

Quick start guide

KIT_DRIVER_2EDF7275F

PMM Gate Driver AE

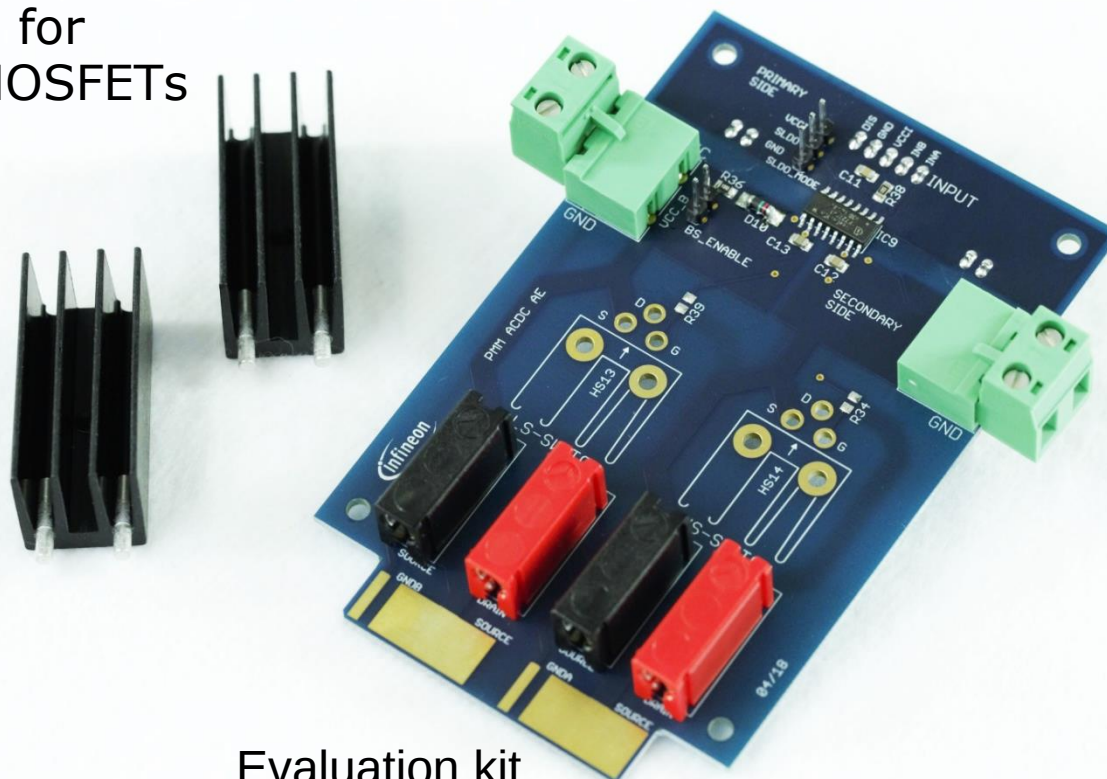


KIT_DRIVER_2EDF7275F



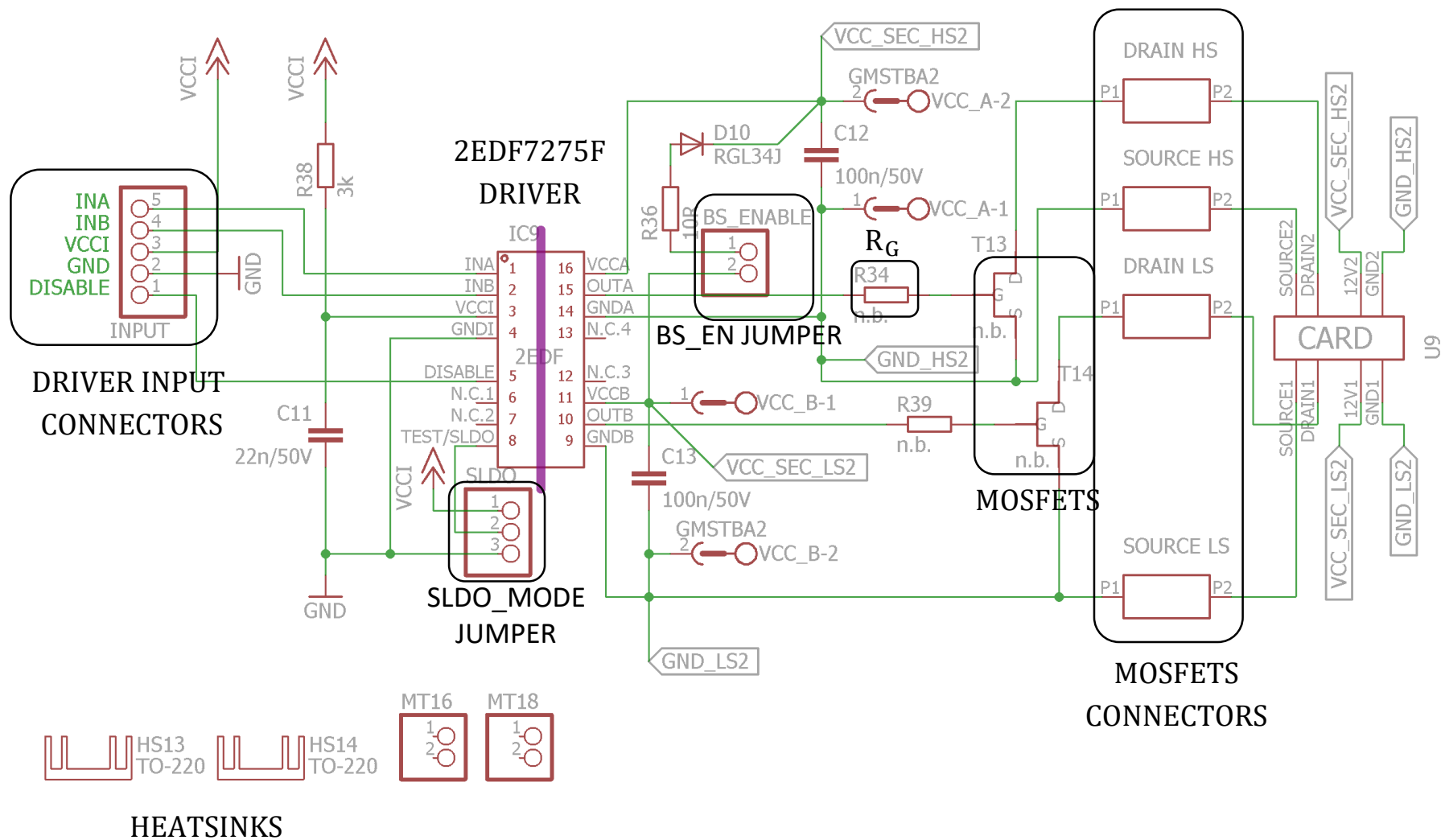
Included in this kit

Heatsinks for
TO-220 MOSFETs

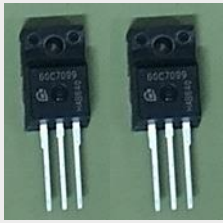


Evaluation kit
KIT_DRIVER_2EDF7275F

Board schematic

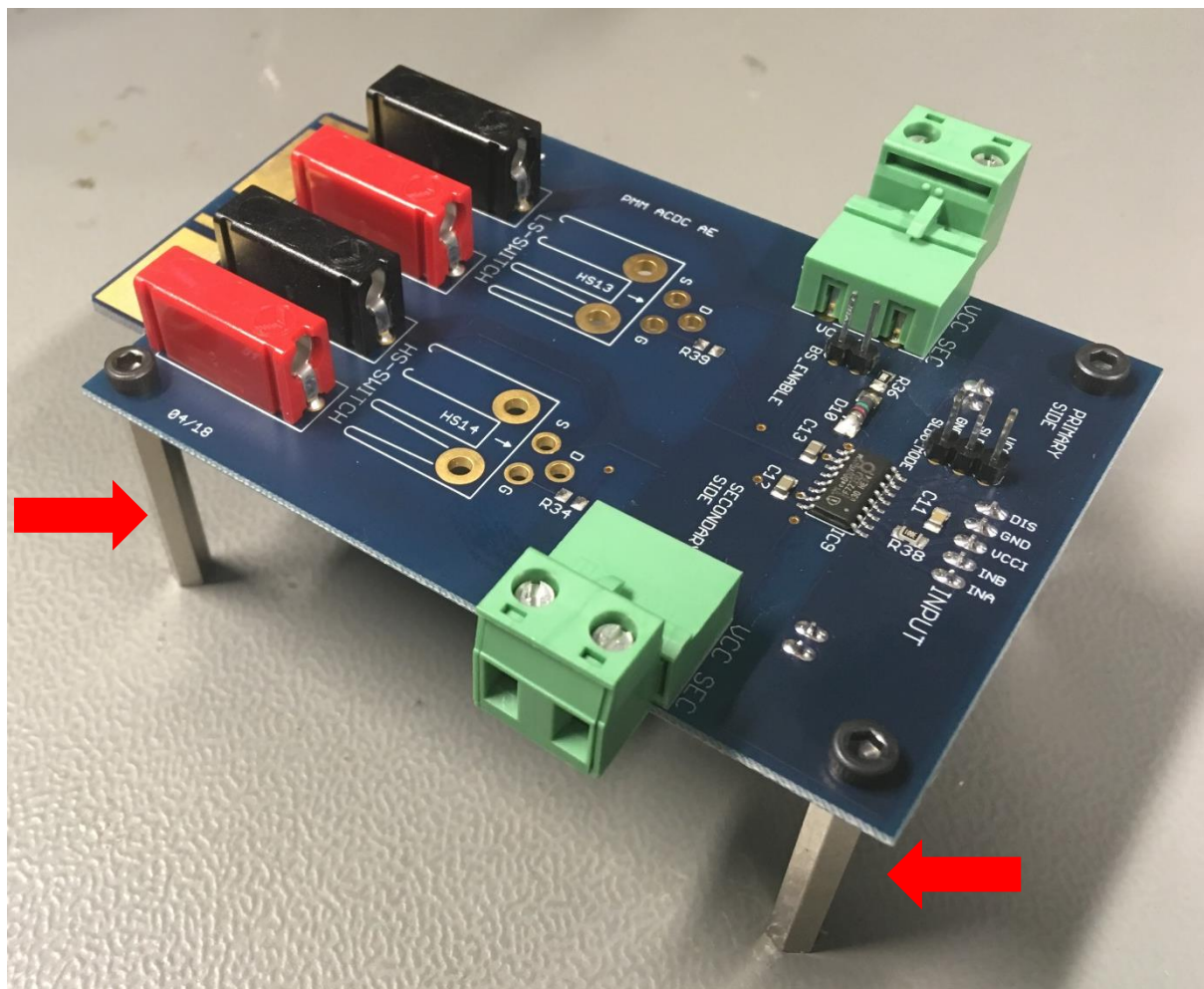


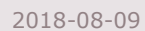
Components to add – BOM suggestion

Distance bolts	Screws for distance bolts	Screws and washers for MOSFET mounting to heatsink
		
TO-220 sockets	TO-220 MOSFETs	Gate resistors (R34, R39)
		

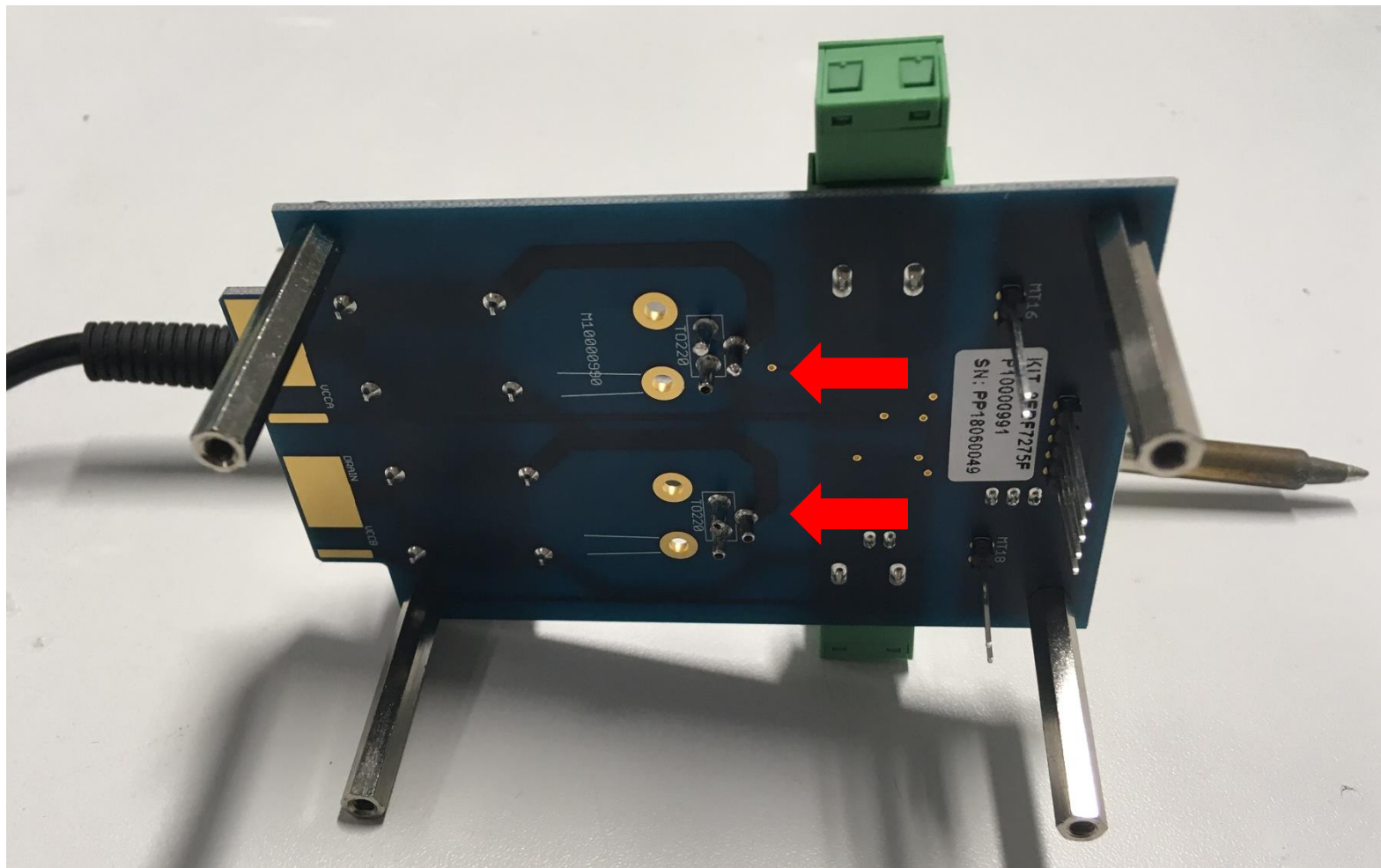
Component	Quantity	Designator	Comment	Voltage	Footprint	Type	Part number/ supplies
Resistors	4	R34,R39			RES805R	SMD ceramic resistor	
TO-220 sockets	2	T13,T14	TO-220 socket		TO-220	Receptacle Connector 0.034" ~ 0.041" (0.86 mm ~ 1.04 mm)	5050865-5 Digi-key

Step 1: Distance bolts mounting

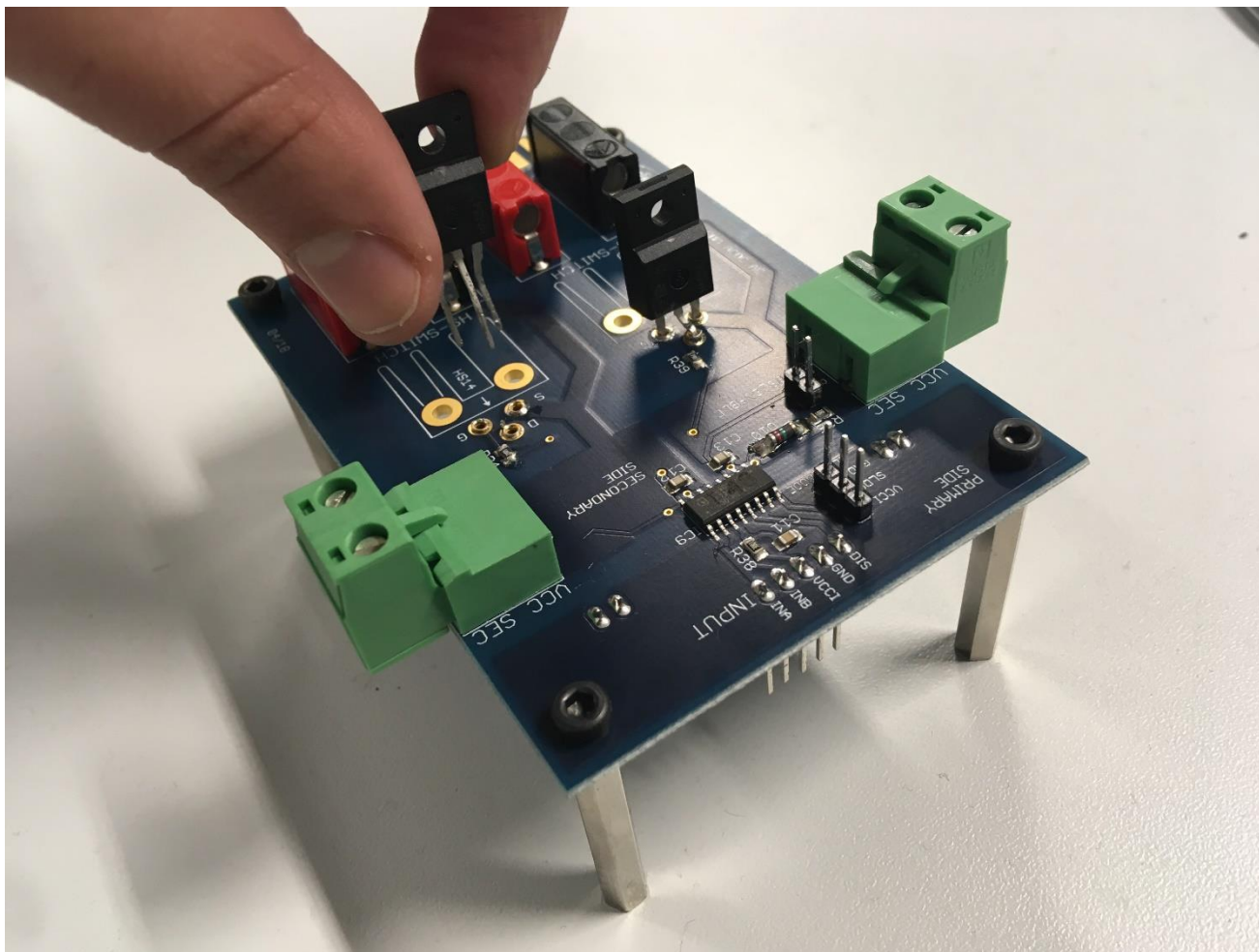




Step 3: TO-220 sockets soldering

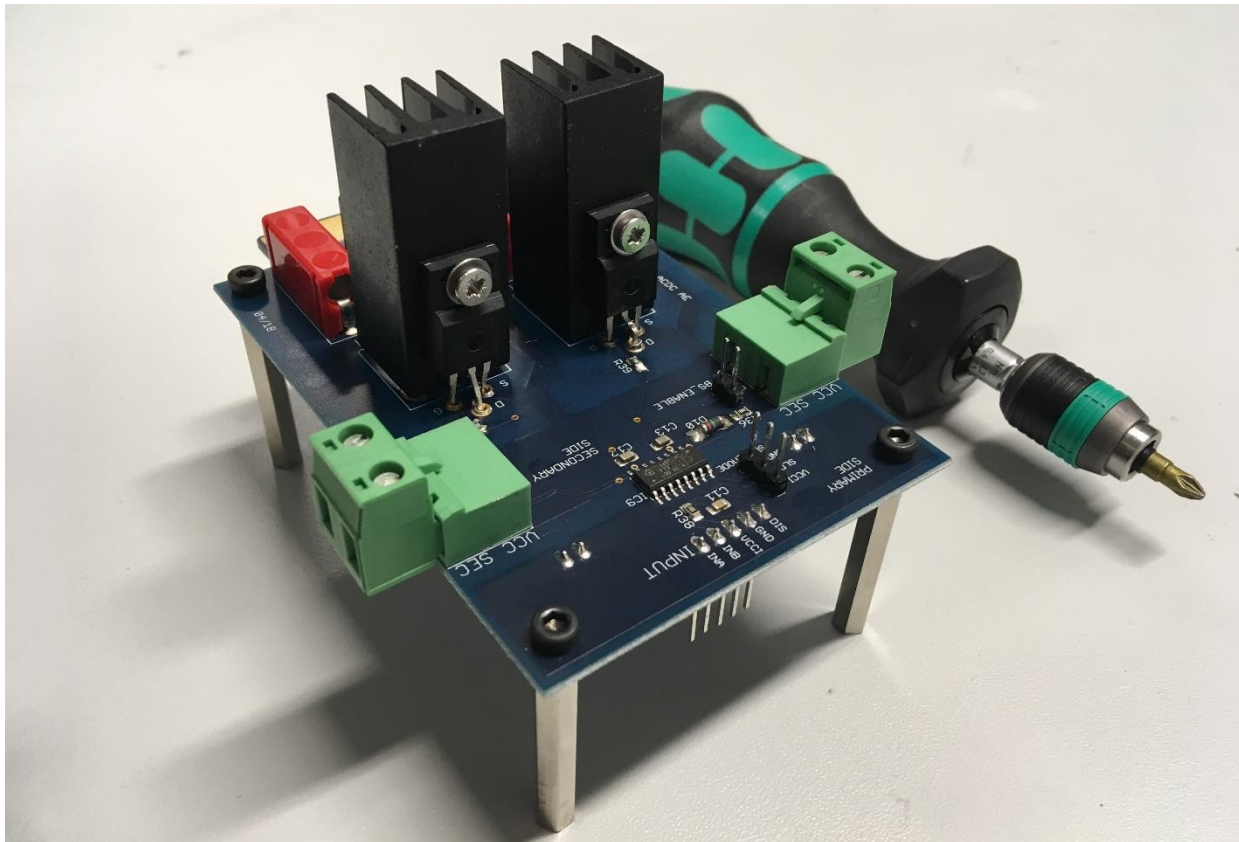


Step 4: MOSFETs placement into the sockets

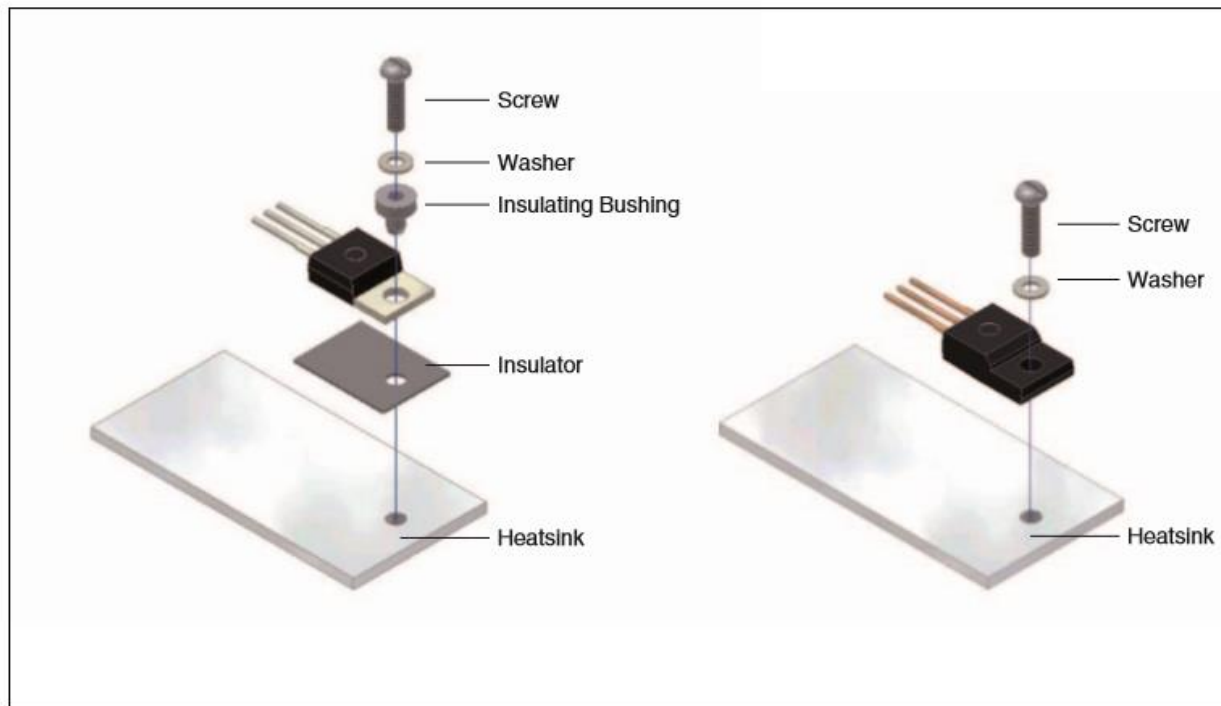


Step 5: Heatsink mounting (optional)

- > 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



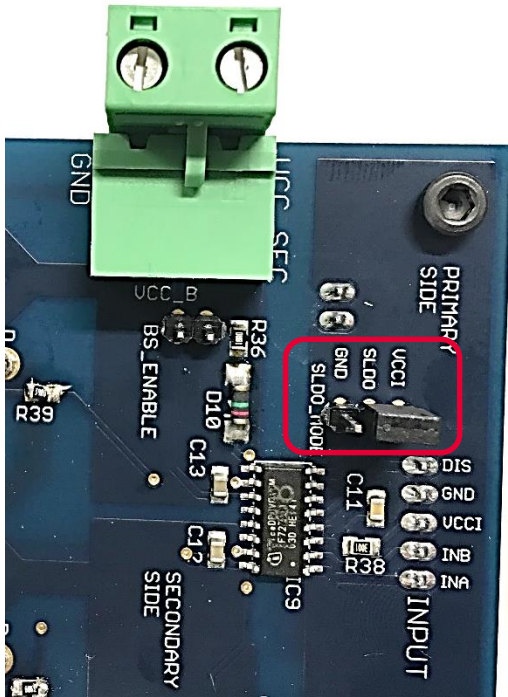
TO-220 MOSFET mounting to the heatsink



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 6: Select the SLDO_MODE jumper configuration

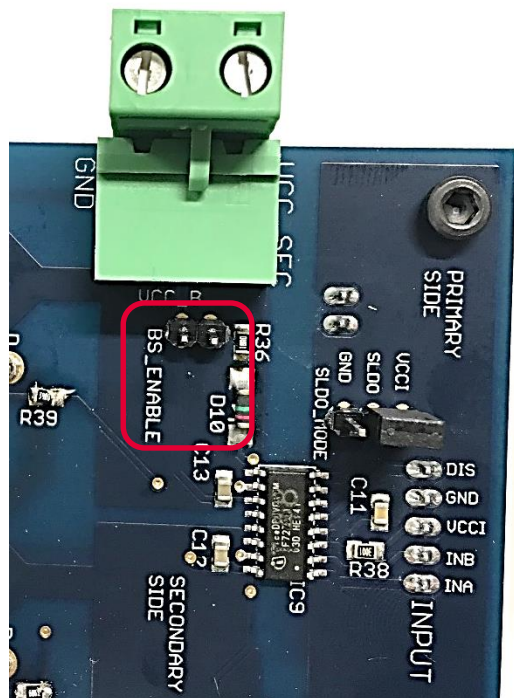


- If $V_{CCI}=3.3V$:
 - connect the SLDO_MODE jumper across VCCI and SLDO (*normal mode operation*)
 - Replace the shunt resistor R30 with 0Ω resistance
- If $V_{CCI} \geq 3.3V$, connect the SLDO_MODE jumper across SLDO and GND (*shunt mode operation*)
 - if $3.3V \leq V_{CCI} \leq 12V$, please decrease the shunt resistor R30 according to the table below

Available supply	Switching frequency		
	100 KHz	1 MHz	3 MHz
5 V	< 732 Ω	< 453 Ω	< 316 Ω
8 V	< 2.15 k Ω	< 1.37 k Ω	< 953 Ω
12 V	< 4.02 k Ω	< 2.61 k Ω	< 1.78 k Ω
15 V	< 5.49 k Ω	< 3.48 k Ω	< 2.43 k Ω

- > In this quick start guide the normal mode operation is used, as example; the SLDO_MODE jumper is connected across SLDO and VCCI pins and 3.3V VCCI is applied.

Step 7: Select the BS_EN jumper configuration



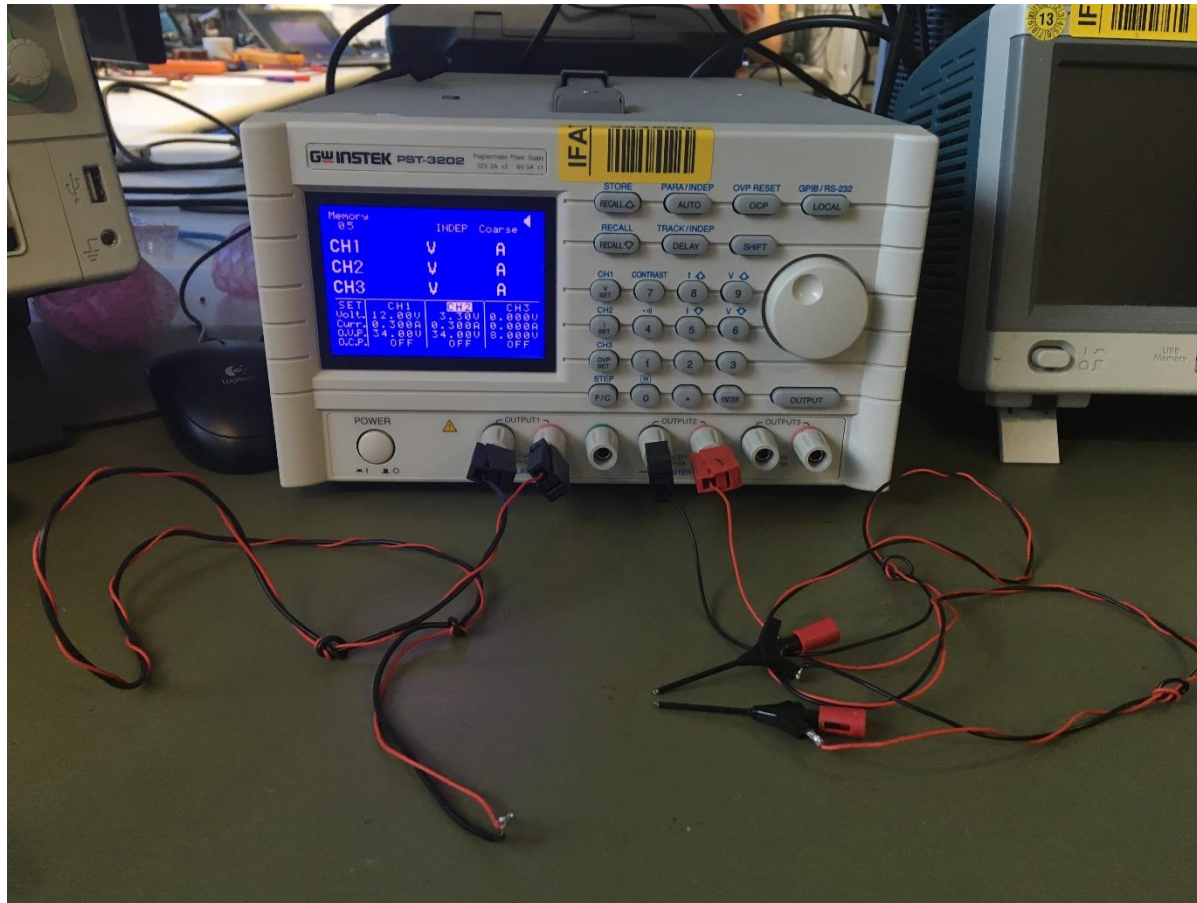
BS_EN jumper:

- Opened, if the MOSFETs are driven independently; in this case, if both channels are used, both VCCA and VCCB must be supplied
- Closed, in half-bridge configurations; in this case the bootstrap circuit is enabled and only VCCB must be supplied

> In this quick start guide only one MOSFET is driven and BS_EN is left opened

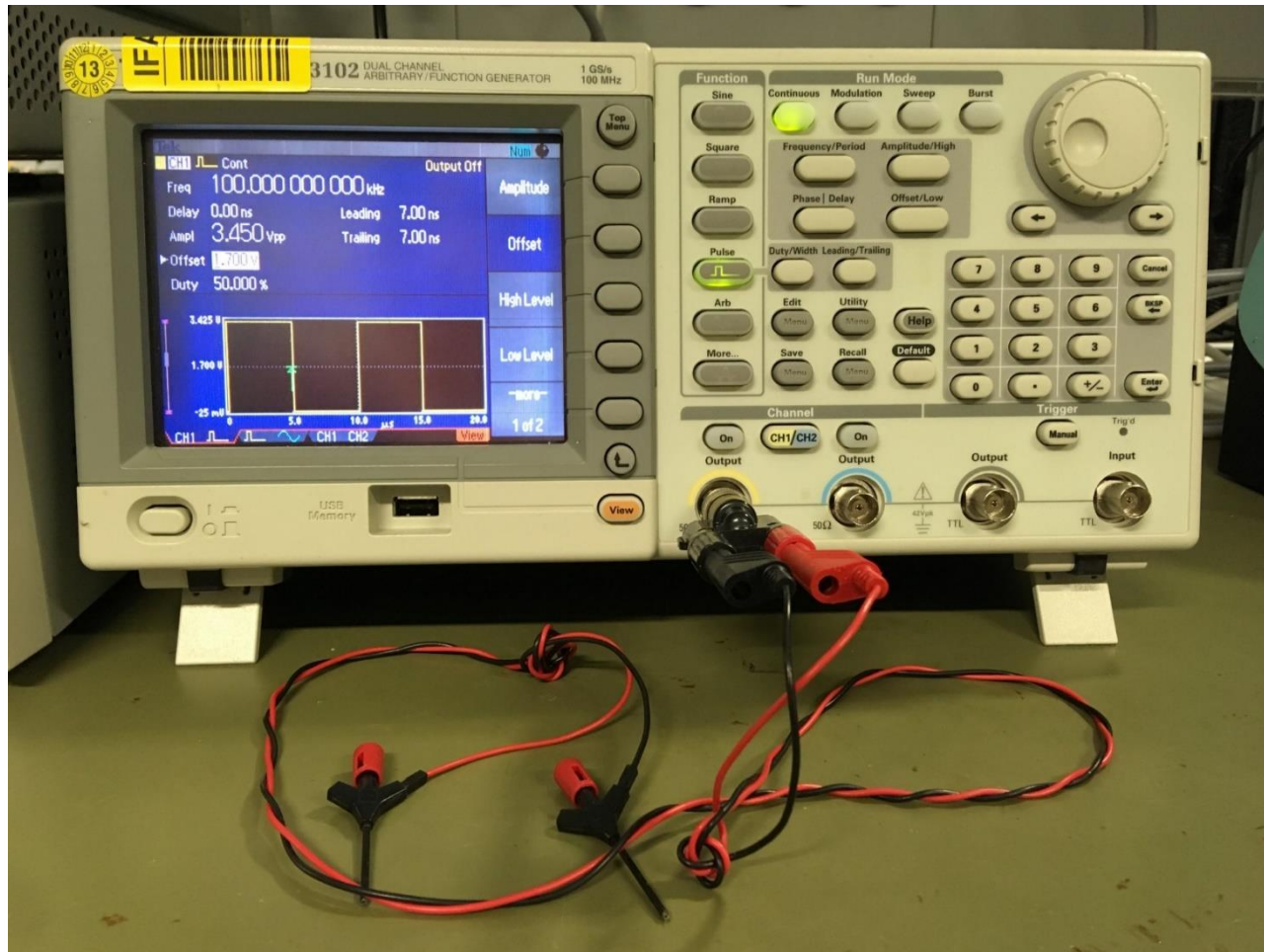


Instrumentation for driver supply generation



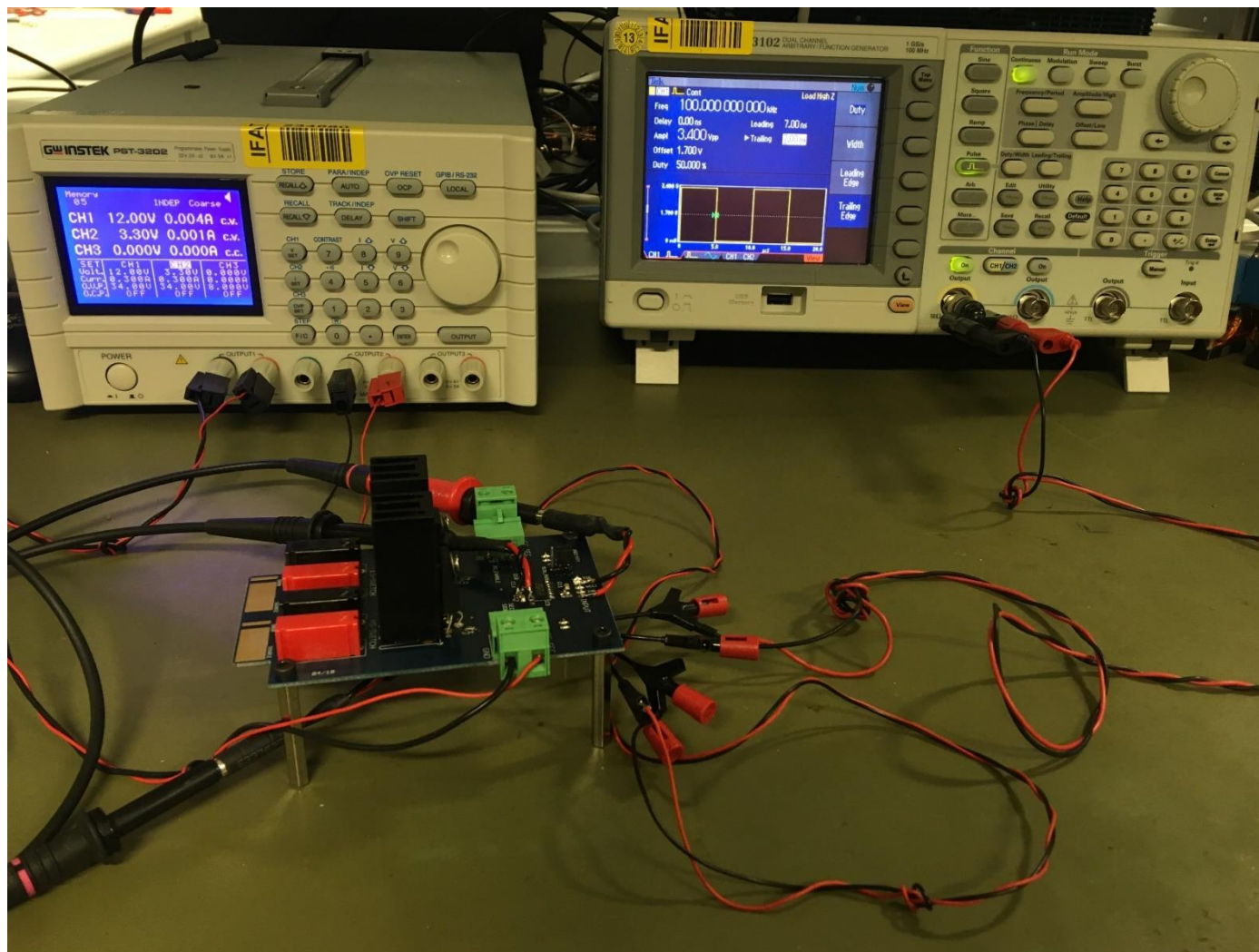
- > V_{CC} = 12 V for CoolMOS™ and 8 V for OptiMOS™
- > Set the current limit to 0.3mA

Instrumentation for PWM signals generation

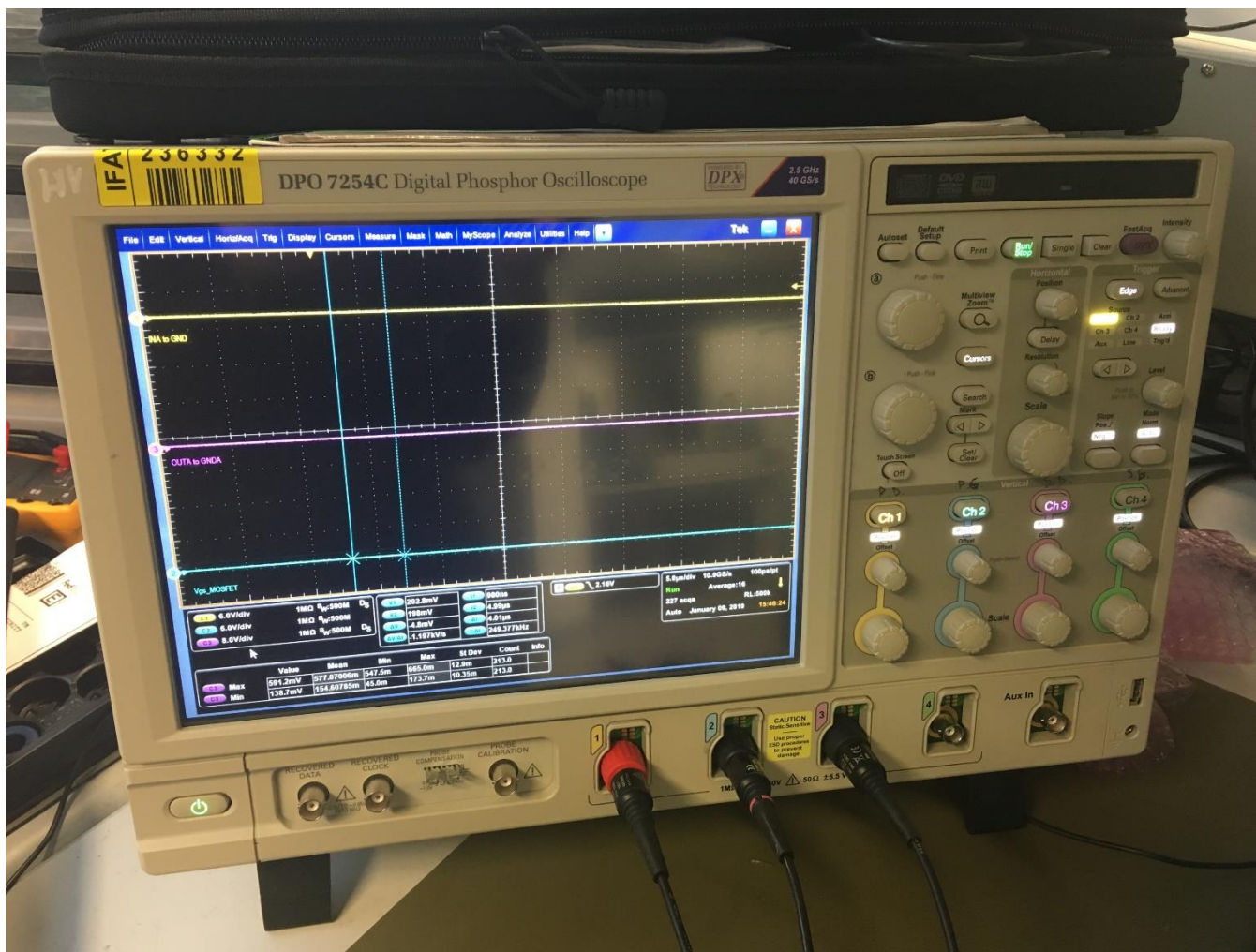


- Use a function generator or a microcontroller

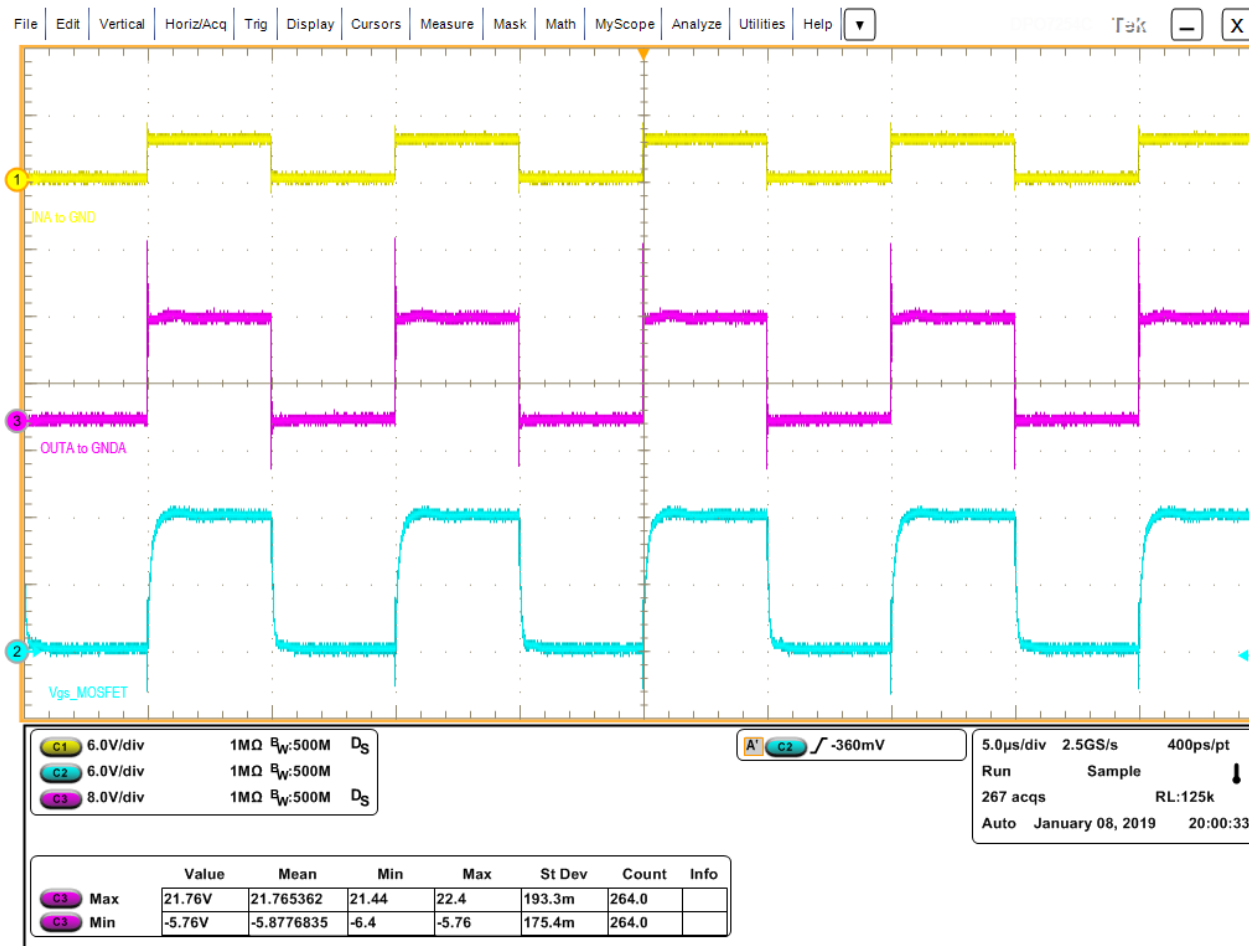
Connections



Instrumentation for signals evaluation

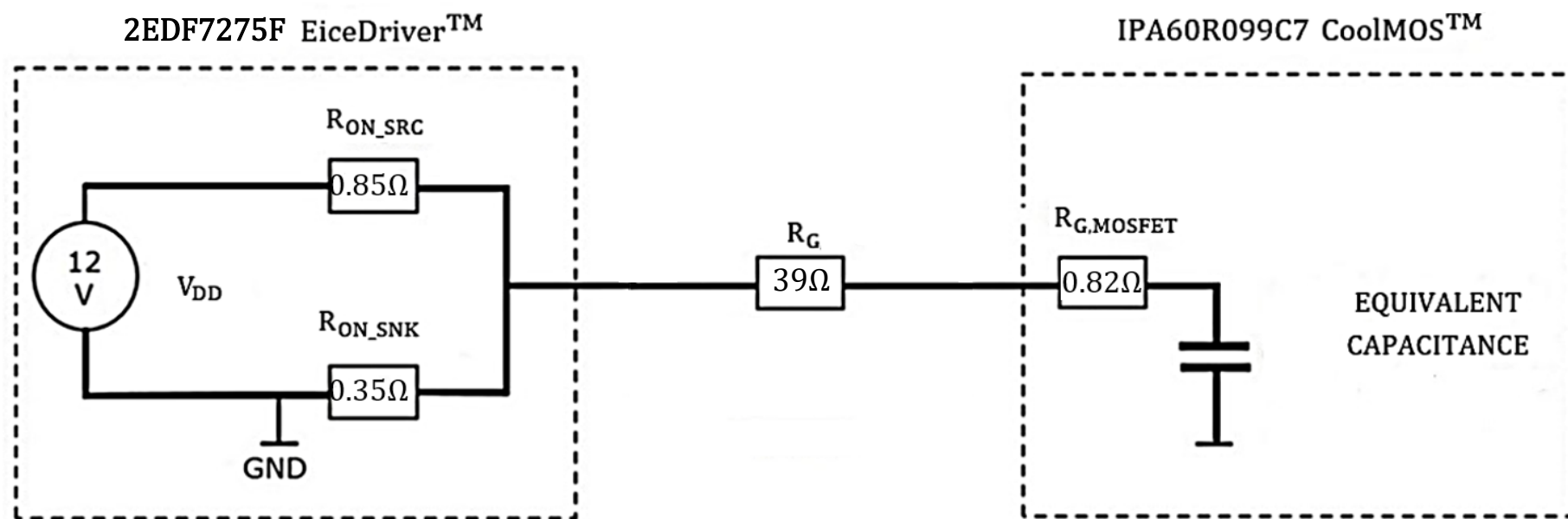


Oscilloscope waveforms

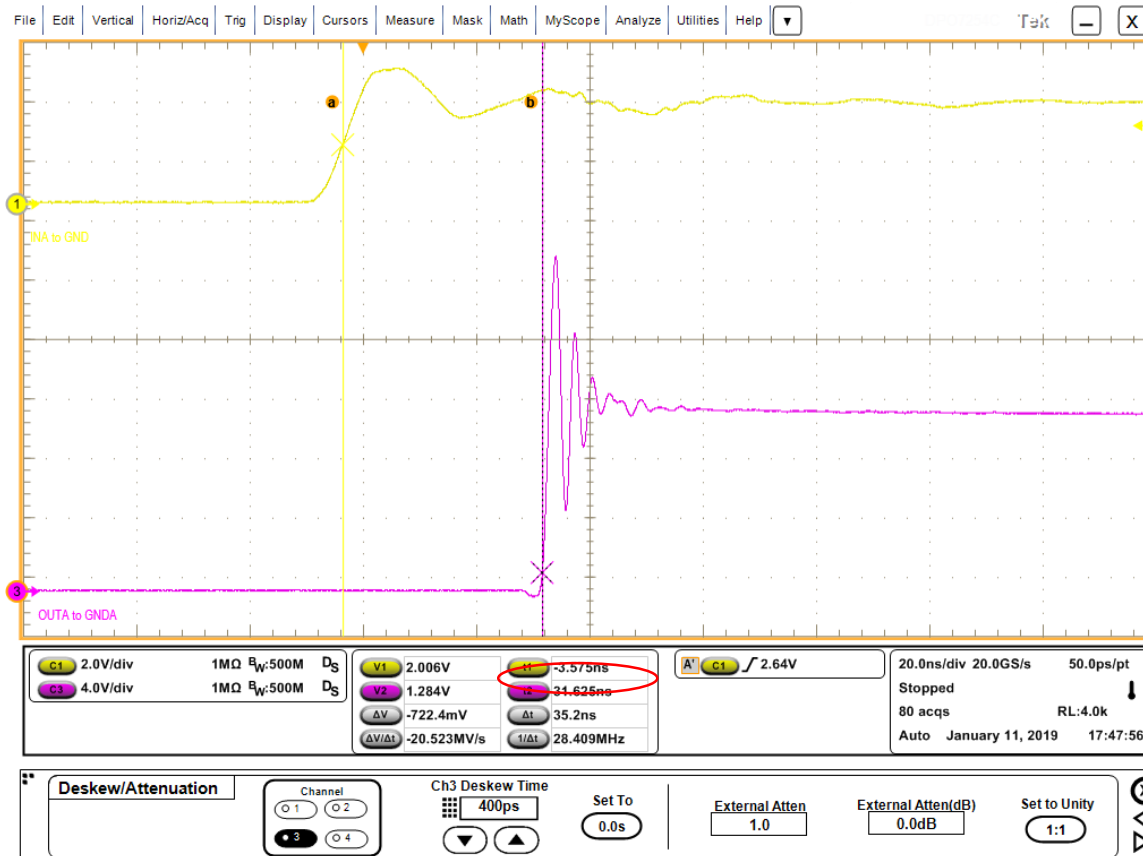


- Measurements done on a single MOSFET with $V_{DS} = 0\text{ V}$ (drain and source shorted)

Equivalent model of the driving circuit



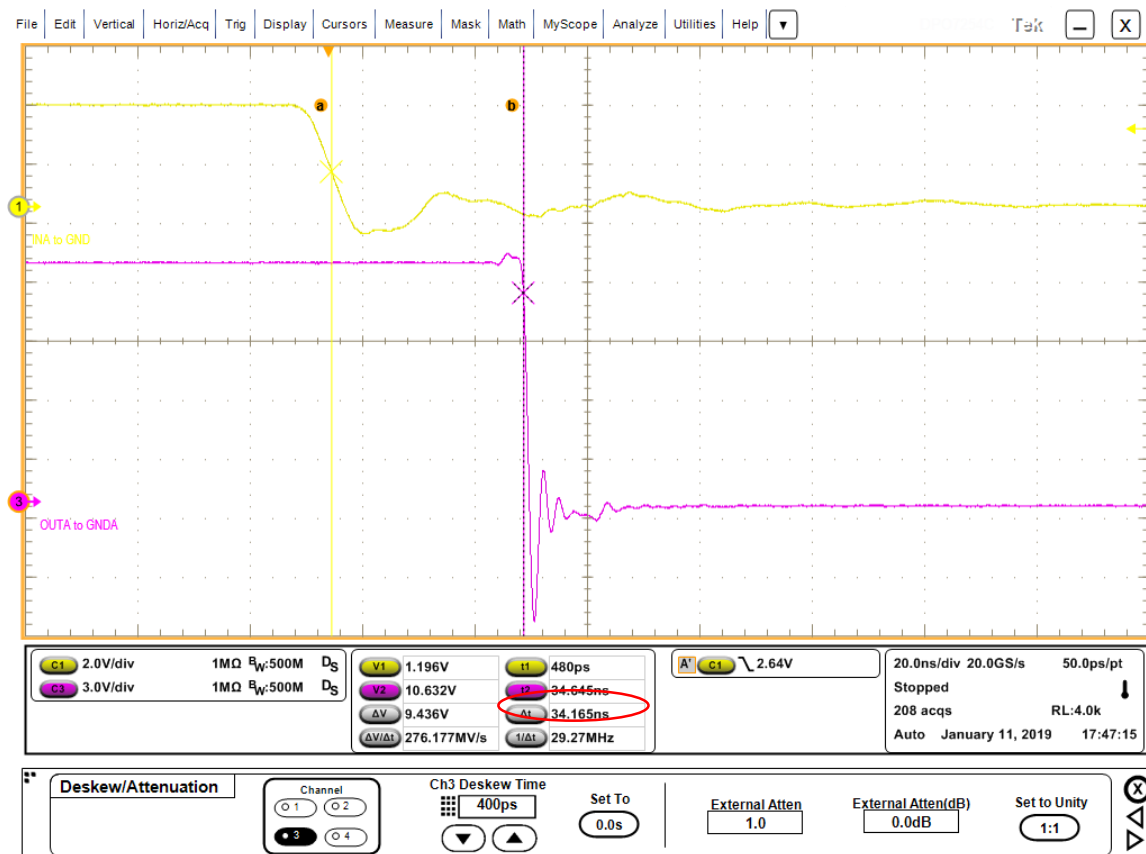
Low-high propagation delay



$R_G = 39 \Omega$
 MOSFET = IPA60R099C7
 $R_{G,MOSFET} = 0.82 \Omega$
 $C_{LOAD} \approx 2.8 \text{ nF}$

- > t_{PDlh} defined in the datasheet as time interval $t(OUTB = 10\% VDD) - t(INB = V_{INH} = 2 \text{ V})$ for a pure capacitive load $C_{LOAD} = 1.8 \text{ nF}$ with $R_G = 0 \Omega$
- > 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



$R_G = 39 \Omega$
 MOSFET = IPA60R099C7
 $R_{G,MOSFET} = 0.82 \Omega$
 $C_{LOAD} \approx 2.8 \text{ nF}$

- > t_{PDhl} defined in the datasheet as time interval $t(INB = V_{INL} = 1.2 \text{ V}) - t(OUTB = 90\% \text{ VDD})$ for a pure capacitive load $C_{LOAD} = 1.8 \text{ nF}$ with $R_G = 0 \Omega$
- > 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

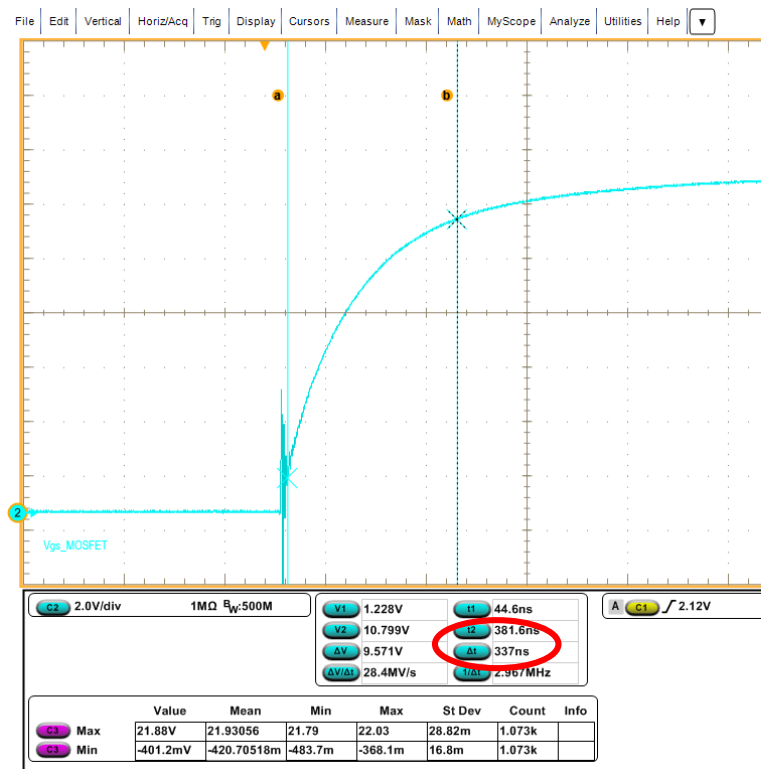


Gate to drain charge	Q_{gd}	-	14	-	nC	$V_{DD}=400V, I_D=9.7A, V_{GS}=0 \text{ to } 10V$
Gate charge total	Q_g	-	42	-	nC	$V_{DD}=400V, I_D=9.7A, V_{GS}=0 \text{ to } 10V$

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

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

Rise/fall times

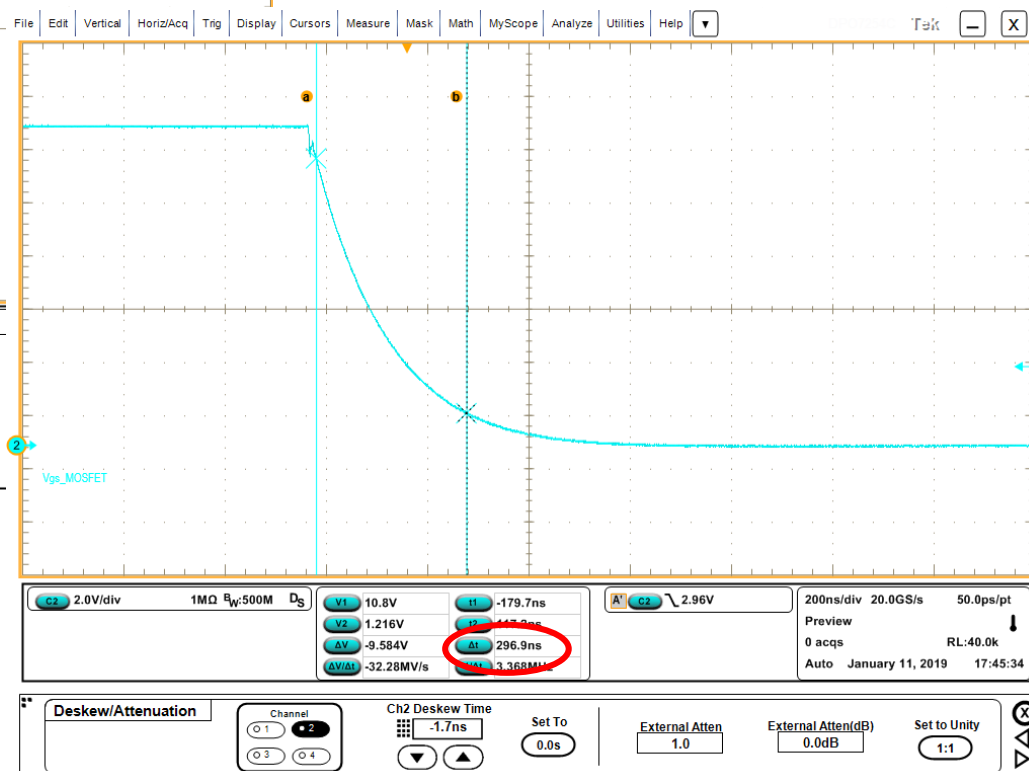


$$R_G = 39 \Omega$$

MOSFET = IPA60R099C7

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

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



Gate resistors replacement

$$R_G = 39 \, \Omega \quad \rightarrow \quad 24 \, \Omega$$

MOSFET = IPA60R099C7

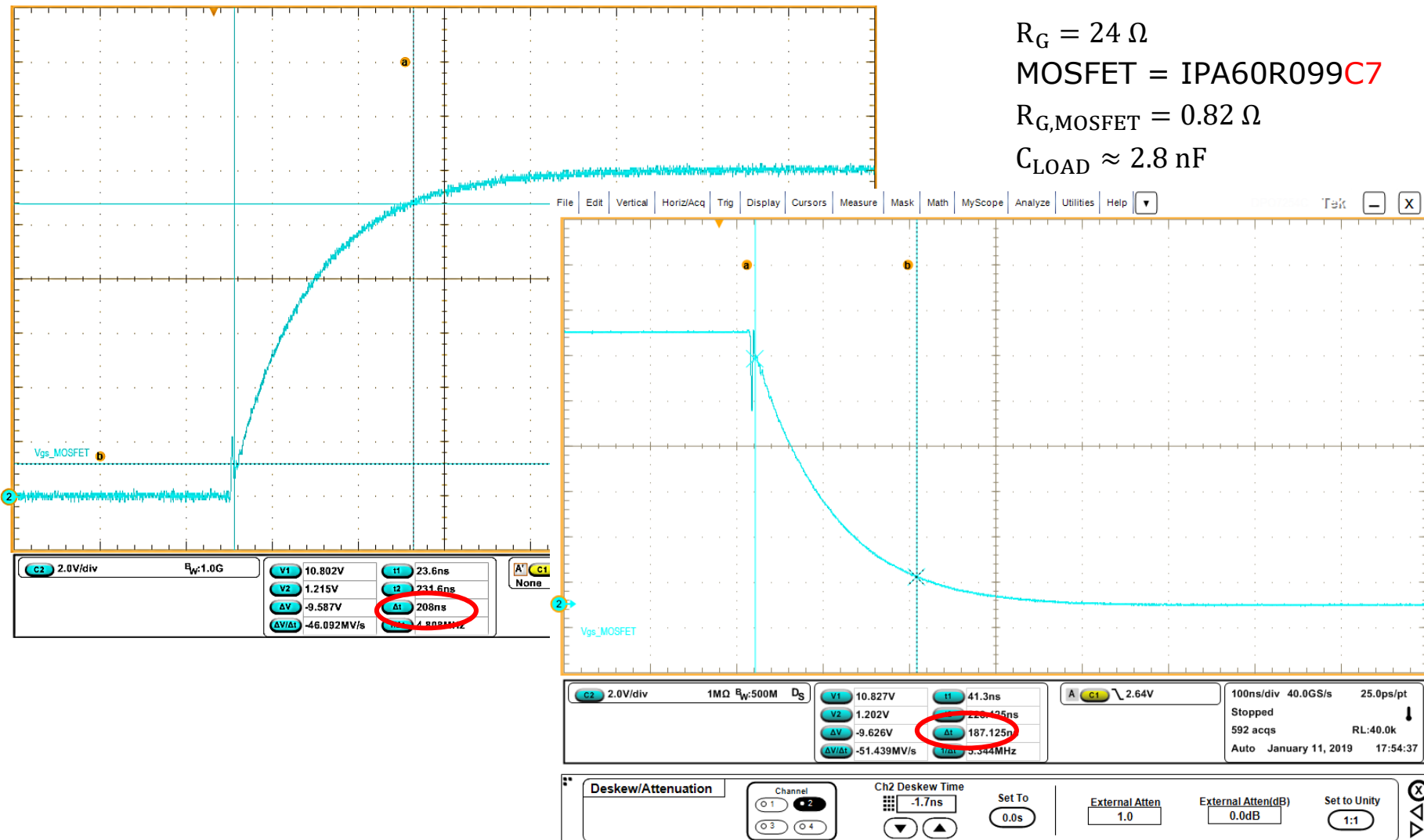
Rise/fall times: New set of gate resistances

$$R_G = 24 \Omega$$

MOSFET = IPA60R099C7

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

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



Gate resistors replacement

$$R_G = 24 \, \Omega \quad \rightarrow \quad 51 \, \Omega$$

MOSFET = IPA60R099C7

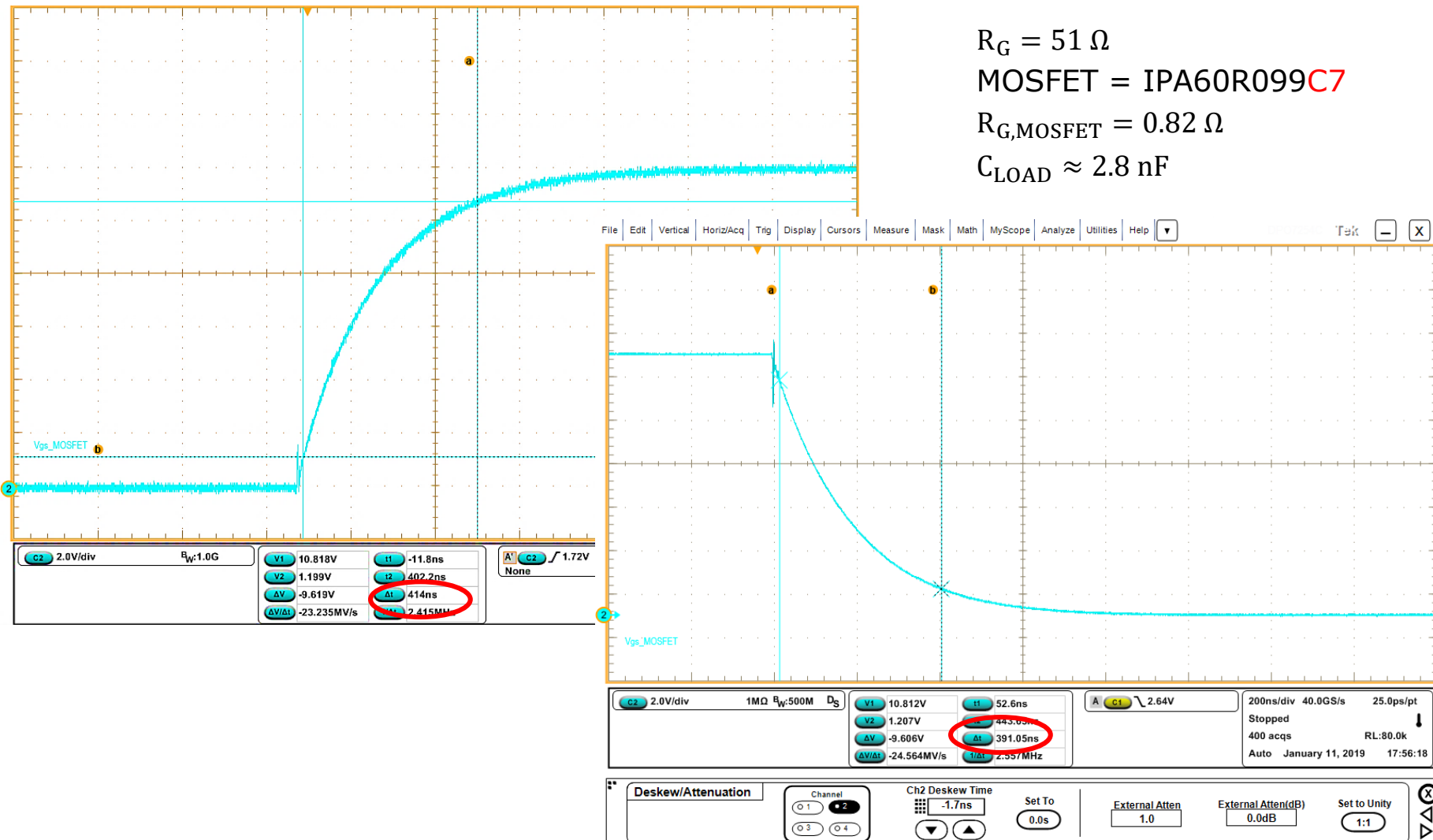
Rise/fall times: New set of gate resistances

$$R_G = 51 \Omega$$

MOSFET = IPA60R099C7

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

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



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	$V_{DD}=400V, I_D=5.0A, V_{GS}=0 \text{ to } 10V$

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

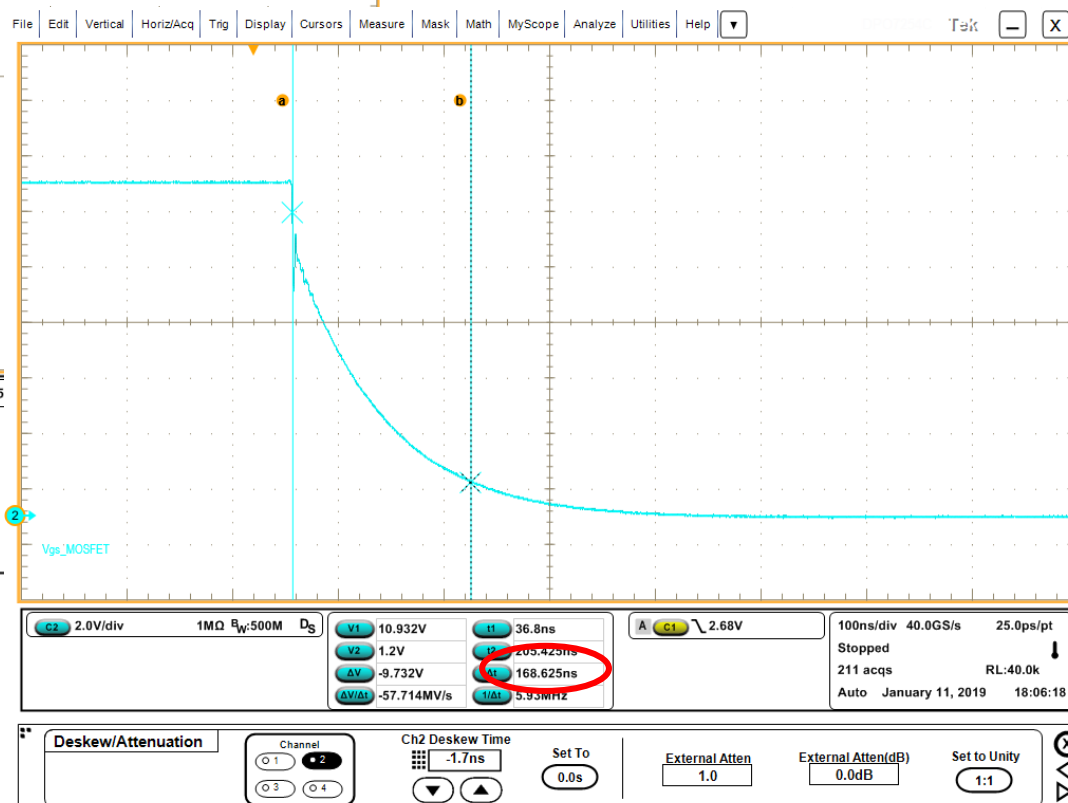
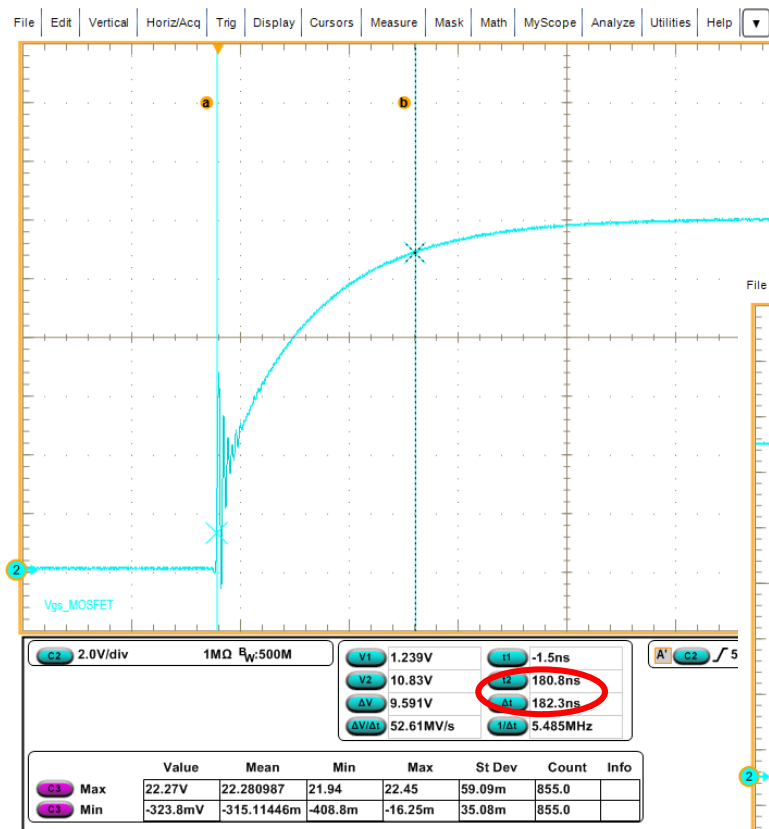
Rise/fall times: New MOSFET

$$R_G = 51 \Omega$$

MOSFET = IPA60R280CFD7

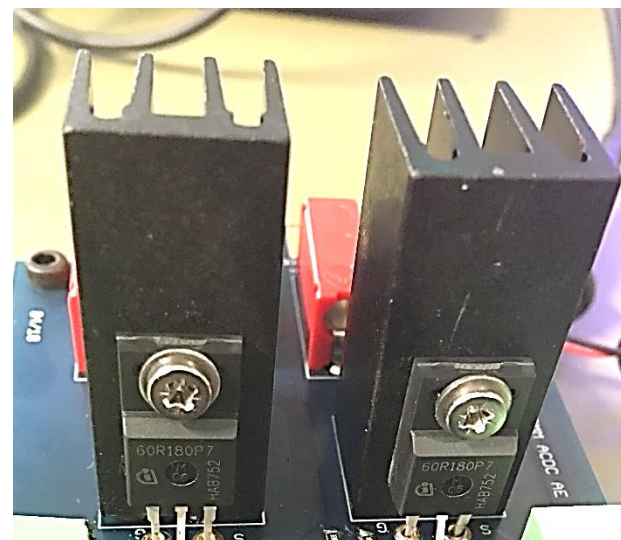
$$R_{G,MOSFET} = 11 \Omega$$

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



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	$V_{DD}=400V, I_D=5.6A, V_{GS}=0 \text{ to } 10V$

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

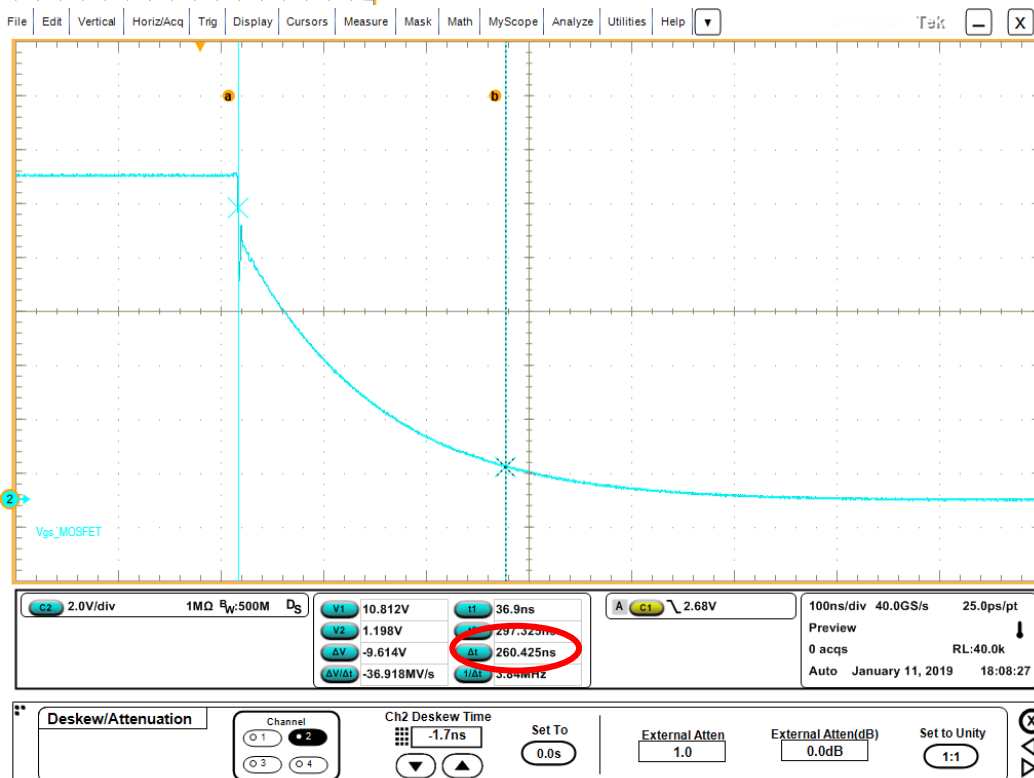
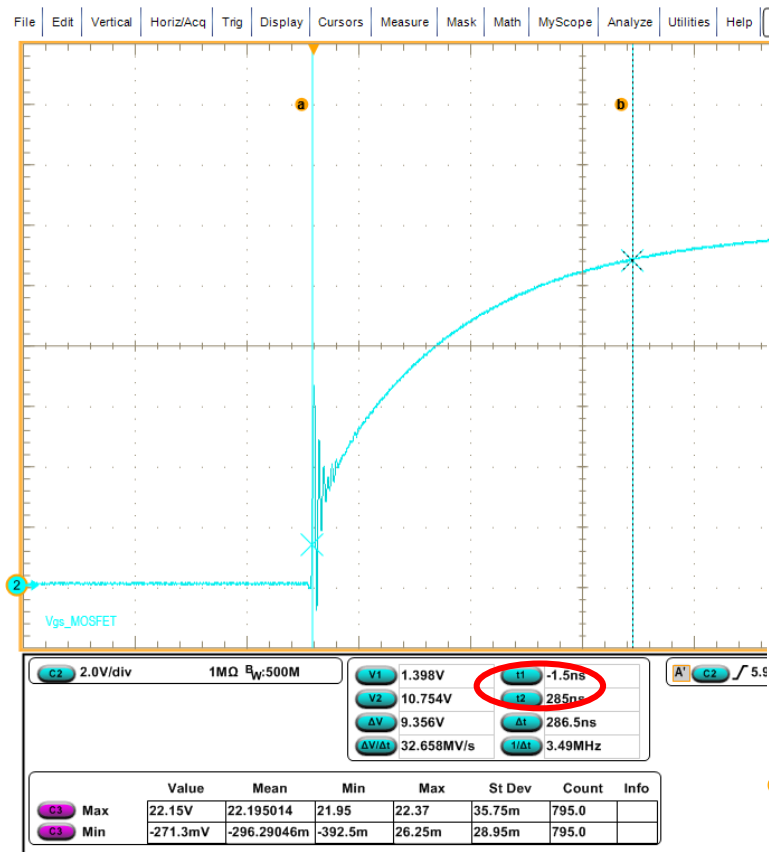
Rise/fall times: New MOSFET

$$R_G = 51 \Omega$$

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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