RDHP-2102

Reference Design Board,
General Purpose Base Board for SCALE-iDriver™ SIC1182K

Product Highlights

- Suitable for TO-247-4 SiC-MOSFETs
- Tested with Mitsubishi BM022N120K
- Up to 800V DC-link voltage
- Onboard DC-link capacitor
- Electrical Interface with 5V-Logic
- Short Circuit Detection
- Source-Controller

Functional Description

The RDHP-2102 is a two-channel gate driver board for TO-247-4 SiC-MOSFETs with an onboard DC-link capacitor which provides a low inductive commutation path for the SiC-MOSFETs. It has an electrical interface with 5V-logic-levels. It receives the switching signals on IN1 and IN2 and provides the feedback signals SO1 and SO2. It contains a built-in isolated power supply for the secondary sides which is 5V-powered along with the primary side by the pins V5 and GND. The total secondary supply as well as the sharing of the voltage levels for turning-on and -off can be adjusted.
The driver provides a short-circuit detection by a resistor chain connected to the drain of the SiC-MOSFET. In order to make fast switching possible the board contains a low inductive DC-link.

The design is proposed for the following application conditions:

- General purpose applications
- SiC-MOSFET in TO-247-4 housing
- Up to 8A gate peak current
- Up to 1.3W gate power per channel
- Ambient Temperature: -40... 85°C

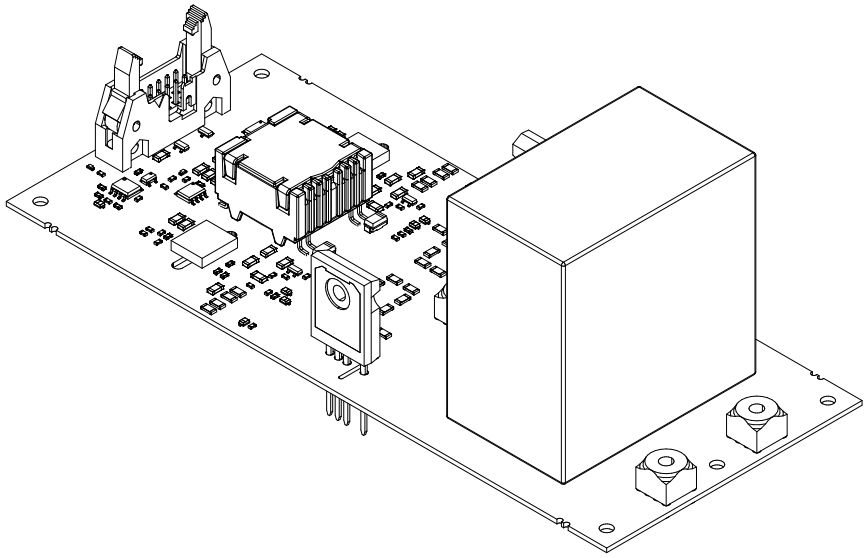

Figure 1. 3D-Picture.

Pin Functional Description

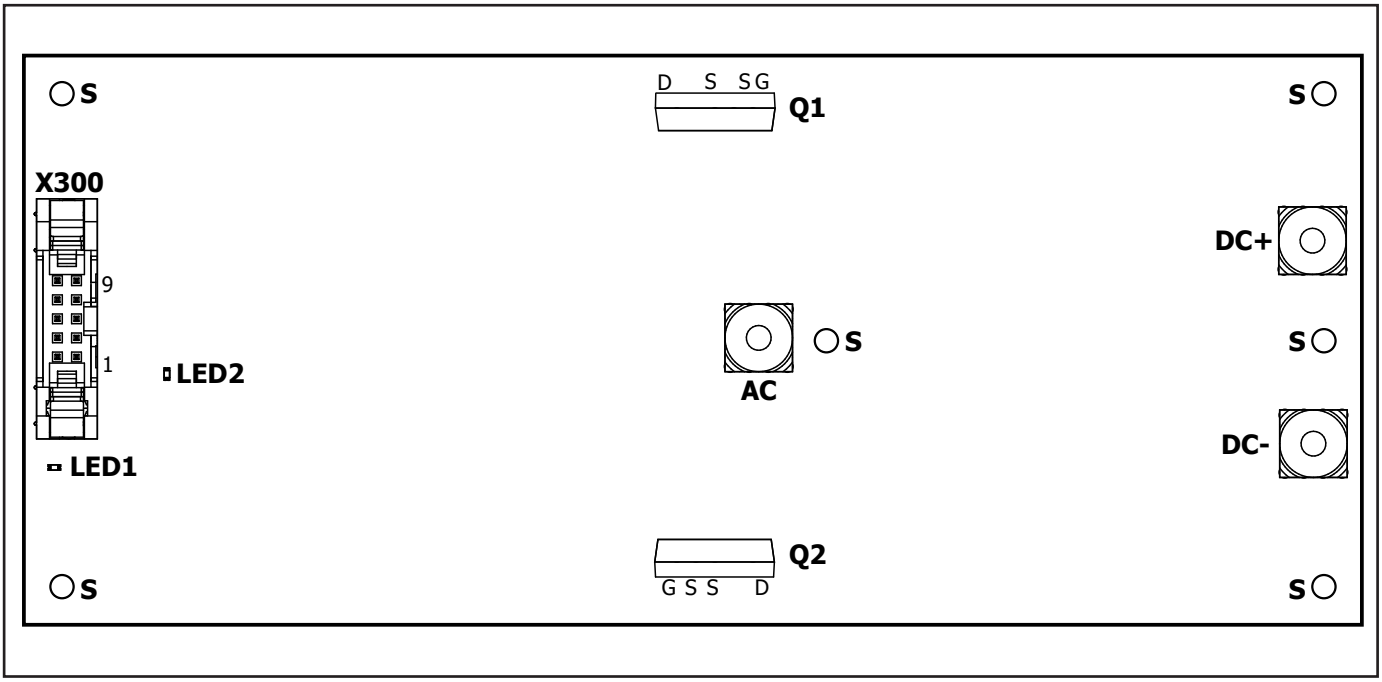

Figure 2. Pin Configuration.

Connector X300

The connector X300 (FCI 71918-110LF) represents the electrical interface of the board.

V5 (Pin 1)
This pin is the primary-side 5 V supply voltage connection for the integrated DC/DC converter which supplies the secondary sides and for the primary side.

INA (Pin 9)
This pin is the 5V-command input for channel 1 (high-side switch).

INB (Pin 5)
This pin is the 5V-command input for channel 2 (low-side switch).

SO1 (Pin 7)
This pin is the status output for channel 1 (high-side switch).

SO2 (Pin 3)
This pin is the status output for channel 2 (low-side switch).

GND (Pins 2, 4, 6, 8, 10)
These pins are the connection to the ground potential. All signals refer to these pins.

LED1

This LED indicates the supply voltage V5. No light means no-voltage.

LED2

This LED indicates the supply voltage VDC used to power the secondary sides. No light means no voltage.

Connector AC

This connector (M4 power socket) represents the AC-connection of the half-bridge.

Connectors DC+ and DC-

These connectors (M4 power socket) represent the DC-connections of the half-bridge.

SiC-MOSFET Q1 and Q2

TH-Solder-pads for the SiC-MOSFETs in TO-247-4 housing.

Screw Holes S

Holes for M3-screws for mechanical fixation.

Equivalent Circuit

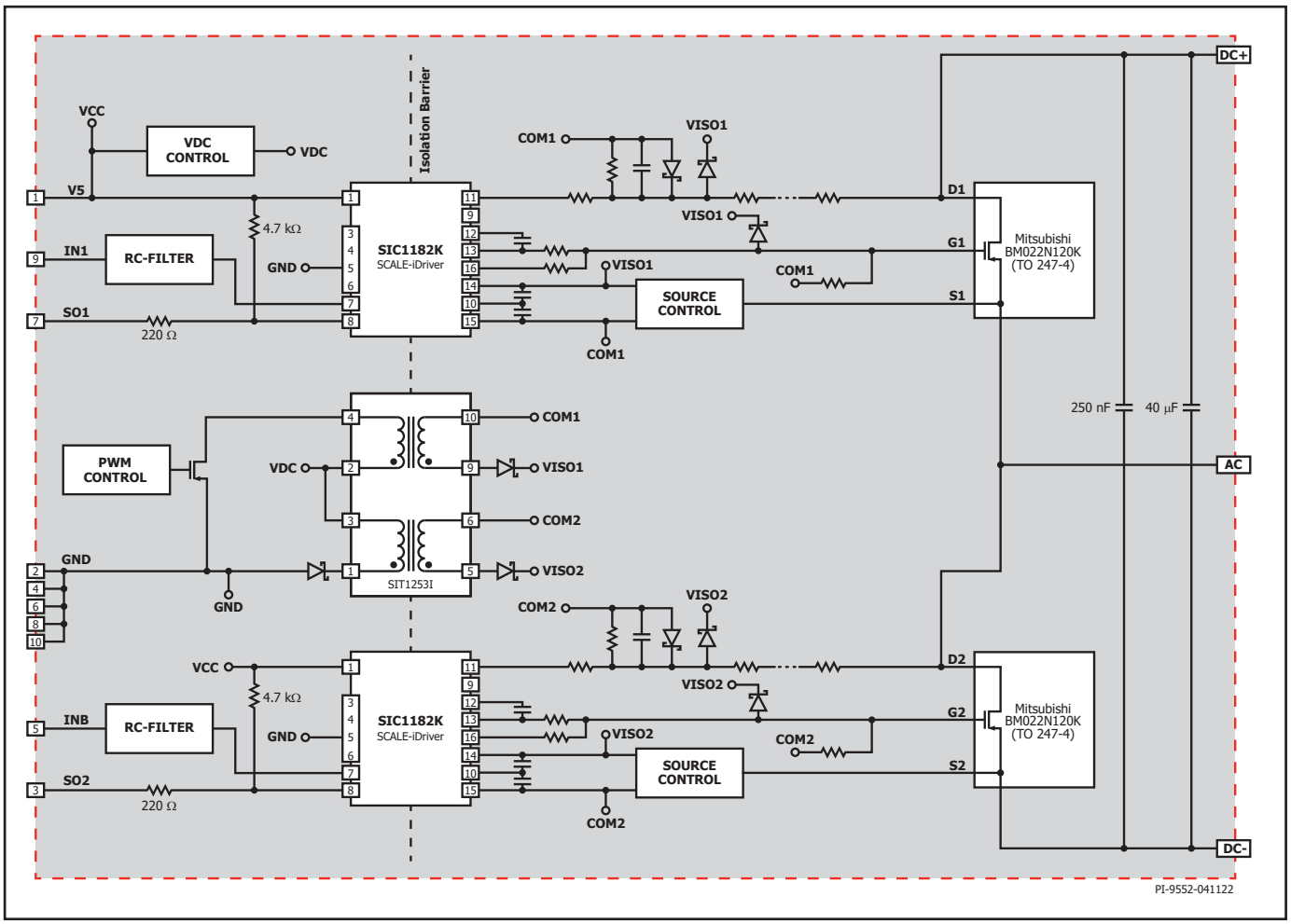

Figure 3. Equivalent Circuit.

Gate Resistors

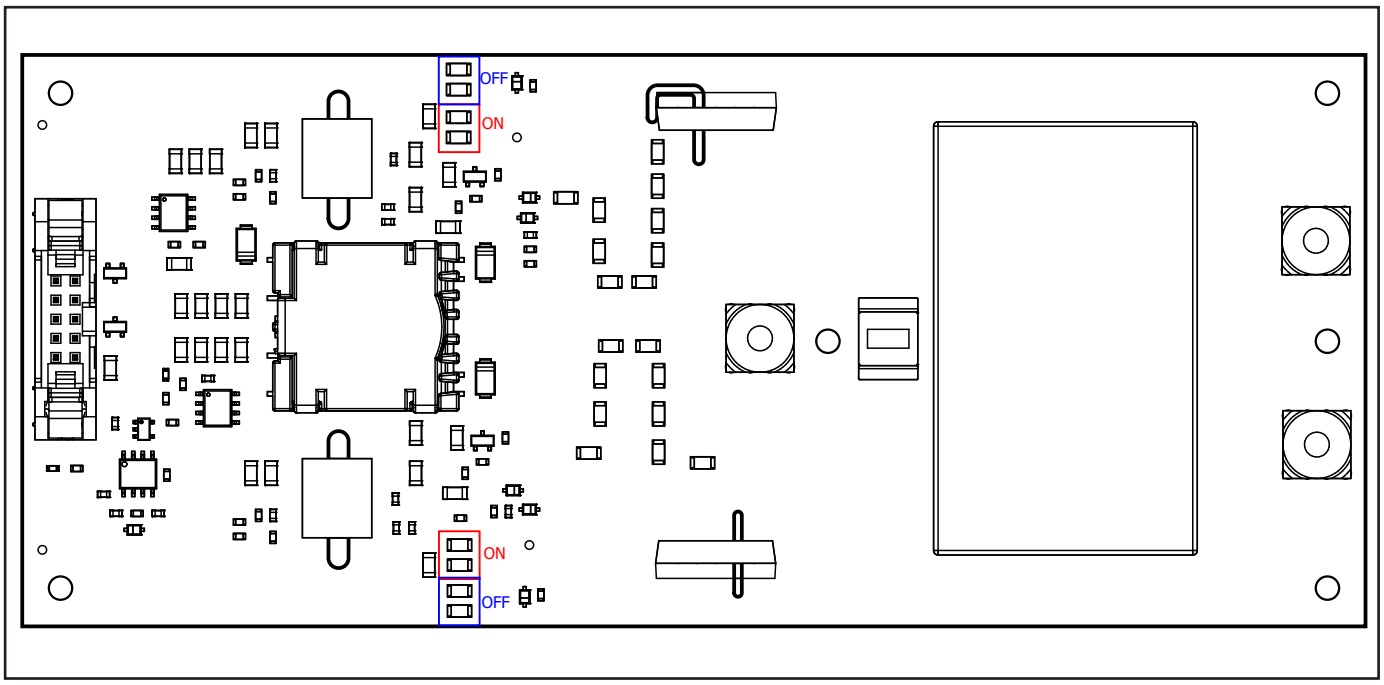

Figure 4. Position of the Gate Resistors.

Gate resistor values can be changed according to the application. Gate resistors of SMD (size 1206) package can be selected. Their position is depicted in Figure 4.

Channel	Turn-On Gate Resistors	Turn-Off Gate Resistors
1	R112a...b in parallel	R113a...b in parallel
2	R212a...b in parallel	R213a...b in parallel

Short Circuit Detection

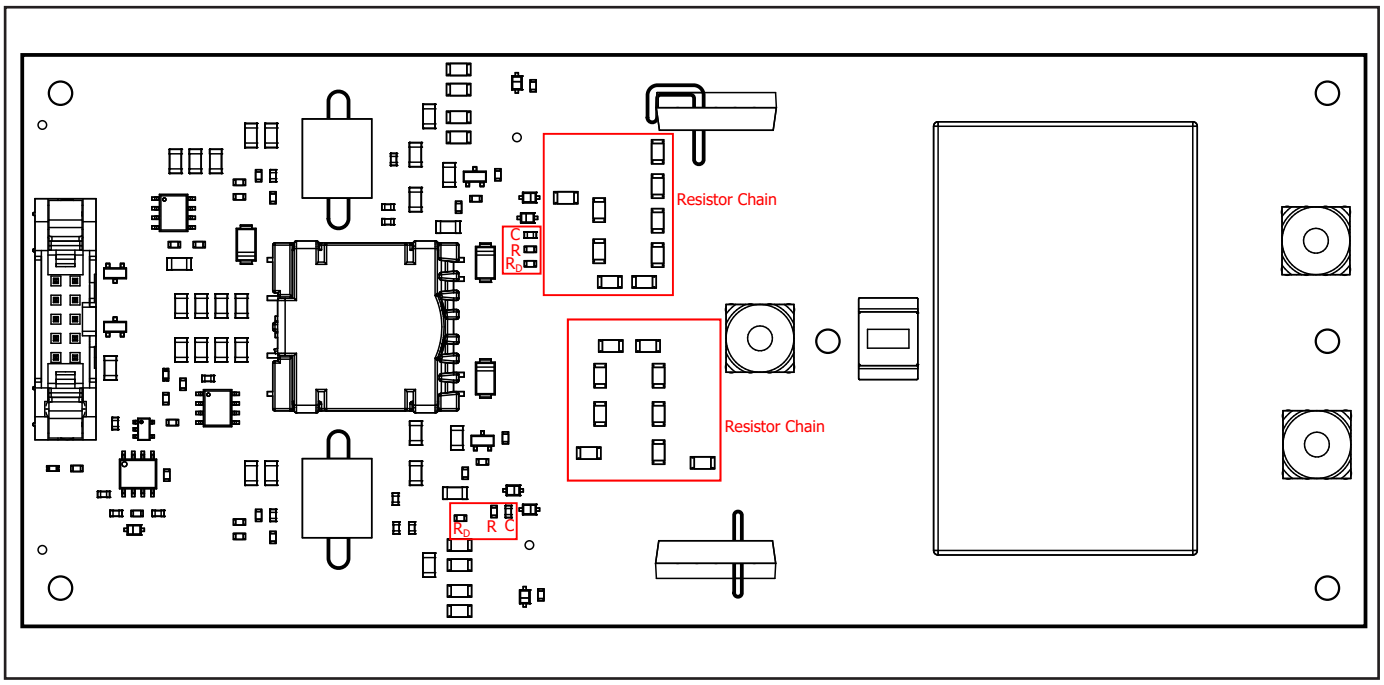

Figure 5. Position of components for Short Circuit Detection.

The SIC1182K gate driver IC from Power Integrations provides a sense input for monitoring short-circuit conditions of the power semiconductor. This design offers a short circuit detection function using a resistor network. A assembly variant of implementation tested with Mitsubishi BM022N120K is described in the following table:

Channel	Resistor Chain	Timing Resistor R	Timing Capacitor C	Decoupling Resistor R_D
1	R100...R108 270 kΩ each	R109 150 kΩ	C100 10 pF	R110 3.3 kΩ
2	R200...R208 270 kΩ each	R209 47 kΩ	C200 47 pF	R210 3.3 kΩ

All mentioned components as shown in Figure 5 can be changed to meet the desired behavior of the short circuit detection.

- R100 ... R108 and R200 ... R208 are dimensioned for 1200V power semiconductors and can be decreased according to the data sheet of SIC1182K when using lower voltage ranges.
- Increasing R109 and R209 accelerates the SC detection time and lowers the detection threshold voltage.
- Increasing C100 and C200 increases the short circuit detection time but avoids false tripping.
- Decreasing R110 and R210 helps to avoid false tripping of the short circuit detection.

The details of the short circuit detection function are described in the corresponding data sheet of the gate driver.

Minimum Pulse Suppression

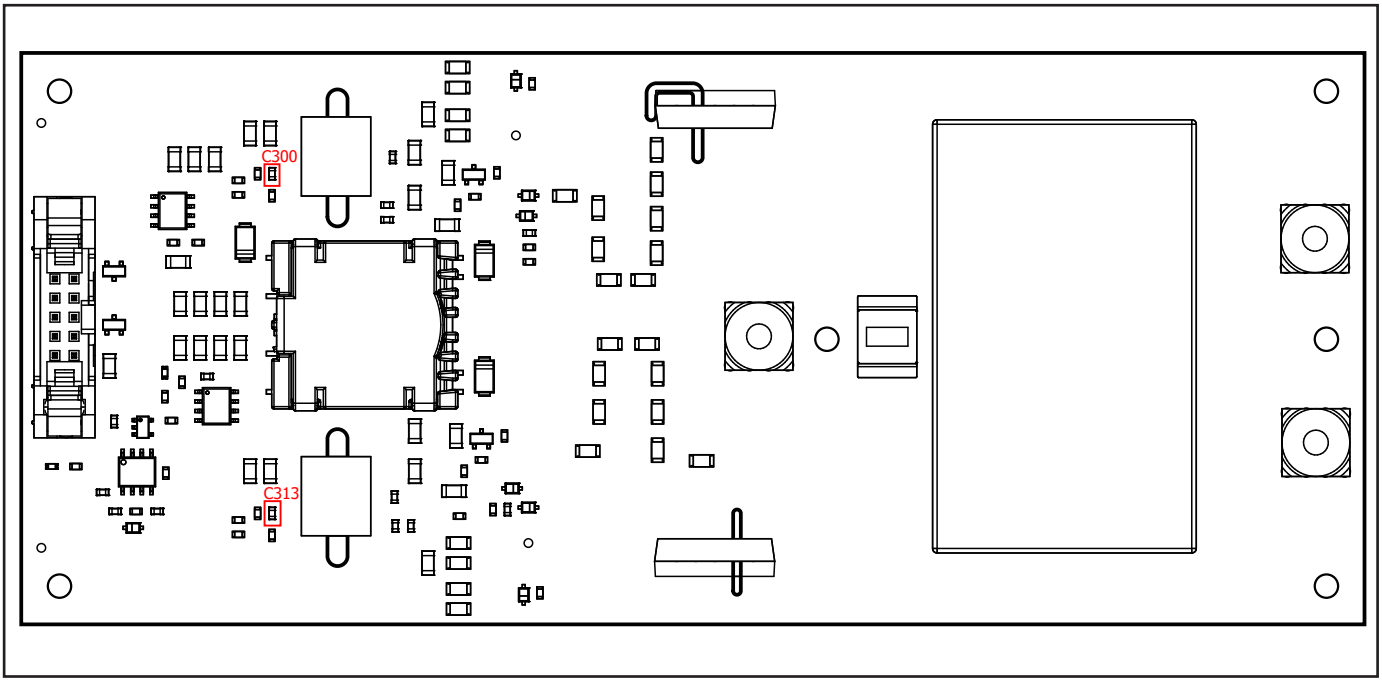

Figure 6. Position of Capacitors for the Minimum Pulse Suppression.

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 C306 which are depicted in Figure 6. The time constants are given by the following equations:

$$\tau_1 = 99\ \Omega \times C300$$
$$\tau_2 = 99\ \Omega \times C313$$

Recommended values of C300 and C313 are in the range of 1 nF (τ_x = 99 ns) to 3.3 nF (τ_x = 327 ns), depending on the actual application conditions.

Blocking Time

During the blocking time, which is set to typically 10 µs, the SIC1182K 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 data sheet of the gate driver SIC1182K.

Source Controller

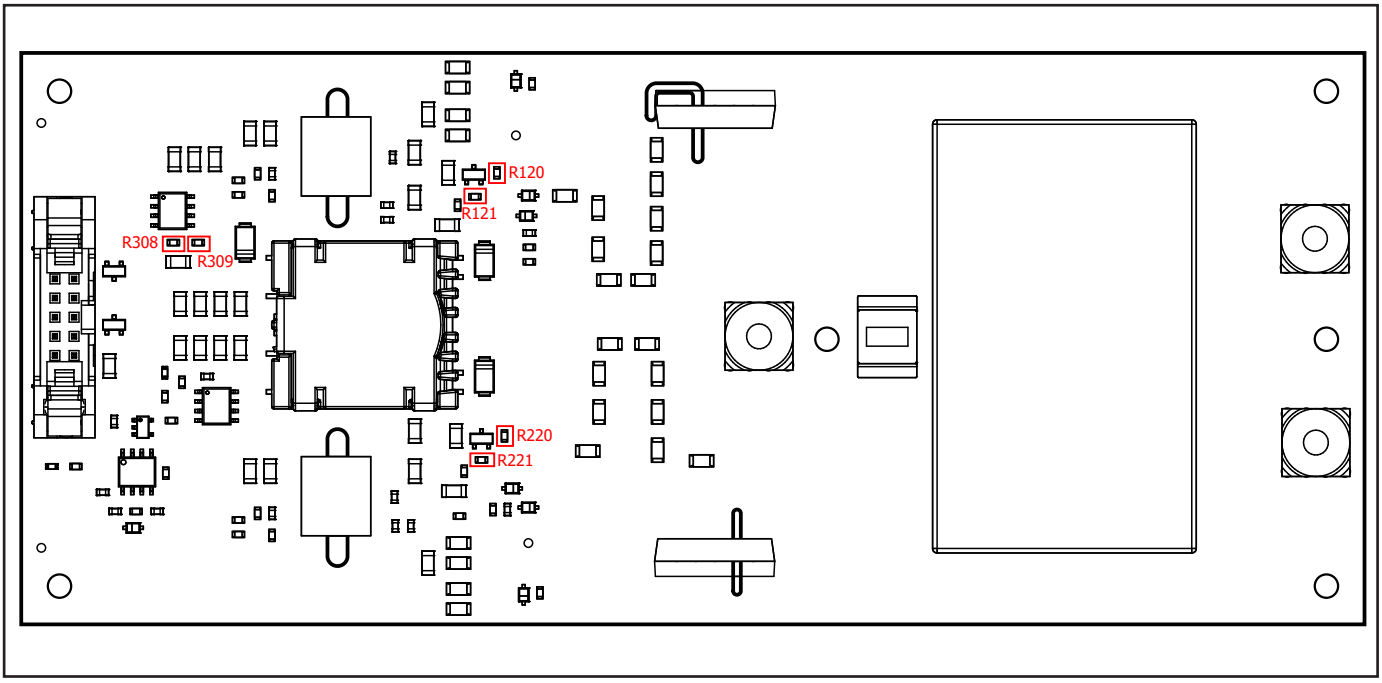

Figure 7. Position of Source Controller and the Voltage Regulator Components.

In order to realize the appropriate gate switching voltage levels an external source controller in addition to the SIC1182K is used. The following voltage levels are provided:

- Positive Rail ($V_{VISO-Source}$): 15 V (load dependent)
- Negative Rail ($V_{Source-COM}$): -5 V (controlled)

The negative rail is controlled by the help of a shunt regulator TL431BFDT by NXP.

The regulated voltage is calculated with $V_{VISO-Source} = V_{ref} \times (1 + Rx21/Rx20)$.

In the proposed design the resistors like highlighted in Figure 7 are set to the following values: Rx21 = 4.7 kΩ, Rx20 = 4.7 kΩ

Secondary Side Voltage Regulator

The total secondary side voltage $V_{VISO-COM}$ is regulated by a linear regulator on the primary side. The winding factor of the transformer is 5. Thus the total secondary side voltage $V_{VISO-COM}$ is calculated by $V_{VISO-COM} = 5 \times 1.25V \times ((R308+R309)/R309)$ with R308 = 2.2 kΩ and R309 = 1 kΩ.

CAD Data

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

Product Dimensions

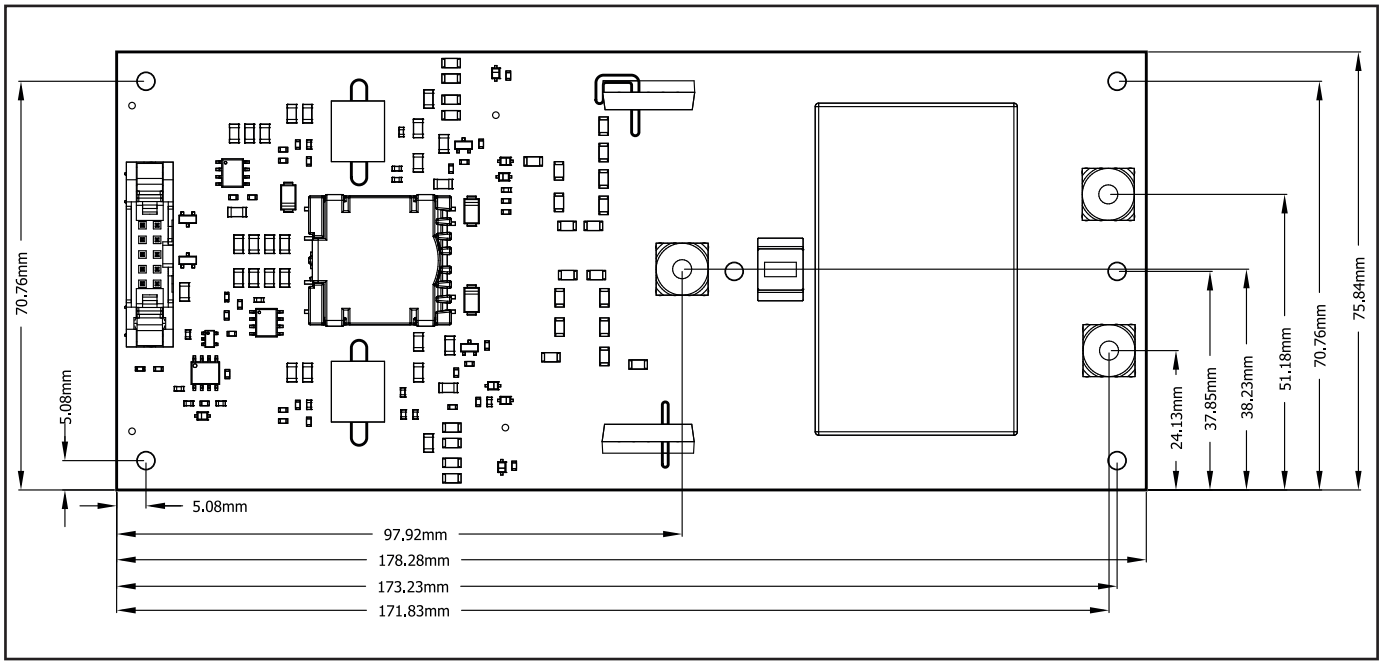

Figure 8. Top View.

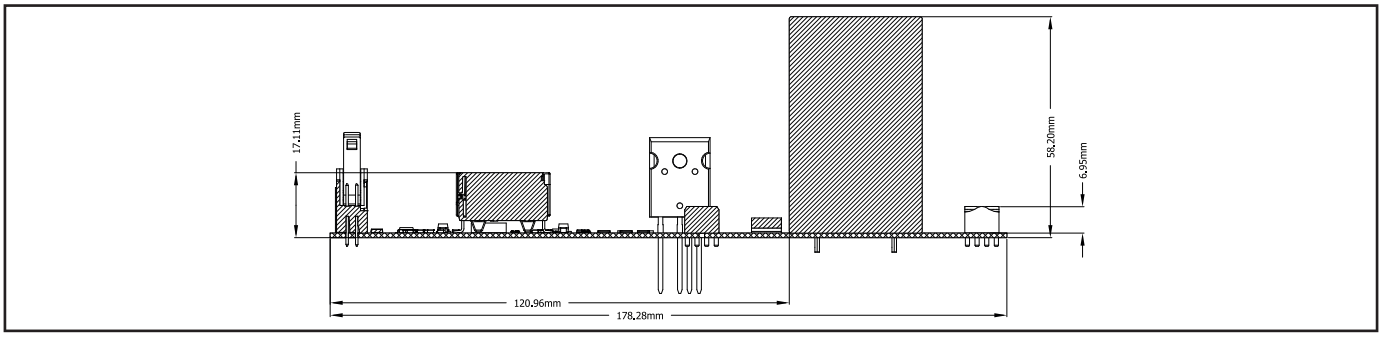

Figure 9. Side View.

Product Details

Part Number	Power Module	Voltage Class	Current Class	Package	Power Device Supplier
RDHP-2102	BM022N120K	1200 V	71 A	TO-247-4	Mitsubishi

Transportation and Storage Conditions

For transportation and storage conditions refer to Power Integrations' Application Note AN-1501.

RoHS Statement

We hereby confirm that the product supplied does not contain any of the restricted substances according Article 4 of the RoHS Directive 2011/65/EU in excess of the maximum concentration values tolerated by weight in any of their homogeneous materials.

Additionally, the product complies with RoHS Directive 2015/863/EU (known as RoHS 3) from 31 March 2015, which amends Annex II of Directive 2011/65/EU.

Notes

Revision	Notes	Date
A	Final Data Sheet.	04/22

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