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**Silicon Carbide N-Channel Power MOSFET Die**

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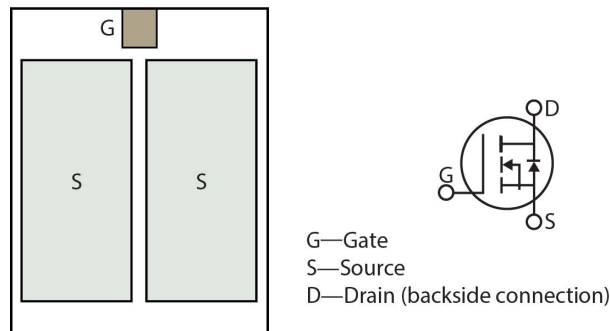
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**Product Overview**

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The silicon carbide (SiC) power MOSFET product line from Microchip increases the performance over silicon MOSFET and silicon IGBT solutions while lowering the total cost of ownership for high-voltage applications. The MSC025SMA330D/S device is a 3300 V, 25 mΩ SiC MOSFET.

**Features**

The following are key features of the MSC025SMA330D/S device:

- Low capacitances and low gate charge
- Fast switching speed due to low internal gate resistance (ESR)
- Stable operation at high junction temperature,  $T_{J(max)} = 150\text{ }^{\circ}\text{C}$
- Fast and reliable body diode
- Superior avalanche ruggedness
- RoHS compliant

**Benefits**

The following are benefits of the MSC025SMA330D/S device:

- High efficiency to enable lighter, more compact system
- Simple to drive and easy to parallel
- Improved thermal capabilities and lower switching losses
- Eliminates the need for external freewheeling diode
- Lower system cost of ownership

**Applications**

The MSC025SMA330D/S device is designed for the following applications:

- PV inverter, converter, and industrial motor drives
- Smart grid transmission and distribution
- Induction heating and welding
- H/EV powertrain and EV charger
- Power supply and distribution

## 1. Device Specifications

This section shows the specifications of the MSC025SMA330D/S device.

### 1.1 Absolute Maximum Ratings

The following table shows the absolute maximum ratings of the MSC025SMA330D/S device.

**Table 1-1. Absolute Maximum Ratings**

Symbol	Parameter	Ratings	Unit
$V_{DSS}$	Drain source voltage	3300	V
$I_D$	Continuous drain current at $T_C = 25\text{ }^\circ\text{C}^1$	104	A
	Continuous drain current at $T_C = 100\text{ }^\circ\text{C}^1$	66	
$I_{DM}$	Pulsed drain current <sup>2</sup>	240	
$V_{GS}$	Gate-source voltage	23 to -10	V

**Notes:**

- $I_D$  values for  $< 0.38\text{ }^\circ\text{C/W}$  die to heatsink thermal resistance based on TO-247 package.
- Repetitive rating; pulse width and case temperature limited by maximum junction temperature.

The following table shows the thermal and mechanical characteristics of the MSC025SMA330D/S device.

**Table 1-2. Thermal and Mechanical Characteristics**

Symbol	Characteristic/Test Conditions	Min	Typ	Max	Unit
$T_J$	Operating junction temperature	-55		150	$^\circ\text{C}$
$T_{STG}$	Storage temperature	-55		150	$^\circ\text{C}$
$T_{proc}$	Assembly soldering temperature (10 minutes maximum)			325	$^\circ\text{C}$

Recommended storage: The die should be stored (as shipped) in dry nitrogen with an ambient temperature of  $25\text{ }^\circ\text{C}$ . ESD practices should comply with JESD-625.

### 1.2 Electrical Performance

The following table shows the static characteristics of the MSC025SMA330D/S device.  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

**Table 1-3. Static Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}, I_D = 100\text{ }\mu\text{A}$	3300			V
$R_{DS(on)}$	Drain-source on resistance <sup>1,2</sup>	$V_{GS} = 20\text{ V}, I_D = 40\text{ A}$		25	31	m $\Omega$
$V_{GS(th)}$	Gate-source threshold voltage	$V_{GS} = V_{DS}, I_D = 7\text{ mA}$	1.9	2.7		V
$I_{DSS}$	Zero gate voltage drain current	$V_{DS} = 3300\text{ V}, V_{GS} = 0\text{ V}$			100	$\mu\text{A}$
		$V_{DS} = 3300\text{ V}, V_{GS} = 0\text{ V}, T_J = 125\text{ }^\circ\text{C}$			500	
$I_{GSS}$	Gate-source leakage current	$V_{GS} = 20\text{ V}/-10\text{ V}$			$\pm 100$	nA

### Notes:

1. Pulse test: pulse width < 380  $\mu$ s, duty cycle < 2%.
2. Based on TO-247 packaged die measurements.

The following table shows the dynamic characteristics of the MSC025SMA330D/S device.  $T_J = 25^\circ\text{C}$  unless otherwise specified. The dynamic characteristics are based on TO-247 packaged die measurements.

**Table 1-4. Dynamic Characteristics**

Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$ , $V_{DD} = 2640\text{ V}$ , $V_{AC} = 25\text{ mV}$ , $f = 200\text{ kHz}$		8720		pF
$C_{rss}$	Reverse transfer capacitance			11		
$C_{oss}$	Output capacitance			194		
$Q_g$	Total gate charge	$V_{GS} = -5\text{ V}/20\text{ V}$ , $V_{DD} = 2640\text{ V}$ , $I_D = 70\text{ A}$		410		nC
$Q_{gs}$	Gate-source charge			138		
$Q_{gd}$	Gate-drain charge			133		
ESR	Gate equivalent series resistance	$f = 1\text{ MHz}$ , 25 mV, drain short		0.4		$\Omega$
SCWT	Short circuit withstand time	$V_{DS} = 2640\text{ V}$ , $V_{GS} = 20\text{ V}$		1.3		$\mu$ s
		$V_{DS} = 1650\text{ V}$ , $V_{GS} = 20\text{ V}$		6		

The following table shows the body diode characteristics of the MSC025SMA330D/S device.  $T_J = 25^\circ\text{C}$  unless otherwise specified. The body diode characteristics are based on TO-247 packaged die measurements.

**Table 1-5. Body Diode Characteristics**

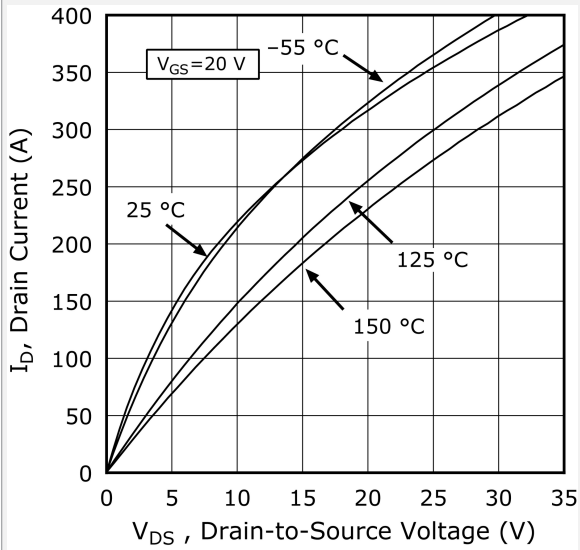
Symbol	Characteristic	Test Conditions	Min	Typ	Max	Unit
$V_{SD}$	Diode forward voltage	$I_{SD} = 40\text{ A}$ , $V_{GS} = 0\text{ V}$		3.55		V
		$I_{SD} = 40\text{ A}$ , $V_{GS} = -5\text{ V}$		3.65		
$t_{rr}$	Reverse recovery time	$I_{SD} = 100\text{ A}$ , $V_{GS} = -5\text{ V}$ , $V_{DD} = 2310\text{ V}$ , $di/dt = -15500\text{ A}/\mu\text{s}$ , Drive $R_g = 4.0\ \Omega$		35		ns
$Q_{rr}$	Reverse recovery charge			4400		nC
$I_{RRM}$	Reverse recovery current				210	

**Note:** Based on scaled measurements,  $di/dt$  and  $I_{RRM}$  will be lower in typical applications.

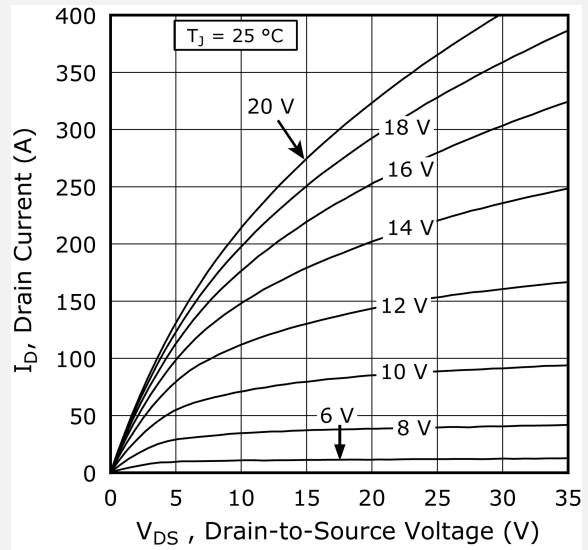
## 1.3 Typical Performance Curves

This section shows the typical performance curves of the MSC025SMA330D/S device. The performance curves are based on TO-247 packaged die measurements.

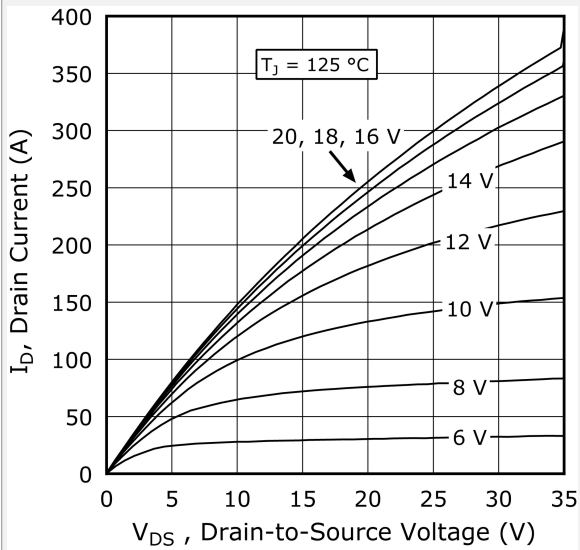
**Figure 1-1. Drain Current vs.  $V_{DS}$  at  $T_J$**



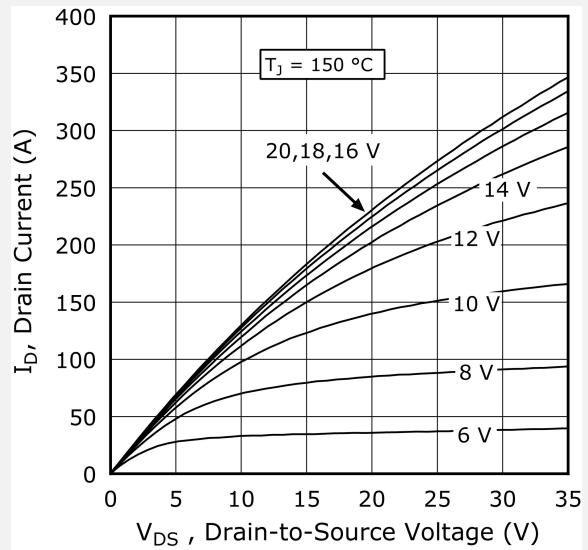
**Figure 1-2. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



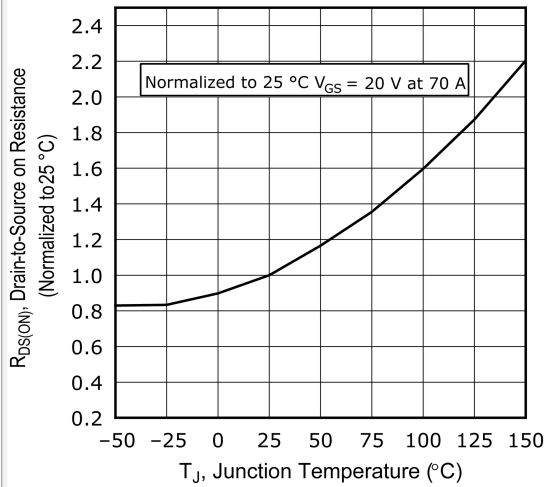
**Figure 1-3. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



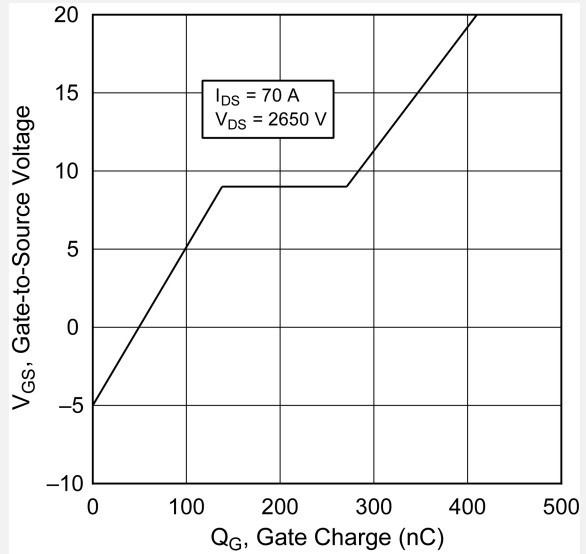
**Figure 1-4. Drain Current vs.  $V_{DS}$  at  $V_{GS}$**



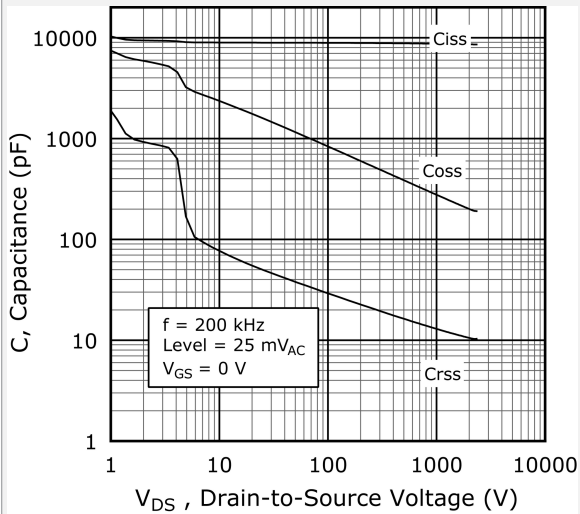
**Figure 1-5.  $R_{DS(on)}$  vs. Junction Temperature**



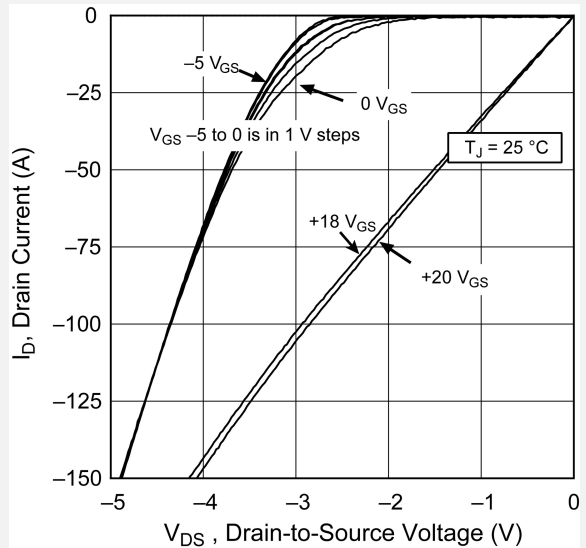
**Figure 1-6. Gate Charge Characteristics**



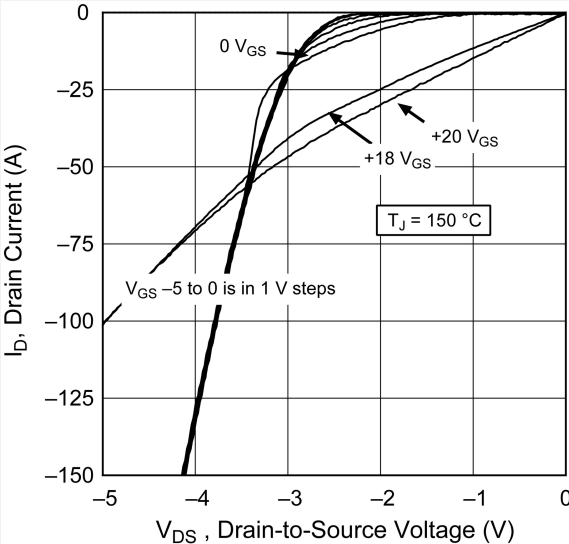
**Figure 1-7. Capacitance vs. Drain-to-Source Voltage**



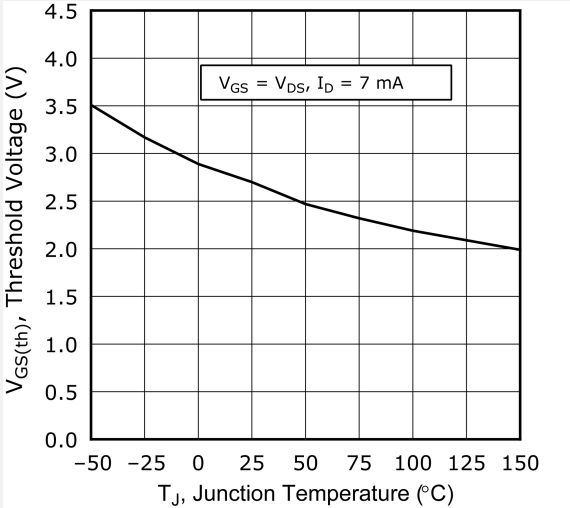
**Figure 1-8.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction**



**Figure 1-9.  $I_D$  vs.  $V_{DS}$  3<sup>rd</sup> Quadrant Conduction**



**Figure 1-10. Threshold Voltage vs. Junction Temp.**



## **2. Die Specification**

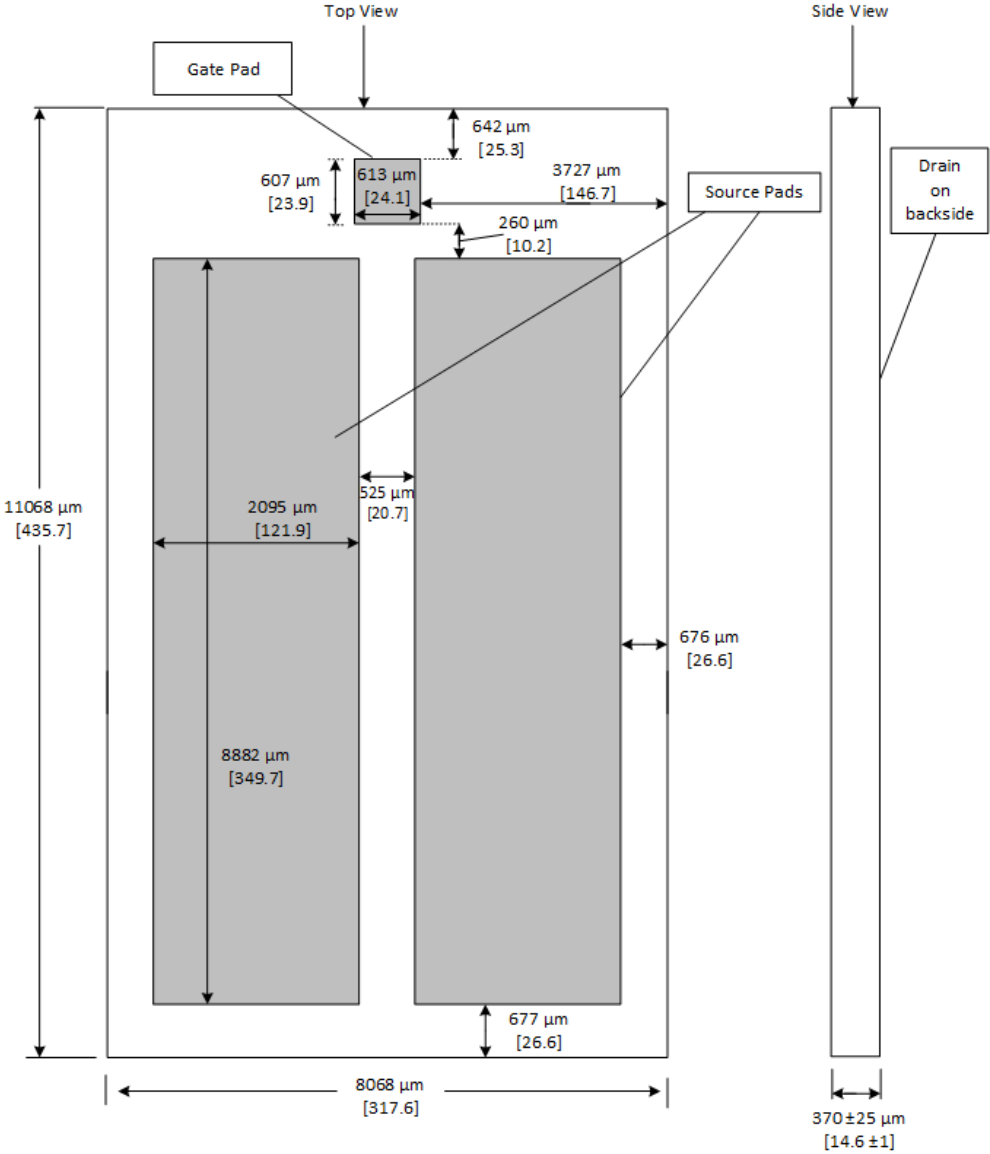
This section shows the die specification of the MSC025SMA330D/S device.

### **2.1 Die Layout**

The Microchip SiC MOSFET die are designed such that all source pads should evenly distribute the package current. The dimensions in this drawing are the nominal dimensions including the scribe street. The final die dimensions are determined by the scribe frame at each fabrication location and the dicing process at each assembly location.

The dimensions in the figure below are in  $\mu\text{m}$  and [mils].

**Figure 2-1. Die Outline Drawing**



**Die Layout**

Description	Thickness	Component
Top metal	5.0 μm	Al/Cu
Backside metal	1.0 μm	Ag



### 3. **Revision History**

**Table 3-1. Revision History**

<b>Revision</b>	<b>Date</b>	<b>Description</b>
A	11/2021	Document created.

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