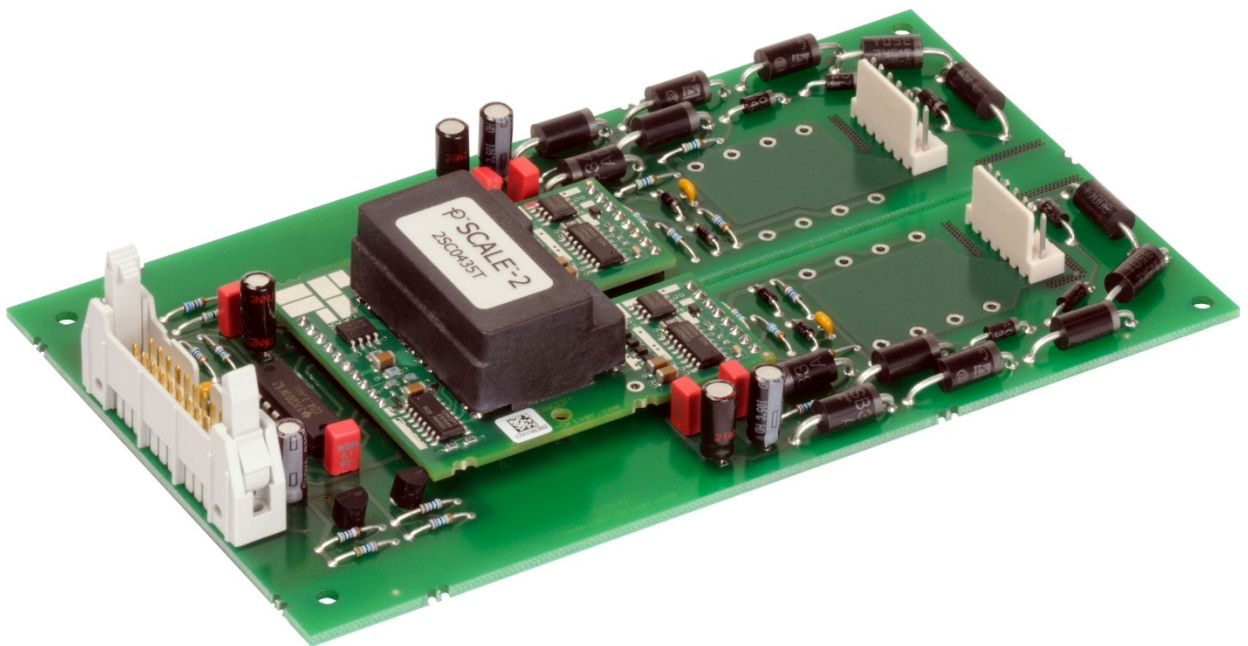


General Purpose THT Base Board for Gate Driver Core 2SC0435T

Application	General purpose drives, traction, solar power and others
Specification	Suitable for IGBT power modules in various housings Up to 1200V DC-link voltage Electrical interfaces Advanced Active Clamping Short-circuit detection
Author	High-Power Application Engineering Department
Document Number	RDHP-1532
Revision¹	A.3



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 1700V
- Advanced Active Clamping
- Short-circuit detection
- Electrical command inputs and status outputs
- 0V/15V command input logic
- 0V/15V status output logic
- Minimum pulse suppression
- Direct or Half-Bridge mode selection
- 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 2SC0435T 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. THT (size PR03) gate resistors can be selected.

Turn-on gate resistors:

Channel	THT Package
1	R112, R113
2	R212, R213

Turn-off gate resistors:

Channel	THT Package
1	R110, R111
2	R210, R211

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 2SC0435T.

V_{CEsat} Monitoring

2SC0435T gate drivers from Power Integrations provide sense inputs for monitoring IGBT short-circuit conditions. The details of the V_{CEsat} monitoring function are described in the corresponding application manual of the gate driver.

Soft Shut Down (SSD)

For this design proposal no dedicated Soft Shut Down function is implemented. Instead, for over voltage protection Active Clamping is implemented.

Advanced 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.

Advanced active clamping topologies implement the same structure as basic active clamping topologies, but in addition a fraction of the active clamping current is fed into the gate driver core at pins ACLx via 20 Ω resistors. In this case, when active clamping is activated, the turn-off MOSFET of the 2SC0435T driver is switched off in order to improve the effectiveness of the active clamping and to reduce the losses in the TVS diodes. This feature – called Advanced Active Clamping – is mainly integrated in the secondary-side ASIC of gate driver core 2SC0435T.

In the schematic and bill of material, the TVS networks (D106 to D109 and D206 to D209) 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 tables.

IGBT voltage	Max. DC-link voltage	D112, D212	D106 ... D108, D206 ... D208	D109, D209
1200V	800V	SB340	1.5KE220A-E3	1.5KE250CA-E3
1700V	1200V	SB340	1.5KE350A-E3	1.5KE300CA-E3

For further details refer to the application manual of the gate driver core 2SC0435T.

Minimum Pulse Suppression

This design possesses a minimum pulse suppression with a time constant τ of typically 470ns. If required the setting can be changed by adjusting C302 and C303. The time constant τ is given by the following equations:

$$\tau_1 = 4.7k\Omega \cdot C302$$

$$\tau_2 = 4.7k\Omega \cdot C303$$

Recommended values of C302 and C303 are in the range of 33pF ($\tau_x = 155ns$) to 120pF ($\tau_x = 564ns$), 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 (R310) 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:

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

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 2SC0435T.

Interfaces**Electrical Interfaces**

X3		
Pin	Designation	Description
1	VDC	15V supply (referenced to GND)
3	VDC	15V supply (referenced to GND)
5	VCC	15V supply (referenced to GND)
7	VCC	15V supply (referenced to GND)
9	SO2	Status output channel 2
11	INB	Command input channel 2
13	SO1	Status output channel 1
15	INA	Command input channel 1
17	MOD	Mode selector
19	TB	Set blocking time

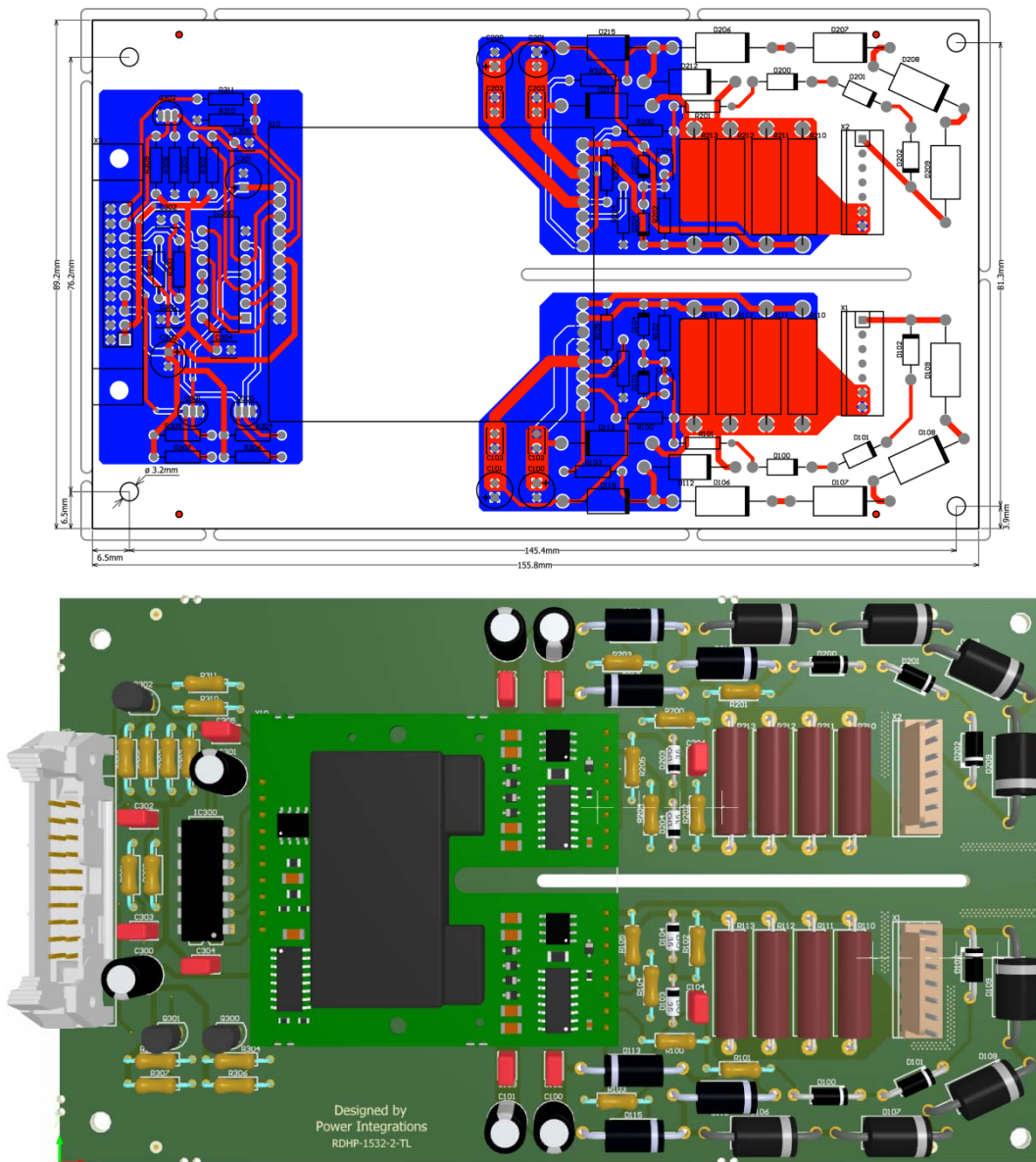
X3		
Pin	Designation	Description
2	GND	Ground
4	GND	Ground
6	GND	Ground
8	GND	Ground
10	GND	Ground
12	GND	Ground
14	GND	Ground
16	GND	Ground
18	GND	Ground
20	GND	Ground

CAD Data

The set of CAD data, which includes the circuit schematics, Gerber files, BOM and Pick-and-Place file are available as separate documents bundled together with this documentation.

Layout Example

An example for a suitable layout is shown in the following picture. The recommended PCB thickness is 1.55mm (for gate driver cores with terminal length of 2.54mm) and 2.0mm (for gate driver cores with terminals length ≥ 3.1 mm).



Switching Characteristic

Turn-On/Off

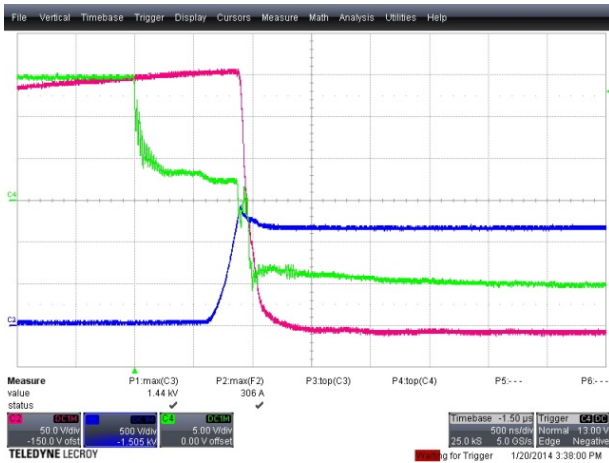
The following measurement examples were carried out at room temperature with the IGBT power module FF300R17KE3 from Infineon Technologies ($R_{Gon} = 4.7\Omega$ and $R_{Goff} = 4.7\Omega$) in a double-pulse test using a half-bridge topology setup with an initial DC-link voltage of $1200V_{DC}$. The adjusted load current is either 300A (I_{nom}) or 600A ($2x I_{nom}$).

Channel assignment:

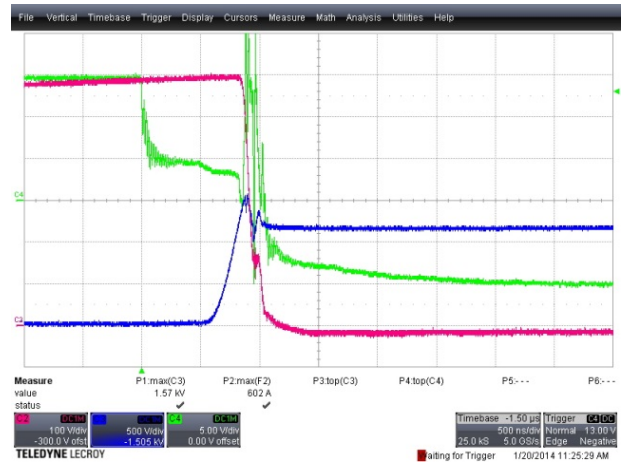
Channel C2: Collector current ($1V \cong 1A$)

Channel C3: Collector-emitter voltage

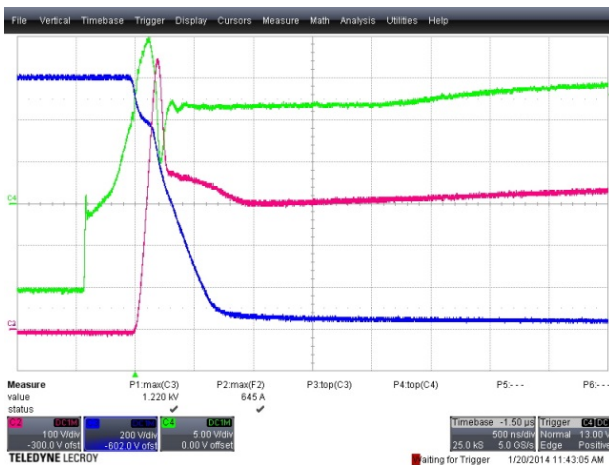
Channel C4: Gate-emitter voltage



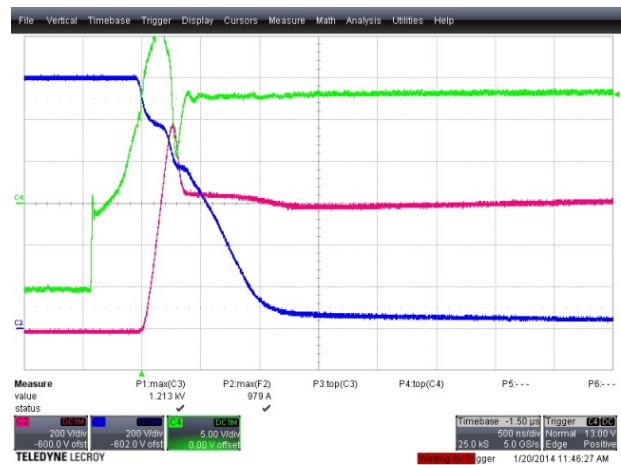
Turn-off bottom side (I_{nom})



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



Turn-on bottom side (I_{nom})



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

Short-Circuit

The following measurement example was carried out at room temperature with the IGBT power module FF300R17KE3 from Infineon Technologies ($R_{Gon} = 4.7\Omega$ and $R_{Goff} = 4.7\Omega$) with an initial DC-link voltage of $1200V_{DC}$.

Channel assignment:

Channel C1: Command input signal

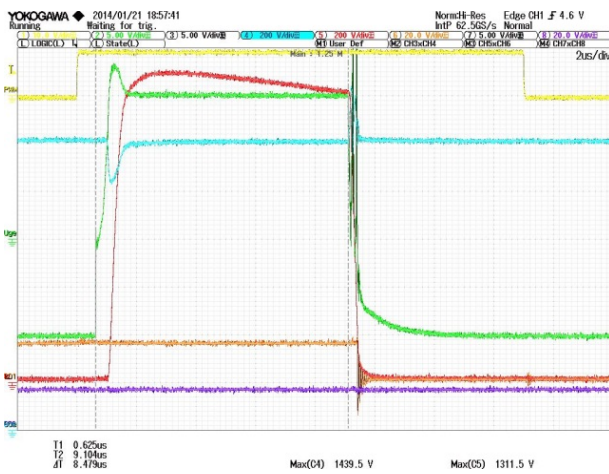
Channel C2: Gate-emitter voltage

Channel C4: Collector-emitter voltage

Channel C5: Collector current ($1V \triangleq 1A$)

Channel C6: Status output SO1

Channel C8: Status output SO2



Bottom side

Handling

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

References

- /1/ 2SC0435T2xx-17 Data Sheet, Power Integrations
- /2/ 2SC0435T2xx-17 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: eurossales@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: eurossales@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: eurossales@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