power supply. By mounting optional resistors R14 and R32, it is possible to control the EV/UVLO pin of the LT8301 from the 11 pin of connector U11 on the interface board.

11. Device option

The pin assignment differs depending on the mounted Gate Driver. EV-GDIS16 is designed to allow evaluation of different pin out products with 0 ohm resistors and jumpers settings. The following 0 ohm resistors and jumpers are optional for future Gate Driver products.

Table 8. Setting for target Gate Driver device (The parts in parentheses are low side parts)

Parts No.	RAJ293000
R4 (R24)	Mount
R5 (R18)	-
JP1 (JP2)	-
R7 (R29)	-
R81~R86	Mount
R87 (R89)	-
R88 (R90)	-
R91 (R92)	-
R93	-
R74 (R76)	-
R75 (R77)	-
Q3 (Q4)	-

12. Schematics

The EV-GDIS16 board schematic is shown below.

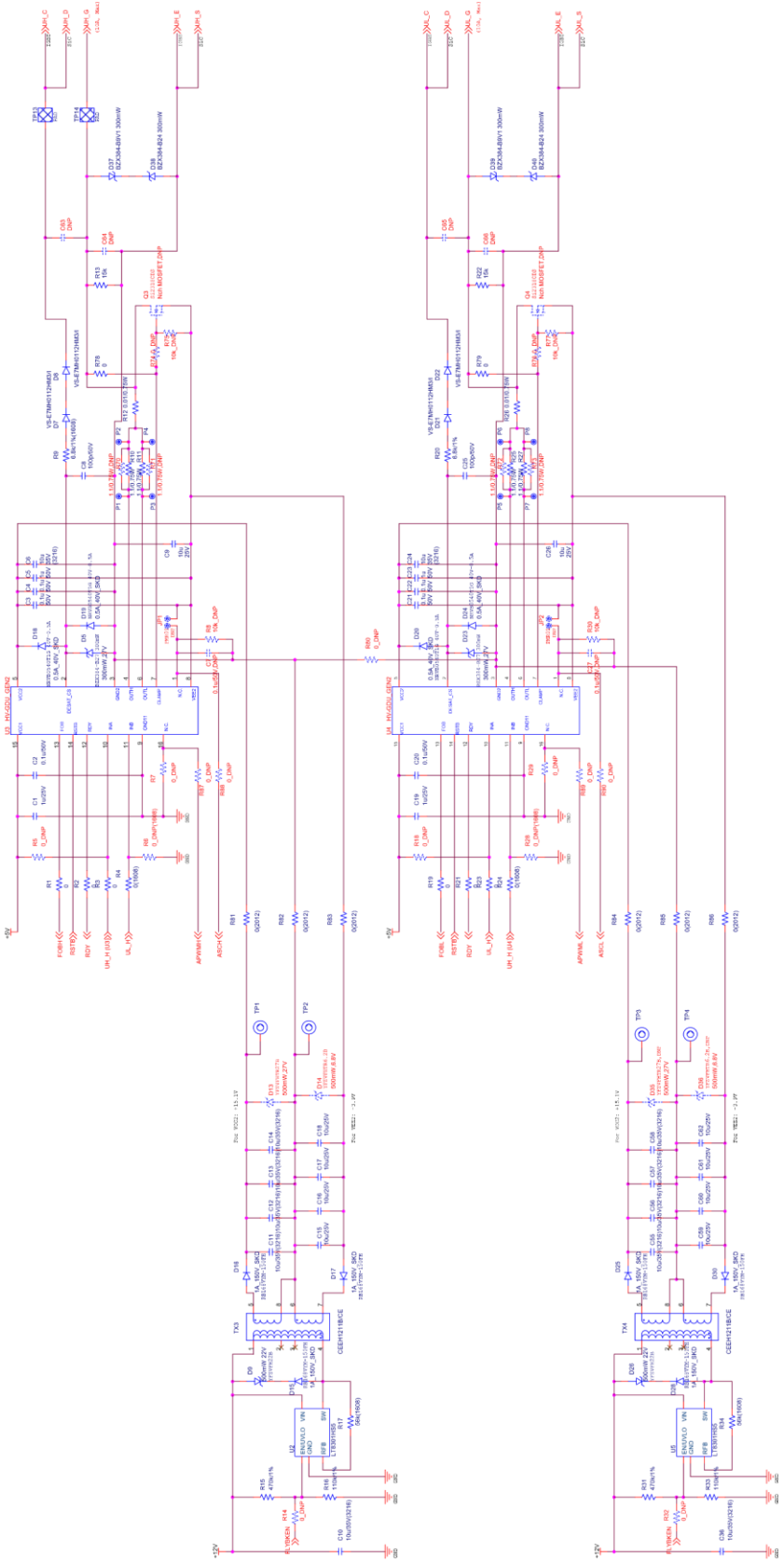


Figure 11. EV-GDIS16 schematics - Gate Driver IC and flyback

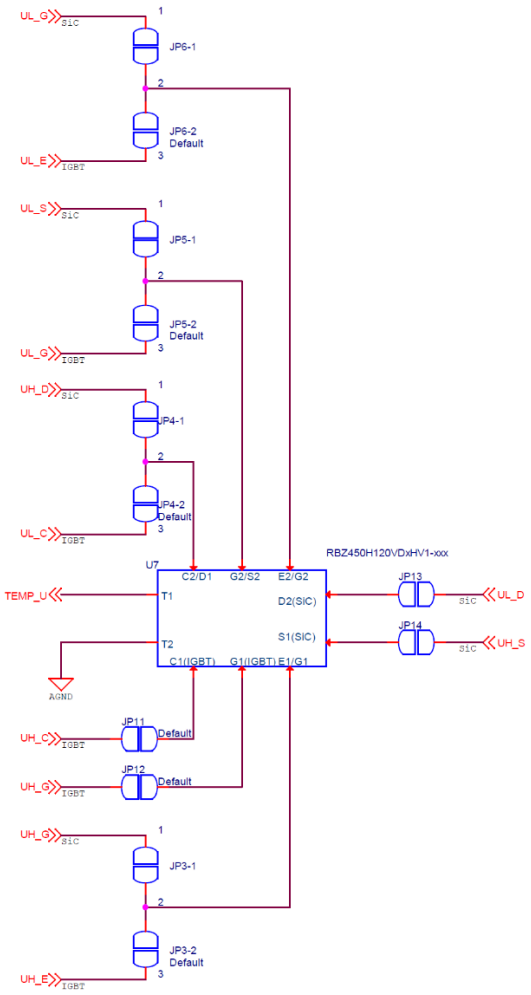


Figure 12. EV-GDIS16 schematics – IGBT/SiC module interface.

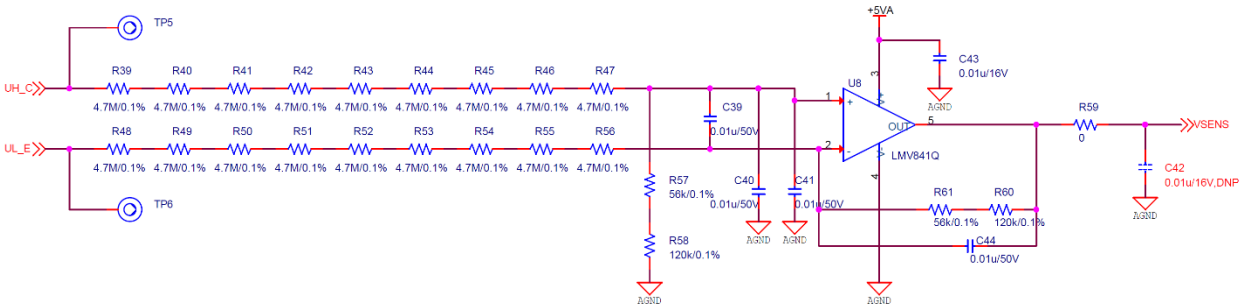


Figure 13. EV-GDIS16 schematics - VSENS

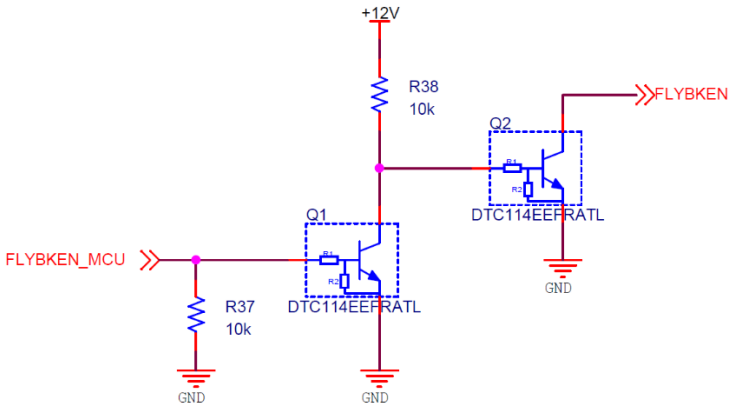


Figure 14. EV-GDIS16 schematics – FLYBACK voltage conversion

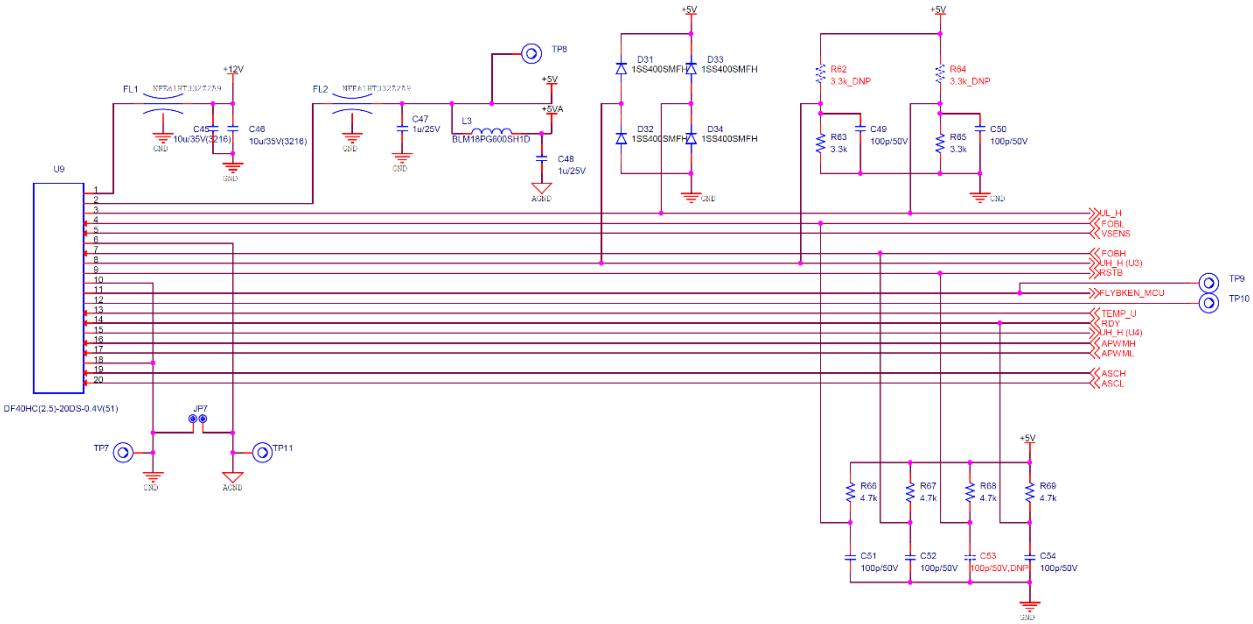


Figure 15. EV-GDIS16 schematics – Interface and power

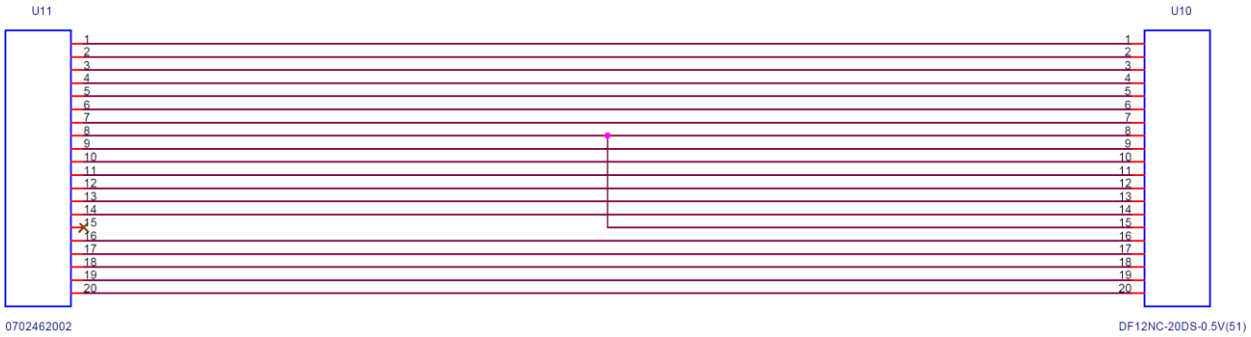


Figure 16. EV-GDIS16 schematics – Interface Board

13. Parts list

The following is a list of the components mounted on the EV-GDIS16. Some of the mounted components have lower heat resistance than the operating temperature range of Gate Driver. If evaluated in high temperature, remove the parts as necessary.

Table 9. EV-GDIS16 parts list - 1/4

Symbol	Parts name	Part number	Vendor	Note
U3, U4	Gate Driver IC	RAJ293000/SO_1	Renesas	
U2, U5	Flyback converter	LT8301JS5#WTRMPBF	Linear Technology	
U8	Op-Amp	LMV841Q	Texas Instruments	
U9	Connector	DF12NC(3.5)-20DP-0.5V(51)	Hirose	
TX3	Trans	CEEH1211B/CE	Sumida	
TX4	Trans	CEEH1211B/CE	Sumida	
FL1, FL2	NFE61HT332Z2A9	NFE61HT332Z2A9L	Murata	
Q1, Q2	DTC114EEFRA	DTC114EEFRATL	ROHM	
Q3, Q4	Si2318CDS, N/A	SI2318CDS-T1-GE3	VISHAY	
L3	BLM18PG600SH1D	BLM18PG600SH1D	Murata	
D5	BZX384-B27 300mV	BZX384-B27,115	Nexperia	
D7, D8	VS-E7MH0112HM3/I	VS-E7MH0112HM3/I	Vishay Semiconductors	
D9	YFZVFH22B	YFZVFHTR22B	ROHM	
D13	YFZVFHTR27B N/A	YFZVFHTR27B	ROHM	
D14	YFZVFHTR6.2B N/A	YFZVFHTR6.2B	ROHM	
D15, D16, D17	RB168VYM-150FH	RB168VYM150FHTR	ROHM	
D18, D19	STPS0540Z	STPS0540Z	ST Micro	
D20, D24	STPS0540Z	STPS0540Z	ST Micro	
D21, D22	VS-E7MH0112HM3/I	VS-E7MH0112HM3/I	Vishay Semiconductors	
D23	BZX384-B27 300mV	BZX384-B27,115	Nexperia	
D25, D28, D30	RB168VYM-150FH	RB168VYM150FHTR	ROHM	
D26	YFZVFH22B	YFZVFHTR22B	ROHM	
D31, D32, D33, D34	1SS400SMFH	1SS400SMFHT2R	ROHM	
D35	YFZVFHTR27B N/A	YFZVFHTR27B	ROHM	
D36	YFZVFHTR6.2B N/A	YFZVFHTR6.2B	ROHM	
D37	BZX384-B9V1 300mW	BZX384-B9V1,115	Nexperia	

Table 10. EV-GDIS16 parts list - 2/4

Symbol	Parts name	Part number	Vendor	Note
D38	BZX384-B24 300mW	BZX384-B24,115	Nexperia	
D39	BZX384-B9V1 300mW	BZX384-B9V1,115	Nexperia	
D40	BZX384-B24 300mW	BZX384-B24,115	Nexperia	
P1, P2, P3, P4, P5, P6, P7, P8	Test pin	PE-1	MAC8	
JP1	PMR01 N/A	PMR01ZZPJ000	ROHM	
JP2	PMR01 N/A	PMR01ZZPJ000	ROHM	
JP3-1, JP3-2, JP4-1, JP4-2, JP5-1, JP5-2, JP6-1, JP6-2, JP11, JP12, JP13, JP14	Solder short jumper	-	-	
JP7	Jumper	HWC-2P-G	MAC8	
TP1, TP2, TP13, TP14	Test Pin	(φ1mm round hole)	-	
TP3, TP4	Test Pin	(φ1mm round hole)	-	
TP5, TP6, TP7, TP8, TP9, TP10, TP11	Test Pin	(φ1mm round hole)	-	
R1, R2, R3, R78	0	RK73Z1ERTTP	KOA	
R10, R11	1.1/0.75W	ERJ-B2BF1R1V	Panasonic	
R12	0.01/0.75W	ERJ-B2CFR01V	Panasonic	
R13	15k	ERJ-2GEJ153X	Panasonic	
R15	470k/1%	ERJ-2RKF4703X	Panasonic	
R16	110k/1%	ERJ-2RKF1103X	Panasonic	
R17	IGBT/SiC:56k/1%	ERJ-3EKF5602V	Panasonic	
R18, R29, R32, R76, R89, R90	0 N/A	RK73Z1ERTTP	KOA	
R19, R21, R23, R79	0	RK73Z1ERTTP	KOA	
R20	6.8k/1%	ERJ-3EKF6801V	Panasonic	
R22	15k	ERJ-2GEJ153X	Panasonic	
R25, R27	1.1/0.75W	ERJ-B2BF1R1V	Panasonic	

Table 11. EV-GDIS16 parts list - 3/4

Symbol	Parts name	Part number	Vendor	Note
R26	0.01/0.75W	ERJ-B2CFR01V	Panasonic	
R30, R77	10kN/A	ERJ-2GEJ103X	Panasonic	
R31	470k/1%	ERJ-2RKF4703X	Panasonic	
R33	110k/1%	ERJ-2RKF1103X	Panasonic	
R34	IGBT/SiC:56k/1%	ERJ-3EKF5602V	Panasonic	
R37, R38	10k	ERJ-2GEJ103X	Panasonic	
R39, R40, R41, R42, R43, R44, R45, R46, R47, R48, R49, R50, R51, R52, R53, R54, R55, R56	4.7M/0.1%	MCA1206MD4704BP100	Vishay	
R5, R7, R14, R74, R78, R87, R88	0 N/A	RK73Z1ERTTP	KOA	
R4, R6, R24, R28	0	RK73Z1JTTD	KOA	
R57, R61	56k/0.1%	ERA-3AEB563V	Panasonic	
R58, R60	120k/0.1%	ERA-3AEB124V	Panasonic	
R59	0	RK73Z1ERTTP	KOA	
R62, R64	3.3k N/A	ERJ-2GEJ332X	Panasonic	
R63, R65	3.3k	ERJ-2GEJ332X	Panasonic	
R66, R67, R68, R69	4.7k	ERJ-2GEJ472X	Panasonic	
R70, R71	1.1/0.75W N/A	ERJ-B2BF1R1V	Panasonic	
R72, R73	1.1/0.75W N/A	ERJ-B2BF1R1V	Panasonic	
R8, R75	10kN/A	ERJ-2GEJ103X	Panasonic	
R80	0 N/A	RK73Z1ERTTP	KOA	
R81, R82, R83	0	RK73Z2ATTD	KOA	
R84, R85, R86	0	RK73Z2ATTD	KOA	
R9	6.8k/1%	ERJ-3EKF6801V	Panasonic	

Table 12. EV-GDIS16 parts list - 4/4

Symbol	Parts name	Part number	Vendor	Note
C1	1uF/25V	CGA3E1X7R1E105K080AC	TDK	
C2, C3, C4	0.1uF/50V	CGA3E2X7R1H104K080AA	TDK	
C5	1uF/50V	CGA4J3X7R1H105K125AB	TDK	
C6, C10, C11, C12, C13, C14	10uF/35V(3216)	CGA5L1X7R1V106M160AE	TDK	
C7	0.1uF/50VN/A	CGA3E2X7R1H104K080AA	TDK	
C8	100pF/50V	CGA2B2C0G1H101J050BA	TDK	
C9, C15, C16, C17, C18	10uF/25V	CGA5L1X7R1E106K160AC	TDK	
C19	1uF/25V	CGA3E1X7R1E105K080AC	TDK	
C20, C21, C22	0.1uF/50V	CGA3E2X7R1H104K080AA	TDK	
C23	1uF/50V	CGA4J3X7R1H105K125AB	TDK	
C24, C36, C55, C56, C57, C58	10uF/35V(3216)	CGA5L1X7R1V106M160AE	TDK	
C25	100pF/50V	CGA2B2C0G1H101J050BA	TDK	
C26, C59, C60, C61, C62	10uF/25V	CGA5L1X7R1E106K160AC	TDK	
C27	0.1uF/50VN/A	CGA3E2X7R1H104K080AA	TDK	
C39, C40, C41, C44	0.01uF/50V	CGA2B3X7R1H103K050BB	TDK	
C42	0.01uF/16V N/A	C0805C103J4RECAUTO7210	KEMET	
C43	0.1uF/16V	CGA2B1X7R1C104K050BC	TDK	
C45, C46	10uF/35V (3216)	CGA5L1X7R1V106M160AE	TDK	
C47, C48	1uF/25V	CGA3E1X7R1E105K080AC	TDK	
C49, C50, C51, C52, C54	100pF/50V	CGA2B2C0G1H101J050BA	TDK	
C53	100pF/50V(N/A)	CGA2B2C0G1H101J050BA	TDK	
C63, C64	N/A	-	-	
C65, C66	N/A	-	-	

14. Reference document

For the specifications of the Gate Driver ICs supported by the EV-GDIS16 board, please refer to the following datasheet.

Table 13. Gate Driver datasheets

Part number	Datasheet document number
RAJ293000	R33DS0037EJ

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Feb. 08, 2024	-	First official release
1.01	May 12, 2025	5,9	Description revised

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