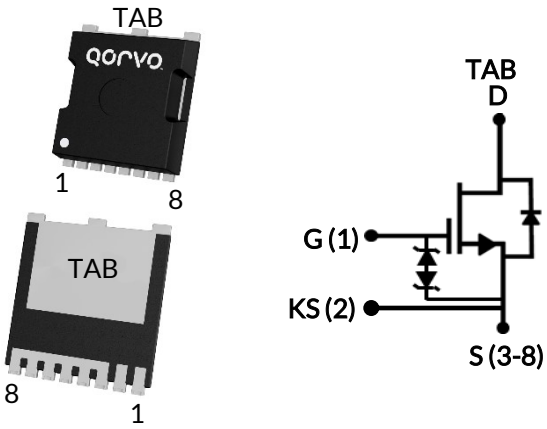
DATASHEET

UJ4SC075005L8S



Part Number	Package	Marking
UJ4SC075005L8S	MO-229	UJ4SC075005

RoHS COMPLIANT | Pb LEAD FREE | HF HALOGEN FREE

750V-5.4mΩ SiC FET

Rev. A, February 2023

Description

The UJ4SC075005L8S is a 750V, 5.4mΩ G4 SiC FET. It is based on a unique 'cascode' circuit configuration, in which a normally-on SiC JFET is co-packaged with a Si MOSFET to produce a normally-off SiC FET device. The device's standard gate-drive characteristics allows use of off-the-shelf gate drivers hence requiring minimal re-design when replacing Si IGBTs, Si superjunction devices or SiC MOSFETs. Available in the space-saving MO-229 package which enables automated assembly, this device exhibits ultra-low gate charge and exceptional reverse recovery characteristics, making it ideal for switching inductive loads and any application requiring standard gate drive.

Features

- On-resistance $R_{DS(on)}$: 5.4mΩ (typ)
- Operating temperature: 175°C (max)
- Excellent reverse recovery: Q_{rr} = 440nC
- Low body diode V_{FSD}: 1.03V
- Low gate charge: Q_G =164nC
- Threshold voltage $V_{G(th)}$: 4.7V (typ) allowing 0 to 15V drive
- Low intrinsic capacitance
- ESD protected, HBM class 2
- MO-229 package for faster switching, clean gate waveforms

Typical applications

- Solid state relays and circuit-breakers
- Line rectification and active-bridge rectification circuits in AC/DC front-ends
- EV charging
- PV inverters
- Switch mode power supplies
- Power factor correction modules
- Motor drives
- Induction heating

Maximum Ratings

Parameter	Symbol	Test Conditions	Value	Units
Drain-source voltage	V_{DS}		750	V
Gate-source voltage	V_{GS}	DC	-20 to +20	V
		AC (f > 1Hz)	-25 to +25	V
Continuous drain current [1]	I_D	T_C < 144°C	120	A
Pulsed drain current [2]	I_{DM}	T_C = 25°C	588	A
Single pulsed avalanche energy [3]	E_{AS}	L=15mH, I_{AS} = 6.5A	316	mJ
Short circuit withstand time [4]	t_{SC}	V_{DS} = 400V, $T_{J(START)}$ = 175°C	5	µs
SiC FET dv/dt ruggedness	dv/dt	$V_{DS} \leq$ 500V	100	V/ns
Power dissipation	P_{tot}	T_C = 25°C	1153	W
Maximum junction temperature	$T_{J,max}$		175	°C
Operating and storage temperature	T_J, T_{STG}		-55 to 175	°C
Reflow soldering temperature	T_{solder}	reflow MSL 1	260	°C

1. Limited by bondwires
2. Pulse width t_p limited by $T_{J,max}$
3. Starting T_J = 25°C
4. Short circuit current is independent of the gate voltage V_{GS}>12V

Thermal Characteristics

Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Thermal resistance, junction-to-case	$R_{\theta JC}$			0.10	0.13	°C/W

Electrical Characteristics (T_J = +25°C unless otherwise specified)

Typical Performance - Static

Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Drain-source breakdown voltage	BV_{DS}	V_{GS}=0V, I_D=1mA	750			V
Total drain leakage current	I_{DSS}	V_{DS}=750V, V_{GS}=0V, T_J=25°C		6	130	µA
		V_{DS}=750V, V_{GS}=0V, T_J=175°C		45		
Total gate leakage current	I_{GSS}	V_{DS}=0V, T_J=25°C, V_{GS}=-20V / +20V		6	20	µA
Drain-source on-resistance	$R_{DS(on)}$	V_{GS}=12V, I_D=80A, T_J=25°C		5.4	7.2	mΩ
		V_{GS}=12V, I_D=80A, T_J=125°C		9.3		
		V_{GS}=12V, I_D=80A, T_J=175°C		12.2		
Gate threshold voltage	$V_{G(th)}$	V_{DS}=5V, I_D=10mA	4	4.7	6	V
Gate resistance	R_G	f=1MHz, open drain		0.8	1.5	Ω

Typical Performance - Reverse Diode

Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Diode continuous forward current [1]	I_S	T_C < 144°C			120	A
Diode pulse current [2]	$I_{S,pulse}$	T_C=25°C			588	A
Forward voltage	V_{FSD}	V_{GS}=0V, I_S=50A, T_J=25°C		1.03	1.16	V
		V_{GS}=0V, I_S=50A, T_J=175°C		1.06		
Reverse recovery charge	Q_{rr}	V_{DS}=400V, I_S=80A, V_{GS}=0V, R_G=20Ω di/dt=2800A/µs, T_J=25°C		440		nC
Reverse recovery time	t_{rr}			31		ns
Reverse recovery charge	Q_{rr}	V_{DS}=400V, I_S=80A, V_{GS}=0V, R_G=20Ω di/dt=2800A/µs, T_J=150°C		525		nC
Reverse recovery time	t_{rr}			37		ns

Typical Performance - Dynamic

Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Input capacitance	C_{iss}	V_{DS}=400V, V_{GS}=0V f=100kHz		8374		pF
Output capacitance	C_{oss}			362		
Reverse transfer capacitance	C_{rss}			4		
Effective output capacitance, energy related	$C_{oss(er)}$	V_{DS}=0V to 400V, V_{GS}=0V		475		pF
Effective output capacitance, time related	$C_{oss(tr)}$	V_{DS}=0V to 400V, V_{GS}=0V		950		pF
C_{OSS} stored energy	E_{oss}	V_{DS}=400V, V_{GS}=0V		38		µJ
Total gate charge	Q_G	V_{DS}=400V, I_D=80A, V_{GS} = 0V to 15V		164		nC
Gate-drain charge	Q_{GD}			24		
Gate-source charge	Q_{GS}			46		
Turn-on delay time	$t_{d(on)}$	Notes 5 and 6, V_{DS}=400V, I_D=80A, Gate Driver =0V to +15V, Turn-on $R_{G,EXT}$=1.5Ω, Turn-off $R_{G,EXT}$=5Ω, inductive Load, FWD: same device with V_{GS} = 0V and R_G = 5Ω, RC snubber: R_S=5Ω and C_S=680pF, T_J=25°C		35		ns
Rise time	t_r			39		
Turn-off delay time	$t_{d(off)}$			109		
Fall time	t_f			13		
Turn-on energy including R_S energy	E_{ON}			766		µJ
Turn-off energy including R_S energy	E_{OFF}			162		
Total switching energy	E_{TOTAL}			928		
Snubber R_S energy during turn-on	E_{RS_ON}			17.6		
Snubber R_S energy during turn-off	E_{RS_OFF}			7.2		
Turn-on delay time	$t_{d(on)}$	Notes 5 and 6, V_{DS}=400V, I_D=80A, Gate Driver =0V to +15V, Turn-on $R_{G,EXT}$=1.5Ω, Turn-off $R_{G,EXT}$=5Ω, inductive Load, FWD: same device with V_{GS} = 0V and R_G = 5Ω, RC snubber: R_S=5Ω and C_S=680pF, T_J=150°C		37		ns
Rise time	t_r			41		
Turn-off delay time	$t_{d(off)}$			114		
Fall time	t_f			13		
Turn-on energy including R_S energy	E_{ON}			808		µJ
Turn-off energy including R_S energy	E_{OFF}			187		
Total switching energy	E_{TOTAL}			995		
Snubber R_S energy during turn-on	E_{RS_ON}			18.3		
Snubber R_S energy during turn-off	E_{RS_OFF}			10.3		

5. Measured with the switching test circuit in Figure 26.

6. In this datasheet, all the switching energies (turn-on energy, turn-off energy and total energy) presented in the tables and Figures include the device RC snubber energy losses.

Typical Performance Diagrams

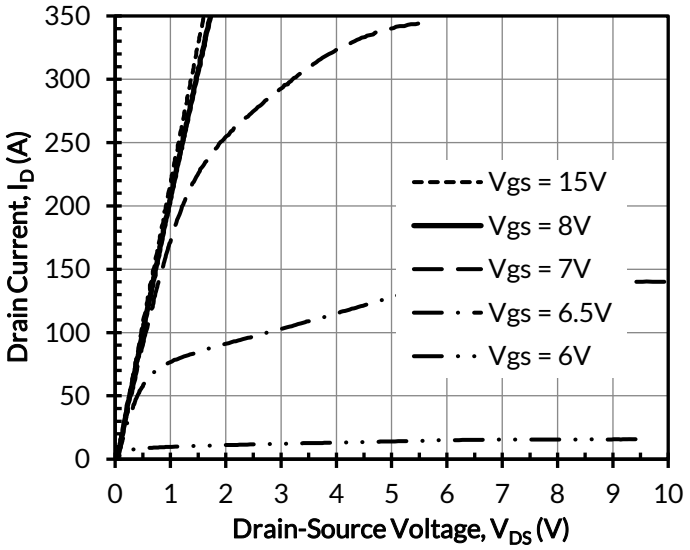


Figure 1. Typical output characteristics at T_J = - 55°C, tp < 250µs

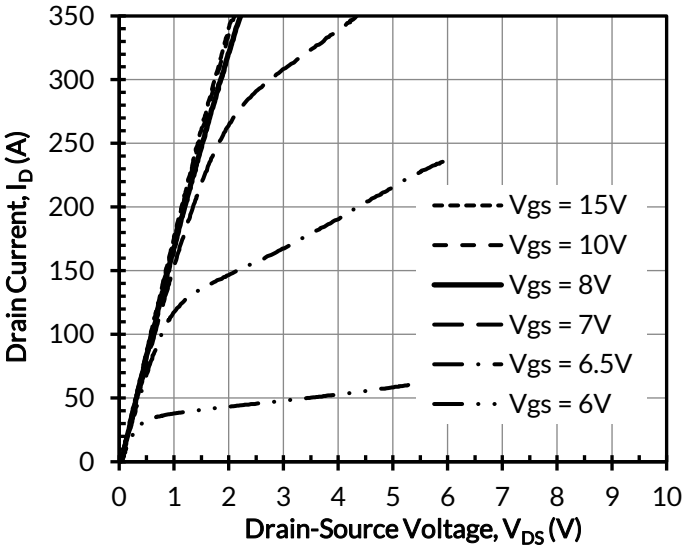


Figure 2. Typical output characteristics at T_J = 25°C, tp < 250µs

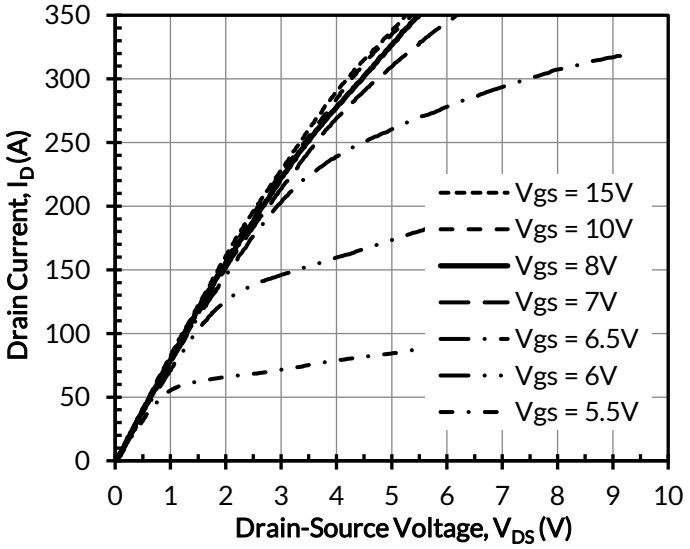


Figure 3. Typical output characteristics at T_J = 175°C, tp < 250µs

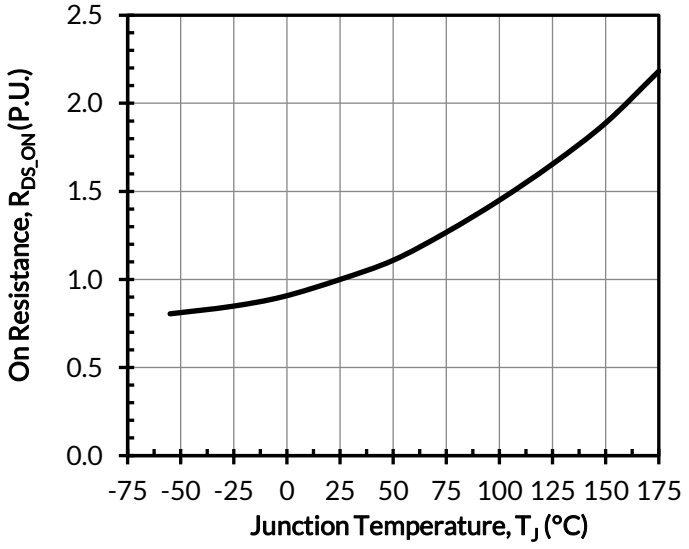


Figure 4. Normalized on-resistance vs. temperature at V_{GS} = 12V and I_D = 80A

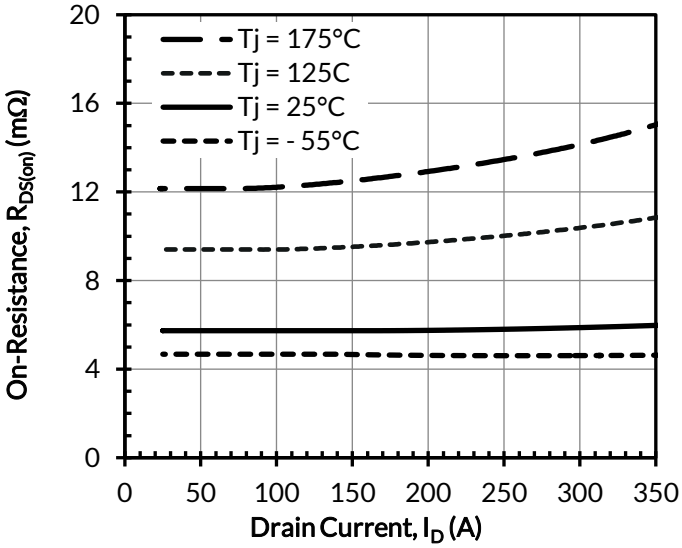


Figure 5. Typical drain-source on-resistances at V_{GS} = 12V

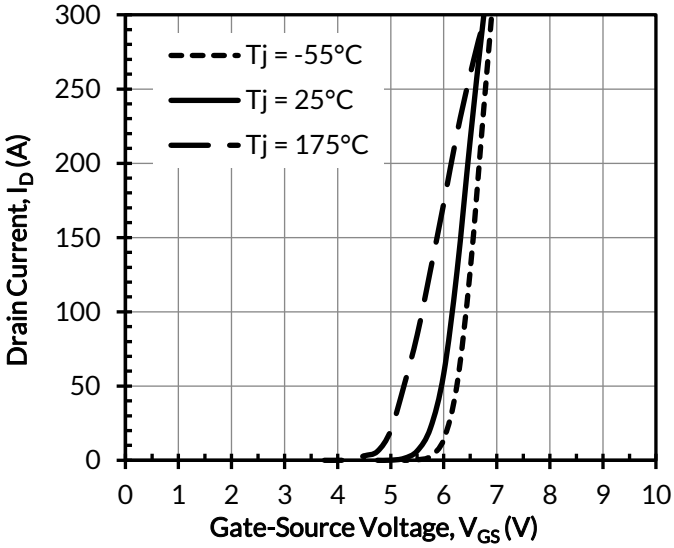


Figure 6. Typical transfer characteristics at V_{DS} = 5V

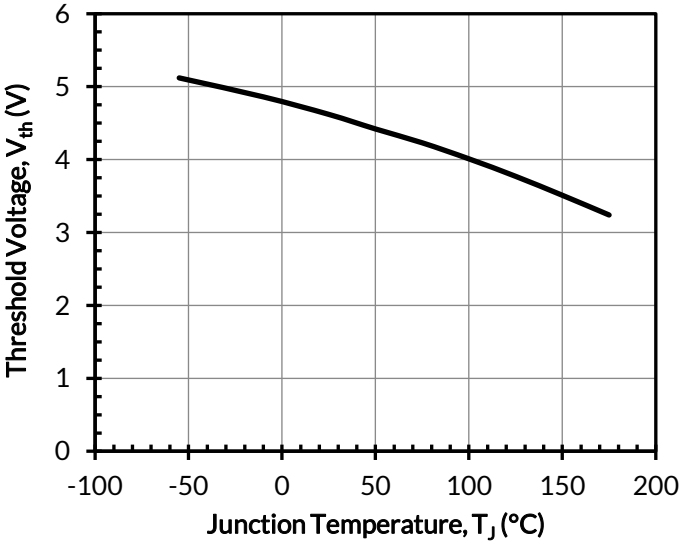


Figure 7. Threshold voltage vs. junction temperature at V_{DS} = 5V and I_D = 10mA

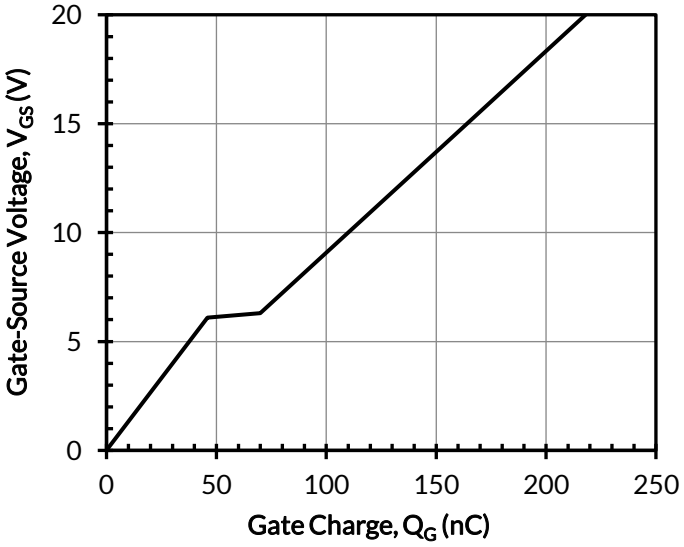


Figure 8. Typical gate charge at V_{DS} = 400V and I_D = 80A

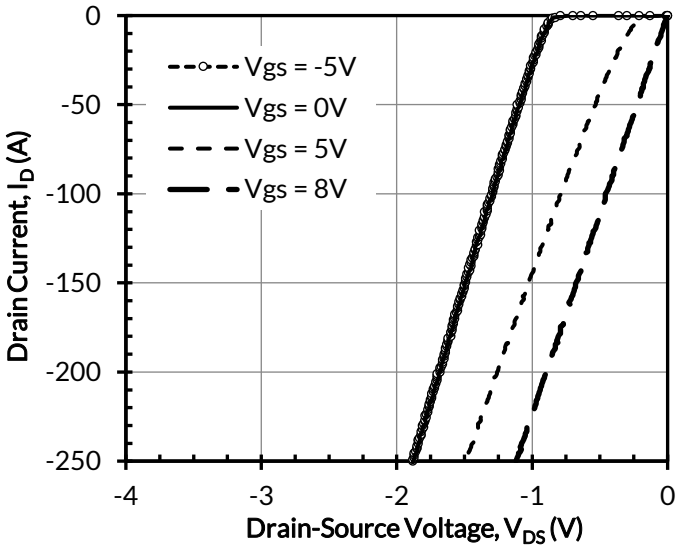


Figure 9. 3rd quadrant characteristics at T_J = -55°C

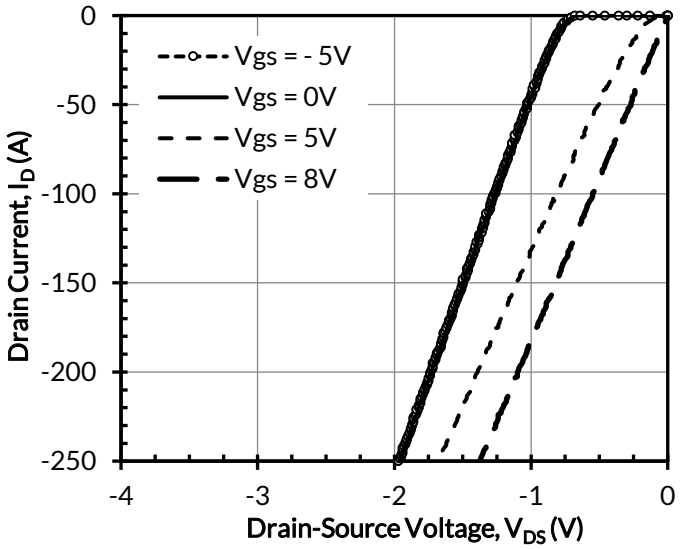


Figure 10. 3rd quadrant characteristics at T_J = 25°C

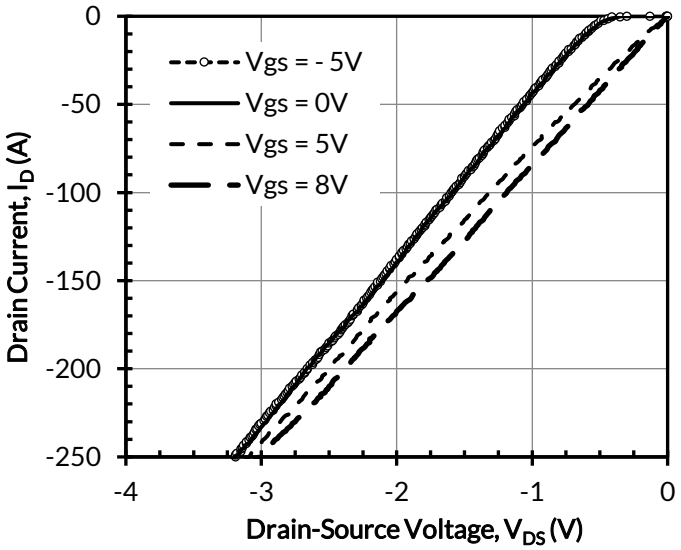


Figure 11. 3rd quadrant characteristics at T_J = 175°C

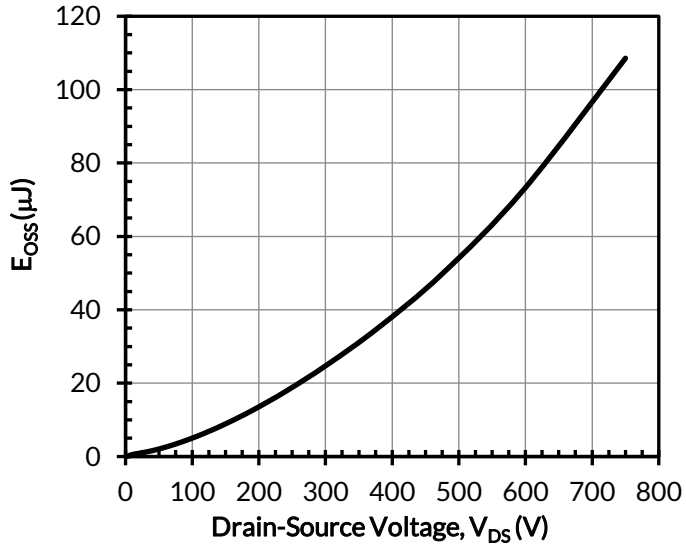


Figure 12. Typical stored energy in C_{OSS} at V_{GS} = 0V

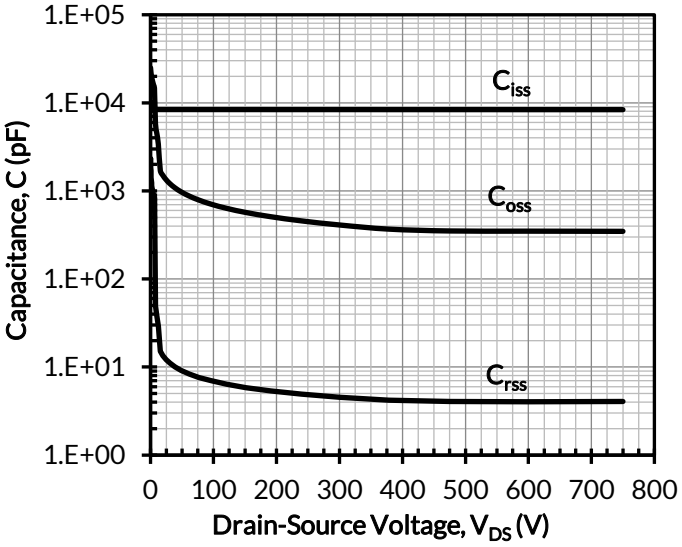


Figure 13. Typical capacitances at f = 100kHz and V_{GS} = 0V

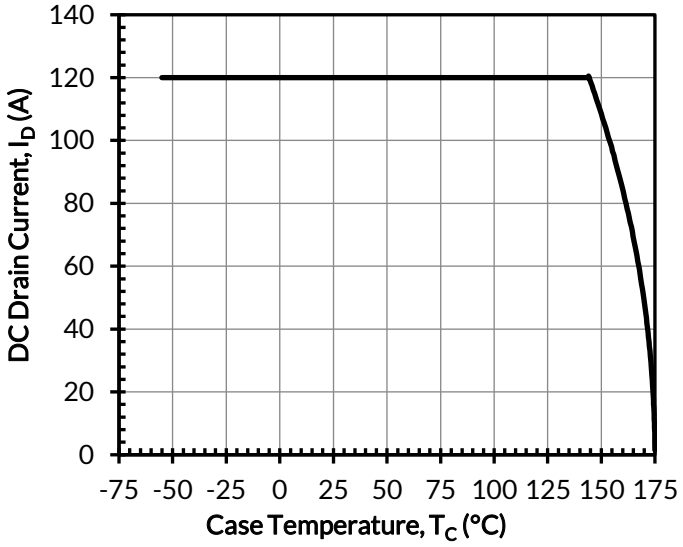


Figure 14. DC drain current derating

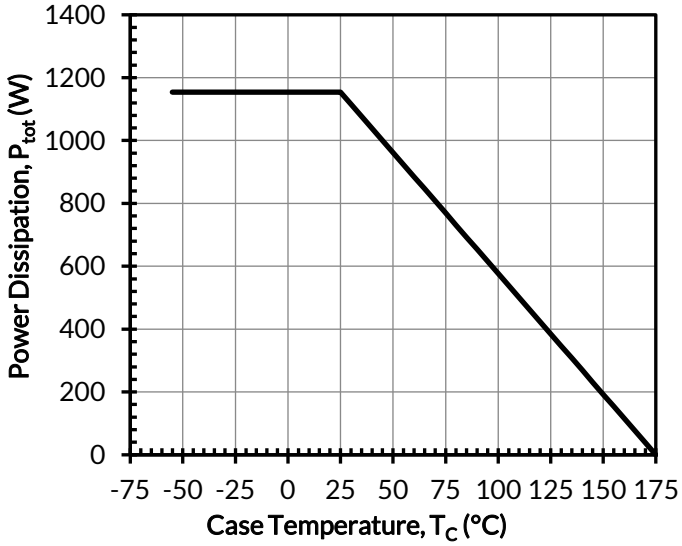


Figure 15. Total power dissipation

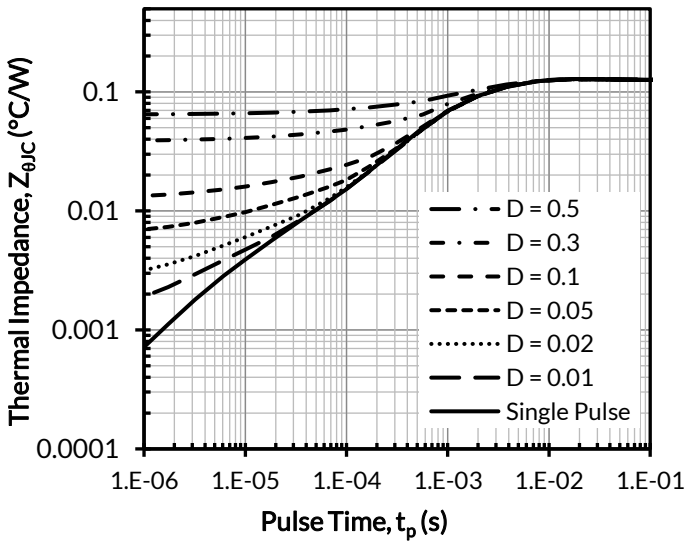


Figure 16. Maximum transient thermal impedance

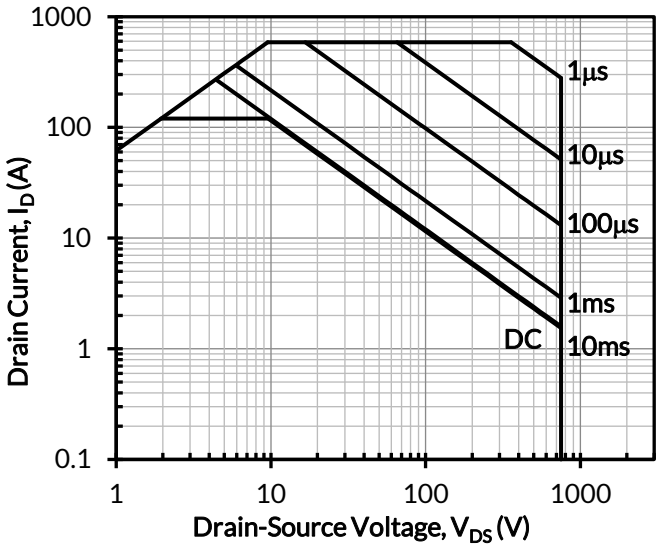


Figure 17. Safe operation area at T_C = 25°C, D = 0, Parameter t_p

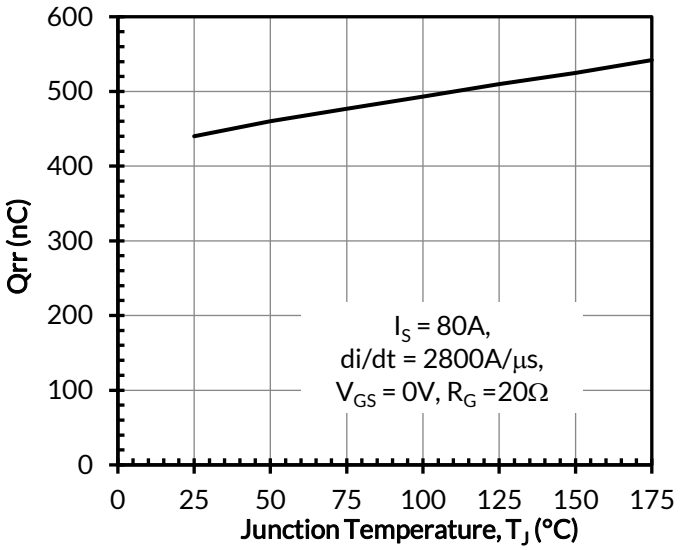


Figure 18. Reverse recovery charge Qrr vs. junction temperature at V_{DS} = 400V

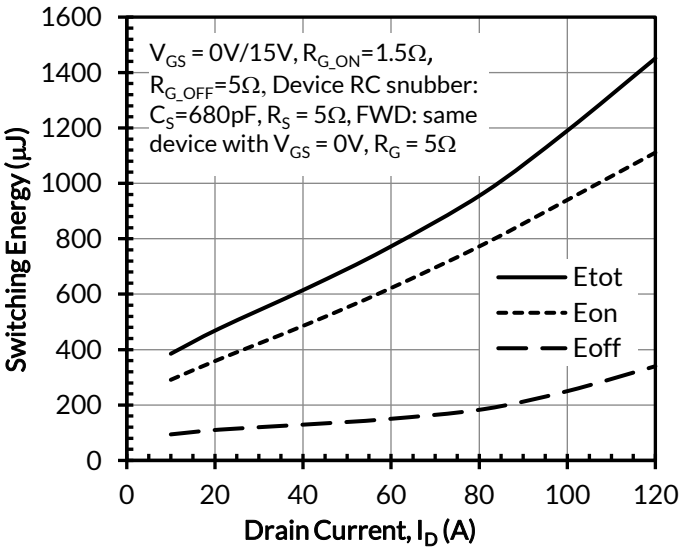


Figure 19. Clamped inductive switching energy vs. drain current at V_{DS} = 400V and T_J = 25°C

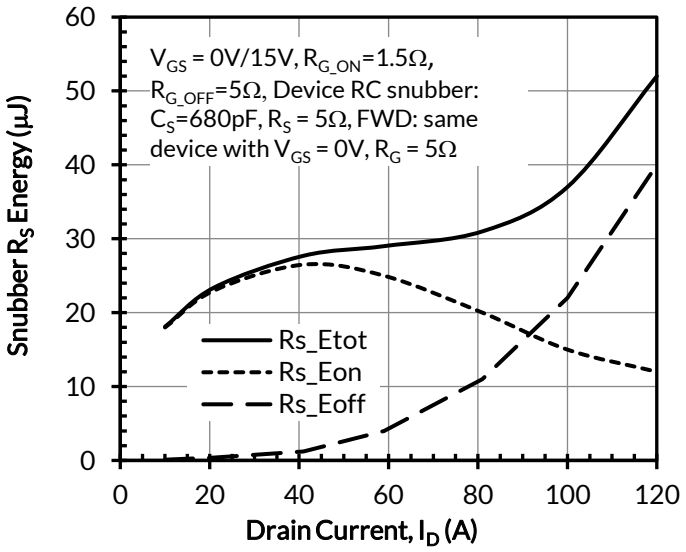


Figure 20. RC snubber energy loss vs. drain current at V_{DS} = 400V and T_J = 25°C

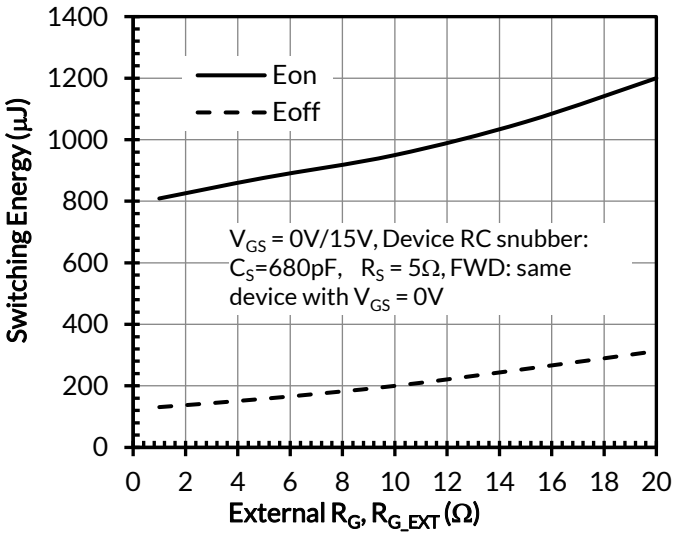


Figure 21. Clamped inductive switching energies vs. $R_{G,EXT}$ at V_{DS} = 400V, I_D = 80A, and T_J = 25°C

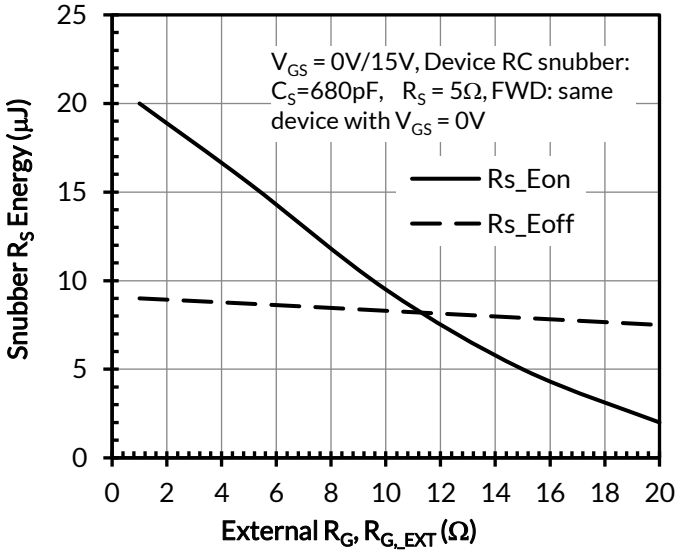


Figure 22. RC snubber energy losses vs. $R_{G,EXT}$ at V_{DS} = 400V, I_D = 80A, and T_J = 25°C

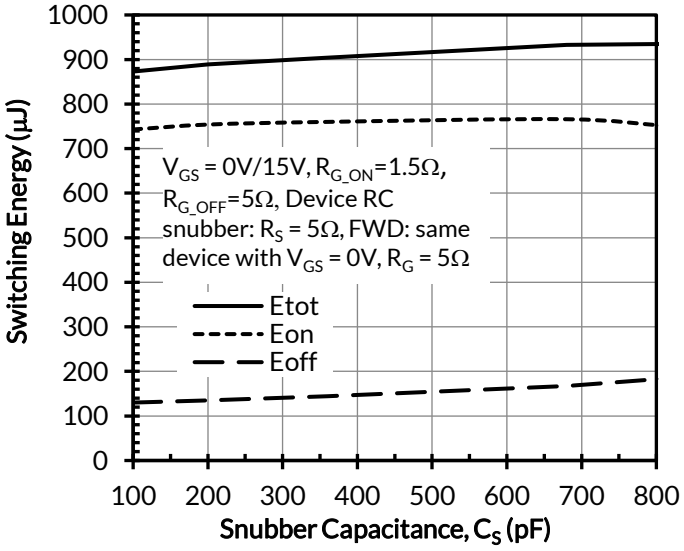


Figure 23. Clamped inductive switching energies vs. snubber capacitance C_S at V_{DS} = 400V, I_D = 80A, and T_J = 25°C

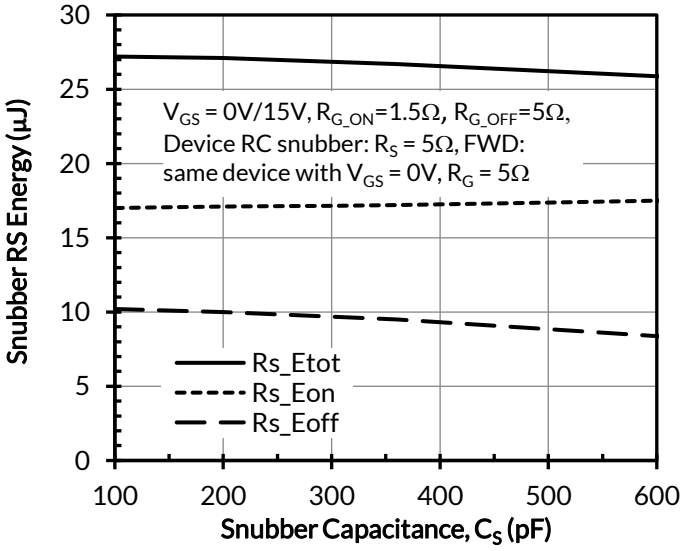


Figure 24. RC snubber energy losses vs. snubber capacitance C_S at V_{DS} = 400V, I_D = 80A, and T_J = 25°C

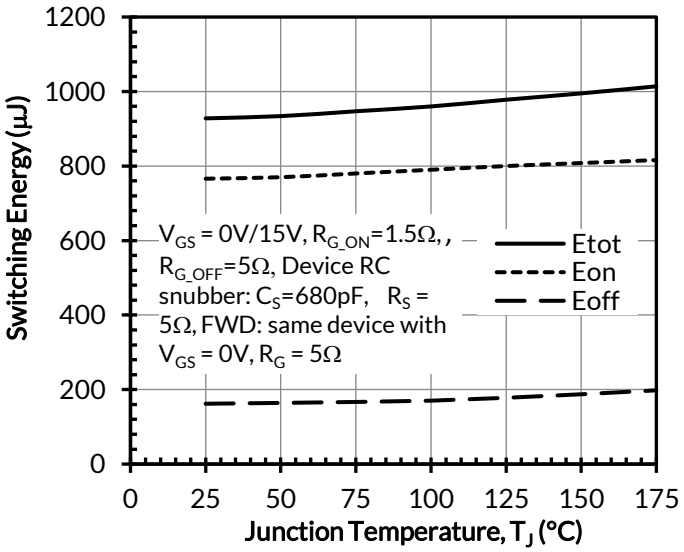


Figure 25. Clamped inductive switching energy vs. junction temperature at V_{DS} =400V and I_D = 80A

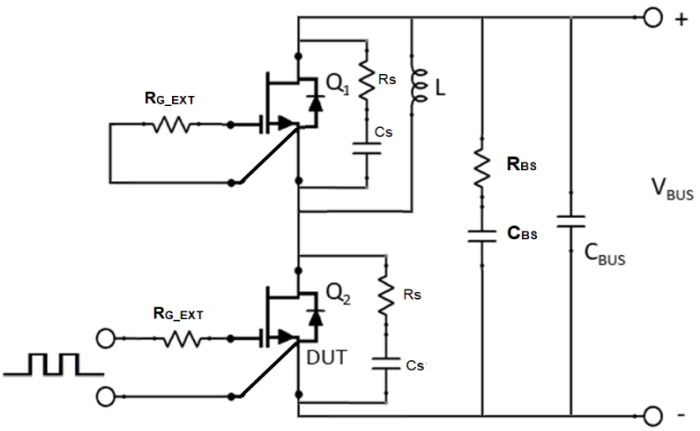


Figure 26. Schematic of the half-bridge mode switching test circuit. Note, a device snubber (Rs =5Ω, Cs = 680pF) and bus RC snubber (R_{BS} = 1Ω, C_{BS}=100nF) is used to reduce the power loop high frequency oscillations.