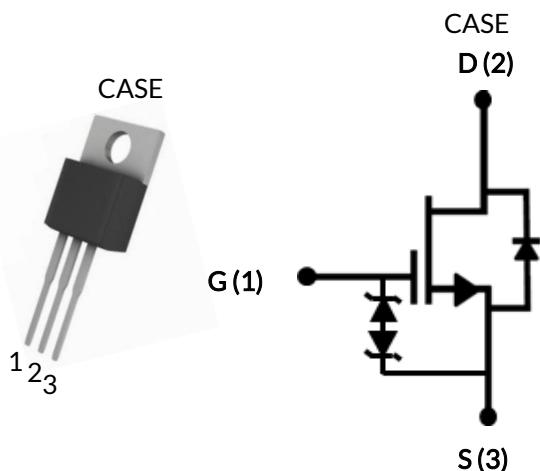


# DATASHEET

# UF3C065030T3S



Part Number	Package	Marking
UF3C065030T3S	TO-220-3L	UF3C065030T3S



## 650V-27mΩ SiC Cascode

Rev. C, June 2019

### Description

United Silicon Carbide's cascode products co-package its high-performance G3 SiC JFETs with a cascode optimized MOSFET to produce the only standard gate drive SiC device in the market today. This series exhibits ultra-low gate charge, but also the best reverse recovery characteristics of any device of similar ratings. These devices are excellent for switching inductive loads when used with recommended RC-snubbers, and any application requiring standard gate drive.

### Features

- Typical on-resistance  $R_{DS(on),typ}$  of 27mΩ
- Maximum operating temperature of 175°C
- Excellent reverse recovery
- Low gate charge
- Low intrinsic capacitance
- ESD protected, HBM class 2
- Very low switching losses (required RC-snubber loss negligible under typical operating conditions)

### Typical applications

- 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	$V_{DS}$		650	V
Gate-source voltage	$V_{GS}$	DC	-25 to +25	V
Continuous drain current <sup>1</sup>	$I_D$	$T_C = 25^\circ\text{C}$	85	A
		$T_C = 100^\circ\text{C}$	62	A
Pulsed drain current <sup>2</sup>	$I_{DM}$	$T_C = 25^\circ\text{C}$	230	A
Single pulsed avalanche energy <sup>3</sup>	$E_{AS}$	$L=15\text{mH}, I_{AS} = 4\text{A}$	120	mJ
Power dissipation	$P_{tot}$	$T_C = 25^\circ\text{C}$	441	W
Maximum junction temperature	$T_{J,max}$		175	$^\circ\text{C}$
Operating and storage temperature	$T_J, T_{STG}$		-55 to 175	$^\circ\text{C}$
Max. lead temperature for soldering, 1/8" from case for 5 seconds	$T_L$		250	$^\circ\text{C}$

1. Limited by  $T_{J,max}$

2. Pulse width  $t_p$  limited by  $T_{J,max}$

3. Starting  $T_J = 25^\circ\text{C}$

## Thermal Characteristics

Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Thermal resistance, junction-to-case	$R_{\thetaJC}$			0.26	0.34	$^\circ\text{C}/\text{W}$

## Electrical Characteristics ( $T_J = +25^\circ\text{C}$ unless otherwise specified)

### Typical Performance - Static

Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Drain-source breakdown voltage	$\text{BV}_{\text{DS}}$	$\text{V}_{\text{GS}}=0\text{V}, \text{I}_D=1\text{mA}$	650			V
Total drain leakage current	$\text{I}_{\text{DSS}}$	$\text{V}_{\text{DS}}=650\text{V}, \text{V}_{\text{GS}}=0\text{V}, \text{T}_J=25^\circ\text{C}$		6	150	$\mu\text{A}$
		$\text{V}_{\text{DS}}=650\text{V}, \text{V}_{\text{GS}}=0\text{V}, \text{T}_J=175^\circ\text{C}$		30		
Total gate leakage current	$\text{I}_{\text{GSS}}$	$\text{V}_{\text{DS}}=0\text{V}, \text{T}_J=25^\circ\text{C}, \text{V}_{\text{GS}}=-20\text{V} / +20\text{V}$		6	$\pm 20$	$\mu\text{A}$
Drain-source on-resistance	$\text{R}_{\text{DS(on)}}$	$\text{V}_{\text{GS}}=12\text{V}, \text{I}_D=50\text{A}, \text{T}_J=25^\circ\text{C}$		27	35	$\text{m}\Omega$
		$\text{V}_{\text{GS}}=12\text{V}, \text{I}_D=50\text{A}, \text{T}_J=175^\circ\text{C}$		43		
Gate threshold voltage	$\text{V}_{\text{G(th)}}$	$\text{V}_{\text{DS}}=5\text{V}, \text{I}_D=10\text{mA}$	4	5	6	V
Gate resistance	$\text{R}_G$	f=1MHz, open drain		4.5		$\Omega$

### Typical Performance - Reverse Diode

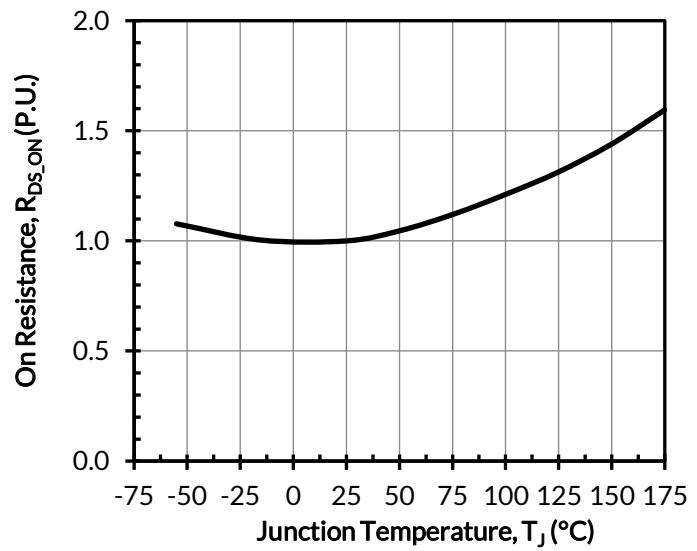
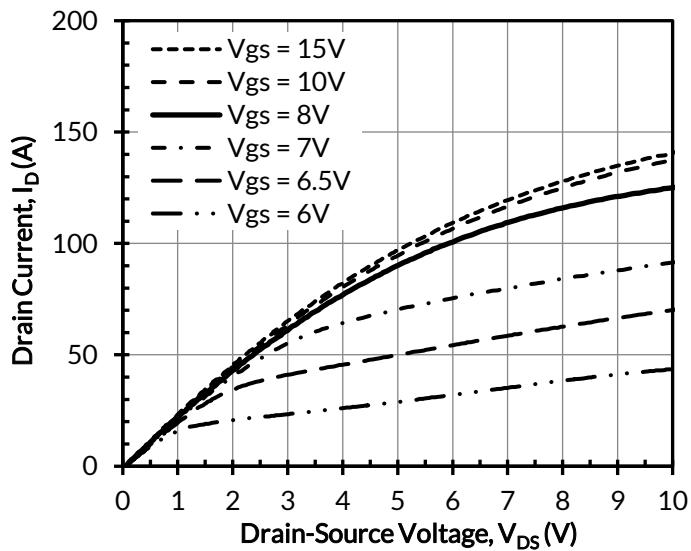
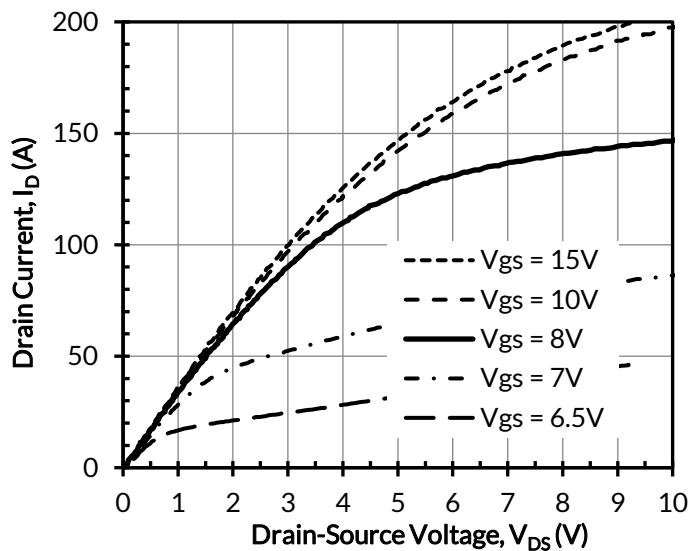
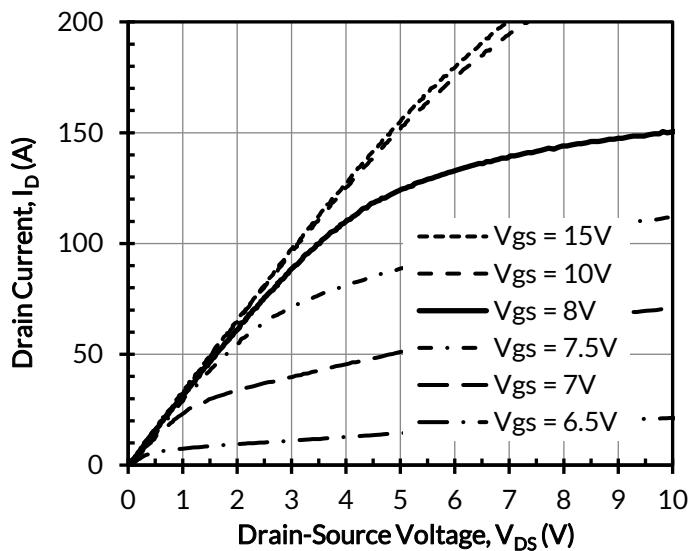
Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Diode continuous forward current <sup>1</sup>	$\text{I}_S$	$\text{T}_C=25^\circ\text{C}$			85	A
Diode pulse current <sup>2</sup>	$\text{I}_{\text{S,pulse}}$	$\text{T}_C=25^\circ\text{C}$			230	A
Forward voltage	$\text{V}_{\text{FSD}}$	$\text{V}_{\text{GS}}=0\text{V}, \text{I}_F=20\text{A}, \text{T}_J=25^\circ\text{C}$		1.3	1.4	V
		$\text{V}_{\text{GS}}=0\text{V}, \text{I}_F=20\text{A}, \text{T}_J=175^\circ\text{C}$		1.35		
Reverse recovery charge	$\text{Q}_{\text{rr}}$	$\text{V}_R=400\text{V}, \text{I}_F=50\text{A}, \text{V}_{\text{GS}}=-5\text{V}, \text{R}_{\text{G,EXT}}=20\Omega, \text{di/dt}=1300\text{A}/\mu\text{s}, \text{T}_J=25^\circ\text{C}$		218		nC
Reverse recovery time	$\text{t}_{\text{rr}}$			38		ns
Reverse recovery charge	$\text{Q}_{\text{rr}}$	$\text{V}_R=400\text{V}, \text{I}_F=50\text{A}, \text{V}_{\text{GS}}=-5\text{V}, \text{R}_{\text{G,EXT}}=20\Omega, \text{di/dt}=1300\text{A}/\mu\text{s}, \text{T}_J=150^\circ\text{C}$		188		nC
Reverse recovery time	$\text{t}_{\text{rr}}$			35		ns

## Typical Performance - Dynamic

Parameter	Symbol	Test Conditions	Value			Units
			Min	Typ	Max	
Input capacitance	$C_{iss}$	$V_{DS}=100V, V_{GS}=0V$ $f=100kHz$		1500		pF
Output capacitance	$C_{oss}$			293		
Reverse transfer capacitance	$C_{rss}$			2		
Effective output capacitance, energy related	$C_{oss(er)}$	$V_{DS}=0V$ to $400V$ , $V_{GS}=0V$		215		pF
Effective output capacitance, time related	$C_{oss(tr)}$	$V_{DS}=0V$ to $400V$ , $V_{GS}=0V$		480		pF
$C_{oss}$ stored energy	$E_{oss}$	$V_{DS}=400V, V_{GS}=0V$		17.5		$\mu J$
Total gate charge	$Q_G$	$V_{DS}=400V, I_D=50A$ , $V_{GS} = -5V$ to $15V$		51		nC
Gate-drain charge	$Q_{GD}$			11		
Gate-source charge	$Q_{GS}$			19		
Turn-on delay time	$t_{d(on)}$	$V_{DS}=400V, I_D=50A$ , Gate Driver =-5V to +15V, Turn-on $R_{G,EXT}=1.8\Omega$ , Turn-off $R_{G,EXT}=22\Omega$ Inductive Load, FWD: same device with $V_{GS} = -5V$ and $R_G = 22\Omega$ , RC snubber: $R_S=5\Omega$ and $C_S=330pF$ , $T_J=25^\circ C$		45		ns
Rise time	$t_r$			28		
Turn-off delay time	$t_{d(off)}$			59		
Fall time	$t_f$			18		
Turn-on energy including $R_S$ energy <sup>4</sup>	$E_{ON}$			752		$\mu J$
Turn-off energy including $R_S$ energy <sup>4</sup>	$E_{OFF}$			178		
Total switching energy including $R_S$ energy <sup>4</sup>	$E_{TOTAL}$			930		
Snubber $R_S$ energy during turn-on	$E_{RS\_ON}$			4.4		
Snubber $R_S$ energy during turn-off	$E_{RS\_OFF}$			11.3		
Turn-on delay time	$t_{d(on)}$	$V_{DS}=400V, I_D=50A$ , Gate Driver =-5V to +15V, Turn-on $R_{G,EXT}=1.8\Omega$ , Turn-off $R_{G,EXT}=22\Omega$ Inductive Load, FWD: same device with $V_{GS} = -5V$ and $R_G = 22\Omega$ , RC snubber: $R_S=5\Omega$ and $C_S=330pF$ , $T_J=150^\circ C$		43		ns
Rise time	$t_r$			28		
Turn-off delay time	$t_{d(off)}$			61		
Fall time	$t_f$			17		
Turn-on energy including $R_S$ energy <sup>4</sup>	$E_{ON}$			704		
Turn-off energy including $R_S$ energy <sup>4</sup>	$E_{OFF}$			195		
Total switching energy including $R_S$ energy <sup>4</sup>	$E_{TOTAL}$			899		
Snubber $R_S$ energy during turn-on	$E_{RS\_ON}$			4.2		
Snubber $R_S$ energy during turn-off	$E_{RS\_OFF}$			11.3		

4. The switching performance are evaluated with a RC snubber circuit as shown in Figure 24.

## Typical Performance Diagrams



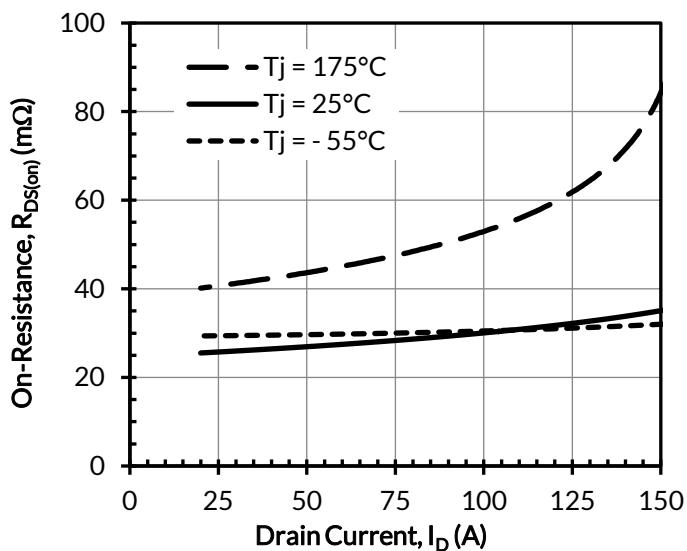


Figure 5. Typical drain-source on-resistances at  $V_{GS} = 12\text{V}$

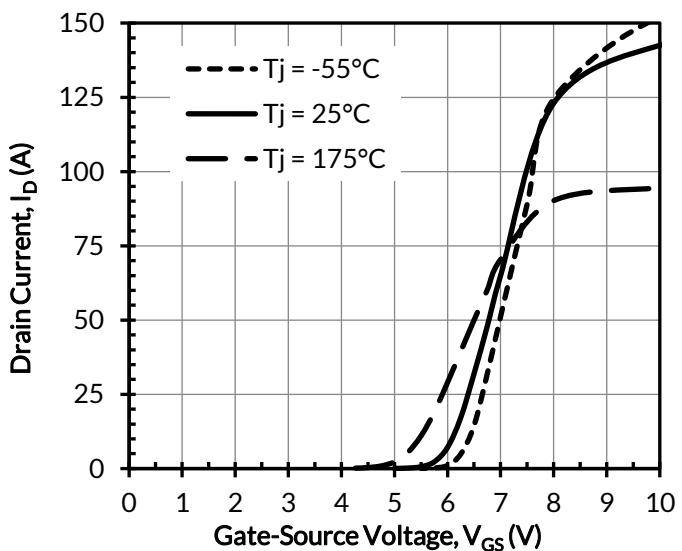


Figure 6. Typical transfer characteristics at  $V_{DS} = 5\text{V}$

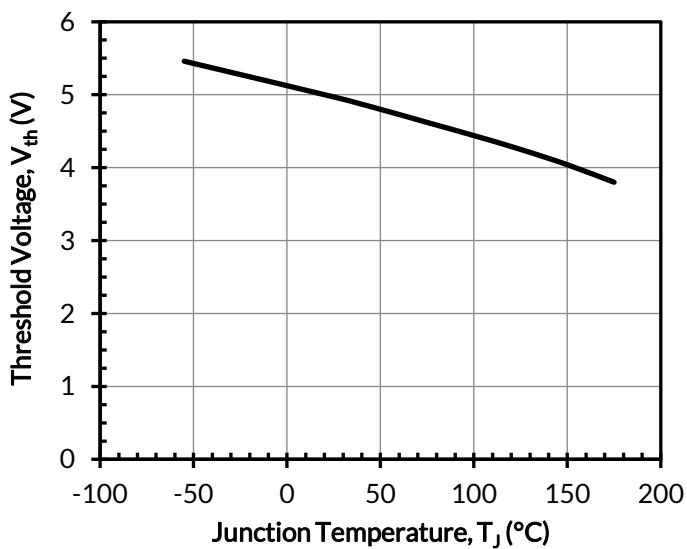


Figure 7. Threshold voltage vs. junction temperature at  $V_{DS} = 5\text{V}$  and  $I_D = 10\text{mA}$

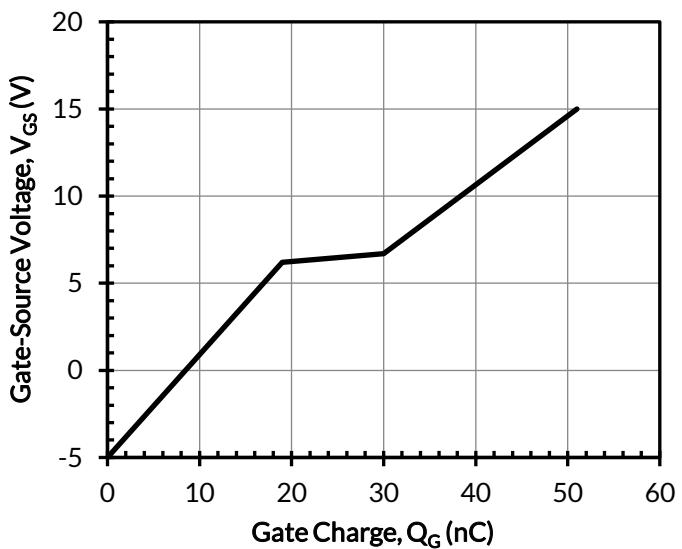


Figure 8. Typical gate charge at  $V_{DS} = 400\text{V}$  and  $I_D = 50\text{A}$

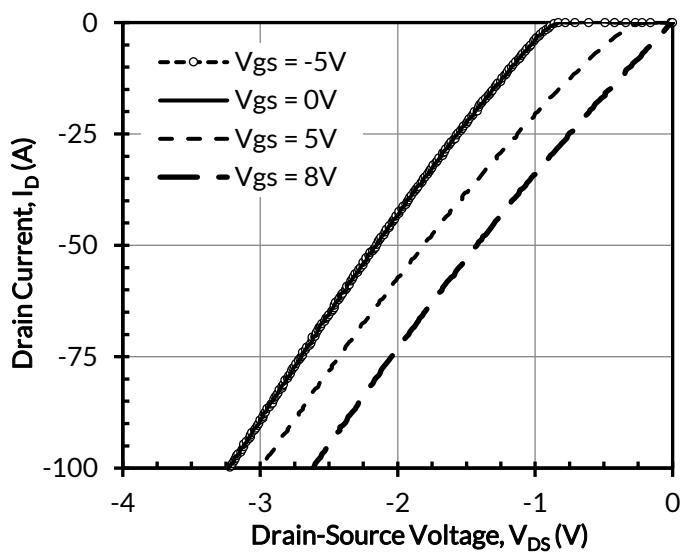


Figure 9. 3rd quadrant characteristics at  $T_J = -55^\circ\text{C}$

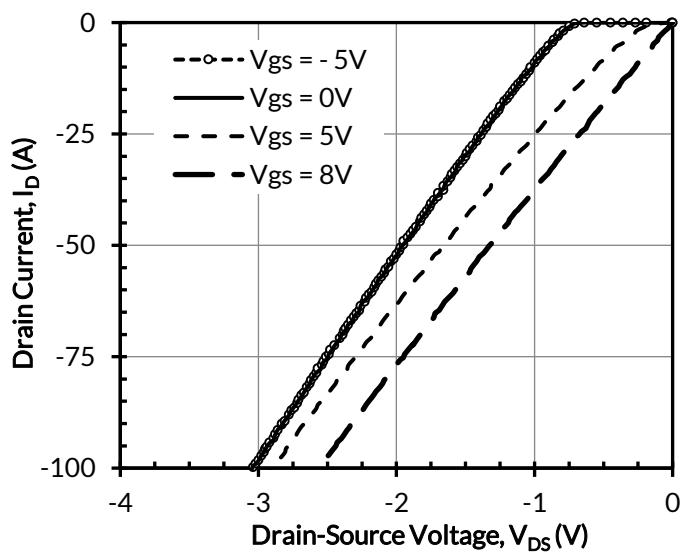


Figure 10. 3rd quadrant characteristics at  $T_J = 25^\circ\text{C}$

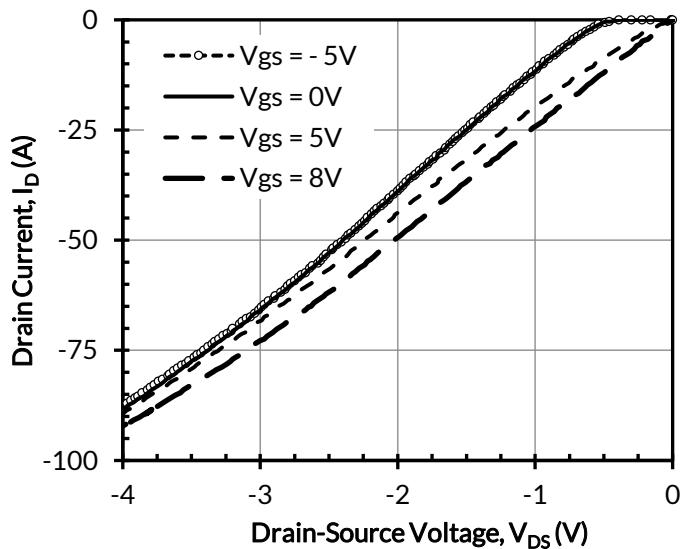


Figure 11. 3rd quadrant characteristics at  $T_J = 175^\circ\text{C}$

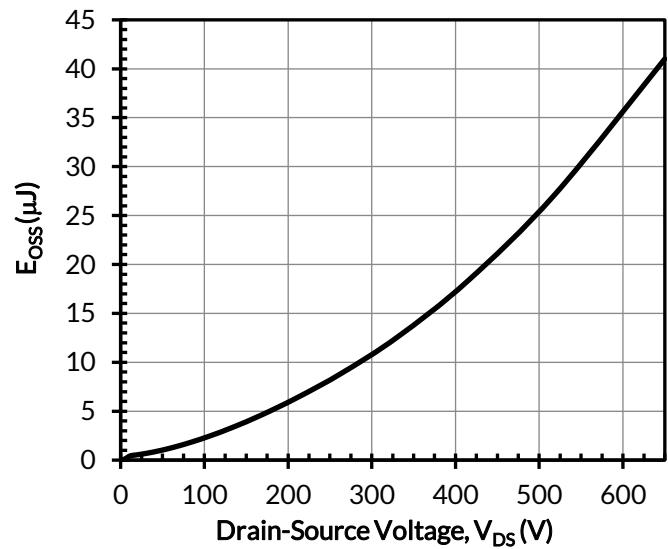


Figure 12. Typical stored energy in  $C_{OSS}$  at  $V_{GS} = 0\text{V}$

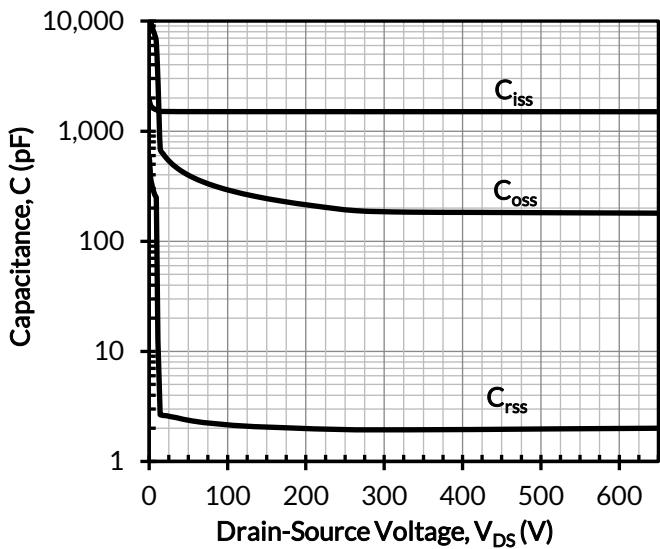


Figure 13. Typical capacitances at  $f = 100\text{kHz}$  and  $V_{GS} = 0\text{V}$

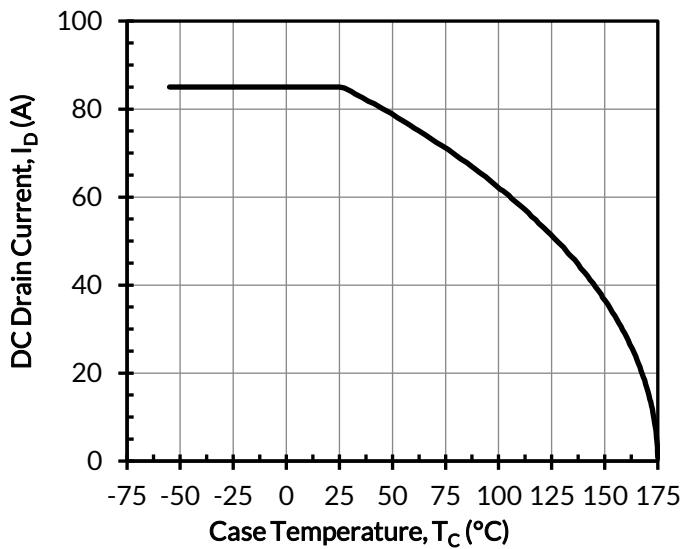


Figure 14. DC drain current derating

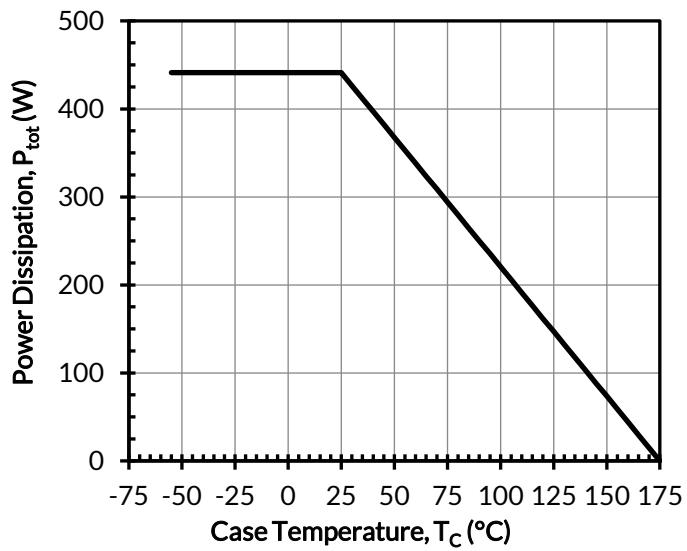


Figure 15. Total power dissipation

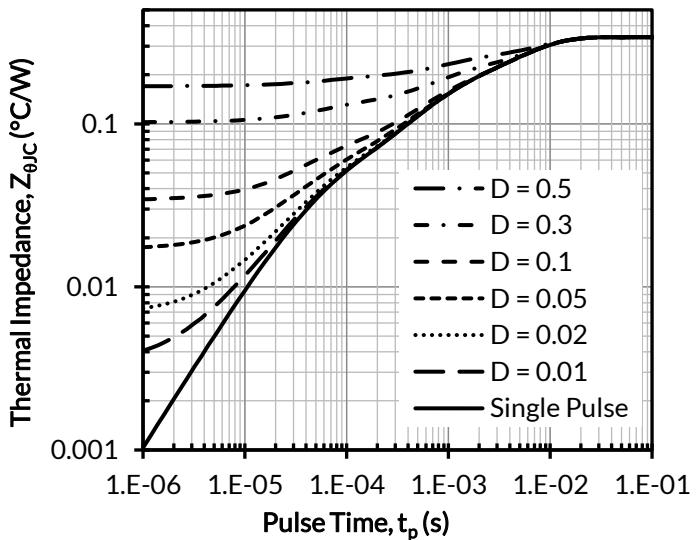


Figure 16. Maximum transient thermal impedance

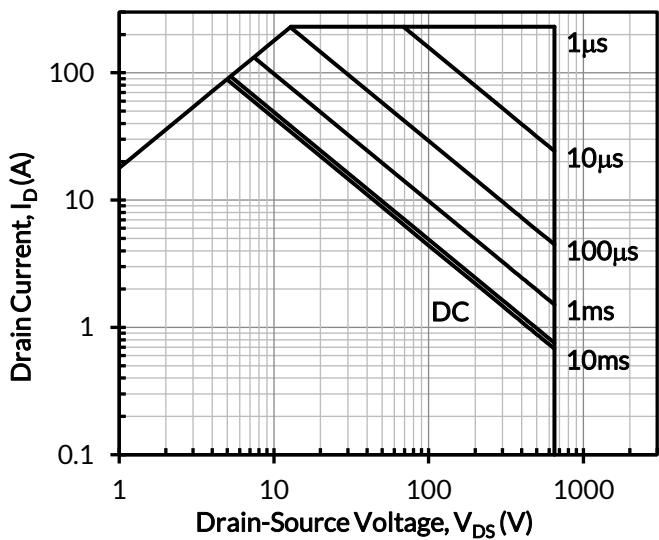


Figure 17. Safe operation area at  $T_C = 25^\circ\text{C}$ ,  $D = 0$ , Parameter  $t_p$

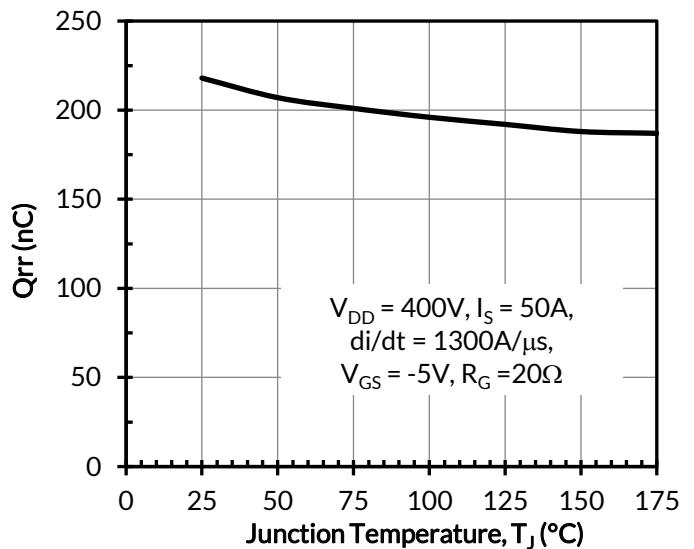
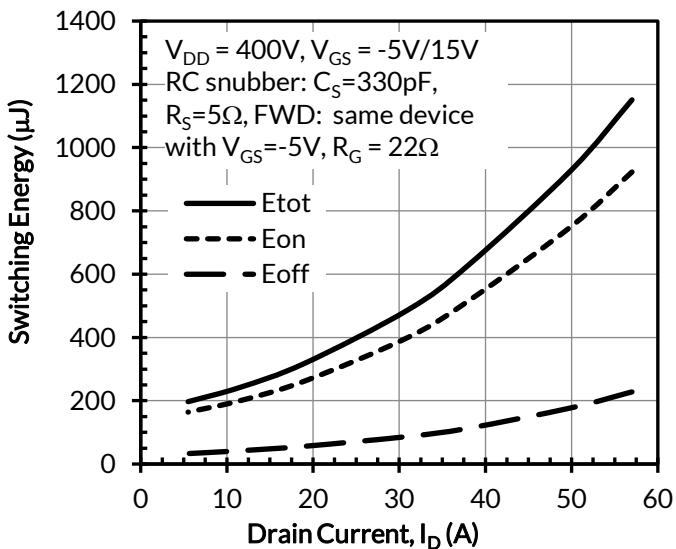
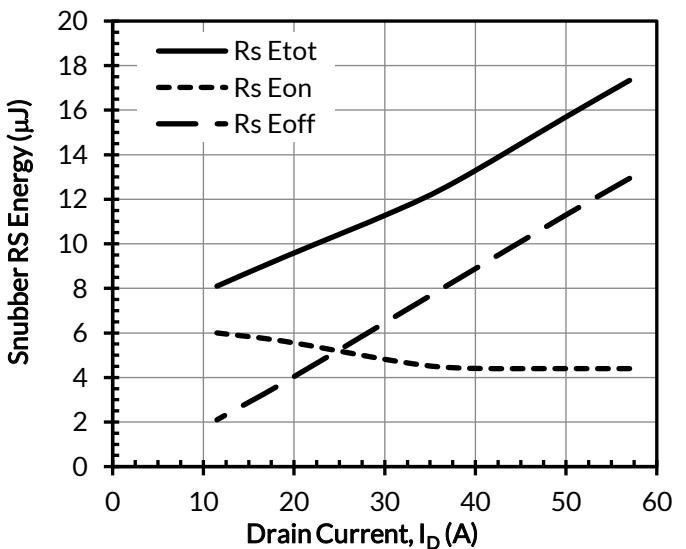


Figure 18. Reverse recovery charge  $Q_{rr}$  vs. junction temperture

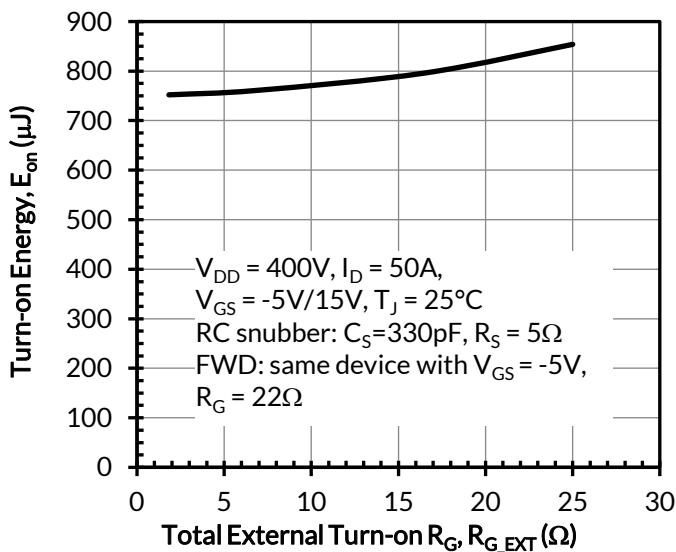


(a)

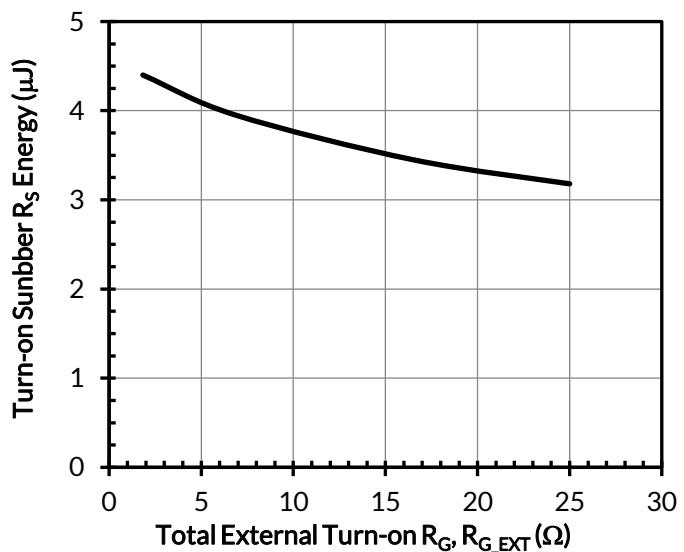


(b)

Figure 19. Clamped inductive switching energy (a) and RC snubber energy loss (b) vs. drain current at  $T_J = 25^\circ\text{C}$ , turn-on  $R_{G,EXT} = 1.8\Omega$ , and turn-off  $R_{G,EXT} = 22\Omega$

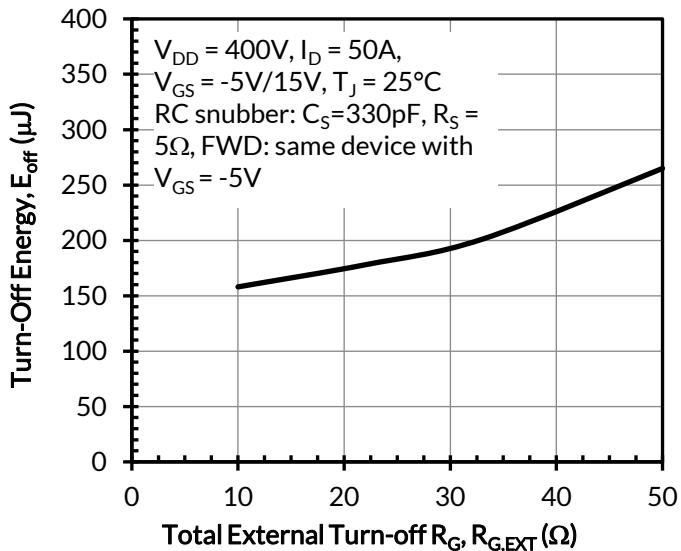


(a)

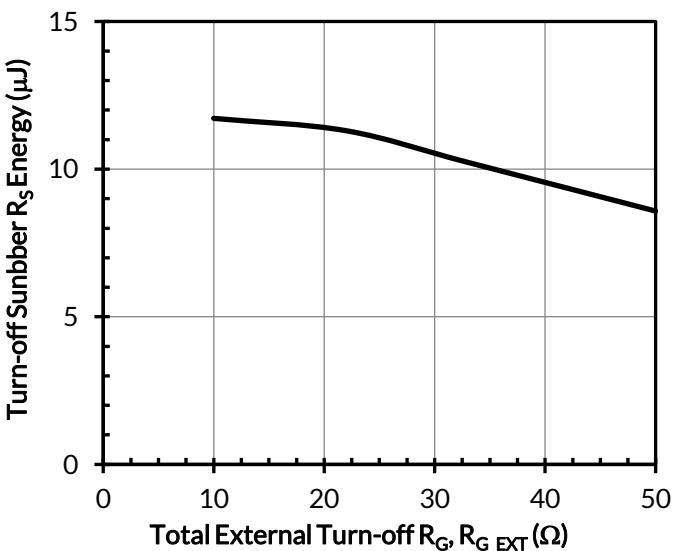


(b)

Figure 20. Clamped inductive switching turn-on energy including RC snubber energy loss (a) and RC snubber energy loss (b) as a function of total external turn-on gate resistor  $R_{G\_EXT}$

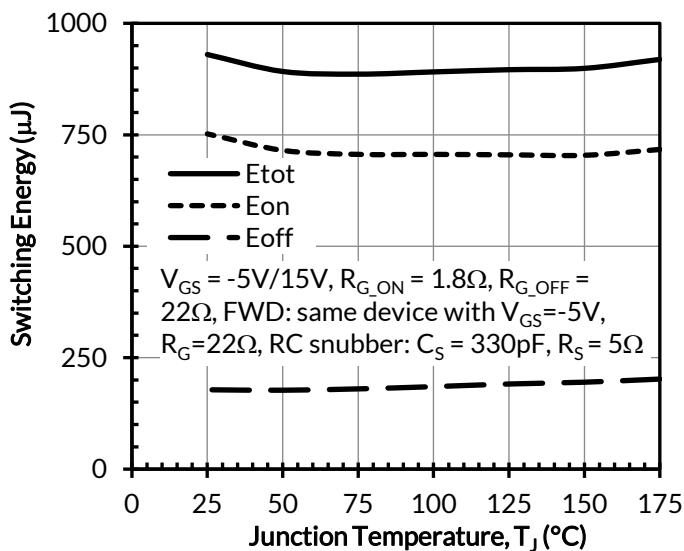


(a)

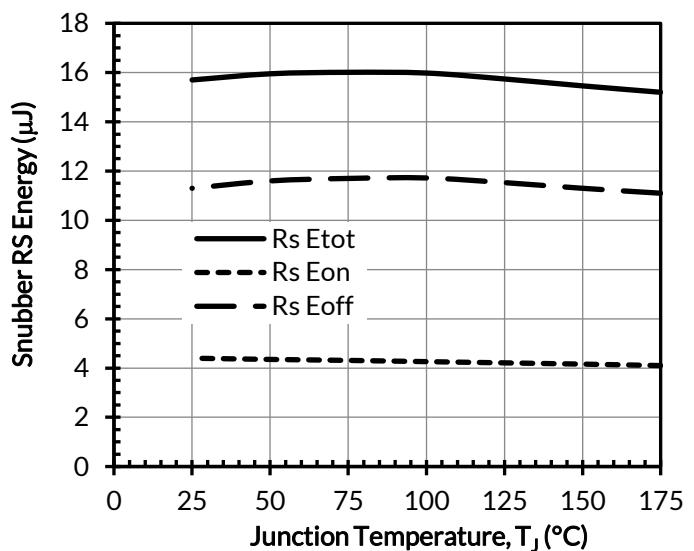


(b)

Figure 21. Clamped inductive switching turn-off energy including RC snubber energy loss (a) and RC snubber energy loss (b) as a function of total external turn-off gate resistor  $R_{G\_EXT}$

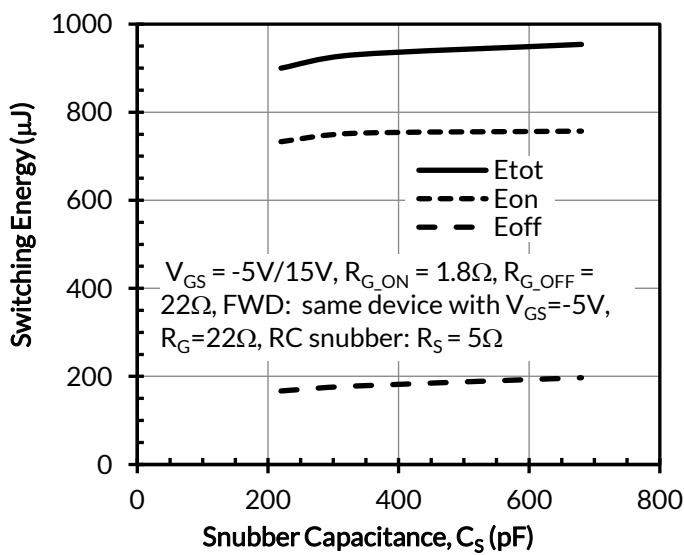


(a)

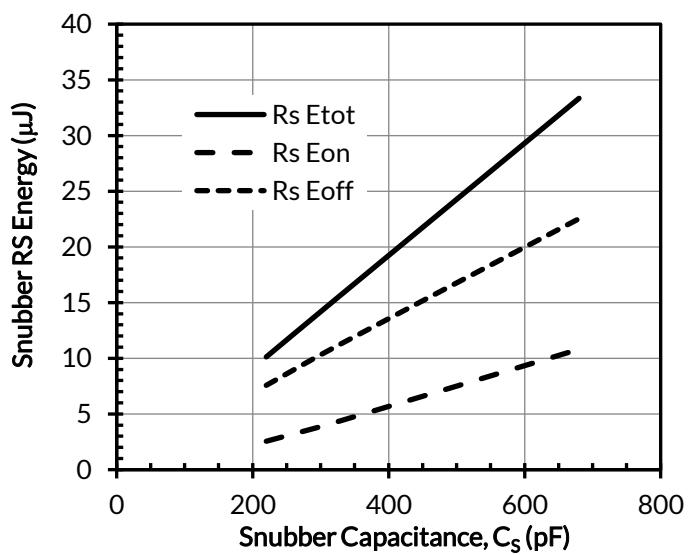


(b)

Figure 22. Clamped inductive switching energy including RC snubber energy loss (a) and RC snubber energy loss (b) as a function of junction temperature at  $I_D = 50A$  and  $V_{DD} = 400V$



(a)



(b)

Figure 23. Clamped inductive switching energy including RC snubber energy loss (a) and RC snubber energy loss (b) as a function of snubber capacitance at  $I_D = 50A$ ,  $V_{DD} = 400V$ , and  $T_J = 25^\circ C$

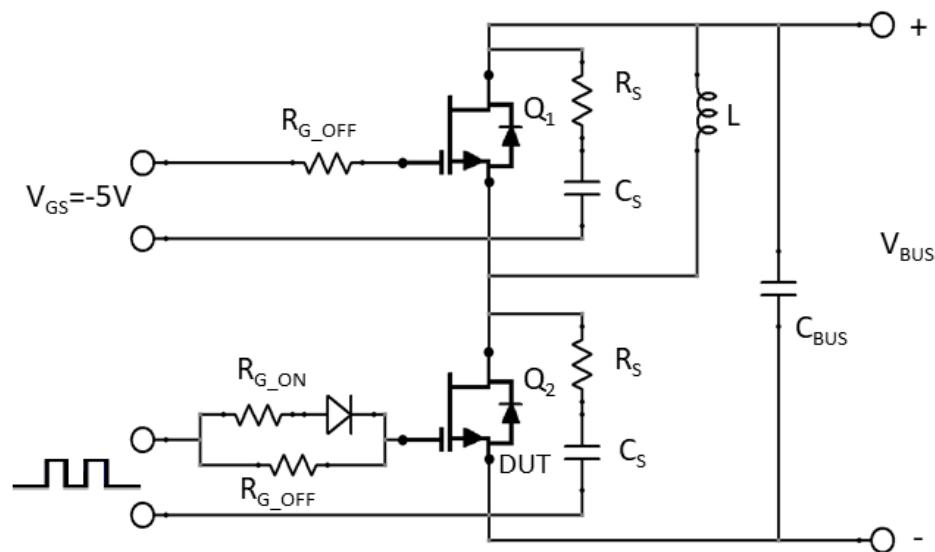


Figure 24. Clamped inductive load switching test circuit

An RC snubber ( $R_S = 5\Omega$  and  $C_S = 330\text{pF}$ ) is required to improve the turn-off waveforms.

## Applications Information

SiC cascodes are enhancement-mode power switches formed by a high-voltage SiC depletion-mode JFET and a low-voltage silicon MOSFET connected in series. The silicon MOSFET serves as the control unit while the SiC JFET provides high voltage blocking in the off state. This combination of devices in a single package provides compatibility with standard gate drivers and offers superior performance in terms of low on-resistance ( $R_{DS(on)}$ ), output capacitance ( $C_{oss}$ ), gate charge ( $Q_G$ ), and reverse recovery charge ( $Q_{rr}$ ) leading to low conduction and switching losses. The SiC cascodes also provide excellent reverse conduction capability eliminating the need for an external anti-parallel diode.

Like other high performance power switches, proper PCB layout design to minimize circuit parasitics is strongly recommended due to the high  $dv/dt$  and  $di/dt$  rates. An external gate resistor is recommended when the cascode is working in the diode mode in order to achieve the optimum reverse recovery performance. For more information on cascode operation, see [www.unitedsic.com](http://www.unitedsic.com).

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ООО "ЛайфЭлектроникс"

"LifeElectronics" LLC

ИНН 7805602321 КПП 780501001 Р/С 40702810122510004610 ФАКБ "АБСОЛЮТ БАНК" (ЗАО) в г.Санкт-Петербурге К/С 30101810900000000703 БИК 044030703

Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибуторов Европы, Америки и Азии.

С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибуторских договоров

Мы предлагаем:

- Конкурентоспособные цены и скидки постоянным клиентам.
- Специальные условия для постоянных клиентов.
- Подбор аналогов.
- Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.
- Приемлемые сроки поставки, возможна ускоренная поставка.
- Доставку товара в любую точку России и стран СНГ.
- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
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- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помочь разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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