Smart Battery Switch (SBS) First Steps

Hardware Version 3

ATV SYS SE
Rev 2
25.08.2015

SBS First Steps
Product Safety Warnings

- The Smart Battery Switch (SBS) is only intended to be used as an engineering demonstrator. It is not intended for extensive use or to be re-used in a product or system that is sold to consumers.
- Battery Clamp is compliant to IEC 60095-2_Ed.4 (2009)
- The SBS is intended to be used by electrical engineers who are experts in the field of high current design. If you are not qualified, seek the help of an expert before using the demonstrator.
- Questions about the SBS should be directed to Infineon Application Engineering.
- The cable, cable lug, washer and nut used to connect to the bolt mounted onto the SBS demonstrator's circuit board must all be made of high current-capable metals which will not experience a significant temperature rise while conducting the current.
- The cable lug must be mounted directly to the bolt. (torque 6Nm +-1Nm)
- Keep the current below 1800A. The time a current may be applied is limited by the temperature rise.
- Don't exceed 1 Joule of switching energy.
- Switching to high currents or to high switch off energy may destroy the switch and the test setup and end up in fire.

SBS First Steps
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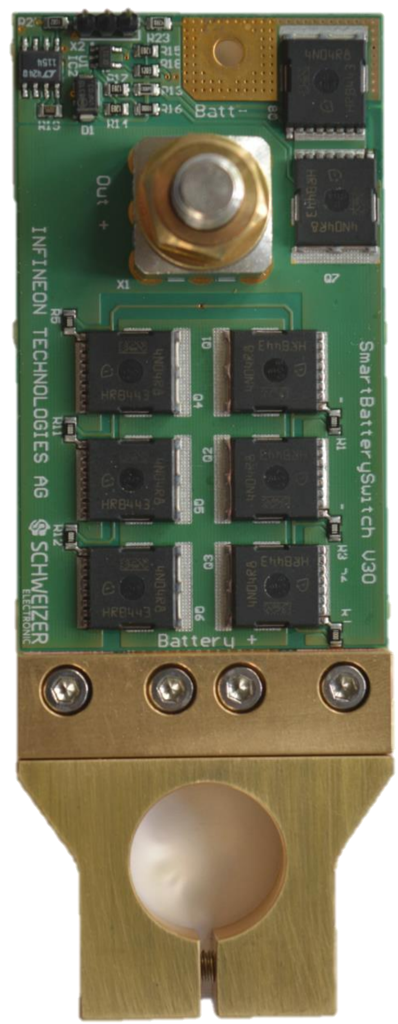

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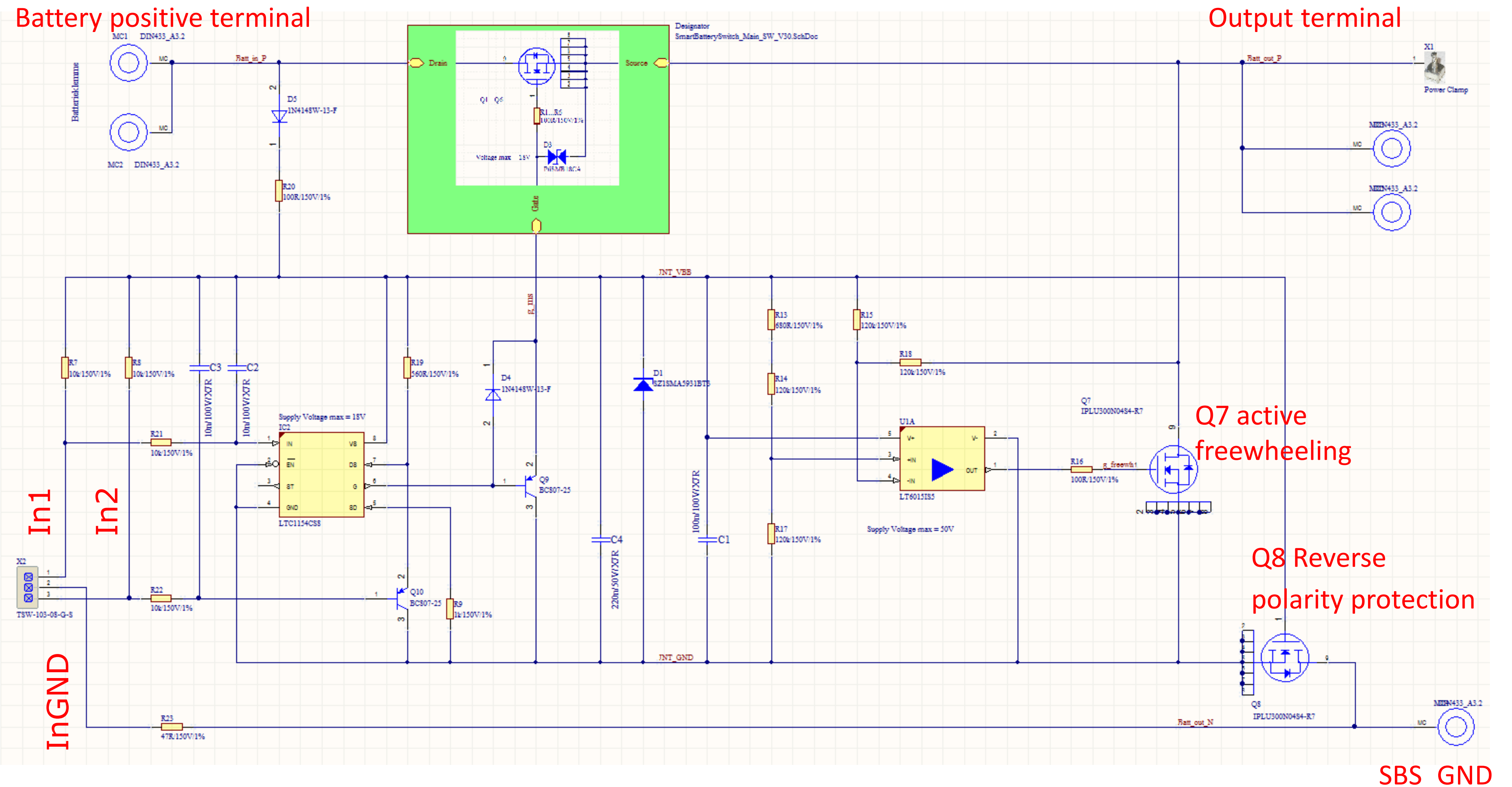
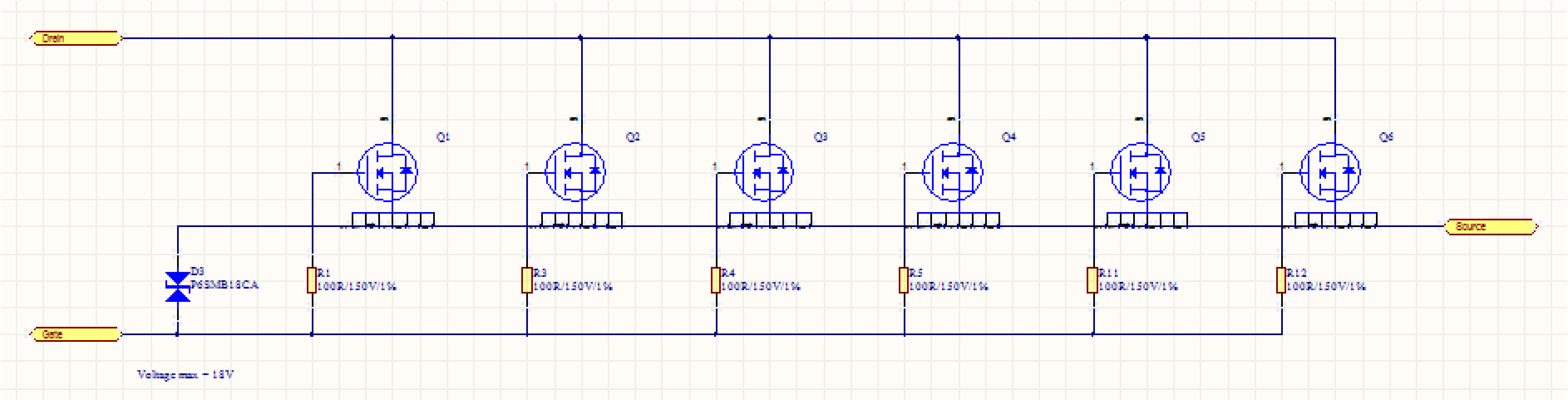
SBS First Steps Schematic



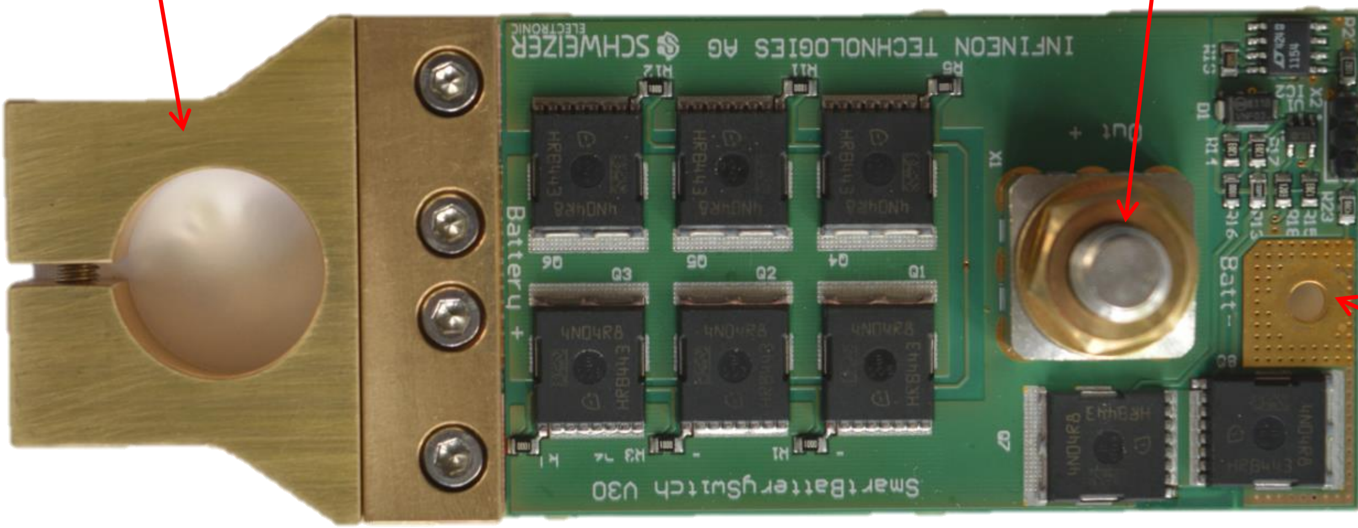
SBS First Steps
Schematic

Q1…Q6 parallel connection



D3 Gate protection (18V)

SBS First Steps
How to connect the SBS



In1	In2	Switch
NC	NC	on
L	NC	off
NC	L	off (latched)
	NC	reset latched

NC = not connected

L = connected to InGND

= pull down In2 to InGND and release again

SBS First Steps
Test 1: Switch on/off and latch

Test setup:

V_Batt = 12V (current limitation 100mA)

RL=1k

Verify the switch <u>on status</u> of the SBS:

In1 and In2 are not connected (NC)

SBS (Q1…Q6) is on

measure V[DS] of Q1…Q6 (check if < 2 mV)

measure V[GS] of Q1…Q6 (check if > 16 V)

measure the Leakage Current I_GND (check if between 400uA and 600µA)

Verify the switch <u>off status</u> of the SBS:

In1 is connected to InGND

SBS (Q1…Q6) is off

measure VGS of Q1…Q6 (check if < 50mV)

check if VDS of Q1…Q6 is around V_Batt

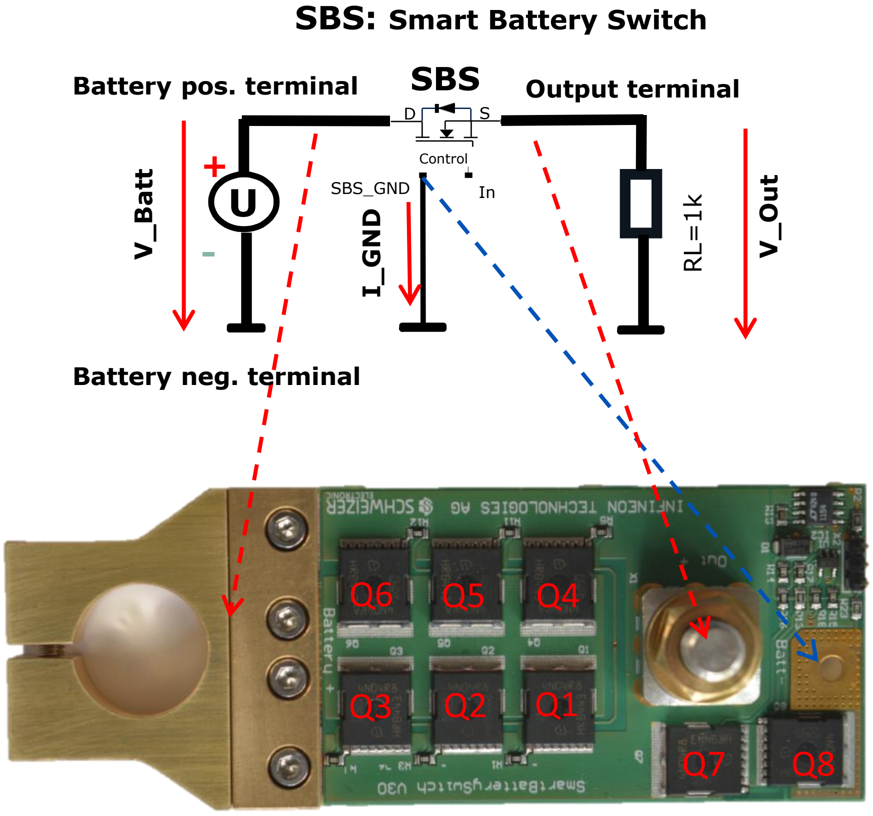
Verify the latch function of the SBS:

Pull down In2 to InGND and release again

check <u>off status</u> of SBS

To reset the latch pull In2 to InGND and release again

check <u>on status</u> of SBS



SBS First Steps
Test 2: Wrong polarity protection

Test setup:

V_Batt = 12V (current limitation 100mA)

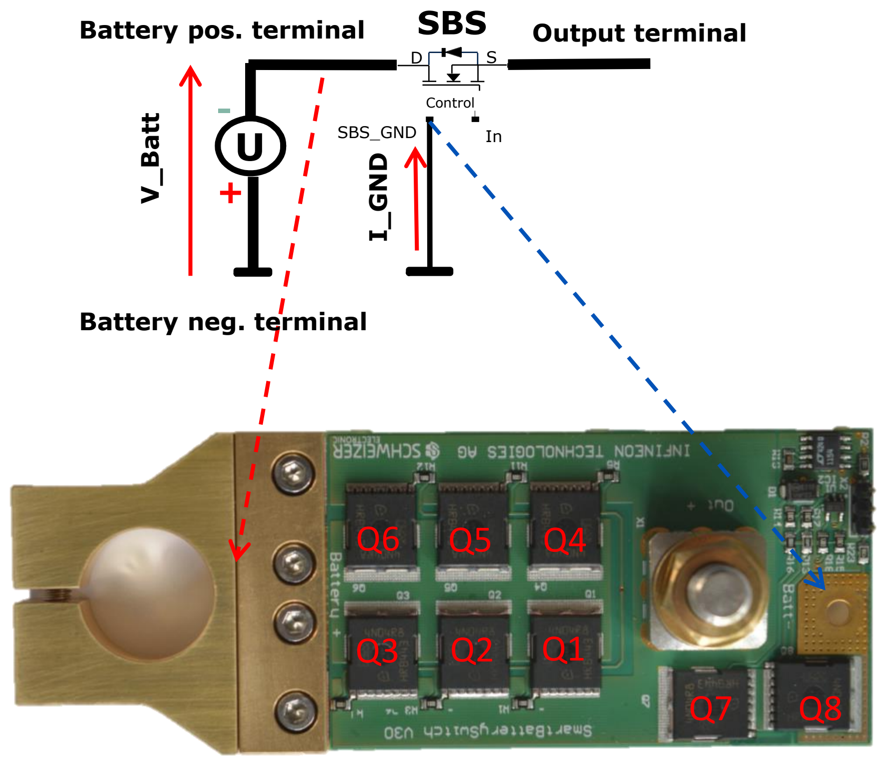
In1 and In2 are not connected

Output terminal is not connected

Verify the wrong polarity capability:

- Q8 is switched off
- measure the GND current (I_GND) (check if < 10uA)

SBS: Smart Battery Switch



SBS First Steps
Test 3: Active freewheeling (static)

Test setup:

V_Batt = 12V (current limitation 100mA)

V_aft = 12V (current limitation 100mA)

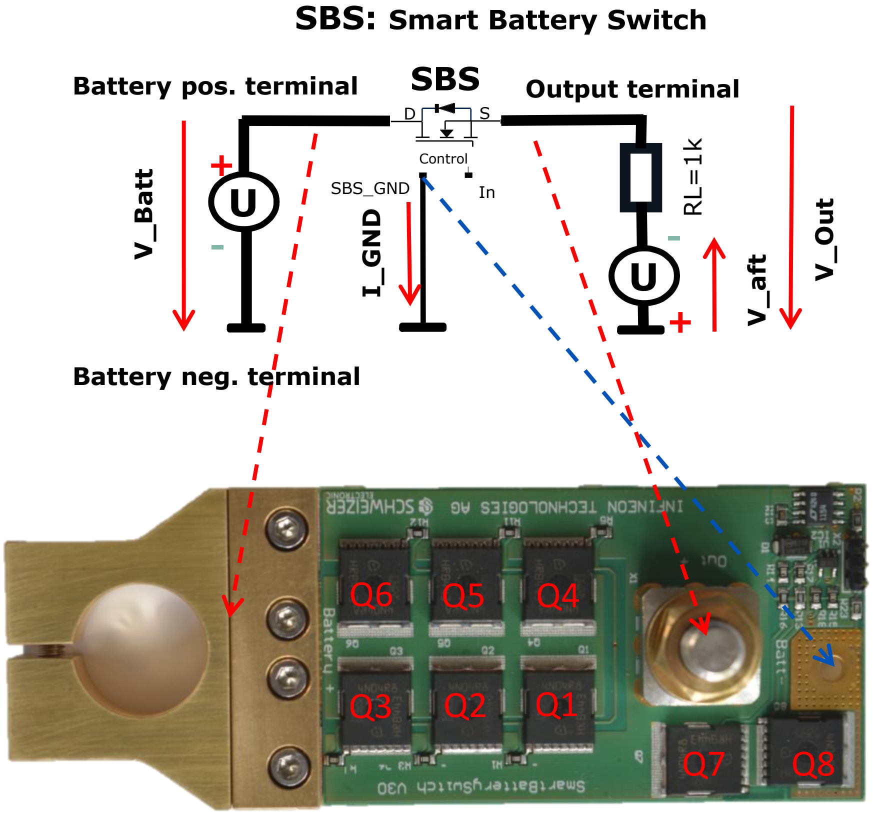
RL=1k

In1 and InGND are linked with a jumper

In2 are not connected

Verify the active freewheeling capability:

- SBS is switched off
- Q7 is switched on
- measure VGS of Q7 (check if between 3,6 V – 3,95 V)
- measure V_Out (check if < 10mV) V_Out is negative to GND!



SBS First Steps
Test 4: Static high current

Test setup:

V_Batt = 12V (current limitation 100mA)

I_out= 250A (voltage limitation 2V)

In1 and In2 are not connected

All the components used in the high-current path should be properly selected.

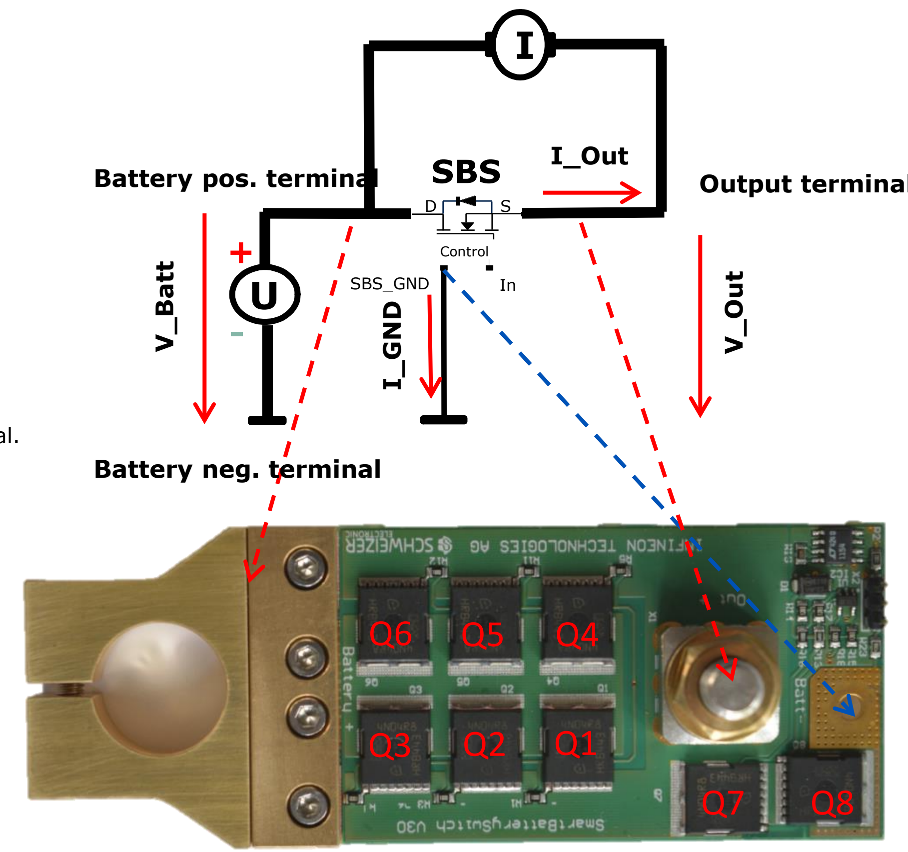
Cables 50qmm / no washers between cable shoe an terminal etc.

Verify the high current capability:

SBS is switched on

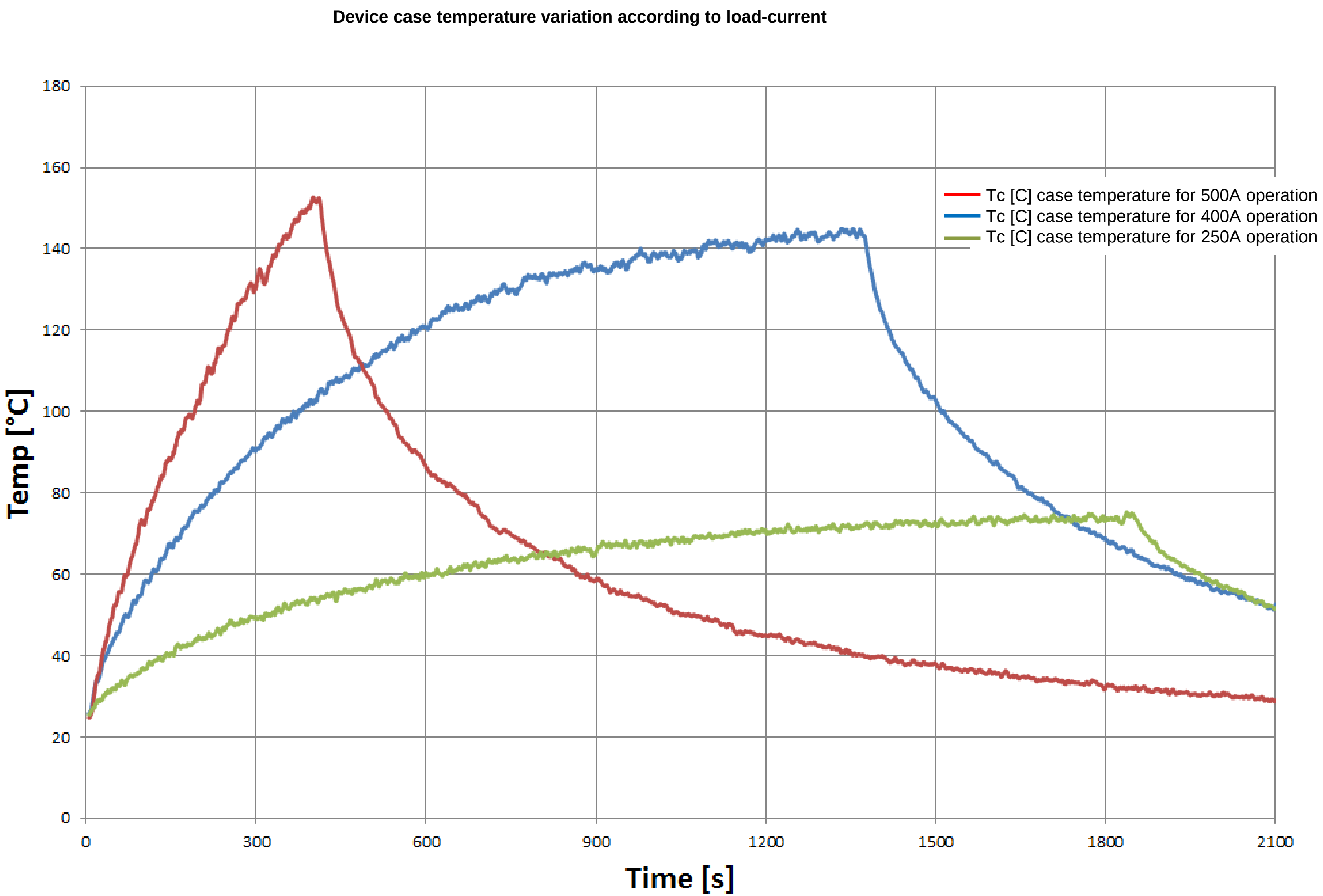
measure the voltage between the battery positive terminal and the output terminal.
(heck if < 30mV)

SBS: Smart Battery Switch



Thermal Image after 10 minutes and 250A of output current

SBS First Steps
Test 4: Static high current



SBS First Steps
Test 5: Switching high current

Test setup:

V_Batt = AGM Battery 105Ah charged to 13V

Load = cable 25qmm; length 4.5m windings 3.5; diameter 30cm; 7uH

SC switch = fast potential free switch to simulate a short circuit (controlled by P2)

T1 is with an opt coupler and connected to In2 of the SBS (controlled by P1)

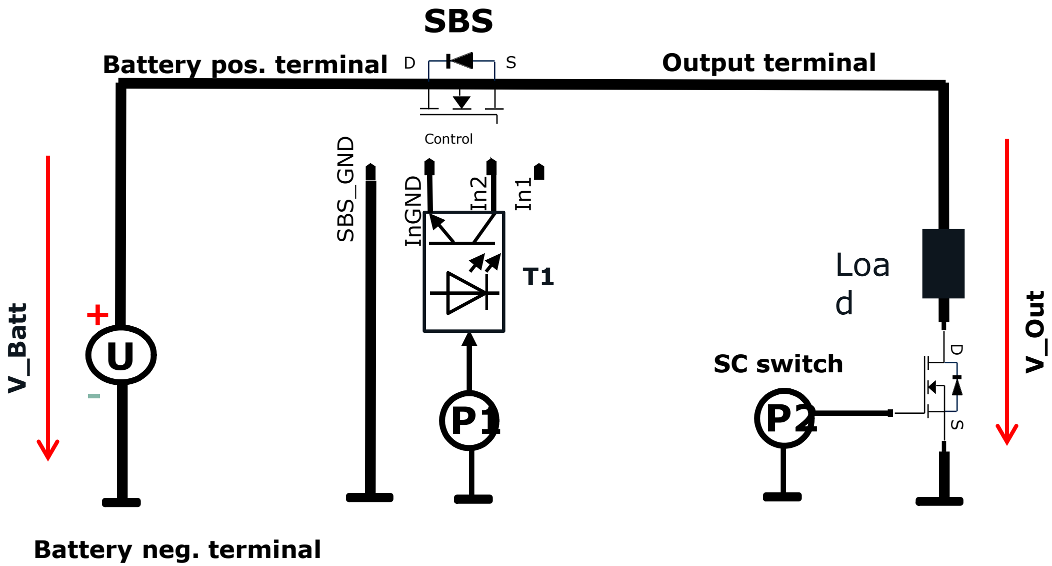
P1/P2 Pulse generator synchronised outputs 1 and 2

To reset the latch of SBS use In1

All parts inside the high current path should be appropriate for the current!

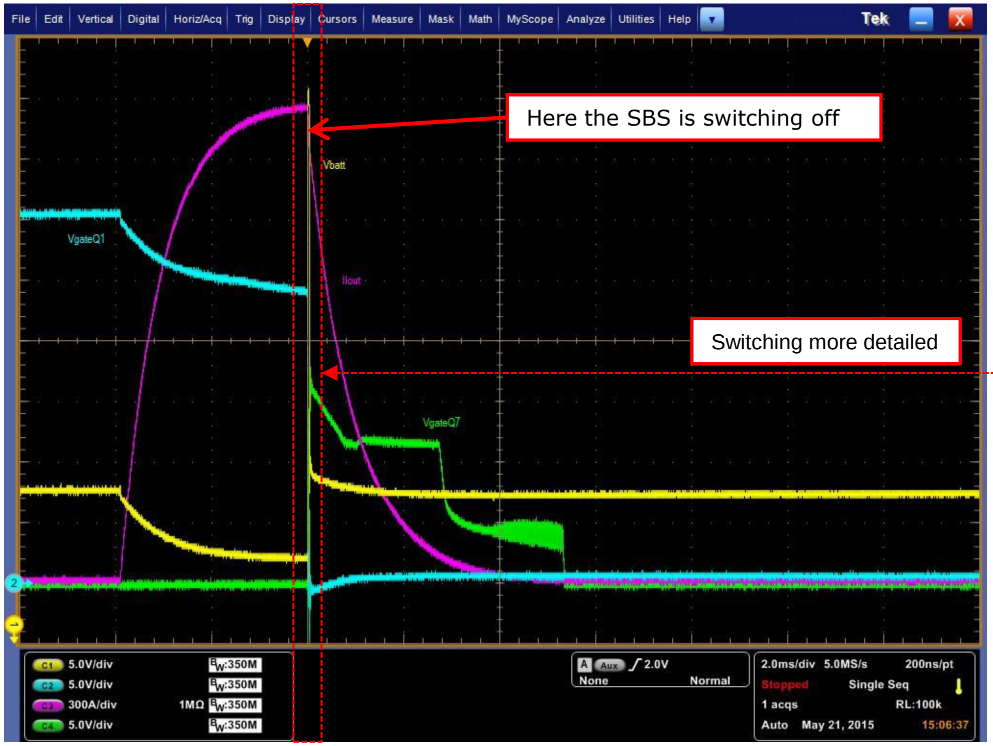
Verify the high current switching capability:

1. Switch on SBS by resetting the latch and wait until the SBS is fully on
2. Apply a load or "short circuit" by switching on the SC switch
3. Wait until you reach the expected current
4. Switch of the SBS by applying low to In2

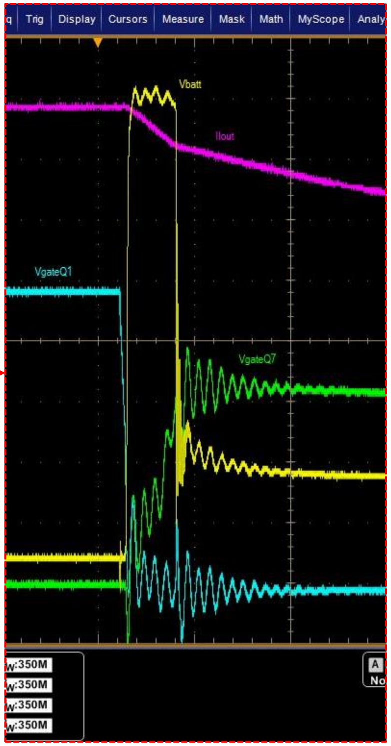


SBS First Steps
Test 5: Switching high current

2ms/DIV Graph1: Overall trend (applying a short circuit and switching off)
Pink (CH3) is the output current.



50us/DIV Graph2: Switching more detailed



Ch1: VBatt (GND Pos: -5)
Ch2: Vgate Q1…Q6 (GND Pos: -4)
Ch3: Iout (GND Pos: -4)
Ch4: Vgate Q7 (GND Pos: -4)

GND of the probes are connected to SBS_GND

SBS First Steps
Test 5: Switching high current

10us/DIV Graph3: Switching more detailed with switching power (M2)
PQ1…Q6=(Vbatt-Vout)*Ibatt

This glitch in the Output signal is expected in version 3 and will be resolved in the next version

Ch1: Vbatt (Pos:- 5)
CH2:
CH3: Iout (Pos: -4)
CH4: Vout (Pos: -3)
Math2: PQ1…Q6 (Ch1-Ch4)*Math4 (Pos: -4)
Math4: Ibatt Ch3-Ch2 (Pos: -4)

GND of the probes are connected to SBS_GND

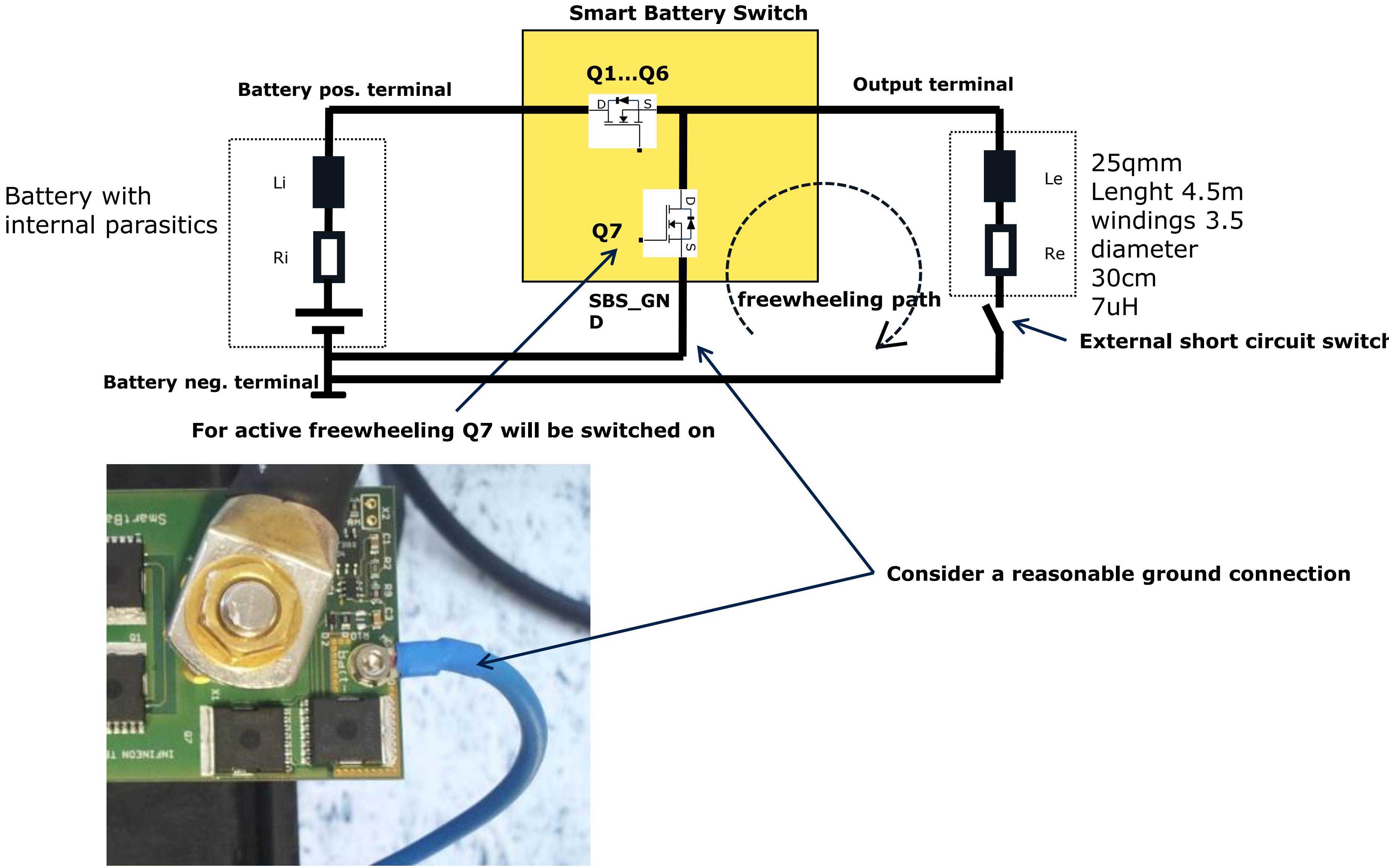
SBS First Steps
Test 5: Switching high current

10us/DIV Graph4: Switching more detailed with the transfer of current and switching energy (M1)

Ch1: Vbatt (Pos:- 5)
CH2: Ignd (Pos: -4)
CH3: Iout (Pos: -4)
CH4: Vout (Pos: -3)
Math3: E Q1…Q6 INTG(Math2) (Pos: -1)
Math4: Ibatt Ch3-Ch2 (Pos: -4)

GND of the probes are connected to SBS_GND

SBS First Steps
Active freewheeling



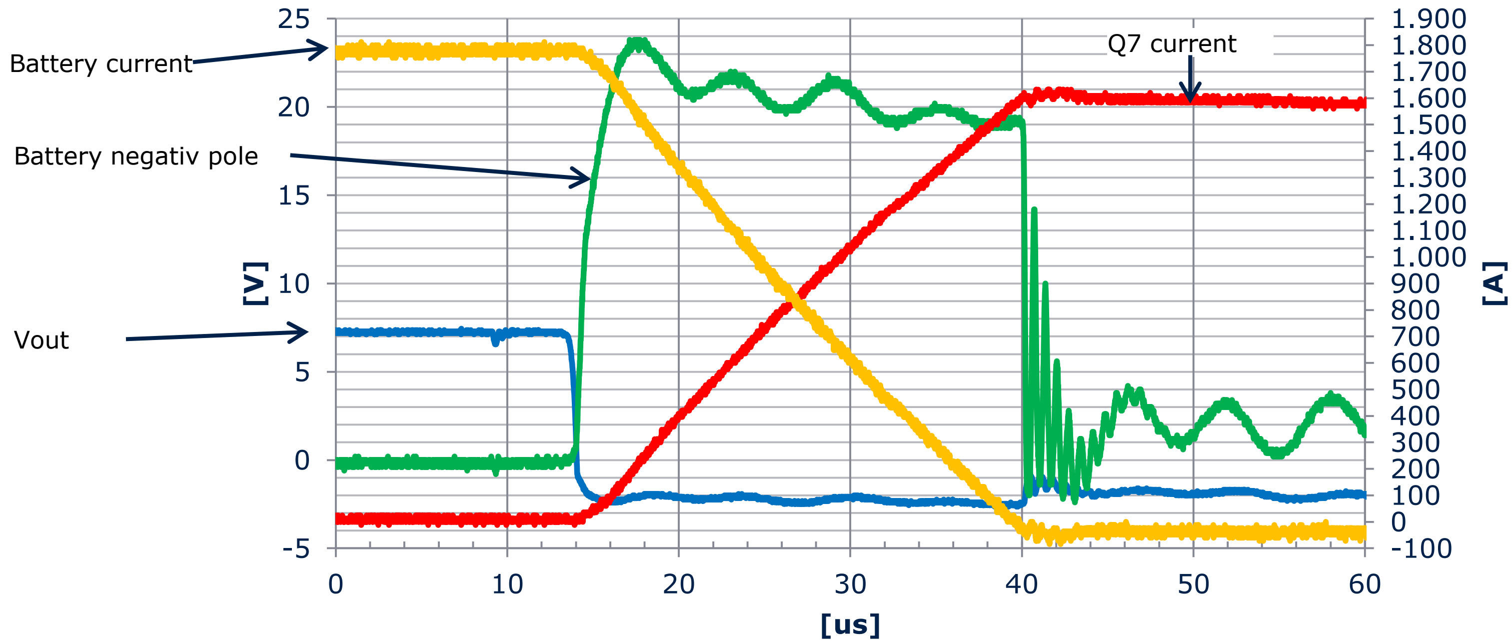
SBS First Steps
Active freewheeling

Setup example:

Same as described in "Switching high current"

1. SBS (Q1…Q6) is switched on
2. Turning on the external switch (SC switch) generates a short circuit on the output terminal: Current is rising
3. At the user defined current switch the SBS (Q1…Q6)
Le and Li are now charged!
4. **Le** is charged and is forcing the output voltage drop until the body diode of Q7 is conductive. Q7 is additionally switched on. The whole current is now flowing through the SBS_GND and Q7/Q8. Due to the high current the Battery negative pole is rising up.
(Remark: Negative pole of the battery is the reference point of all other ECU's)
5. **Li** is charged and is rising the input voltage up to the breakdown stage of the Q1..Q6 which will run into avalanche.

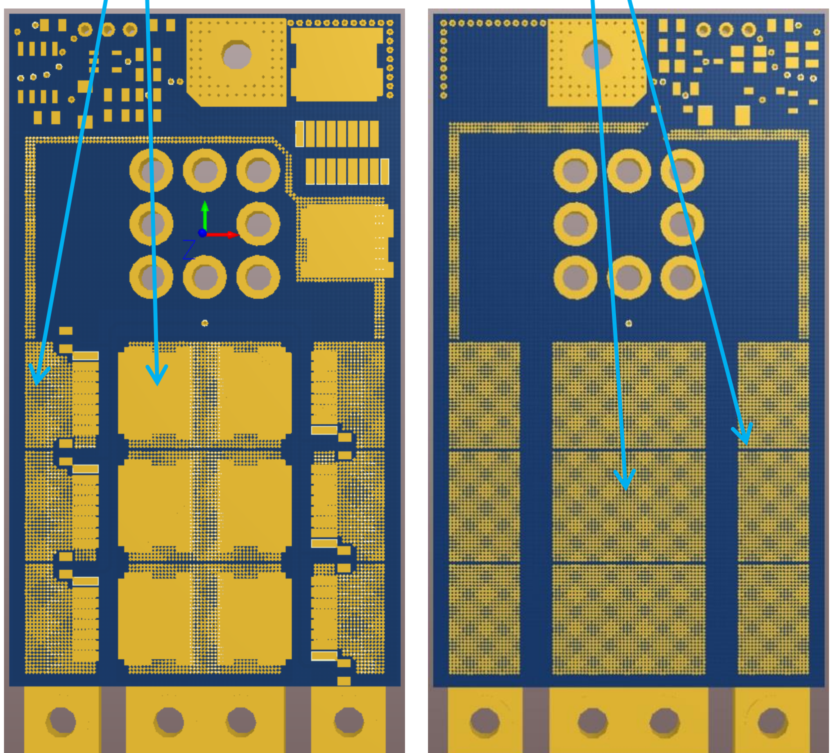
All GND's of the Probes are connected to SBS_GND directly on the SBS



SBS First Steps
PCB description

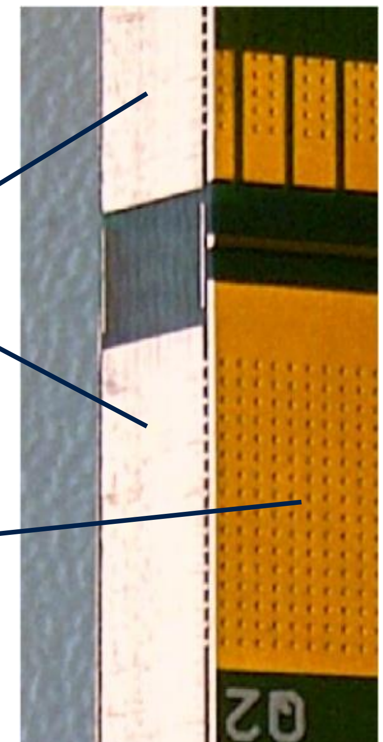
Outer layers 100um
Inlay 2mm

microvias - cooling area with microvias



2mm Cu-Inlay

thermal-vias



SBS First Steps
Version History

Rev1:
26.05.2015 Initial Version
28.05.2015 Modify Active freewheeling test
02.06.2015 Official Version
Rev2:
02.06.2015 Add Graphs to chapter 5
29.06.2015 PCB chapter added
02.07,2015 Active freewheeling chapter added
07.07.2015 rework of “Active freewheeling” and “Switching high current chapters”
25.08.2015 rework all pages

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