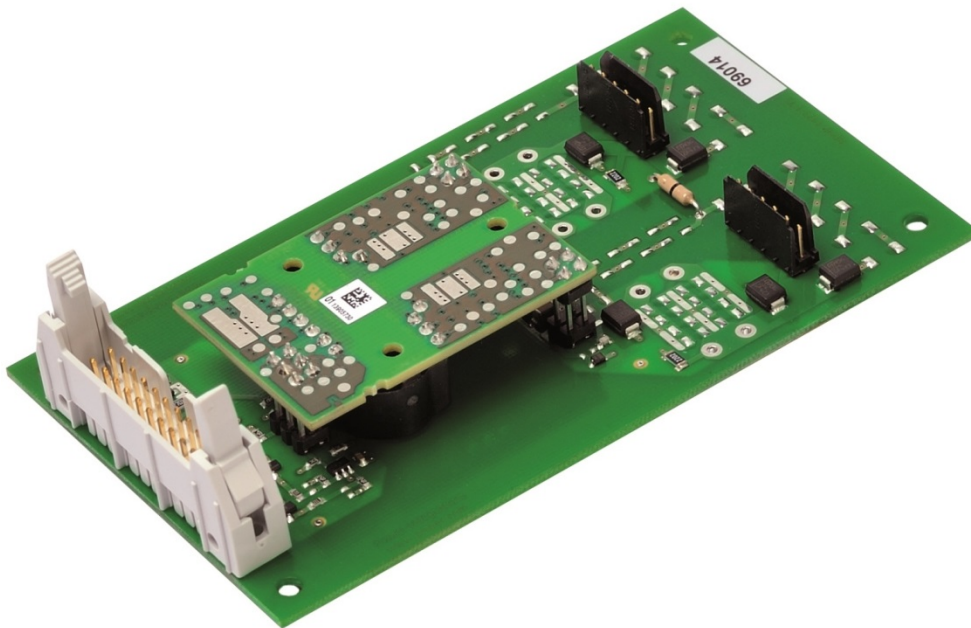


General Purpose Base Board for Gate Driver Core 2SC0106T

Application	General purpose drives, UPS, solar power and others
Specification	Suitable for IGBT power modules in various housings Up to 800V DC-link voltage Electrical interfaces Basic Active Clamping Short-circuit detection with Soft Shut Down (SSD)
Author	High-Power Application Engineering Department
Document Number	RDHP-1423
Revision¹	A.4



¹ The letter refers to the hardware revision. The number refers to the documentation revision.

Scope

This application proposal provides a circuit design for a general purpose base board for driving various IGBT power modules.

The main features of the design are:

- Suitable for IGBT power modules in various housings such as 17mm dual, 17mm six-pack, 62mm, PrimePACK™, etc. with a maximum blocking voltage of 1200V
- (Optional) Basic Active Clamping
- Short-circuit detection with Soft Shut Down (SSD)
- Electrical command inputs and status outputs
- 0V/15V command input logic
- 0V/15V status output logic
- Minimum pulse suppression (optional)
- Adjustable blocking time
- 15V supply voltage
- Single PCB solution with soldered-in gate driver core

Intellectual Property Licensing

The design proposal, products and applications illustrated herein (including transformer construction and circuits external to the products) may be covered by one or more U.S. and foreign patents, or potentially by pending U.S. and foreign patent applications assigned to Power Integrations.

A complete list of Power Integrations patents may be found at <https://www.power.com/>.

Power Integrations grants its customers a license under certain patent rights as set forth at <https://www.power.com/company/intellectual-property-licensing/>.

Application Conditions

The design is proposed for the following application conditions:

- General purpose applications and IGBT power modules
- Adaptations such as adjustment of gate resistors can easily be done

Design Description

In addition to the following design description, reference to the datasheet(s) and application manual of the 2SC0106T gate driver family is recommended.

Gate Resistors

Gate resistor values are not explicitly given as they depend on the IGBT power module used and on the application. Gate resistors of either SMD (size 1206) or THT (size PR02) package can be selected. The turn-on and turn-off gate resistors are setup according to the following scheme ($x = 1$ for gate resistors for channel 1 and $x = 2$ for channel 2):

SMD gate resistors

$$R_{Gon} = R_a * R_b / (R_a + R_b) \text{ and } R_{Goff} = R_a$$

$$\text{with } R_a^{-1} = Rx30a^{-1} + Rx30b^{-1} + Rx30c^{-1} + Rx30d^{-1} \text{ and } R_b^{-1} = Rx40a^{-1} + Rx40b^{-1} + Rx40c^{-1} + Rx40d^{-1}$$

THT gate resistors

$$R_{Gon} = Rx20 * Rx21 / (Rx20 + Rx21) \text{ and } R_{Goff} = Rx21$$

The gate resistors must be determined and assembled by the user. Minimum required gate resistor values are defined in the datasheet of the gate driver 2SC0106T.

V_{CEsat} Monitoring

In the schematic and bill of material, the resistor networks of the V_{CEsat} monitoring function are marked with "N.A." (not assembled), as their concrete value depends on the IGBT power module and applied DC-link voltage.

Recommended values are listed in the following table:

IGBT voltage	Max. DC-link voltage	R100	R101 to R108	R200	R201 to R208
600V	400V	62kΩ	82kΩ	62kΩ	82kΩ
1200V	800V	120kΩ	150kΩ	120kΩ	150kΩ

Recommended values of the blanking capacitors C103 and C203 as well as further details of the V_{CEsat} monitoring function are described in the corresponding application manual of the gate driver 2SC0106T.

Soft Shut Down (SSD)

The gate driver cores 2SC0106T with SCALE-2+ chip set feature an SSD function, which reduces the turn-off di/dt to limit V_{CE} overvoltage spikes as soon as a short-circuit condition is detected. An excessive turn-off overvoltage is therefore avoided and the IGBT is turned off within its safe operating area.

The SSD function is only active under short-circuit conditions, but not under normal operating conditions (e.g. at nominal current or in over-current conditions), i.e. it is triggered by the V_{CEsat} monitoring function.

The SSD function may also have performance limitations, such as at high DC-link voltages and/or high commutation loop stray inductances. If the application is operated at these boundary conditions, it is recommended to implement Basic Active Clamping.

For further details concerning the SSD function refer to the application manual of the gate driver core 2SC0106T.

Basic Active Clamping

Active clamping is a technique designed to partially turn on the IGBT in case the collector-emitter voltage exceeds a predefined threshold. The IGBT is then kept in linear operation. Basic Active Clamping topologies implement a single feedback path from the IGBT's collector through transient voltage suppressor (TVS) diodes to the IGBT gate.

In the schematic and bill of material the TVS networks (D101 to D106 and D201 to D206) are marked with "N.A." (not assembled) as their specific value depends on the IGBT power module and applied DC-link voltage. Recommended values are listed in the following table.

IGBT voltage	Max. DC-link voltage	D109, D209	D101 ... D106, D201 ... D206
600V	400V	STPS340U	P6SMBJ70A
1200V	800V	STPS340U	SMBJ130A-E3

Basic Active Clamping is recommended as an additional option in case the Soft Shut Down (SSD) function of the gate driver core is used.

Minimum Pulse Suppression

This design possesses the option to implement a minimum pulse suppression with a time constant τ . If required the minimum pulse suppression can be set by adjusting C304 and C305. The time constant τ is given by the following equations:

$$\tau_1 = 0.88\text{k}\Omega \cdot C304$$

$$\tau_2 = 0.88\text{k}\Omega \cdot C305$$

Recommended values of C304 and C305 are in the range of 100pF ($\tau_x = 88\text{ns}$) to 470pF ($\tau_x = 414\text{ns}$), depending on actual application conditions.

Blocking Time

During the blocking time the gate driver ignores incoming command signals. The blocking time starts once a fault was detected by the gate driver's secondary side (undervoltage lock-out or a short-circuit event) or when an undervoltage condition ends on the primary side.

The terminal TB allows the default blocking time of typically 99ms (R307) to be reduced by connecting an optional external resistor to GND. The external resistor R_b needs to be equal or larger than 129k Ω to fulfill the following formula:

$$(R_b + 6.8\text{k}\Omega) \parallel 150\text{k}\Omega \triangleq T_b + 51\text{ms} \text{ with } 20\text{ms} < T_b < 99\text{ms}$$

In case the terminal TB is directly shorted to GND ($R_b = 0\Omega$), the blocking time is set to its minimum value as described in the datasheet of the gate driver core 2SC0106T.

Interfaces

Electrical Interfaces

X3		
Pin	Designation	Description
1	n.c.	Not connected
3	n.c.	Not connected
5	VCC	15V supply (referenced to GND)
7	VCC	15V supply (referenced to GND)
9	n.c.	Not connected
11	INB	Command input channel 2
13	SO	Combined status output
15	INA	Command input channel 1
17	n.c.	Not connected
19	TB	Set blocking time

X3		
Pin	Designation	Description
2	GND	Ground
4	GND	Ground
6	GND	Ground
8	GND	Ground
10	GND	Ground
12	GND	Ground
14	GND	Ground
16	GND	Ground
18	GND	Ground
20	GND	Ground

X1		
Pin	Designation	Description
1	C1	Collector channel 1
2	n.c.	Not connected
3	n.c.	Not connected
4	n.c.	Not connected
5	G1	Gate channel 1
6	VE1	Emitter channel 1

X2		
Pin	Designation	Description
1	C2	Collector channel 2
2	n.c.	Not connected
3	n.c.	Not connected
4	n.c.	Not connected
5	G2	Gate channel 2
6	VE2	Emitter channel 2

Switching Characteristic

Switching Examples

The measurement examples shown with the IGBT power module FF450R12KT4 from Infineon Technologies ($R_{Gon} = 4.3\Omega$ and $R_{Goff} = 4.3\Omega$) were carried out in a double pulse test using a half-bridge topology setup at room temperature with an initial DC-link voltage of $800V_{DC}$. The adjusted load current is $900A$ ($2x I_{nom}$). Basic Active Clamping (BAC) was implemented for these tests.

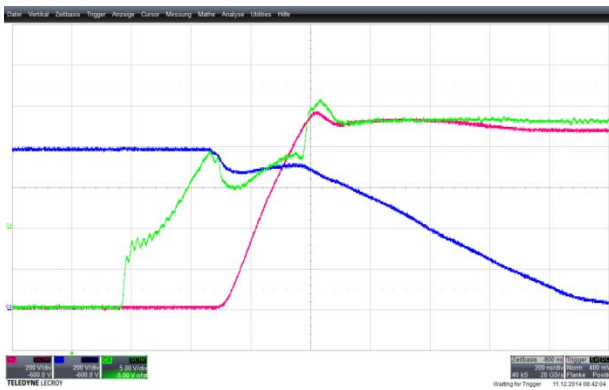
Channel assignment:

Channel C1: Status output (short-circuit only)

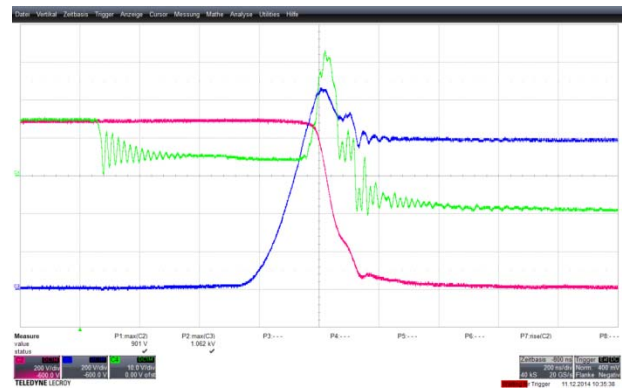
Channel C2: Collector current ($1V \triangleq 1A$)

Channel C3: Collector-emitter voltage

Channel C4: Gate-emitter voltage



Turn-on top side ($2x I_{nom}$)



Turn-off top side ($2x I_{nom}$)



Short-circuit top side

Handling

To avoid possible failures caused by ESD, a handling- and assembly-process with persistent ESD protection is necessary /3/.

References

- /1/ 2SC0106T2Ax-12 Data Sheet, Power Integrations
- /2/ 2SC0106T2Ax-12 Description & Application Manual, Power Integrations
- /3/ Application Note AN-0902, "Avoiding ESD with CONCEPT Drivers", Power Integrations

Technical Support

Power Integrations provides expert help with your questions and problems:

Website <http://www.power.com/igbt-driver/go/support>

Email igbt-driver.support@power.com

Quality

The obligation to high quality is one of the central features laid down in the mission statement of Power Integrations. Our total quality management system assures state-of-the-art processes throughout all functions of the company, certified by ISO9001:2008 standards.

Legal Disclaimer

Reference Designs are technical proposals concerning how to use Power Integrations' gate drivers in particular applications and/or with certain power modules. These proposals are "as is" and are not subject to any qualification process. The suitability, implementation and qualification are the sole responsibility of the end user.

The statements, technical information and recommendations contained herein are believed to be accurate as of the date hereof. All parameters, numbers, values and other technical data included in the technical information were calculated and determined to our best knowledge in accordance with the relevant technical norms (if any). They may base on assumptions or operational conditions that do not necessarily apply in general. We exclude any representation or warranty, express or implied, in relation to the accuracy or completeness of the statements, technical information and recommendations contained herein. No responsibility is accepted for the accuracy or sufficiency of any of the statements, technical information, recommendations or opinions communicated and any liability for any direct, indirect or consequential loss or damage suffered by any person arising therefrom is expressly disclaimed.

Power Integrations Sales Offices

WORLD HEADQUARTERS

5245 Hellyer Avenue
San Jose, CA 95138 USA
Tel: +1-408-414-9200
Fax: +1-408-414-9765
Email: usasales@power.com

AMERICAS WEST

5245 Hellyer Avenue
San Jose, CA 95138 USA
Tel: +1-408-414-8778
Fax: +1-408-414-3760
Email: usasales@power.com

GERMANY (AC-DC/LED Sales)

Lindwurmstrasse 114
80337 München, Germany
Tel: +49-89-5527-39100
Fax: +49-89-1228-5374
Email: eurosales@power.com

INDIA (Mumbai)

Unit: 106-107, Sagar Tech Plaza-B
Sakinaka, Andheri Kurla Road
Mumbai, Maharashtra 400072 India
Tel 1: +91-22-4003-3700
Tel 2: +91-22-4003-3600
Email: indiasales@power.com

JAPAN

Kosei Dai-3 Bldg.
2-12-11, Shin-Yokohama, Kohoku-ku
Yokohama-shi, Kanagawa
Japan 222-0033
Tel: +81-45-471-1021
Fax: +81-45-471-3717
Email: japansales@power.com

TAIWAN

5F, No. 318, Nei Hu Rd., Sec. 1
Nei Hu Dist.
Taipei, 114 Taiwan
Tel: +886-2-2659-4570
Fax: +886-2-2659-4550
Email: taiwansales@power.com

AMERICAS EAST

7360 McGinnis Ferry Road
Suite 225
Suwannee, GA 30024 USA
Tel: +1-678-957-0724
Fax: +1-678-957-0784
Email: usasales@power.com

CHINA (Shanghai)

Room 2410, Charity Plaza
No. 88 North Caoxi Road
Shanghai, 200030 China
Tel: +86-21-6354-6323
Fax: +86-21-6354-6325
Email: chinasales@power.com

GERMANY (IGBT Driver Sales)

HellwegForum 1
59469 Ense, Germany
Tel: +49-2938-64-39990
Email: igbt-driver.sales@power.com

INDIA (New Dehli)

#45, Top Floor
Okhla Industrial Area, Phase - III
New Dehli, 110020 India
Tel 1: +91-11-4055-2351
Tel 2: +91-11-4055-2353
Email: indiasales@power.com

KOREA

RM602, 6FL, 22
Teheran-ro 87-gil, Gangnam-gu
Seoul, 06164 Korea
Tel: +82-2-2016-6610
Fax: +82-2-2016-6630
Email: koreasales@power.com

UNITED KINGDOM

Bulding 5, Suite 21
The Westbrook Centre
Milton Road
Cambridge, CB4 1YG United Kingdom
Tel: +44-7823-557-484
Email: eurosales@power.com

AMERICAS CENTRAL

333 Sheridan Road
Winnetka, IL 60093 USA
Tel: +1-847-721-6293
Email: usasales@power.com

CHINA (Shenzhen)

17/F, Hivac Building, No 2
Keji South 8th Road, Nanshan District
Shenzhen, 518057 China
Tel: +86-755-8672-8689
Fax: +86-755-8672-8690
Email: chinasales@power.com

INDIA (Bangalore)

#1, 14th Main Road
Vasanthangar
Bangalore, 560052 India
Tel 1: +91-80-4113-8020
Tel 2: +91-80-4113-8028
Fax: +91-80-4113-8023
Email: indiasales@power.com

ITALY

Via Milanese 20
20099 Sesto San Giovanni (MI), Italy
Tel: +39-02-4550-8708
Email: eurosales@power.com

SINGAPORE

51 Newton Road
#19-01/05 Goldhill Plaza
Singapore, 308900
Tel 1: +65-6358-2160
Tel 2: +65-6358-4480
Fax: +65-6358-2015
Email: singaporesales@power.com