Quick start guide KIT_DRIVER_1EDN7550B

October 2018

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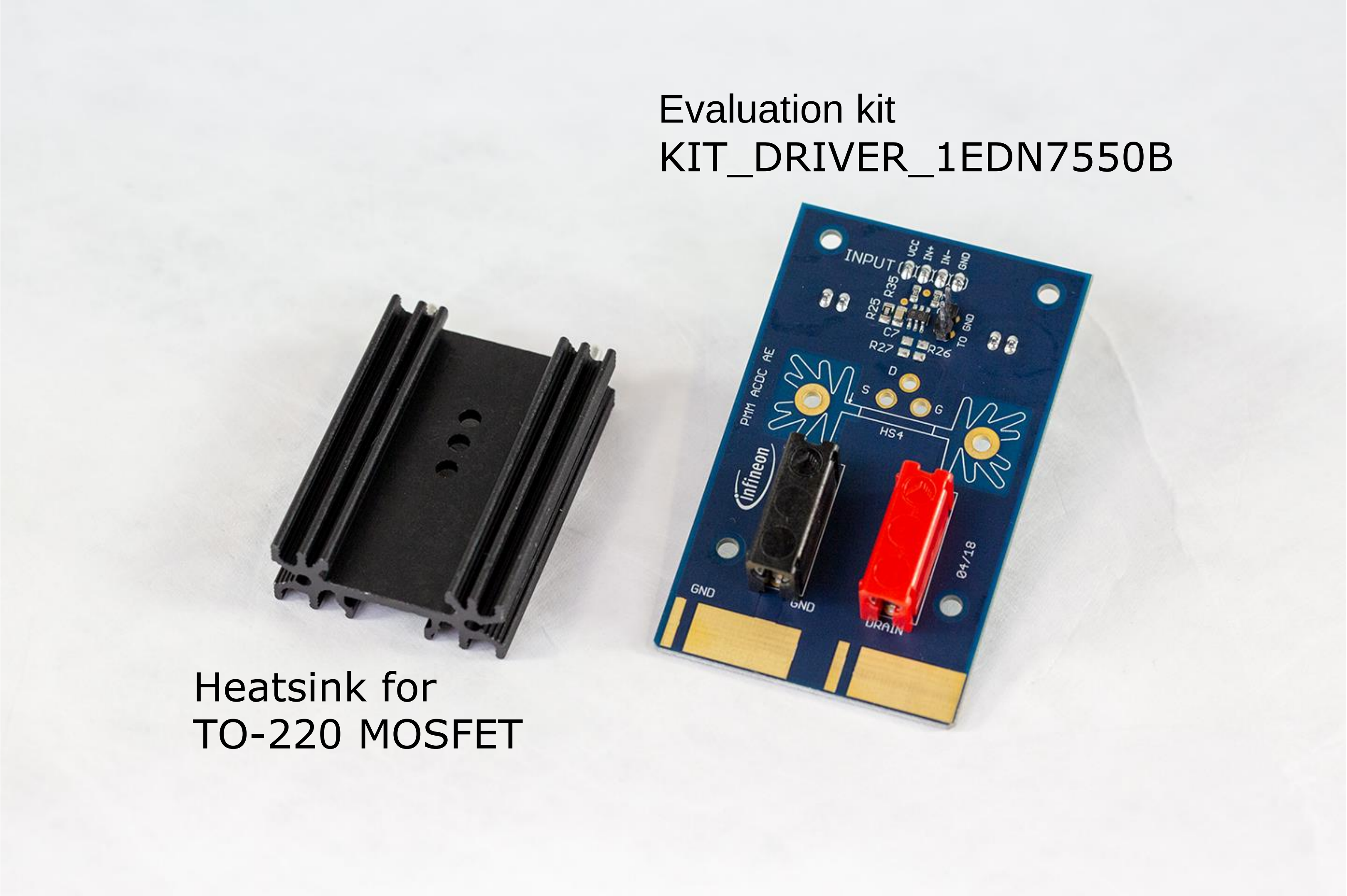
Included in this kit



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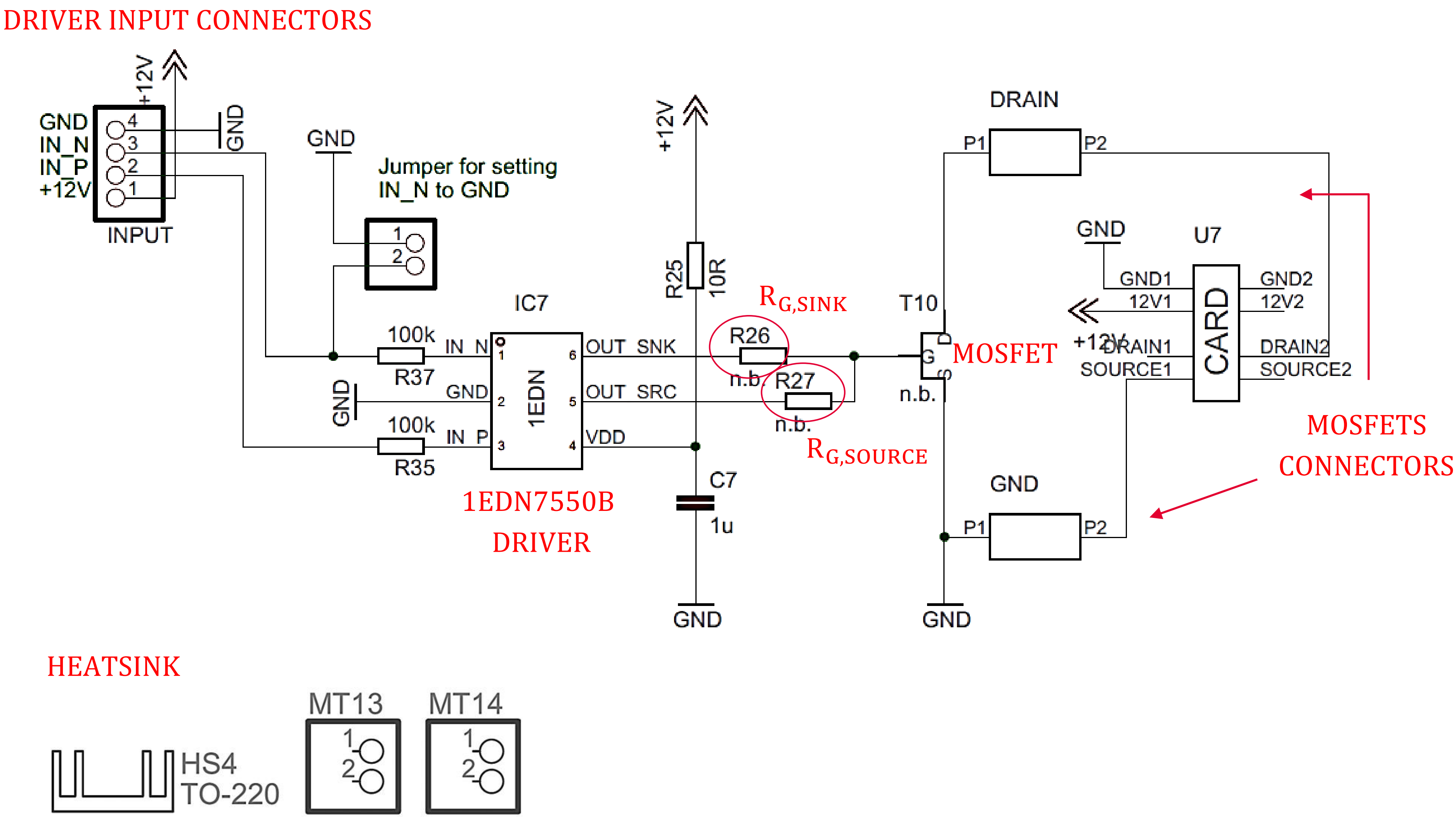
Board schematic



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Components to add – BOM suggestion

Distance bolts	Screws for distance bolts	Screw and washer for MOSFET mounting to heatsink	TO-220 sockets
			
TO-220 MOSFET	**Source resistor (R27)**	**Sink resistor (R26)**	
			

Component	Quantity	Designator	Comment	Voltage	Footprint	Type	Part number/ supplies
Resistors	2	R26,R27			RES805R	SMD ceramic resistor	
TO-220 sockets	1	T10	TO-220 socket		TO-220	Receptacle Connector 0.034" ~ 0.041" (0.86 mm ~ 1.04 mm)	5050865-5 Digi-key

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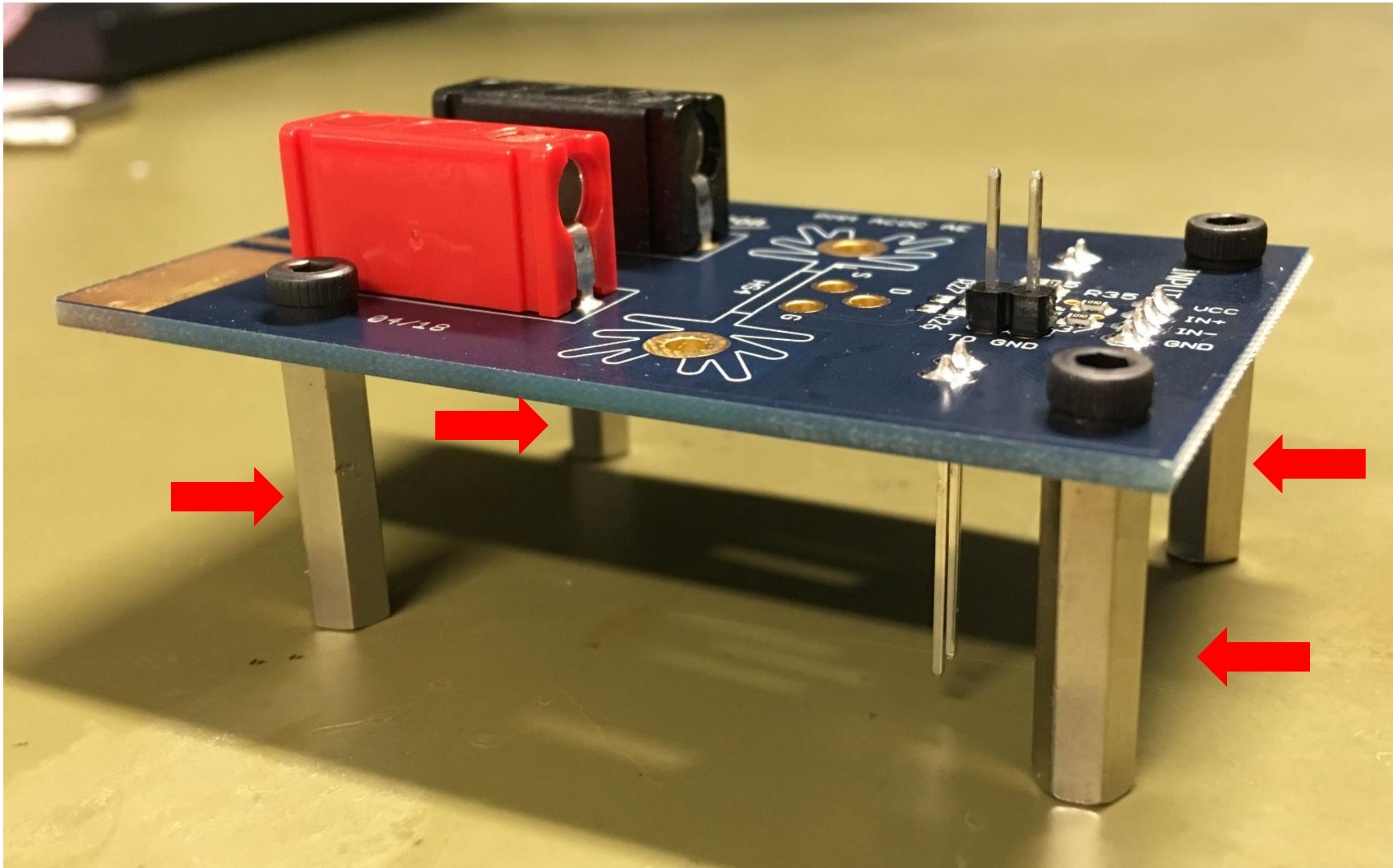
Step 1: Distance bolts mounting



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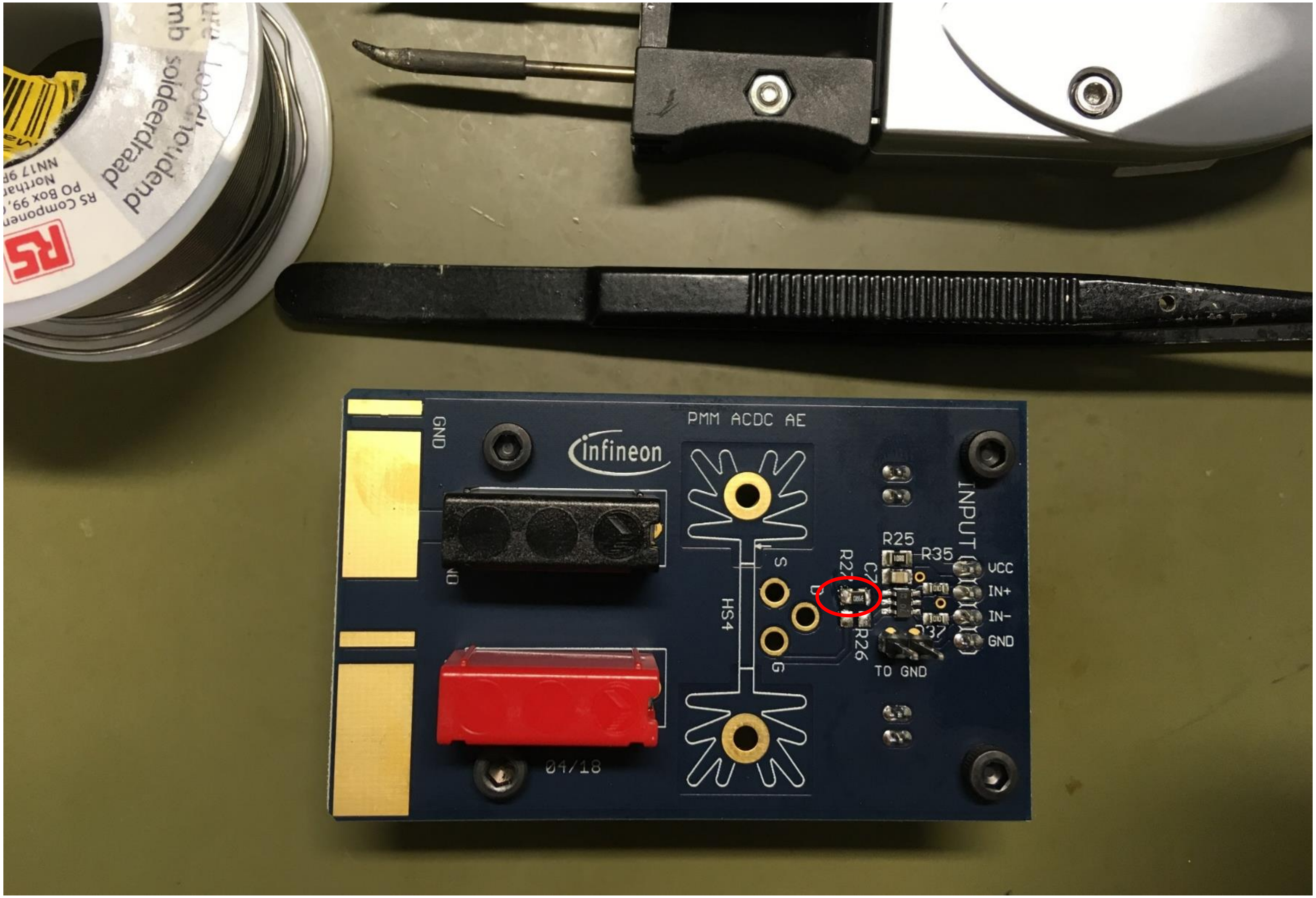
Step 2: Source resistor soldering



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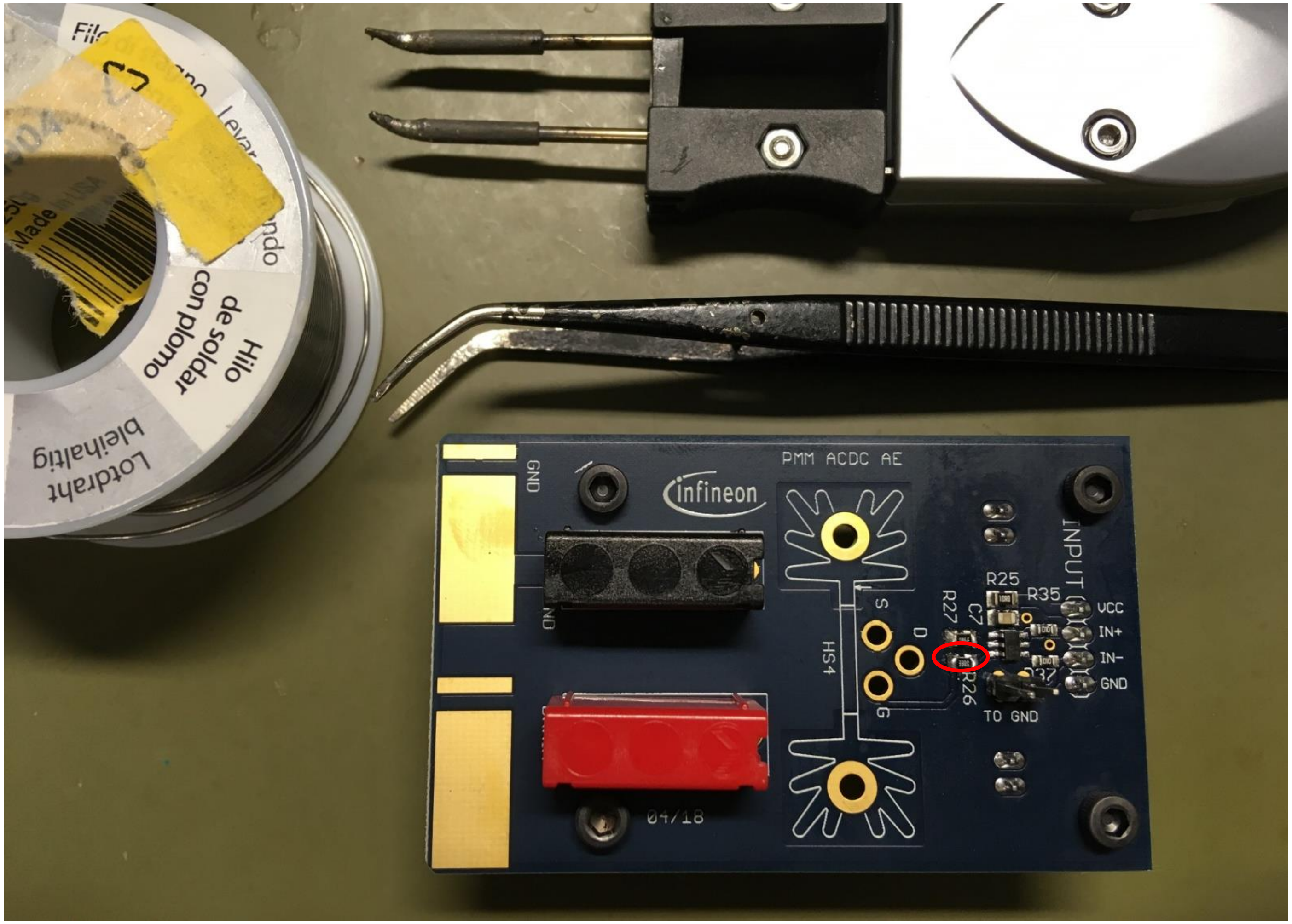
Step 3: Sink resistor soldering



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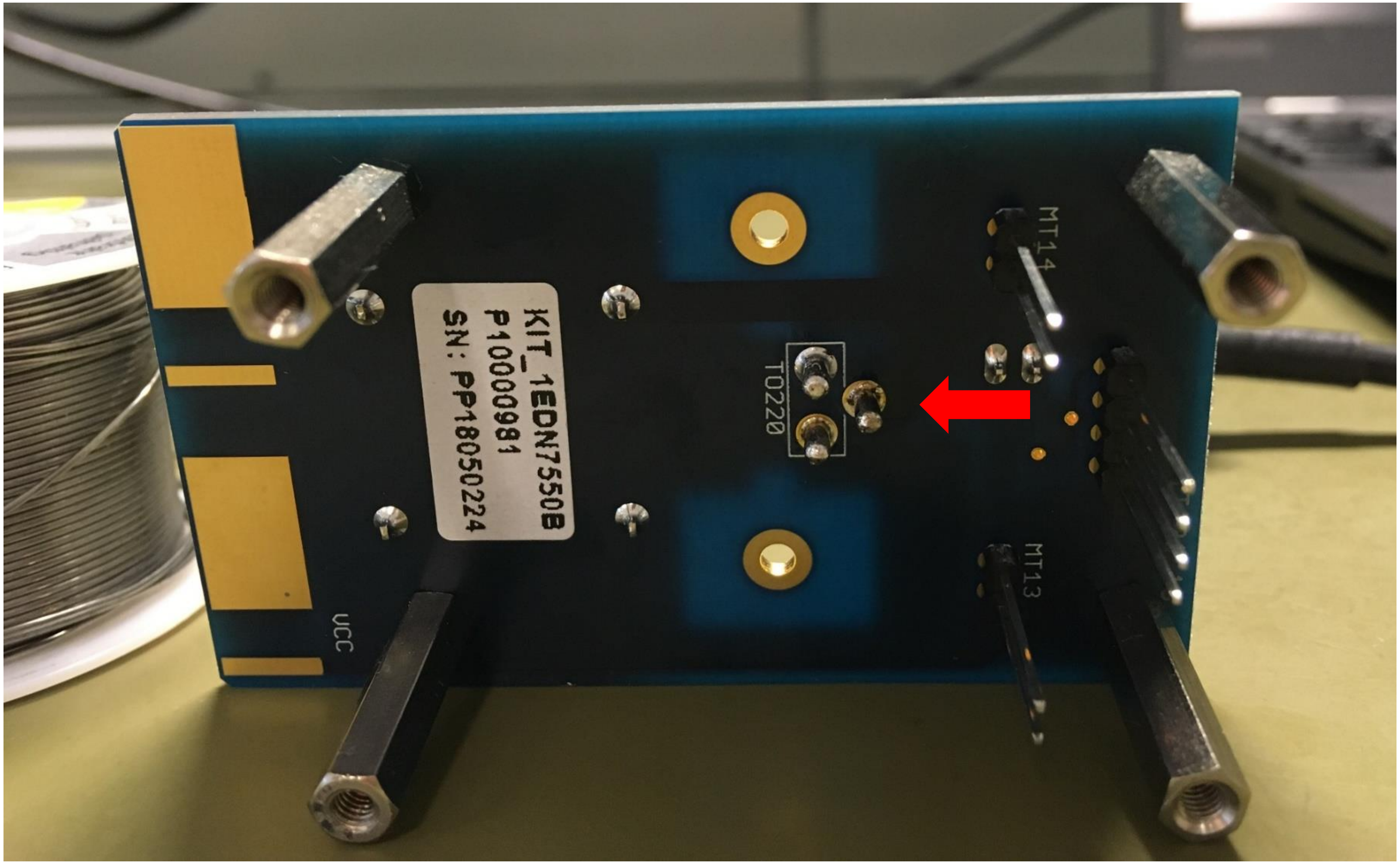
Step 4: TO-220 sockets soldering



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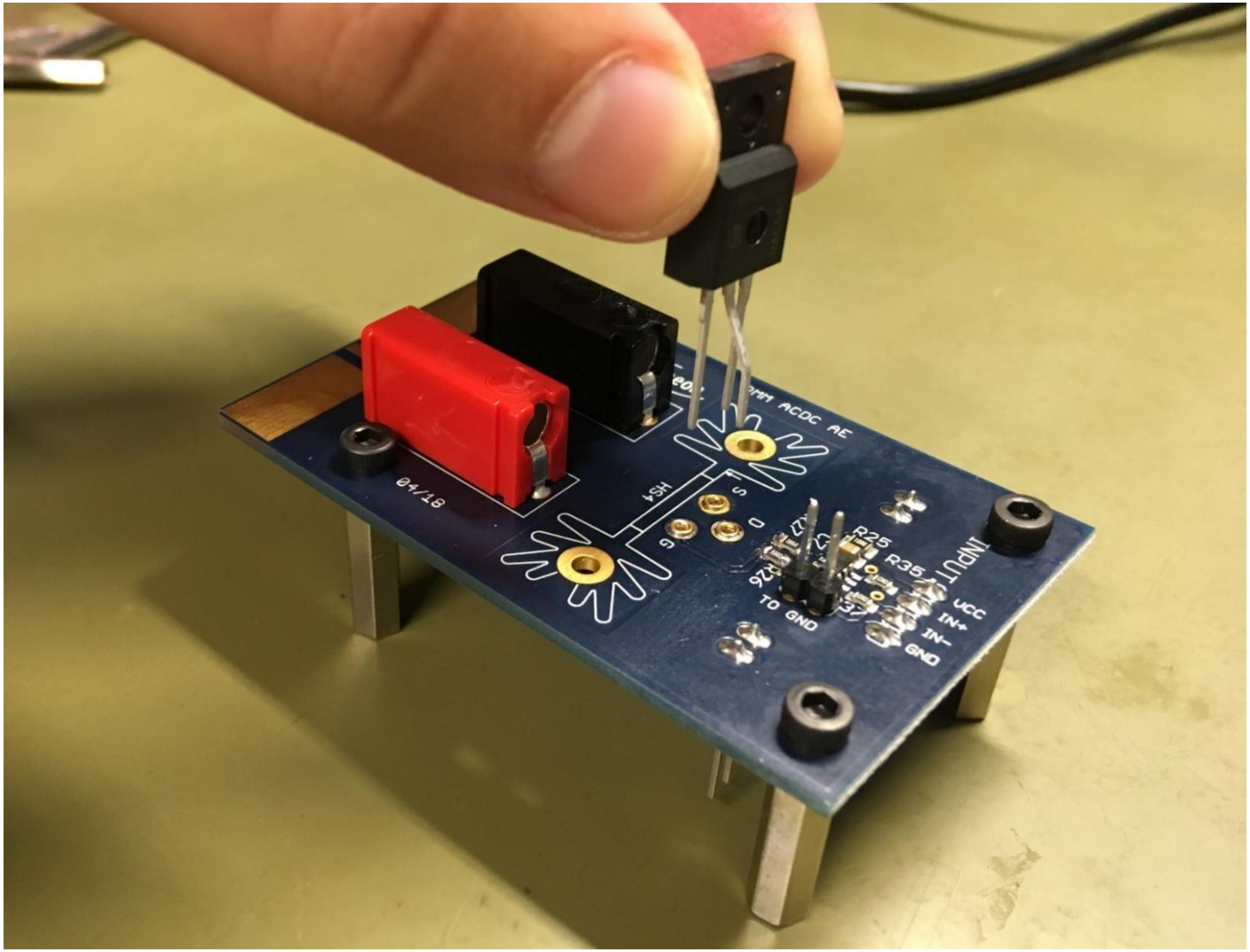
Step 5: MOSFETs placement into the sockets



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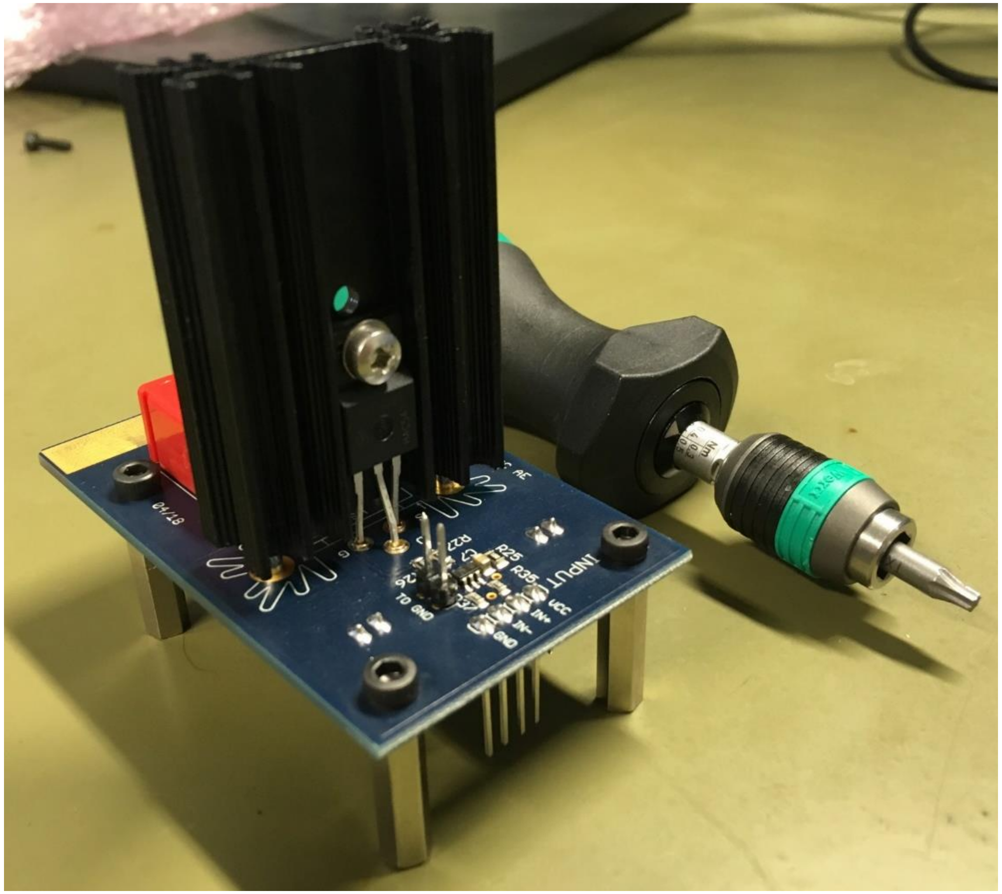
Step 6: Heatsink mounting (optional)

- Solder the heatsink if the board is used in high voltage scenarios
- In basic measurements it is not necessary
- See next slide for further information on how to properly mount the MOSFETs to the heatsink



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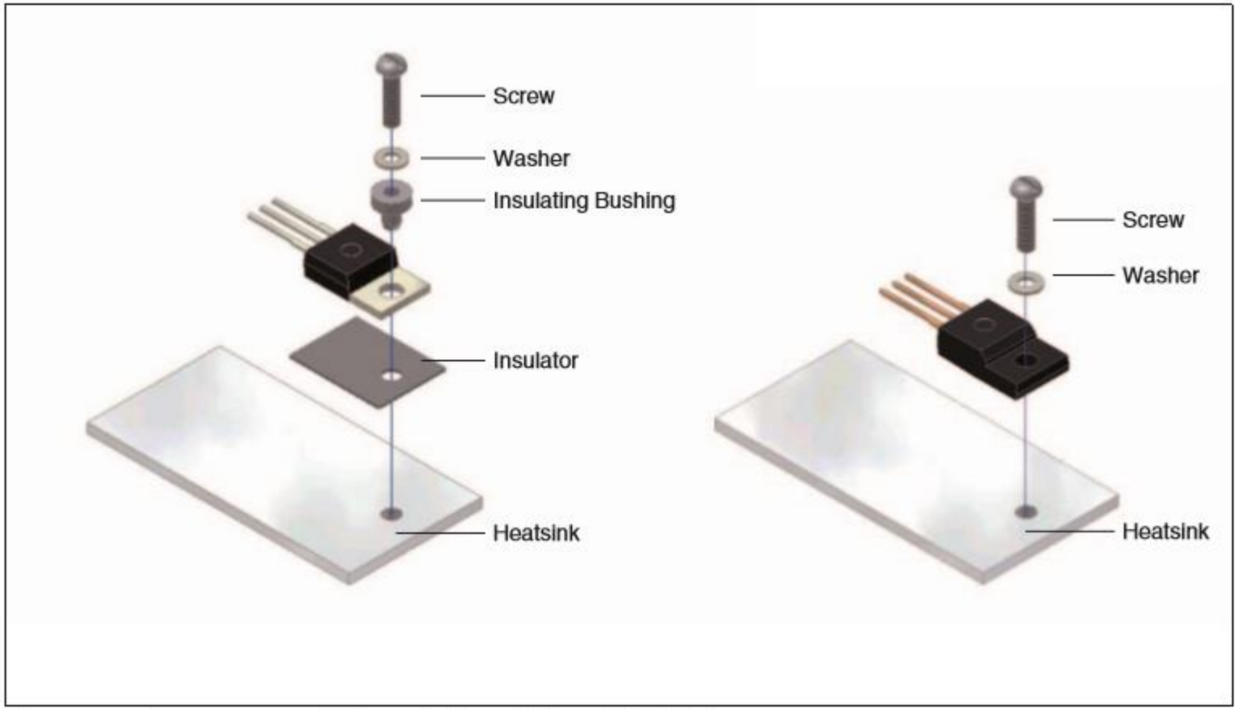
TO-220 MOSFET mounting to the heatsink



Package	Typ. Torque [Nm]	Max. Torque [Nm]	Comment
PG-TO220	0.6	0.7	Screw M3
PG-TO220 FullPAK	0.5	0.7	Screw M2.5

- Recommendations for assembly of Infineon TO packages: https://www.infineon.com/dgdl/Infineon-Package_recommendations_for_assembly_of_Infineon_TO_packages-AN-v01_00-EN.pdf?fileId=db3a30431936bc4b011938532f885a38

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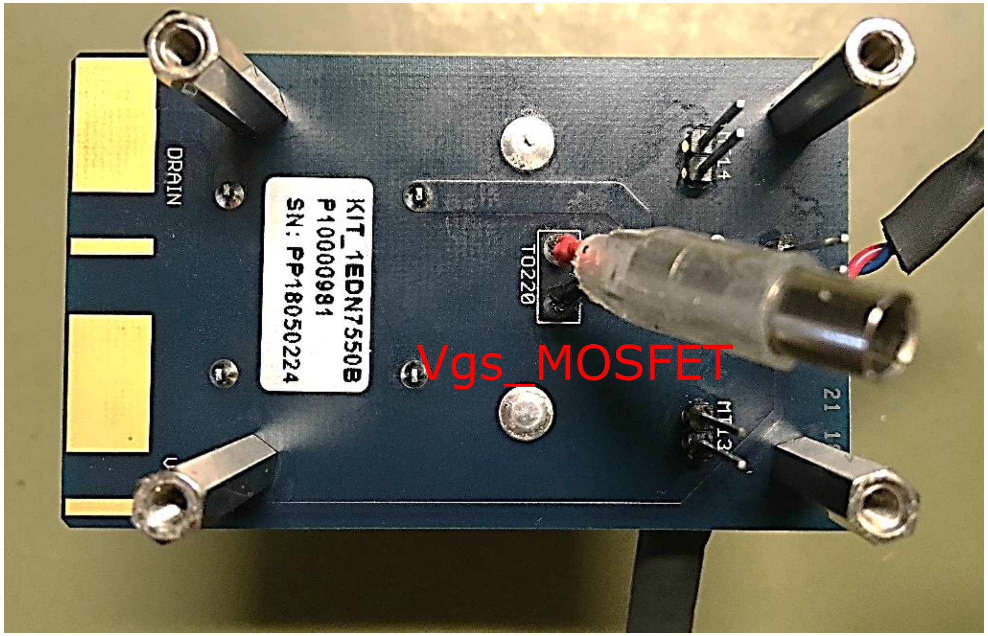
Step 7: BNC connectors soldering



- To measure the input PWM signal apply a differential voltage probe between the IN+ and IN- pins

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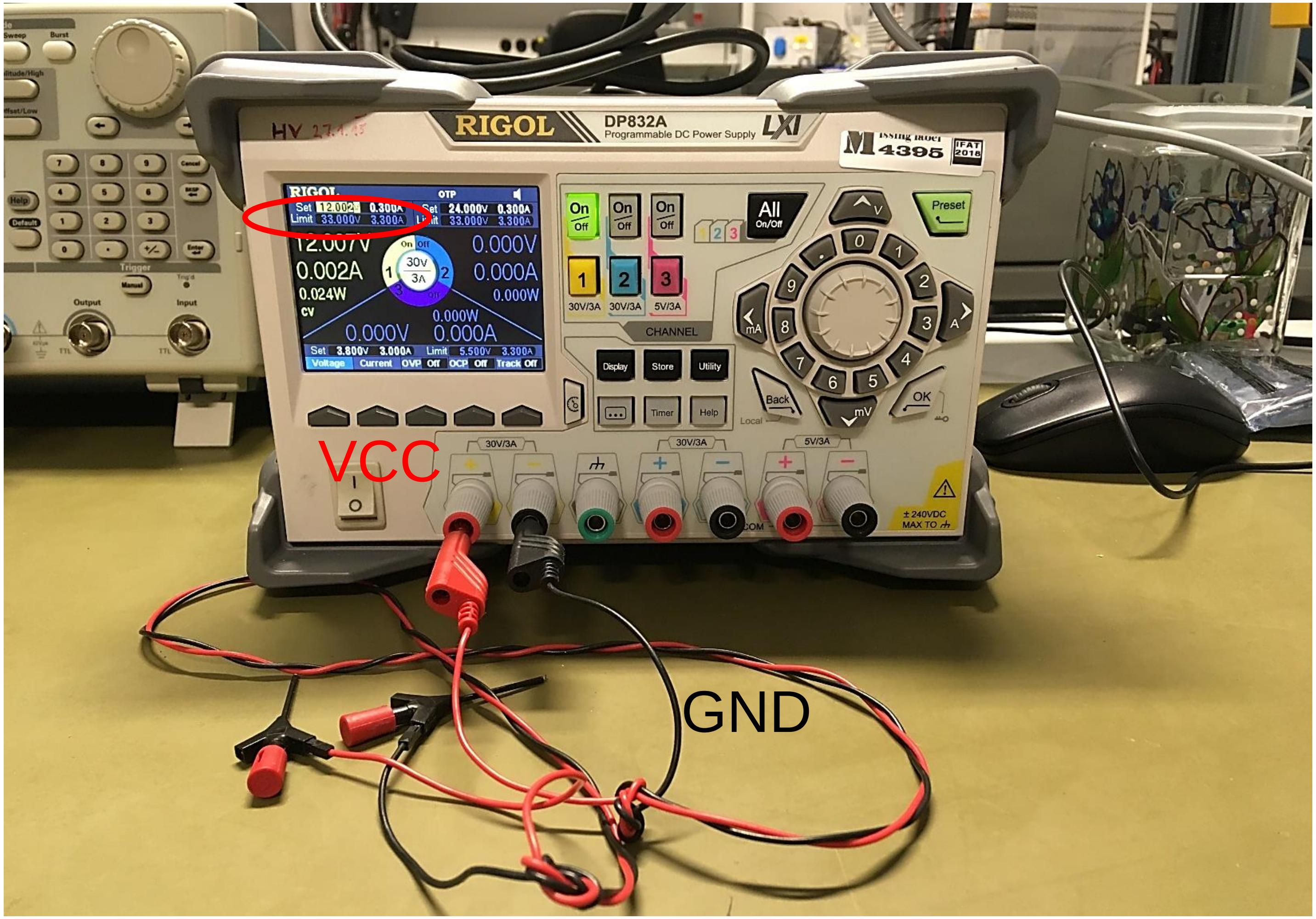
Instrumentation for driver supply generation



- V_{CC}=12 V for CoolMOS™ and 8 V for OptiMOS™
- Set the current limit below 1 A (0.3A e.g.)

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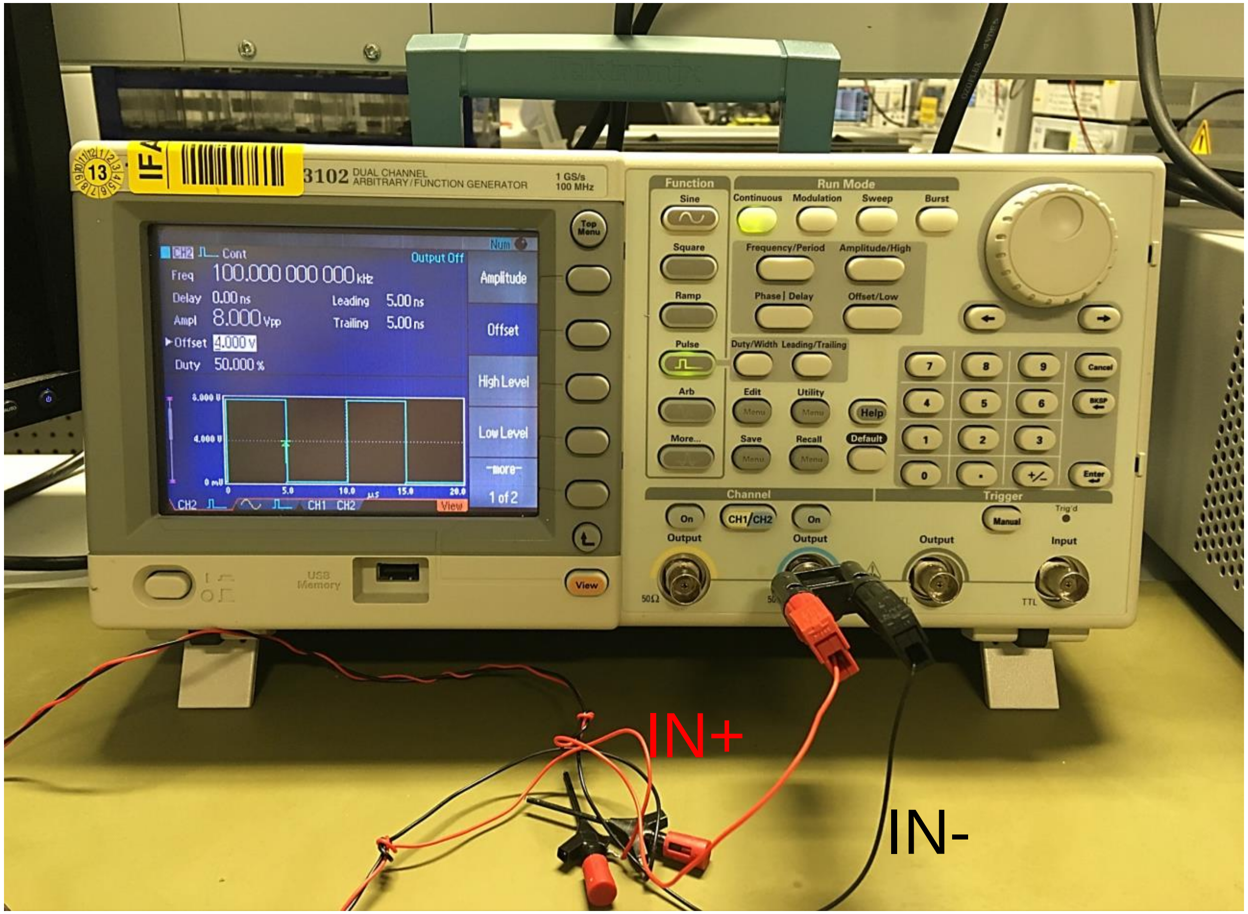
Instrumentation for PWM signals generation



- Generate a PWM signal with at least 8 V amplitude
- To generate a 3.3 V PWM signal change the input resistances R35,R37 to 33 kΩ
- To generate a 5 V PWM signal change the input resistances R35,R37 to 52 kΩ

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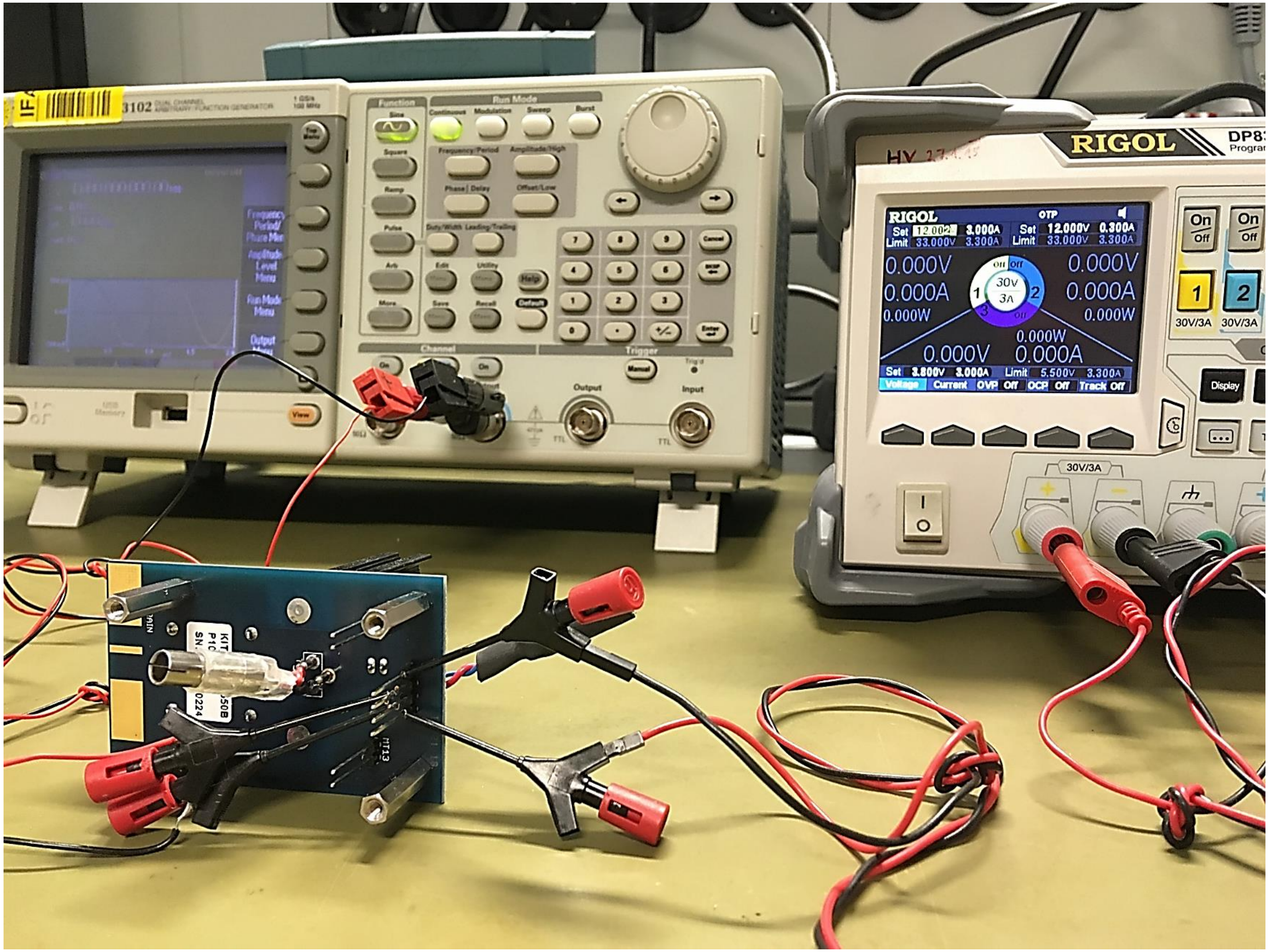
Connections



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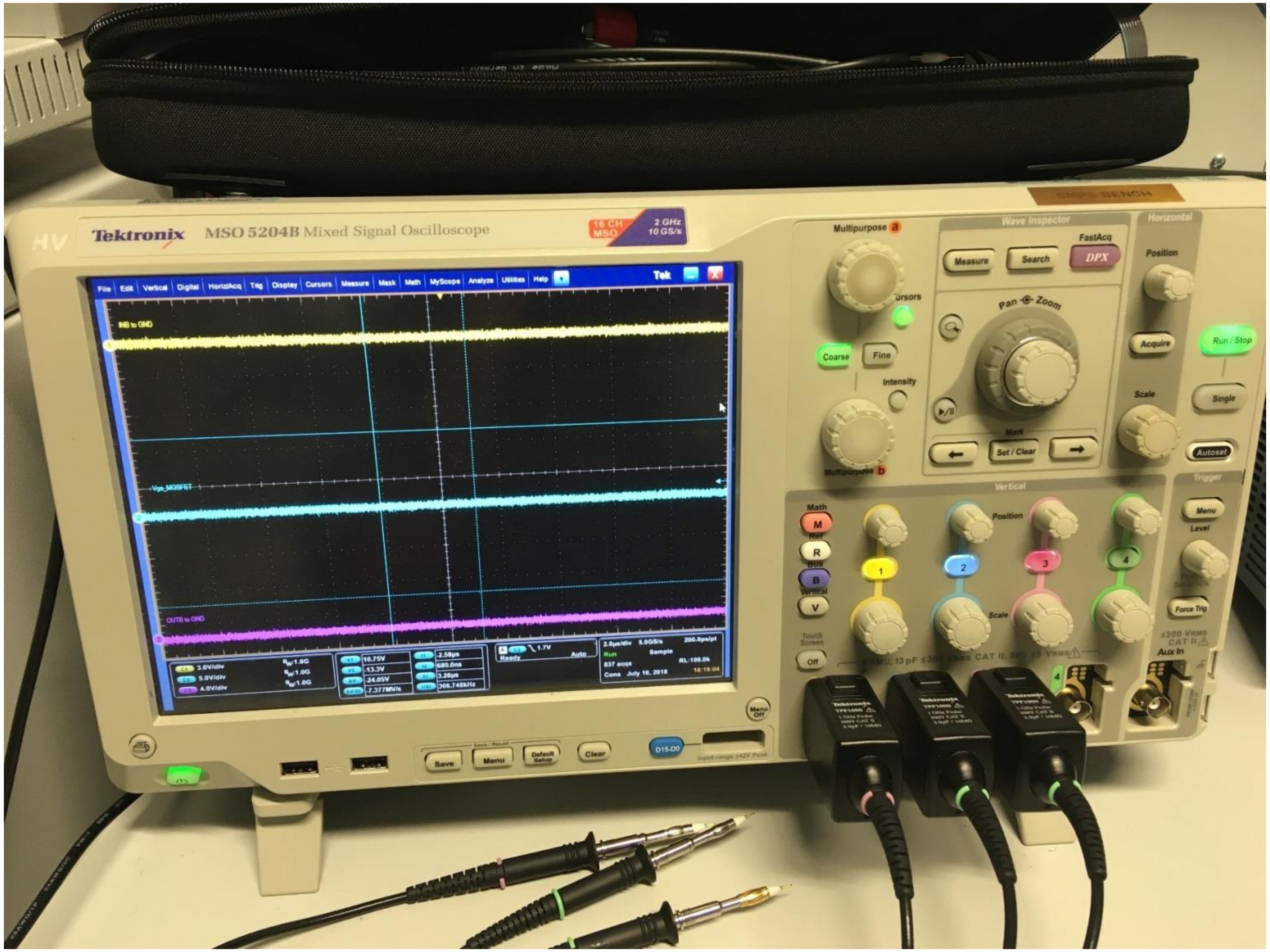
Instrumentation for signals evaluation



- Voltage probes used: Tetronix TPP1000 1 GHz, 3.9 pF

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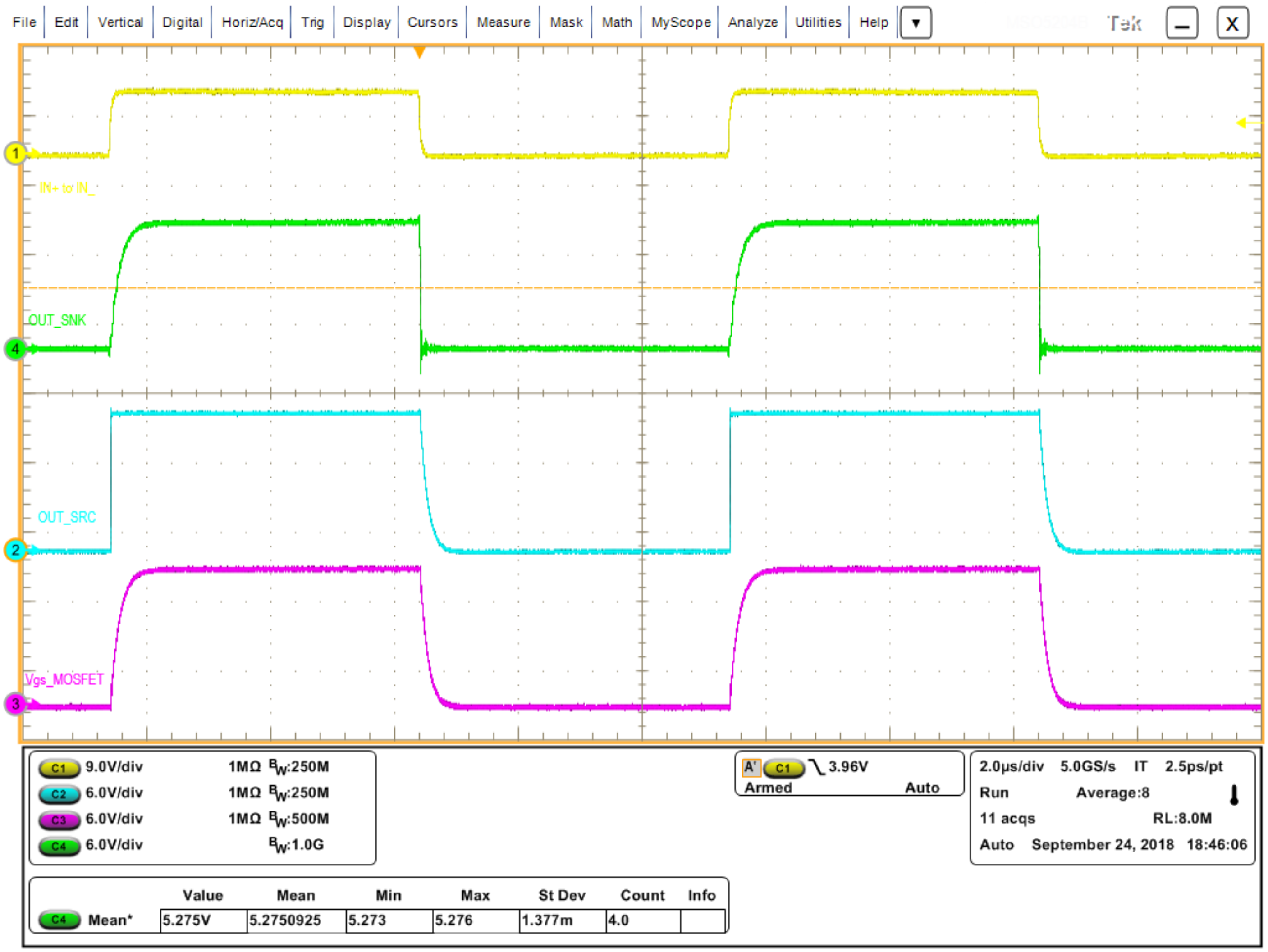
Oscilloscope waveforms



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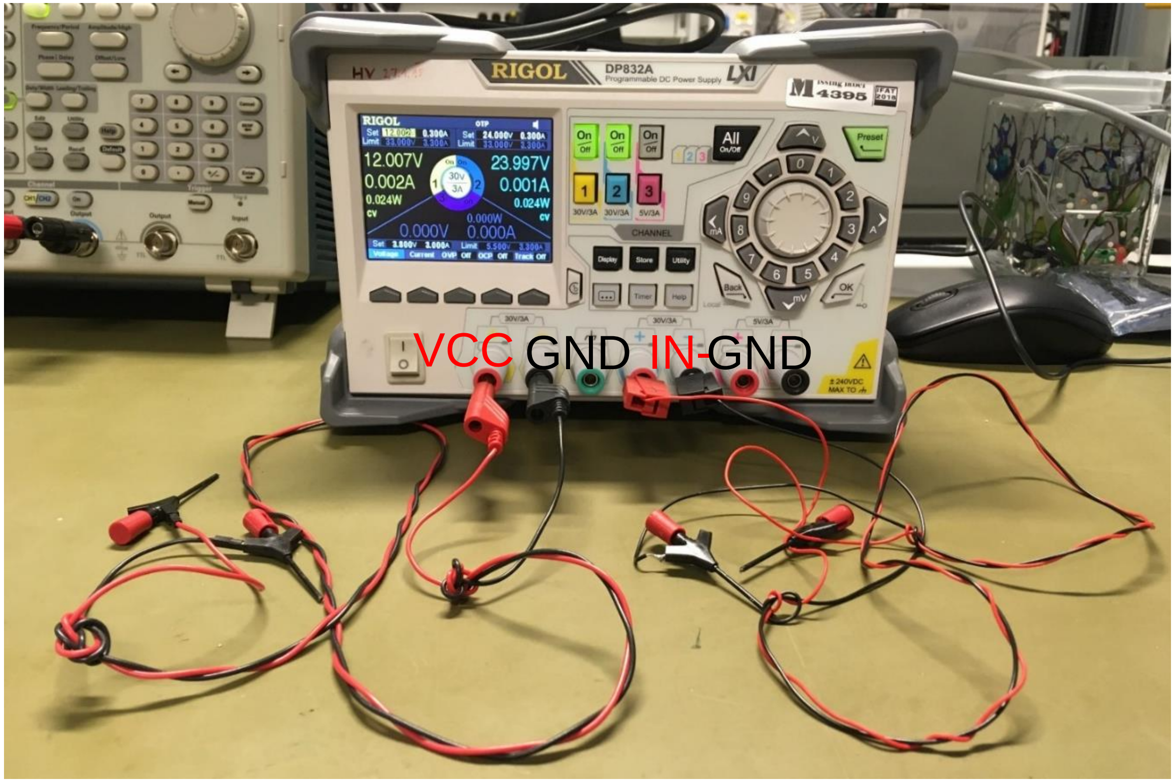
Evaluation of 1EDN7550B robustness to DC offsets: measurement setup

- The truly differential input 1EDN7550B gate driver is able to withstand DC offsets between the microcontroller ground (IN-) and the driver ground (GND)



- How to test: use the 2nd channel of the DC source generator to create an offset between IN- and GND
- How to measure: soldering a BNC connector between IN- and GND to measure the DC offset

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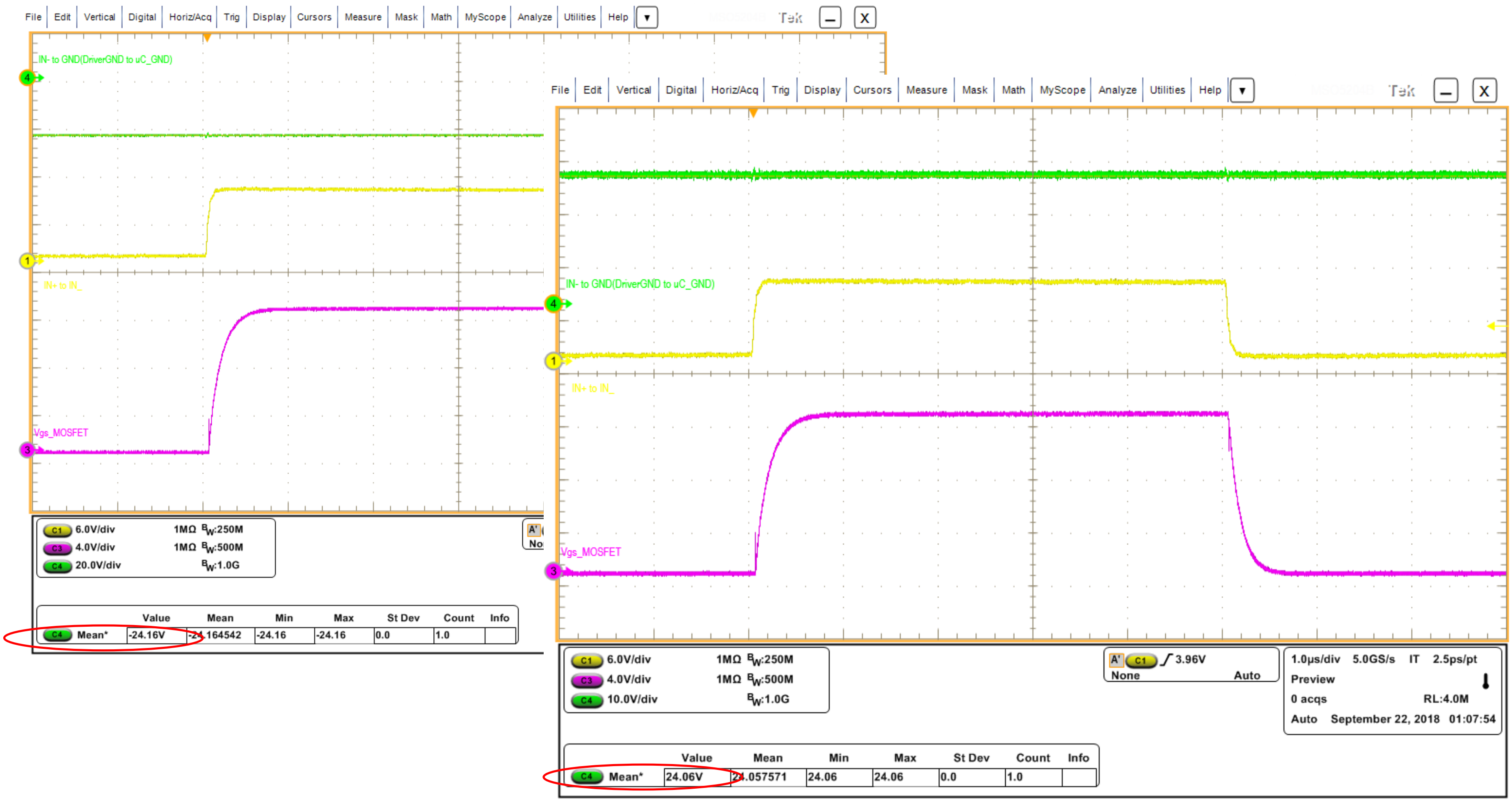
Evaluation of 1EDN7550B robustness to DC offsets: measurement results



Conclusion: contrary to a standard 1-channel low-side driver, the 1EDN7550B properly turns ON and OFF with DC GND shifts between the microcontroller ground and the driver ground

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Investigation of the driving behavior with different loads

How – Changing the gate resistances and/or the gate MOSFET

What – Monitor the impact on the gate signal delivered to the MOSFET

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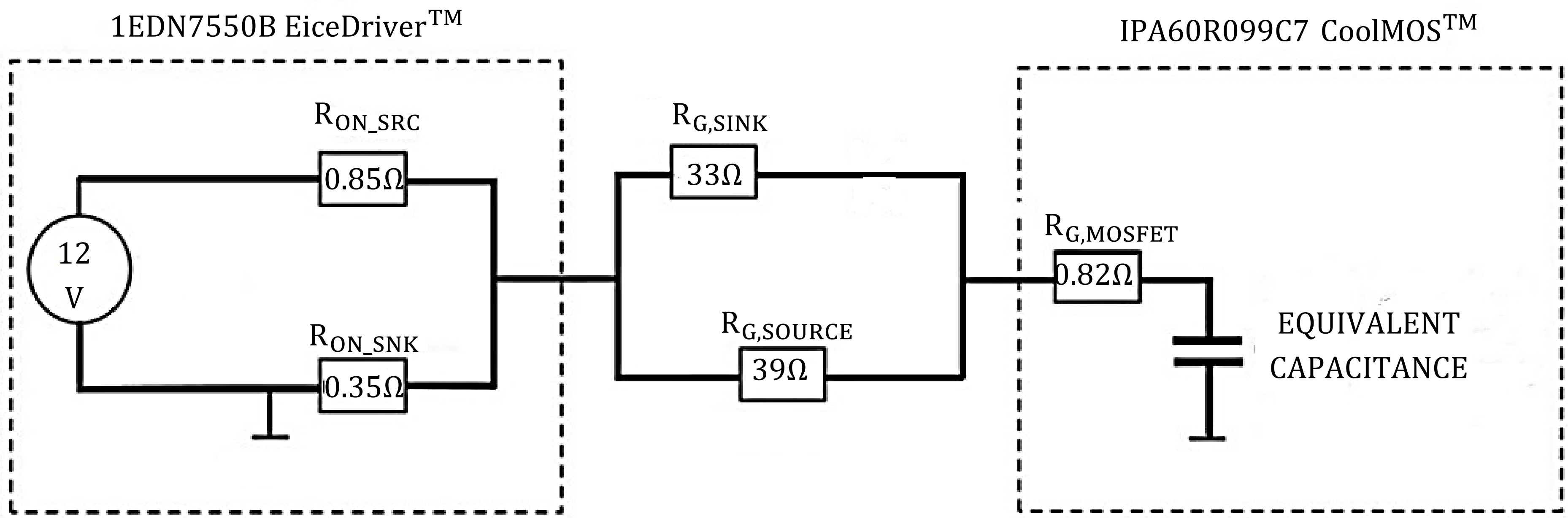
Equivalent model of the driving circuit



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C_{LOAD} calculation for IPA60R099C7

Gate to drain charge	Q_{gd}	-	14	-	nC	V_{DD}=400V, I_D=9.7A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	42	-	nC	V_{DD}=400V, I_D=9.7A, V_{GS}=0 to 10V

$$Q_{LOAD} = Q_g - Q_{gd} = 28\,nC \rightarrow C_{LOAD} = \frac{Q_{LOAD}}{V_{GS}} = 2.8\,nF \quad for\; V_{GS} = 10\,V \longrightarrow$$

$$C_{LOAD} \approx 2.8\,nF \quad for\; V_{GS} = 12\,V$$

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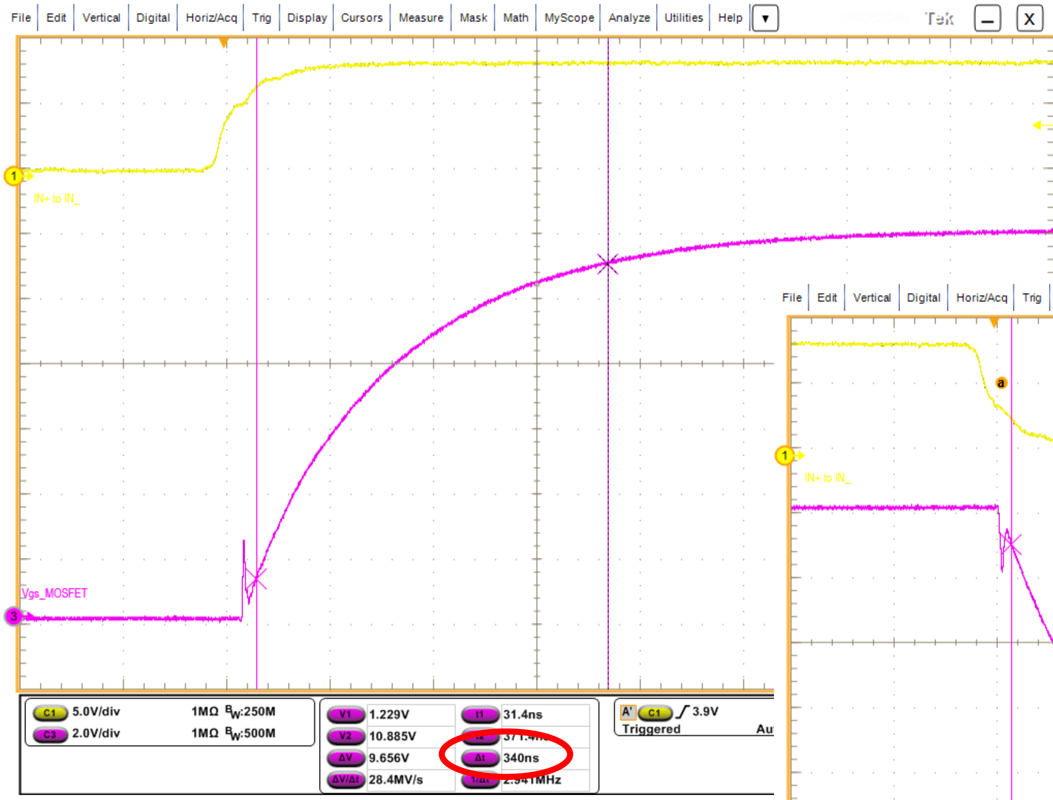
Rise/fall times



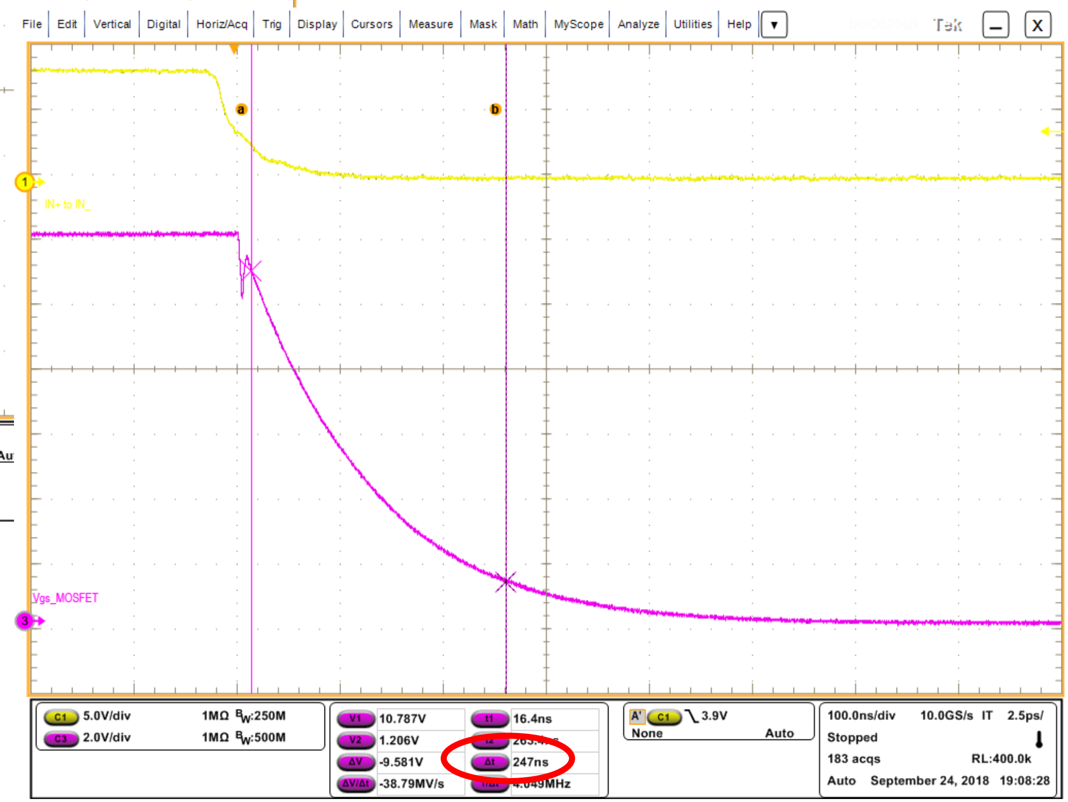
$R_{G,SOURCE} = 39\ \Omega$

$R_{G,SINK} = 33\ \Omega$

MOSFET = IPA60R099C7

$R_{G,MOSFET} = 0.82\ \Omega$

$C_{LOAD} \approx 2.8\ nF$



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Gate resistors replacement

$$R_{G,SOURCE} = 39\ \Omega \quad \rightarrow \quad 24\ \Omega$$

$$R_{G,SINK} = 33\ \Omega \quad \rightarrow \quad 20\ \Omega$$

MOSFET = IPA60R099C7

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Rise/fall times: New set of gate resistances

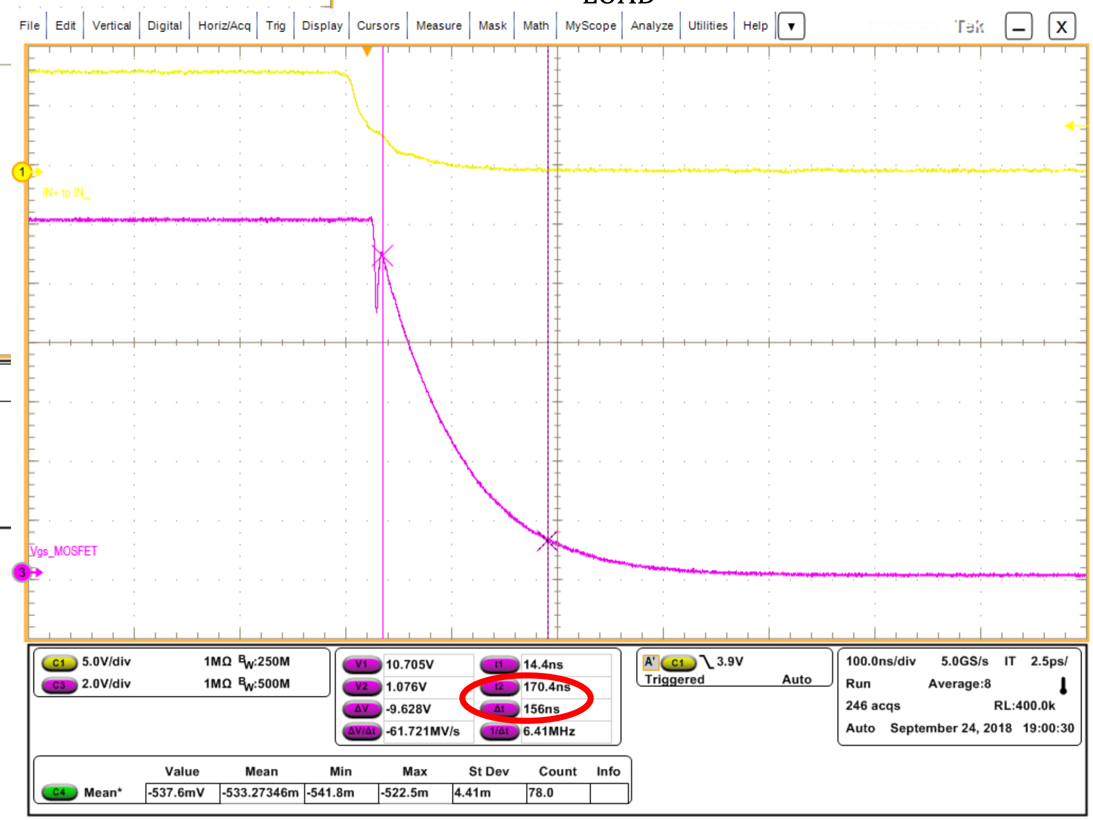
$R_{G,SOURCE} = 24\ \Omega$

$R_{G,SINK} = 20\ \Omega$

$MOSFET = IPA60R099C7$

$R_{G,MOSFET} = 0.82\ \Omega$

$C_{LOAD} \approx 2.8\ nF$



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Gate resistors replacement

$$R_{G,SOURCE} = 24\ \Omega \quad \rightarrow \quad 51\ \Omega$$

$$R_{G,SINK} = 20\ \Omega \quad \rightarrow \quad 43\ \Omega$$

MOSFET = IPA60R099C7

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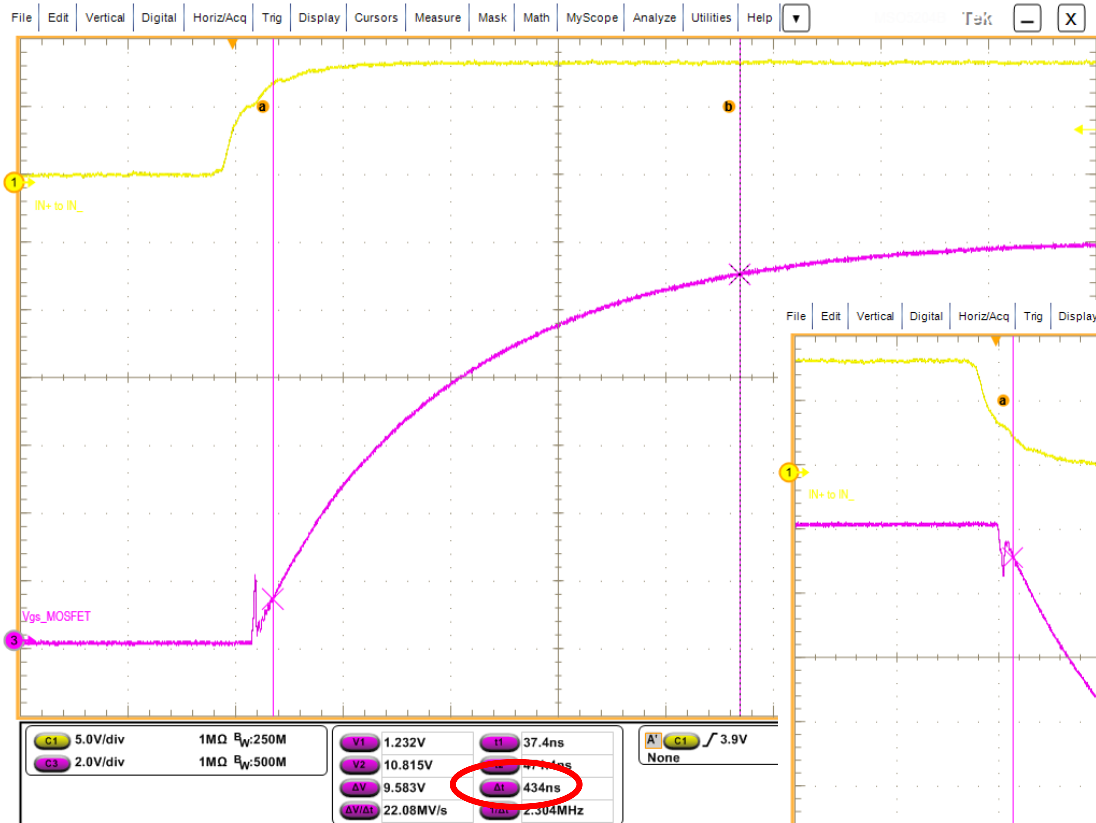
Rise/fall times: New set of gate resistances



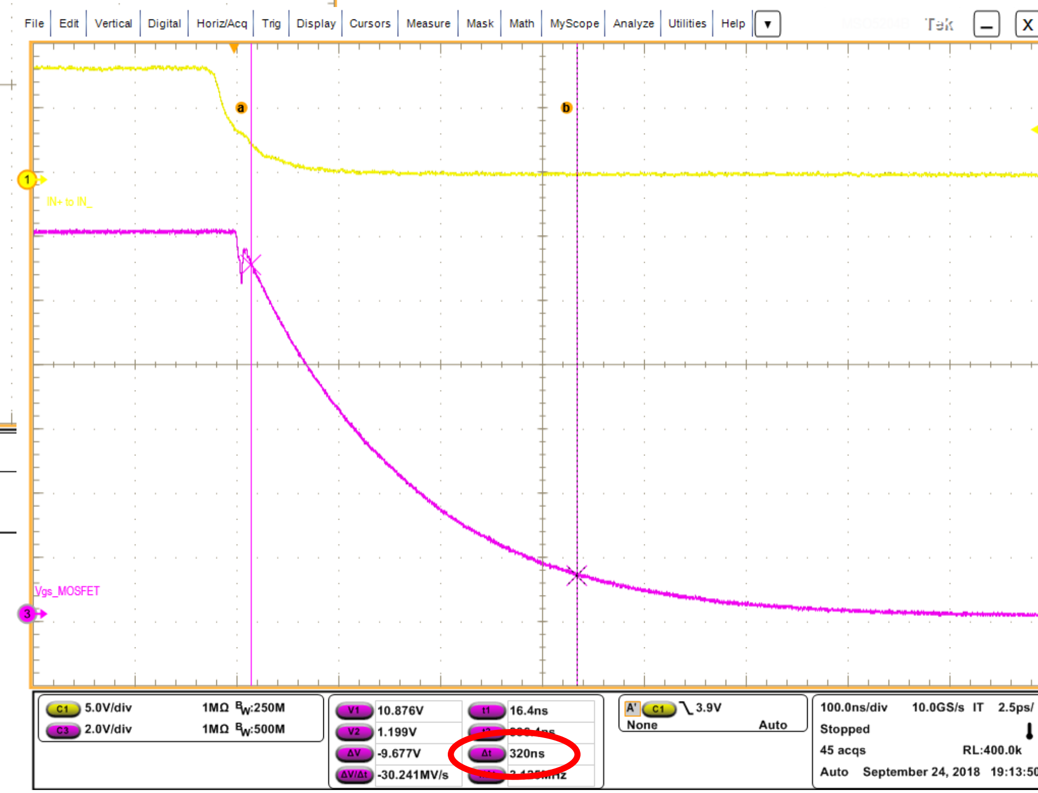
$R_{G,SOURCE} = 51\ \Omega$

$R_{G,SINK} = 43\ \Omega$

MOSFET = IPA60R099C7

$R_{G,MOSFET} = 0.82\ \Omega$

$C_{LOAD} \approx 2.8\ nF$



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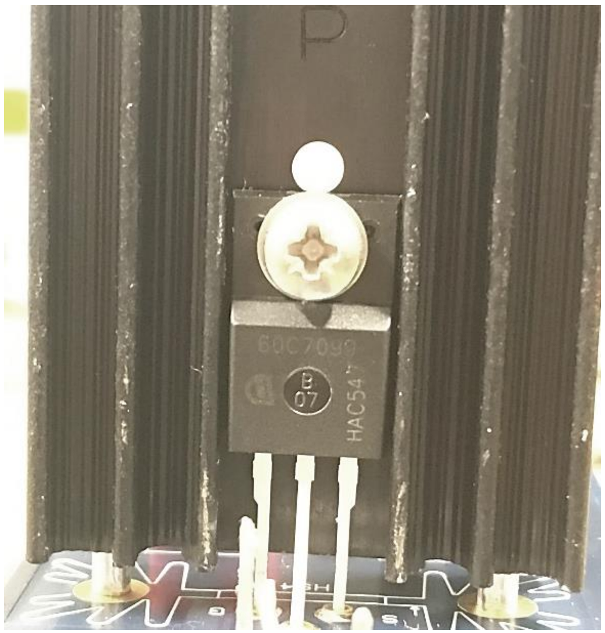
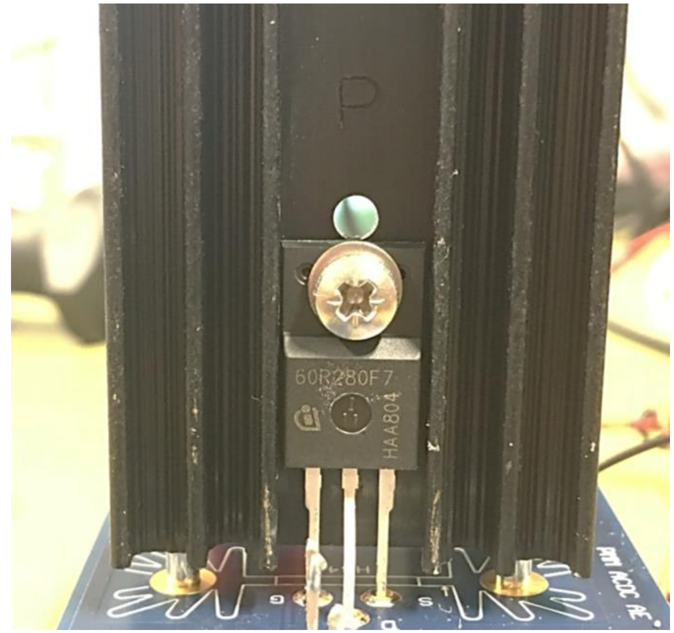
MOSFET replacement

IPA60R099C7 → IPA60R280CFD7





Gate to drain charge	Q_{gd}	-	5	-	nC	V_{DD}=400V, I_D=5.0A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	18	-	nC	V_{DD}=400V, I_D=5.0A, V_{GS}=0 to 10V

$$C_{LOAD} \approx \frac{13\ nC}{10\ V} = 1.3\ nF \quad for\ V_{GS} = 12\ V$$

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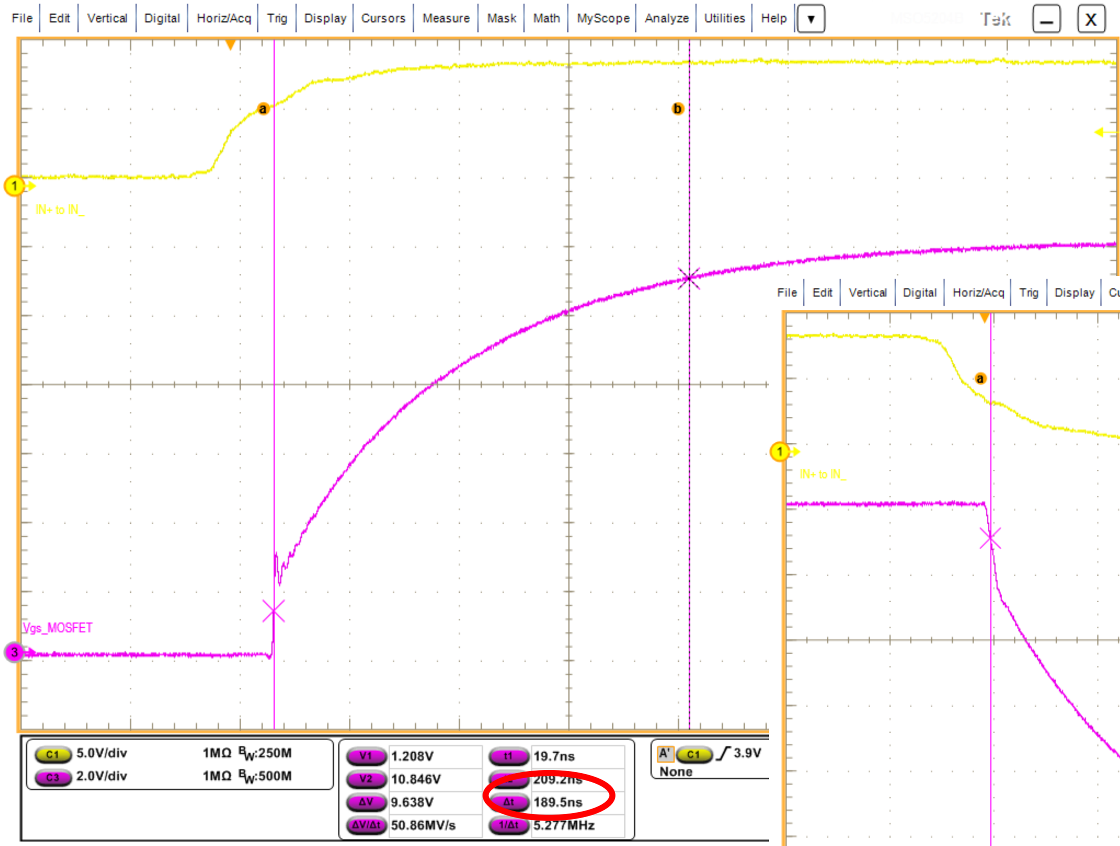
Rise/fall times: New MOSFET



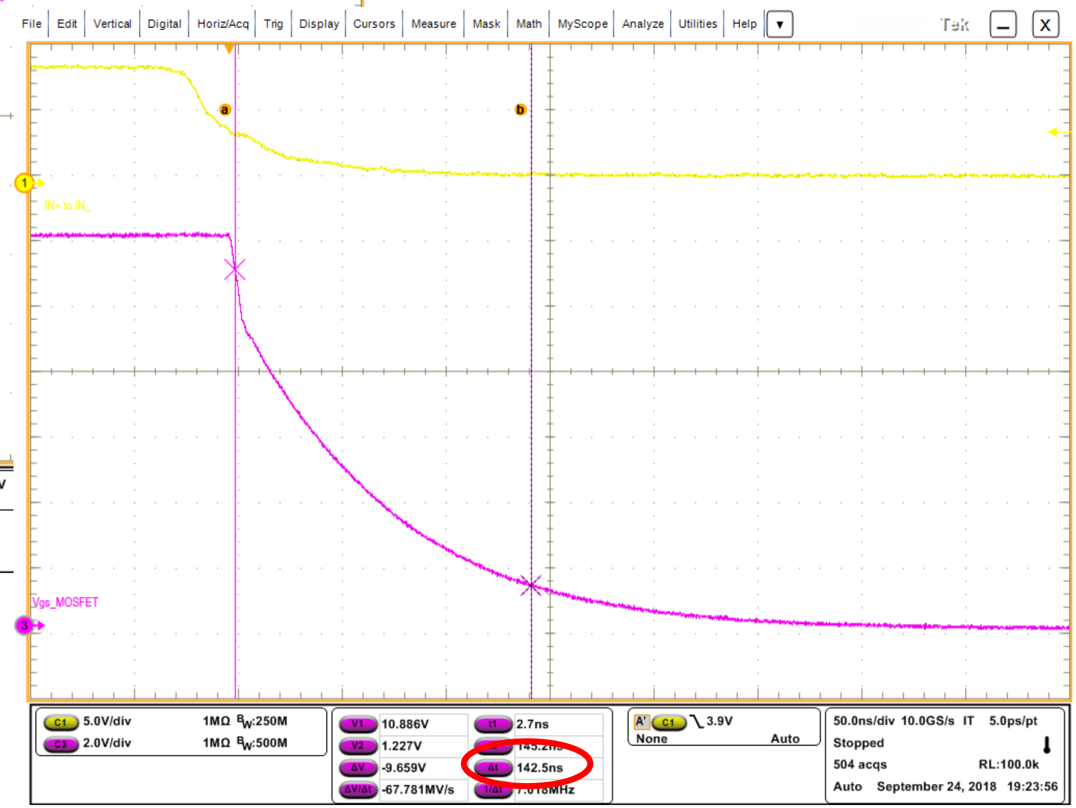
$R_{G,SOURCE} = 51\ \Omega$

$R_{G,SINK} = 43\ \Omega$

MOSFET = IPA60R280CFD7

$R_{G,MOSFET} = 11\ \Omega$

$C_{LOAD} \approx 1.3\ nF$



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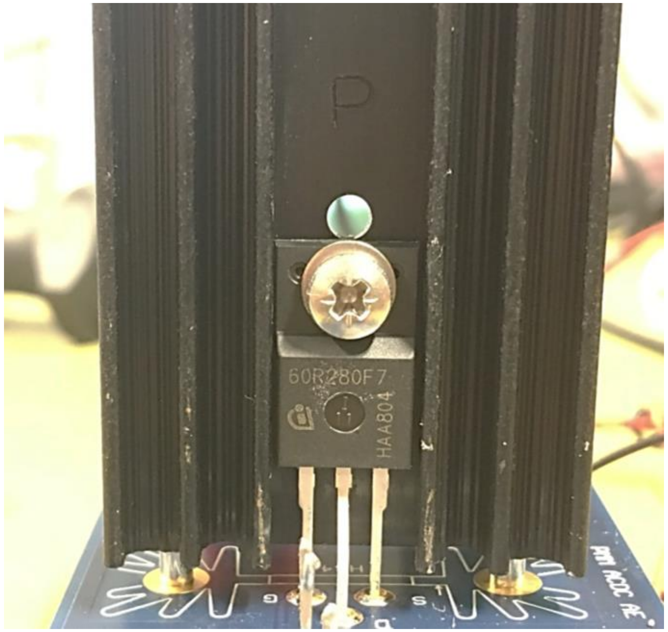
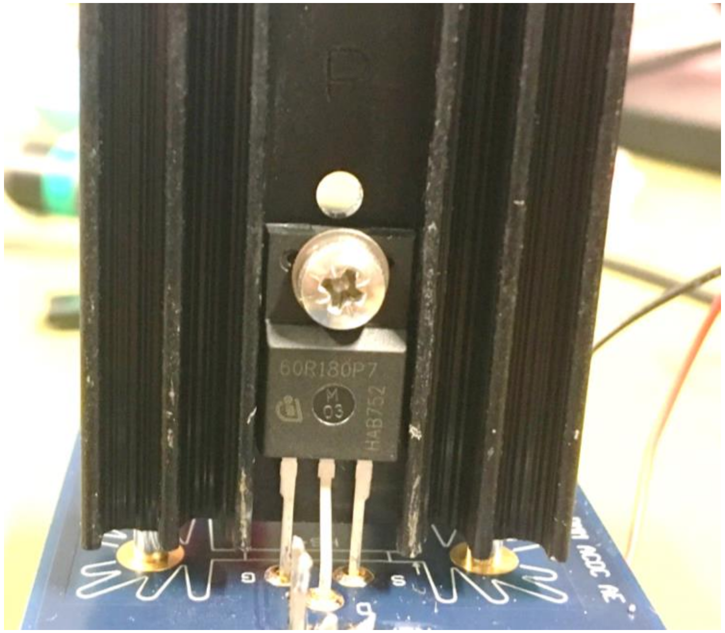
MOSFET replacement

IPA60R280CFD7 → IPA60R180P7





Gate to drain charge	Q_{gd}	-	8	-	nC	V_{DD}=400V, I_D=5.6A, V_{GS}=0 to 10V
Gate charge total	Q_g	-	25	-	nC	V_{DD}=400V, I_D=5.6A, V_{GS}=0 to 10V

$$C_{LOAD} \approx \frac{19\,nC}{10\,V} = 1.9\,nF \;\; for\, V_{GS} = 12\,V$$

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Rise/fall times: New MOSFET

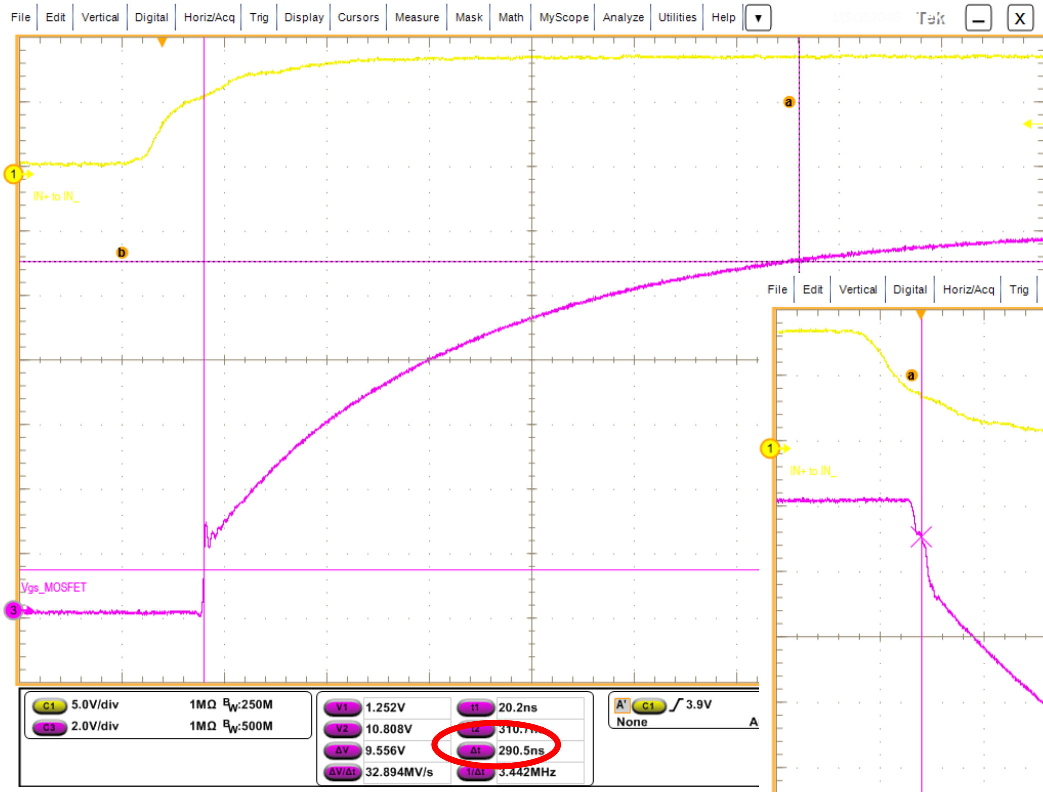
$R_{G,SOURCE} = 51\ \Omega$

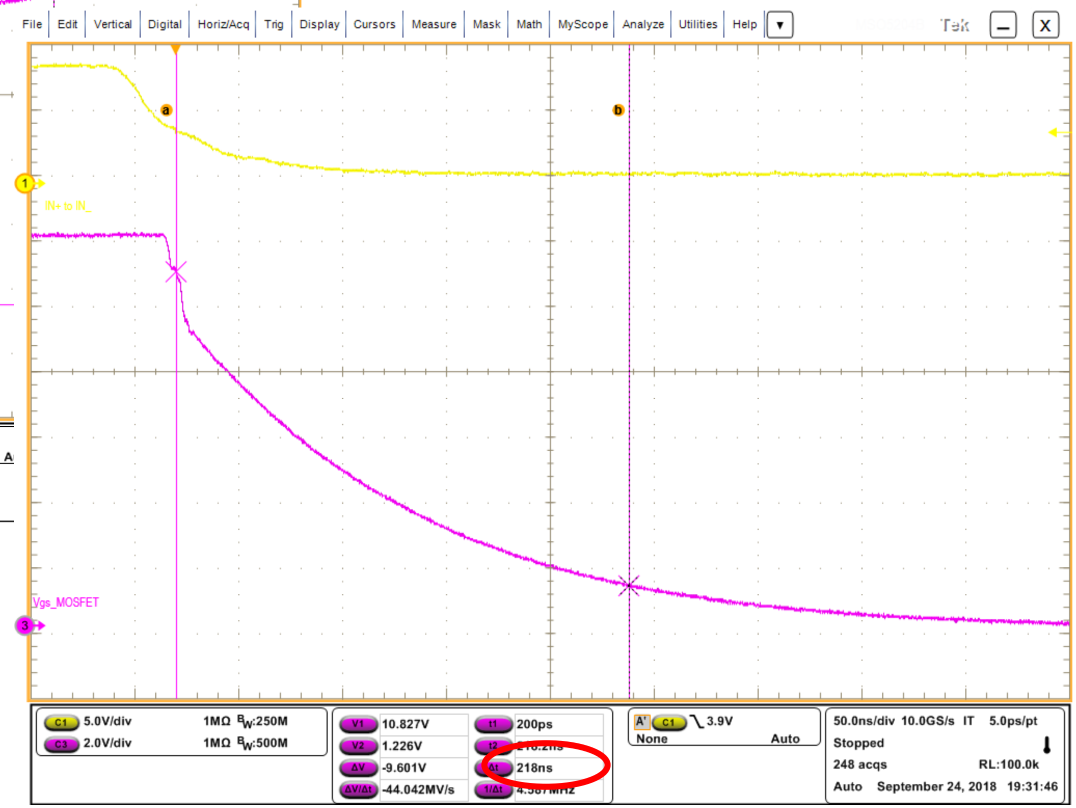
$R_{G,SINK} = 43\ \Omega$

MOSFET = IPA60R180P7

$R_{G,MOSFET} = 11\ \Omega$

$C_{LOAD} \approx 1.9\ nF$





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Additional notes

- Note that the MOSFET is not turned-on or -off, you are only charging/discharging the gate-to-source capacitance
- Changing the gate resistors and the MOSFETs, you are changing the load for the driver
- If you want to turn-on or turn-off the MOSFET, you must integrate the board in a proper circuit
- You can not apply directly the voltage (e.g 400 V) across the MOSFET through the banana connectors on the board
- You must limit the input current from the DC source generator → add an inductance
- You must create a freewheeling path for the current when MOSFET is off

Example: boost converter, simple MOSFET in clamped inductive mode

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