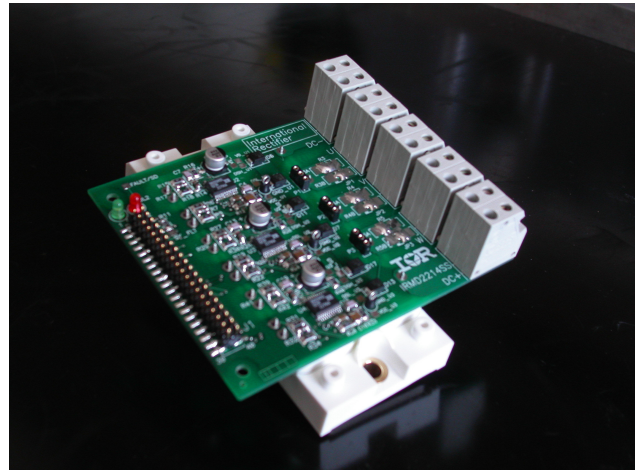


IRMD22141SS Demo Board

For 3-phase / 380V motor drives

IRMD22141SS Demo Board

- Up to 1200V DC-bus capability
- Up to 50A maximum phase current
- Optional on-board phase shunt resistors
- 3 x IR22141SS devices connected in 3-phase configuration
- On-board bootstrap supply for high-side gate drive
- Full protection of phase-to-phase, DC-bus and ground short circuit by monitoring IGBT de-saturation
- Fault feedback to ground level
- Internal minimum dead time
- Anti-shoot-through management
- Undervoltage lockout
- 3.3V digital input/output CMOS compatible



IR22141SS Demo Board
(Shown with optional IGBT Power Module)

Power Module

- Standard ECONO2-6PACK IGBT module compatible
- IGBT short circuit rated up to 1200V/50A.
- Easy to mount heat-sink

INTRODUCTION

The IRMD22141SS demo board is an evaluation board for IR22141SS gate driver. With three connected IR22141SS (see the device datasheet), IRMD22141SS is designed to drive 3-phase power modules with pin-out compatible to ECONO2-6PACK. The board can drive AC or Brushless motors using power modules with up to 50A output current. The board is a flexible solution for different applications and can be customized providing place for external components. The control signals are 3.3V CMOS compatible; three-phase shunt resistor (with sensing pins) can be placed for current loop control; power module short circuits are managed synchronizing the IGBT turn off in a local network. Board layout reduces the noise coupling between high and low voltage signals and EM emissions.

Application Block Diagram

(Refer to connections section to know the interface pins) This diagram shows the main blocks and connections of the demo board and the external components necessary in a typical motor drive application.

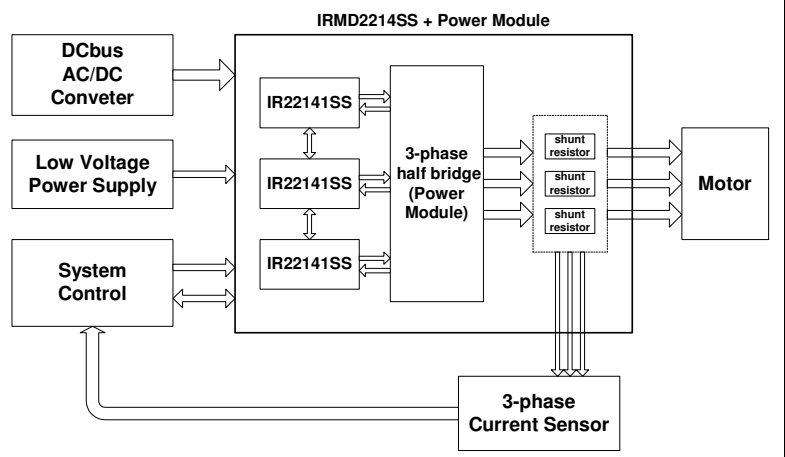


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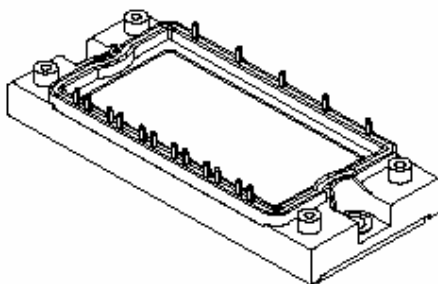
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| Parameters | Values | Description, condition |
|-------------------------------|------------------------|---|
| Input Power | | |
| DC+ | 0 to 1200V | DCBus voltage positive with 1200V power module |
| DC- | ground | DCbus voltage negative |
| Vcc | 15V typ | Low voltage power supply. Follow IR22141 datasheet for supply setting |
| Vss | ground | Low voltage ground |
| Icc | 100 mA | quiescent Vcc current |
| Output Power | | |
| I_{lmax} | 50A @25C | max phase dc output current |
| Control Inputs/Outputs | | |
| 40 pin connector J1 I/Os | 3.3V to 15V compatible | see "Board Connectors" section on page 4 |

The IR22141SS

The IR22141SS is a half bridge gate driver suited for power switching applications. The high side driver can float up to 1200V. The IR22141SS have a high gate driving capability (2A source and 3A sink) with a low quiescent current. The device is designed to manage all the half-bridge faults by turning off smoothly the desaturated transistor through the dedicated soft shut down pin preventing over-voltages and reducing EM emissions. In a multi-phase system the drivers communicate using a dedicated local network (SY_FLT and FAULT/SD signals) to properly manage phase-to-phase short circuits. The system controller may force shutdown or read device fault state through the 3.3 V compatible CMOS I/O pin (FAULT/SD). To improve the signal immunity from DC-bus noise, the control and power ground use dedicated pins enabling low-side emitter current sensing as well. Undervoltage conditions in floating and low voltage circuits are managed independently.

For further technical information see the IR2214/IR22141 datasheet at <http://www.irf.com>.



ECONO2 6PACK

The power module

IRMD22141SS demo board is ECONO2 compatible with SixPack™ standard pin out.

Important Notice

IRMD22141SS demo board is supplied with a Bill Of Material suitable for a 1200V/50A@100C power module. The BOM presented on page 15 provides a suggestion for the above

mentioned power module.

It is strongly recommended to customize the demo board to fit the application requirements for the power module that has been chosen.

Suggestions on passive sizing are also present in "Design Tips: Using monolithic high voltage gate drivers".

BOARD CONNECTORS

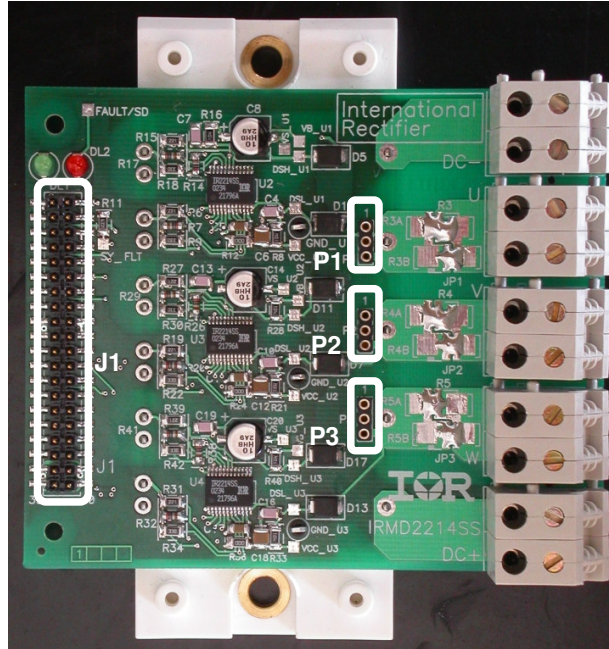


Figure 1: TOP image of board

Connection with the system controller

On board there is a 40 pins connector for the control signals. The driver board uses only 17 pins. The remaining pins are for the sensing board (IRCS2277S) that can be connected on top of IRMD22141SS board.

| CONNECTOR J1 | | |
|--------------|---------|--|
| HIN1 | 1 | |
| LIN1 | 2 | |
| HIN2 | 12 | |
| LIN2 | 13 | |
| HIN3 | 24 | |
| LIN3 | 25 | |
| FLT_CLR | 3 | |
| FAULT/SD | 5/6 | |
| VCC | 37 - 40 | |
| VSS | 17 - 20 | |

Table 1: 40-pin connector J1

Input logical signals HIN1, LIN1, HIN2, LIN2, HIN3, LIN3 and FLT_CLR:

These logic inputs are 3.3 V compatible CMOS I/O port. The logic signals are active high with internal pull-down resistor of 10 kOhm. When both HIN and LIN of the same phase are active at the same time an internal anti-shot trough circuit turns off the output drivers. HIN turns on the high side IGBT while LIN the low side.

FLT_CLR is active high and it is used to reset the fault state of all devices (see also the Fault management section and the IR22141SS datasheet).

FAULT/SD logic signal

This is an input/output logic signal, 3.3 V compatible CMOS I/O port. The logic signal is active low, tied to connector VCC with a 10 kΩ pull-up resistor. As an input, the signal shuts down (SD) all the drivers; as an output, it reports the power module fault (IGBT desaturation detection) or the VCC undervoltage (see also IR22141SS datasheet for more information).

On board a red LED (DL2) indicates when the signal is active; Figure 2a shows the connection.

VCC supply pin

This is the supply pin for all the devices. On board a green LED (DL1) indicates the supply power on; Figure 2b shows the connection.

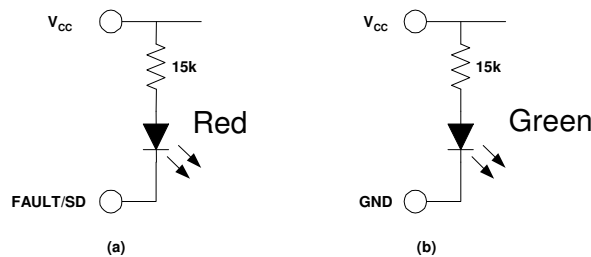


Figure 2: LED connection

VSS ground pin (GND)

The board ground is connected to the power module DC- pin. The VSS pin of the connector and the devices ground pin are star-connected to the DC- pin. DC- star connection has been chosen to reduce the noise coupled from the floating signals.

Connecting the current sensors

P1, P2 and P3 are connected with the optional shunt resistors placed on the phase output nodes.

| CONNECTOR P1 | | |
|-----------------------------|---|--|
| SHU+ (motor side) | 1 | |
| SHU- (power module side) | 2 | |
| U | 3 | |
| CONNECTOR P2 | | |
| SHV+ (motor side) | 1 | |
| SHV- (power module side) | 2 | |
| V | 3 | |
| CONNECTOR P3 | | |
| SHW+ (motor side) | 1 | |
| SHW- (power module side) | 2 | |
| W | 3 | |

Table 2: P1, P2 and P3 connectors for kelvin contacts to shunt signals

The SHU, SHV and SHW are sense pins connected as close as possible to the shunt resistors terminals to reduce the parasitic effects of the traces.

High power signal connector

There are two connectors dedicated to each power signal (DC+, U, V, W and DC-). Each single connector has 30 Ampere of maximal nominal dc current. DCbus traces are both on top and on one of the internal layers of the PC board in order to reduce power dissipation. Connectors, DC-bus, phase and ground wires can be soldered directly on board using the corresponding pads located under the power connectors (to be removed).

Connecting the power module

The board is fully compatible with the ECONO2-6PACK power module. The following table shows the module pin-out.

| CONNECTION POINTS BETWEEN BOARD AND MODULE | |
|--|---|
| 1 | VGHU - phase U - high side IGBT gate |
| 2 | VEHU - phase U - high side IGBT emitter |
| 3 | VGLU - phase U - low side IGBT gate |
| 4 | VELU - phase U - low side IGBT emitter |
| 5 | VGHV - phase V - high side IGBT gate |
| 6 | VEHV - phase V - high side IGBT emitter |
| 7 | VGLV - phase V - low side IGBT gate |
| 8 | VELV - phase V - low side IGBT emitter |
| 9 | VGHW - phase W - high side IGBT gate |
| 10 | VEHW - phase W - high side IGBT emitter |
| 11 | VGLW - phase W - low side IGBT gate |
| 12 | VELW - phase W - low side IGBT emitter |
| 13 | DC+ |
| 14 | Phase W |
| 15 | Phase V |
| 16 | Phase U |
| 17 | DC- (GND) |

Table 3: High power module connection

Test Points

Test points on board provide signals that are not available at the connectors. See the following table:

| ONE FOR EACH DEVICE (U1 -> U, U2 -> V, U3 -> W) | |
|---|--|
| V _B | High side floating supply voltage |
| V _S | High side floating supply offset voltage |
| DSH | High side desat input voltage |
| DSL | Low side desat input voltage |
| VCC | Low side and logic fixed supply voltage |
| GND | Device VSS |
| COMMON FOR ALL DEVICES | |
| FAULT/SD | Fault and Shut Down (or-wired) |
| SY_FLT | Synchronized Fault (or-wired) |

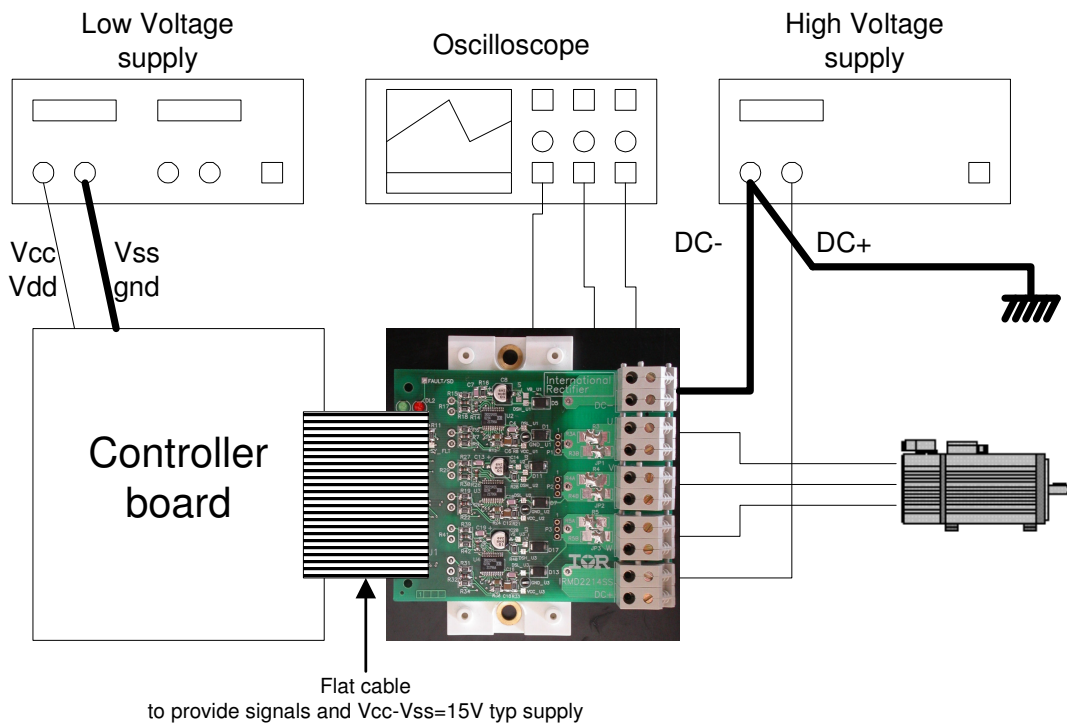
Table 4: Test points

Note: the FAULT/SD signal is present on pin 5 and 6 of the 40-pin connector, too.

TEST BENCH CONNECTION

IRMD22141SS does NOT provide opto isolation.

The following picture shows the recommended connections for board evaluation. Bold lines are equipotential (DC=Vss=gnd).



OPERATING DESCRIPTION

Power on sequence

Before beginning the normal operating mode, it is strongly recommended to follow the power ON sequence. The purpose of this procedure is to set the internal device logic. This is achieved by charging all bootstrap capacitors for the first time with the FLT_CLR signal active. See Figure 4 for the correct procedure.

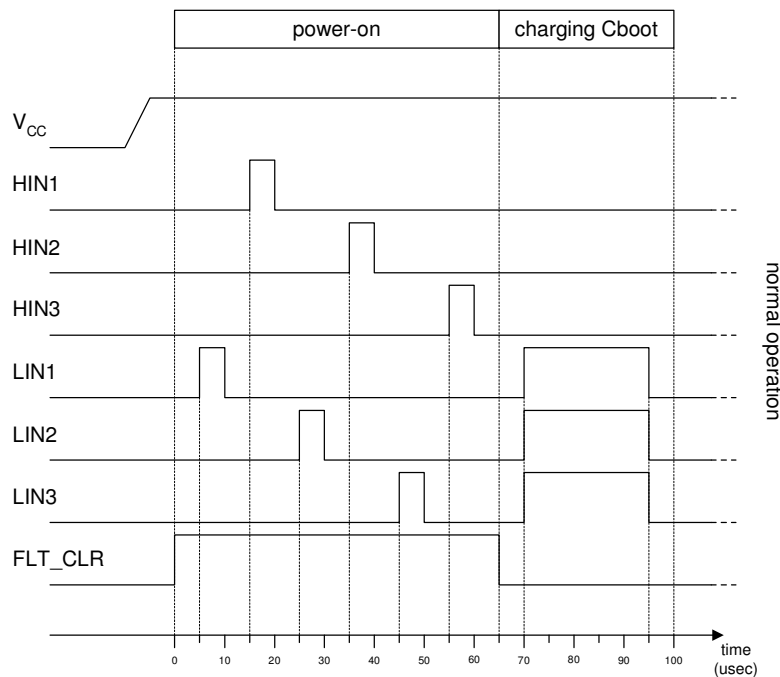


Figure 4: Power on sequence

Normal operating mode

In the normal operating mode when HIN or LIN is active the high or low side IGBT turns on respectively. Turn on and turn off propagation delays and the propagation delay matching are specified in the IR22141SS datasheet. Devices introduce also a minimum dead-time (typical 330 ns).

Fault management

The IR22141SS is able to detect the excessive current increase by monitoring the IGBT desaturation. The three-phase connection of the IR22141SS allows managing all power module faults using the FAULT/SD and SYNC_FLT signals in a local network.

Figure 5 shows how the devices are interconnected to each other and with the FAULT/SD pin on the connector. The fault management procedure starts when one of the drivers senses the IGBT desaturation (see Figure 5 where, as an example, only one low side IGBT is shown).

Figure 6 shows an example where the low side IGBT of U1 and U3 and the high side of U2 are on. The procedure is totally managed by an integrated FAULT LOGIC block without the controller assistance.

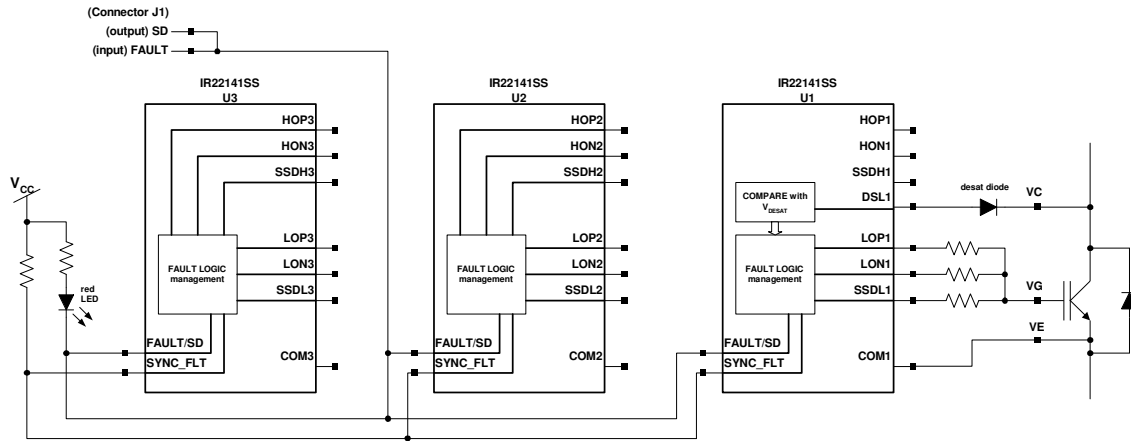


Figure 5: Three phase connection

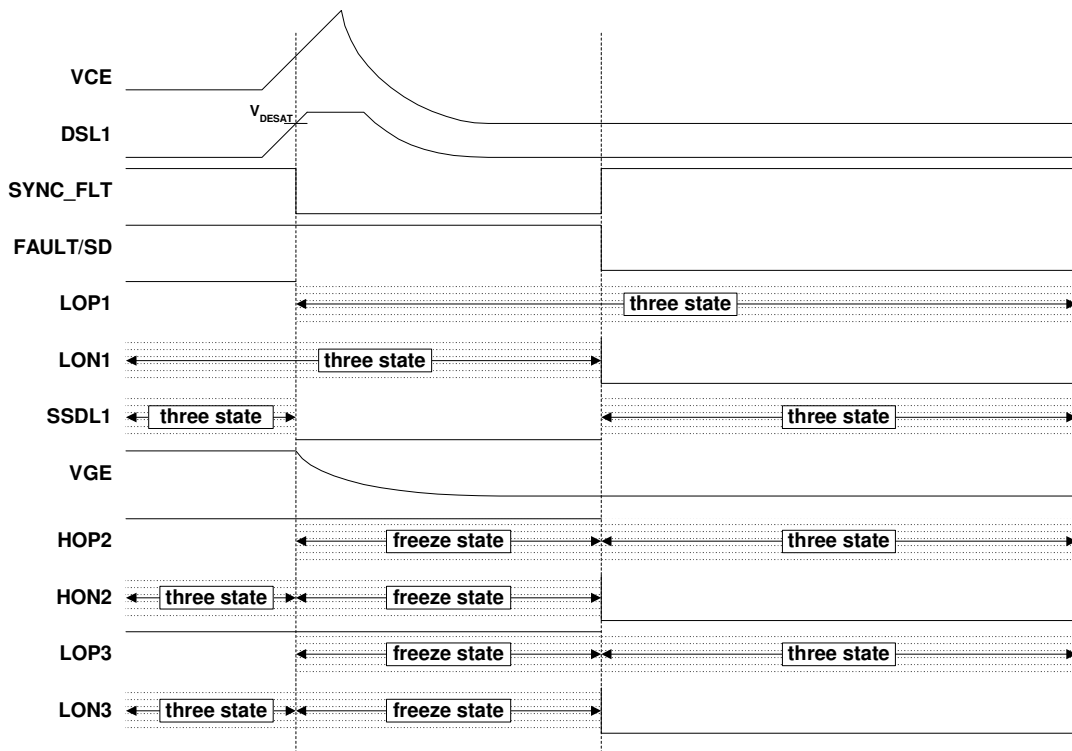


Figure 6: Example of a desaturation detection event

Multilevel board solution

With the optional shunt resistor the IRMD22141SS driver board can be connected with the IRCS2277S current sensing board through J1 and P1, P2, and P3 connectors. More information available with IRCS2277S board datasheet.

BOARD SOLUTIONS

Sizing of the components mentioned in this section is indicated in the Bill of material on page 15.

Bootstrap circuit

The high side floating supply (V_{BS}) is provided by a bootstrap capacitor. Figure 7 shows the circuit on board.

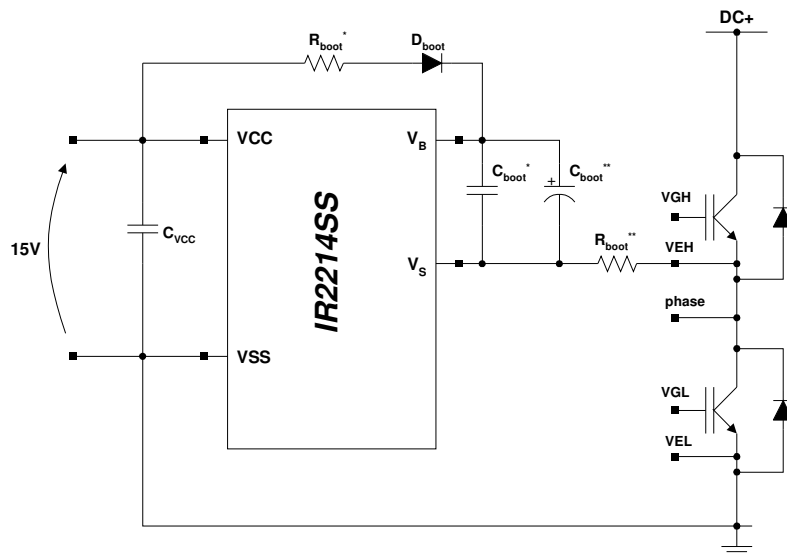


Figure 7: Bootstrap circuit

The following table shows the names of these components on board.

| | U | V | W |
|-----------------|-----|-----|-----|
| C_{VCC} | C5 | C11 | C17 |
| C_{boot}^* | C9 | C15 | C21 |
| C_{boot}^{**} | C8 | C14 | C20 |
| R_{boot}^* | R13 | R25 | R37 |
| R_{boot}^{**} | R14 | R26 | R38 |

Gate resistances

The following table shows the names of gate resistances on board.

| | U | V | W |
|------------------------|-----|-----|-----|
| high side gate to HOP | R18 | R30 | R42 |
| high side gate to HON | R17 | R29 | R41 |
| high side gate to SSDH | R15 | R27 | R39 |
| low side gate to LOP | R9 | R22 | R34 |
| low side gate to LON | R7 | R20 | R32 |
| low side gate to SSDL | R6 | R19 | R31 |

OTHER EXTRA COMPONENTS

These components are provided to make IRMD22141SS board as customizable as possible. In many cases the extra components are not required.

Desat circuit

The IR22141S is able to detect the IGBT desaturation. To reject the noise on the desat pins the IR22141SS have an internal filter of 1 μ sec. If this is not enough an RC filter has been placed on board (see figure 8, R_{DSH} , C_{DSH} and R_{DSL} , C_{DSL}).

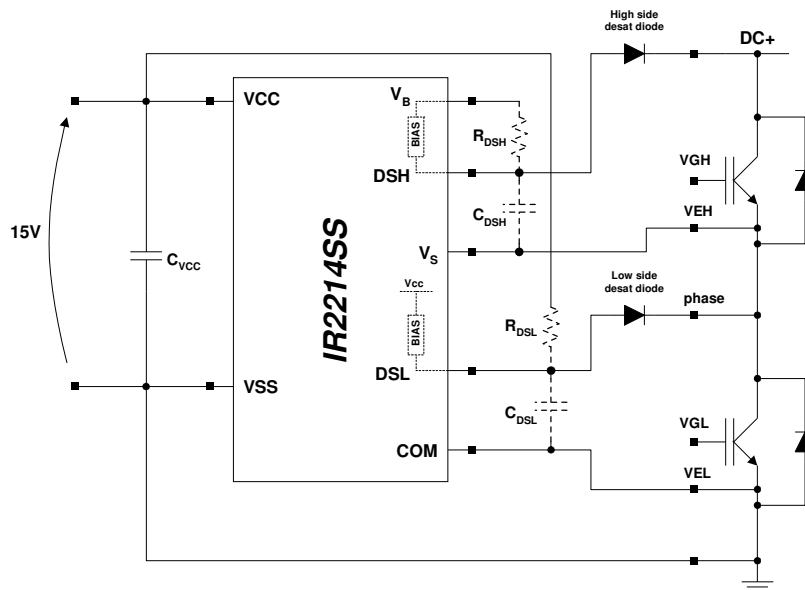


Figure 8: Desat external filter

The external resistor is in parallel with the internal bias circuit of the desat diode. If added, the external resistor may cause a higher diode bias current that must be taken into account in bootstrap capacitor sizing.

External RC filter delays desaturation detection, that causes a delay in turning the IGBT off. Consider this delay when sizing the soft-shut-down resistors.

The following table shows the names of these components on board.

| | U | V | W |
|-----------|-----|-----|-----|
| C_{DSH} | C7 | C13 | C19 |
| R_{DSH} | R16 | R28 | R40 |
| C_{DSL} | C4 | C10 | C16 |
| R_{DSL} | R8 | R21 | R33 |

Clamping Diode for V_S below ground

This solution preserves the device when the V_S pin goes below ground out of the device absolute maximum ratings. The V_S voltage is clamped to the maximum value allowed by a zener diode.

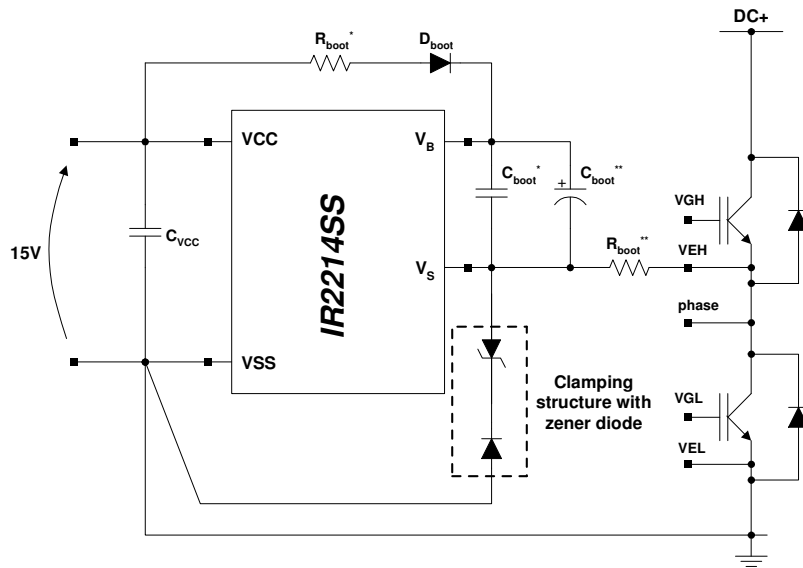


Figure 9: -Vs clamp

The following table shows the names of these components on board.

| | U | V | W |
|-------|----|-----|-----|
| DIODE | D4 | D10 | D16 |
| ZENER | Z2 | Z5 | Z8 |

RC filter on com pin

An RC filter (R_{COM} , C_{COM}) is provided to preserve the IC device from low side IGBT emitter undervoltage spikes.

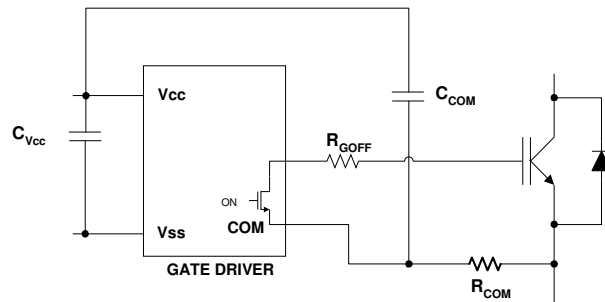


Figure 10: COM below ground protection

The following table shows the names of these components on board.

| | U | V | W |
|-----------|-----|-----|-----|
| C_{COM} | C6 | C12 | C18 |
| R_{COM} | R10 | R23 | R35 |

Fast diode between gate and supply pin

On all low and high side drivers a fast diode is provided to clamp the gate coming over the V_{CC} or V_B supply pins and to recover the current coming from the collector node through the gate-collector capacitance.

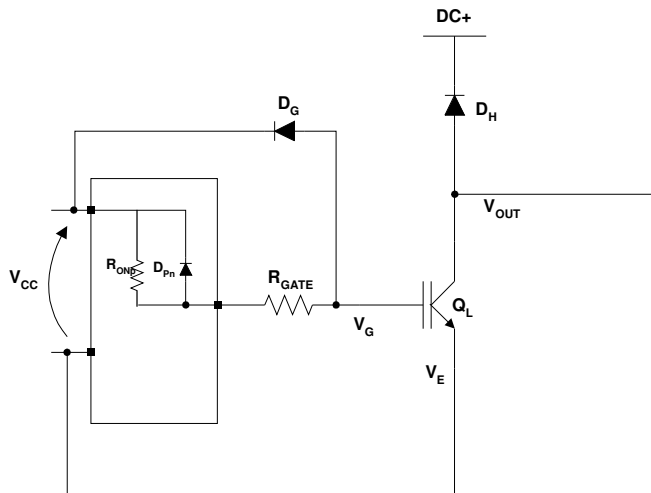


Figure 11: Collector-Gate current protection

The following table shows the names of these components on board.

| | U | V | W |
|-------------------|----|-----|-----|
| (high side) D_G | D6 | D12 | D18 |
| (low side) D_G | D2 | D8 | D14 |

Zener diode to preserve the IGBT gate

To avoid a V_{GE} increasing over the absolute maximum rating a zener diode is connected between gate and emitter pins on all the IGBTs.

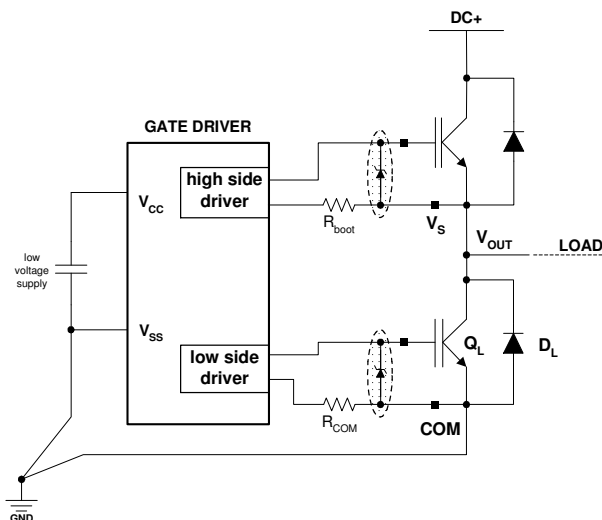


Figure 12: Zener clamp for IGBT gate

The following table shows the names of these components on board.

| | U | V | W |
|-------------------|----|----|----|
| (high side) ZENER | Z3 | Z6 | Z9 |
| (low side) ZENER | Z1 | Z4 | Z7 |

Optional output shunt resistor

Two type of output shunt resistor, for current sensor, are possible see the following table:

| | U | V | W |
|----------|------------|------------|------------|
| TO220 or | R3 | R4 | R5 |
| OARS-1 | R3A // R3B | R4A // R4B | R5A // R5B |

The OARS-1 type (A and B) are connected in parallel.

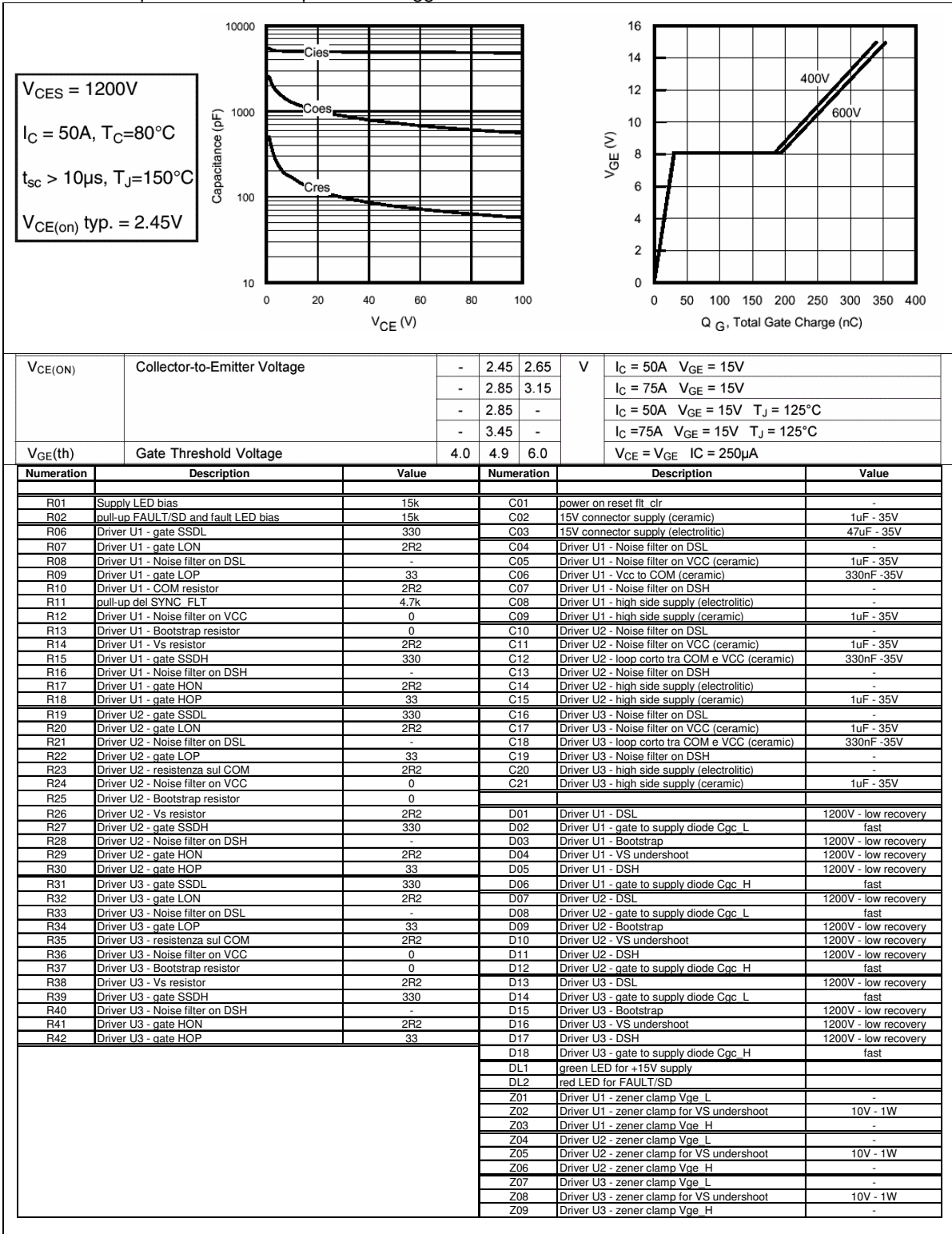
Resistor on v_{cc}

Provided to decouple VCC_U1, VCC_U2 and VCC_U3 from supply line.

| | U | V | W |
|----------------|-----|-----|-----|
| Vcc decoupling | R12 | R24 | R36 |

BILL OF MATERIAL

The hereafter provided BOMs represent a suggestion based on the IGBT characteristics shown below.



LAYOUT

TOP SILK LAYER

