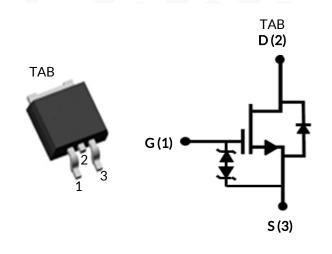


### $650V\text{-}27m\Omega\,\text{SiC}\,\text{FET}$

Rev. C, May 2023

#### DATASHEET

# UJ3C065030B3



Part Number	Package	Marking
UJ3C065030B3	D <sup>2</sup> PAK-3L	UJ3C065030B3



#### Description

This SiC FET device 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 for a true "drop-in replacement" to Si IGBTs, Si FETs, SiC MOSFETs or Si superjunction devices. Available in the D<sup>2</sup>PAK-3L package, this device exhibits ultralow gate charge and exceptional reverse recovery characteristics, making it ideal for switching inductive loads and any application requiring standard gate drive.

#### Features

- + Typical on-resistance  $R_{DS(on),typ}$  of  $27m\Omega$
- Maximum operating temperature of 175°C
- Excellent reverse recovery
- Low gate charge
- Low intrinsic capacitance
- ESD protected: HBM class 2 and CDM class C3

#### **Typical applications**

- EV charging
- PV inverters
- Switch mode power supplies
- Power factor correction modules
- Motor drives
- Induction heating





#### **Maximum Ratings**

Parameter	Symbol	<b>Test Conditions</b>	Value	Units
Drain-source voltage	V <sub>DS</sub>		650	V
Gate-source voltage	V <sub>GS</sub>	DC	-25 to +25	V
Continuous drain current <sup>1</sup>		T <sub>C</sub> = 25°C	65	А
Continuous drain current	I <sub>D</sub>	T <sub>C</sub> = 100°C	47	А
Pulsed drain current <sup>2</sup>	I <sub>DM</sub>	T <sub>C</sub> = 25°C	230	А
Single pulsed avalanche energy <sup>3</sup>	E <sub>AS</sub>	L=15mH, I <sub>AS</sub> =4A	120	mJ
Power dissipation	P <sub>tot</sub>	T <sub>C</sub> = 25°C	242	W
Maximum junction temperature	T <sub>J,max</sub>		175	°C
Operating and storage temperature	T <sub>J</sub> , T <sub>STG</sub>		-55 to 175	°C
Reflow soldering temperature	T <sub>solder</sub>	reflow MSL 1	245	°C

1. Limited by  $T_{\mbox{\tiny J,max}}$ 

2. Pulse width  $t_{p}$  limited by  $T_{J,\text{max}}$ 

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

#### **Thermal Characteristics**

Parameter	Symbol	Test Conditions		Units		
			Min	Тур	Max	Onits
Thermal resistance, junction-to-case	$R_{\theta JC}$			0.48	0.62	°C/W

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#### Electrical Characteristics (T<sub>J</sub> = +25°C unless otherwise specified)

#### **Typical Performance - Static**

Parameter	Cumhal	Test Conditions		Linte			
Parameter	Symbol	Test Conditions	Min	Тур	Max	Units	
Drain-source breakdown voltage	BV <sub>DS</sub>	V <sub>GS</sub> =0V, I <sub>D</sub> =1mA	650			V	
Total ducin lockage comment		V <sub>DS</sub> =650V, V <sub>GS</sub> =0V, T <sub>J</sub> =25°C		6	150		
Total drain leakage current	I <sub>DSS</sub>	V <sub>DS</sub> =650V, V <sub>GS</sub> =0V, T <sub>J</sub> =175°C	30			μΑ	
Total gate leakage current	I <sub>GSS</sub>	V <sub>DS</sub> =0V, T <sub>J</sub> =25°C, V <sub>GS</sub> =-20V / +20V			±20	μA	
Drain-source on-resistance	R <sub>DS(on)</sub>	V <sub>GS</sub> =12V, I <sub>D</sub> =50A, T <sub>J</sub> =25°C		27	35		
		V <sub>GS</sub> =12V, I <sub>D</sub> =50A, T <sub>J</sub> =125°C		35		mΩ	
		V <sub>GS</sub> =12V, I <sub>D</sub> =50A, T <sub>J</sub> =175°C		43			
Gate threshold voltage	V <sub>G(th)</sub>	$V_{DS}$ =5V, $I_{D}$ =10mA	4	5	6	V	
Gate resistance	R <sub>G</sub>	f=1MHz, open drain		4.5		Ω	

#### Typical Performance - Reverse Diode

Parameter	Symbol	Test Conditions		Units			
	Symbol	Test Conditions	Min	Тур	Max	Units	
Diode continuous forward current <sup>1</sup>	I <sub>S</sub>	T <sub>C</sub> =25°C			65	А	
Diode pulse current <sup>2</sup>	$I_{S,pulse}$	T <sub>C</sub> =25°C			230	А	
Forward voltage	V <sub>FSD</sub>	V <sub>GS</sub> =0V, I <sub>S</sub> =20A, T <sub>J</sub> =25°C		1.3	1.4	V	
		V <sub>GS</sub> =0V, I <sub>S</sub> =20A, T <sub>J</sub> =175°C	1.35				
Reverse recovery charge	Q <sub>rr</sub>	V <sub>R</sub> =400V, I <sub>S</sub> =50A, V <sub>GS</sub> =0V, R <sub>G_EXT</sub> =20Ω		400		nC	
Reverse recovery time	t <sub>rr</sub>	di/dt=1550A/µs, T_=150°C		33		ns	





#### Typical Performance - Dynamic

Parameter	Symbol	Test Conditions		Value		- Units	
Parameter	Symbol	Test Conditions	Min	Тур	Max	Units	
Input capacitance	C <sub>iss</sub>	- V <sub>DS</sub> =100V, V <sub>GS</sub> =0V -		1500			
Output capacitance	C <sub>oss</sub>	f=100kHz		320		pF	
Reverse transfer capacitance	C <sub>rss</sub>	1-100KHZ		2.3			
Effective output capacitance, energy related	C <sub>oss(er)</sub>	$V_{DS}=0V$ to 400V, $V_{GS}=0V$		230		pF	
Effective output capacitance, time related	C <sub>oss(tr)</sub>	V <sub>DS</sub> =0V to 400V, V <sub>GS</sub> =0V 520		520		pF	
C <sub>OSS</sub> stored energy	E <sub>oss</sub>	V <sub>DS</sub> =400V, V <sub>GS</sub> =0V		18.5		μJ	
Total gate charge	Q <sub>G</sub>	– V <sub>DS</sub> =400V, I <sub>D</sub> =40A, –		51		nC	
Gate-drain charge	$Q_{GD}$	$V_{DS} = -5V \text{ to } 15V$		11			
Gate-source charge	Q <sub>GS</sub>	$- v_{GS} - 5v_{1015}v_{-}$		19			
Turn-on delay time	t <sub>d(on)</sub>			32			
Rise time	t <sub>r</sub>	V <sub>DS</sub> =400V, I <sub>D</sub> =40A, Gate		19			
Turn-off delay time	t <sub>d(off)</sub>	Driver =-5V to +15V,		58		– ns	
Fall time	t <sub>f</sub>	Turn-on $R_{G,EXT}$ =1Ω, Turn-off $R_{G,EXT}$ =20Ω		15		-	
Turn-on energy	E <sub>ON</sub>	Inductive Load,		341		1	
Turn-off energy	E <sub>OFF</sub>	FWD: UJ3D065030TS,		180		 	
Fotal switching energy	E <sub>TOTAL</sub>	T_=150°C		521		- μJ	



#### Typical Performance Diagrams

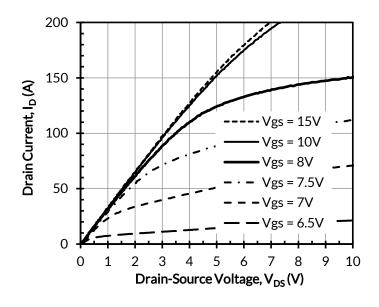


Figure 1. Typical output characteristics at T\_J = - 55°C, tp < 250 $\mu$ s

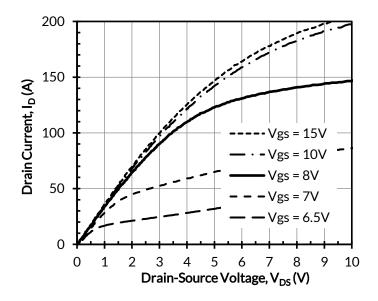


Figure 2. Typical output characteristics at T\_J = 25°C, tp < 250 $\mu$ s

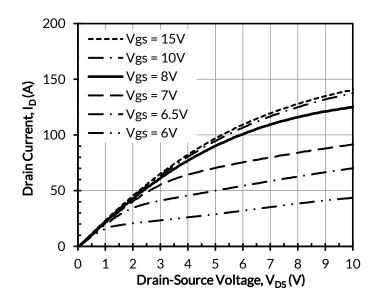


Figure 3. Typical output characteristics at T  $_{\rm J}$  = 175°C, tp < 250 $\mu s$ 

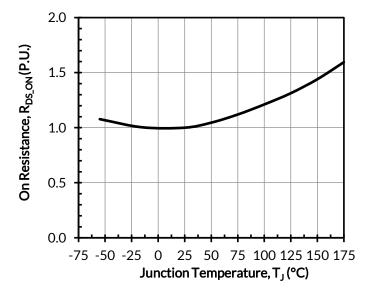


Figure 4. Normalized on-resistance vs. temperature at  $V_{GS}$  = 12V and  $I_D$  = 50A

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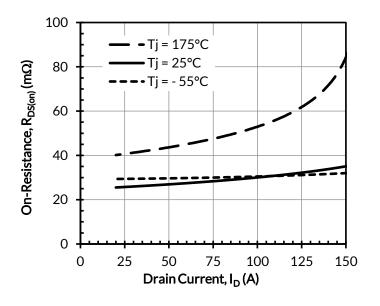


Figure 5. Typical drain-source on-resistances at  $V_{\rm GS}$  = 12V

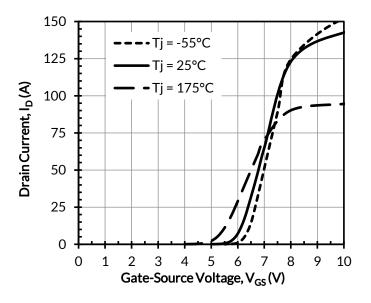


Figure 6. Typical transfer characteristics at  $V_{DS}$  = 5V

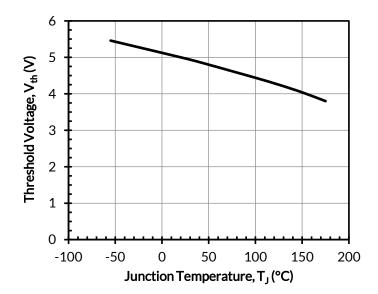


Figure 7. Threshold voltage vs. junction temperature at  $V_{\text{DS}}$  = 5V and  $I_{\text{D}}$  = 10mA

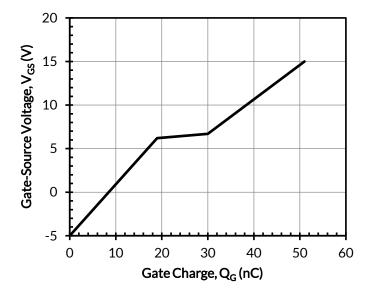


Figure 8. Typical gate charge at  $V_{\text{DS}}$  = 400V and  $I_{\text{D}}$  = 40A

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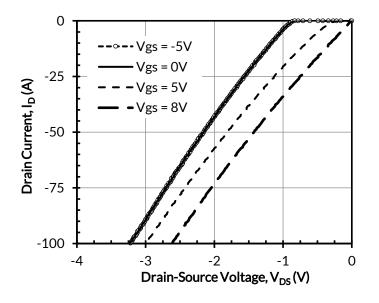


Figure 9. 3rd quadrant characteristics at  $T_J = -55^{\circ}C$ 

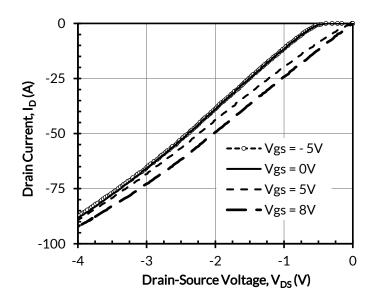


Figure 11. 3rd quadrant characteristics at T<sub>J</sub> = 175°C

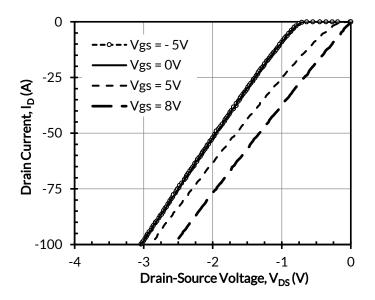


Figure 10. 3rd quadrant characteristics at T<sub>J</sub> = 25°C

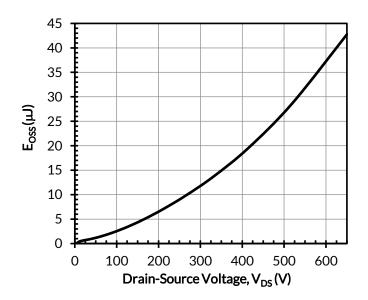


Figure 12. Typical stored energy in  $C_{OSS}$  at  $V_{GS}$  = 0V



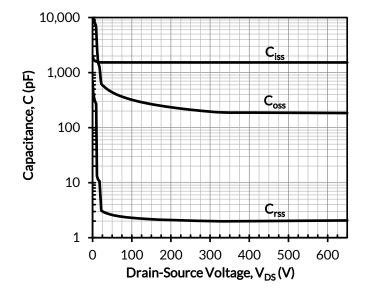


Figure 13. Typical capacitances at f = 100kHz and  $V_{\rm GS}$  = 0V

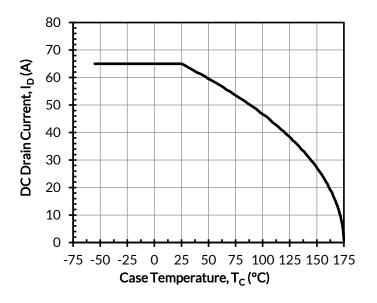


Figure 14. DC drain current derating

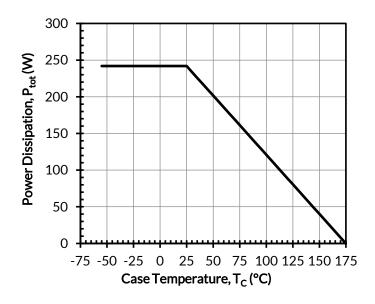


Figure 15. Total power dissipation

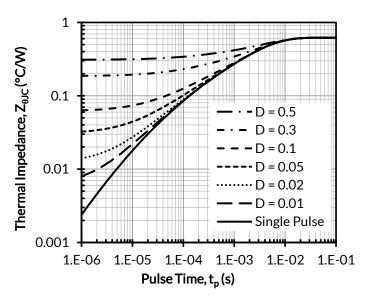


Figure 16. Maximum transient thermal impedance



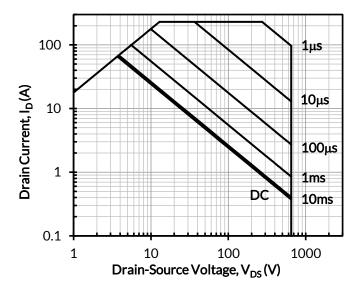


Figure 17. Safe operation area at  $T_{C}$  = 25°C, D = 0, Parameter  $t_{\rm p}$ 

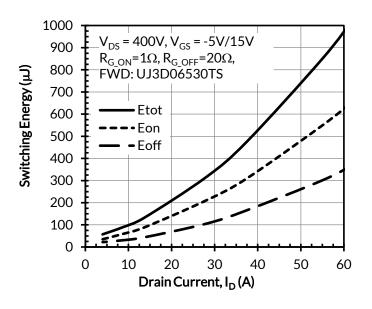


Figure 18. Clamped inductive switching energy vs. drain current at  $T_J = 150^{\circ}C$ 

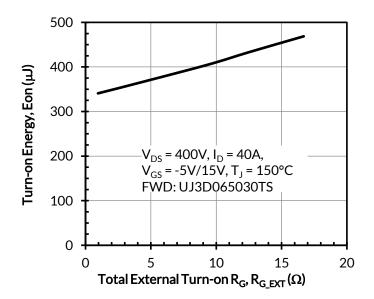


Figure 19. Clamped inductive switching turn-on energy vs.  $R_{G,\text{EXT\_ON}}$ 

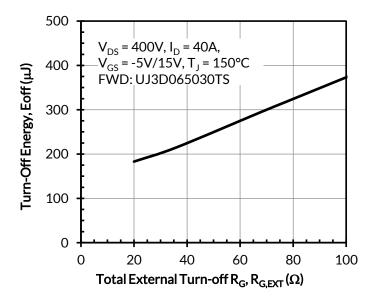


Figure 20. Clamped inductive switching turn-off energy vs.  $R_{G,EXT_OFF}$ 

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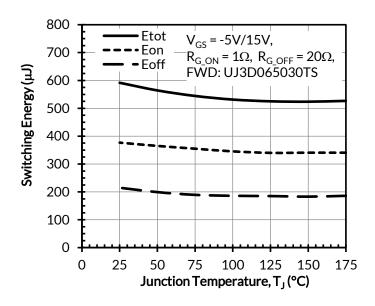


Figure 21. Clamped inductive switching energy vs. junction temperature at  $V_{DS}$  =400V and  $I_D$  = 40A

#### **Applications Information**

SiC FETs 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 FETs 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 FET is working in the diode mode in order to achieve the optimum reverse recovery performance. For more information on SiC FET operation, see www.unitedsic.com.

A snubber circuit with a small  $R_{(G)}$ , or gate resistor, provides better EMI suppression with higher efficiency compared to using a high  $R_{(G)}$  value. There is no extra gate delay time when using the snubber circuitry, and a small  $R_{(G)}$  will better control both the turn-off  $V_{(DS)}$  peak spike and ringing duration, while a high  $R_{(G)}$  will damp the peak spike but result in a longer delay time. In addition, the total switching loss when using a snubber circuit is less than using high  $R_{(G)}$ , while greatly reducing  $E_{(OFF)}$  from mid-to-full load range with only a small increase in  $E_{(ON)}$ . Efficiency will therefore improve with higher load current. For more information on how a snubber circuit will improve overall system performance, visit the UnitedSiC website at www.unitedsic.com





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