pcim ASIA Hybrid Platform

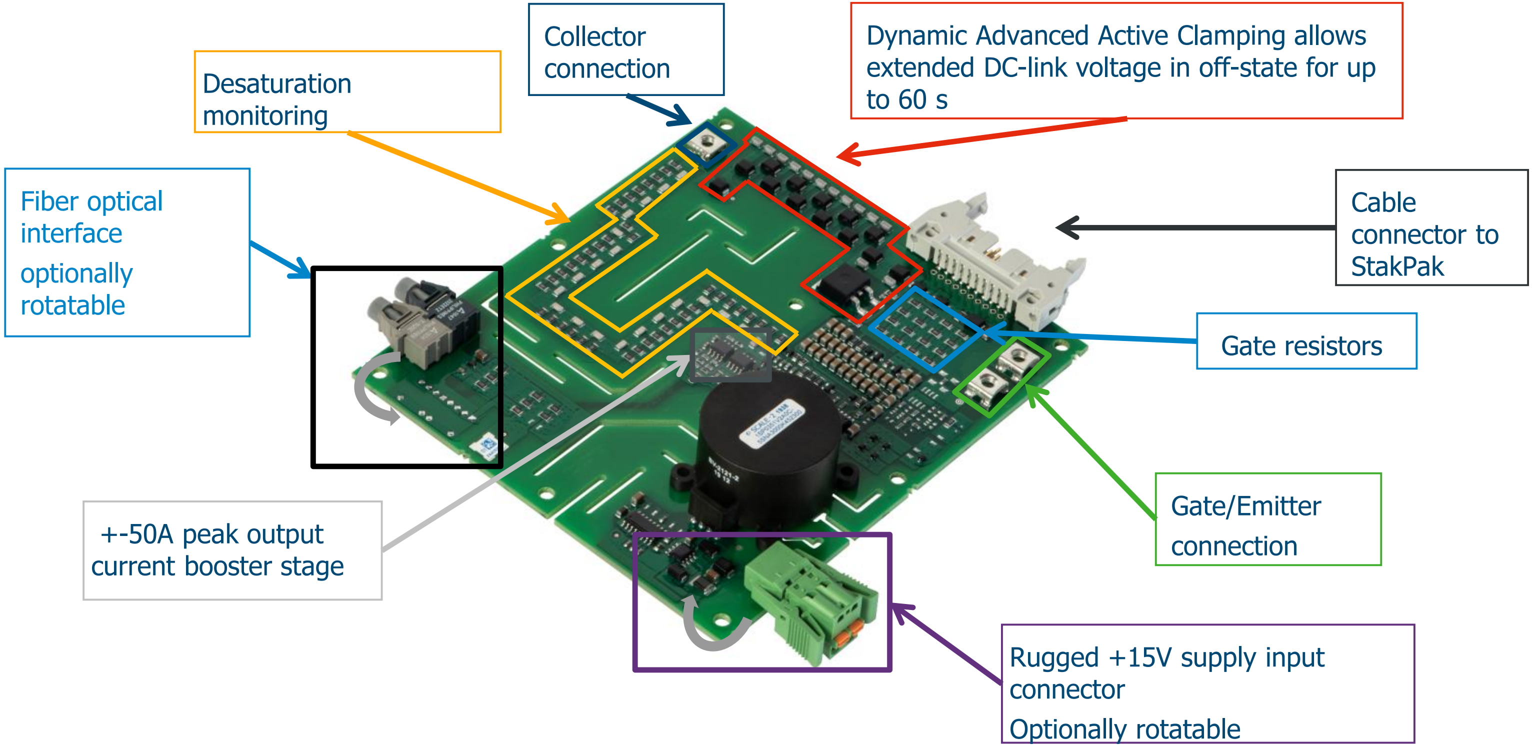
Digitally Controlled IGBT Gate Driver for HVDC Applications with Advance Protection Features in a Short -Circuit Type II Scenario

Richa Singh, Power Integrations GmbH

About the Speaker

Richa Singh is an Application Engineer in Industrial Gate Driver group of Power Integrations, where I am working on Gate drivers for HVDC applications. She received her Bachelors degree from Galgotias College of Engineering and Technology, India and Masters degree from Ernst Abbe Hochschule, Jena, Germany. During her Masters internship and thesis, she worked in Robert Bosch GmbH for an year on topics related to characterization of passive components. Later she worked for 2 years in Würth Elektronik GmbH as a Product Manager for passive components.

1SP0351-Functional Blocks

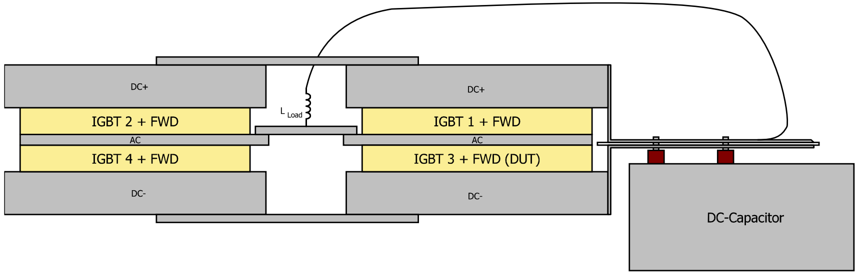


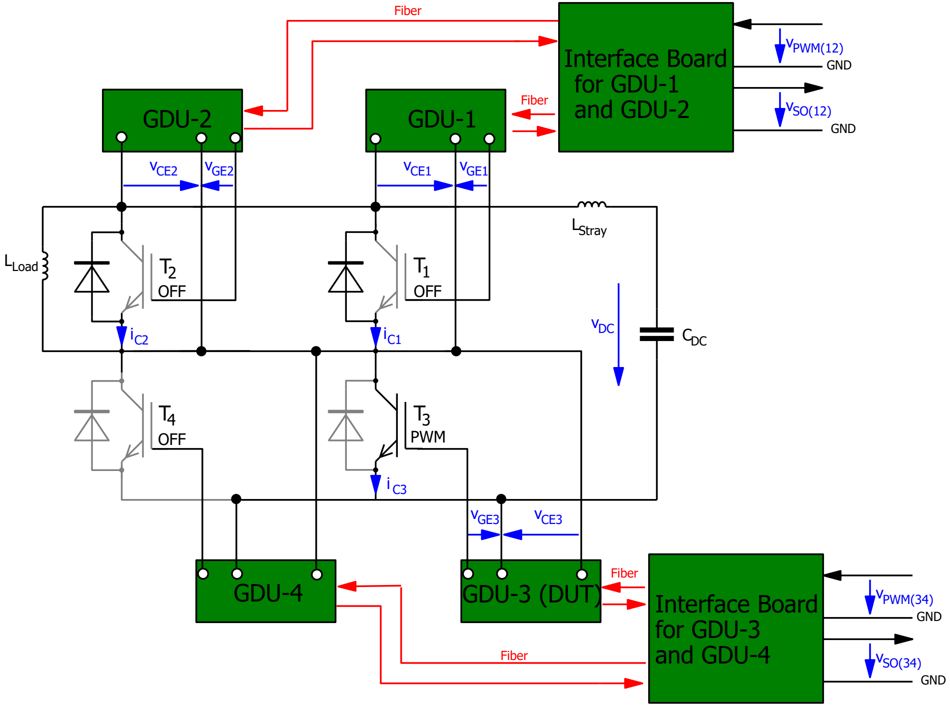
Data for Press Pack IGBT used as DUT

DC collector current (I_C)	2000A
Collector-emitter voltage (V_{CES})	4500V
Gate-emitter voltage (V_{GES})	±20V
Mounting force (F_M)	70kN

Normal IGBT Switching Characteristics

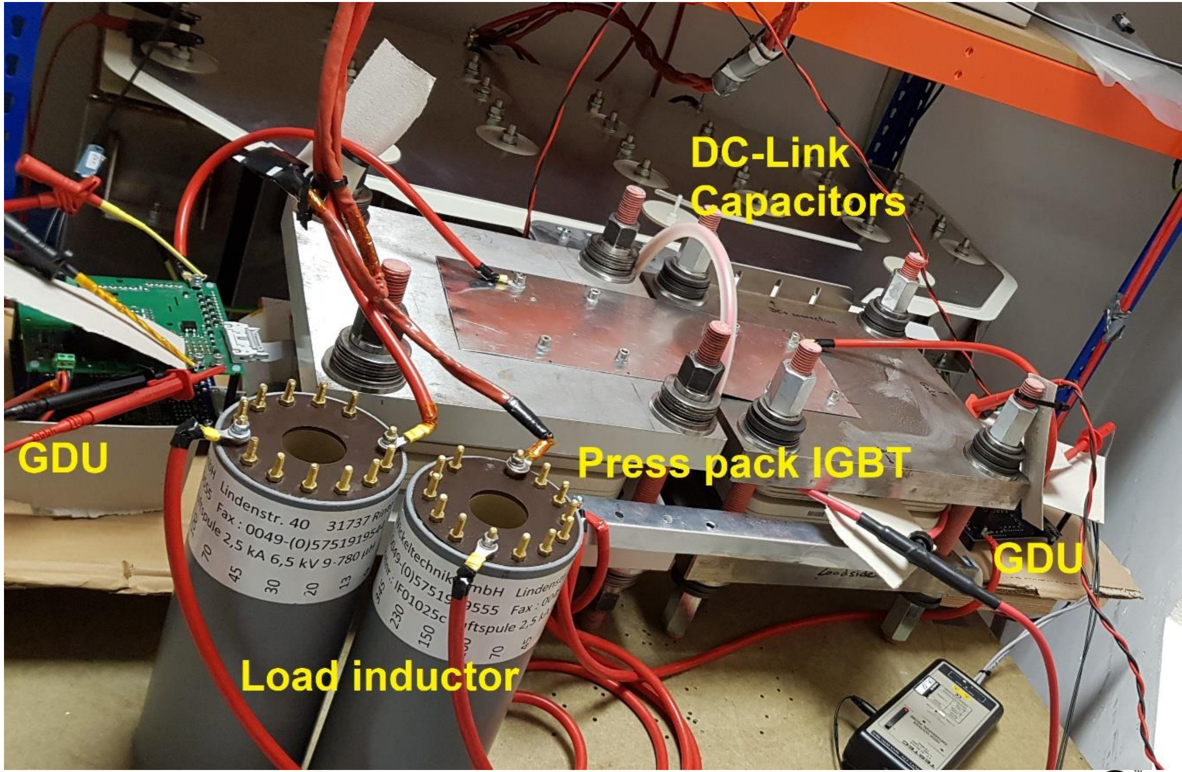
Normal Switching–Equivalent Circuit





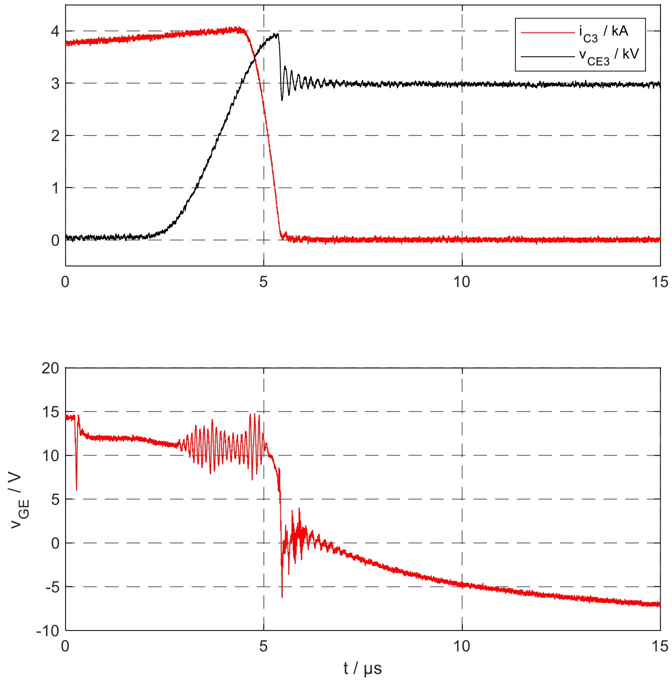
Normal Switching–Test Setup

- **DUT: 5SNA 2000K452300**
- **GDU: 1SP0351**
- **The parallel connection is necessary in order to realize the SC condition without saturating the other IGBT**



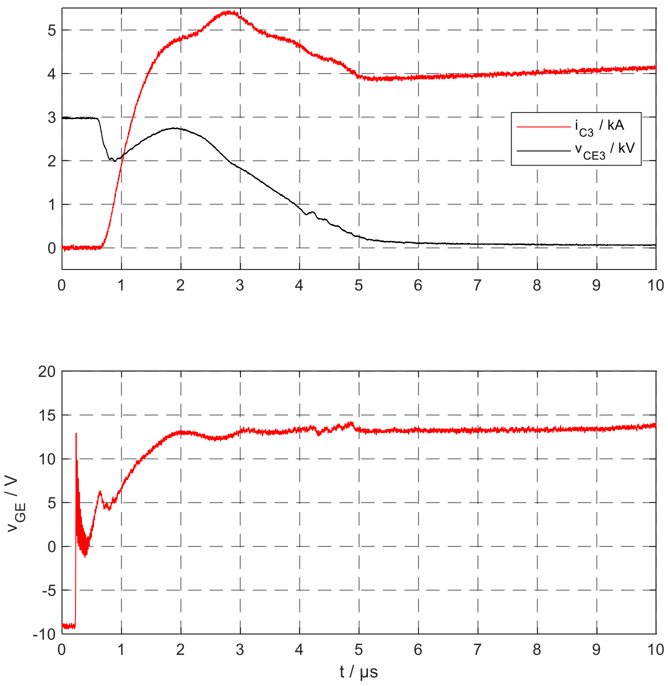
Normal Switching–Turn-OFF

- Single-Pulse-Test was performed on ABB's 5SNA 2000K452300
- V_{DC} = 3000V
- i_C = 4000A



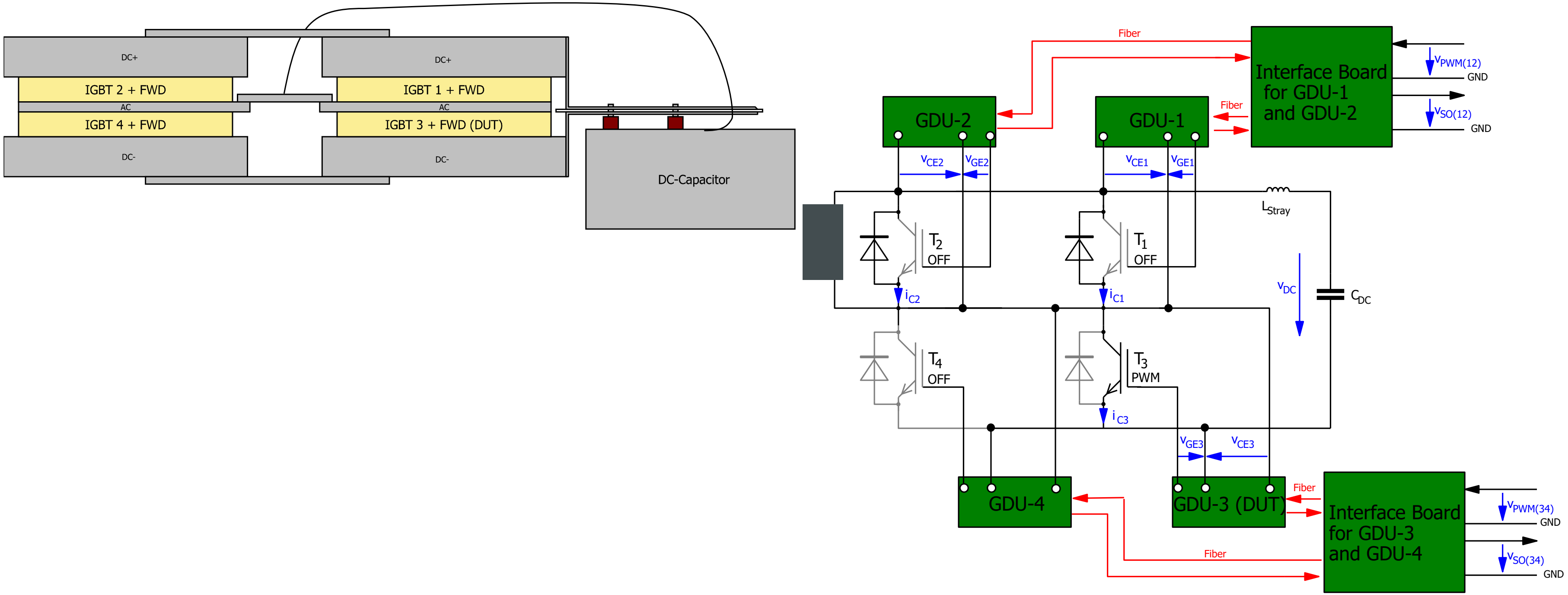
Normal Switching–Turn-ON

- Double-Pulse-Test was performed on ABB's 5SNA 2000K452300
- V_{DC} = 3000V
- i_C = 4000A



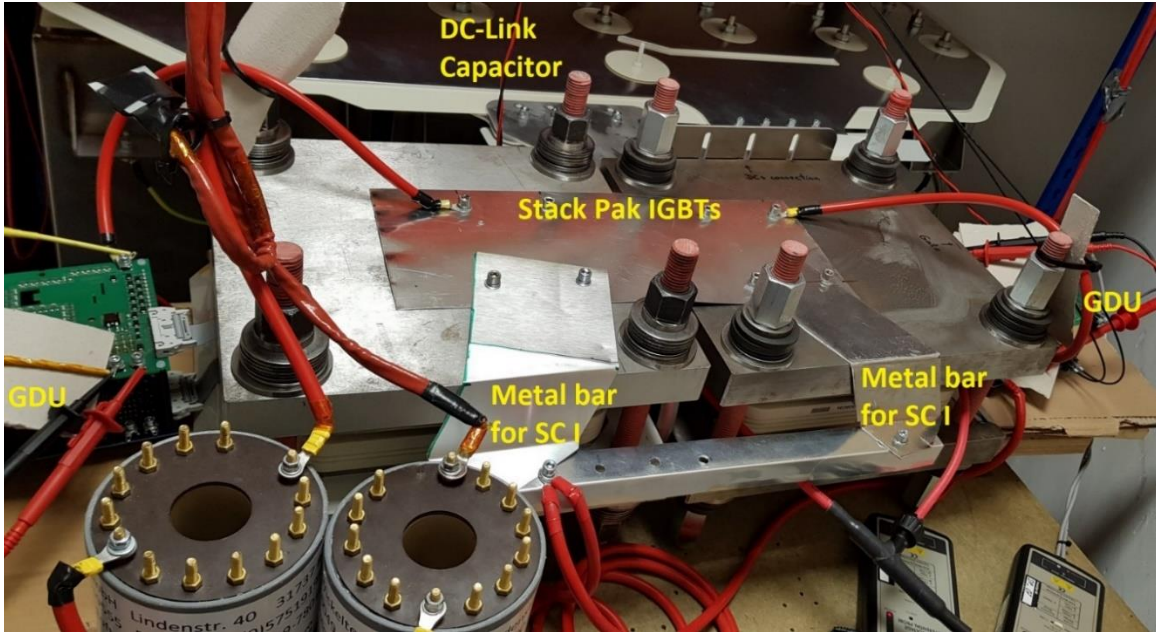
Short Circuit Type I

Short Circuit Type I–Equivalent Circuit



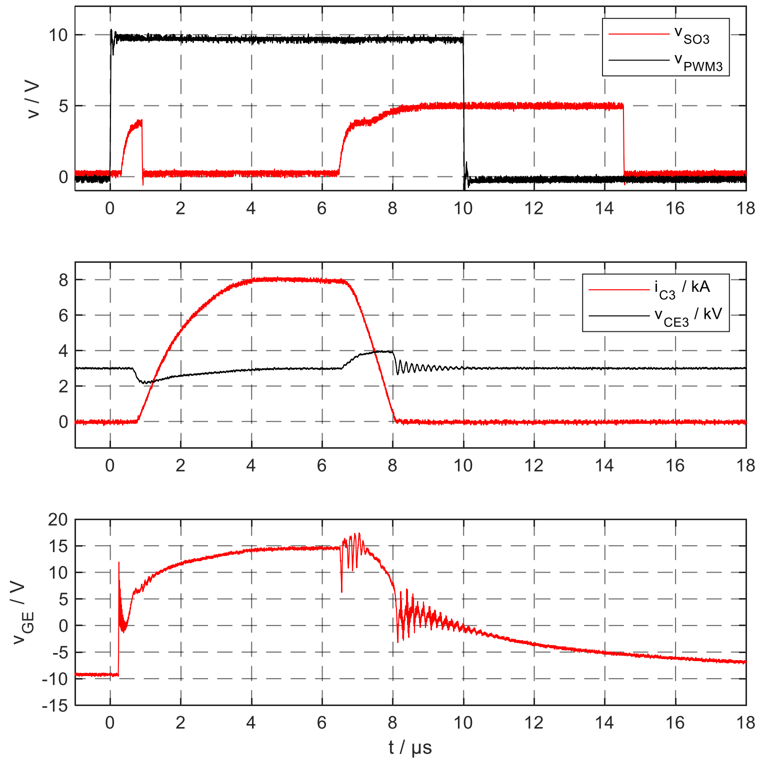
Short Circuit Type I–Test Setup

- **DUT: 5SNA 2000K452300**
- **GDU: 1SP0351**
- **Load inductor is replaced by metal bar**



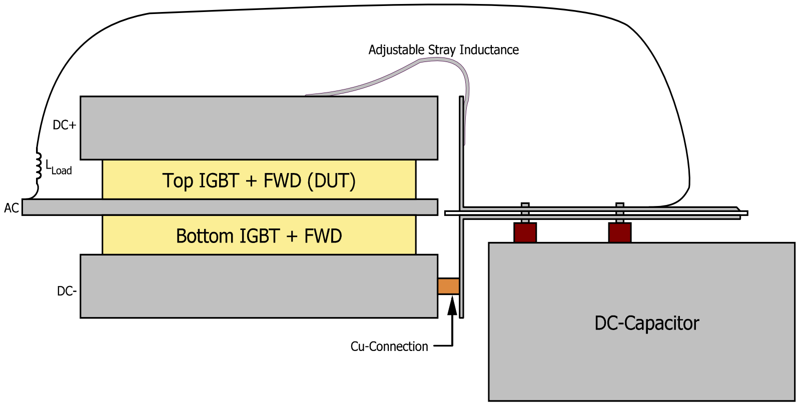
Short Circuit Type I–Result

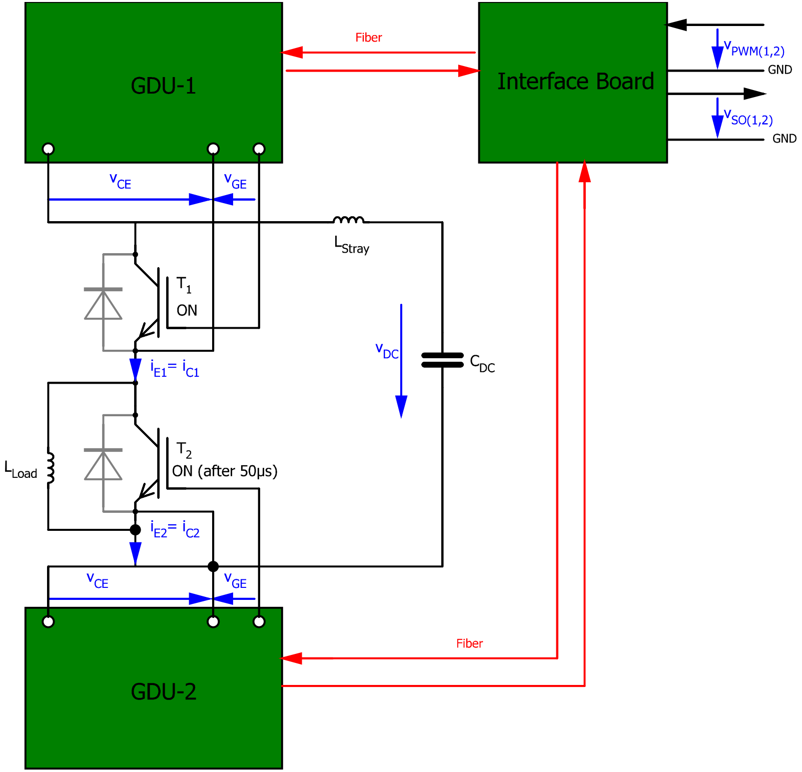
- V_{DC} = 3000V
- i_{SC} = 8kA



Bridge Shoot Through

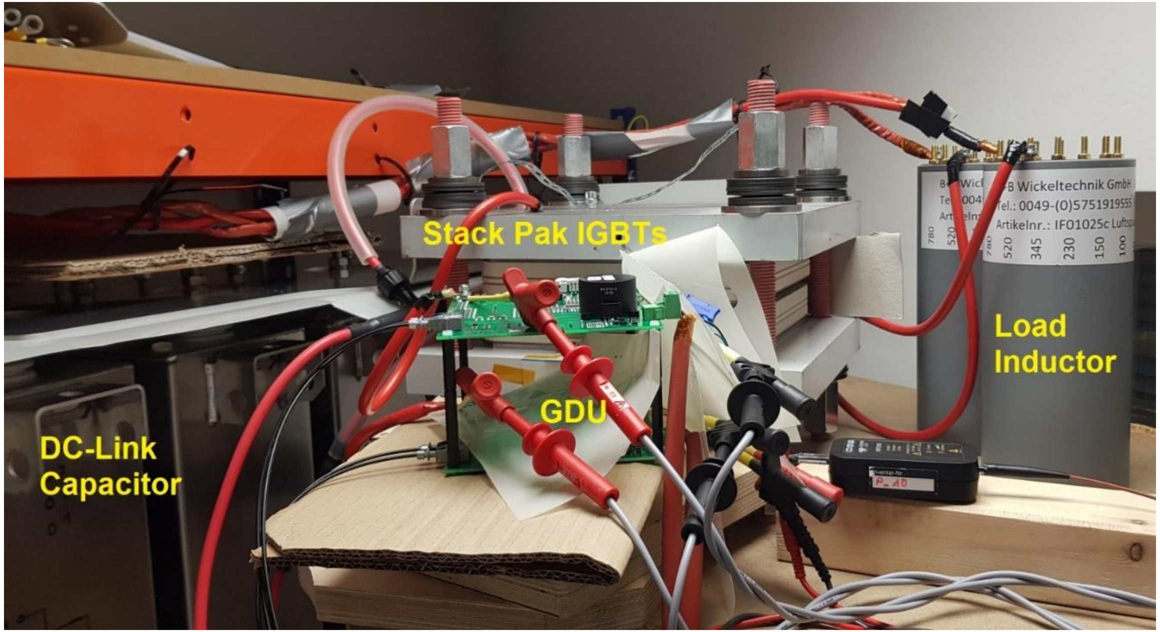
Bridge Shoot Through–Equivalent Circuit





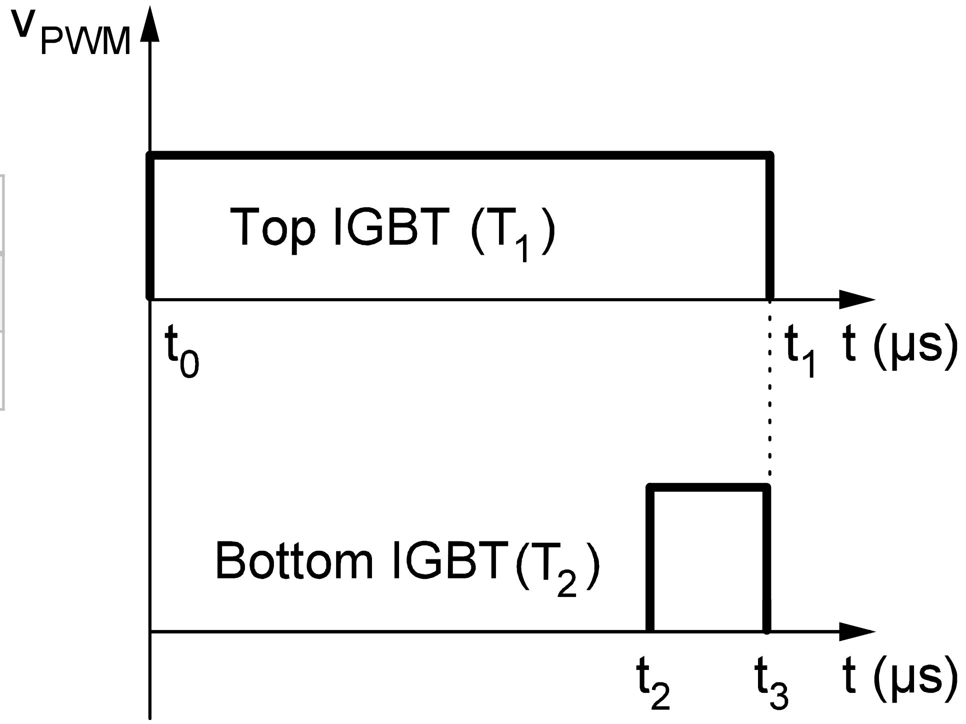
Bridge Shoot Through–Test Setup

- **DUT: 5SNA 2000K452300**
- **GDU: 1SP0351**



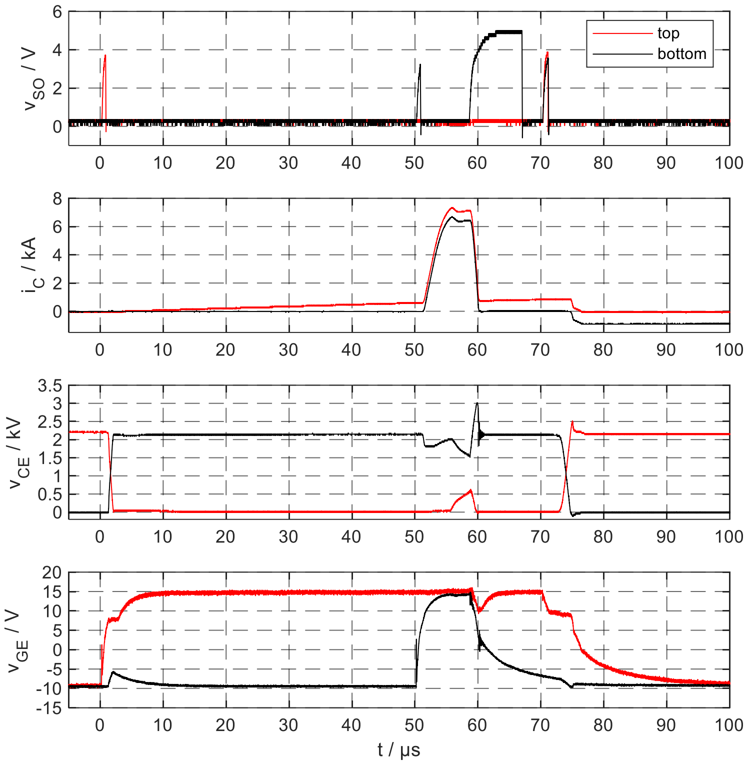
Bridge Shoot Through–Control Signal

$T_{Pulse,top}$ $(t_1\text{-}t_0)$	70µs
$T_{Pulse,bot}$ $(t_3\text{-}t_2)$	20µs
$T_{Delay,bot}$ $(t_2\text{-}t_0)$	50µs



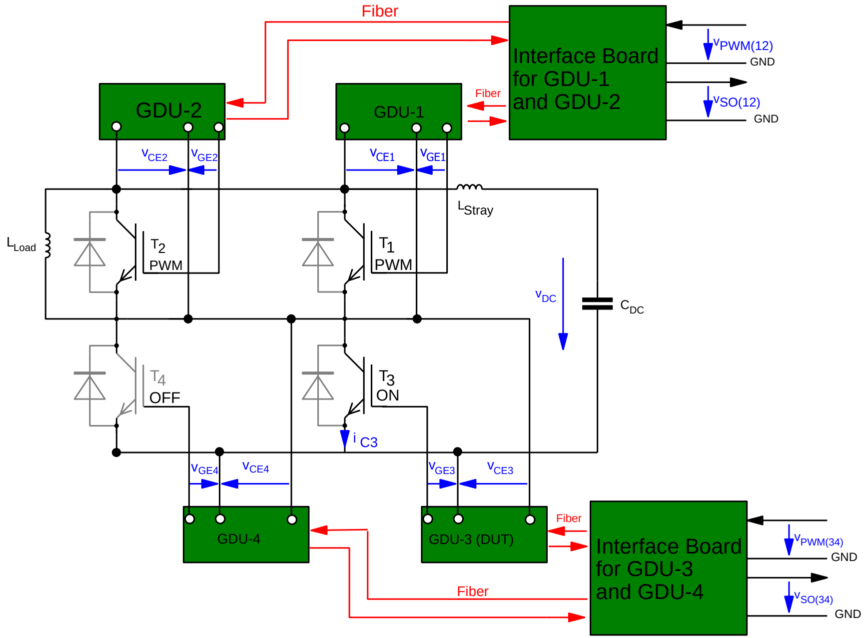
Bridge Shoot Through–Result

- V_{DC} = 2200V
- $i_{SC,top}$ = 7.3kA
- $i_{SC,bot}$ = 6.7kA



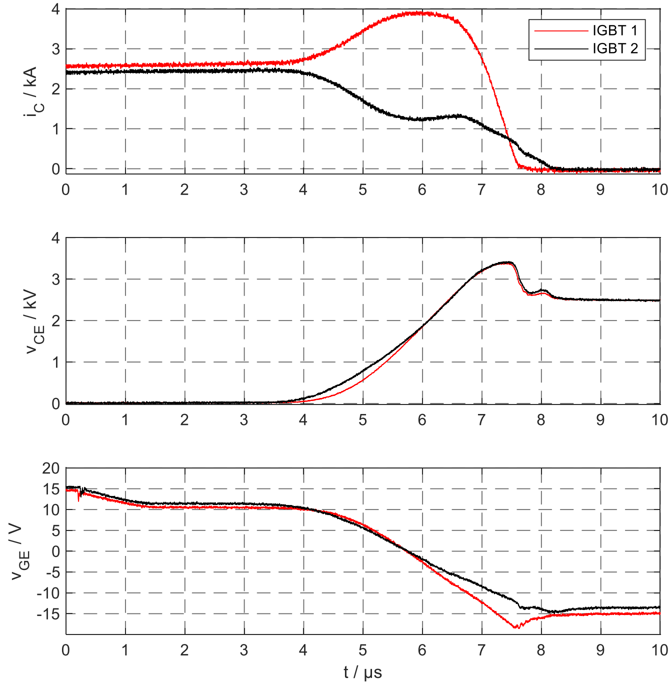
Short Circuit Type II

Short Circuit Type II–Equivalent Circuit

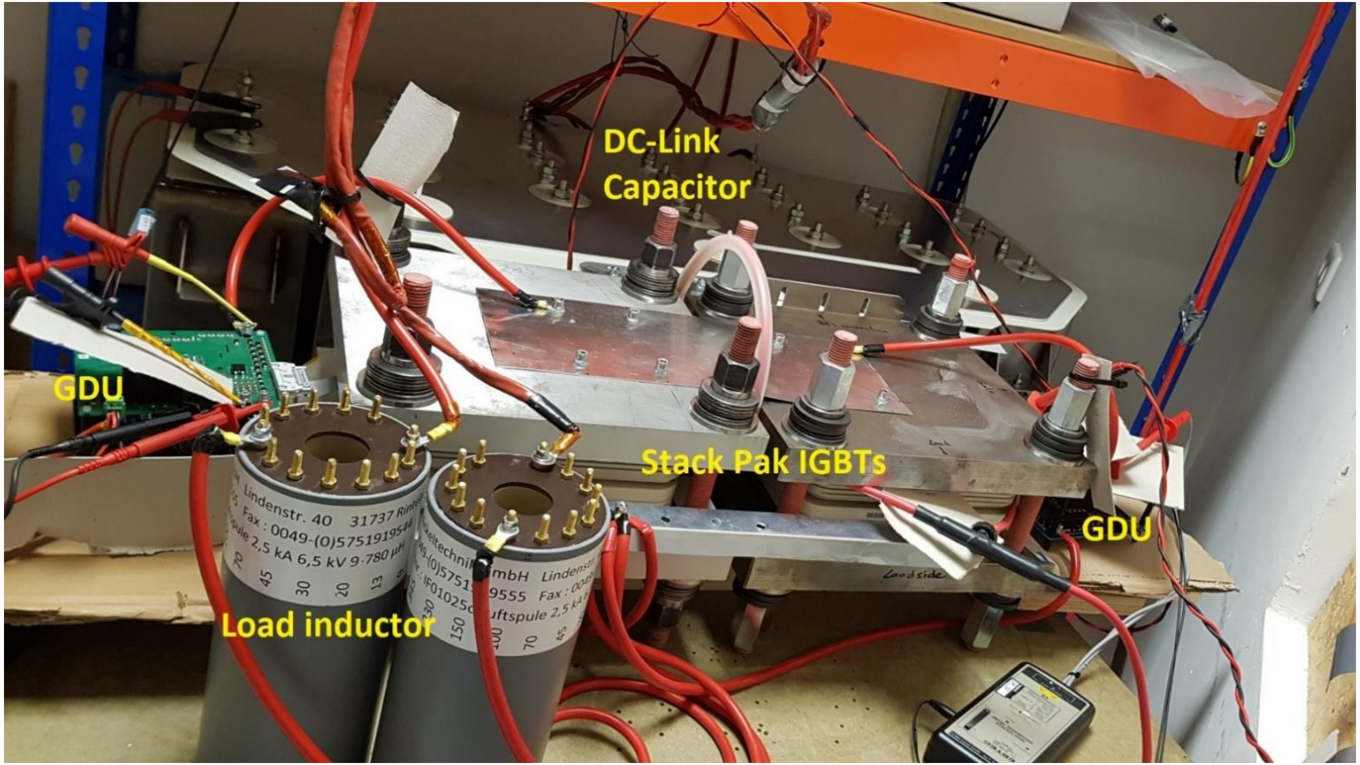


Current Sharing during Turn-Off for T_1 and T_2

- Due to the distance differences between T_1 and T_2 to the DC link capacitor, IGBT T_1 (red) takes dynamically more current than IGBT T_2 (black), but is still sufficient for testing IGBT T_3 in SC II scenario. The static current sharing (t < 4 µs) is optimal.

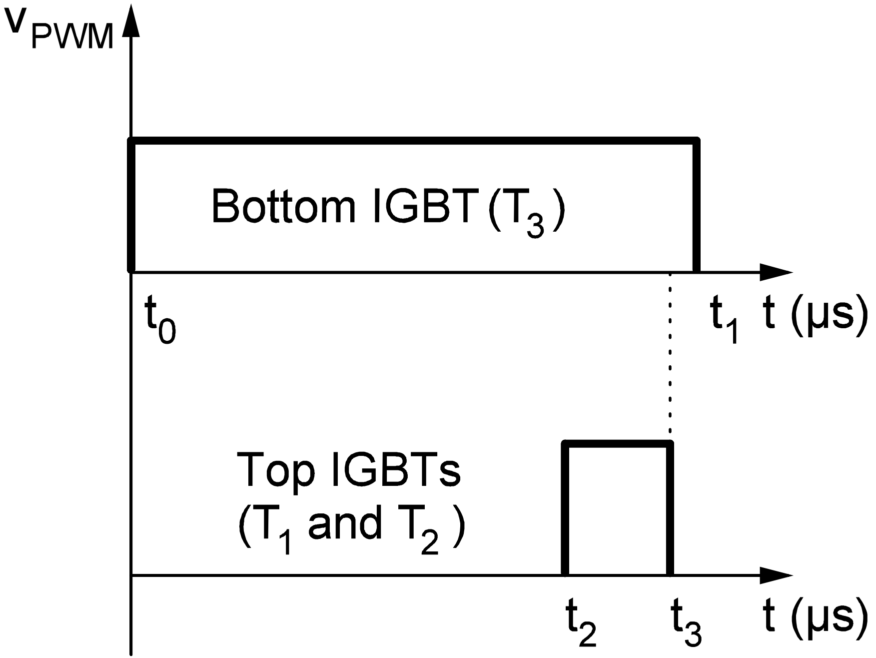


Short Circuit Type II–Test Setup



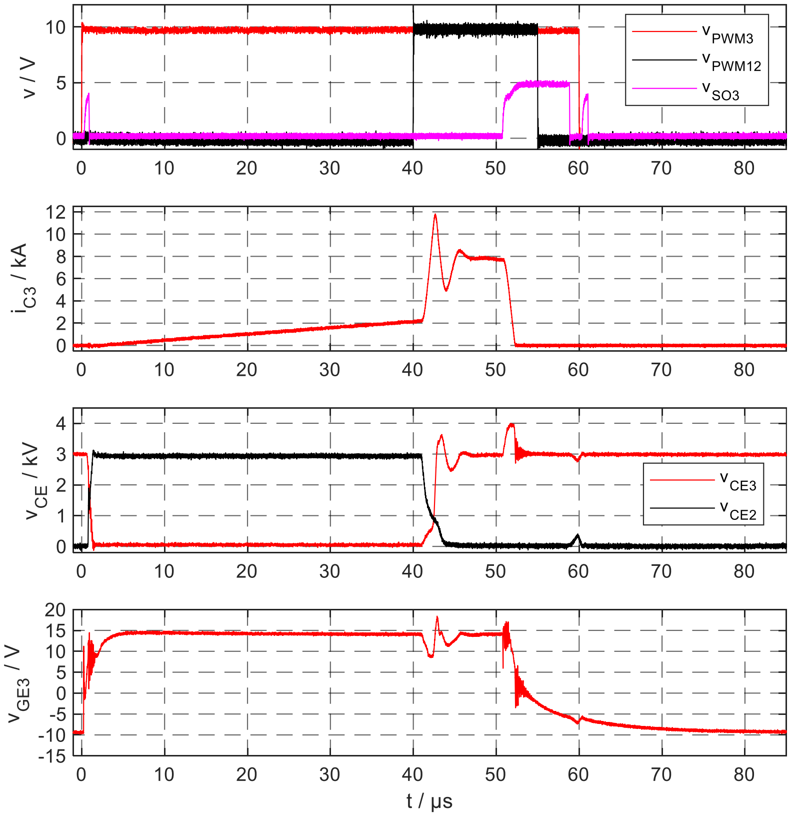
Short Circuit Type II–Control Signals

$T_{Pulse,bot}$ $(t_1 - t_0)$	60µs
$T_{Pulse,top}$ $(t_3 - t_2)$	15µs
$T_{Delay,bot}$ $(t_2 - t_0)$	40µs



Short Circuit Type II–Result

- V_{DC} = 3000V
- i_{SC3} = 11.8kA



Conclusion

- Gate Driver function is to protect costly power semiconductor
- Power Integrations 1SP0351 gate driver can protect the IGBT in 3 different short circuit scenario – SC I, Bridge-Shoot-Through, SC II
- A fault signal is generated by the gate-driver which turns off the IGBT within the SCSOA

For Further Question

Please drop an E-mail:

Richa.Singh@power.com

power.com

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