

以**Double Pulse Tester**協助寬能隙半導體於 電源轉換器功率級的設計及驗證 實驗展示

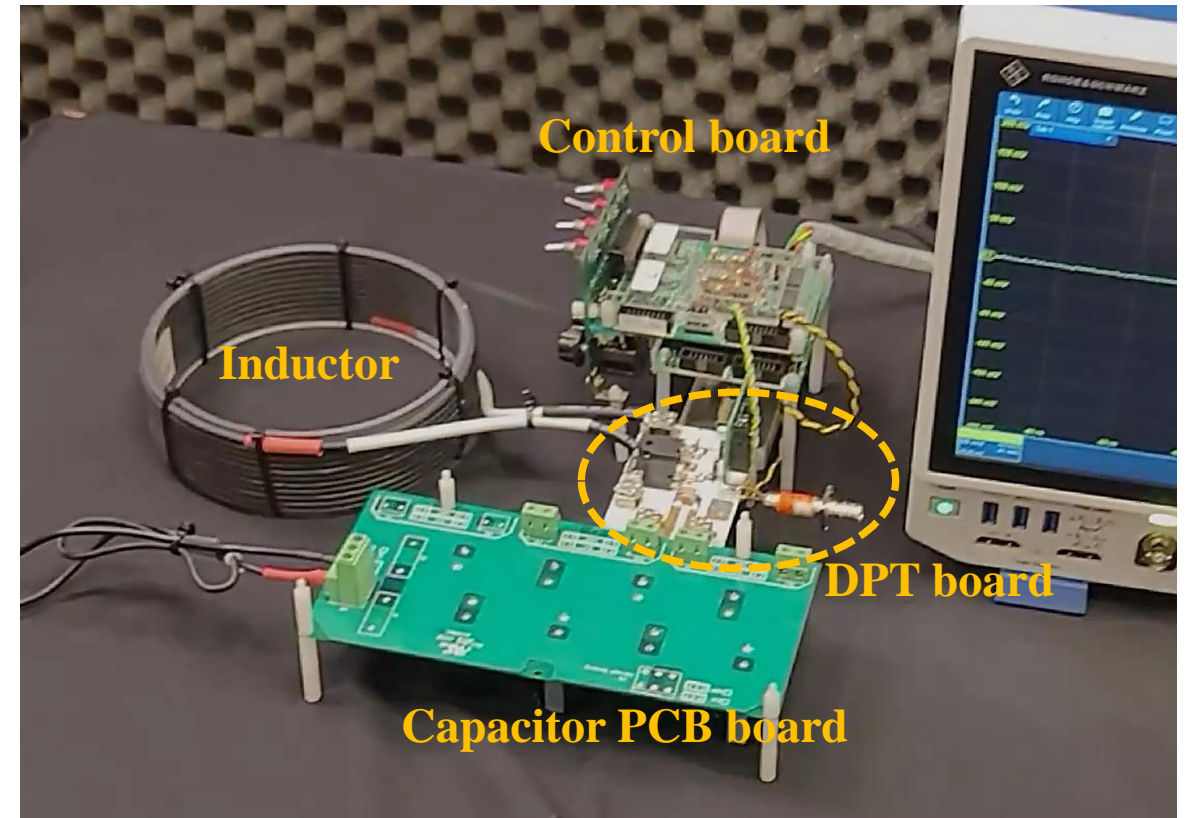
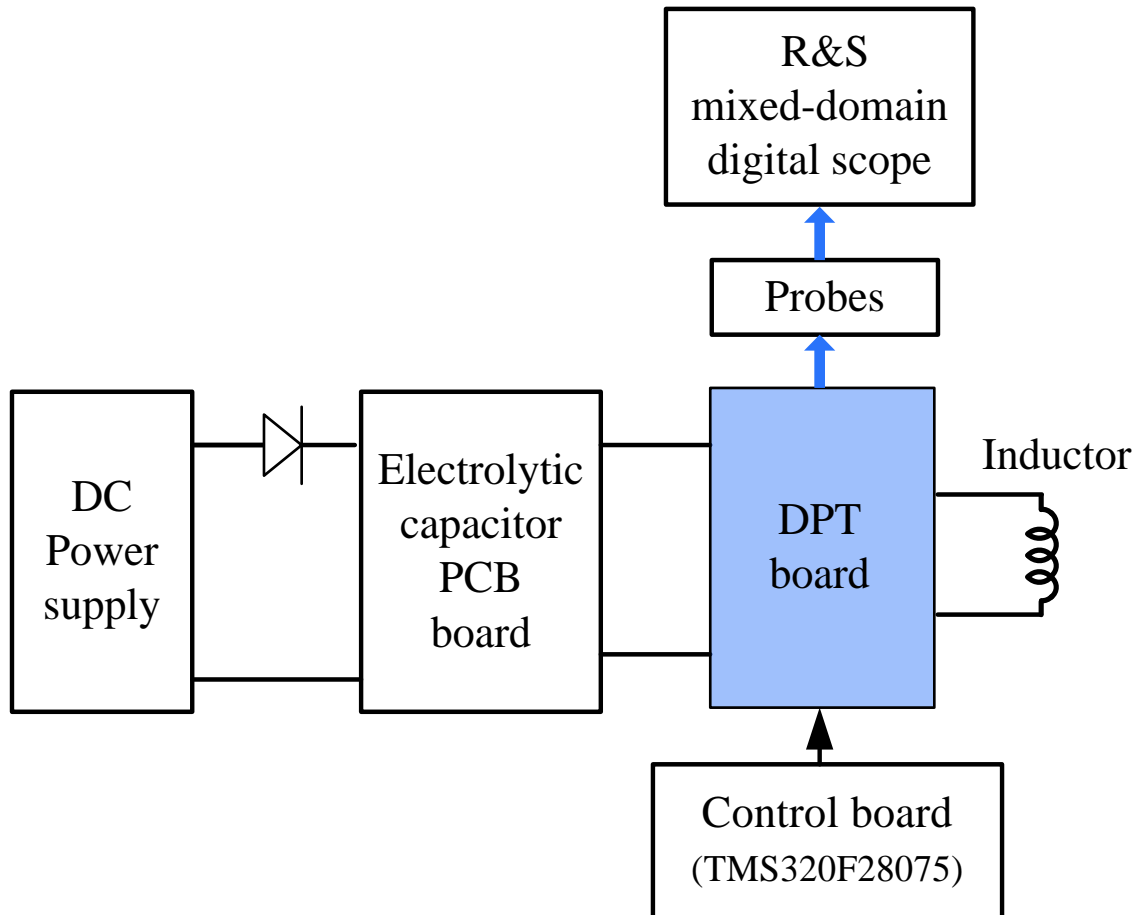
Using Double Pulse Tester to Assist in the Design and Verification of Wide Bandgap-Based Power Stage for Converter/Inverter – Experimental Demonstration

臺北科技大學 電機系

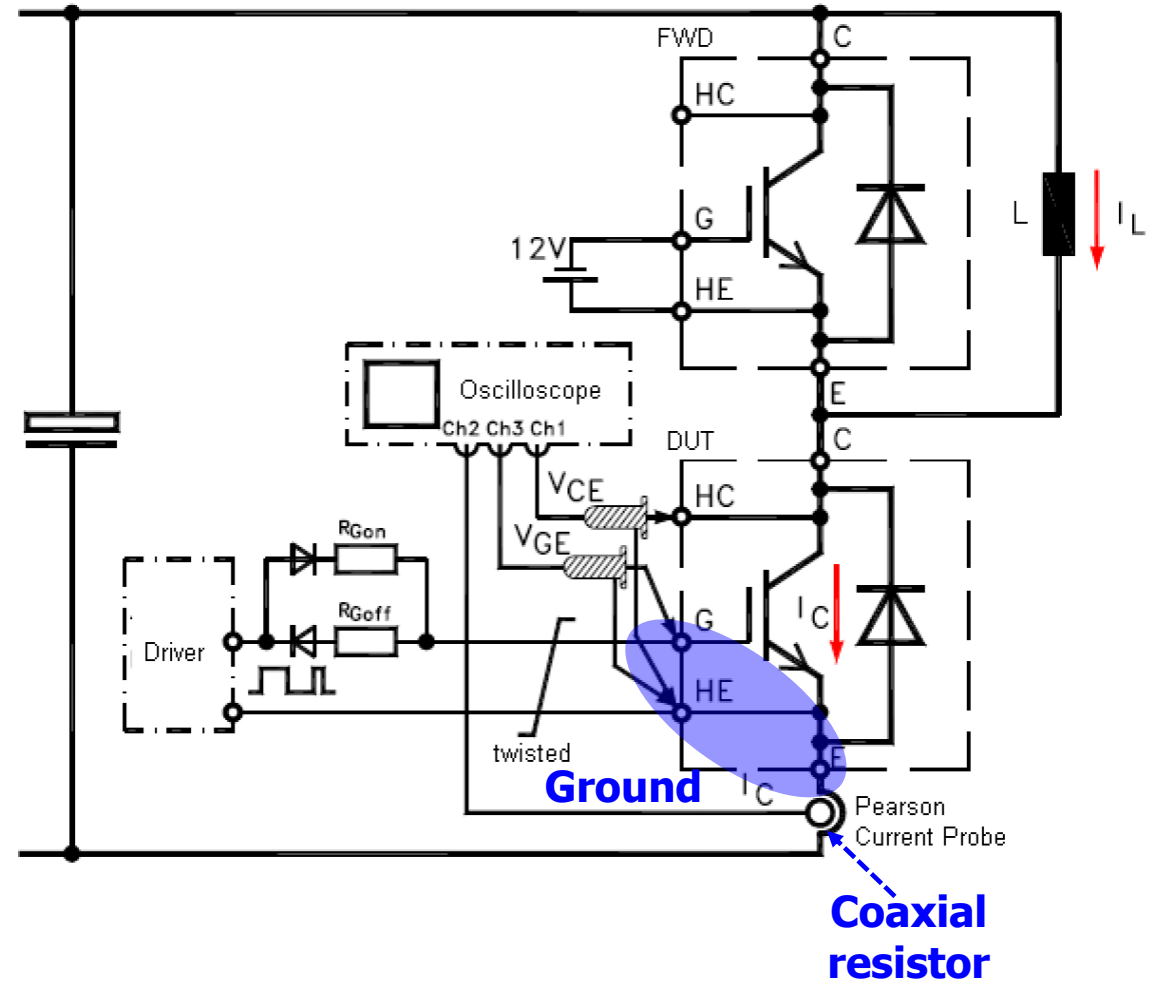
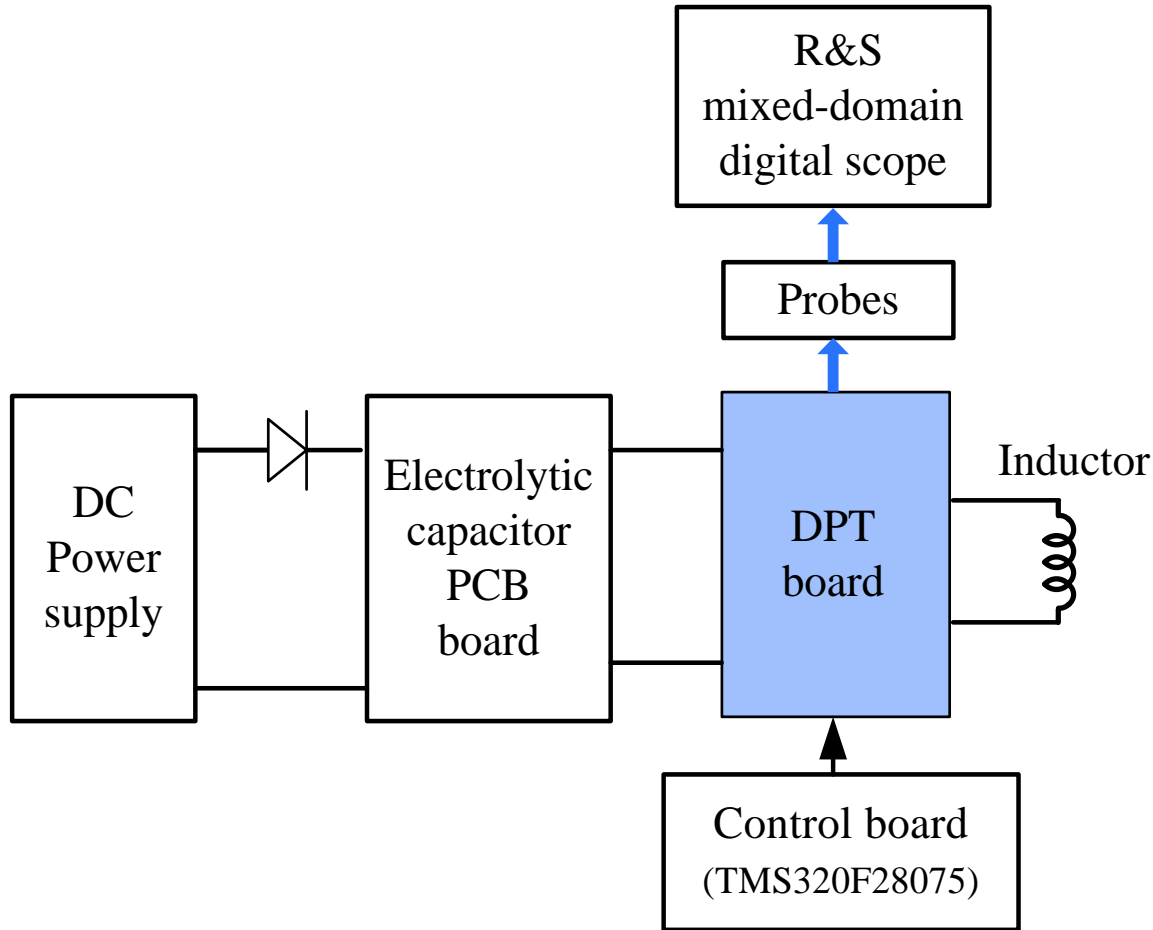
黃明熙

2023.12

Experimental Setup

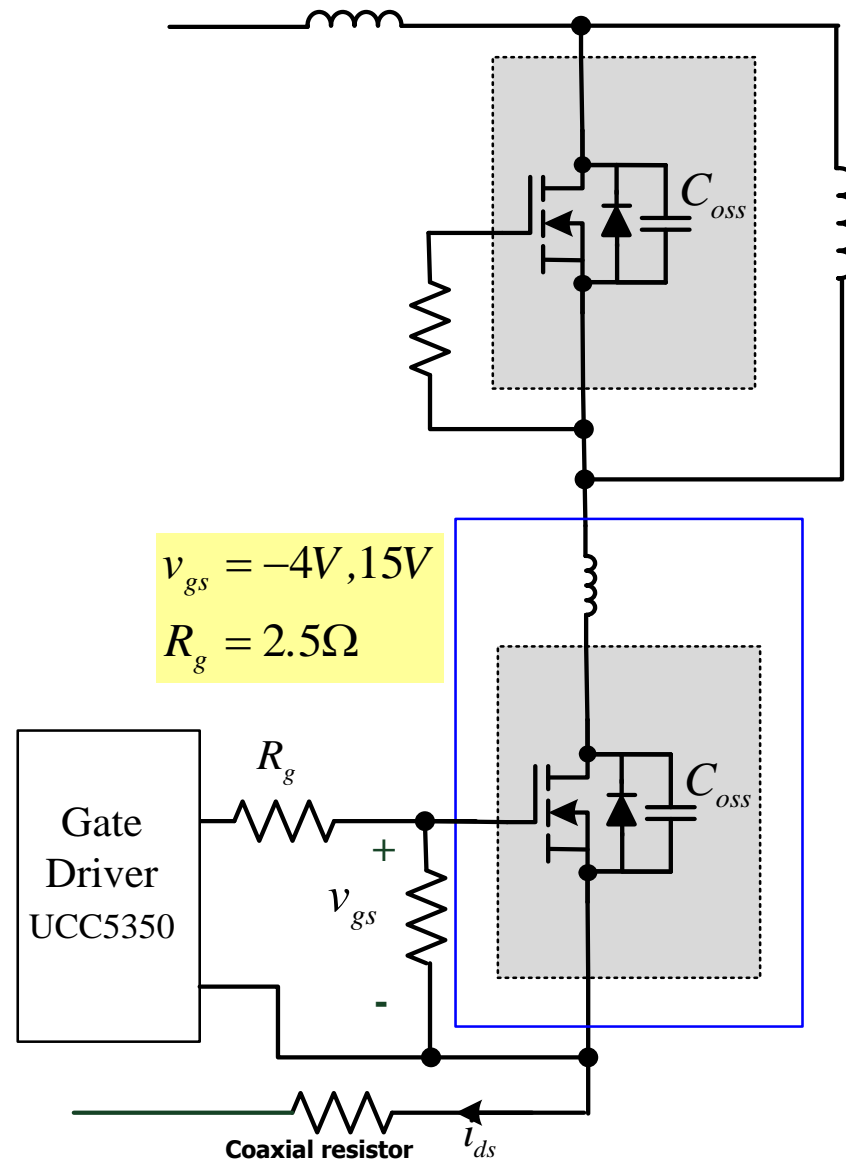


Experimental Setup - Ground



Experimental Setup

□ DPT equivalent circuit and key components



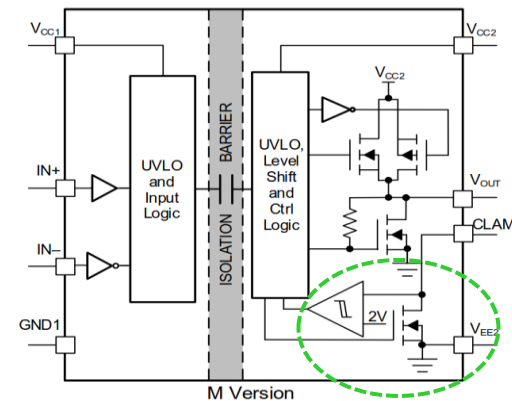
GaN probe
(100:1, 700MHz)



Coaxial resistor
(25mΩ/3Joule/BW=1200MHz/
Rising time <=0.3ns)



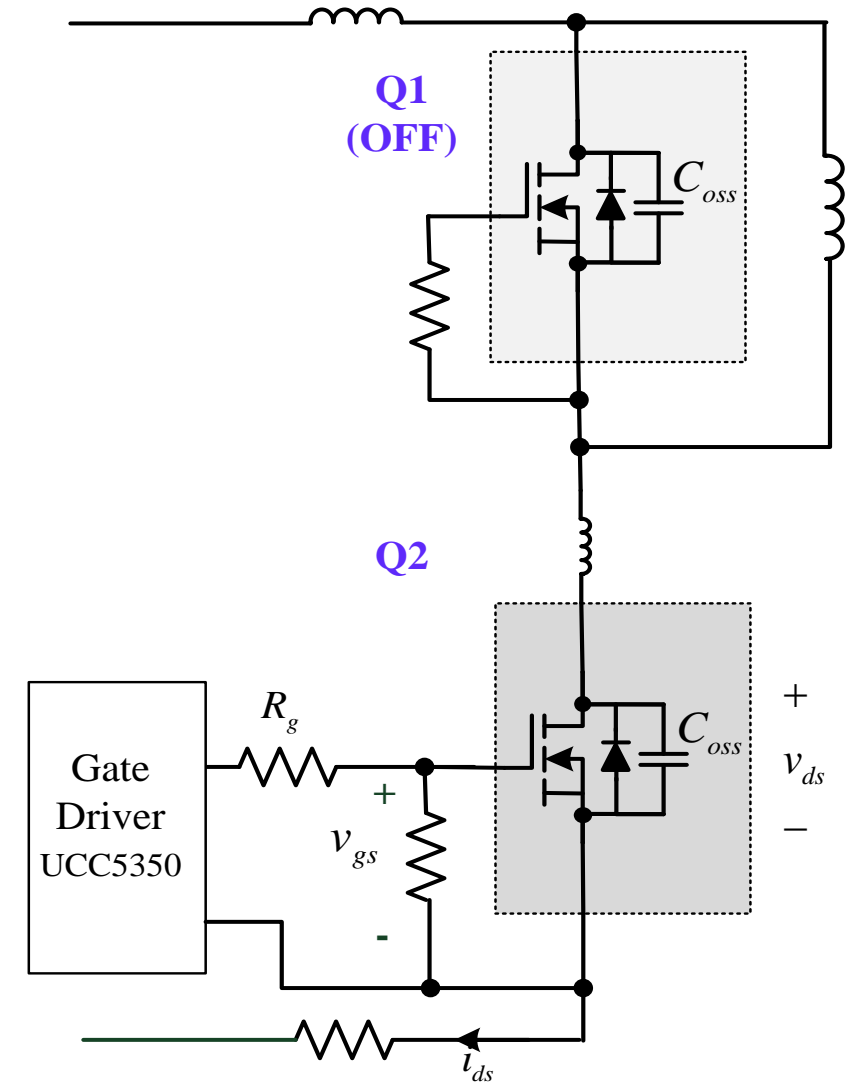
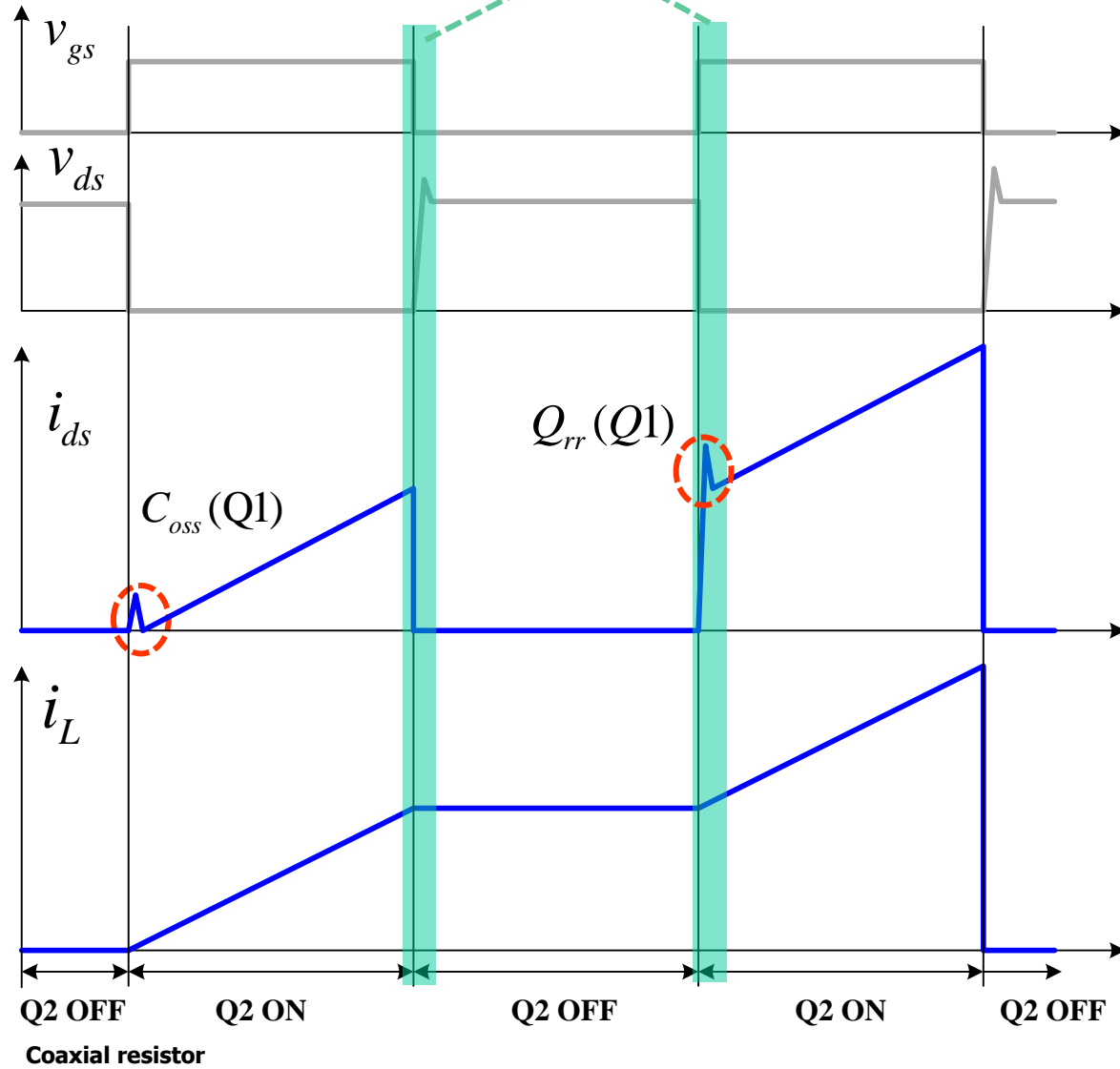
Gate driver - UCC5350



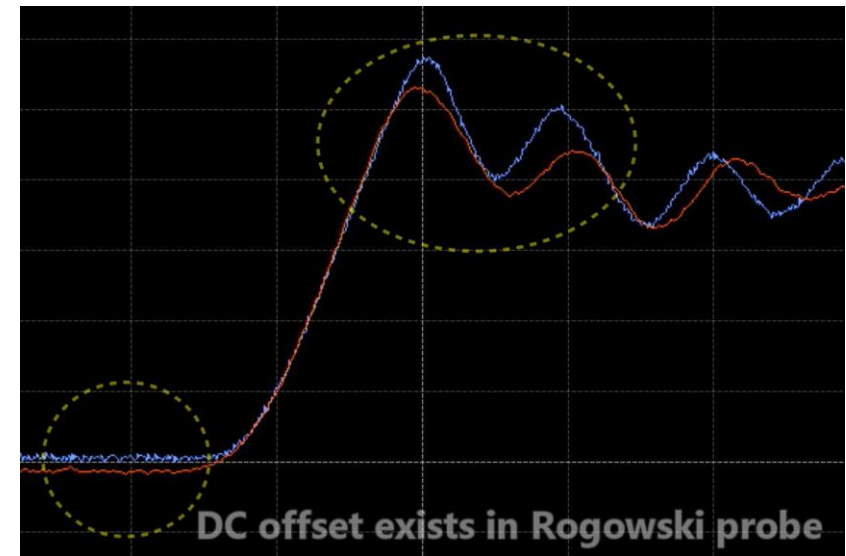
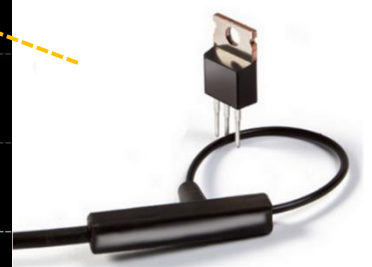
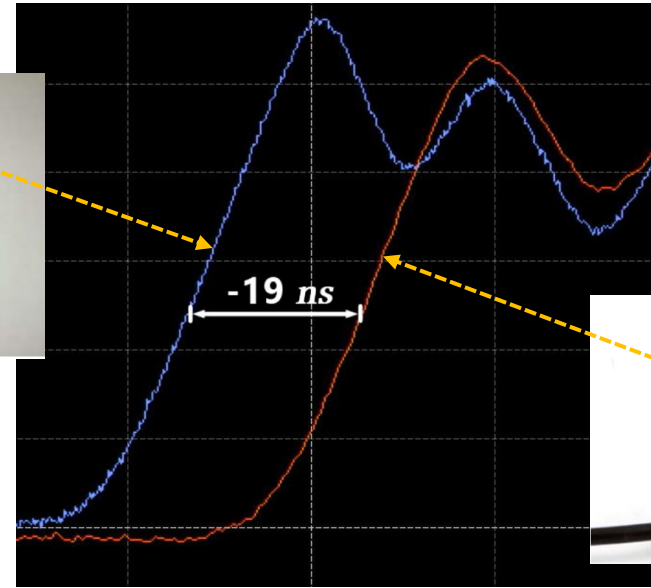
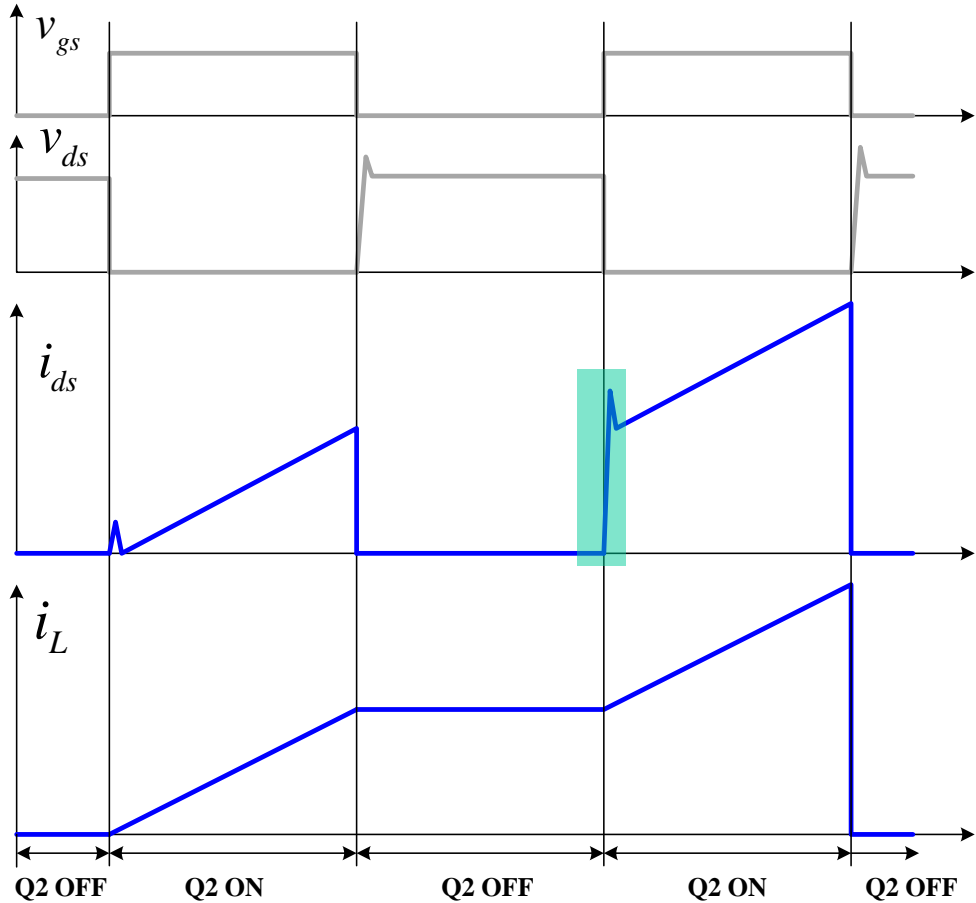
Miller clamp circuit

DPT Test Items

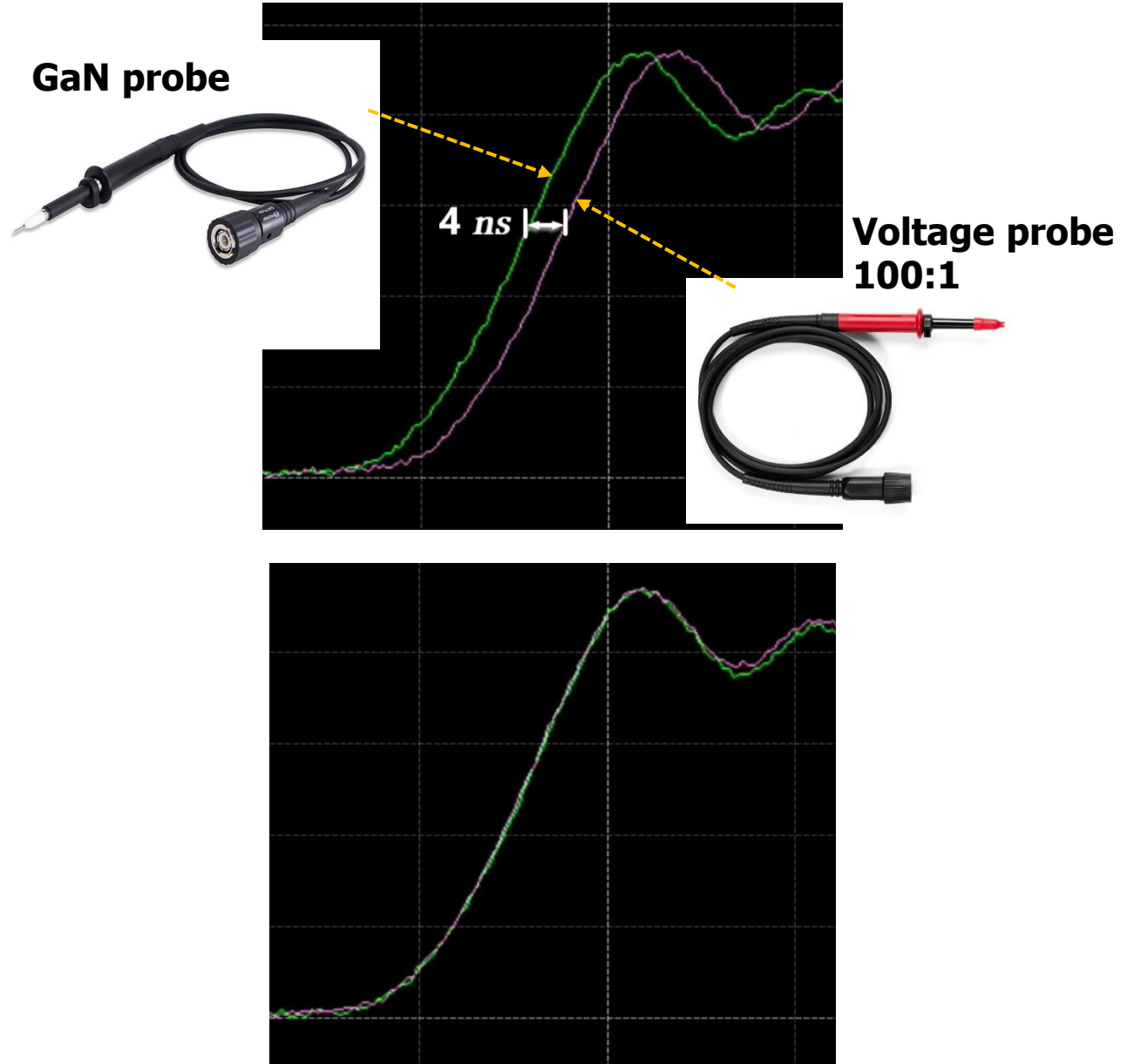
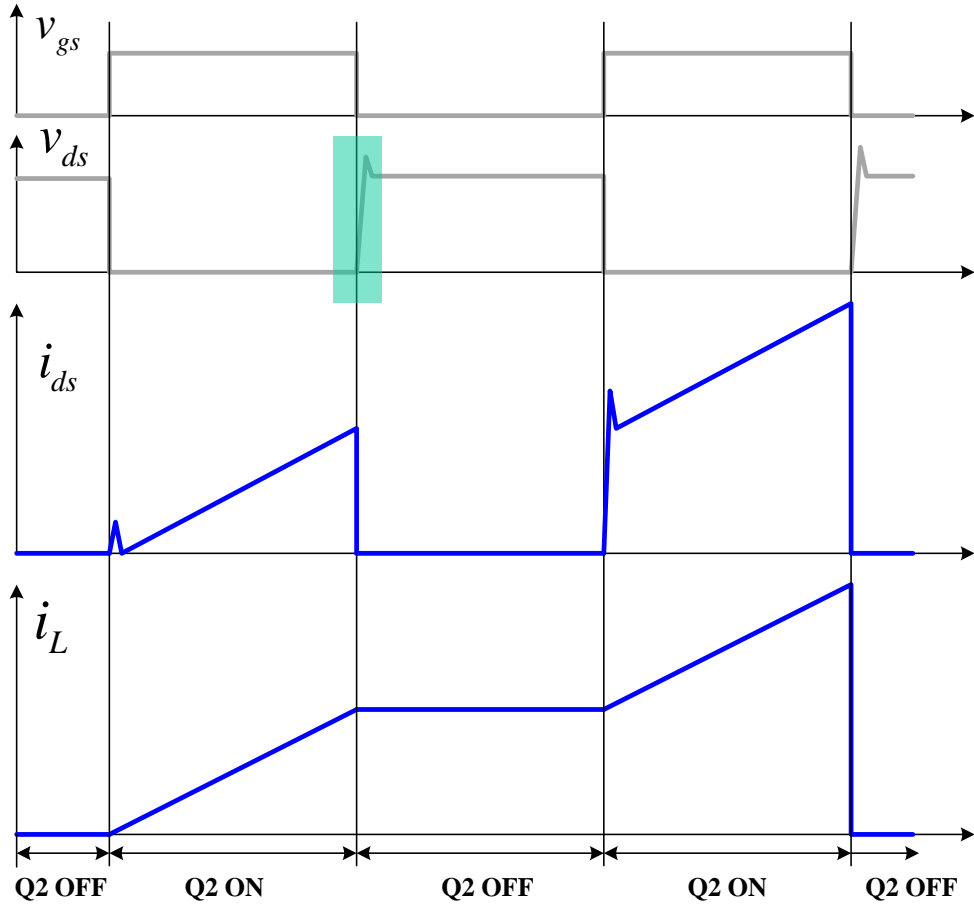
Switching losses(Q2)



Current Probe Calibration

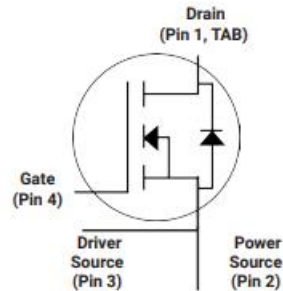


Voltage Probe Calibration



□ Specification of the SiC MOSFET

DUT: SiC MOSFET (C3M0016120K)



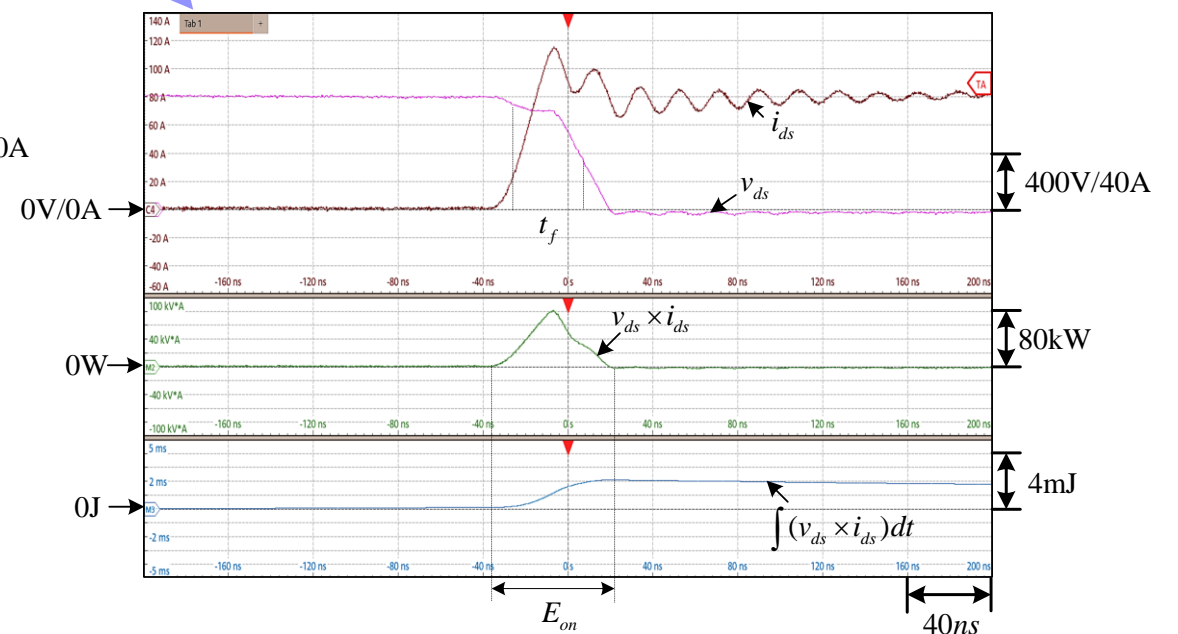
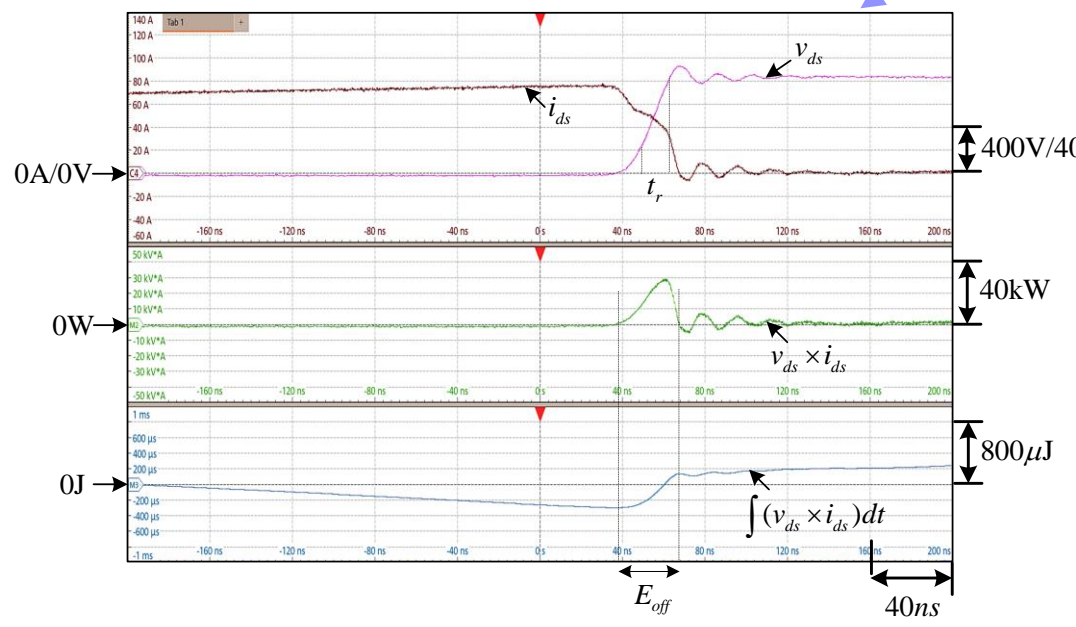
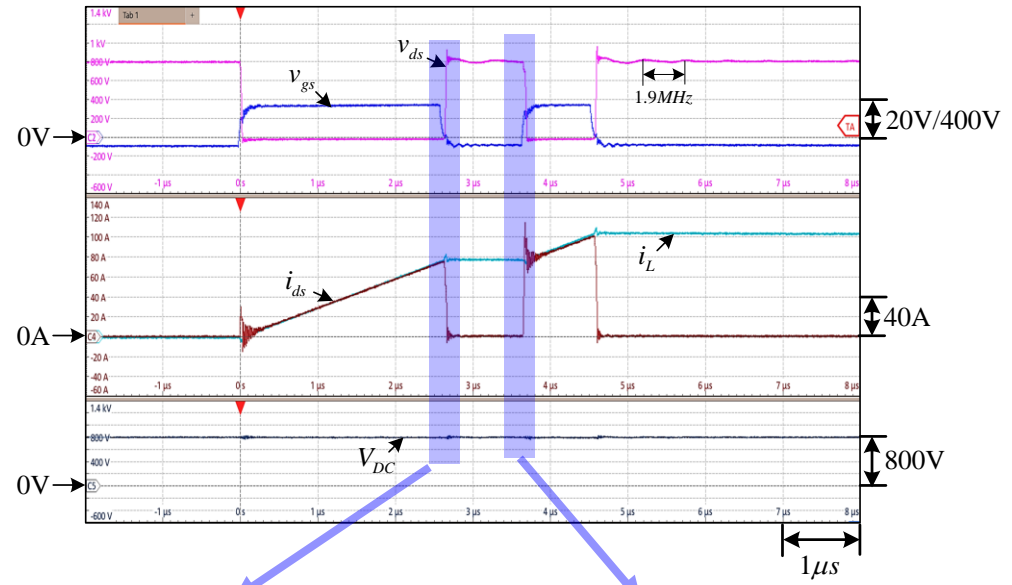
Part Number	Package	Marking
C3M0016120K	TO 247-4	C3M0016120K

Maximum Ratings ($T_c = 25^\circ\text{C}$ unless otherwise specified)

Symbol	Parameter	Value	Unit	Test Conditions	Note
V_{DSmax}	Drain - Source Voltage	1200	V	$V_{GS} = 0\text{ V}, I_D = 100\ \mu\text{A}$	
V_{GSmax}	Gate - Source Voltage (dynamic)	-8/+19	V	AC ($f > 1\text{ Hz}$)	Note 1
V_{GSop}	Gate - Source Voltage (static)	-4/+15	V	Static	Note 2
I_D	Continuous Drain Current	115	A	$V_{GS} = 15\text{ V}, T_c = 25^\circ\text{C}$	Fig. 19
		85		$V_{GS} = 15\text{ V}, T_c = 100^\circ\text{C}$	
$I_{D(pulse)}$	Pulsed Drain Current	250	A	Pulse width t_p limited by T_{Jmax}	
P_D	Power Dissipation	556	W	$T_c = 25^\circ\text{C}, T_J = 175^\circ\text{C}$	Fig. 20
T_J, T_{stg}	Operating Junction and Storage Temperature	-40 to +175	$^\circ\text{C}$		
T_L	Solder Temperature	260	$^\circ\text{C}$	1.6mm (0.063") from case for 10s	

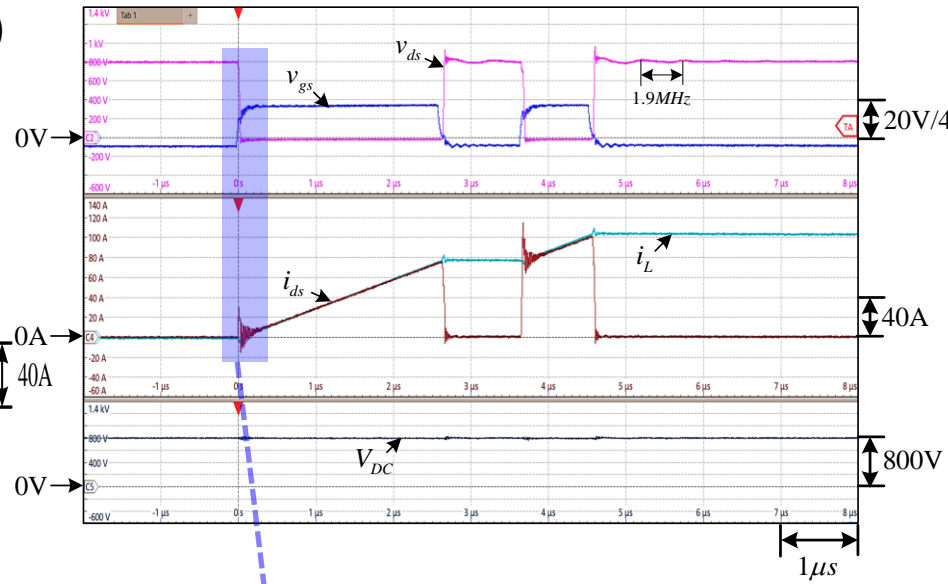
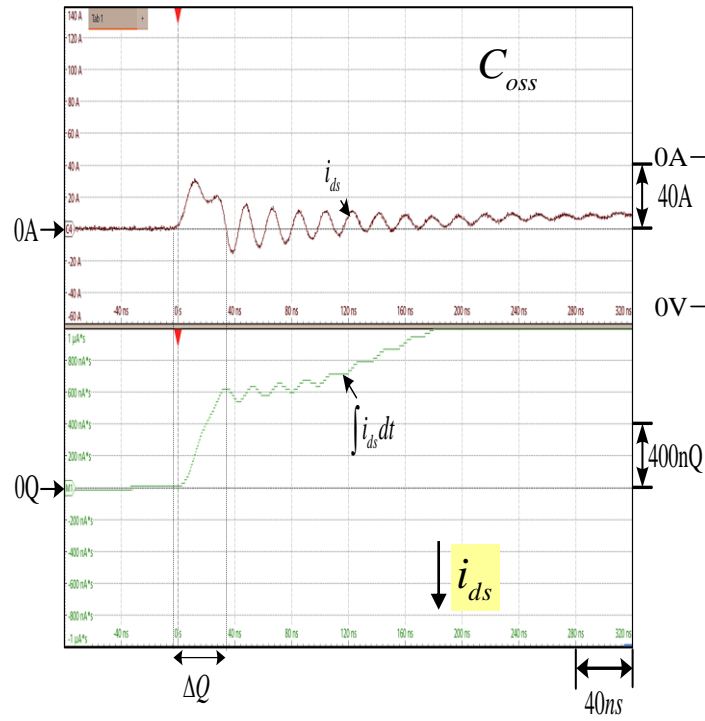
DPT Demo – CREE SiC MOSFET

□ Test results : switching loss



DPT Demo – CREE SiC MOSFET

□ Test results : $C_{o(tr)}$



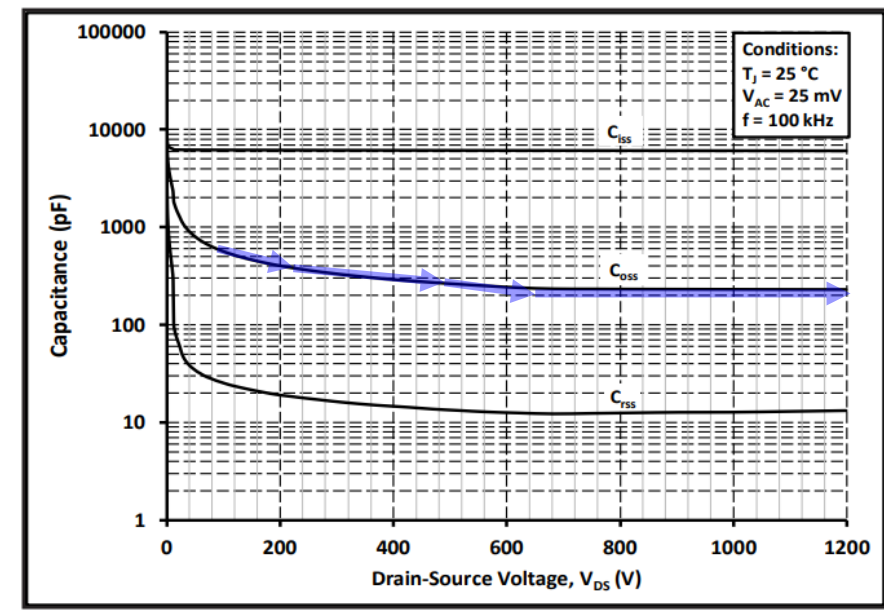
@voltage rising transient

$$\Delta V = 800V$$

$$\Delta Q_C = 607nC$$

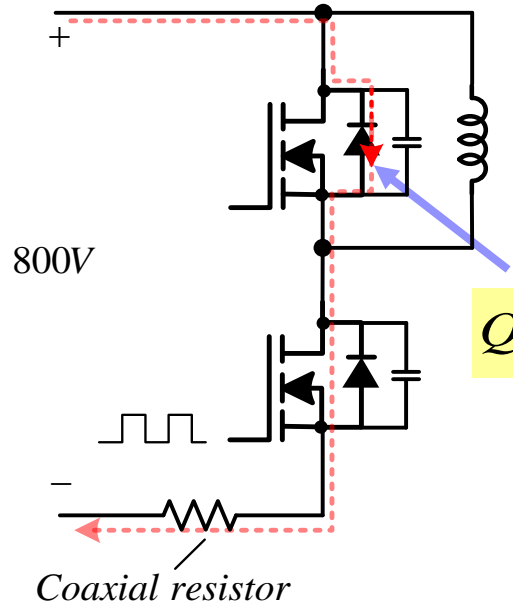
$$C_{o(tr)} = \frac{\Delta Q_C}{\Delta V} = \frac{607nC}{800V} = 758.7 pF$$

i_{ds}

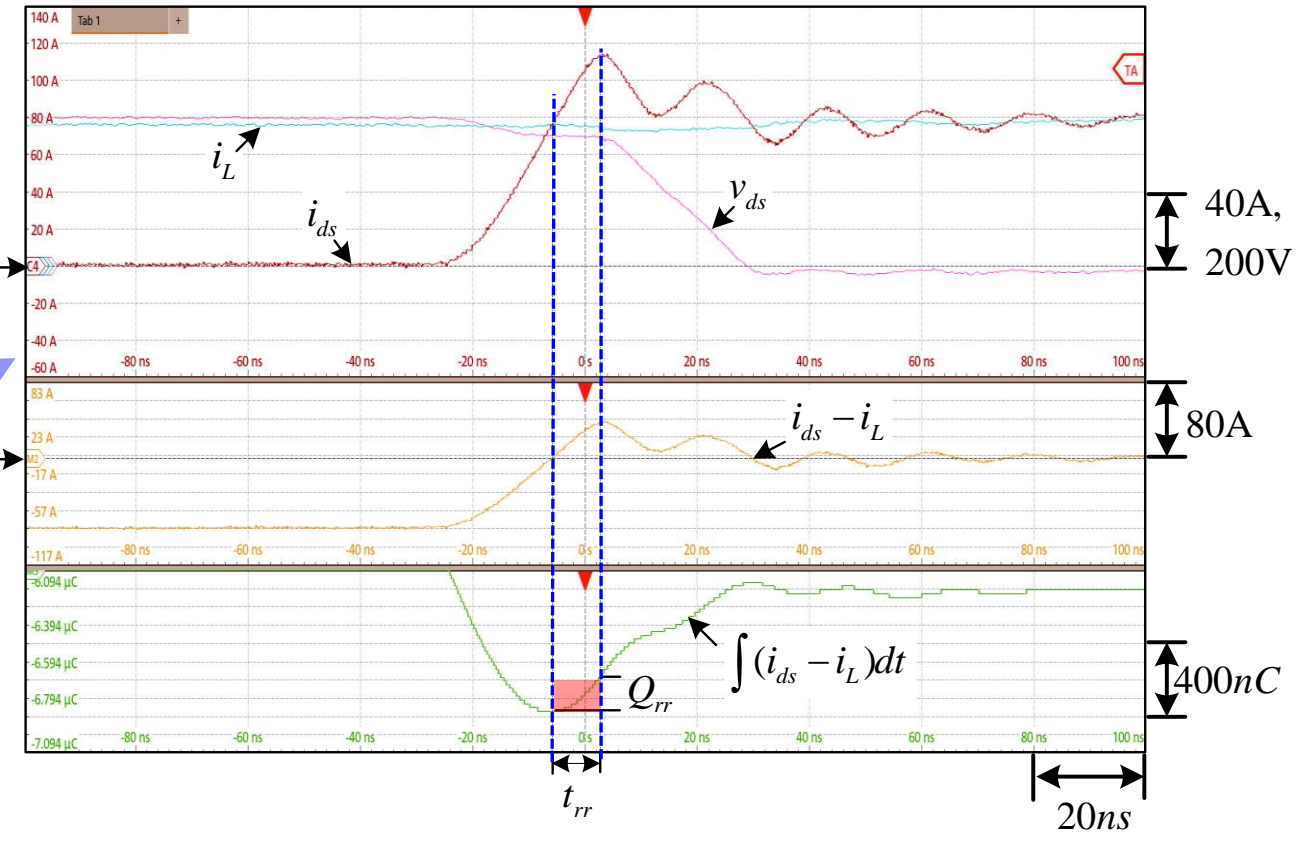
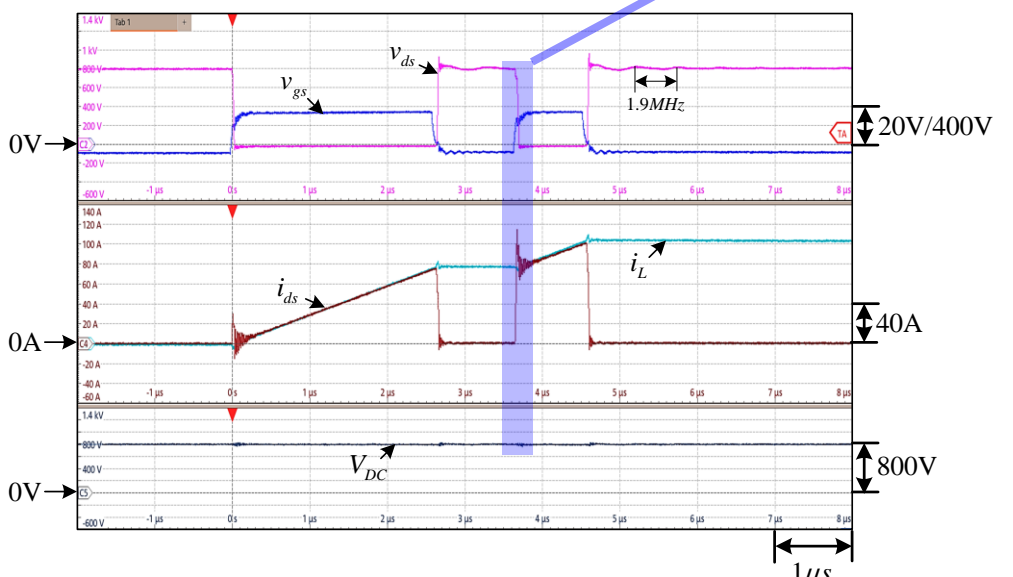


DPT Demo – CREE SiC MOSFET

□ Test results : Qrr



$$Q_{rr} = \int (i_{DS} - i_L) dt$$



$$Q_{rr} = 206nC, t_{rr} = 9.1ns$$

□ Test results

CREE SiC MOSFET C3M0016120K

Test conditions	Test items	Data sheet	Test results
$R_g=2.5\Omega$ $V_{in}=800V$ $i_{ds}=75A$ $v_{gs} = -4V / +15 V$	t_r (ns)	33	40
	t_f (ns)	13	16.6
	E_{on} (mJ)	1.80	1.97
	E_{off} (μJ)	540	430
	Q_{rr} (nC)	1261 (@175°C)	206 (@25°C)
	$C_{o(tr)}$ (pF)	TBD	758.7
	t_{rr} (ns)	27(@175°)	9.1

