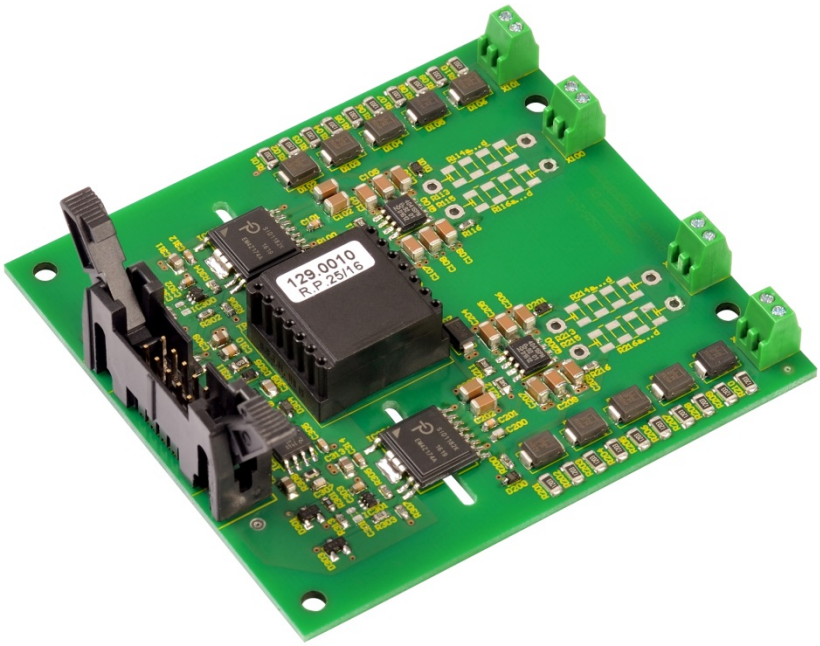
General Purpose Base Board for SCALE™-iDriver SID1182K with Booster Stage

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 Advanced Soft Shut Down
Author	High-Power Application Engineering Department
Document Number	RDHP-1526
Revision[1]	A.1



[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
- Basic Active Clamping
- Short-circuit detection with Advanced Soft Shut Down (ASSD)
- External booster stage
- Electrical command inputs and status outputs
- 0V/5V command input logic
- 0V/5V status output logic
- Minimum pulse suppression
- 5V supply voltage
- Single PCB solution with soldered-in gate driver IC

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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 of the SID1182K gate driver IC 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.

Turn-on gate resistors:

Channel	SMD Package	THT Package
1	R114a … R114d	R113
2	R214a … R214d	R213

Turn-off gate resistors:

Channel	SMD Package	THT Package
1	R116a … R116d	R115
2	R216a … R216d	R215

The gate resistors must be determined and assembled by the user.

V_{CEsat} Monitoring

SID1182K gate driver ICs 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 datasheet of the gate driver.

Advanced Soft Shut Down (ASSD)

The driver ICs SID1182K of the SCALE-iDriver family feature an Advanced Soft Shut Down (ASSD) 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 ASSD 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 ASSD 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 ASSD function refer to the datasheet of the gate driver IC SID1182K.

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.

Basic Active Clamping is recommended as an option in addition to the Advanced Soft Shut Down (ASSD) function in the following cases depending on actual application conditions:

- High DC-link voltage and/or high commutation loop stray inductances
- Turning-off overcurrents and/or high commutation loop stray inductances

Minimum Pulse Suppression

This design possesses a minimum pulse suppression with a time constant τ of typically 99ns. If required the setting can be changed by adjusting C300 and C301. The time constant τ is given by the following equations:

$\tau_1 = 99\Omega \cdot C300$

$\tau_2 = 99\Omega \cdot C301$

Recommended values of C300 and C301 are in the range of 1nF (τ_x = 99ns) to 3.3nF (τ_x = 327ns), depending on actual application conditions.

Blocking Time

During the blocking time, which is set to typically 10µs, the gate driver IC ignores incoming command signals. The blocking time starts once a fault was detected by the gate driver IC's secondary side (undervoltage lock-out or a short-circuit event) or when an undervoltage condition ends on the primary side.

For further details refer to the datasheet of the gate driver SID1182K.

Interfaces

Electrical Interfaces

X300		
Pin	Designation	Description
1	V5	5V supply (referenced to GND)
3	SO2	Status output channel 2
5	INB	Command input channel 2
7	SO1	Status output channel 1
9	INA	Command input channel 1

X300		
Pin	Designation	Description
2	GND	Ground
4	GND	Ground
6	GND	Ground
8	GND	Ground
10	GND	Ground

X100		
Pin	Designation	Description
1	E1	Emitter channel 1
2	G1	Gate channel 1

X101		
Pin	Designation	Description
1	C1	Collector channel 1
2	C1	Collector channel 1

X200		
Pin	Designation	Description
1	G2	Gate channel 2
2	E2	Emitter channel 2

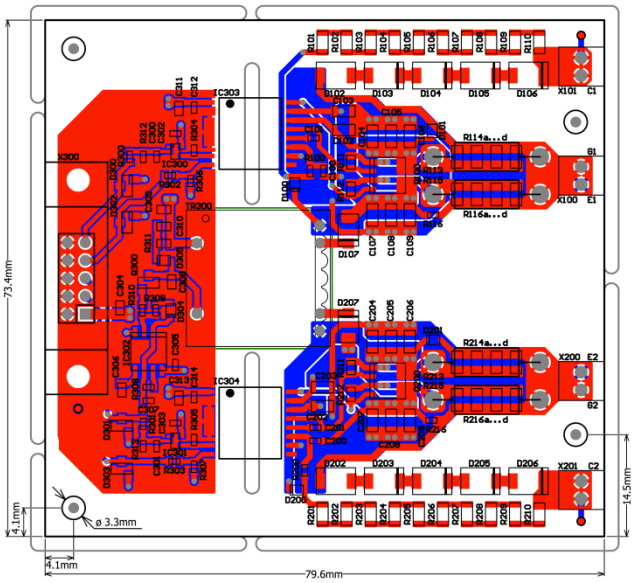
X201		
Pin	Designation	Description
1	C2	Collector channel 2
2	C2	Collector channel 2

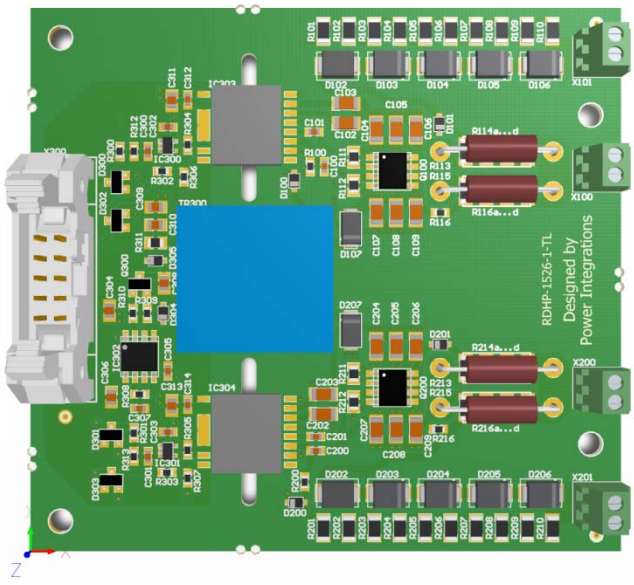
CAD Data

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.





Switching Characteristic

Turn-On / Off

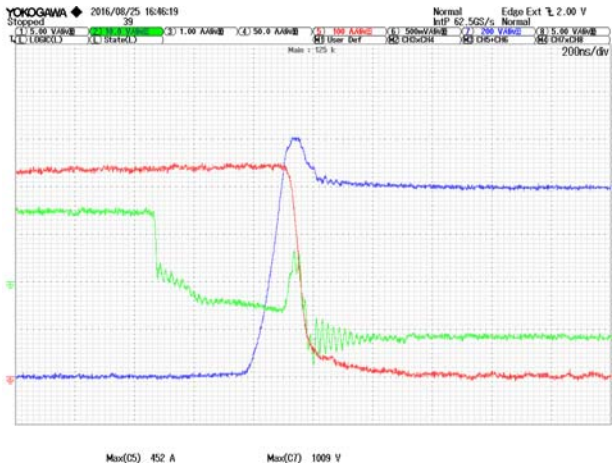
The measurement examples shown with the IGBT power module FF450R12KT4 from Infineon Technologies (R_{Gon} = 1Ω and R_{Goff} = 1Ω) were carried out in a double-pulse test using a half-bridge topology setup at room temperature with an initial DC-link voltage of 800V_{DC}. The adjusted load current is either 450A (I_{nom}) or 900A (2x I_{nom}).

Channel assignment:

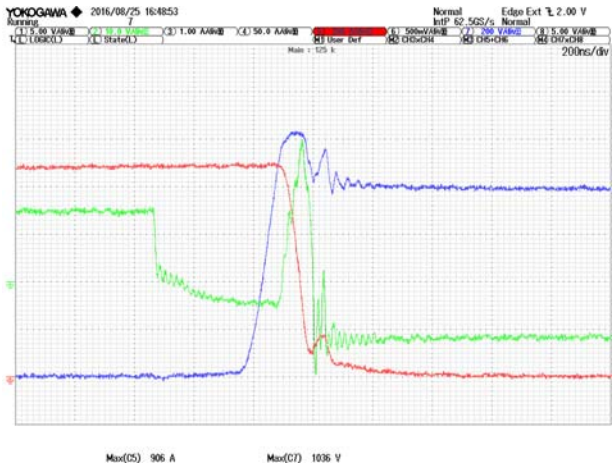
Channel C2: Gate-emitter voltage

Channel C5: Collector current

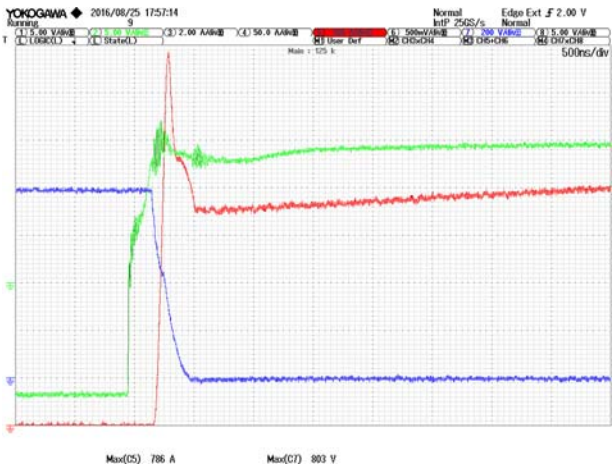
Channel C7: Collector-emitter voltage



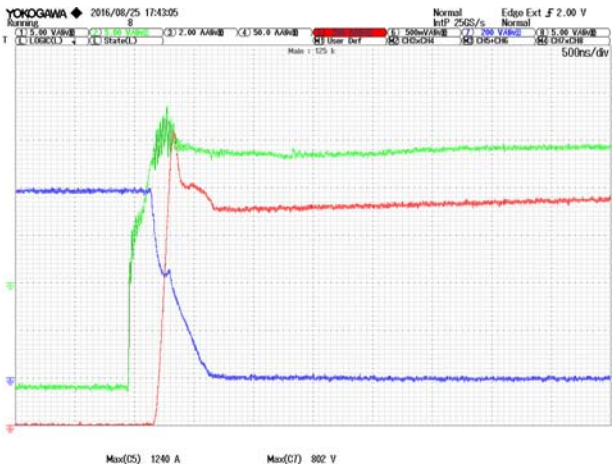
Turn-off bottom side (I_{nom})



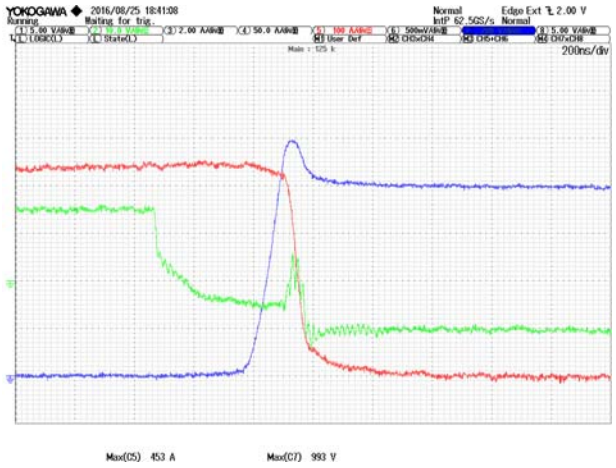
Turn-off bottom side (2x I_{nom})



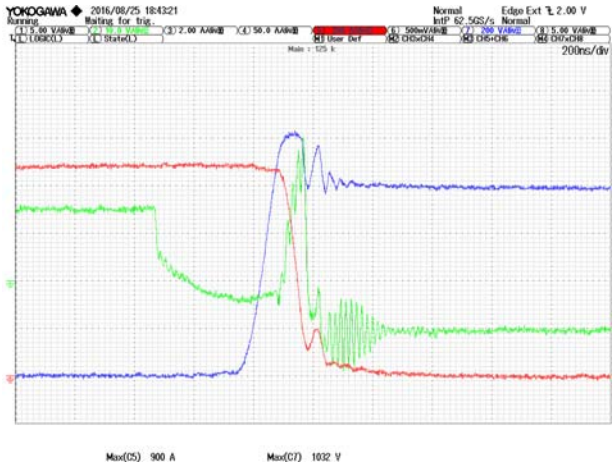
Turn-on bottom side (I_{nom})



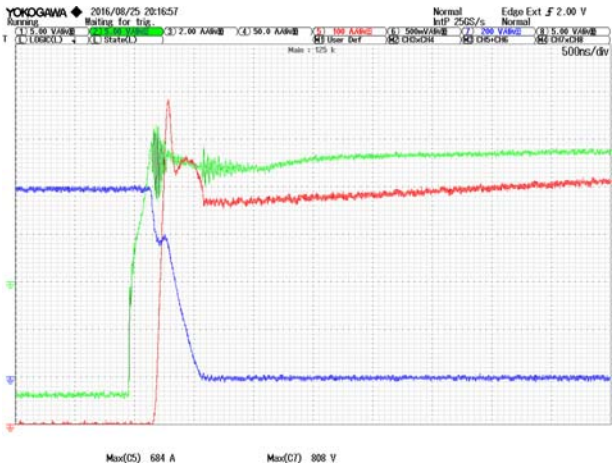
Turn-on bottom side (2x I_{nom})



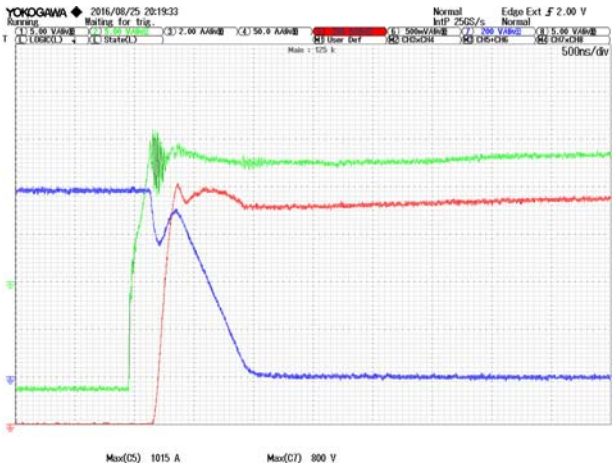
Turn-off top side (I_{nom})



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



Turn-on top side (I_{nom})



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

Short-Circuit

The measurement examples shown with the IGBT power module FF450R12KT4 from Infineon Technologies (R_{Gon} = 1Ω and R_{Goff} = 1Ω) were carried out at room temperature with an initial DC-link voltage of $800V_{DC}$.

Channel assignment:

Channel C1: Command input signal

Channel C2: Gate-emitter voltage

Channel C5: Collector current

Channel C7: Collector-emitter voltage

Bottom side

Top side

Handling

To avoid possible failures caused by ESD, a handling- and assembly-process with persistent ESD protection is necessary /2/.

References

/1/ SID11x2K SCALE-iDriver Family Data Sheet, Power Integrations

/2/ Application Note AN-0902, "Avoiding ESD with CONCEPT Drivers", Power Integrations

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