

# TO-247-3

## SiC Power MOSFETs

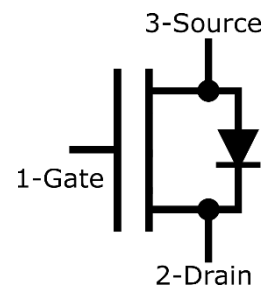
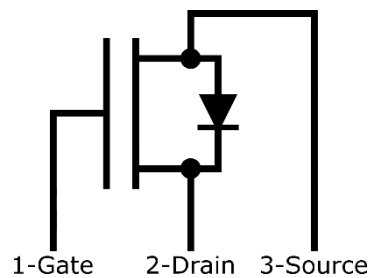
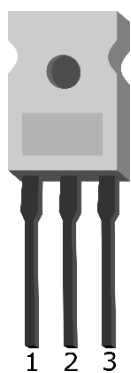
CoolCAD Power MOSFETs exceed power, efficiency and portability capabilities of standard silicon devices and are available in a variety of breakdown voltages (650V, 1200V, 1700V & 3300V) and current ratings. They have low on-resistance and low leakage in the blocking state. Fabricated on high-quality SiC epitaxial layers, our proprietary fabrication process includes carefully chosen annealing procedures to ensure a high-quality SiC-SiO<sub>2</sub> gate oxide dielectric layer. Doping profile, neck region, and edge termination ensure extremely low R<sub>on</sub> and high breakdown voltage.

### BENEFITS

- ✓ Higher efficiency
- ✓ Reduced cooling
- ✓ Increased power
- ✓ Reduced system volume

### APPLICATIONS INCLUDE

Electromechanical power converters, DC to DC, AC to DC and DC to AC converters, switching power supplies, electric vehicles, hybrid vehicles, solar and wind energy power converters.



Part Number	Package	Marking
CC-CL-75-1023	TO-247-3	CoolCADElectronics

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Maximum Ratings						
*Characteristics	Symbol	Comments	Min	Typ	Max	Units
DC blocking voltage	$V_{DSmax}$	$T_J=25^{\circ}C$ to $175^{\circ}C$	1200			V
Gate input voltage range	$V_{GS}$	Recommended range Dynamic	-5 -7		20 22	V
Avalanche rating	$V_{AVA}$	$V_{GS}=0V$ ; $I_{DS}=100\mu A$ ; $T_J=25^{\circ}C$ $V_{GS}=0V$ ; $I_{DS}=100\mu A$ ; $T_J=175^{\circ}C$	1200		1550 1620	V
Pulsed drain current	$I_{Dpulsed}$	$V_{GS}=20V$ ; $T_J=25^{\circ}C$ $V_{GS}=20V$ ; $T_J=100^{\circ}C$ limited by $T_J$ , $tp=300\mu s$		100 80		A
Continuous drain current	$I_D$	$V_{GS}=20V$ ; $T_J=25^{\circ}C$ $V_{GS}=20V$ ; $T_J=100^{\circ}C$			33 23	A
Continuous drain power	P	$V_{GS}=20V$ ; $T_J=25^{\circ}C$			135	W
Maximum- junction temperature	$T_{Jmax}$	Normal operation During processing / soldering			175 250	$^{\circ}C$

Electrical and Thermal Characteristics						
*Characteristics	Symbol	Comments	Min	Typ	Max	Units
Gate threshold voltage	$V_{TH}$	$V_{GS}=V_{DS}$ ; $I_{DS}=10mA$ ; $T_J=25^{\circ}C$ $V_{GS}=V_{DS}$ ; $I_{DS}=10mA$ ; $T_J=175^{\circ}C$	2.4	2.65 1.6	2.9	V
Gate leakage	$I_{GSS}$	$V_{GS}=20V$ ; $V_{DS}=0$ ; $T_J=25^{\circ}C$ $V_{GS}=20V$ ; $V_{DS}=0$ ; $T_J=175^{\circ}C$		35 65	80 100	pA
Drain leakage	$I_{DSS}$	$V_{DS}=1000V$ ; $V_{GS}=0$ ; $T_J=25^{\circ}C$ $V_{DS}=1000V$ ; $V_{GS}=0$ ; $T_J=175^{\circ}C$		0.1 1	10 20	$\mu A$
Drain-source on-resistance	$R_{DS(on)}$	$V_{GS}=20V$ ; $I_{DS}=10A$ ; $T_J=175^{\circ}C$ $V_{GS}=15V$ ; $I_{DS}=10A$ ; $T_J=25^{\circ}C$ $V_{GS}=15V$ ; $I_{DS}=10A$ ; $T_J=175^{\circ}C$		115 85 125		m $\Omega$
Transconductance	$G_m$	$V_{DS}=10V$ ; $I_{DS}=20A$ ; $T_J=25^{\circ}C$ $V_{DS}=10V$ ; $I_{DS}=20A$ ; $T_J=175^{\circ}C$		7.8 8.2		S
Input capacitance	$C_{ISS}$	$V_{GS}=0V$ ; $V_{DS}=200 / 1000V$		960 / 930		
Output capacitance	$C_{OSS}$	$f=1MHz$ ; $T_J=25^{\circ}C$		95 / 55		pF
Reverse transfer capacitance	$C_{RSS}$			12 / 8		
Stored energy at output	$E_{OSS}$	Double integral of $C_{OSS}$		40		
Turn on switching energy (with body diode)	$E_{ON}$	$V_{GS}=-4/19V$ ; $V_{DD}=800V$ ; $R_{G(ext)}=0\Omega$ $I_{DS}=20A$ ; $L=180\mu H$ ; $T_J=25^{\circ}C$		595		$\mu J$
Turn off switching energy (with body diode)	$E_{OFF}$	Clamped inductive switching waveform test circuit: Figure 27		110		
Rise time	$t_r$	$V_{GS}=-4/19V$ ; $V_{DD}=800V$ ; $R_{G(ext)}=0\Omega$ $I_{DS}=20A$ ; $L=180\mu H$ ; $T_J=25^{\circ}C$		18		
Fall time	$t_f$	Clamped inductive switching waveform test circuit: Figure 27		15.5		ns
Turn off delay time	$t_{d(on)}$ $t_{d(off)}$	Relative to $V_{DS}$ inductive load: Figure 26		47 35.5		
Gate Charge	$Q_G$	$V_{GS}=-4/18V$ ; $V_{DD}=800V$ ; $R_{G(ext)}=0\Omega$ $I_{DS}=16A$ ; $R_L=50\Omega$ ; $I_{GS}=38mA$ ; $T_J=25^{\circ}C$ Figure 28		90		nC
Internal gate resistance	$R_G$	$f=1Mz$ ; $V_{AC}=25mV$ ; $T_J=25^{\circ}C$		10		$\Omega$
Thermal resistance:Junction to Case	$R_{JC}$			1.1		$^{\circ}C/W$

2.3

Body diode characteristics						
*Characteristics	Symbol	Comments	Min	Typ	Max	Units
Diode forward voltage	$V_F$	$I_F=3A; V_{GS}=0V; T_J=25^\circ C$ $I_F=3A; V_{GS}=0V; T_J=175^\circ C$ $I_F=10A; V_{GS}=-4V; T_J=25^\circ C$ $I_F=10A; V_{GS}=-4V; T_J=175^\circ C$		2.6 2.1 4.4 3.7		V
Pulsed diode current	$I_{S(pulsed)}$	$V_{GS}=0V; V_{DS}=-3V; T_J=25^\circ C$ $V_{GS}=0V; V_{DS}=-3V; T_J=175^\circ C$		5.6 9.1		A
Reverse recovery time	$t_{rr}$	$V_{DD}=800V; V_{GS}=-4V; I_{DS}=20A$		39		ns
Reverse recovery charge	$Q_{rr}$	$R_{G(ext)}=20\Omega; L=180\mu H; di/dt=400A/\mu s$ Clamped inductive switching waveform test circuit: Figure 27		123		nC
Peak reverse recovery current	$I_{RRM}$			6.5		A

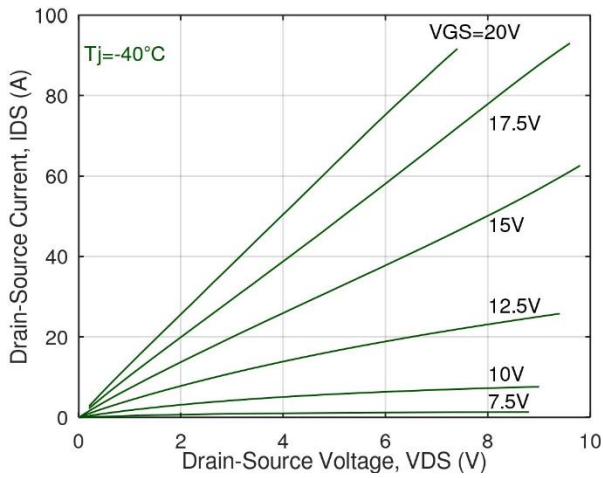


Figure 1: Low temperature output characteristics†.

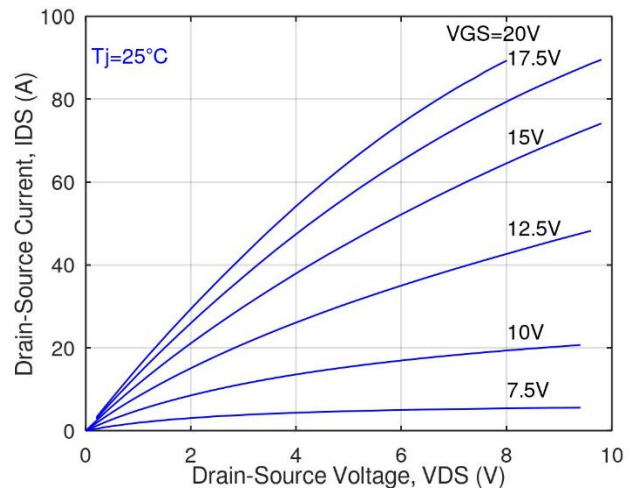


Figure 2: Room temperature output characteristics†.

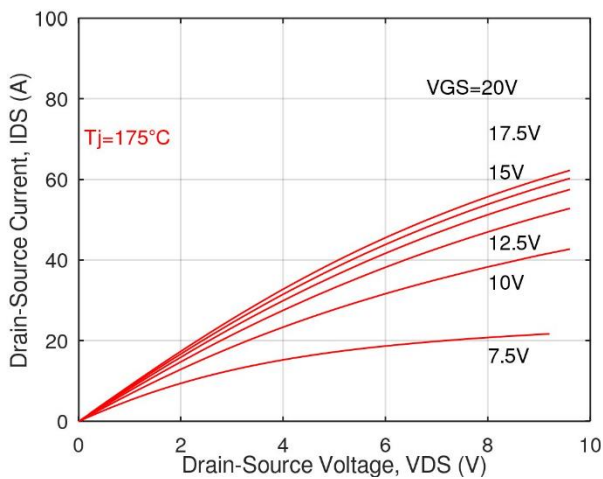


Figure 3: High temperature output characteristics†.

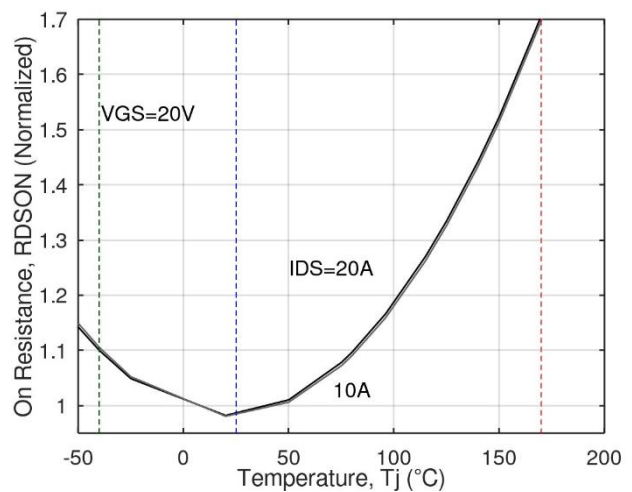
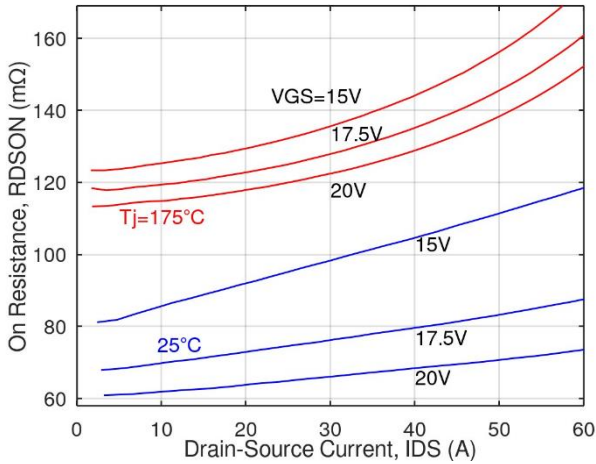


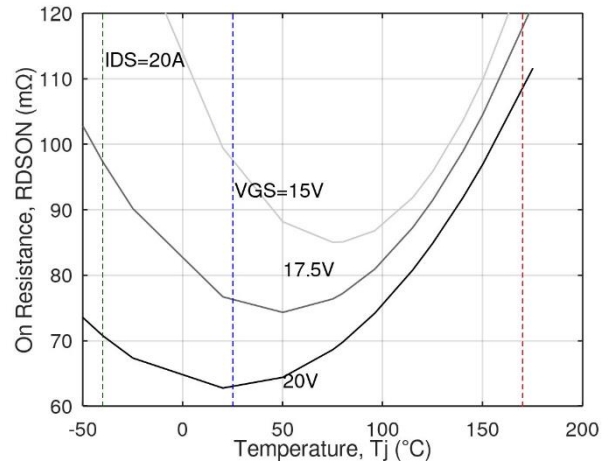
Figure 4: Normalized on-resistance vs. temperature. Dashed vertical lines indicate to room (25°C), high (175°C) and low (-40°C) temperatures.

†  $t_p=300\mu s$  in pulsed IV measurements.

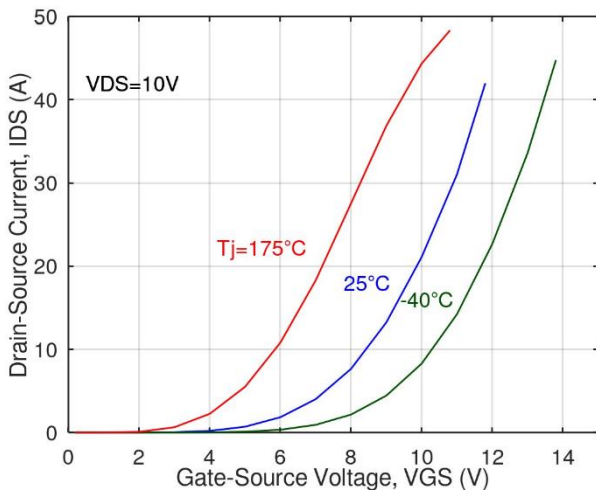
Blue, red and green colors indicate data corresponding to room (25°C), high (175°C) and low (-40°C) temperatures, respectively. Unless stated otherwise, temperature corresponds to junction temperature.



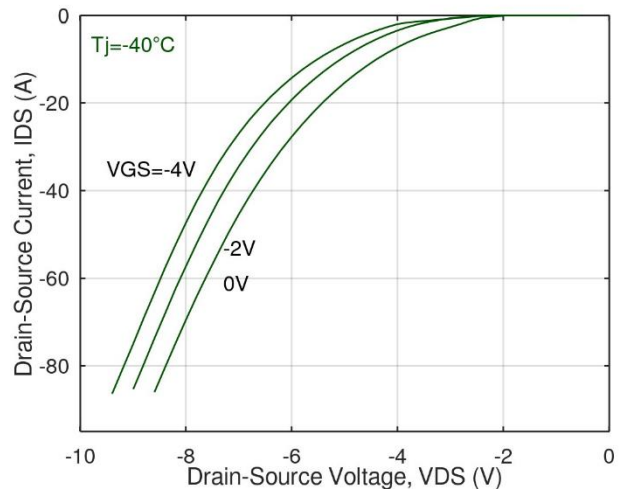
**Figure 5:** On-resistance vs. drain current.



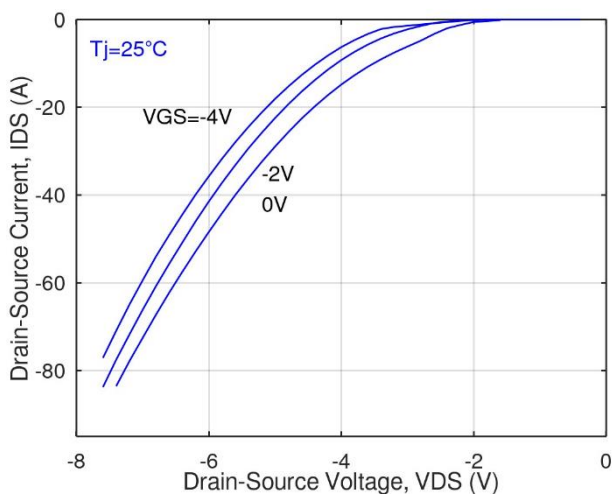
**Figure 6:** On-resistance vs. temperature. Dashed vertical lines indicate to room (25°C), high (175°C) and low (-40°C) temperatures.



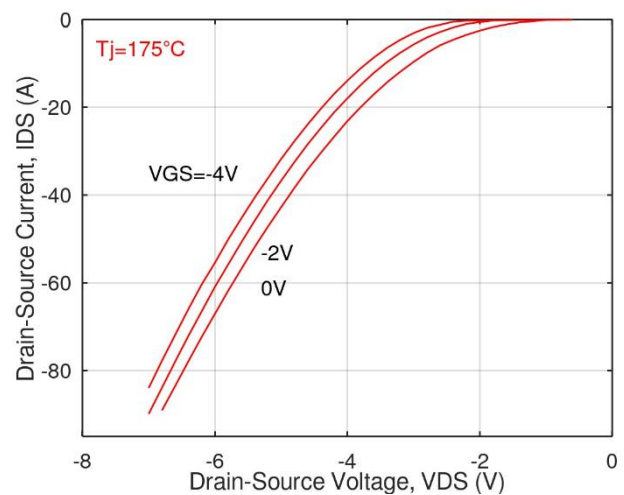
**Figure 7:** Transfer characteristics†.



**Figure 8:** Low temperature body diode characteristics†.



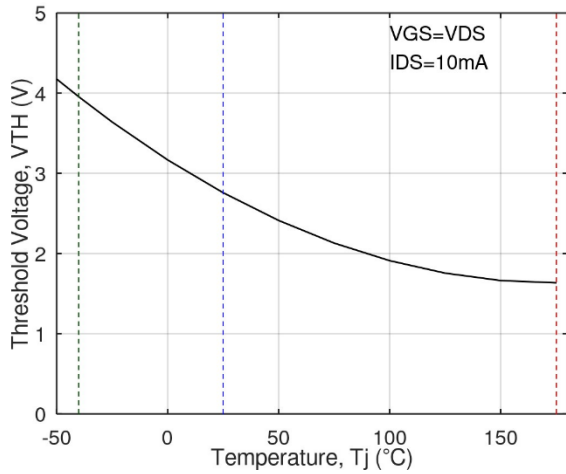
**Figure 9:** Room temperature body diode characteristics†.



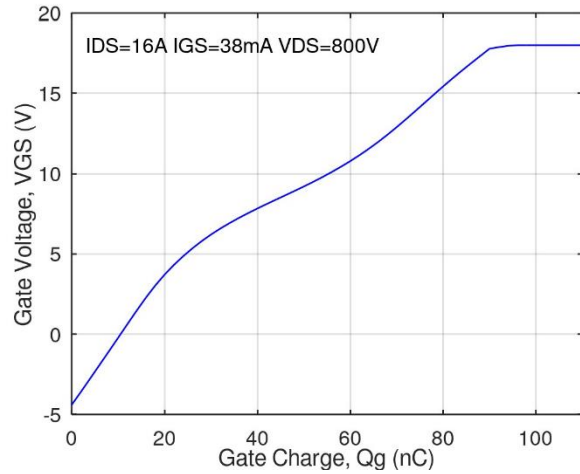
**Figure 10:** High temperature body diode characteristics†.

† tp=300μs in pulsed IV measurements.

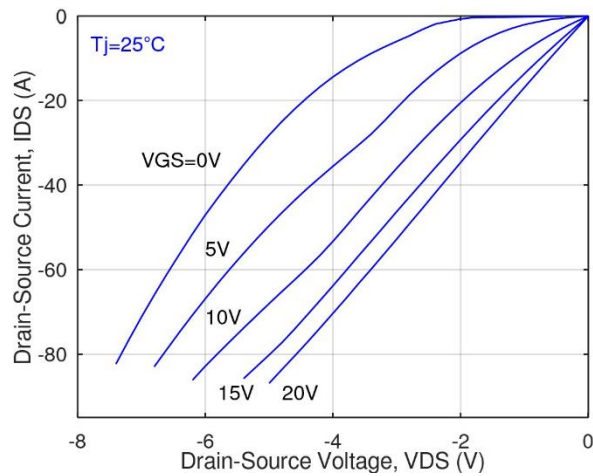
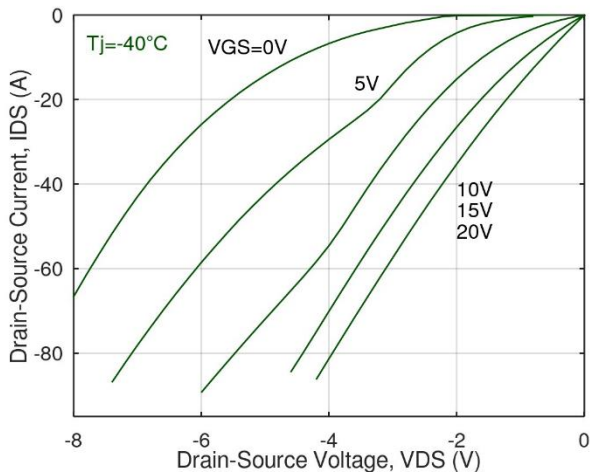
Blue, red and green colors indicate data corresponding to room (25°C), high (175°C) and low (-40°C) temperatures, respectively. Unless stated otherwise, temperature corresponds to junction temperature.



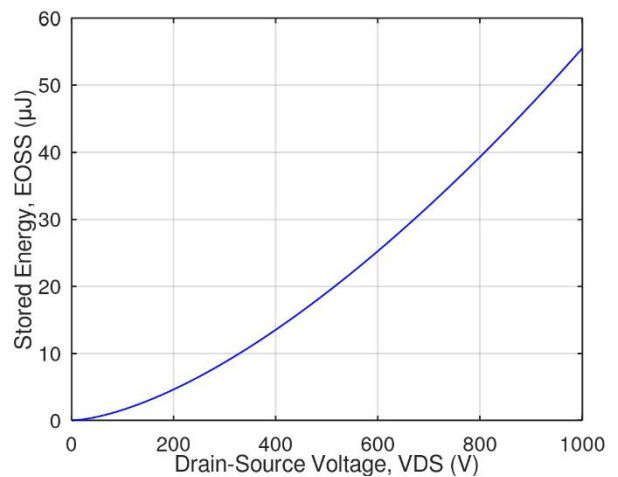
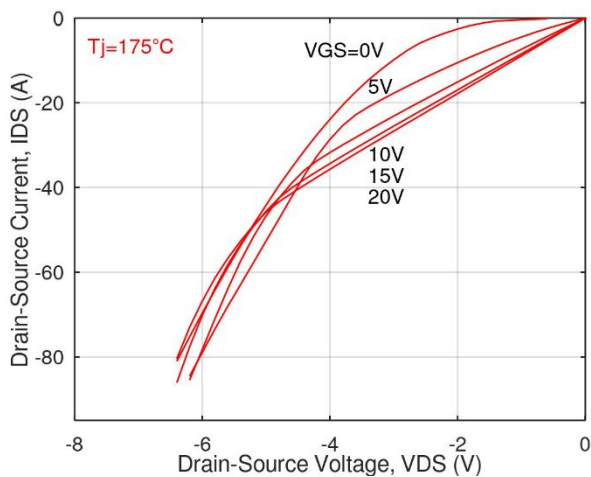
**Figure 11:** Threshold vs. temperature. Dashed vertical lines indicate to room (25°C), high (175°C) and low (-40°C) temperatures.



**Figure 12:** Gate charge characteristics.



**Figure 13:** Low temperature third quadrant characteristics†. **Figure 14:** Room temperature third quadrant characteristics†.



**Figure 15:** High temperature third quadrant characteristics†.

**Figure 16:** Output capacitor stored energy.

†  $t_p=300\mu s$  in pulsed IV measurements.

Blue, red and green colors indicate data corresponding to room (25°C), high (175°C) and low (-40°C) temperatures, respectively. Unless stated otherwise, temperature corresponds to junction temperature.

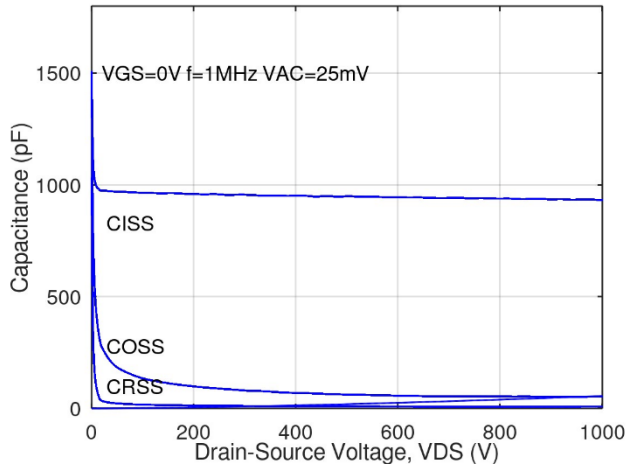


Figure 17: Capacitance vs. drain voltage.

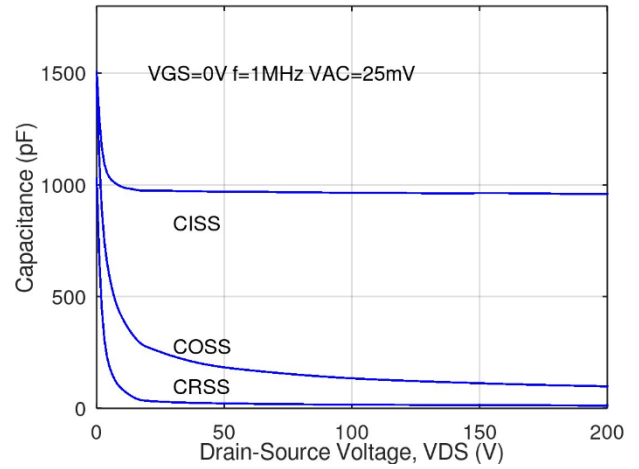


Figure 18: Capacitance vs. drain voltage.

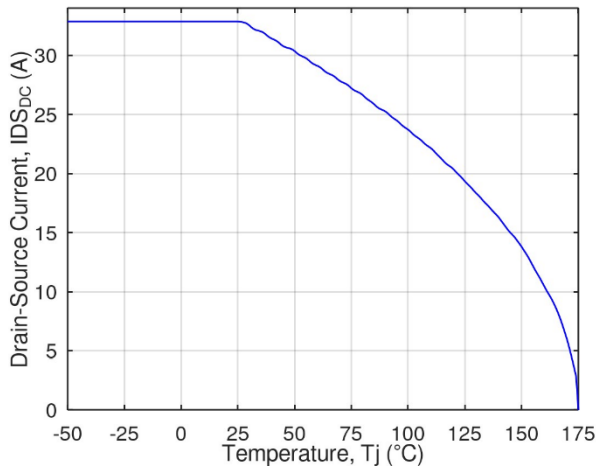


Figure 19: Continuous drain current vs. temperature.

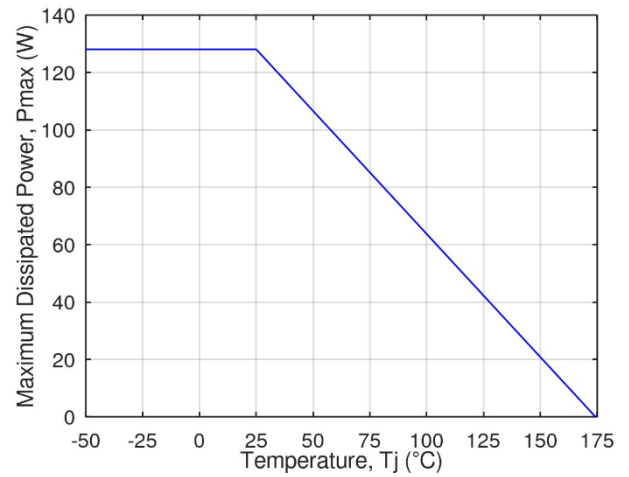


Figure 20: Power dissipation derating vs. temperature.

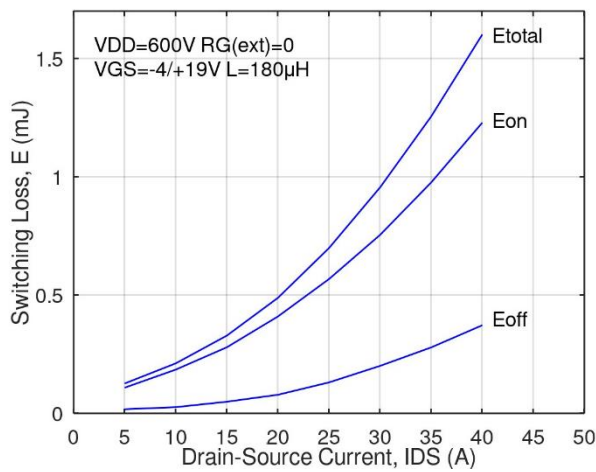


Figure 21: Clamped inductive switching energy vs. drain current at 600V VDD.

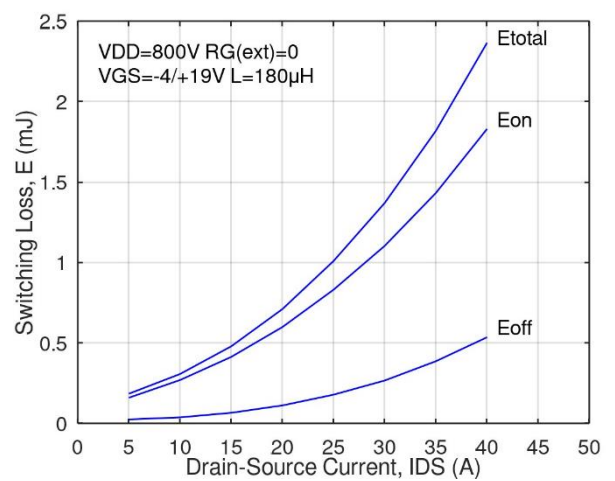
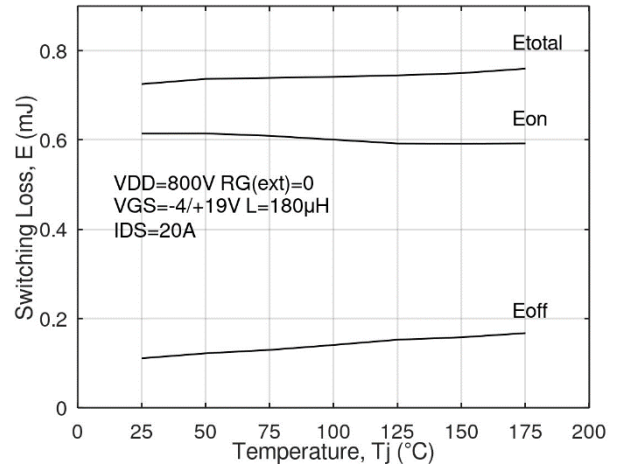
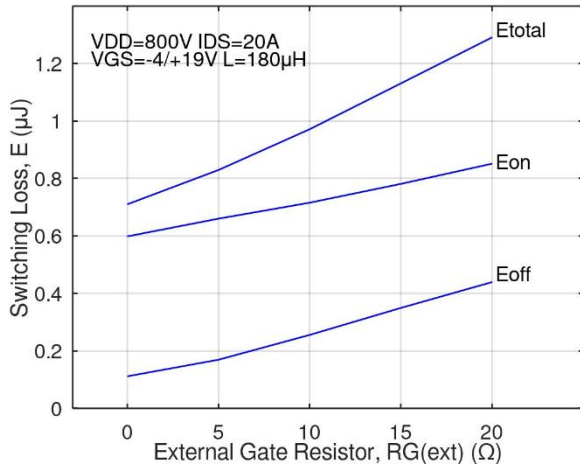


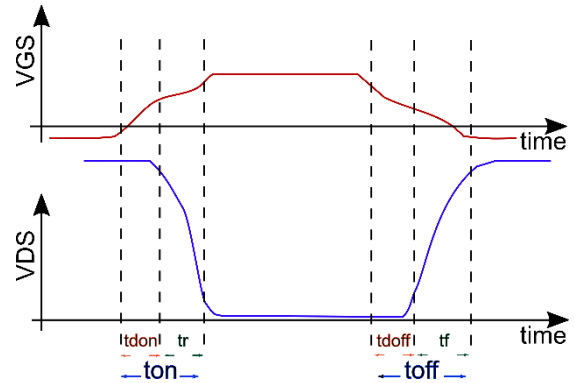
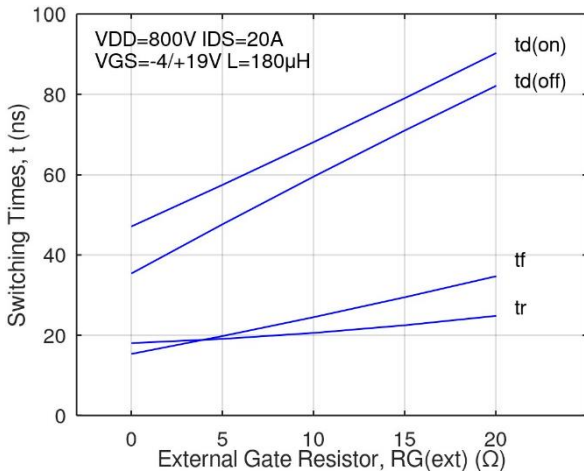
Figure 22: Clamped inductive switching energy vs. drain current at 800V VDD.

Blue color indicates data corresponding to room temperature measurements.  
Unless stated otherwise, temperature corresponds to junction temperature.



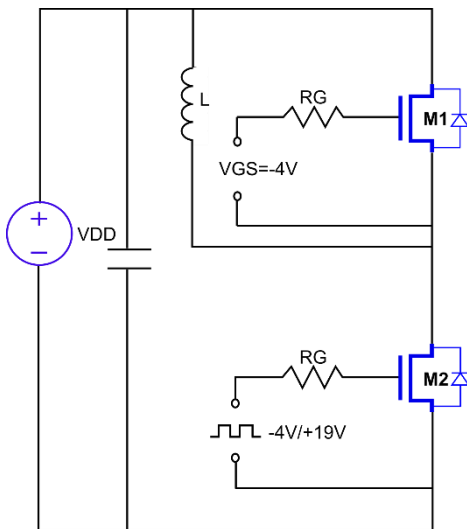
**Figure 23:** Clamped inductive switching energy vs. external gate resistance.

**Figure 24:** Clamped inductive switching energy vs. temperature.

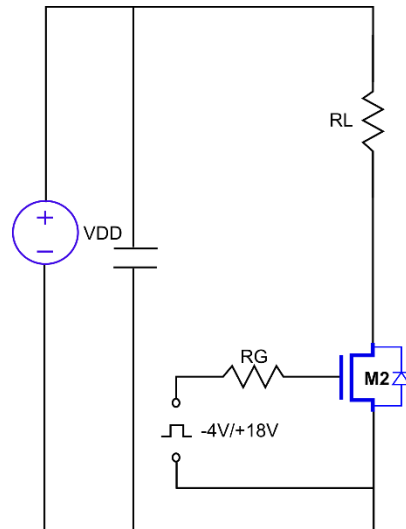


**Figure 25:** Switching times vs. external gate resistance.

**Figure 26:** Timing references.

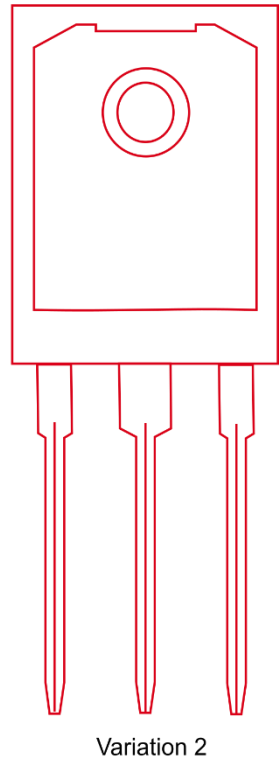
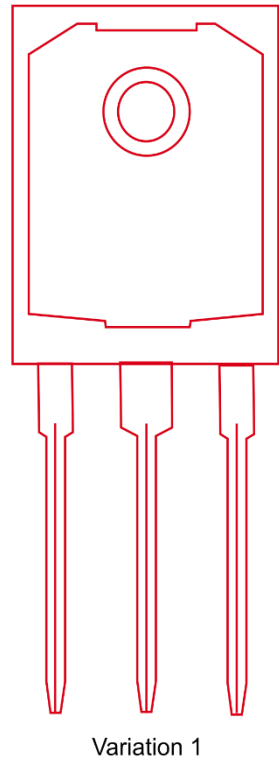
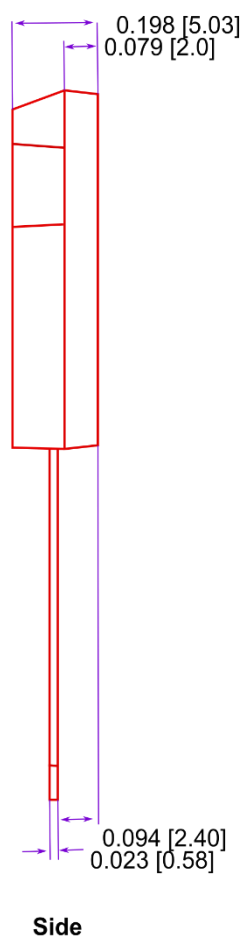
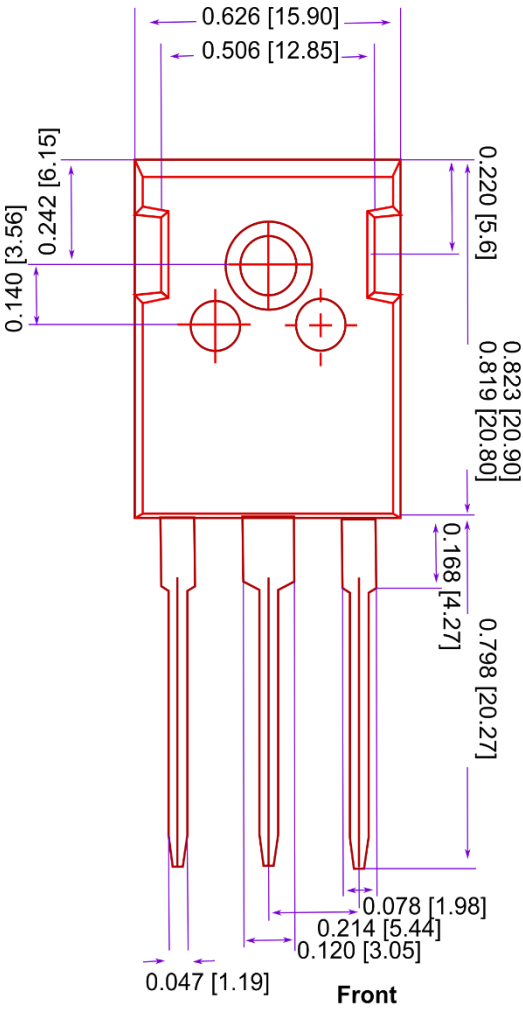


**Figure 27:** Clamped inductive switching waveform test circuit.



**Figure 28:** Gate charge test circuit.

Blue color indicates data corresponding to room temperature measurements.  
Unless stated otherwise, temperature corresponds to junction temperature.



Unit: inch [mm]



CAUTION: These devices are ESD sensitive. Use proper handling procedures.

**Disclaimer:** These specifications may not be considered as a guarantee of components characteristics. Components have to be tested depending on intended application as adjustments may be necessary. The use of CoolCAD Electronics components in life support appliances and systems are subject to written approval of CoolCAD Electronics.