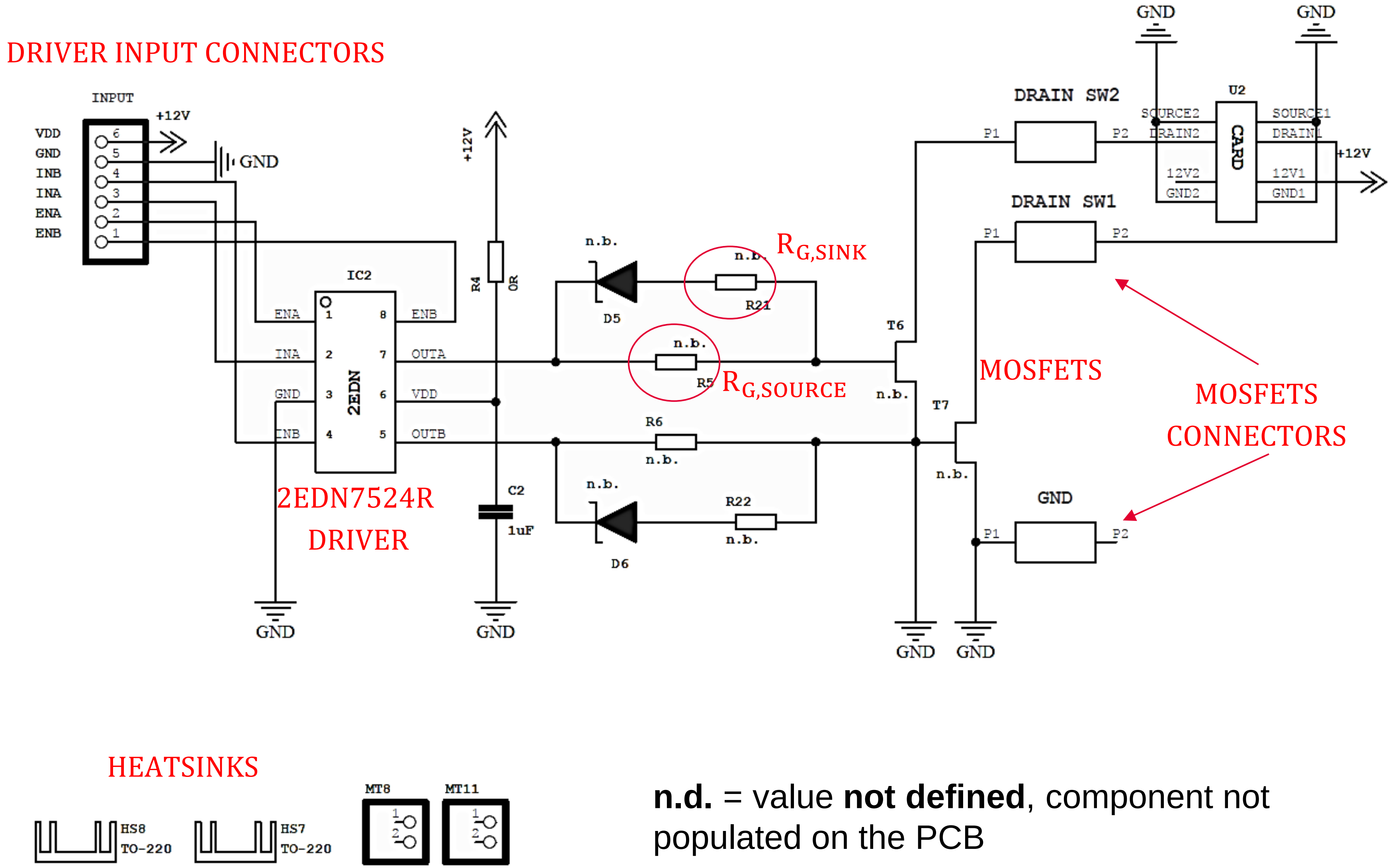
Quick start guide KIT_DRIVER_2EDN7524R

August 2018

KIT_DRIVER_2EDN7524R

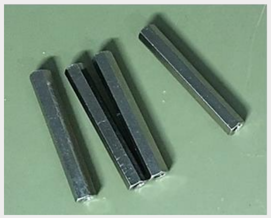
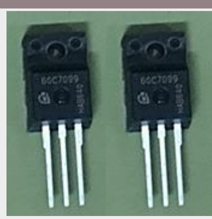
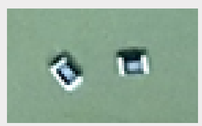
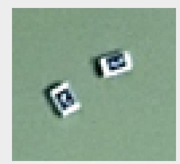
Included in this kit

Board schematic



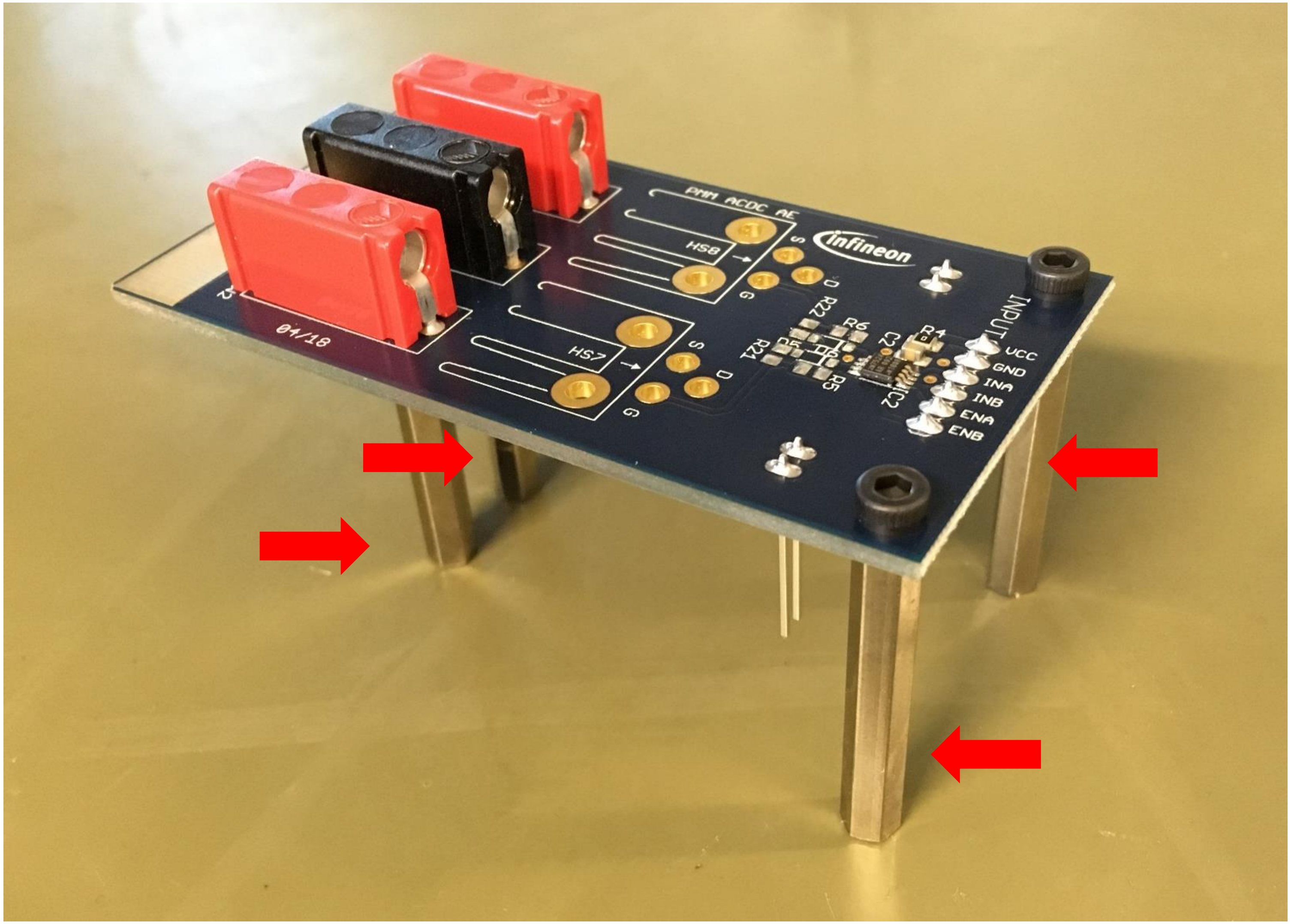
n.d. = value **not defined**, component not populated on the PCB

Components to add – BOM suggestion

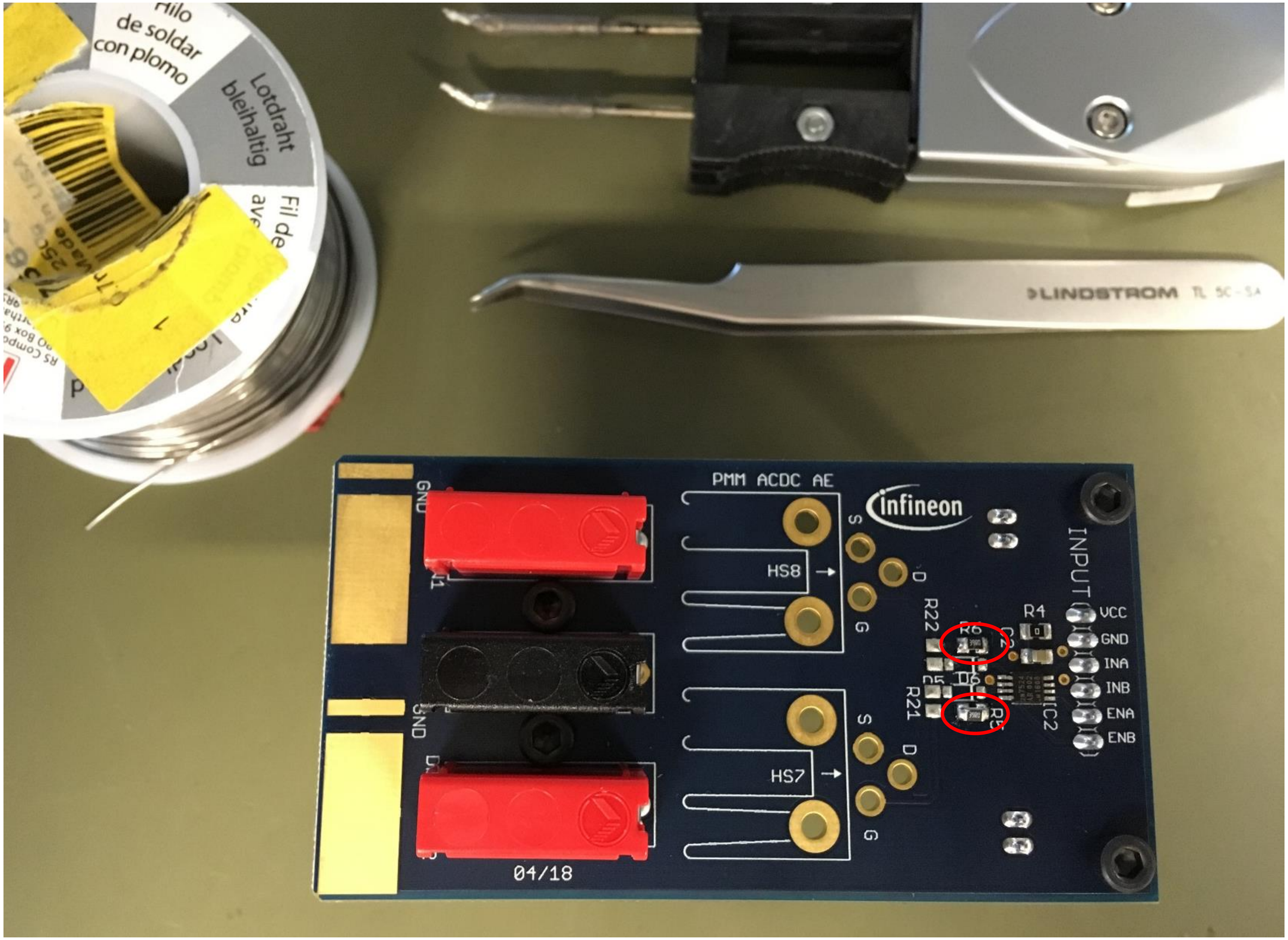
Distance bolts	Screws for distance bolts	Screws and washers for MOSFET mounting to heatsink	TO-220 sockets
			
TO-220 MOSFETs	**Source resistors (R5, R6)**	**Sink resistors (R21, R22)**	**Sink diodes**
			

Component	Quantity	Designator	Comment	Voltage	Footprint	Type	Part number/ supplies
Sink diode	2	D5,D6	Schottky diode	30 V	SOD-123	PMEG3020 Schottky diode	816-6858 RS-Components
Resistors	4	R5,R6,R21,R22			RES805R	SMD ceramic resistor	
TO-220 sockets	2	T6,T7	TO-220 socket		TO-220	Receptacle Connector 0.034" ~ 0.041" (0.86 mm ~ 1.04 mm)	5050865-5 Digi-key

Step 1: Distance bolts mounting

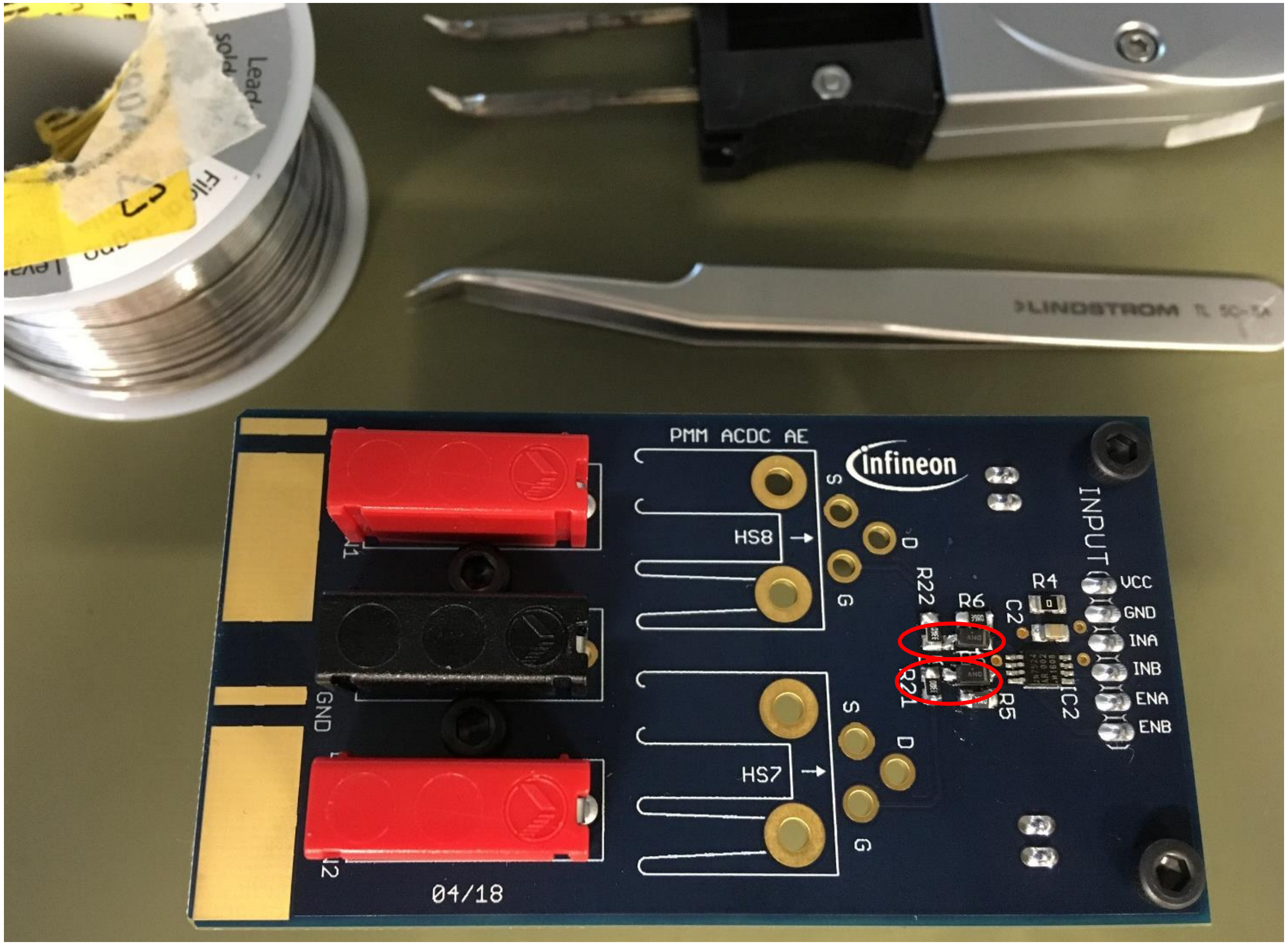


Step 2: Source resistors soldering

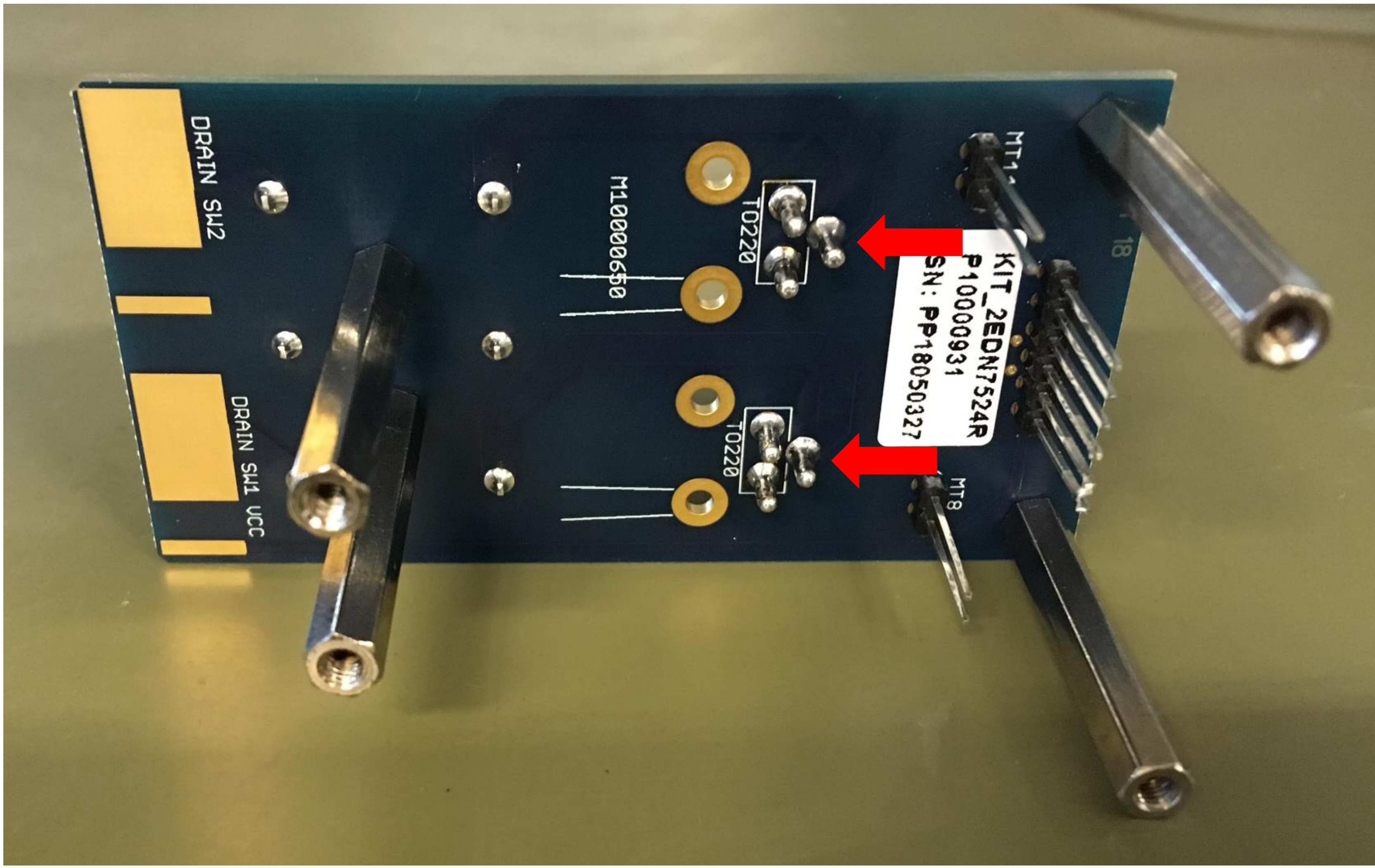


Step 3: Sink resistors and sink diodes soldering

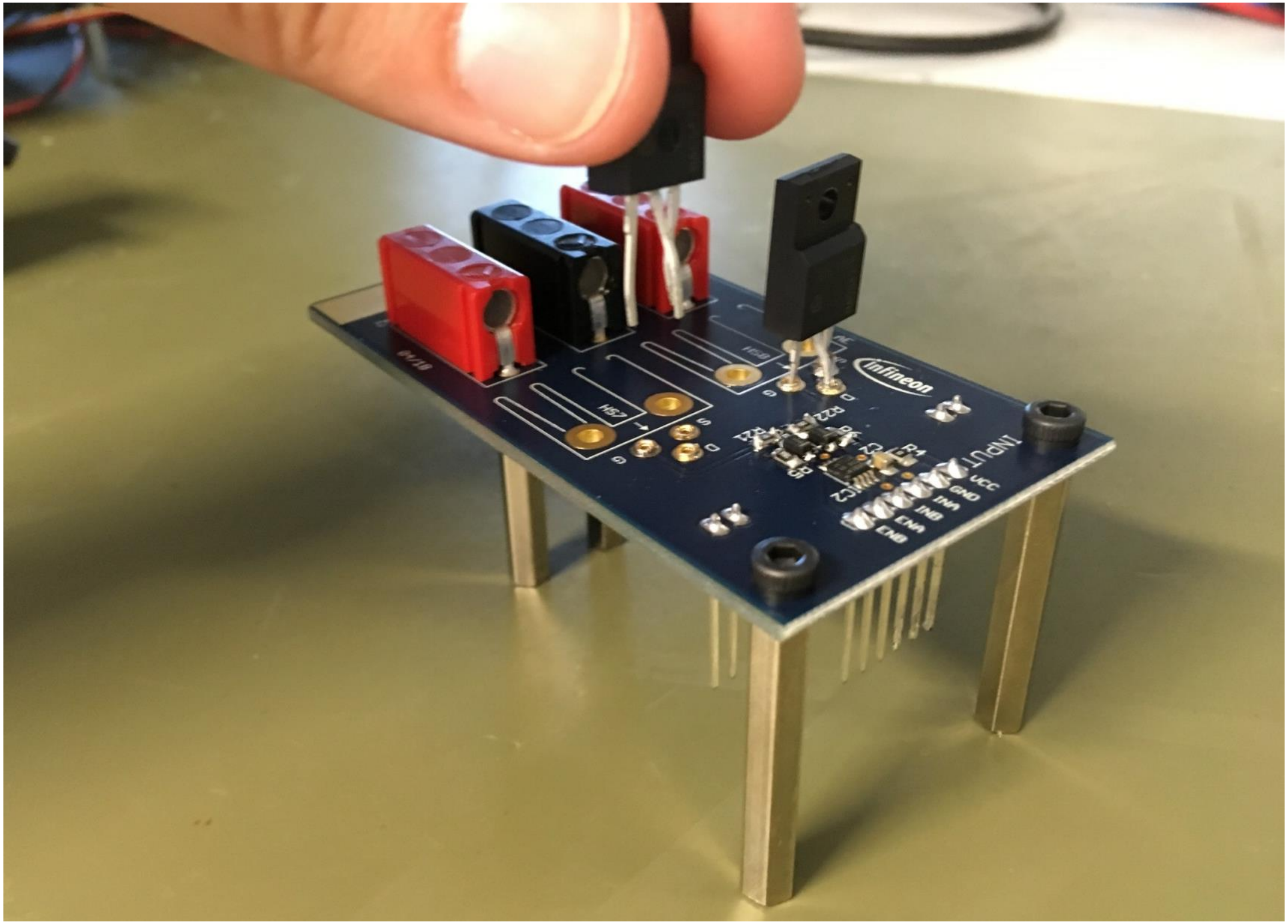
- Add the sink resistors and the sink diodes only if a differentiation between the turn-on and the turn-off behavior is required



Step 4: TO-220 sockets soldering

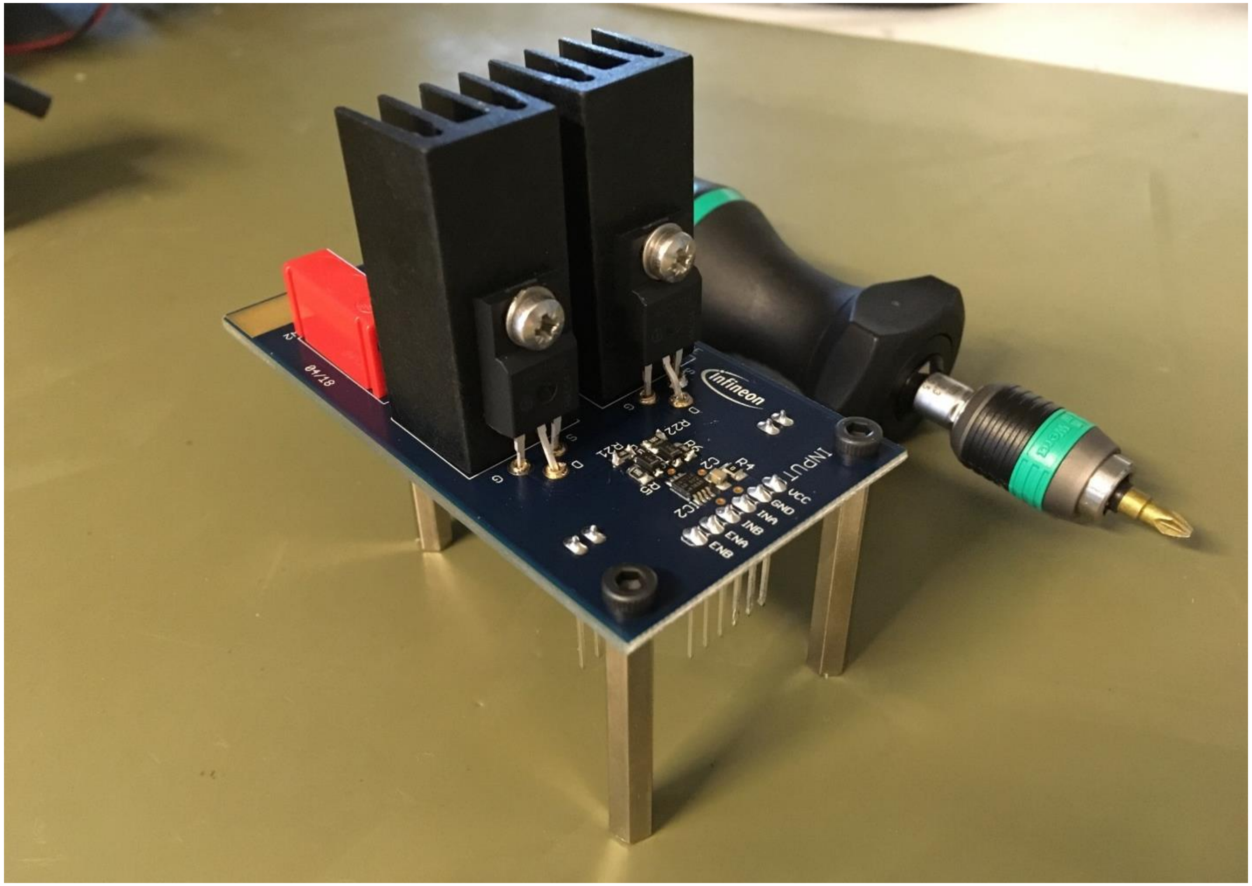


Step 5: MOSFETs placement into the sockets

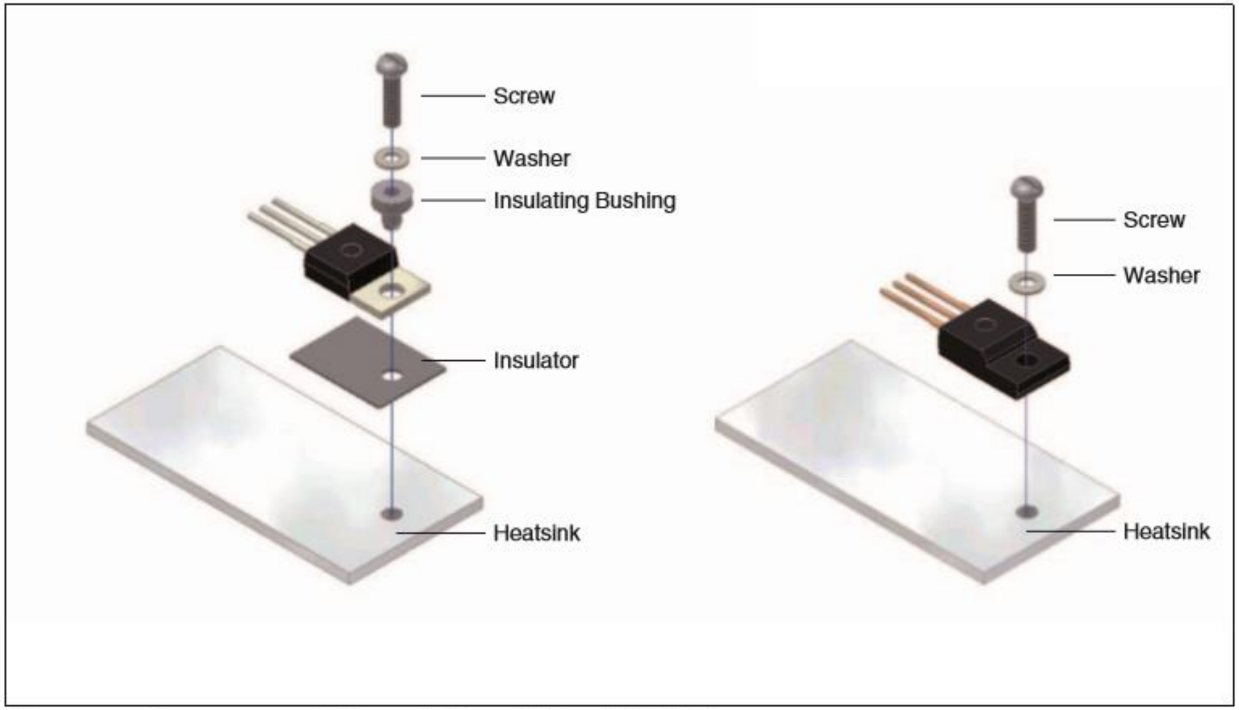


Step 6: Heatsink mounting (optional)

- 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



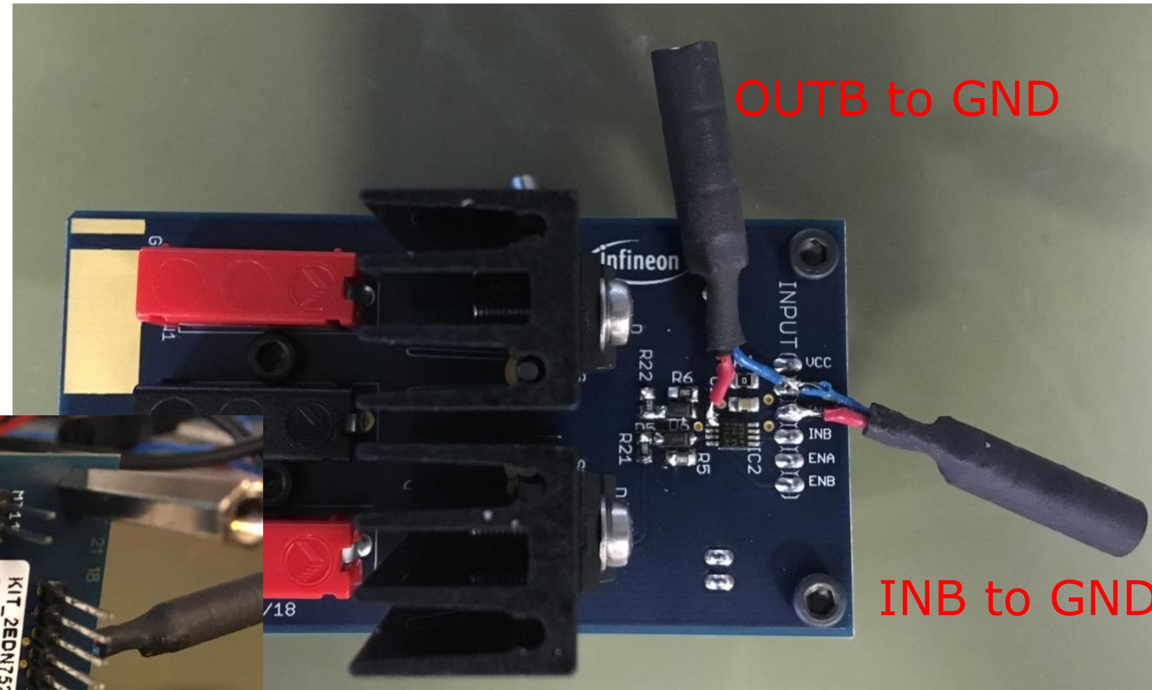
TO-220 MOSFET mounting to the heatsink

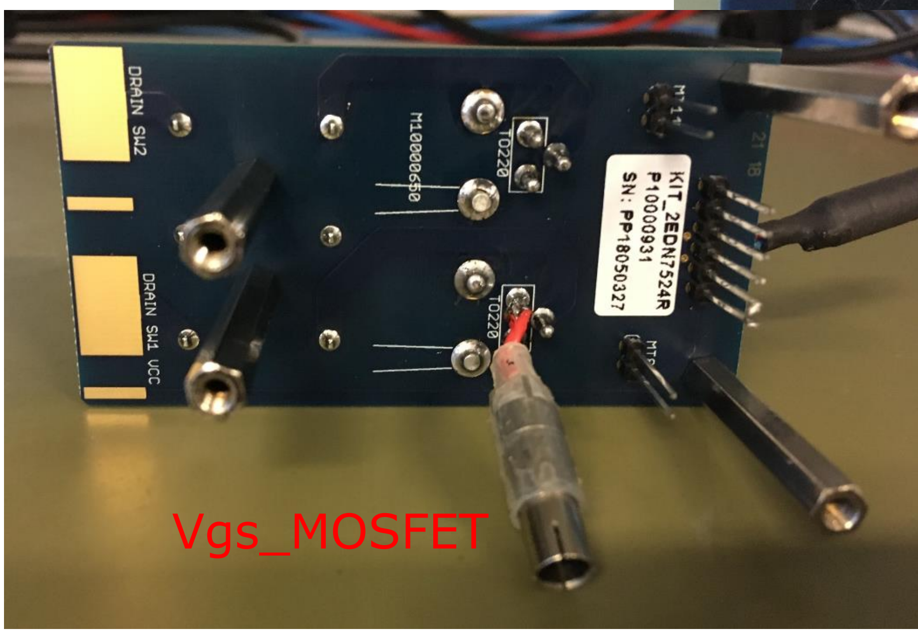


Package	Typ. Torque [Nm]	Max. Torque [Nm]	Comment
PG-TO220	0.6	0.7	Screw M3
PG-TO220 FullPAK	0.5	0.7	Screw M2.5

- 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

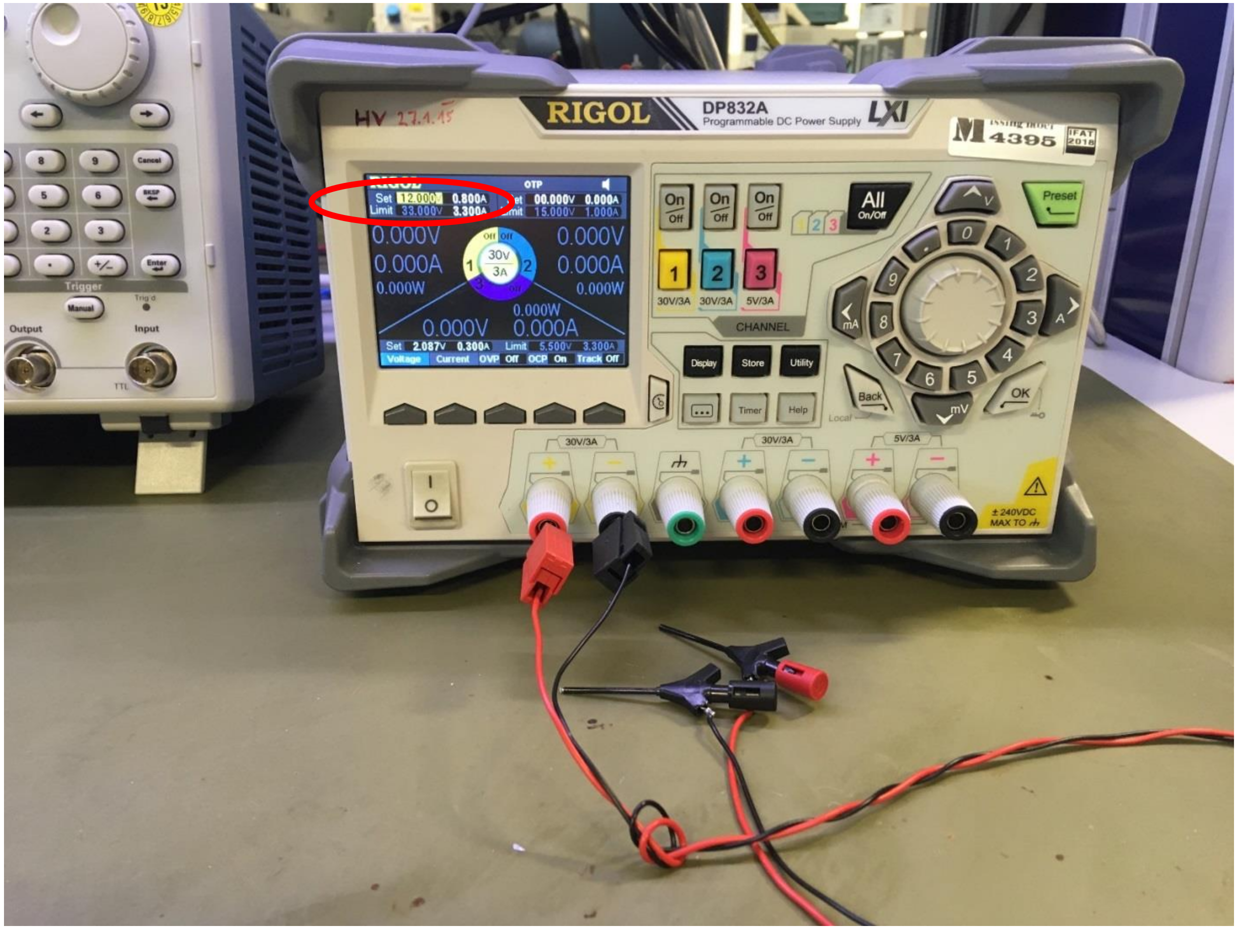
Step 7: BNC connectors soldering





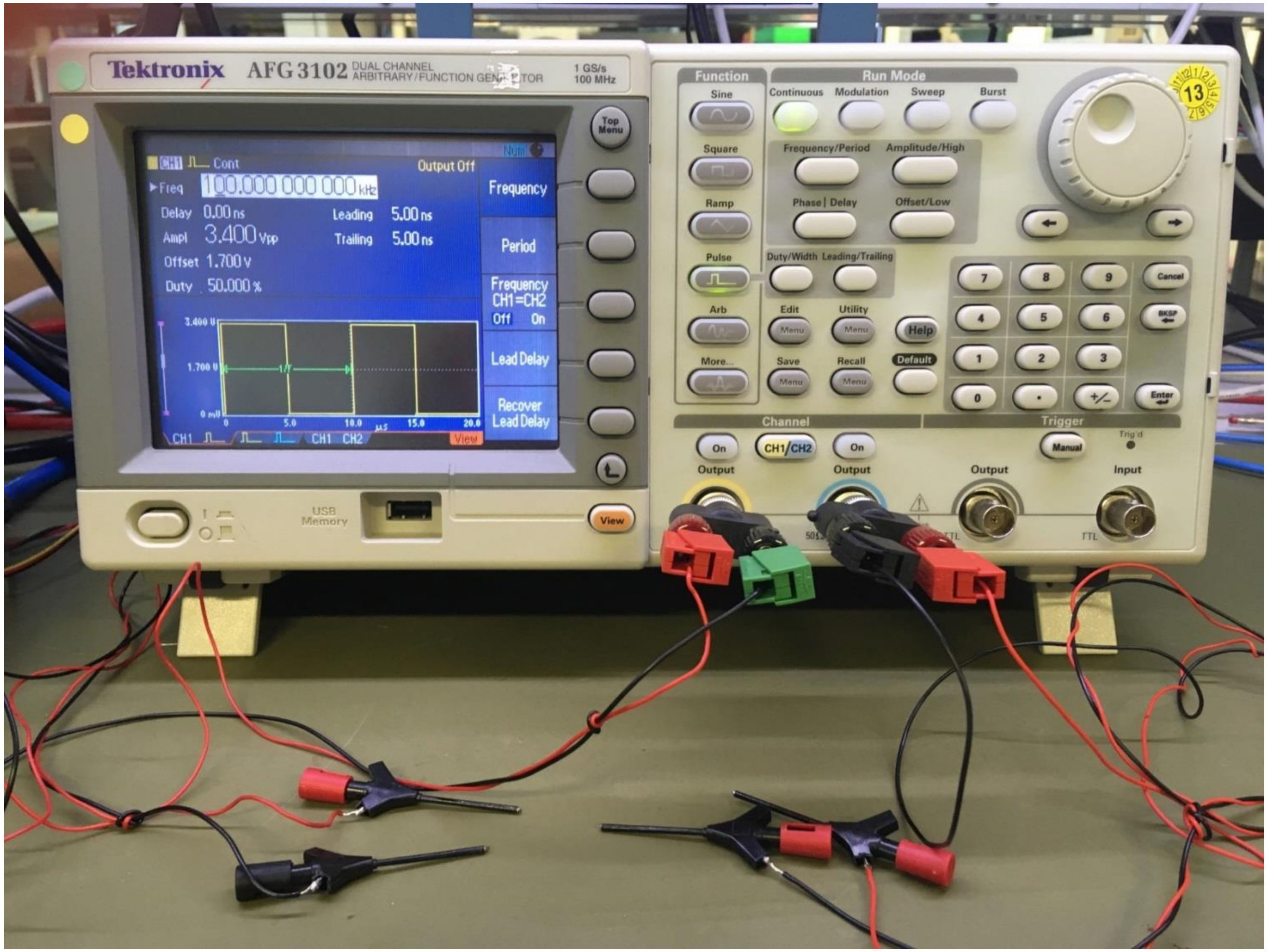
› N.B. Please note that the silkscreen labels for INA and INB are merged

Instrumentation for driver supply generation



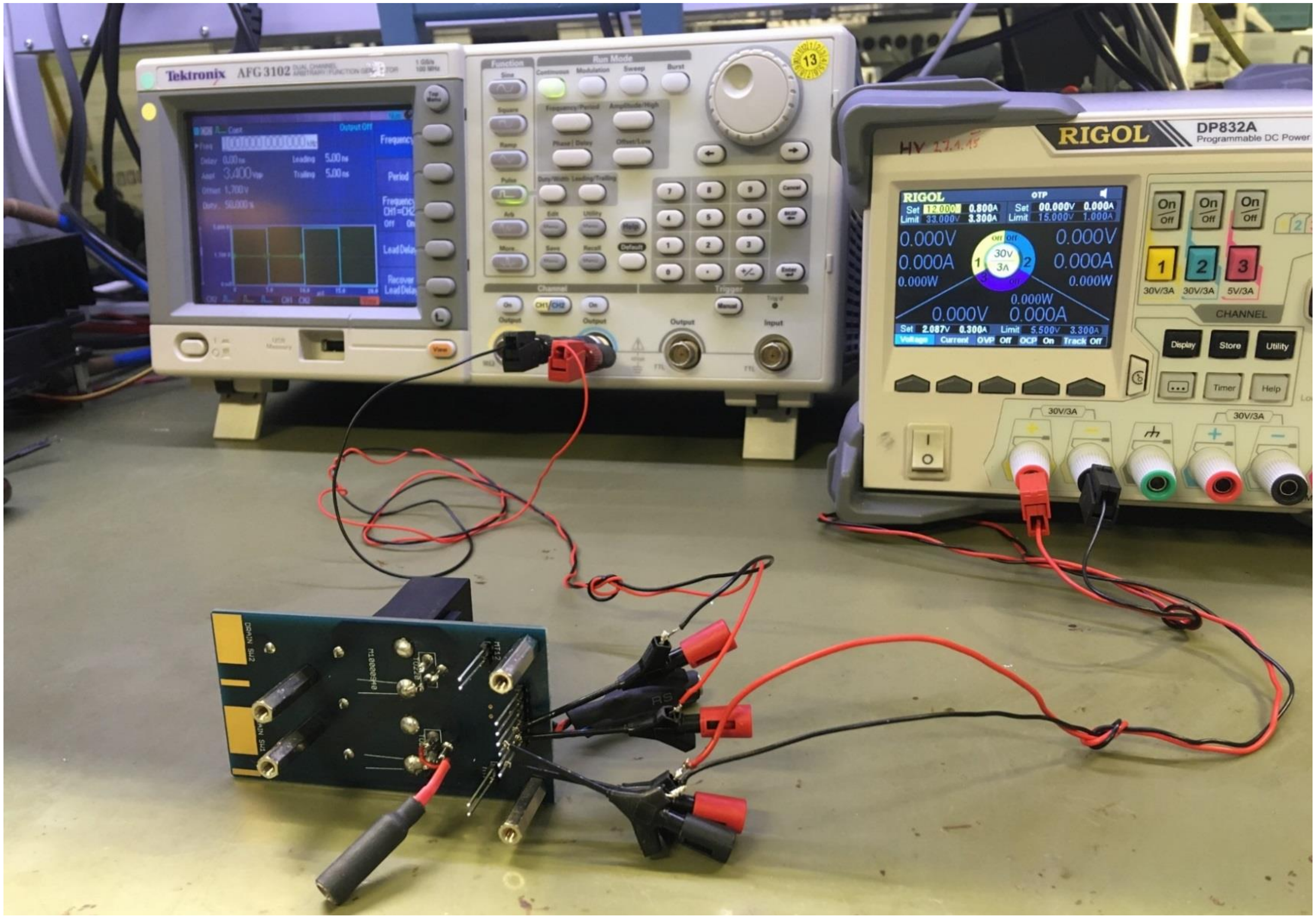
- V_{cc}=12 V for CoolMOS™ and 8 V for OptiMOS™
- Set the current limit below 1 A (0.8 A e.g.)

Instrumentation for PWM signals generation

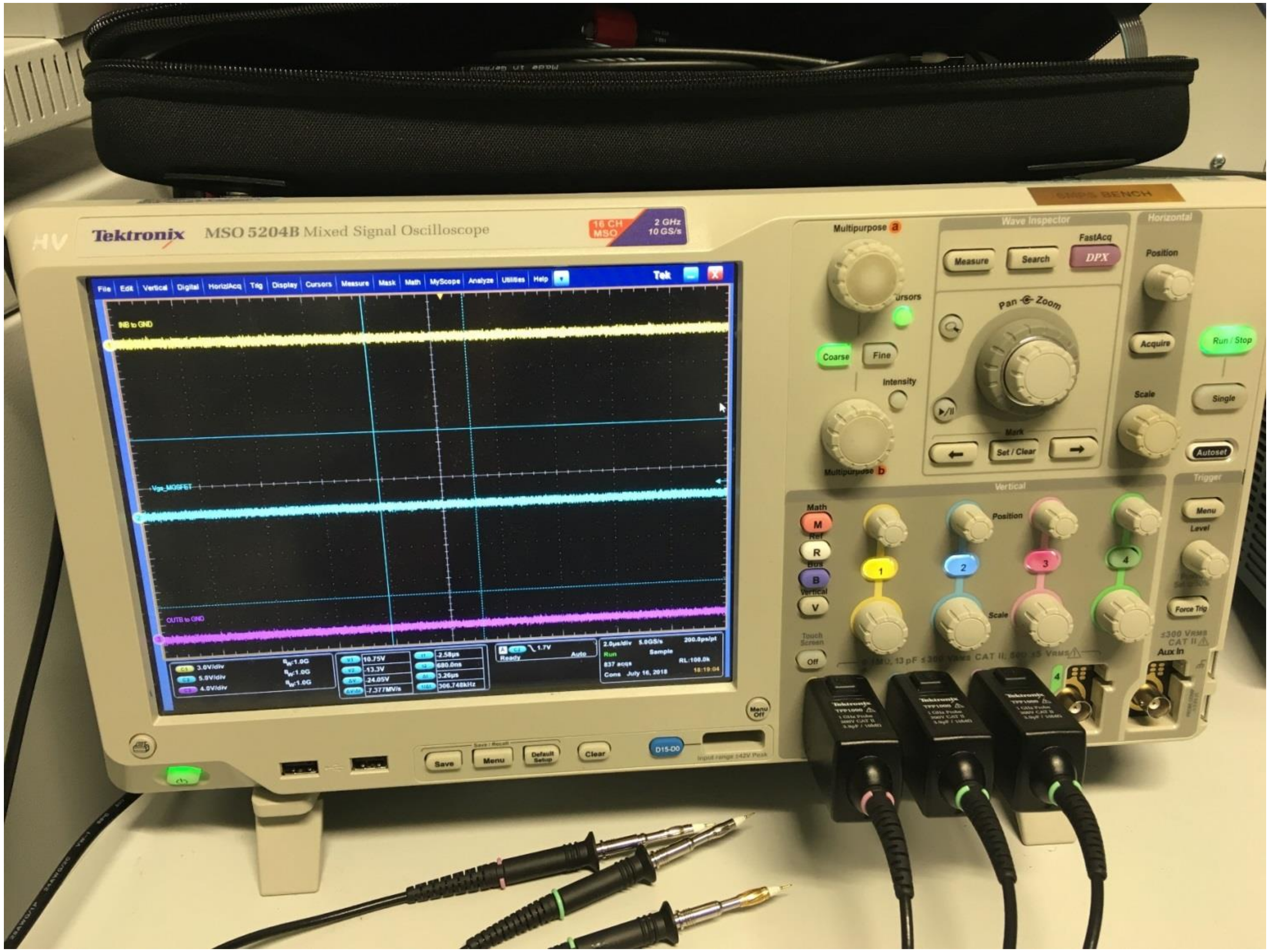


› Use a function generator or a microcontroller

Connections

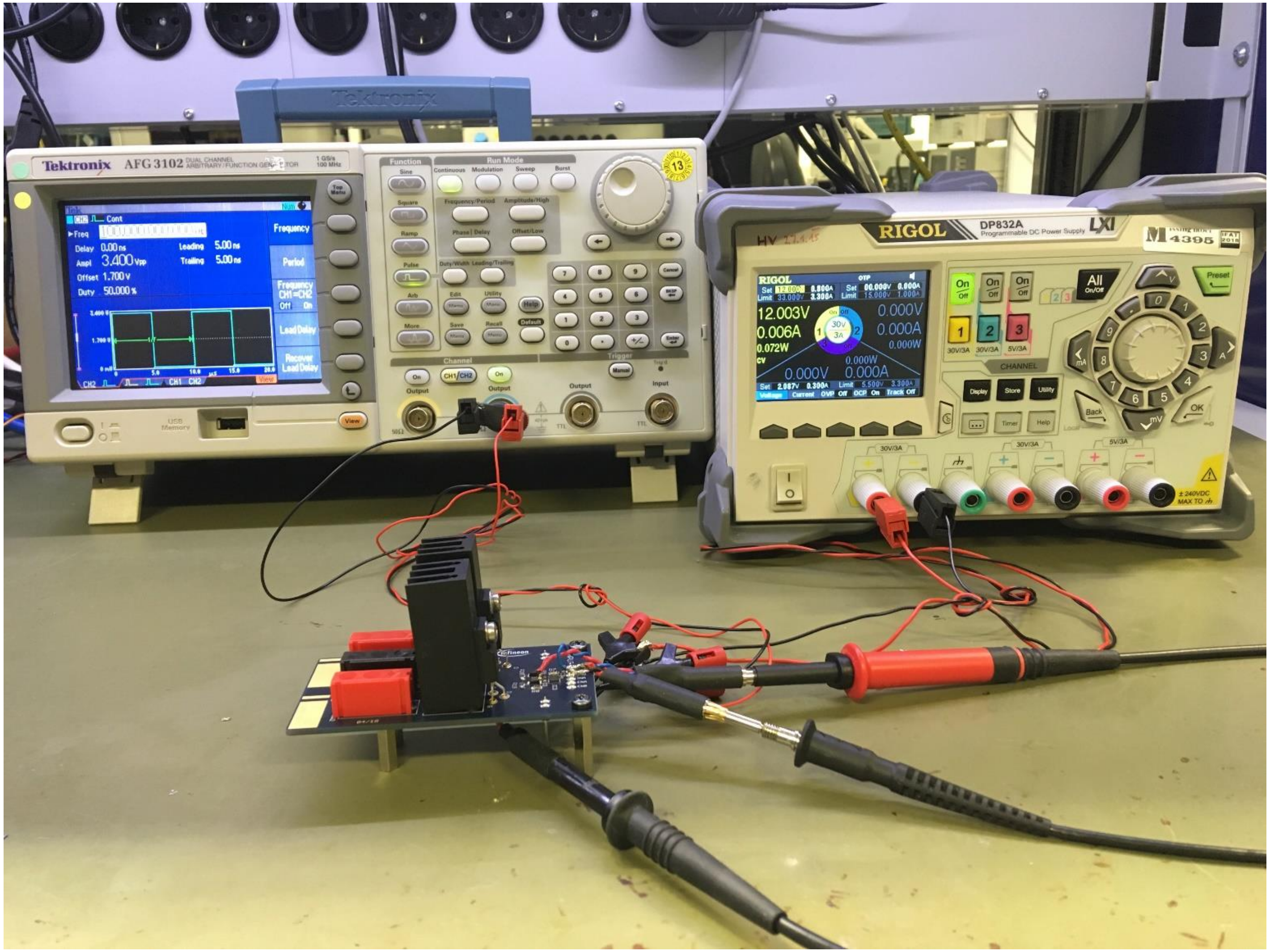


Instrumentation for signals evaluation

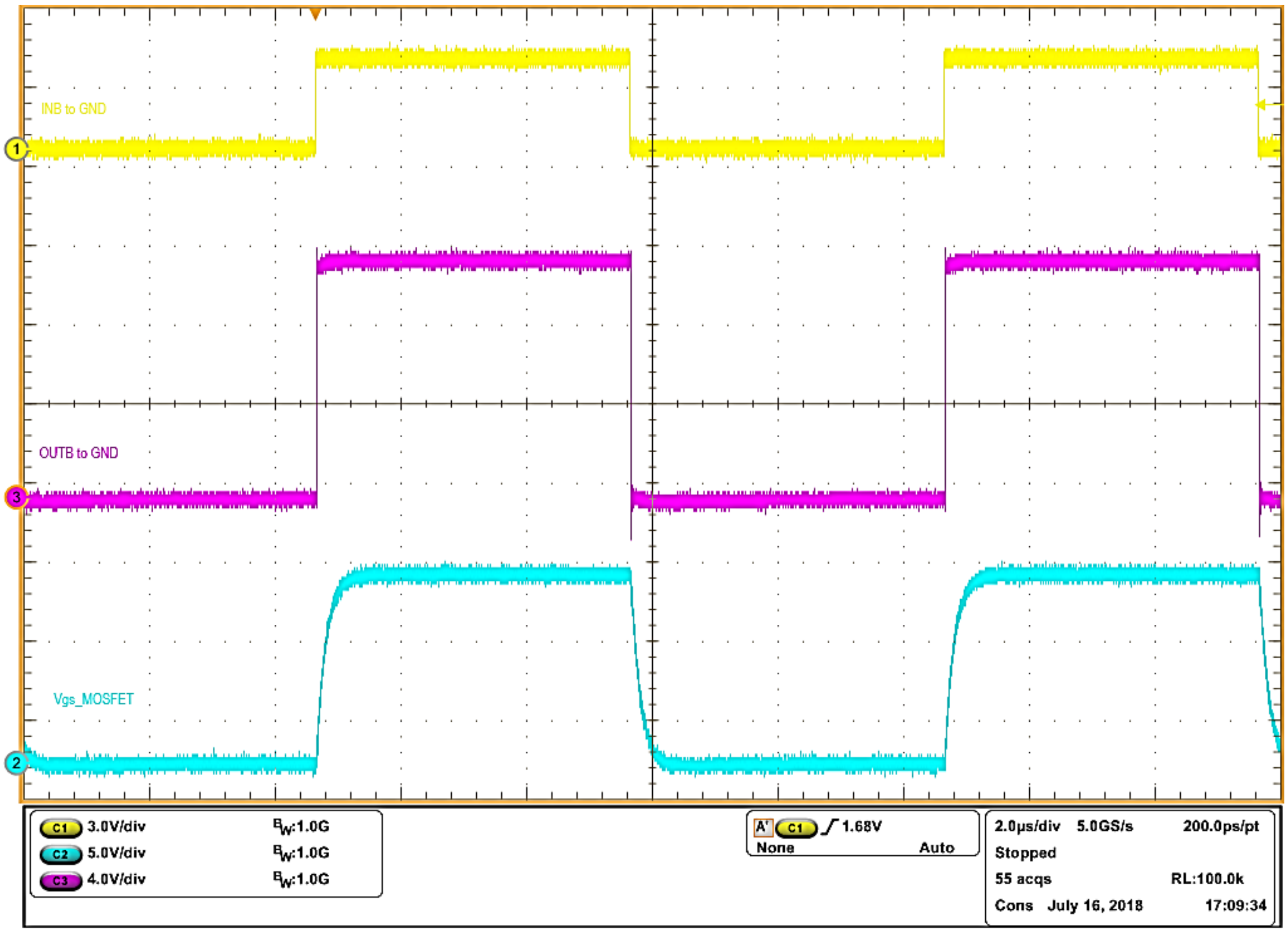


- Voltage probes used: Tetronix TPP1000 1 GHz, 3.9 pF

Complete measurement setup

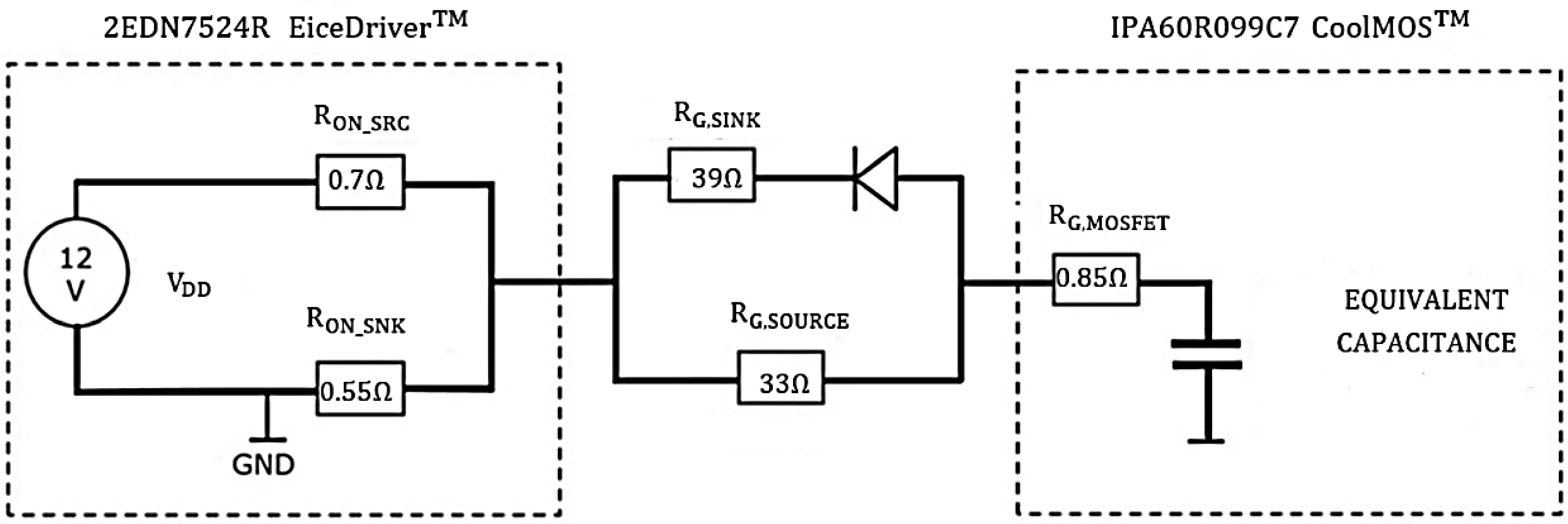


Oscilloscope waveforms

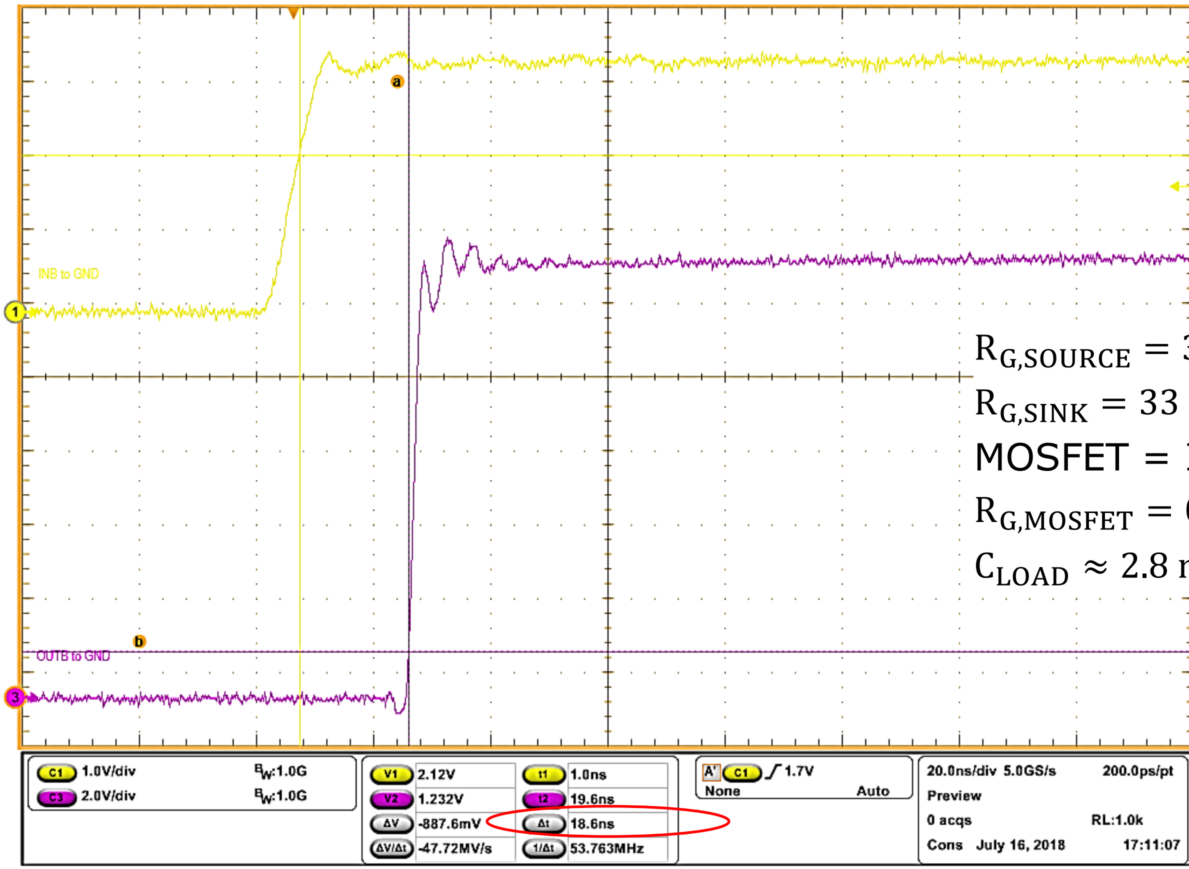


- Measurements done on a single MOSFET with $V_{DS} = 0\,V$ (drain and source shorted)

Equivalent model of the driving circuit



Low-high propagation delay



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

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

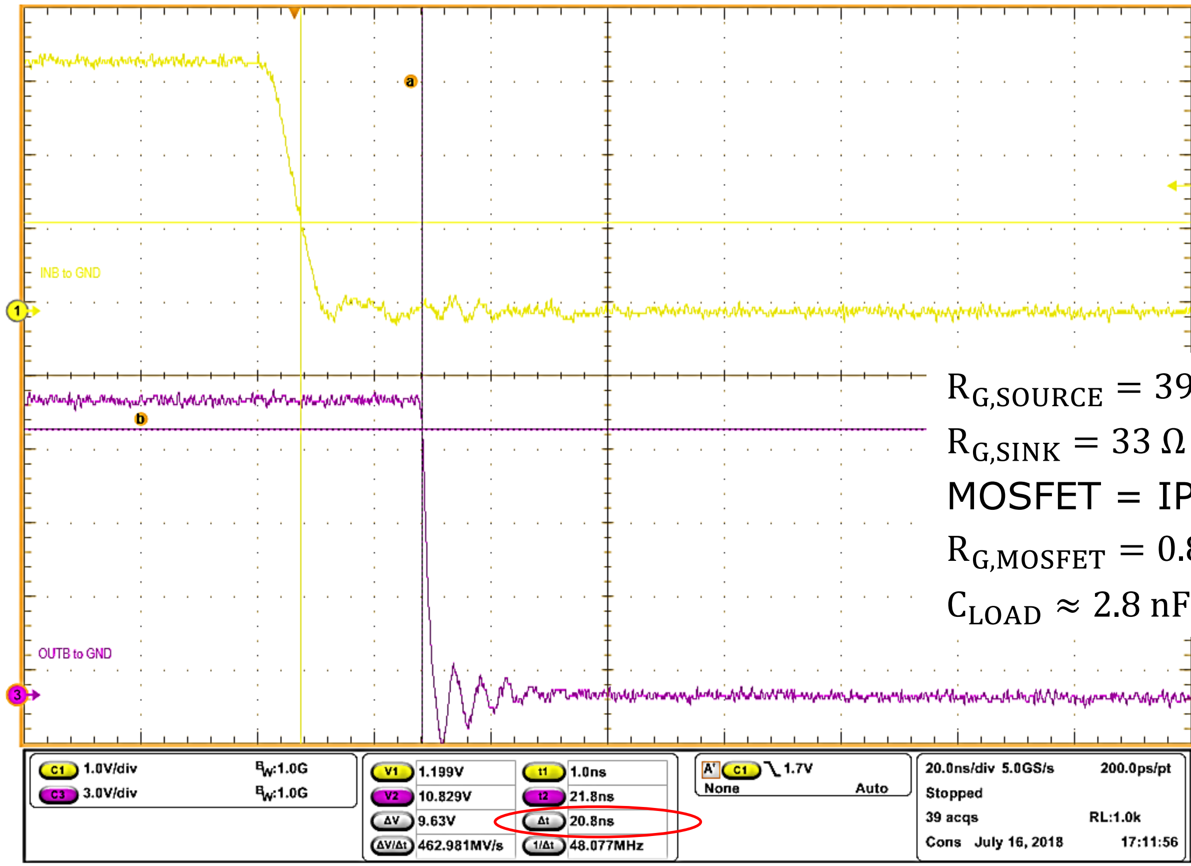
MOSFET = IPA60R099C7

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

$C_{LOAD} \approx 2.8\ \mathrm{nF}$

- t_{PDlh} defined in the datasheed as time interval t($\mathrm{OUTB} = 10\%\ \mathrm{VDD}$) - t($\mathrm{INB} = V_{INH} = 2.1\ \mathrm{V}$) for a pure capacitive load $C_{LOAD} = 1.8\ \mathrm{nF}$ with $R_{G,SOURCE} = 0\ \Omega$
- N.B. In the considered measurements the load is the transistor with $R_{G,MOSFET} = 0.82\ \Omega$, $R_{G,SOURCE} = 39\ \Omega$, $C_{LOAD} \approx 2.8\ \mathrm{nF}$ (see slide 23 for C_{LOAD} calculation)

High-Low propagation delay



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

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

MOSFET = IPA60R099C7

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

$C_{LOAD} \approx 2.8\ nF$

- t_{PDhl} defined in the datasheed as time interval t$(OUTB = 90\%\ VDD)$ - t$(INB = V_{INL} = 1.02\ V)$ for a pure capacitive load $C_{LOAD} = 1.8\ nF$ with $R_{G,SINK} = 0\ \Omega$
- N.B. In the considered measurements the load is the transistor with $R_{G,MOSFET} = 0.82\ \Omega$, $R_{G,SINK} = 33\ \Omega$, $C_{LOAD} \approx 2.8\ nF$

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

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

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

Rise/fall times

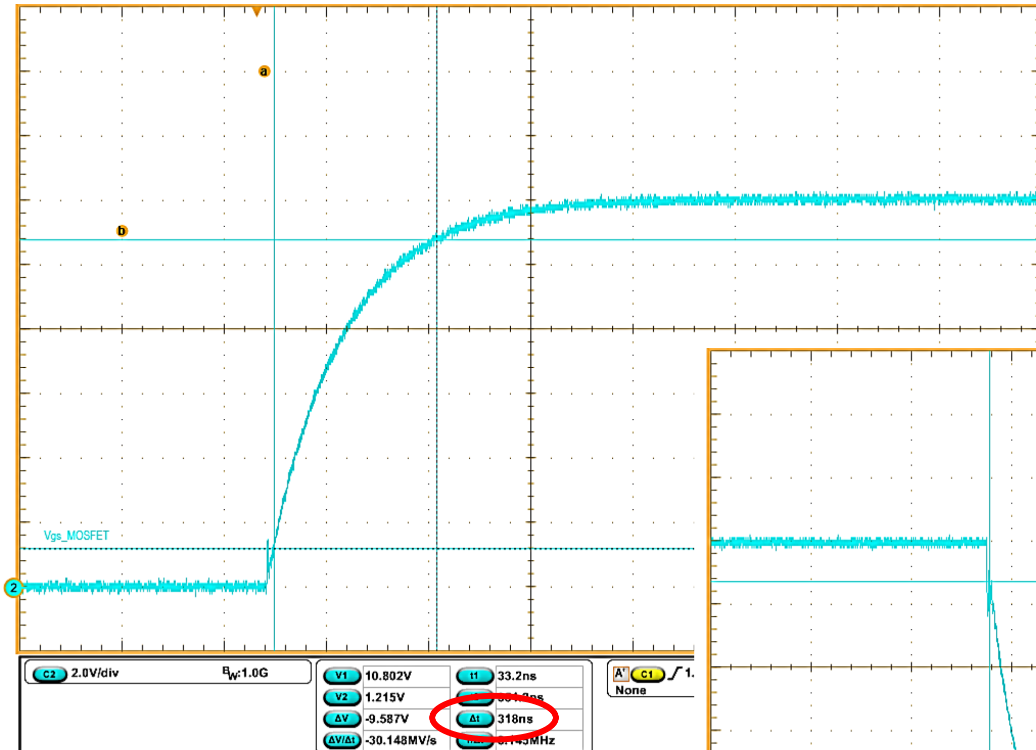
$R_{G,SOURCE} = 39\ \Omega$

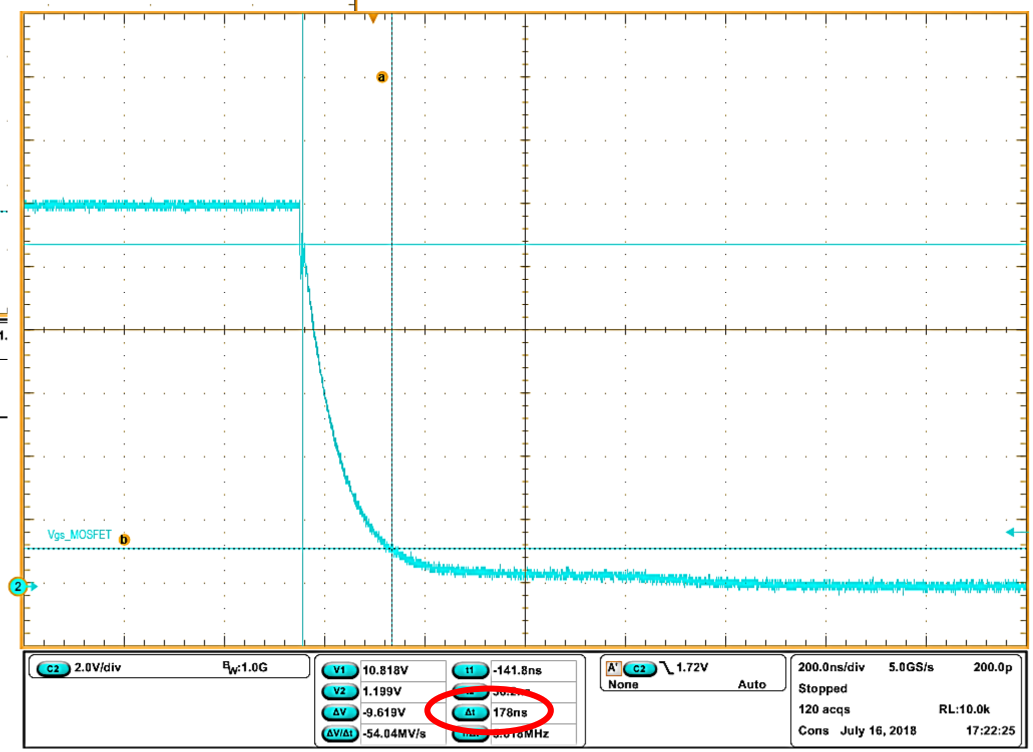
$R_{G,SINK} = 33\ \Omega$

MOSFET = IPA60R099C7

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

$C_{LOAD} \approx 2.8\ nF$





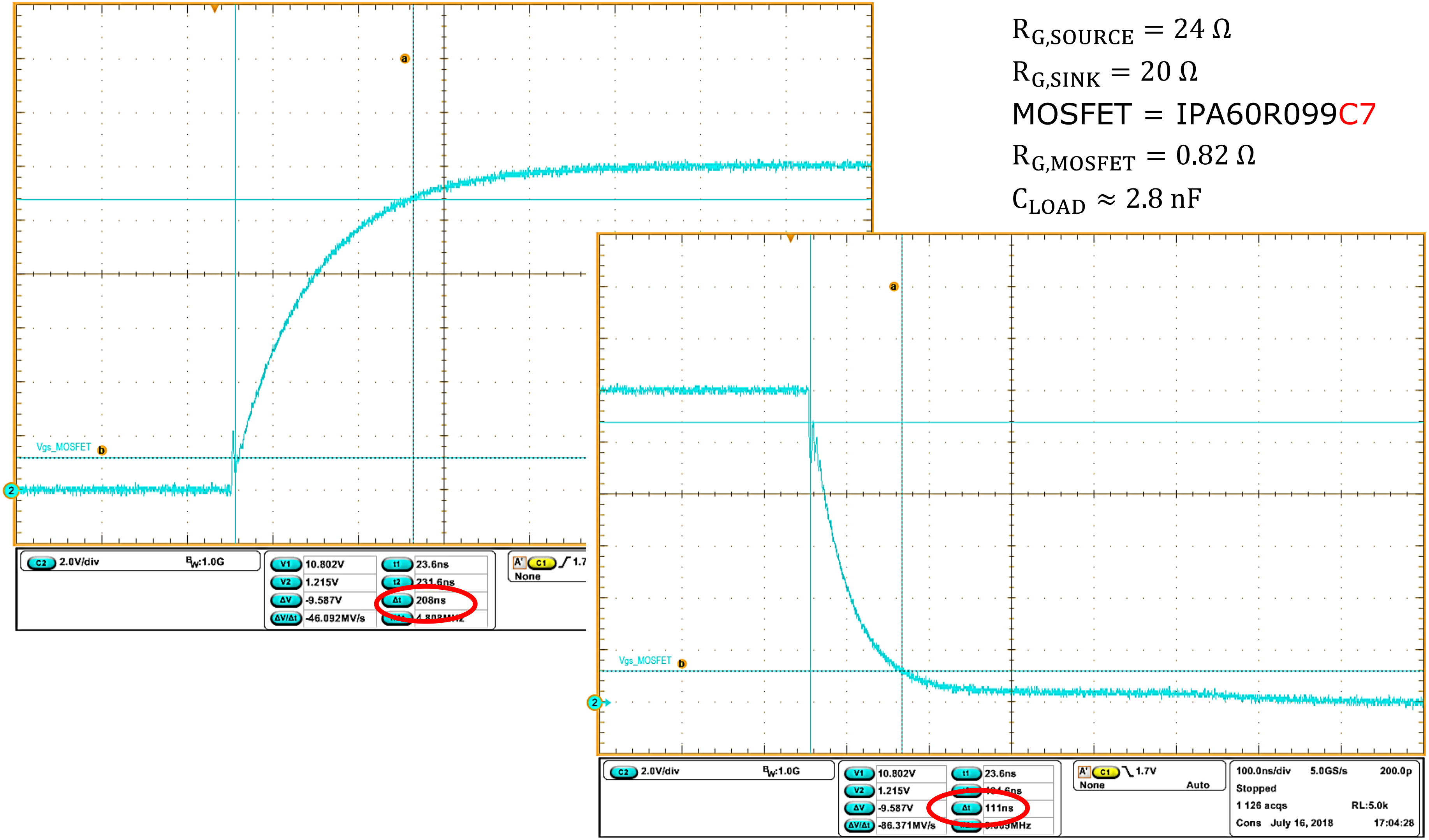
Gate resistors replacement

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

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

MOSFET = IPA60R099C7

Rise/fall times: New set of gate resistances



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

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

MOSFET = IPA60R099C7

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

$C_{LOAD} \approx 2.8\ nF$

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

Rise/fall times: New set of gate resistances

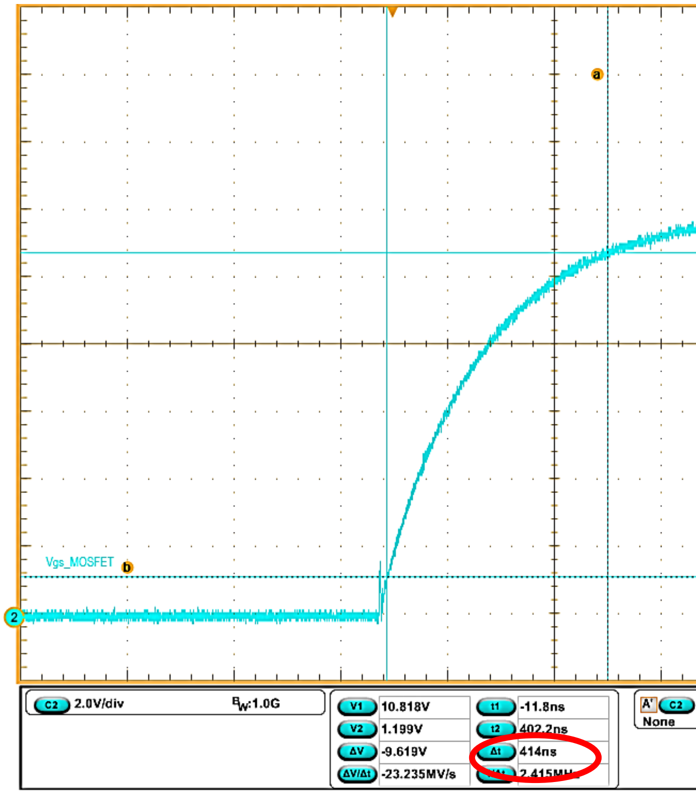
$R_{G,SOURCE} = 51\ \Omega$

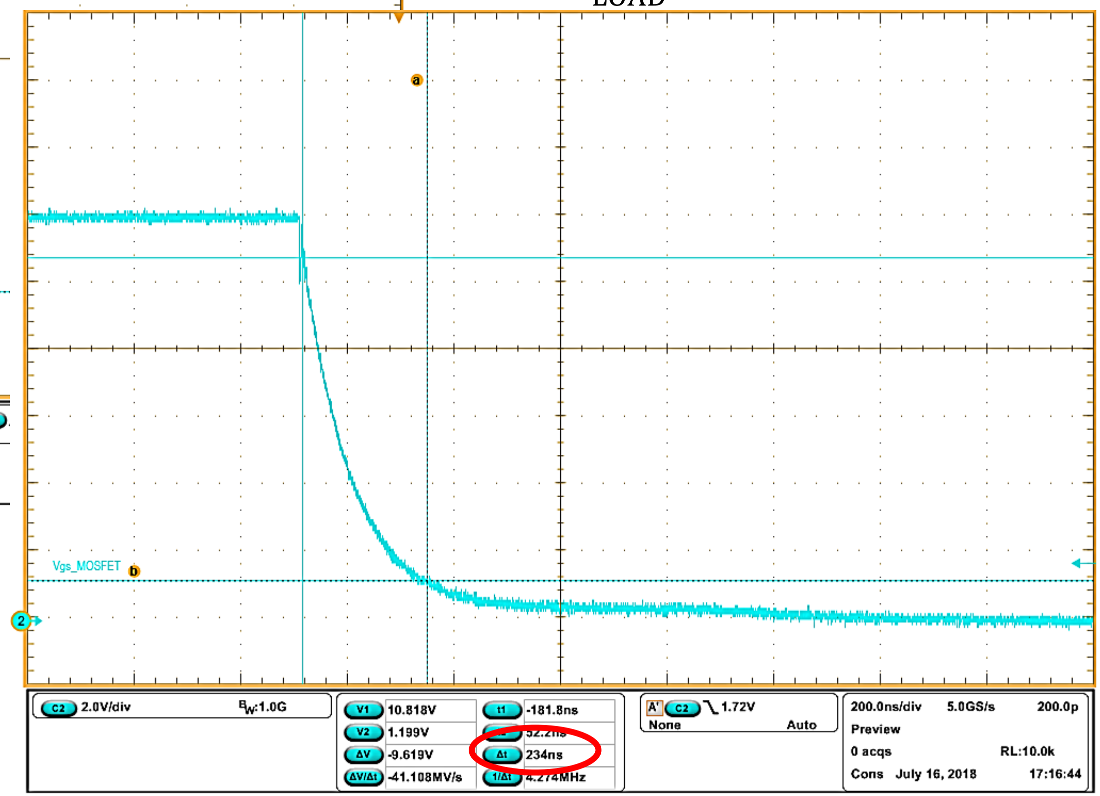
$R_{G,SINK} = 43\ \Omega$

MOSFET = IPA60R099C7

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

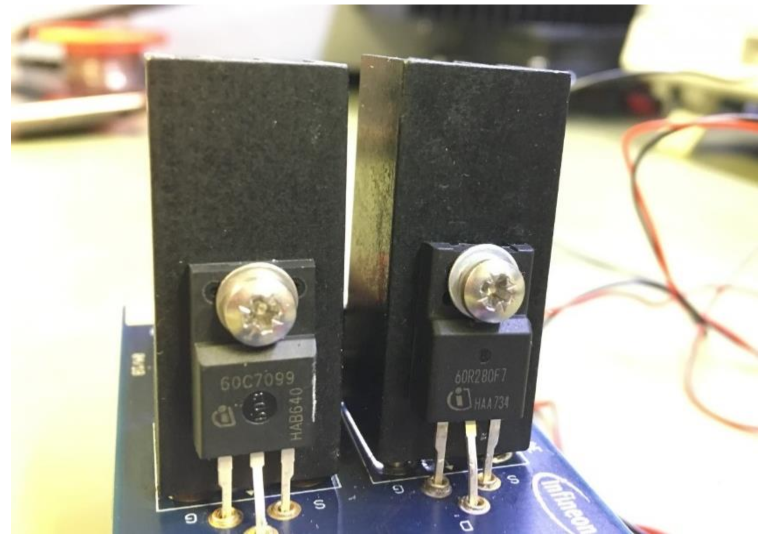
$C_{LOAD} \approx 2.8\ nF$





MOSFET Replacement

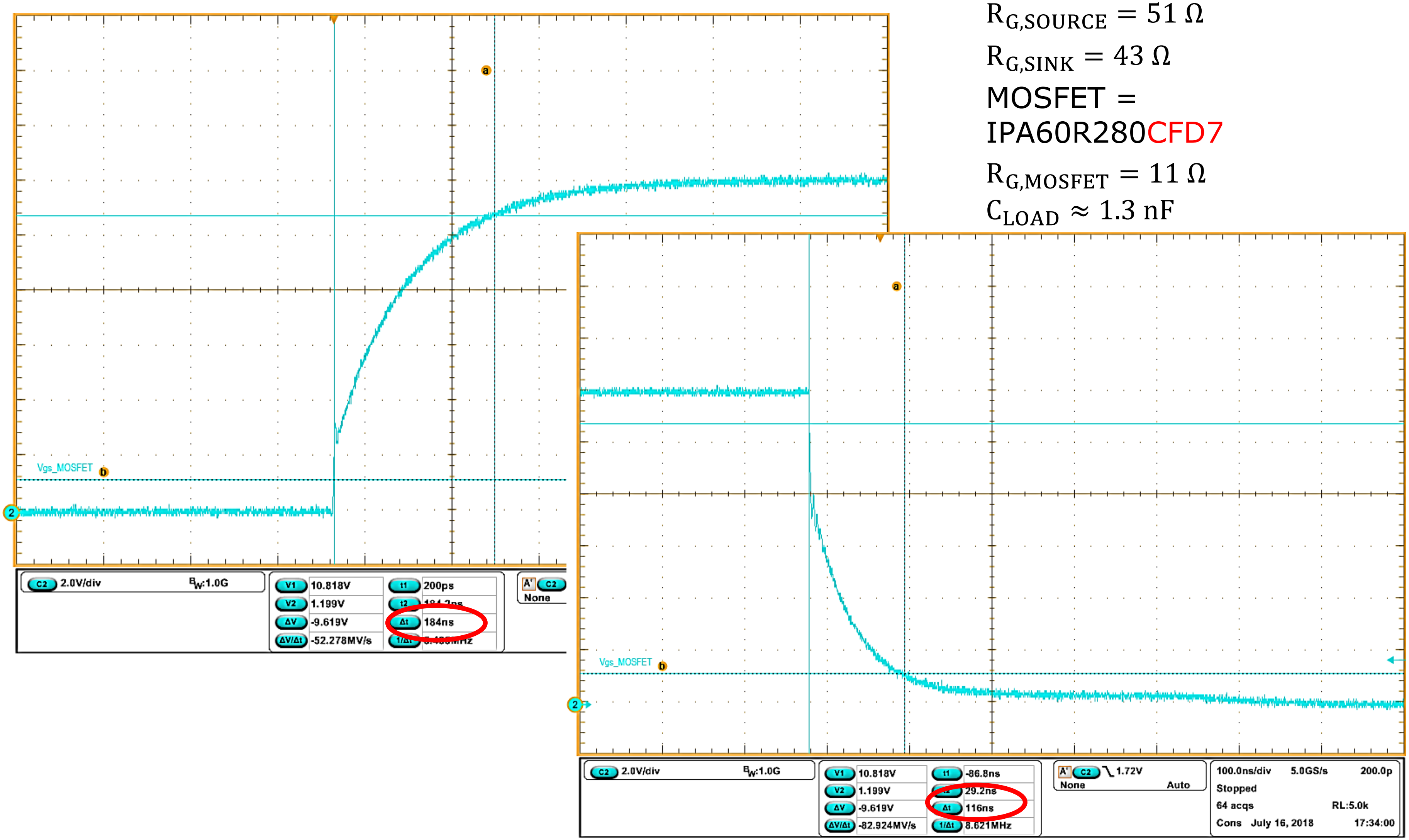
IPA60R099C7 → IPA60R280CFD7



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

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

Rise/fall times: New MOSFET



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

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

MOSFET = IPA60R280CFD7

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

$C_{LOAD} \approx 1.3\ nF$

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

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

Rise/fall times: New MOSFET

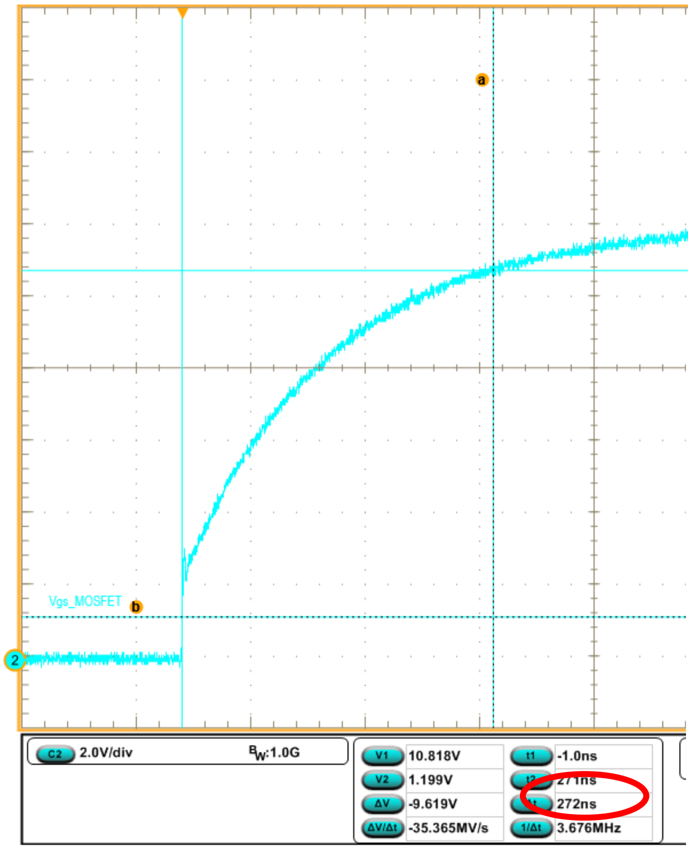
$R_{G,SOURCE} = 51\ \Omega$

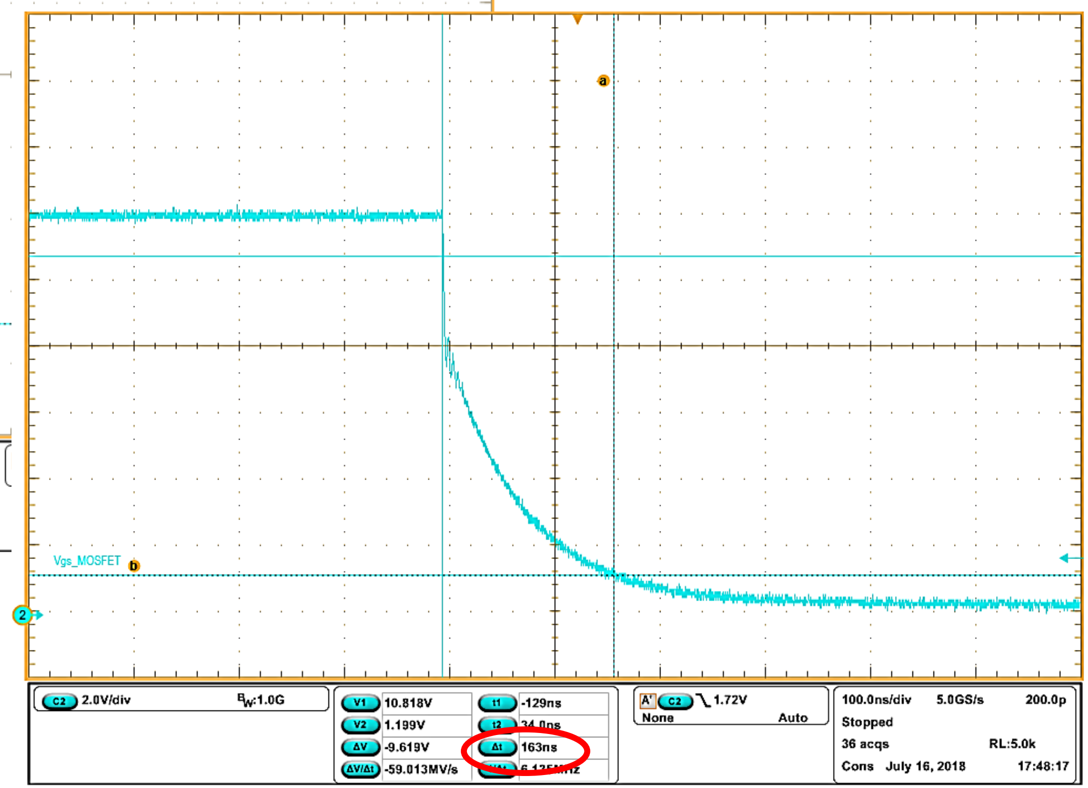
$R_{G,SINK} = 43\ \Omega$

MOSFET = IPA60R180P7

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

$C_{LOAD} \approx 1.9\ nF$





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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