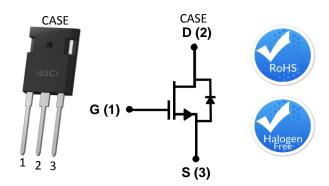
Datasheet

Description

United Silicon Carbide's cascode products co-package its xJ series highperformance 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, and any application requiring standard gate drive.



Part Number	Package	Marking
UJC1206K	TO-247-3L	UJC1206K

Features

- Max. on-resistance $R_{DS(on)max}$ of $60m\Omega$
- Standard 12V gate drive
- Maximum operating temperature of 150°C
- Excellent reverse recovery
- Low gate charge
- Low intrinsic capacitance
- RoHS compliant

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}		1200	V
Gate-source voltage	V _{GS}	DC	-20 to +20	V
Continuous drain current	1-	T _C = 25°C	38	А
	Ι _D	T _C = 100°C	24.5	А
Pulsed drain current ¹		T _j = 25°C	138	
	I _{DM}	T _j = 150°C	88	- A
Short-circuit withstand time ²	t _{sc}	V _{GS} =15V, V _{CC} <600V	4	μs
Single pulsed avalanche energy ²	E _{AS}	L=15mH, I _{AS} =4.2A	143	mJ
Power dissipation	P _{tot}	T _C = 25°C	192	w
Maximum junction temperature	T _{J,max}		150	°C
Operating and storage temperature	T _J , T _{STG}		-55 to 150	°C
Max. lead temperature for soldering, 1/8" from case for 5 Seconds	TL		250	°C

1 Pulse width t_p limited by T_{j,max}

2 Starting $T_J = 25^{\circ}C$

Datasheet

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

Typical Performance - Static

Daramatar	Symbol	Test Conditions	Value			Units
Parameter			Min	Тур	Max	Units
Drain-source breakdown voltage	BV _{DS}	V _{GS} =0V, I _D =1mA	1200			V
Total drain leakage current	I _{DSS}	V _{DS} = 1200V, V _{GS} = 0V, T _J = 25°C		110	800	- μΑ
		V _{DS} = 1200V, V _{GS} = 0V, T _J = 150°C		230		
Total gate leakage current	I _{GSS}	V _{DS} =0V, T _j =25°C, V _{GS} = -20V / +20V		5	100	nA
Drain-source on-resistance	R _{DS(on)}	V _{GS} =12V, I _D =20A, T _J = 25°C		42	60	- mΩ
		V _{GS} =12V, I _D =20A, T _J = 150°C		98		
Gate threshold voltage	V _{G(th)}	V _{DS} = 5V, I _D = 10mA	4	4.9	6	V
Gate resistance	R _G	f = 1MHz, open drain		1.1		Ω

Typical Performance - Reverse Diode

Doromotor	Symbol	Test Conditions	Value			Linita
Parameter			Min	Тур	Max	Units
Diode continuous forward current	۱ _s	T _c = 25°C			38	А
Diode pulse current ¹	I _{S,pulse}	T _C = 25°C			138	А
F 1 1	V _{FSD}	V _{GS} = 0V, I _F =20A, T _J = 25°C		1.45	2	- v
Forward voltage		V _{GS} = 0V, I _F = 20A, T _J =150°C		2.1		
Reverse recovery charge	Q _{rr}	V_{R} =800V, I_{F} =24.5A, V_{GS} =0V, $R_{G_{EXT}}$ = 22 Ω		190		nC
Reverse recovery time	t _{rr}	di/dt=1300A/µs, T」 = 25°C		34		ns
Reverse recovery charge	Q _{rr}	V_{R} =800V, I_{F} =24.5A, V_{GS} =0V, $R_{G_{EXT}}$ = 22 Ω		227		nC
Reverse recovery time	t _{rr}	di/dt=1300A/µs, T _J = 150°C		36		ns

Datasheet

Typical Performance - Dynamic

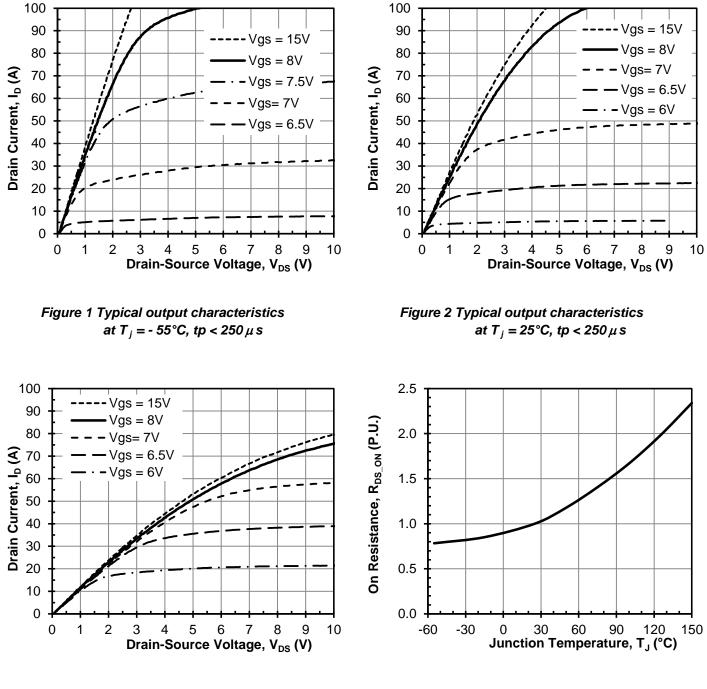
ViscViscMinTypMaxInput capacitance C_{0ss} C_{0ss} $V_{0s} = 100V,$ 2214 PF Reverse transfer capacitance C_{rss} $f = 100kHz$ 3.5 PF Effective output capacitance, energy related $C_{oss(rr)}$ $V_{0s} = 0V$ to $800V,$ $V_{cs} = 0V$ 98 PF Effective output capacitance, time related $C_{oss(rr)}$ $V_{0s} = 0V$ to $800V,$ $V_{cs} = 0V$ 174 PF Effective output capacitance, time related $C_{oss(rr)}$ $V_{0s} = 0V$ to $800V,$ $V_{cs} = 0V$ 311 μ Total gate charge Q_{cs} $V_{0s} = 800V, V_{0s} = 24.5A,$ $V_{0s} = 800V, I_0 = 24.5A,$ $V_{0s} = 800V, I_0 = 24.5A,$ 15 nC Gate-drain charge Q_{cs} $V_{0s} = 800V, I_0 = 24.5A,$ $V_{0s} = 800V, I_0 = 24.5A,$ 41 Pf Turn-on delay time $t_{d(ori)}$ $V_{0s} = 800V, I_0 = 24.5A,$ $V_{0s} = 800V, I_0 = 24.5A,$ 41 Pf Turn-off delay time $t_{d(ori)}$ $V_{0s} = 800V, I_0 = 24.5A,$ $Gate Driver = 0V to12V41PfTurn-off delay timet_{d(ori)}V_{0s} = 800V, I_0 = 24.5A,Gate Driver = 0V to12V411PfTurn-off delay timet_{d(ori)}V_{0s} = 800V, I_0 = 24.5A,Gate Driver = 0V to12V411PfTurn-off delay timet_{d(ori)}V_{0s} = 800V, I_0 = 24.5A,Gate Driver = 0V to12V41294PfTurn-off delay timet_{12}V_{0s} = 800V, I_0 = 24.5A,Gate Driver = 0V to1$	Parameter	symbol	Test Conditions	Value			Units	
Output capacitance C_{oss} $V_{cs} = 0V$, f = 100kHz178 pF Reverse transfer capacitance C_{rss} $f = 100kHz$ 3.5 pF Effective output capacitance, energy related $C_{oss(er)}$ $V_{ps} = 0V$ to 800V, $V_{cs} = 0V$ 98 pF Effective output capacitance, time related $C_{oss(tr)}$ $V_{ps} = 0V$ to 800V, $V_{cs} = 0V$ 174 pF Effective output capacitance, time related $C_{oss(tr)}$ $V_{ps} = 0V$ to 800V, $V_{cs} = 0V$ 174 pF Coss stored energy E_{oss} $V_{ps} = 800V$, $V_{ps} = 0V$ 31 μ Total gate charge Q_{G} $V_{ps} = 800V$, $V_{ps} = 24.5A$, $V_{0s} = 0V$ to 12V 47.5 nC Gate-drain charge $Q_{G_{D}}$ $V_{ps} = 800V$, $V_{p} = 24.5A$, $V_{0s} = 0V$ to 12V 41 pF Turn-ondelay time $t_{d(on)}$ $V_{ps} = 800V$, $V_{p} = 24.5A$, $V_{0s} = 0V$ to 12V 41 pF Turn-ond Regume $t_{q(off)}$ $Turn-on Regume2541pFTurn-ond fielay timet_{q(off)}T_{p} = 24.5A,Turn-onf R_{egem} = 22\OmegaInductive Load,657pFTurn-ond delay timet_{q(off)}T_{p} = 24.5A,T_{p} = 25^{\circ}C411pFTurn-ond delay timet_{q(off)}T_{p} = 25^{\circ}C804411Turn-ond delay timet_{q(off)}T_{p} = 25^{\circ}C804411Turn-ond fielay timet_{q(off)}T_{p} = 25^{\circ}C804411Turn-ond fielay tim$				Min	Тур	Max	Units	
Reverse transfer capacitance C_{rss} $f = 100 \text{ KHz}$ 3.5 Effective output capacitance, energy related $C_{oss(er)}$ $V_{05} = 0V$ to $800V$, $V_{cs} = 0V$ 98 pF Effective output capacitance, time related $C_{oss(tr)}$ $V_{05} = 0V$ to $800V$, $V_{cs} = 0V$ 174 pF Effective output capacitance, time related $C_{oss(tr)}$ $V_{05} = 0V to 800V,V_{cs} = 0V311\muTotal gate chargeQ_{G}V_{05} = 800V, V_{05} = 24.5A,V_{05} = 800V, I_0 = 24.5A,$	Input capacitance	C _{iss}			2214			
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Output capacitance				178		pF	
Effective output capacitance, energy related $C_{oss(er)}$ $V_{GS} = 0V$ 98 ρF Effective output capacitance, time related $C_{oss(tr)}$ $V_{DS} = 0V to 800V, V_{GS} = 0V$ 174 ρF Effective output capacitance, time related $C_{oss(tr)}$ $V_{DS} = 0V to 800V, V_{GS} = 0V$ 31 μJ Total gate charge Q_{G} Q_{G} $V_{DS} = 800V, V_{DS} = 0V$ 31 μJ Total gate charge Q_{G} $V_{DS} = 800V, V_{D} = 24.5A, V_{DS} = 800V, I_{D} = 24.5A, V_{DS} = 0V to 12V$ 15nCGate-drain charge Q_{GS} $V_{DS} = 800V, I_{D} = 24.5A, V_{DS} = 0V to 12V$ 15nCTurn- of delay time $t_{d(on)}$ $V_{DS} = 800V, I_{D} = 24.5A, Gate Driver = 0V to 12V$ 25nrFall time t_r Gate Driver = 0V to 12V251515Turn-off delay time $t_{d(orf)}$ $T_{12} = 25^{\circ}C$ 80415Turn-off R_{G,EXT} = 2Q, Turn-off R_{G,EXT} =	Reverse transfer capacitance	C _{rss}	f = 100kHz		3.5			
Effective output capacitance, time related $C_{oss(tr)}$ $V_{GS} = 0V$ 174 pF $V_{GS} = 0V$ E_{oss} $V_{GS} = 0V$ 31 μ $Total gate chargeQ_GQ_GV_{GS} = 800V, V_{GS} = 0V31\muTotal gate chargeQ_GV_{GS} = 800V, V_G = 0V1547.5Gate-drain chargeQ_{GS}V_{GS} = 800V, I_D = 24.5A, V_{GS} = 0V to 12V15nCGate-drain chargeQ_{GS}V_{DS} = 800V, I_D = 24.5A, V_{GS} = 0V to 12V15nCTurn-on delay timet_d(on)V_{DS} = 800V, I_D = 24.5A, Gate Driver = 0V to + 12V, Turn-on R_{G,EXT} = 2\Omega, Turn-off delay timef_HV_{DS} = 800V, I_D = 24.5A, Gate Driver = 0V to + 12V, Turn-on R_{G,EXT} = 2\Omega, Turn-off R_{G,EXT} $	Effective output capacitance, energy related	C _{oss(er)}	55		98		pF	
International data chargeOrderInternational data chargeInternational data chargeGate-drain charge Q_G V_{DS} =800V, I_D = 24.5A, V_{SS} =0V to 12V47.5nCGate-source charge Q_{GS} V_{DS} =800V, I_D = 24.5A, V_{SS} =0V to 12V15nCTurn-on delay time $t_{d(on)}$ V_{DS} =800V, I_D = 24.5A, Gate Driver =0V to $+12V$, Turn-on R_{G,EXT} = 2Q, Inductive Load, FWD: UJ2D121ST41	Effective output capacitance, time related	C _{oss(tr)}			174		pF	
Gate-drain charge Q_{GD} V_{DS} =800V, $I_D = 24.5A,$ 15 nC Gate-source charge Q_{GS} V_{DS} =800V, $I_D = 24.5A,$ 41 15 nC Turn-on delay time $t_{d(on)}$ V_{DS} =800V, $I_D = 24.5A,$ 41 15 nC Rise time t_r Gate Driver =0V to +12V, 41 15 nS Turn-off delay time $t_{d(off)}$ Turn-on $R_{G,EXT} = 2\Omega,$ 115 nS Turn-off energy E_{ON} FWD: UJ2D121ST 147 μ J Turn-on delay time $t_{d(on)}$ V_{DS} =800V, I_D =24.5A, 657 μ J Turn-off energy E_{ON} Inductive Load, 657 μ J Turn-off delay time $t_{d(on)}$ V_{DS} =800V, I_D =24.5A, 641 μ J Rise time t_r $T_J = 25^{\circ}C$ 804 μ J μ J Turn-off delay time $t_d(off)$ V_{DS} =800V, I_D =24.5A, 41 I_S Fall time t_r I_S I_S I_S I_S I	C _{oss} stored energy	E _{oss}	$V_{DS} = 800V, V_{GS} = 0V$		31		μ	
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Total gate charge	Q _G	N/ 000X/ 1 24 54		47.5		nC	
Gate-source charge Q_{GS} M 15Turn-on delay time $t_{d(on)}$ V_{DS} =800V, I_D =24.5A, Gate Driver =0V to +12V,41	Gate-drain charge	Q _{GD}			15			
A stateA state<	Gate-source charge	Q _{GS}	V _{GS} =0V 10 12V		15			
Rise time t_r $t_{d(off)}$ Gate Driver =0V to $\pm 12V$, Turn-on $R_{G,EXT} = 2\Omega$, Turn-on $R_{G,EXT} = 2\Omega$, Inductive Load, FWD: UJ2D121ST Total switching energy 25 ns Turn-on delay time t_f $Turn-on R_{G,EXT} = 2\Omega$, Inductive Load, FWD: UJ2D121ST T $_J = 25^{\circ}C$ 657 μ Turn-on delay time $t_{d(on)}$ $V_{DS}=800V$, $I_D=24.5A$, Gate Driver =0V to $\pm 12V$, 411 μ Turn-off delay time $t_{d(off)}$ τ $Turn-on R_{G,EXT} = 2\Omega$, Turn-on $R_{G,EXT} = 2\Omega$, $Turn-on free regy102nsTurn-off delay timet_{d(off)}\tau\tau102nsTurn-off R_{G,EXT} = 2\Omega,Turn-off R_{G,E$	Turn-on delay time	t _{d(on)}	Gate Driver =0V to +12V, Turn-on $R_{G,EXT} = 2\Omega$, Turn-off $R_{G,EXT} = 22\Omega$ Inductive Load, FWD: UJ2D1215T		41		_	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Rise time	t _r			25			
Fail time t_f Turn-off $R_{G,EXT} = 22\Omega$ Inductive Load, FWD: UJ2D1215T $T_J = 25^{\circ}C$ 21Turn-off energy E_{OFF} FWD: UJ2D1215T $T_J = 25^{\circ}C$ 657Total switching energy E_{TOTAL} $T_J = 25^{\circ}C$ 804Turn-on delay time $t_{d(on)}$ $V_{DS}=800V, I_D=24.5A,$ Gate Driver =0V to $+12V,$ 41 I_{M} Turn-off delay time $t_{d(off)}$ $Turn-on R_{G,EXT} = 2\Omega,$ Turn-on energy102 I_{SS} Fail time t_f $Turn-on R_{G,EXT} = 2\Omega,$ Turn-off $R_{G,EXT} = 2\Omega,$ 	Turn-off delay time	t _{d(off)}			94			
Turn-on energy E_{ON} Inductive Load, FWD: UJ2D121ST $T_J = 25^{\circ}C$ 657 μ Total switching energy E_{OFF} $FWD: UJ2D121ST$ $T_J = 25^{\circ}C$ 147 μ Turn-on delay time $t_{d(on)}$ $V_{DS}=800V, I_D=24.5A,$ Gate Driver =0V to $+12V,$ 41 ns Turn-off delay time $t_{d(off)}$ $+12V,$ Turn-on $R_{G,EXT} = 2\Omega,$ Inductive Load, 102 ns Fall time t_f $Turn-off R_{G,EXT} = 2\Omega,$ Inductive Load, 22 102 ns Turn-off energy E_{OFF} $FWD: UJ2D121ST$ Turn-off $R_{G,EXT} = 150^{\circ}C$ 186 μ	Fall time	t _f			21			
Turn-on delay time E_{TOTAL} $T_J = 25^{\circ}C$ 804 μ Turn-on delay time $t_{d(on)}$ $V_{DS}=800V, I_D=24.5A,$ Gate Driver =0V to $+12V,$ 41 102 102 Turn-off delay time t_r $t_{d(off)}$ $112V,$ 102 102 102 Fall time t_f t_f 1102 102 102 102 102 Turn-on energy E_{ON} E_{OFF} 102 102 102 102 102 Turn-off R_{G,EXT} = 22Q 102 102 102 102 102 102 102 Turn-off R_{G,EXT} = 22Q 102 102 102 102 102 102 102 Turn-off R_{G,EXT} = 22Q 102	Turn-on energy	E _{ON}			657			
Total switching energy E_{TOTAL} 804Turn-on delay time $t_{d(on)}$ $V_{DS}=800V, I_D=24.5A,$ Gate Driver =0V to $\pm 12V,$ 41Rise time t_r Gate Driver =0V to $\pm 12V,$ 33Turn-off delay time $t_{d(off)}$ Turn-on $R_{G,EXT} = 2\Omega,$ Turn-on freergy102Fall time t_f Turn-off $R_{G,EXT} = 22\Omega,$ Inductive Load,735Turn-off energy E_{OFF} FWD: UJ2D1215T $T_L = 150°C$ 186 μ	Turn-off energy	E _{OFF}			147			
Rise timetr $V_{DS}=800V, I_D=24.5A,$ Gate Driver =0V to +12V,33nsTurn-off delay time $t_{d(off)}$ Turn-on $R_{G,EXT} = 2\Omega,$ Turn-on energyTurn-on $R_{G,EXT} = 2\Omega,$ Turn-off $R_{G,EXT} = 22\Omega$ Inductive Load, FWD: UJ2D1215T102nsTurn-off energy E_{OFF} FWD: UJ2D1215T Tur = 150°C186 μ	Total switching energy	E _{TOTAL}			804			
Rise time t_r Gate Driver =0V to +12V,33nsTurn-off delay time $t_{d(off)}$ Turn-on $R_{G,EXT} = 2\Omega$, Turn-on energyTurn-on $R_{G,EXT} = 22\Omega$ Inductive Load,22102Turn-off energy E_{ON} Inductive Load, FWD: UJ2D1215T735 μ	Turn-on delay time	t _{d(on)}	Gate Driver =0V to +12V, Turn-on $R_{G,EXT} = 2\Omega$, Turn-off $R_{G,EXT} = 22\Omega$ Inductive Load, FWD: UJ2D1215T		41			
Turn-off delay time $t_{d(off)}$ $+12V$, Turn-on $R_{G,EXT} = 2\Omega$, Turn-off $R_{G,EXT} = 22\Omega$ 102Fall time t_f Turn-on $R_{G,EXT} = 2\Omega$, Turn-off $R_{G,EXT} = 22\Omega$ 22Turn-on energy E_{ON} Inductive Load, FWD: UJ2D1215T735Turn-off energy E_{OFF} FWD: UJ2D1215T186Turn-off CTurn-off CTurn-off C	Rise time	t _r			33		ns	
Fall time t_f Turn-off $R_{G,EXT} = 22\Omega$ 22Turn-on energy E_{ON} Inductive Load,735Turn-off energy E_{OFF} FWD: UJ2D1215T186 μJ	Turn-off delay time	t _{d(off)}			102			
Turn-on energy E_{ON} Inductive Load, FWD: UJ2D1215T735Turn-off energy E_{OFF} FWD: UJ2D1215T186 μJ	Fall time	t _f			22			
Turn-off energy E _{OFF} FWD: UJ2D1215T 186 μJ	Turn-on energy	E _{ON}			735			
Total switching energy E_{TOTAL} $T_J = 150^{\circ}C$ 921	Turn-off energy	E _{OFF}			186		μ	
	Total switching energy	E _{TOTAL}	T _J = 150°C		921		1	

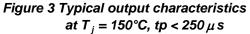
Thermal Characteristics

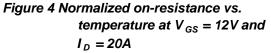
Parameter	symbol	Test Conditions	Value			Units
			Min	Тур	Max	Onits
Thermal resistance, junction-to-case	$R_{\theta JC}$			0.5	0.65	°C/W

Datasheet

Typical Performance Diagrams



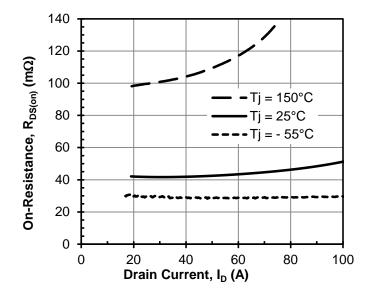


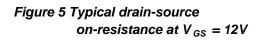


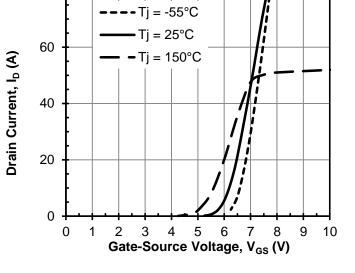
USCi the power to do more with less

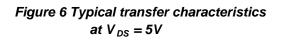
xJ SiC Series | 60m Ω - 1200V SiC Cascode | UJC1206K

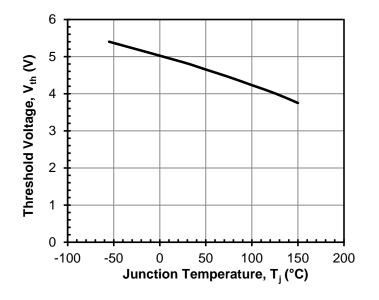
80

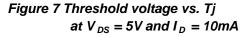












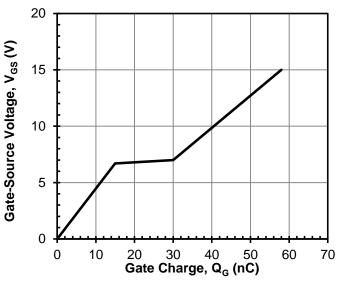
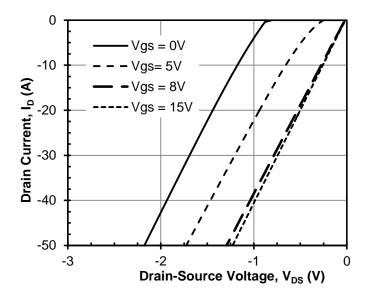
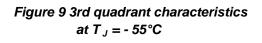
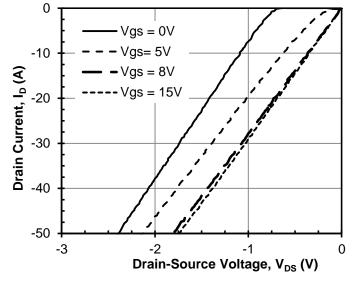


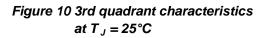
Figure 8 Typical gate charge at V_{DS} = 800V and I_D = 24.5A

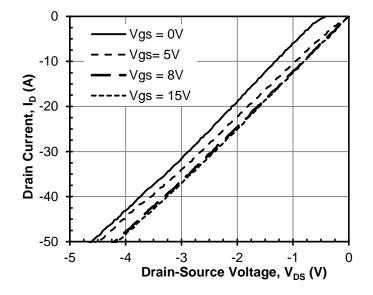


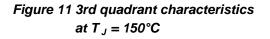


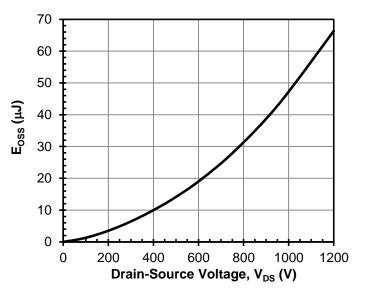


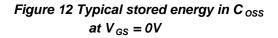




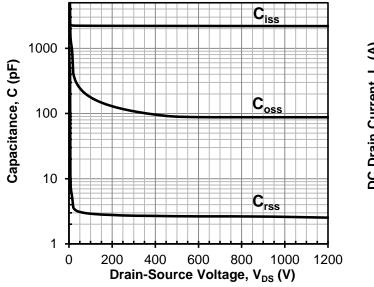


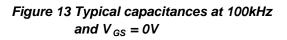












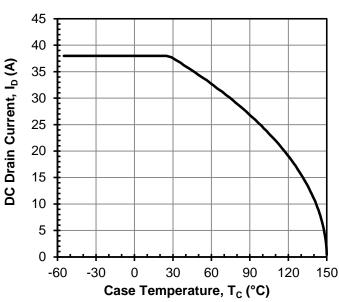


Figure 14 DC drain current derating

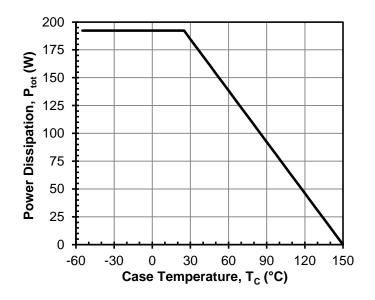


Figure 15 Total power dissipation

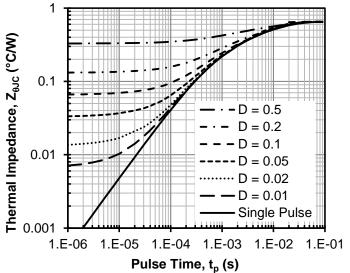
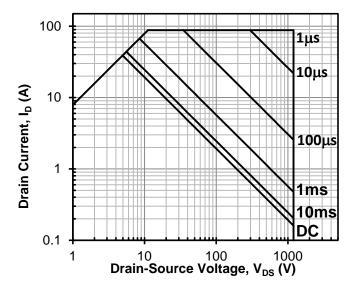
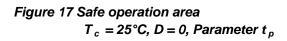


Figure 16 Maximum transient thermal impedance







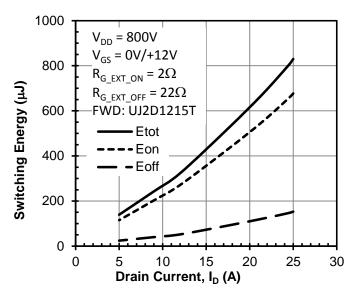
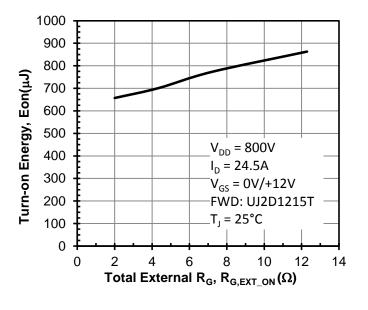
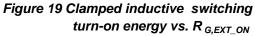


Figure 18 Clamped inductive switching energy vs. drain current at $T_J = 25^{\circ}C$





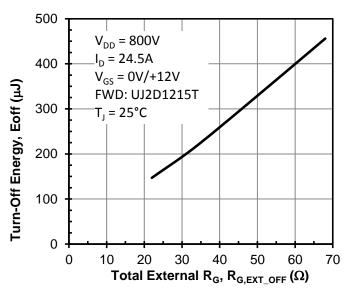


Figure 20 Clamped inductive switching turn-off energy vs. R_{G,EXT_OFF}

Datasheet

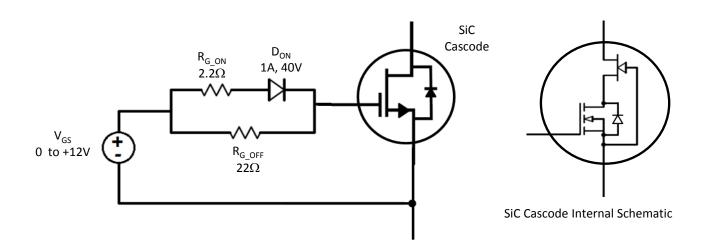


Figure 21 Recommended gate drive and internal circuit schematic of SiC cascode

Applications Information

SiC cascodes are enhancement-mode power siwtches formed by a high-voltage SiC depletion-mode JFET and a low-voltage silicon MOSFET connected in series as shown in Figure 21. 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 (Coss), gate charge (Qg), and reverse recovery charge (Qrr) 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. In particular, separate turn-on and turn-off gate resistors are recommended as shown in Figure 21. In addition, an external gate resistor is recommended when the cascode is working in the diode mode in order to achieve the optimum reverse recover performance. For more information on cascode operation, see www.unitedsic.com.

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