CC1500VSCTV1

Short Circuit Testing

A highly versatile and easy to use evaluation board to perform short circuit tests (SCTs) on TO-247 (4 lead) packaged Silicon Carbide and Silicon power devices.

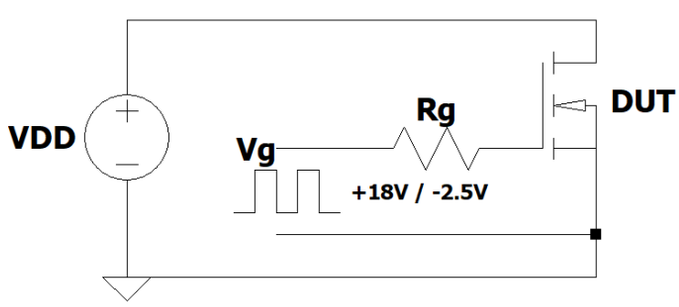
BENEFITS

- Easy to use
- Versatile
- Very low loop inductance
- Optical isolation

APPLICATIONS INCLUDE

SCT is commonly used to determine short circuit characteristics of power MOSFETs, IGBTs, and JFETs. It enables the assessment of key parameters including peak current capability, withstand time, and short-circuit critical energy-the maximum energy the device can safely absorb before failure.

Side view



Circuit diagram

Part Number	Package	Marking
CC1500VSCTV1	PCB	CoolCAD Electronics

contact@coolcadelectronics.com Maryland https://coolcadelectronics.com

Features and Board Functionality:

This evaluation board is designed to perform short circuit testing (SCT) for finding short circuit withstand time in the TO-247-4L package and can be used to test for up to 1.5kV.

The SCT evaluation board includes:

- Daughter card for soldering a TO-247-4L power device, featuring a pre-populated gate driver.
- Daughter card attached to the main board via header pins for easy removal and reinstallation.
- Through holes for soldering the input DC link caps that supplies energy during short circuit event.
- Various tests points for probing pulsed / PWM input voltage and gate-source voltage.
- Swappable gate resistor. (0Ω resistor included.)
- SMA connectors for gate input pulses.
- Safety enclosure for the daughter card.
- Screw terminals for +5V auxiliary input, control ground, VDC, and power ground.

Table 1 lists the physical dimensions of the board.
Figure 1 shows a top side view of the board with key components labeled.
Figure 2 shows a down-side view of the board with components labeled.
Figure 3 shows the daughter card with provision to solder a power device with TO247-4L package.
Figure 4 shows the evaluation board with daughter card mounted.
Figure 5 shows the evaluation board mounted with a safety enclosure for the daughter card.
Figure 6 shows a block diagram of the board circuitry.

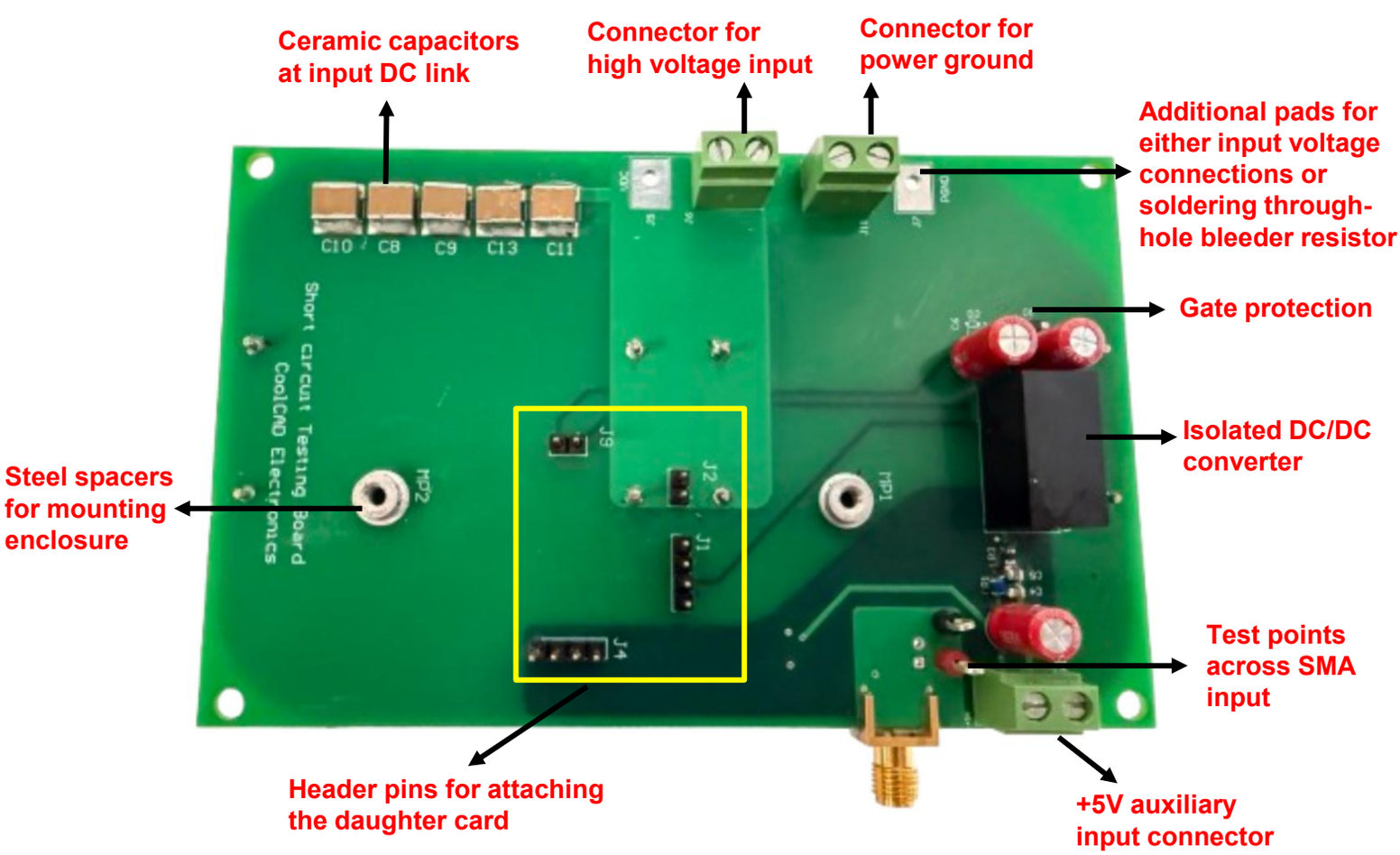


Figure 1 : SCT evaluation board: Top side view with components and test points.

Table 1: SCT board dimensions

	Dimension
Length	127.3mm
Width	80.3mm

Figure 2 : SCT evaluation board: Down-side view with components.

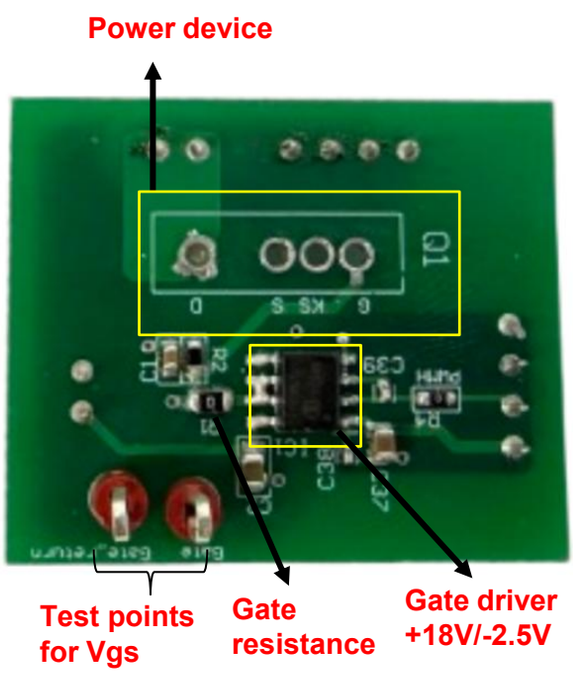


Figure 3 : SCT evaluation board: Daughter card with TO-247-4L footprint and a gate driver.

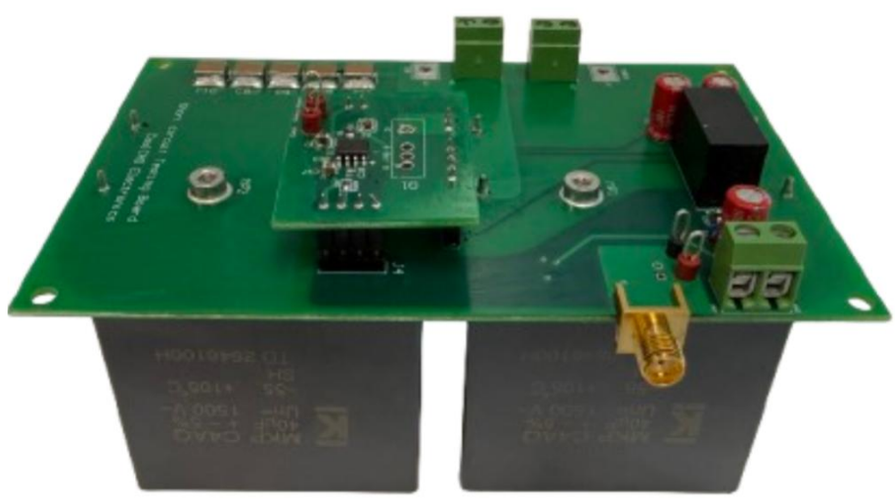


Figure 4 : SCT evaluation board: Up-side view of the board with daughter car mounted.

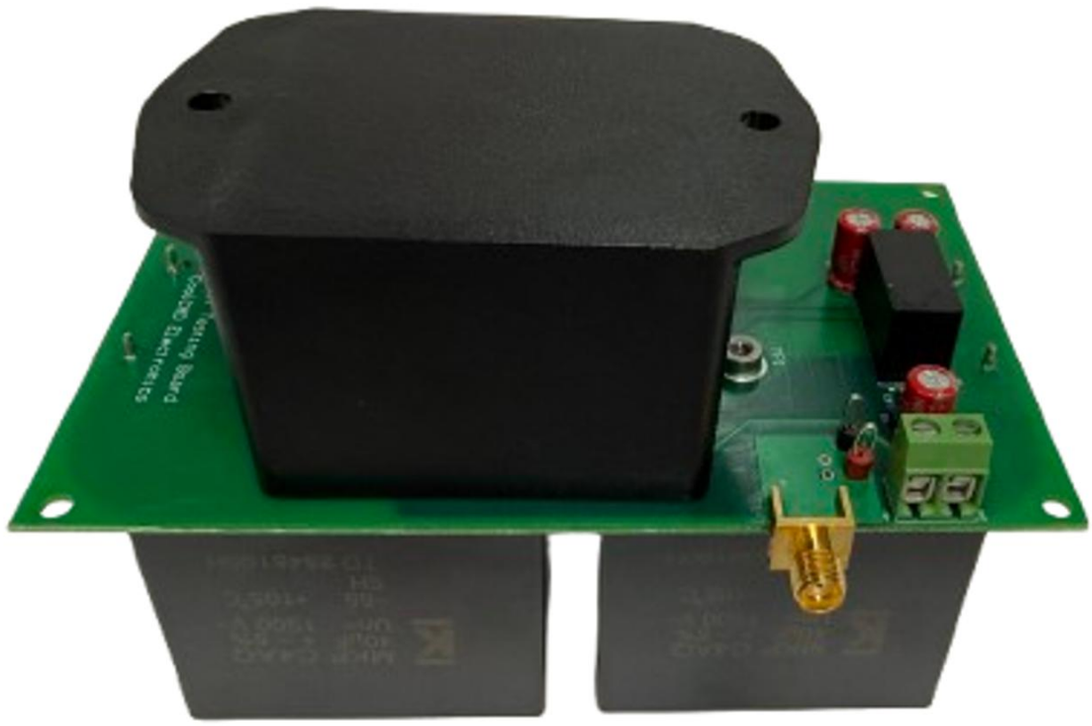


Figure 5 : SCT evaluation board: Up-side view of the board with safety enclosure.

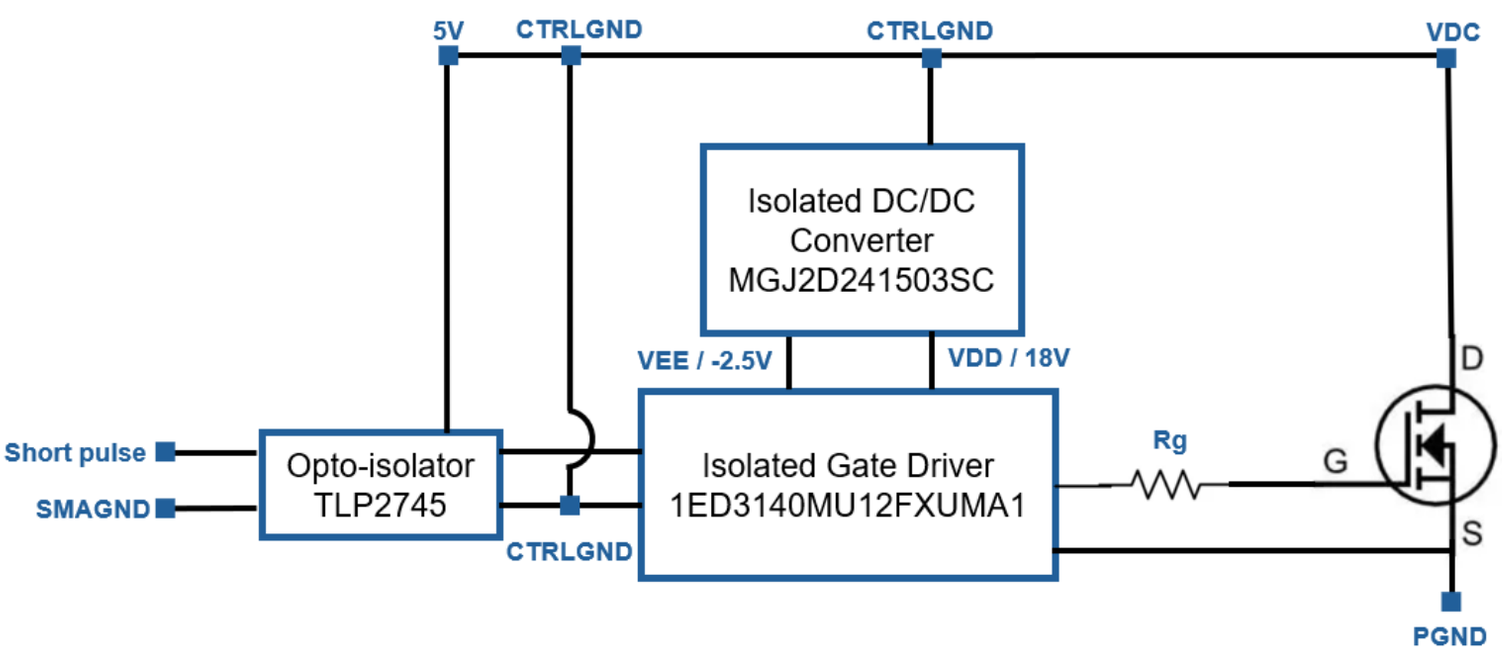


Figure 6: SCT evaluation board block diagram.

Table 2: List of important board components that are labeled in **Figures 1-3** with a detailed description of their functionality.

Component/Subcircuit	Description
Isolated DC/DC Converter	Dual Channel Output Supply for Each Gate Driver Chip (MGJ2D051802SC)
Gate Protection/Regulation	Zener diodes used to stabilize the MOSFET on and off signals and prevent over and under shoot
Gate Driver	Converts a low current input signal to a high current signal that drives the MOSFET gates (1ED3140MU12FXUMA1)
DC Link Capacitors	Stores energy to provide the short circuit with enough energy for the test
Gate Resistors	Swapable resistors for observing effect of gate resistance on switching behavior
SMA Connector	Connectors for providing an input pulse signal for the power device
Terminal Blocks	Screwable terminals for making external connections to +5/GND for auxiliary supply and VDC/PGND for the high voltage bus
TO-247-4L Footprint	Through holes for soldering 4 lead variant of a TO-247 power device
Opto-isolator	Additional protection for the low voltage pulsed input coupled via optical isolation

Table 3: Recommended operating conditions and absolute maximum ratings

Parameter	Symbol	Min	Typ	Max	Unit	Note
High Voltage DC Input	VDC	-	-	**1500**	V	VDC-PGND
Short circuit Current	I_{DUT}	-	-	**1200**	A	-
Auxiliary Supply	+5V	-	**5**	**6**	V	+5V-CTRLGND
Pulsed input	Short pulse	**-0.3**	**5**	**6.5**	V	Pulse-SMAGND
Gate Driver Positive Supply Voltage	VDDH, VDDL		**18**		V	
Gate Driver Negative Supply Voltage	VEEH, VEEL	-	**-2.5**	-	V	-
Ambient Temperature	T_A	**-40**	**27**	**105**	°C	-

Quick Start Instruction:

1. Apply +5V to the auxiliary supply connector with respect to CTRLGND.
2. Install a through-hole bleeder resistor across VDC and PGRND. The resistor may be soldered to terminal pads or secured using the terminal blocks.
3. Solder a compatible **TO-247-4L** power device onto the daughter card. Mount the daughter card onto the main board.
   - *Note: Daughter cards for alternative packages are available upon request.*
4. Connect the high-voltage supply across VDC and PGND using the two screw terminals provided on the board.
5. Connect a signal generator to the SMA connector to provide a short pulse input, referenced to SMAGND.
6. Charge the DC link capacitor bank to the desired test voltage using the power supply. Measure the DC link voltage using a high-voltage differential probe connected across the drain-source (VDS) terminals via the designated header pins on the main board.
7. Use a high-current Rogowski coil to measure short-circuit current at the header pins between the main board and daughter card.
8. Ensure all measurement probes are securely connected. Install the safety enclosure using the provided steel spacers and screws, adjusting the height as required.
9. Once the DC link is charged to the predefined voltage, trigger the pulse using the signal generator. Begin with the minimum pulse width suitable for the device under short-circuit conditions.
   - *Note: For SiC devices, a starting pulse width of approximately 0.5µs is recommended.*
10. The input capacitor is designed to maintain sufficient charge and prevent voltage droop during high-current turn-on events.
11. During turn-off, a peak overshoot in VDS may occur due to parasitic inductance. Adjust the gate resistance accordingly to control this overshoot. The default gate resistance is 0Ω.
12. Gradually increase the pulse width in small increments until permanent device failure occurs. Measure the short-circuit energy using an oscilloscope, as this is a critical parameter for device characterization.
13. Once the test is completed, ensure that the DC link voltage has fully discharged from the capacitors by using an appropriate bleeder resistor installed during the initial setup of the test.

Once the device fails, the same daughter card can be reused for testing another power device. The failed device must be replaced with a new one, along with the gate driver on the daughter card, as it may also be damaged.

Test setup:

Figure 7 shows the test setup used to determine short circuit withstand time of a SiC device at 800V DC link voltage.

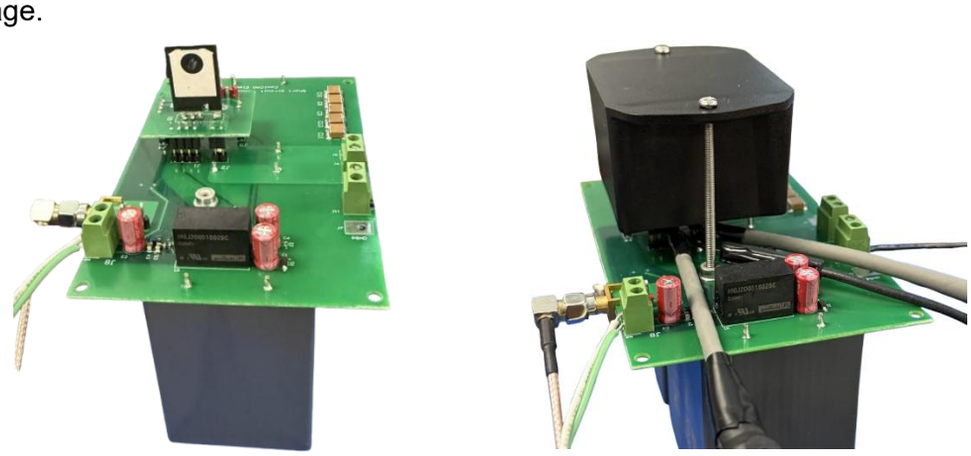


Figure 7 : SCT evaluation board: Test setup without enclosure (left) and with enclosure (right).

Example waveforms:

Figure 8 shows an oscilloscope screenshot from a short-circuit test performed on one of our 1.7kV devices using this evaluation board, with a 5µs input pulse during which the device failed permanently; the yellow waveform shows the drain-source voltage across the device, blue waveform shows the current through the device when turned on, pink waveform shows the pulsed input voltage applied using a signal generator, and green waveform shows the gate-source voltage across the device, with the test conducted at 800V across the DUT and approximately 500A peak current using an 80mF external DC link capacitor and 0Ω gate resistance. The short circuit energy captured at this instant is 1.6J.

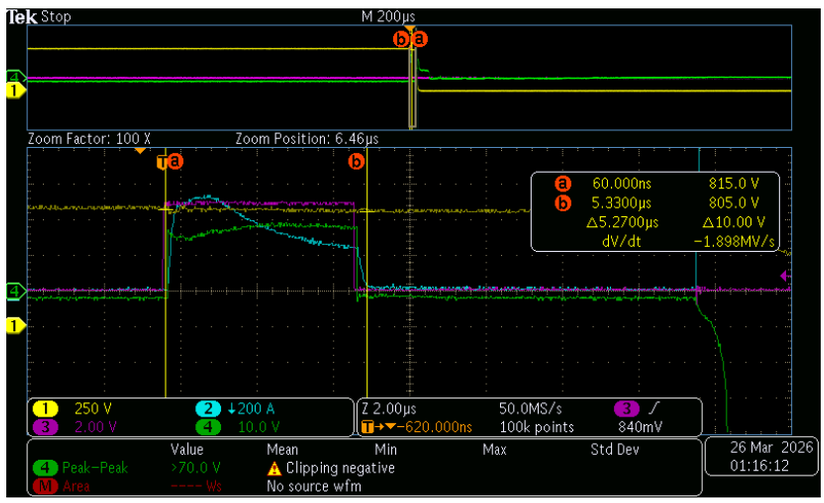


Figure 8: Oscilloscope waveform obtained during an 800V SCT on a 50A rated device CC-17-40-744L using this evaluation board.

Figure 9 shows similar testing on a 3.3kV device, where the device failed permanently at 17µs; voltage drooping is observed at an instant after which the device fails a few microseconds later, and this drop in voltage indicates a significant change in resistance of the device due to temperature, while the orange waveform shows the energy captured at that moment, which is 3.56J.

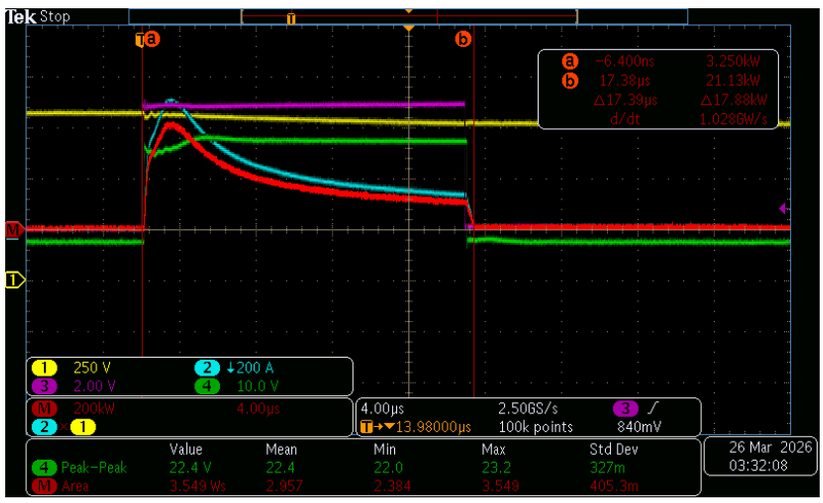


Figure 9: Oscilloscope waveform obtained during an 800V SCT on a 33A rated device CC-3380-354L-Ag using this evaluation board

Warnings

1. The SCT evaluation board should only be used by experts, knowing and understanding of its configuration.

2. The choices of external components including bleeder resistor and timing specifications require understanding of the circuit operation.

3. The user is responsible for the electrical safety and the proper handling and use of the evaluation board. It is your responsibility to use this board correctly and safely.

4. When using this board at high voltage, use it in an environment where sufficient safety measures have been taken.

5. CoolCAD Electronics is not responsible for accidents or injuries caused when using this board.

6. CoolCAD Electronics is not responsible for any consequences arising from the use of this board.

7. The evaluation board is provided as is without any warranties, except for in the case of shipping damage or existing manufacturing issue. The customer should alert CoolCAD Electronics within 30 days of purchase of this board for warranty.

8. If this board is modified or damaged by the customer, it cannot be replaced.

9. This datasheet is provided for reference only.

10. The data collected using this evaluation board may not be considered as a guarantee of components characteristics. Components must be tested thoroughly depending on intended application as adjustments may be necessary.

11.This board cannot be commercialized or sold by incorporating it into another product or equipment.

12.CoolCAD Electronics reserves the right to make any or all changes to the board's documentation, reference manuals, designs and specifications at any time without notice.

13.Diagrams and photos may differ from the actual board you have.

14.Please contact the distributor you purchased from for any inquiries.

CAUTION: These devices and circuits are ESD sensitive. Use proper handling procedures.

Disclaimer: These specifications may not be considered as a guarantee of components characteristics. Components have to be tested depending on intended application as adjustments may be necessary. The use of CoolCAD Electronics components in life support appliances and systems are subject to written approval of CoolCAD Electronics.

contact@coolcadelectronics.com Maryland https://coolcadelectronics.com