

Quick start guide

KIT_DRIVER_2EDN7524R

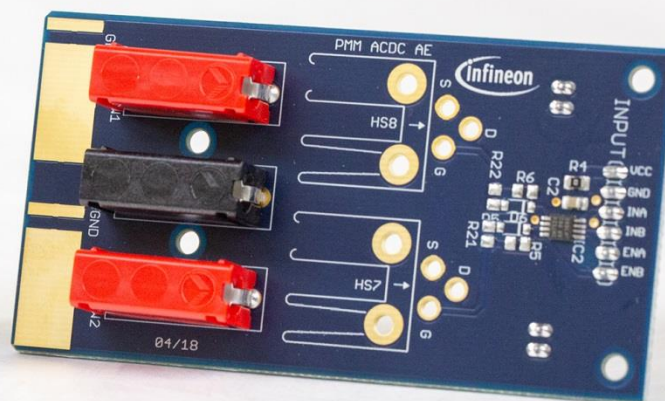
August 2018



KIT_DRIVER_2EDN7524R

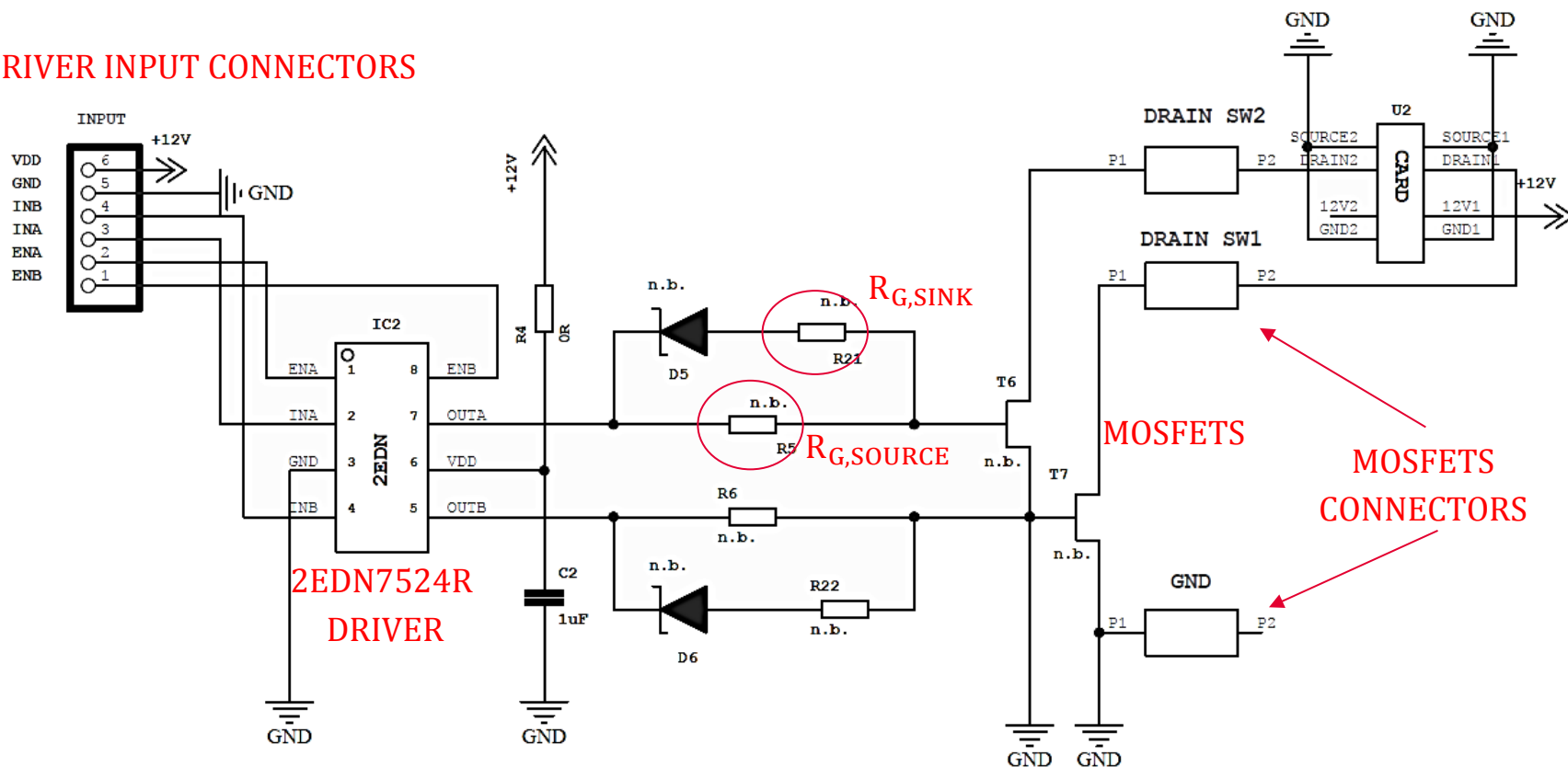


Heatsinks for TO-220 MOSFETs



Board schematic

DRIVER INPUT CONNECTORS

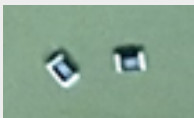
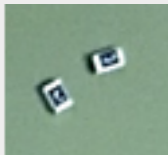


HEATSINKS



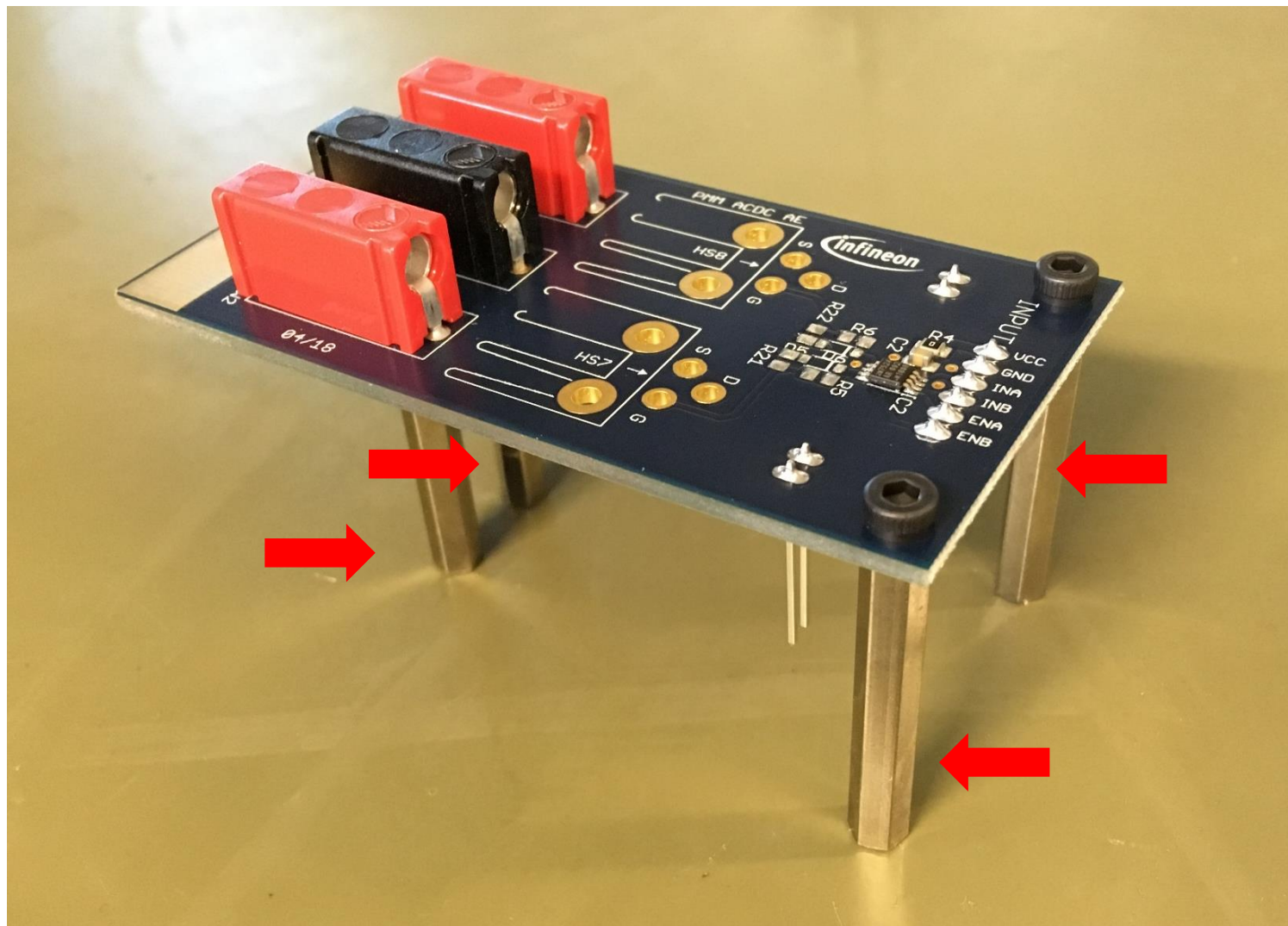
n.d. = value **not defined**, component not populated on the PCB

Components to add – BOM suggestion

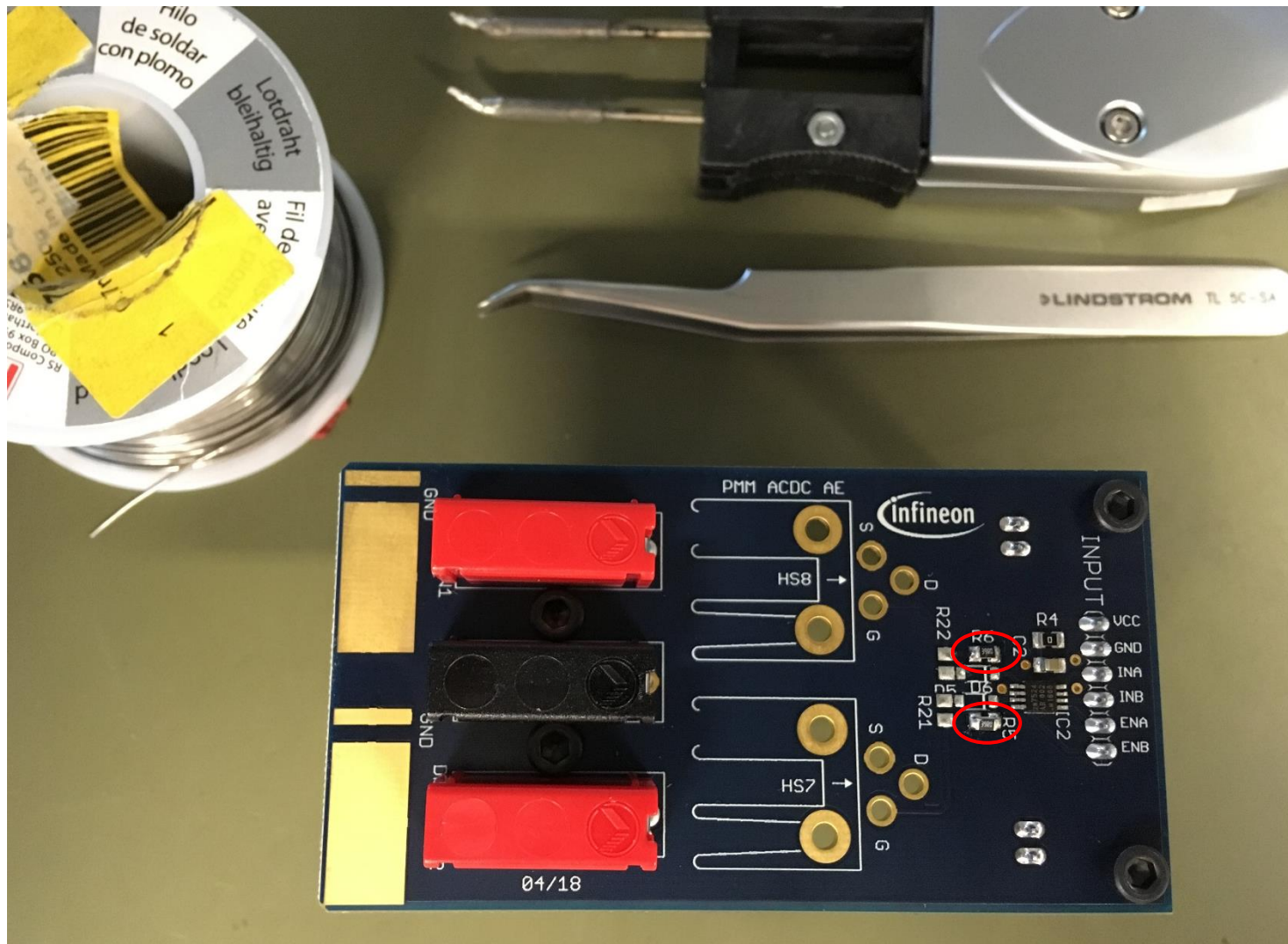
Distance bolts	Screws for distance bolts	Screws and washers for MOSFET mounting to heatsink	TO-220 sockets
			
TO-220 MOSFETs	Source resistors (R5, R6)	Sink resistors (R21, R22)	Sink diodes
			

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

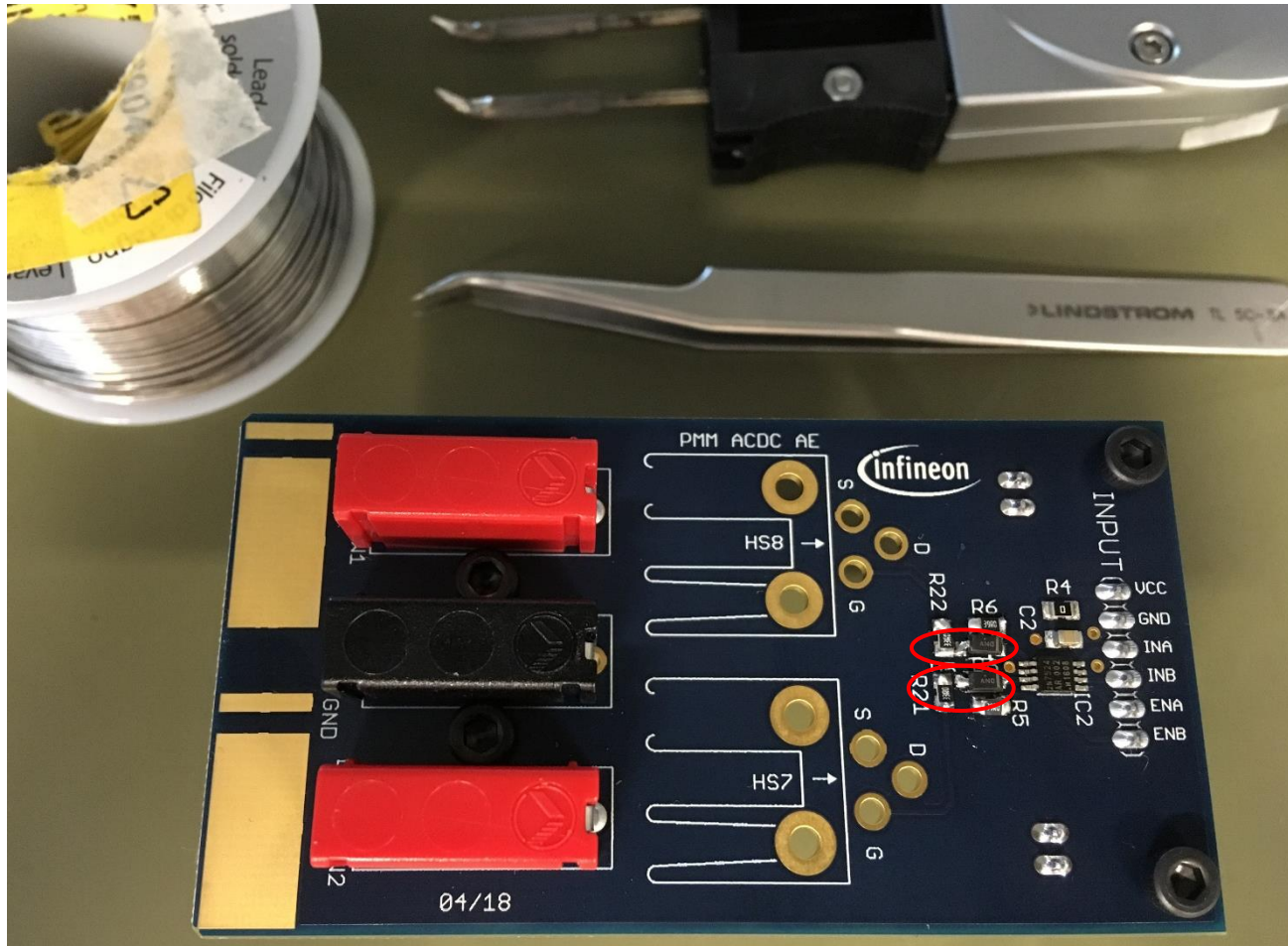


Step 2: Source resistors soldering

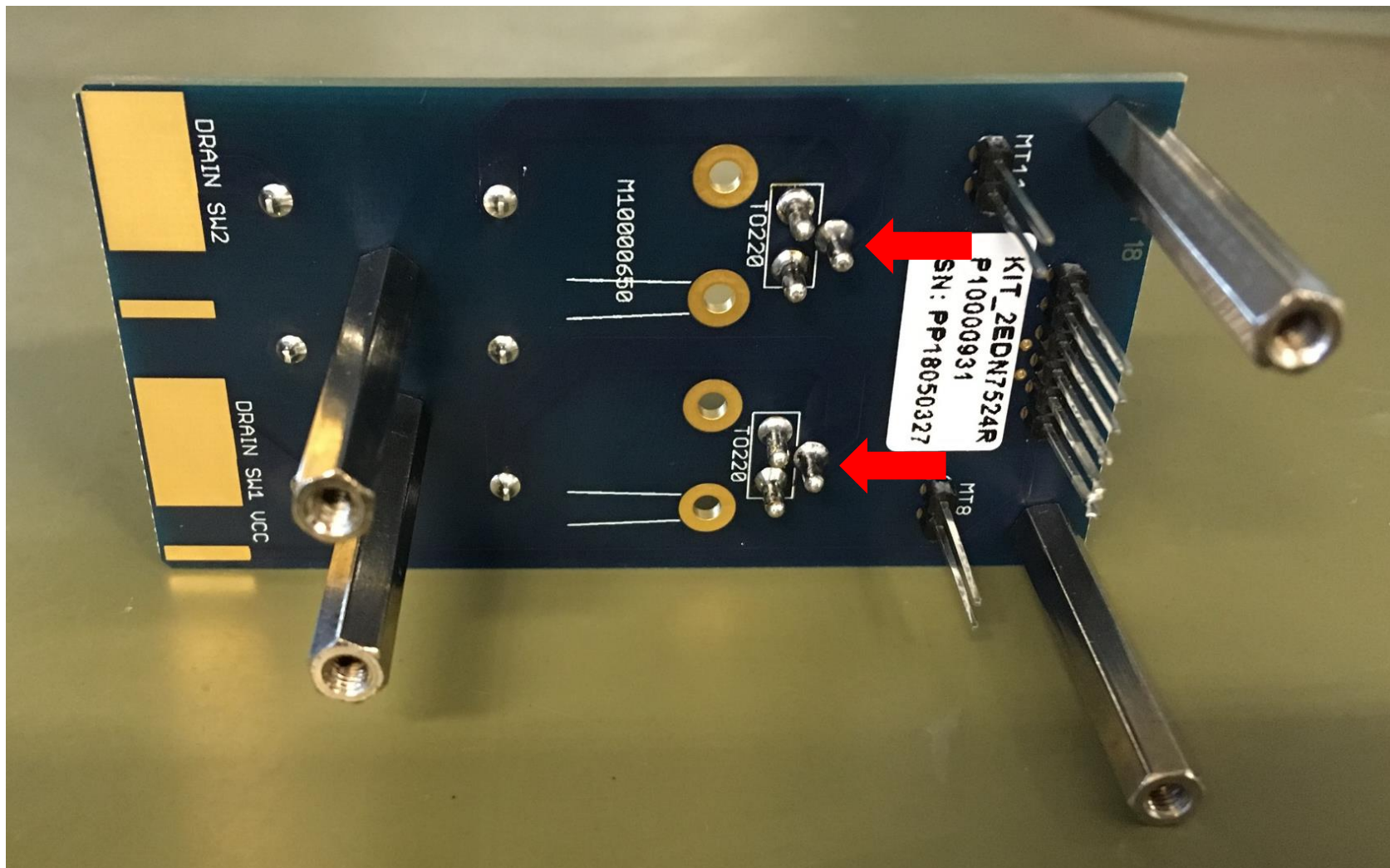


Step 3: Sink resistors and sink diodes soldering

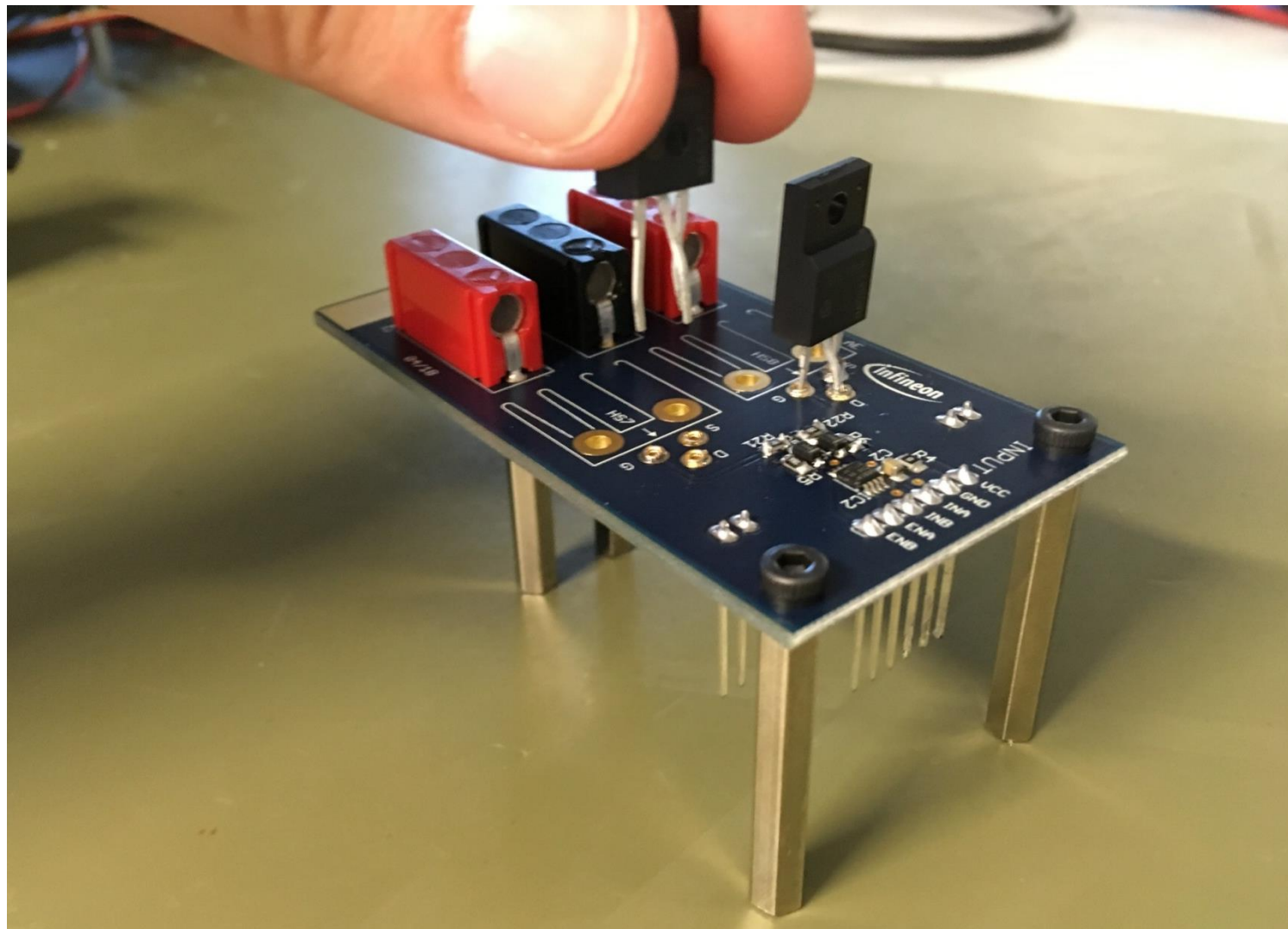
- > Add the sink resistors and the sink diodes only if a differentiation between the turn-on and the turn-off behavior is required



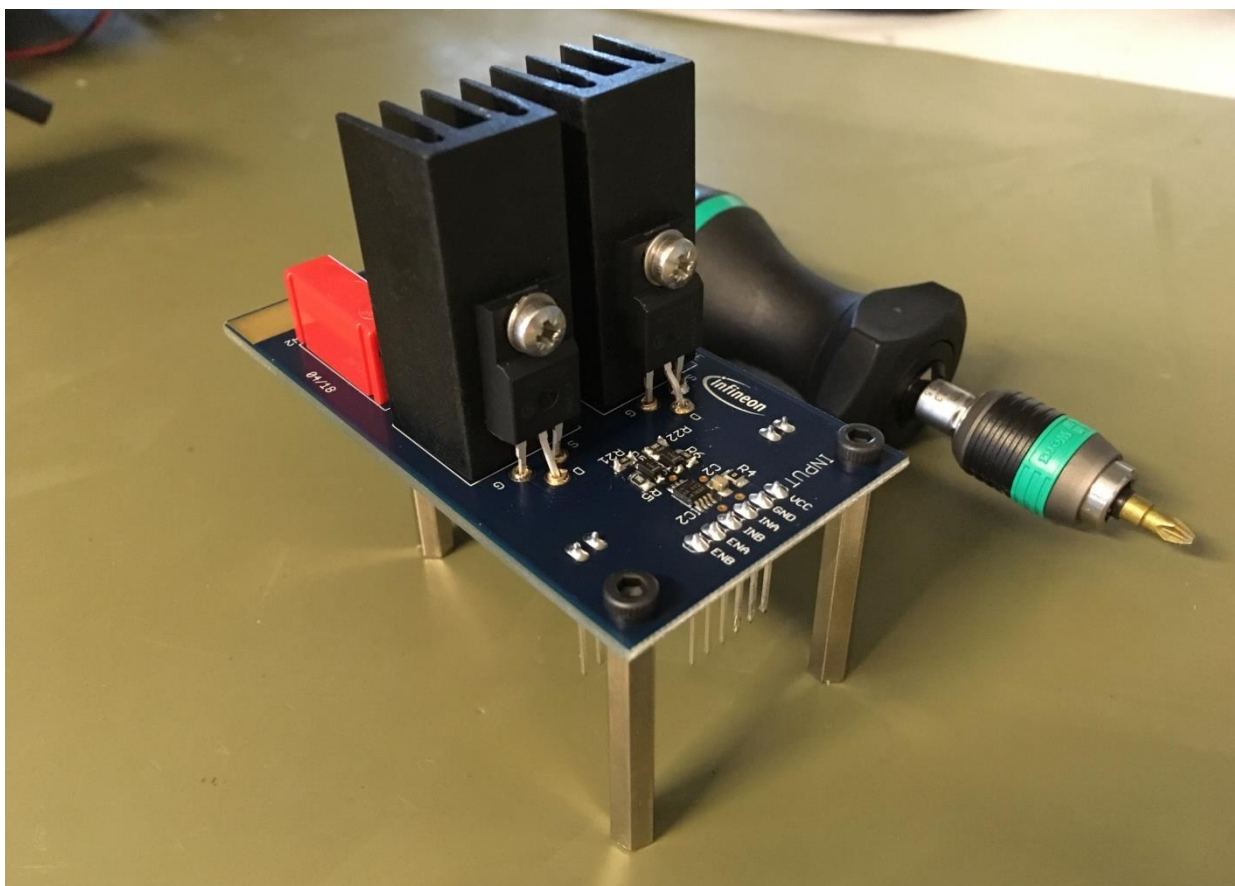
Step 4: TO-220 sockets soldering



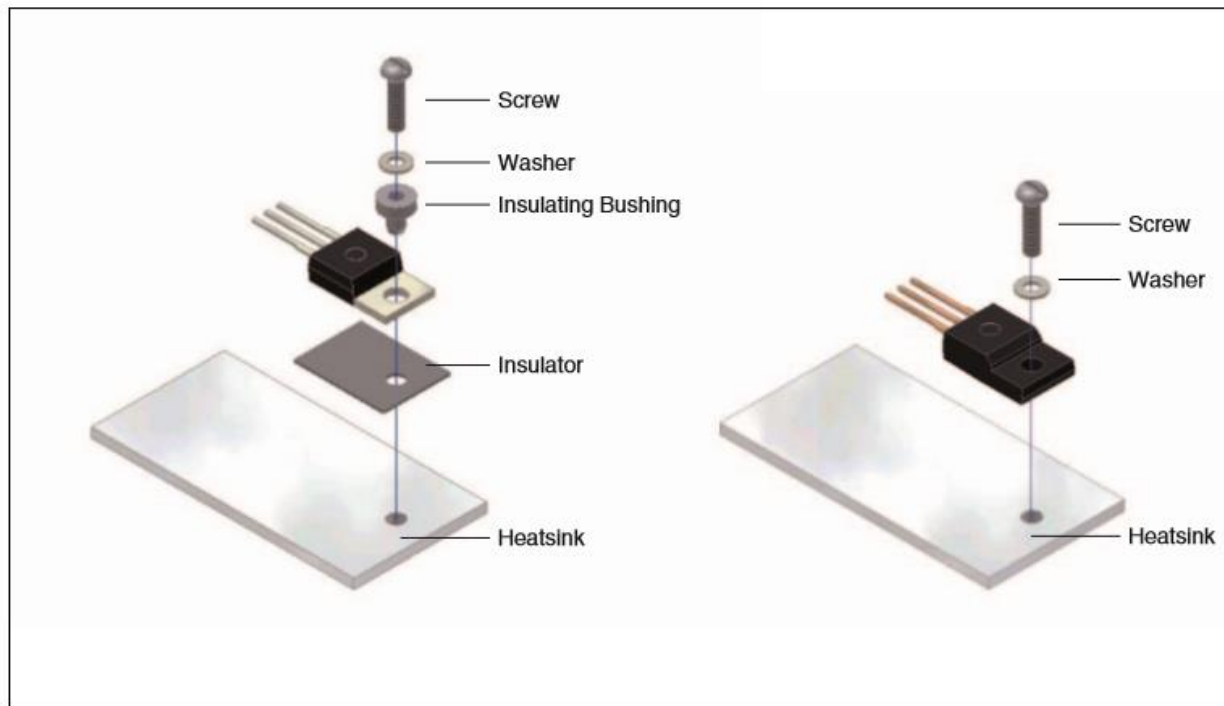
Step 5: MOSFETs placement into the sockets



- > 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



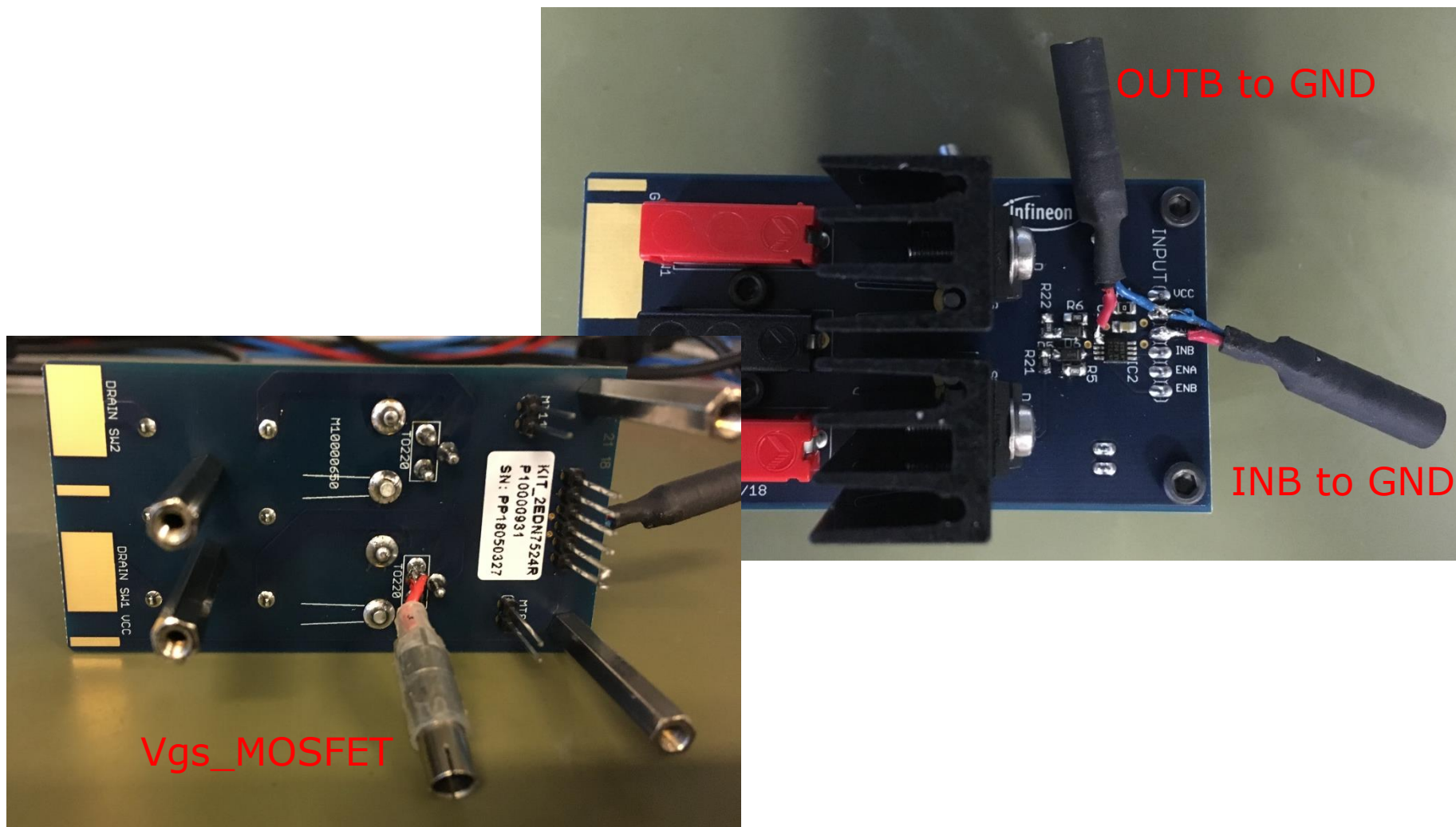
TO-220 MOSFET mounting to the heatsink



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



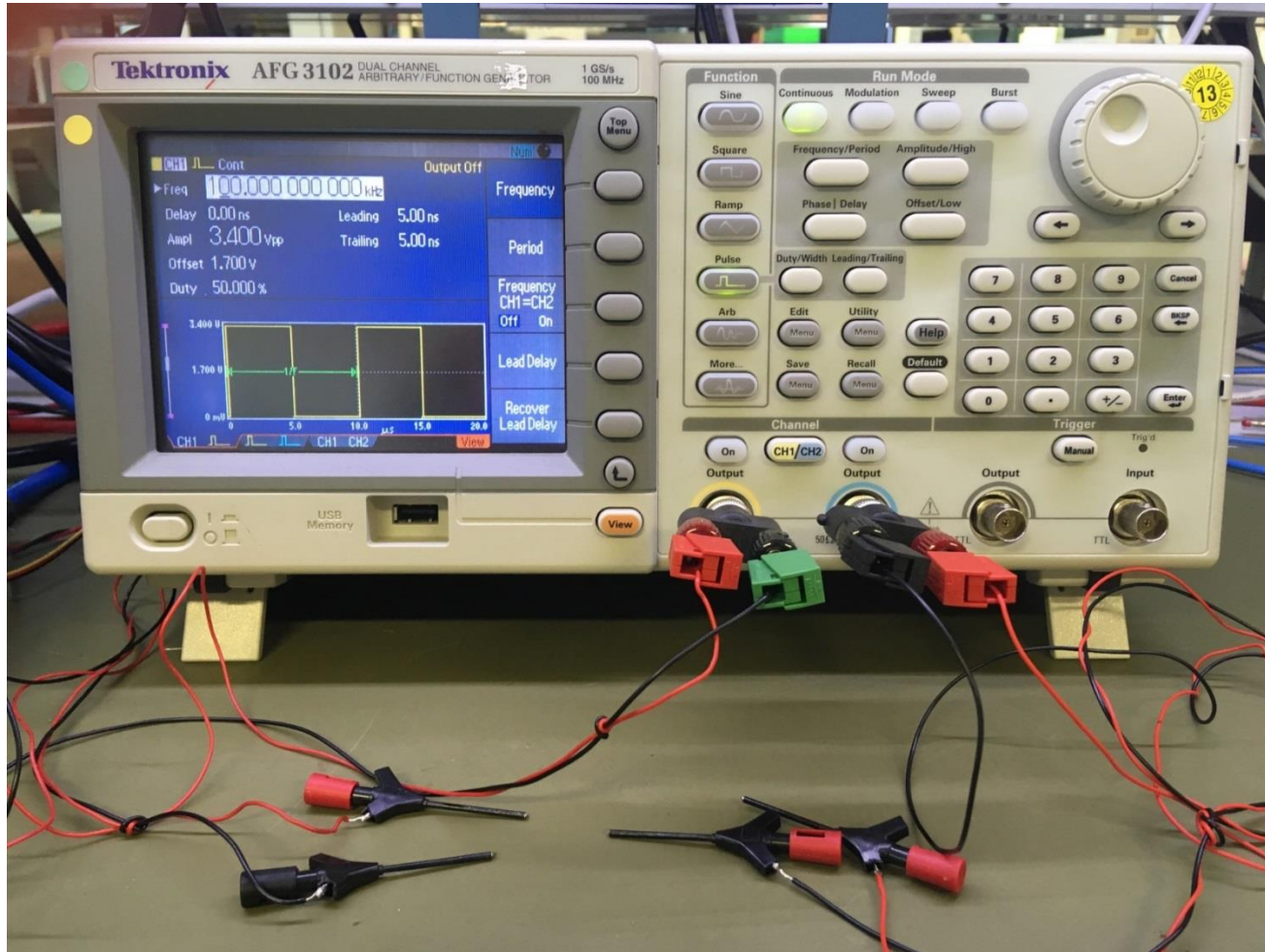
- > N.B. Please note that the silkscreen labels for INA and INB are merged

Instrumentation for driver supply generation



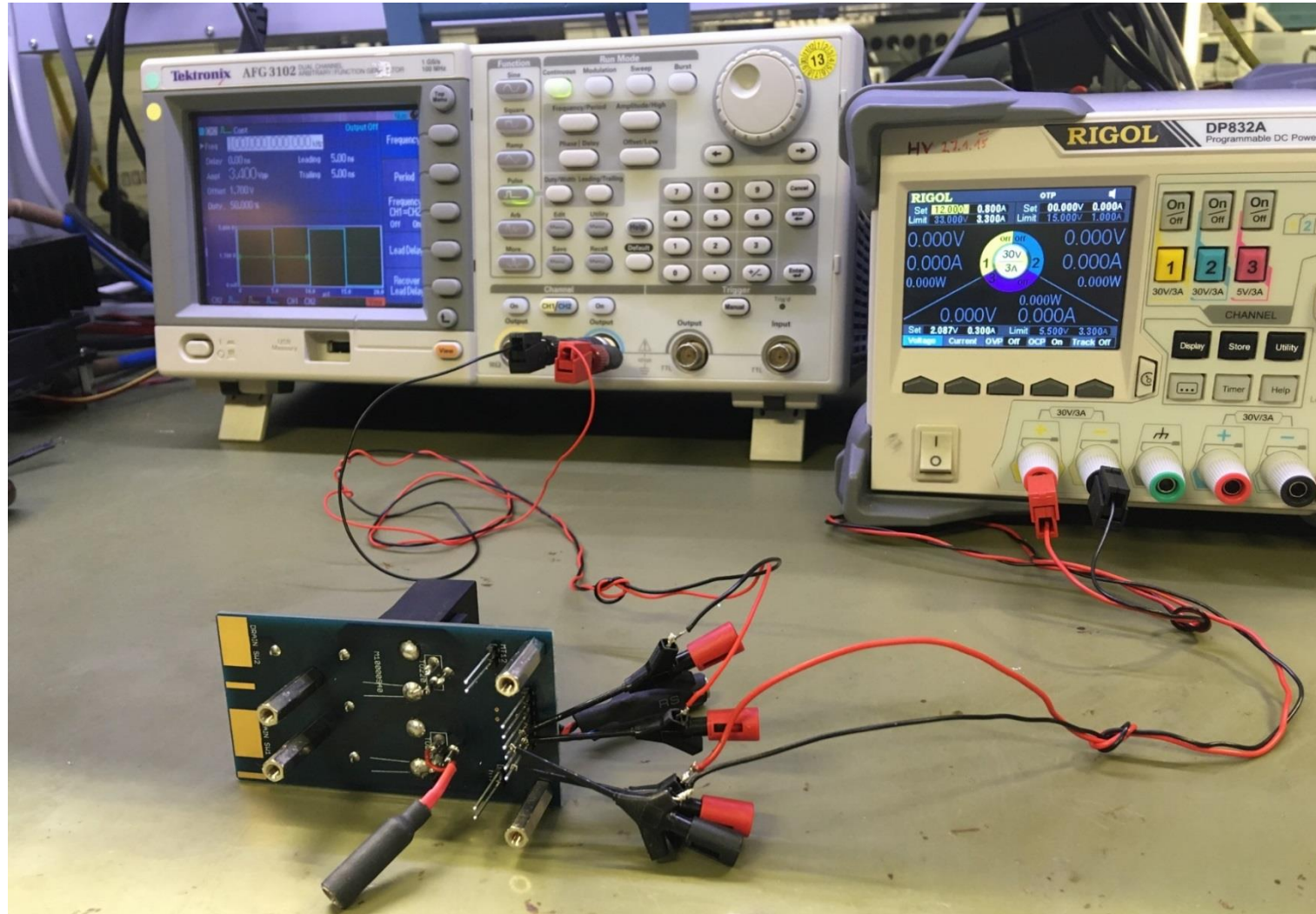
- > V_{CC} = 12 V for CoolMOS™ and 8 V for OptiMOS™
- > Set the current limit below 1 A (0.8 A e.g.)

Instrumentation for PWM signals generation

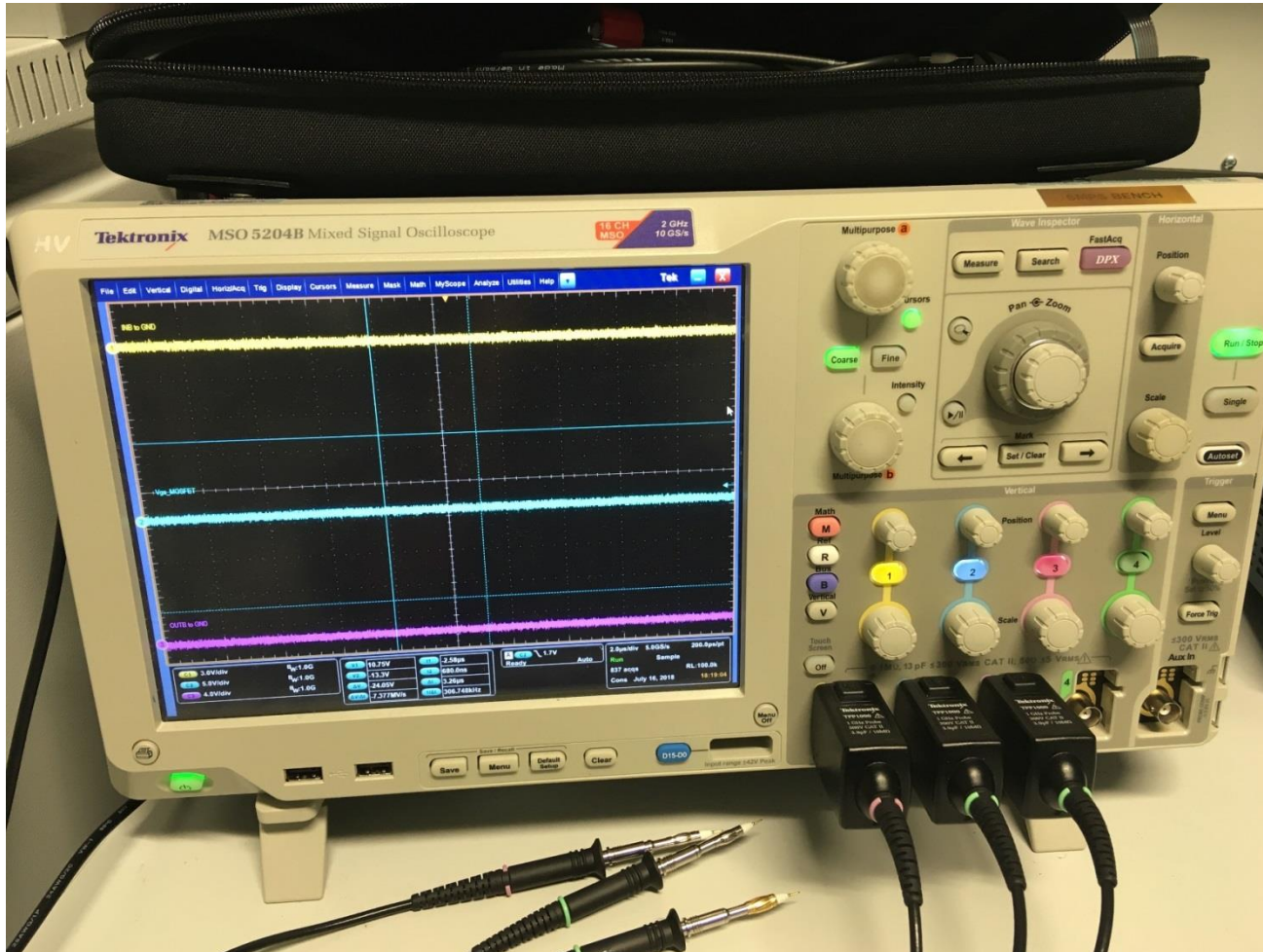


- Use a function generator or a microcontroller

Connections

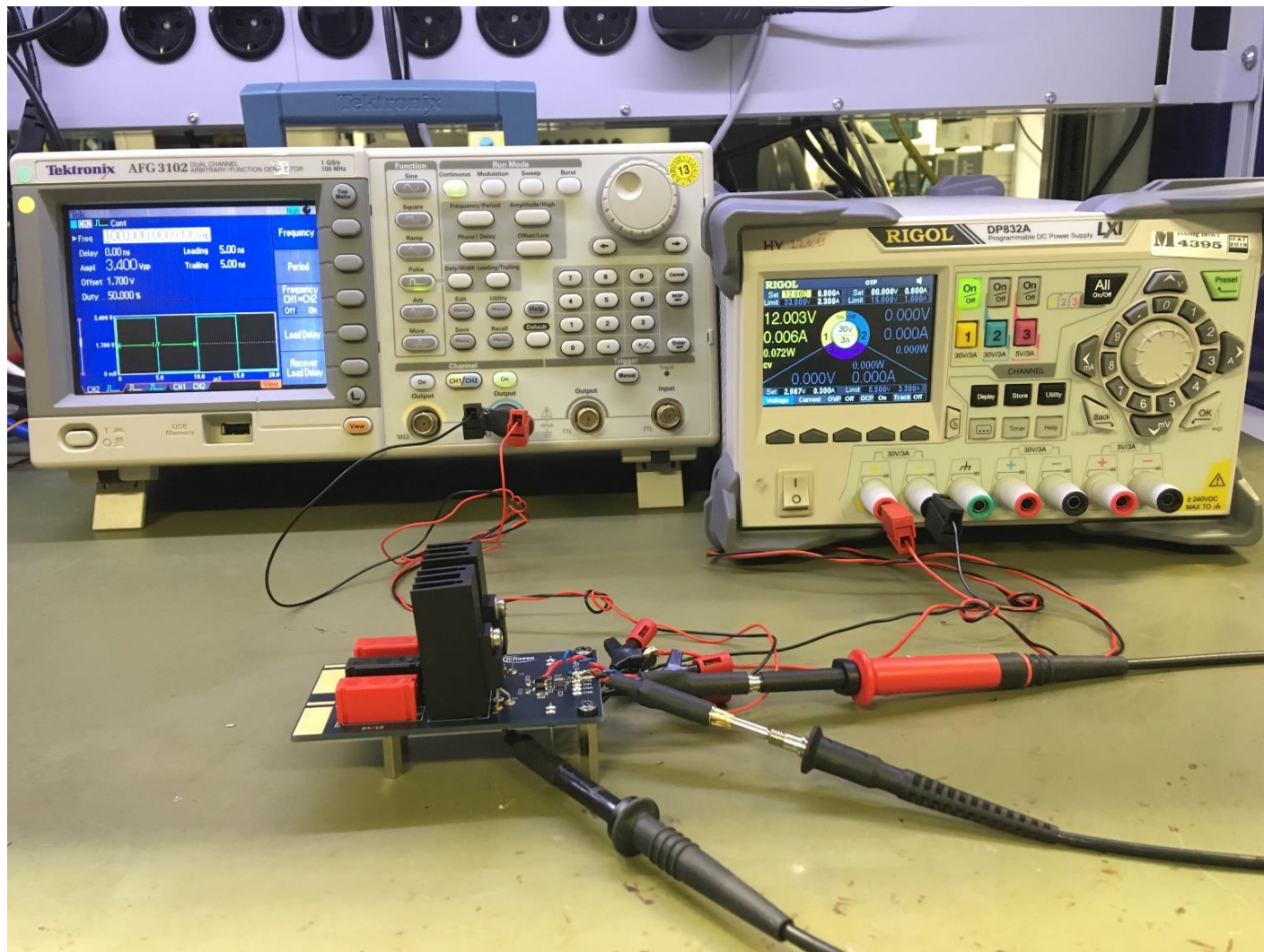


Instrumentation for signals evaluation

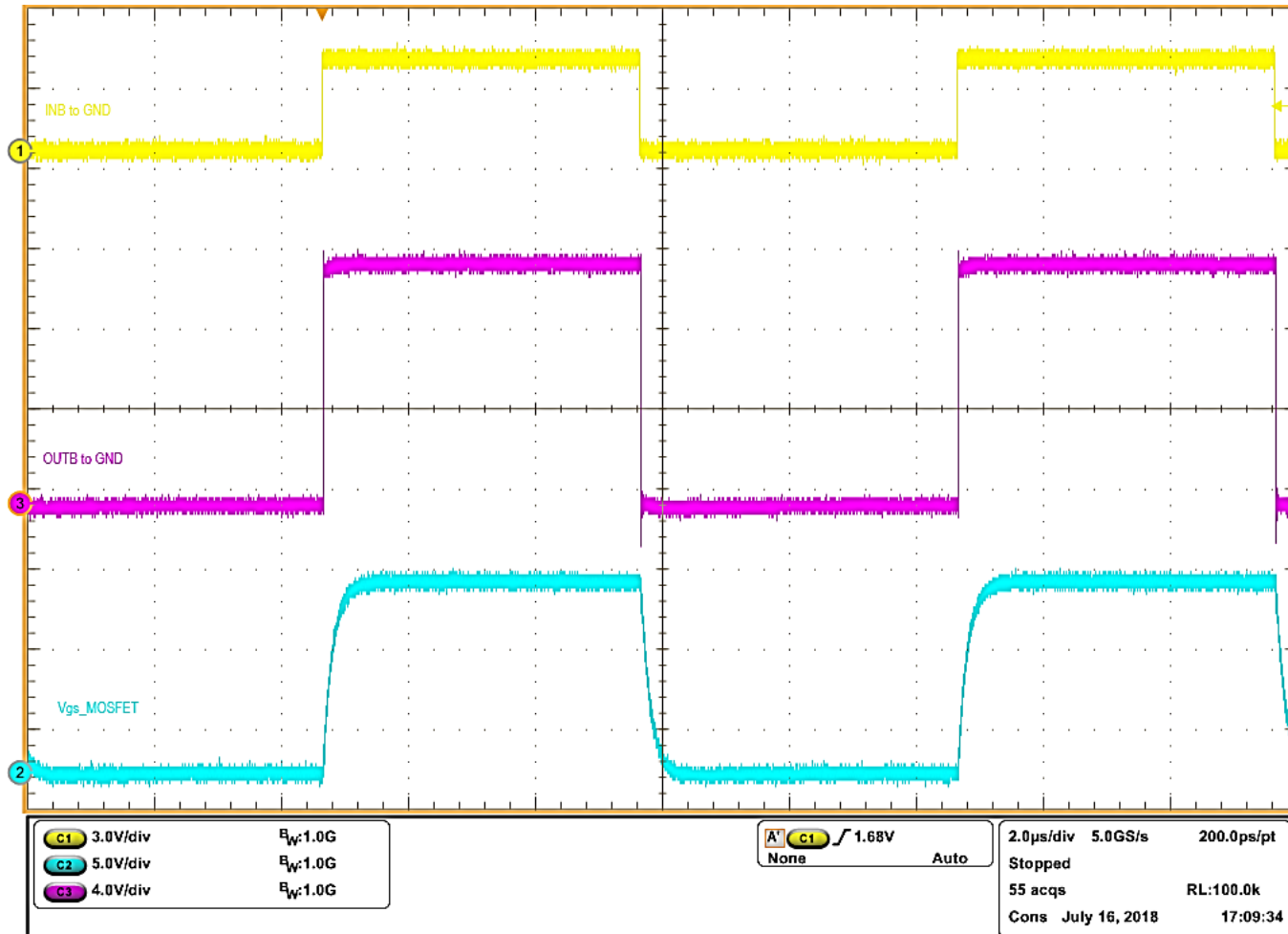


- Voltage probes used: Tetronix TPP1000 1 GHz, 3.9 pF

Complete measurement setup

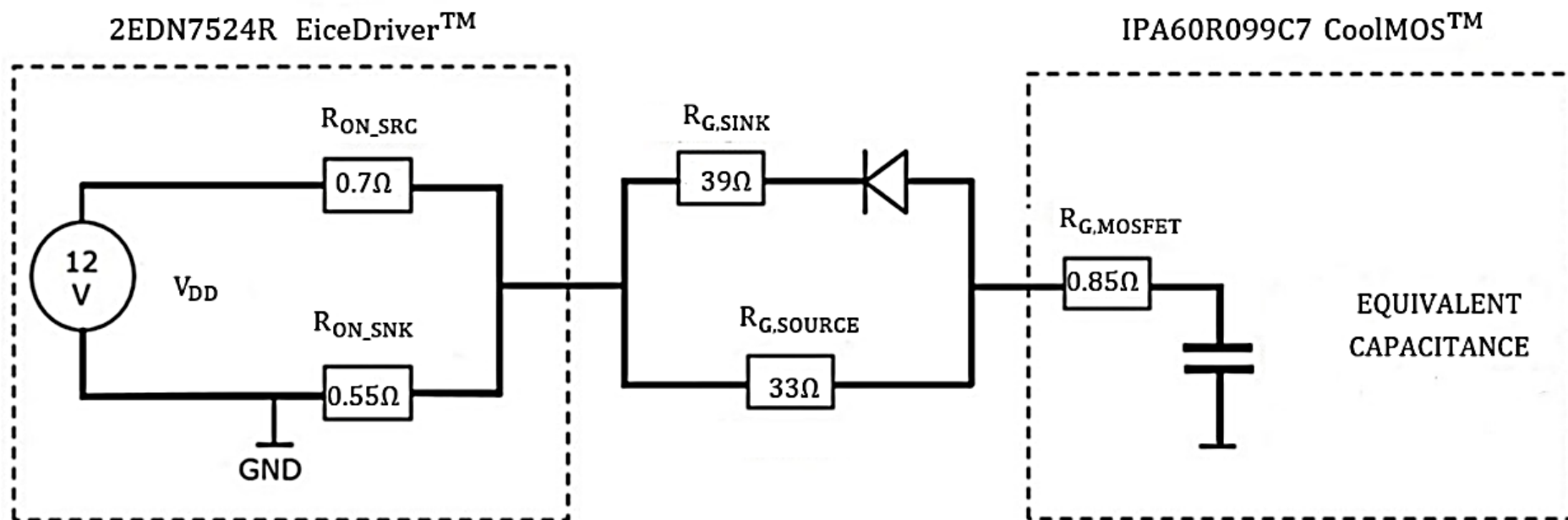


Oscilloscope waveforms

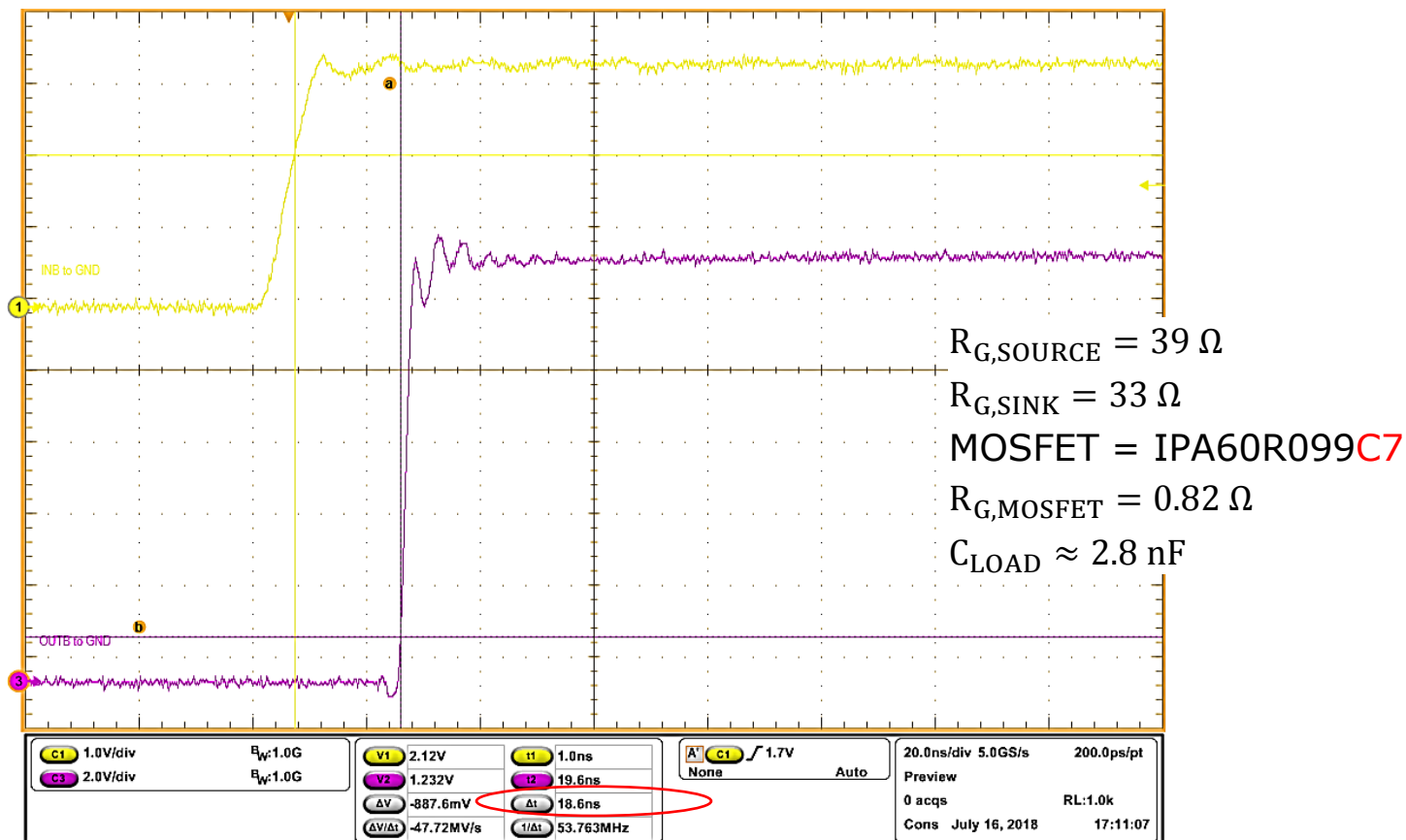


- > Measurements done on a single MOSFET with $V_{DS} = 0\text{ V}$ (drain and source shorted)

Equivalent model of the driving circuit

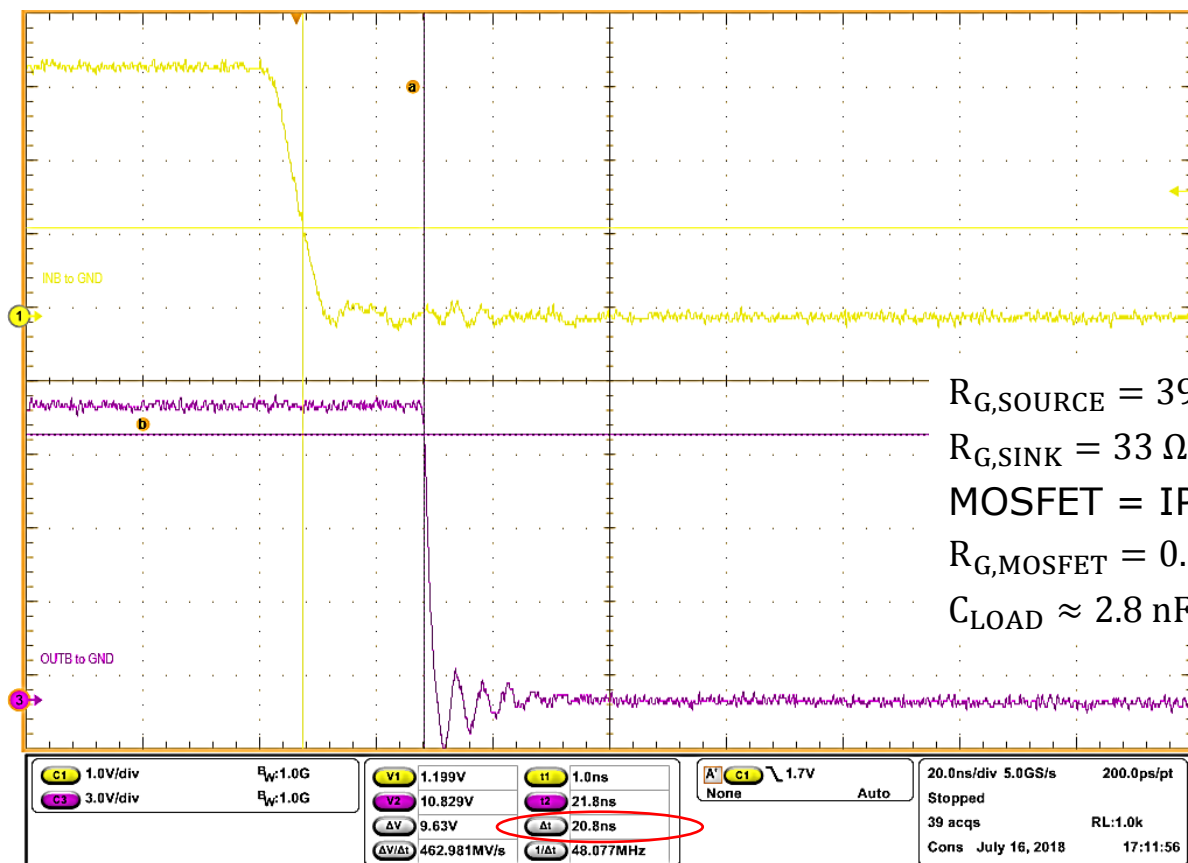


Low-high propagation delay



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

High-Low propagation delay



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

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

MOSFET = IPA60R099C7

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

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

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

C_{LOAD} calculation for IPA60R099C7

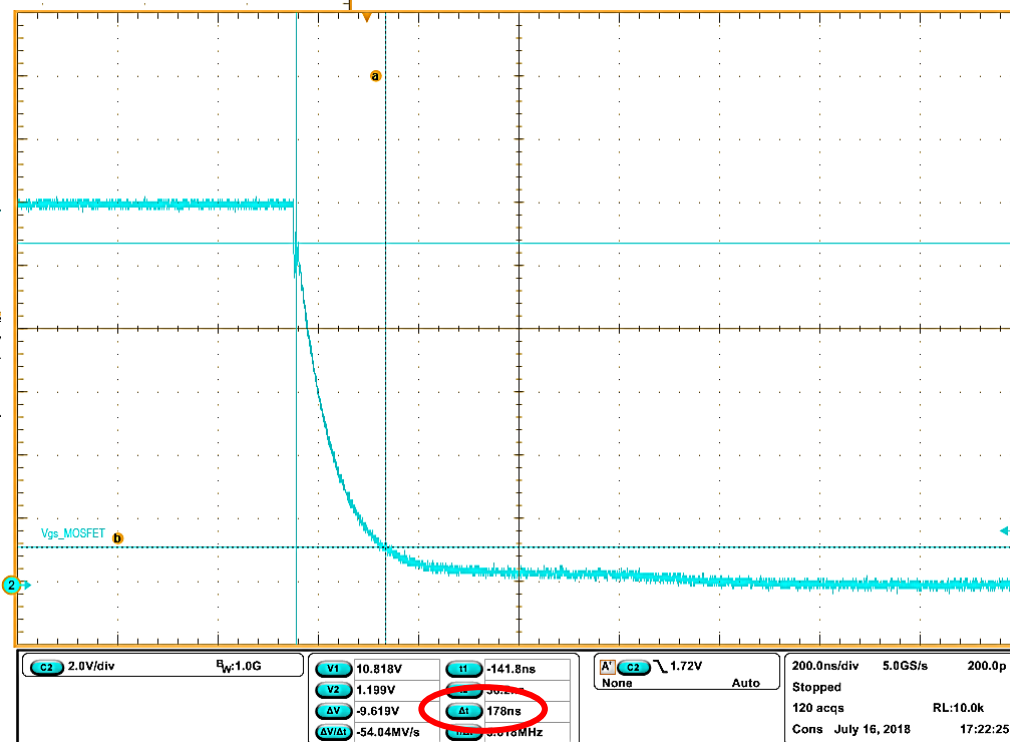
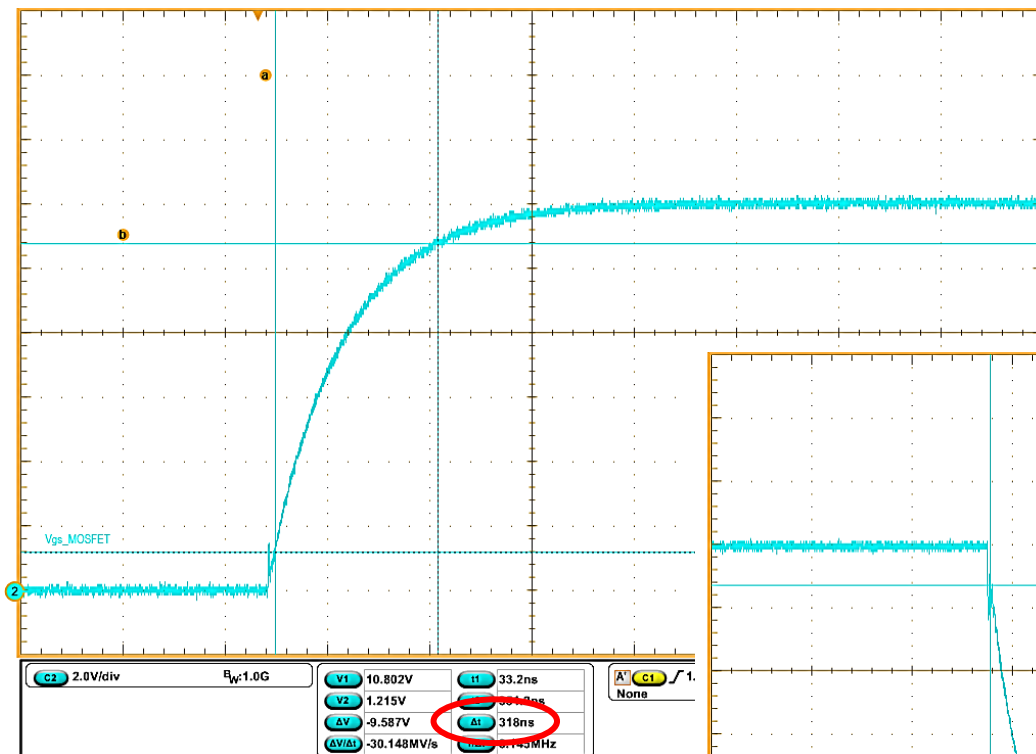


Gate to drain charge	Q_{gd}	-	14	-	nC	$V_{DD}=400V, I_D=9.7A, V_{GS}=0 \text{ to } 10V$
Gate charge total	Q_g	-	42	-	nC	$V_{DD}=400V, I_D=9.7A, V_{GS}=0 \text{ to } 10V$

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

$$C_{LOAD} \approx 2.8 \text{ nF} \text{ for } V_{GS} = 12 \text{ V}$$

Rise/fall times



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

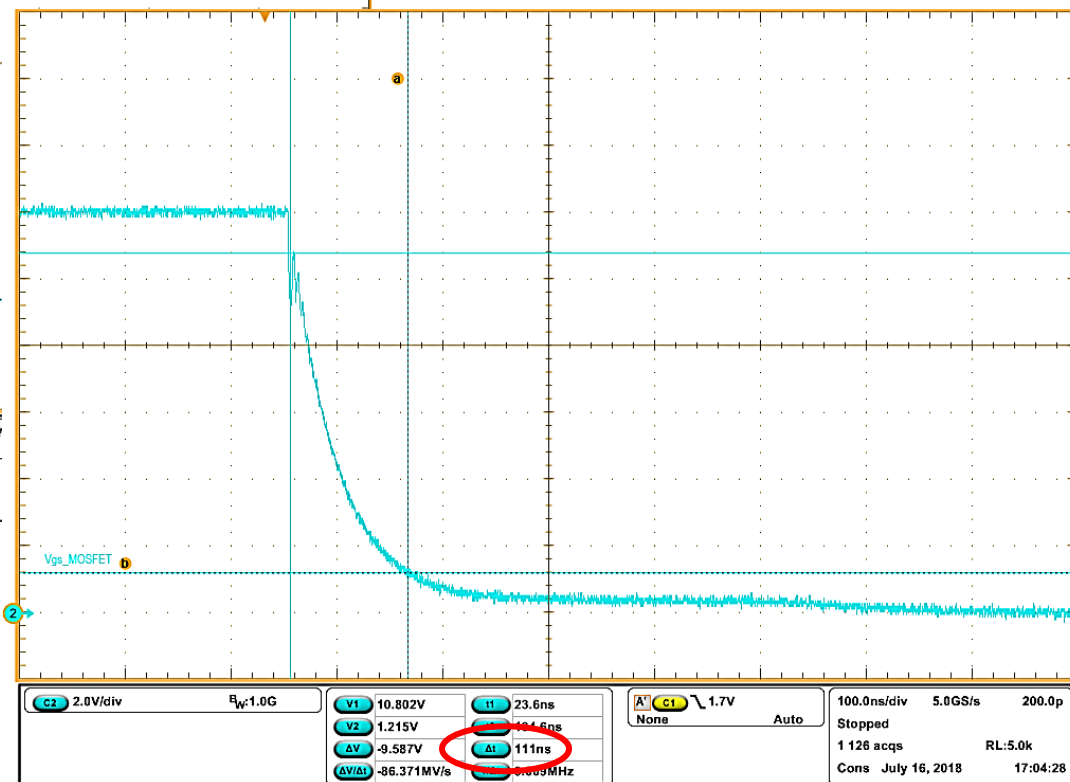
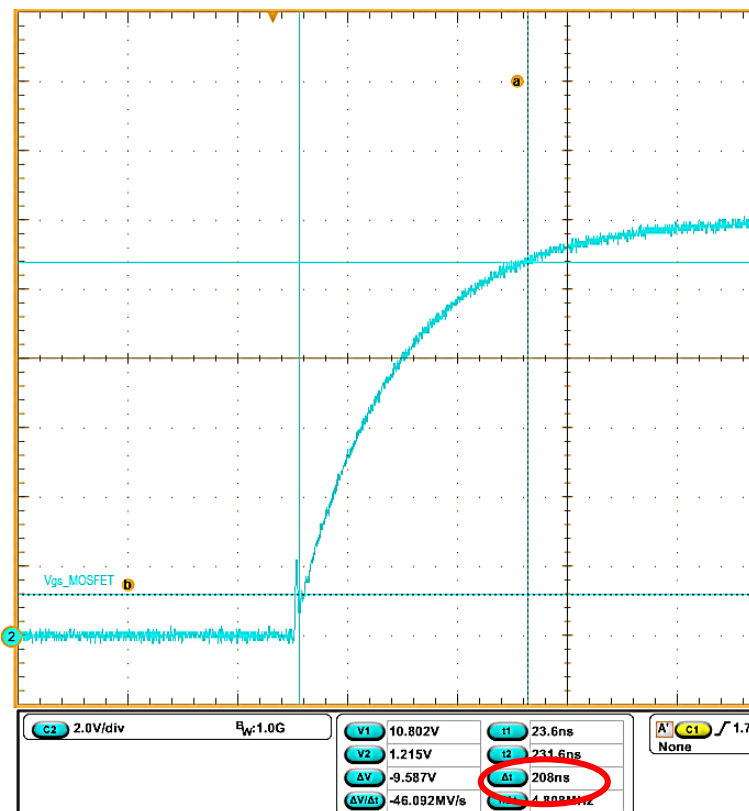
$$R_{G,SOURCE} = 24 \Omega$$

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

MOSFET = IPA60R099C7

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

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



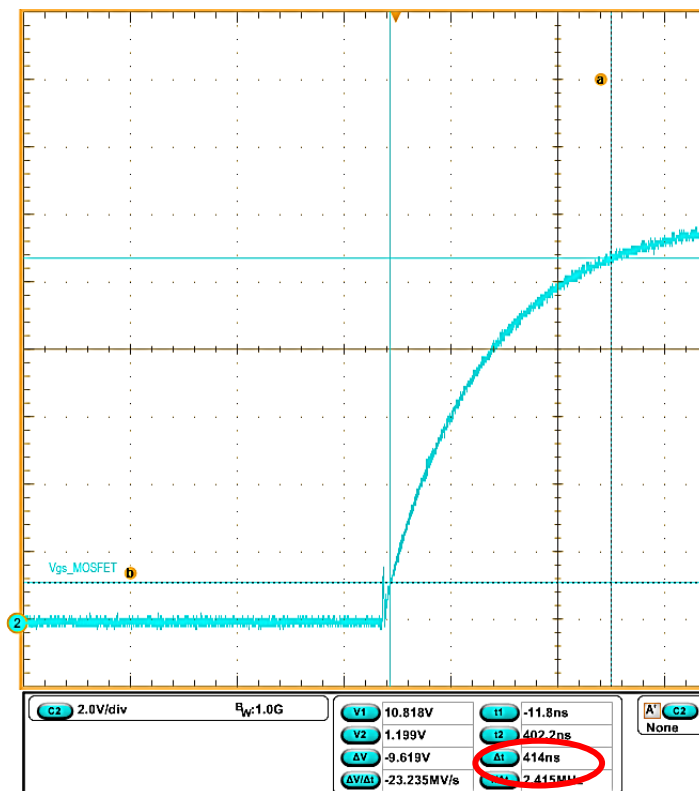
Gate resistors replacement

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

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

MOSFET = IPA60R099C7

Rise/fall times: New set of gate resistances



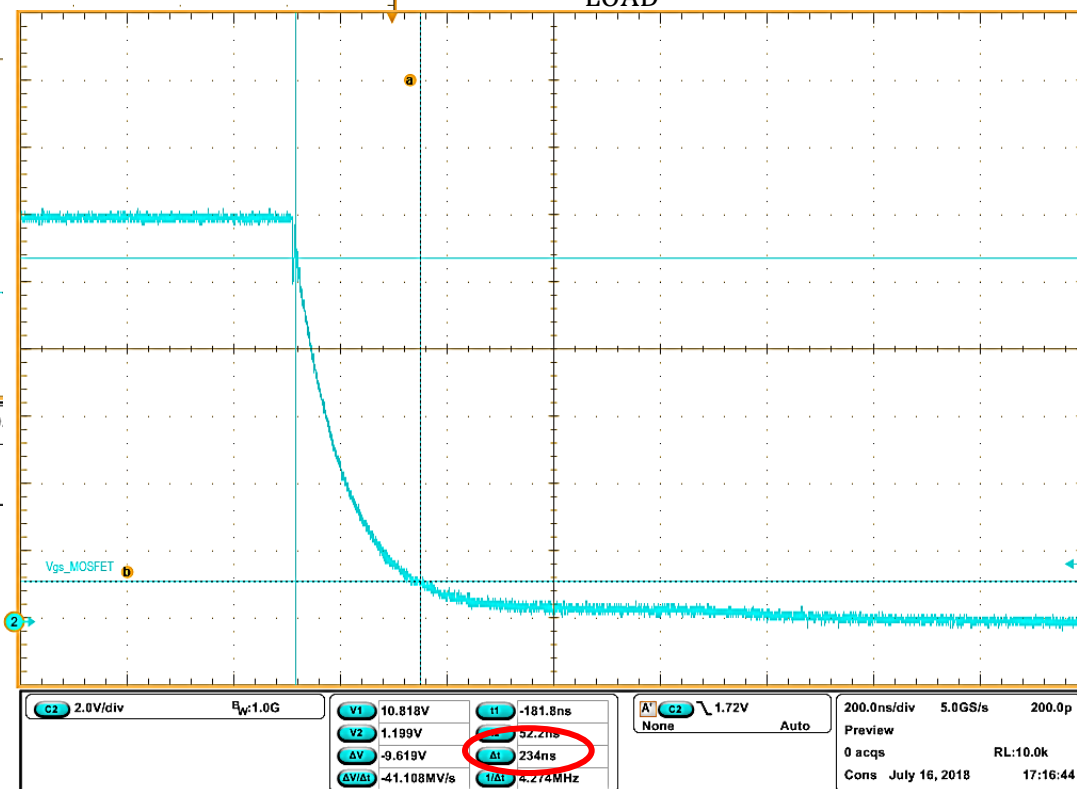
$$R_{G,SOURCE} = 51 \Omega$$

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

MOSFET =
IPA60R099C7

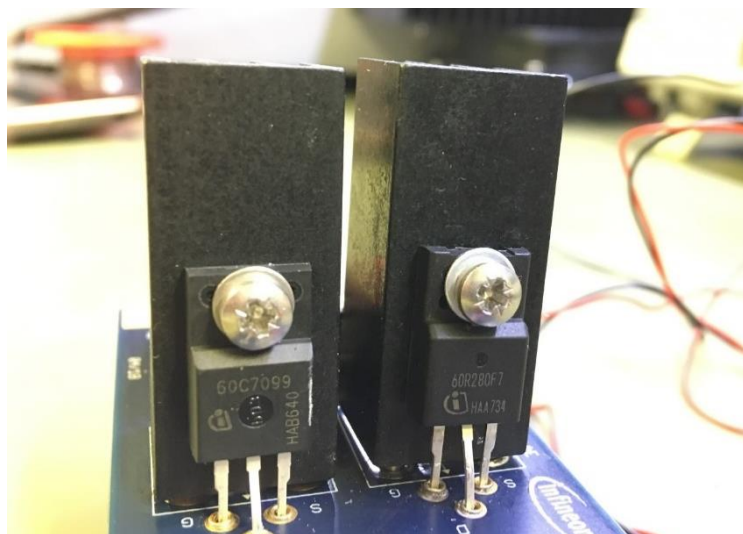
$$R_{G,MOSFET} = 0.82 \Omega$$

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



MOSFET Replacement

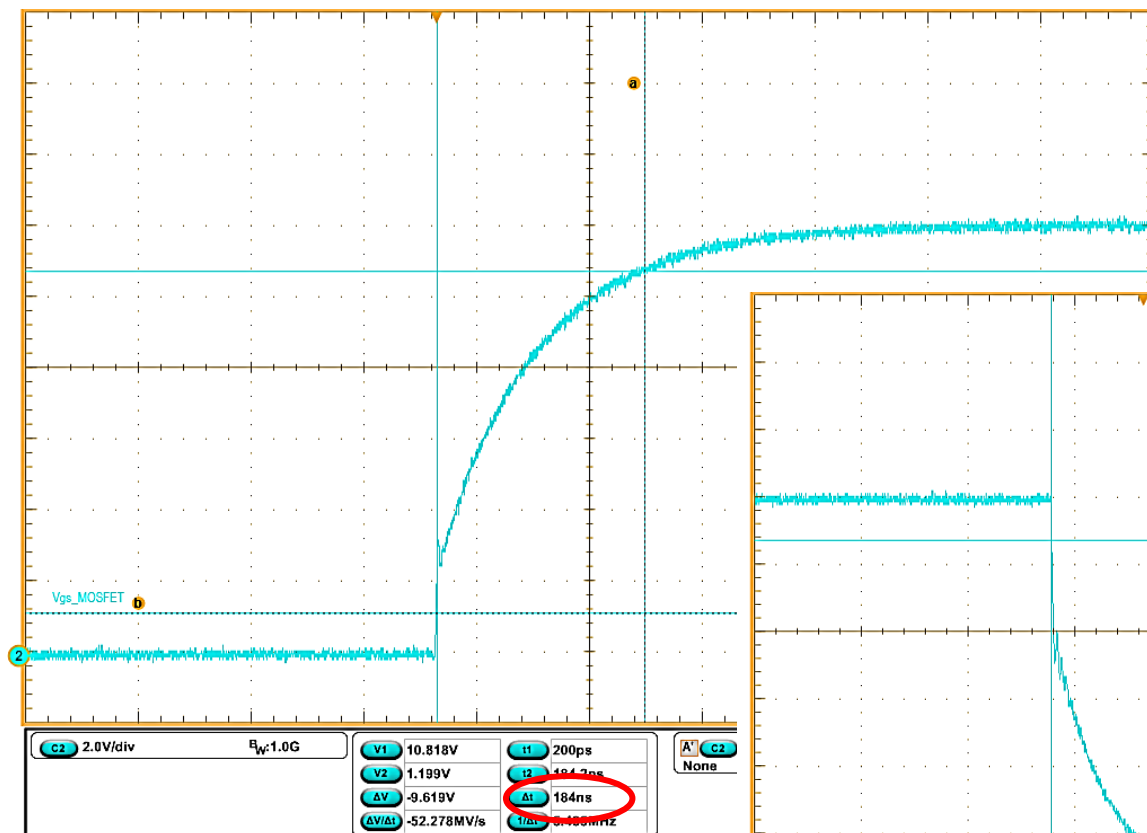
IPA60R099C7 → IPA60R280CFD7



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

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

Rise/fall times: New MOSFET



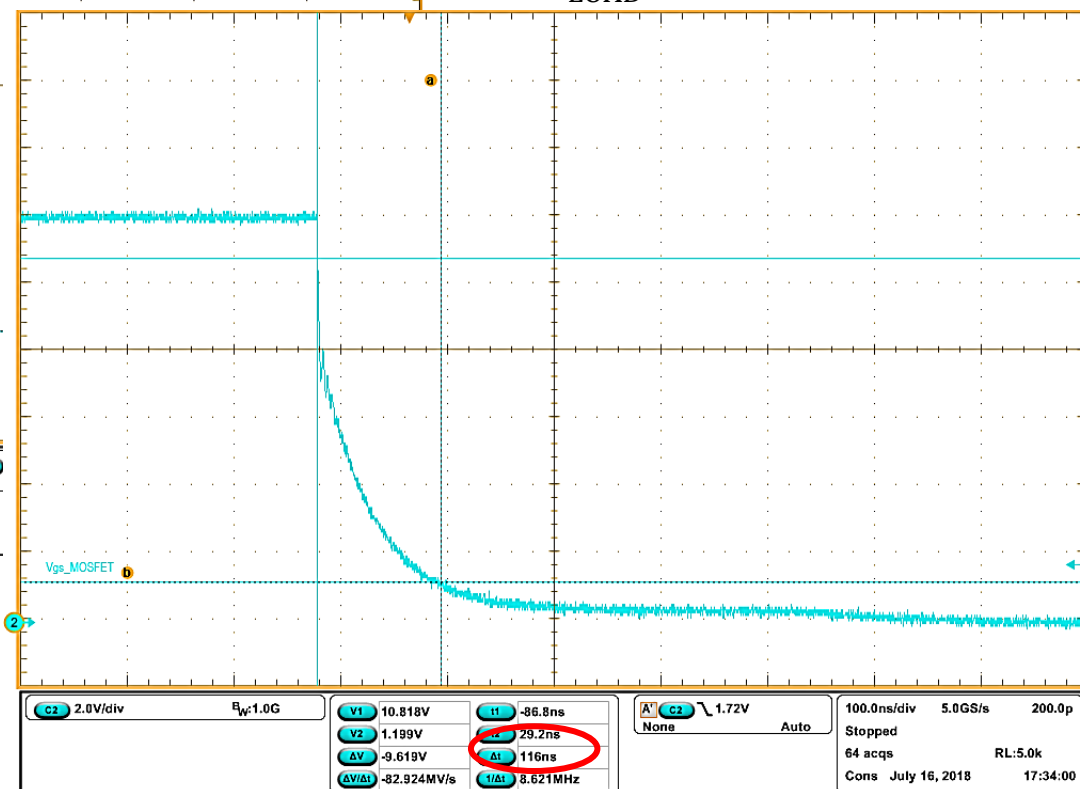
$$R_{G,SOURCE} = 51 \Omega$$

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

MOSFET =
IPA60R280CFD7

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

$$C_{LOAD} \approx 1.3 \text{ nF}$$



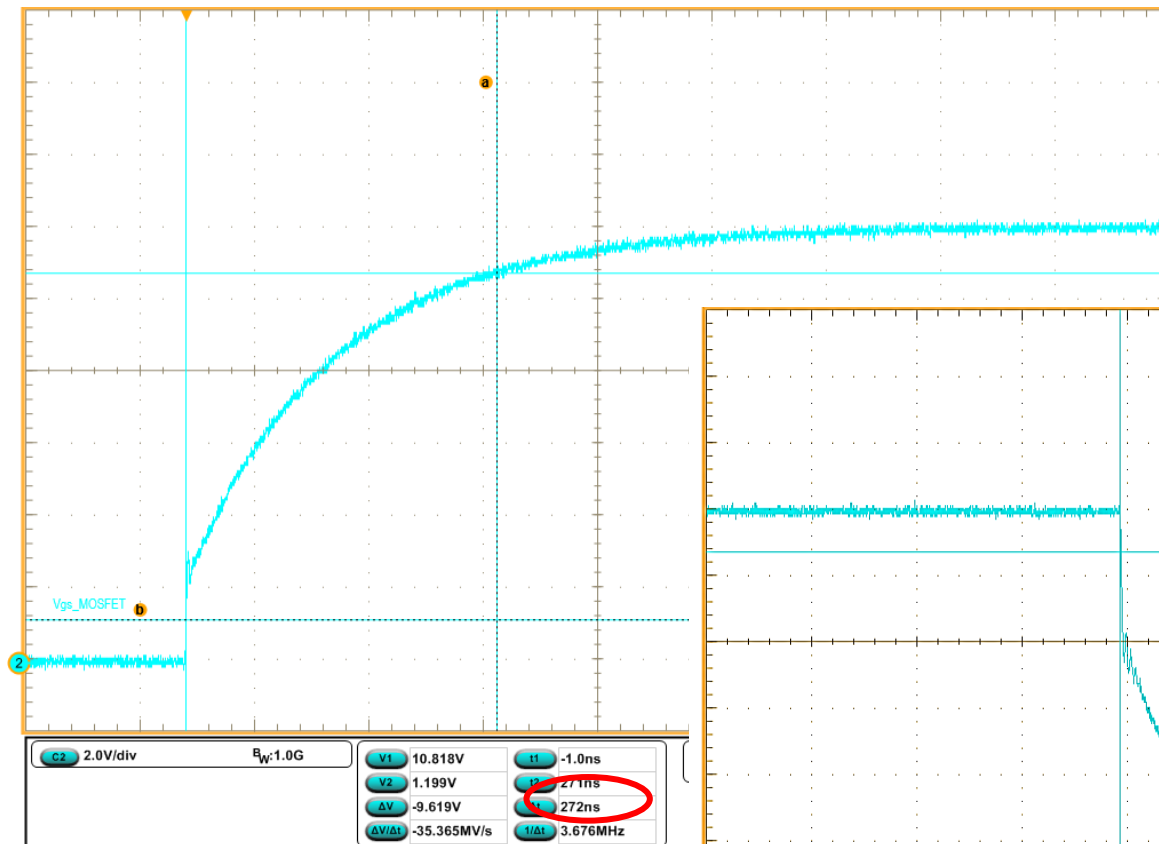
MOSFET replacement

IPA60R280CFD7 → IPA60R180P7

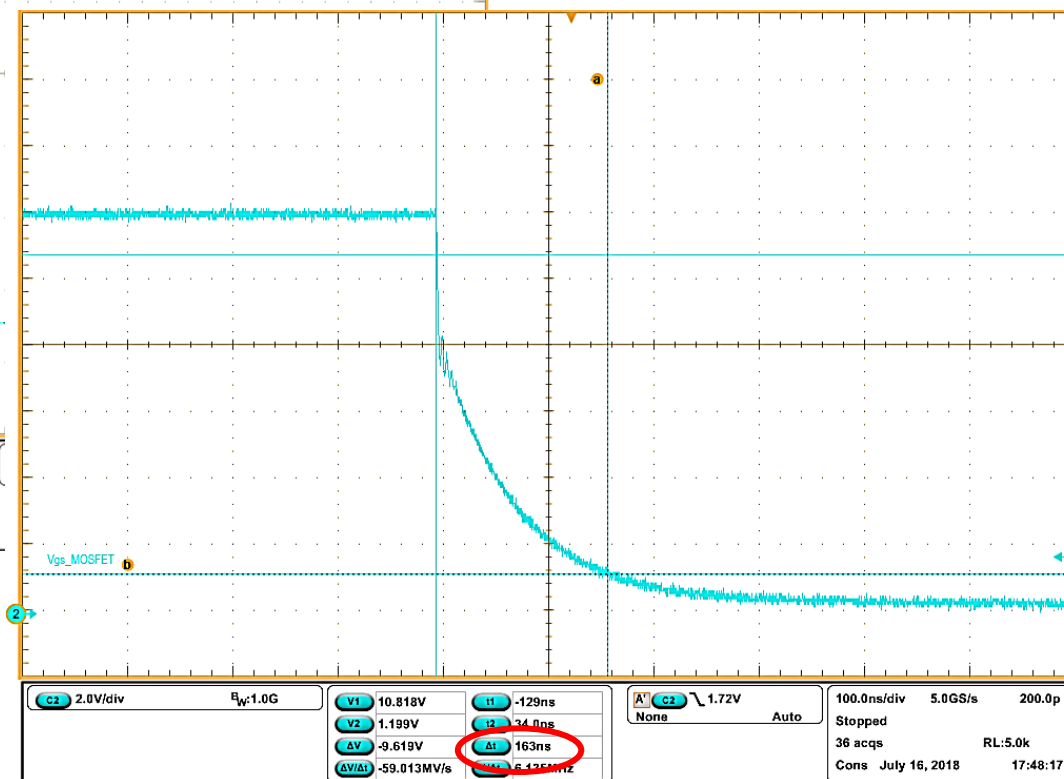
Gate to drain charge	Q_{gd}	-	8	-	nC	$V_{DD}=400V, I_D=5.6A, V_{GS}=0 \text{ to } 10V$
Gate charge total	Q_g	-	25	-	nC	$V_{DD}=400V, I_D=5.6A, V_{GS}=0 \text{ to } 10V$

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

Rise/fall times: New MOSFET



$R_{G,SOURCE} = 51 \Omega$
 $R_{G,SINK} = 43 \Omega$
MOSFET = IPA60R180P7
 $R_{G,MOSFET} = 11 \Omega$
 $C_{LOAD} \approx 1.9 \text{ nF}$



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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