

## CoolSiC™

### 400V CoolSiC™ G2 MOSFET

#### Features

- Ideal for high frequency switching and synchronous rectification
- Commutation robust fast body diode with low  $Q_{fr}$
- Low  $R_{DS(on)}$  dependency on temperature
- Benchmark gate threshold voltage,  $V_{GS(th)} = 4.5\text{ V}$
- Recommended gate driving voltage 0 V to 18 V
- .XT interconnection technology for best-in-class thermal performance
- 100% avalanche tested

#### Potential applications

- SMPS
- Solar PV inverters
- Energy storage, UPS and battery formation
- Class-D audio
- Motor drives

#### Product validation

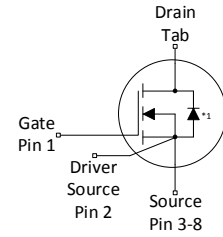
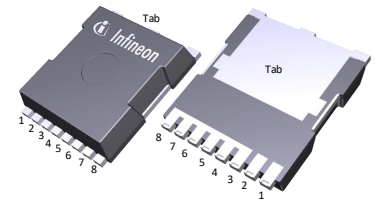
Fully qualified according to JEDEC for Industrial Applications

**Table 1 Key Performance Parameters**

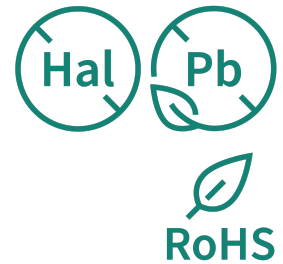
Parameter	Value	Unit
$V_{DS}$	400	V
$R_{DS(on),typ}$	25.4	mΩ
$I_D$	68	A
$Q_{oss}$	59	nC
$E_{oss}$	4.2	μJ
$Q_G$	36	nC

Type/Ordering Code	Package	Marking	Related Links
IMT40R025M2H	PG-HSOF-8	40R025M2	-

TOLL



\*1: Internal body diode



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## 1 Maximum ratings

at  $T_A=25\text{ °C}$ , unless otherwise specified

**Table 2 Maximum ratings**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Continuous drain current <sup>1)</sup>	$I_D$	-	-	68 48 9	A	$V_{GS}=18\text{ V}$ , $T_C=25\text{ °C}$ $V_{GS}=18\text{ V}$ , $T_C=100\text{ °C}$ $V_{GS}=18\text{ V}$ , $T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}^2)$
Pulsed drain current <sup>3)</sup>	$I_{D,pulse}$	-	-	204	A	$T_C=25\text{ °C}$
Avalanche energy, single pulse <sup>4)</sup>	$E_{AS}$	-	-	93	mJ	$I_D=15.7\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Avalanche energy, repetitive	$E_{AR}$	-	-	0.47	mJ	$I_D=15.7\text{ A}$ , $R_{GS}=25\text{ }\Omega$
Gate source voltage (static)	$V_{GS,DC}$	-7	-	23	V	-
Gate source voltage (transient)	$V_{GS,AC}$	-10	-	25	V	$t_{pulse} \leq 500\text{ ns}$ , duty cycle $\leq 1\%$
Power dissipation	$P_{tot}$	-	-	214 3.8	W	$T_C=25\text{ °C}$ $T_A=25\text{ °C}$ , $R_{THJA}=40\text{ °C/W}^2)$
Storage temperature	$T_{stg}$	-55	-	150	°C	-
Operating junction temperature	$T_j$	-55	-	175	°C	-

<sup>1)</sup> Rating refers to the product only with datasheet specified absolute maximum values, maintaining case temperature at 25°C. For higher case temperature please refer to Diagram 2. De-rating will be required based on the actual environmental conditions.

<sup>2)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 µm thick) copper area for drain connection. PCB is vertical in still air.

<sup>3)</sup> See Diagram 3 for more detailed information.

<sup>4)</sup> See Diagram 19 for more detailed information.

## 2 Thermal characteristics

**Table 3 Thermal characteristics**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	-	0.7	°C/W	-
Thermal resistance, junction - ambient, 6 cm <sup>2</sup> cooling area <sup>5)</sup>	$R_{thJA}$	-	-	40	°C/W	-

<sup>5)</sup> Device on 40 mm x 40 mm x 1.5 mm epoxy PCB FR4 with 6 cm<sup>2</sup> (one layer, 70 μm thick) copper area for drain connection. PCB is vertical in still air.

## 3 Operating range

**Table 4 Operating range**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Recommended turn-on voltage	$V_{GS(on)}$	-	18	-	V	-
Recommended turn-off voltage	$V_{GS(off)}$	-	0	-	V	-

## 4 Electrical characteristics

at  $T_j=25\text{ °C}$ , unless otherwise specified

**Table 5 Static characteristics**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	400	-	-	V	$V_{GS}=0\text{ V}$ , $I_D=0.56\text{ mA}$
Gate threshold voltage <sup>6)</sup>	$V_{GS(th)}$	3.5	4.5	5.6	V	$V_{DS}=V_{GS}$ , $I_D=5.6\text{ mA}$
Zero gate voltage drain current	$I_{DSS}$	-	1 2	75 -	$\mu\text{A}$	$V_{DS}=400\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=25\text{ °C}$ $V_{DS}=400\text{ V}$ , $V_{GS}=0\text{ V}$ , $T_j=175\text{ °C}$
Gate-source leakage current	$I_{GSS}$	-	1	100	nA	$V_{GS}=20\text{ V}$ , $V_{DS}=0\text{ V}$
Drain-source on-state resistance	$R_{DS(on)}$	-	25.4 36.5 31.1	32.1 - -	m $\Omega$	$V_{GS}=18\text{ V}$ , $I_D=15.7\text{ A}$ , $T_j=25\text{ °C}$ $V_{GS}=18\text{ V}$ , $I_D=15.7\text{ A}$ , $T_j=175\text{ °C}$ $V_{GS}=15\text{ V}$ , $I_D=15.7\text{ A}$ , $T_j=25\text{ °C}$
Gate resistance	$R_G$	-	3.3	5.0	$\Omega$	-

<sup>6)</sup> Tested after 1ms pulse at  $V_{GS} = +20\text{V}$ .

**Table 6 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	1200	1690	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=200\text{ V}$ , $f=1\text{ MHz}$
Output capacitance	$C_{oss}$	-	180	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=200\text{ V}$ , $f=1\text{ MHz}$
Reverse transfer capacitance	$C_{rss}$	-	14	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=200\text{ V}$ , $f=1\text{ MHz}$
Effective output capacitance, energy related <sup>7)</sup>	$C_{o(er)}$	-	211	-	pF	$V_{GS}=0\text{ V}$ , $V_{DS}=0\dots200\text{ V}$
Effective output capacitance, time related <sup>8)</sup>	$C_{o(tr)}$	-	290	-	pF	$I_D=\text{constant}$ , $V_{GS}=0\text{ V}$ , $V_{DS}=0\dots200\text{ V}$
Turn-on delay time <sup>9)</sup>	$t_{d(on)}$	-	12.5	-	ns	$V_{DD}=200\text{ V}$ , $V_{GS}=0\dots18\text{ V}$ , $I_D=15.7\text{ A}$ , $R_{G,ext}=1.8\text{ }\Omega$
Rise time <sup>9)</sup>	$t_r$	-	11.9	-	ns	$V_{DD}=200\text{ V}$ , $V_{GS}=0\dots18\text{ V}$ , $I_D=15.7\text{ A}$ , $R_{G,ext}=1.8\text{ }\Omega$
Turn-off delay time <sup>9)</sup>	$t_{d(off)}$	-	19.9	-	ns	$V_{DD}=200\text{ V}$ , $V_{GS}=18\dots0\text{ V}$ , $I_D=15.7\text{ A}$ , $R_{G,ext}=1.8\text{ }\Omega$
Fall time <sup>9)</sup>	$t_f$	-	7.9	-	ns	$V_{DD}=200\text{ V}$ , $V_{GS}=18\dots0\text{ V}$ , $I_D=15.7\text{ A}$ , $R_{G,ext}=1.8\text{ }\Omega$

<sup>7)</sup>  $C_{o(er)}$  is a fixed capacitance that gives the same stored energy as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 200 V.

<sup>8)</sup>  $C_{o(tr)}$  is a fixed capacitance that gives the same charging time as  $C_{oss}$  while  $V_{DS}$  is rising from 0 to 200 V.

<sup>9)</sup> Refer to Table 9 for test setup.

**Table 7 Gate Charge Characteristics** <sup>10)</sup>

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	9.8	-	nC	$V_{DD}=200\text{ V}$ , $I_D=15.7\text{ A}$ , $V_{GS}=0\text{ to }18\text{ V}$
Gate to drain charge	$Q_{gd}$	-	7.5	-	nC	$V_{DD}=200\text{ V}$ , $I_D=15.7\text{ A}$ , $V_{GS}=0\text{ to }18\text{ V}$
Gate charge total	$Q_g$	-	36	-	nC	$V_{DD}=200\text{ V}$ , $I_D=15.7\text{ A}$ , $V_{GS}=0\text{ to }18\text{ V}$
Gate charge total, sync. FET	$Q_{g(sync)}$	-	34	-	nC	$V_{DS}=0.1\text{ V}$ , $V_{GS}=0\text{ to }18\text{ V}$
Output charge	$Q_{oss}$	-	59	-	nC	$V_{DS}=200\text{ V}$ , $V_{GS}=0\text{ V}$
Output Energy	$E_{oss}$	-	4.2	-	μJ	$V_{DS}=200\text{ V}$ , $V_{GS}=0\text{ V}$

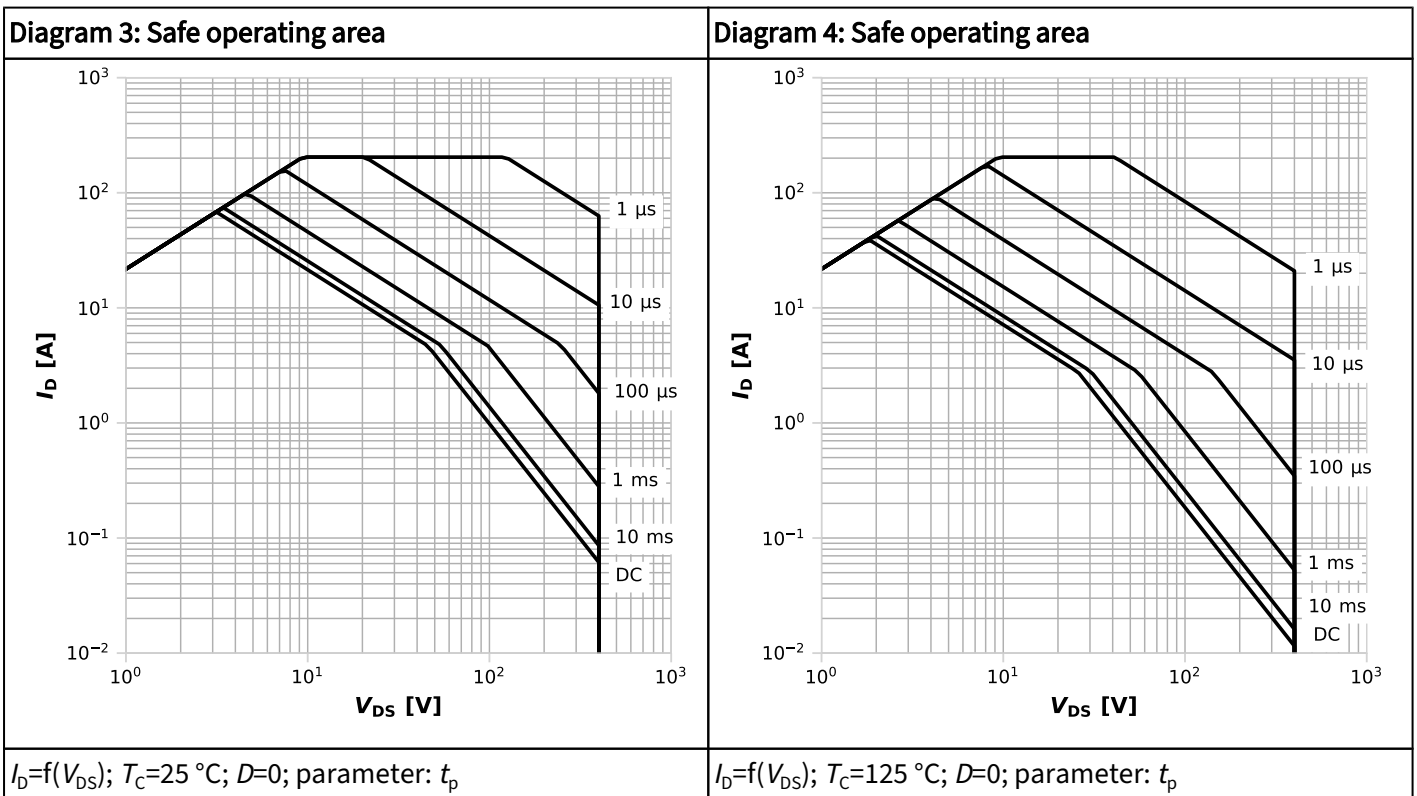
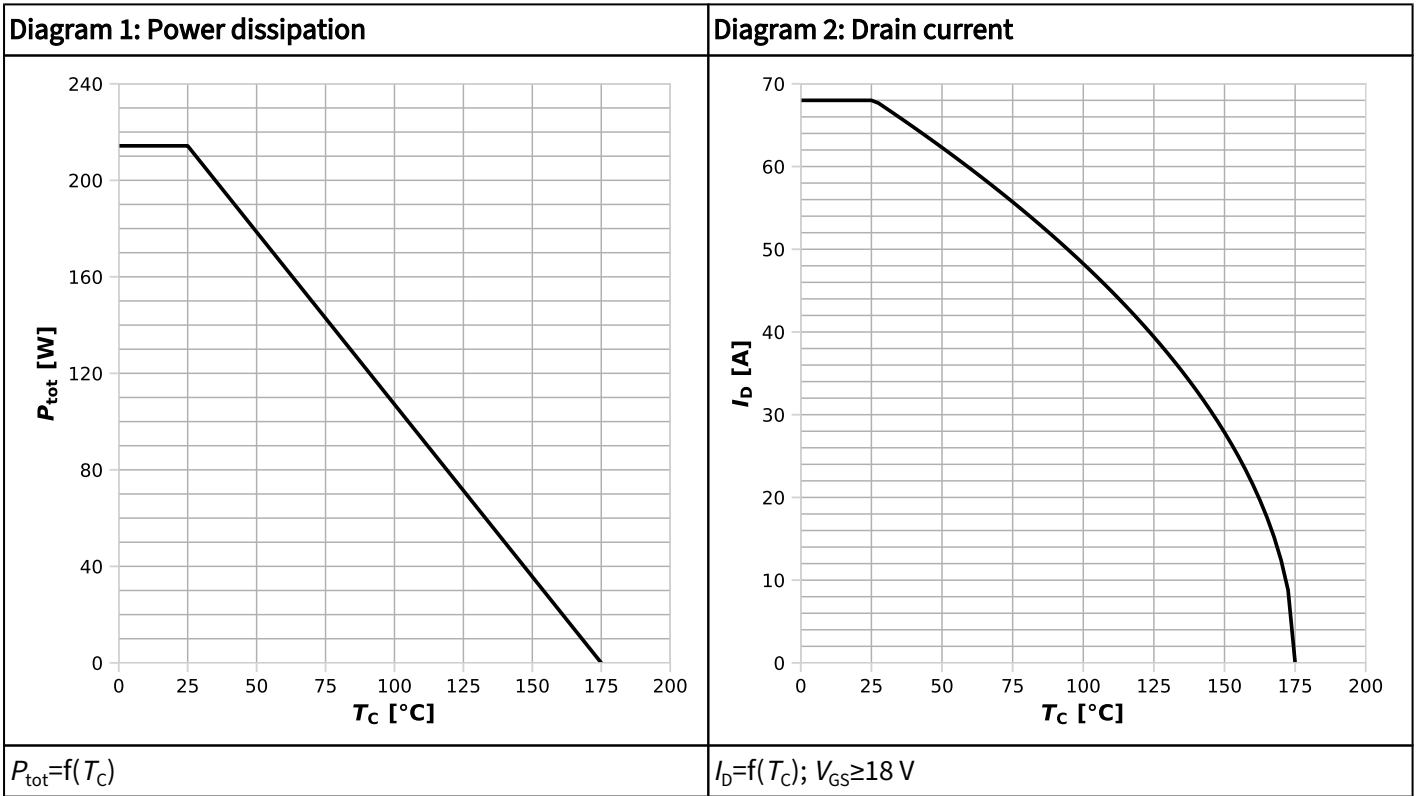
<sup>10)</sup> As per JEP192, Guidelines for Gate Charge ( $Q_g$ ) Test Method for SiC MOSFET.

**Table 8 Reverse diode characteristics**

Parameter	Symbol	Values			Unit	Note/ Test Condition
		Min.	Typ.	Max.		
Diode continuous forward current	$I_S$	-	-	32	A	$T_c=25\text{ °C}$
Diode pulse current	$I_{S,pulse}$	-	-	204	A	$T_c=25\text{ °C}$ , $t_{pulse} \leq 250\text{ ns}$
Diode forward voltage	$V_{SD}$	-	3.5	4.3	V	$V_{GS}=0\text{ V}$ , $I_S=15.7\text{ A}$ , $T_j=25\text{ °C}$
MOSFET forward recovery time	$t_{fr}$	-	13.6 8.9	-	ns	$V_R=200\text{ V}$ , $I_S=15.7\text{ A}$ , $di_S/dt=1000\text{ A}/\mu\text{s}$ $V_R=200\text{ V}$ , $I_S=15.7\text{ A}$ , $di_S/dt=4000\text{ A}/\mu\text{s}$
MOSFET forward recovery charge <sup>11)</sup>	$Q_{fr}$	-	55 116	-	nC	$V_R=200\text{ V}$ , $I_S=15.7\text{ A}$ , $di_S/dt=1000\text{ A}/\mu\text{s}$ $V_R=200\text{ V}$ , $I_S=15.7\text{ A}$ , $di_S/dt=4000\text{ A}/\mu\text{s}$

<sup>11)</sup>  $Q_{fr}$  includes  $Q_{oss}$ . Refer to Table 10 for test setup.

## 5 Electrical characteristics diagrams



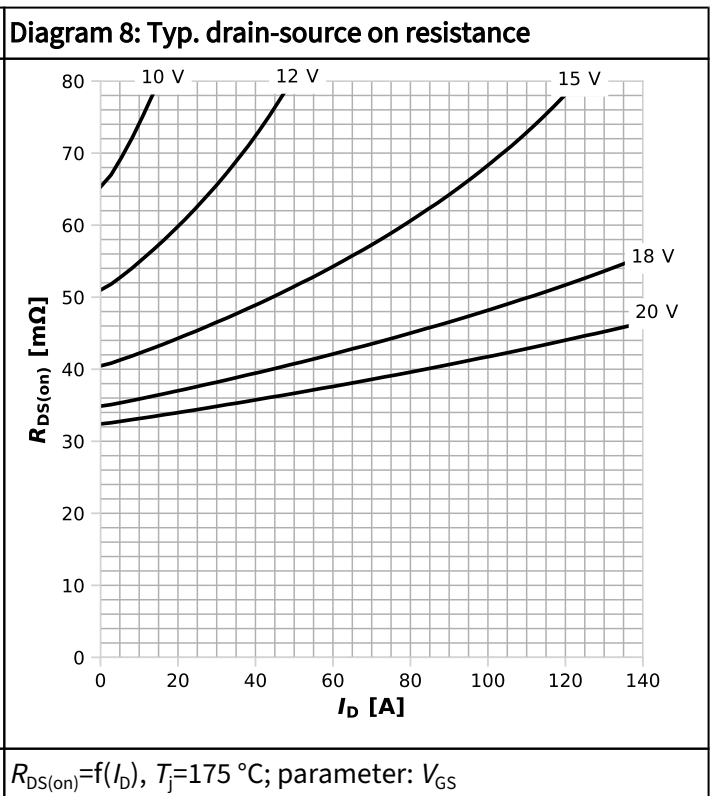
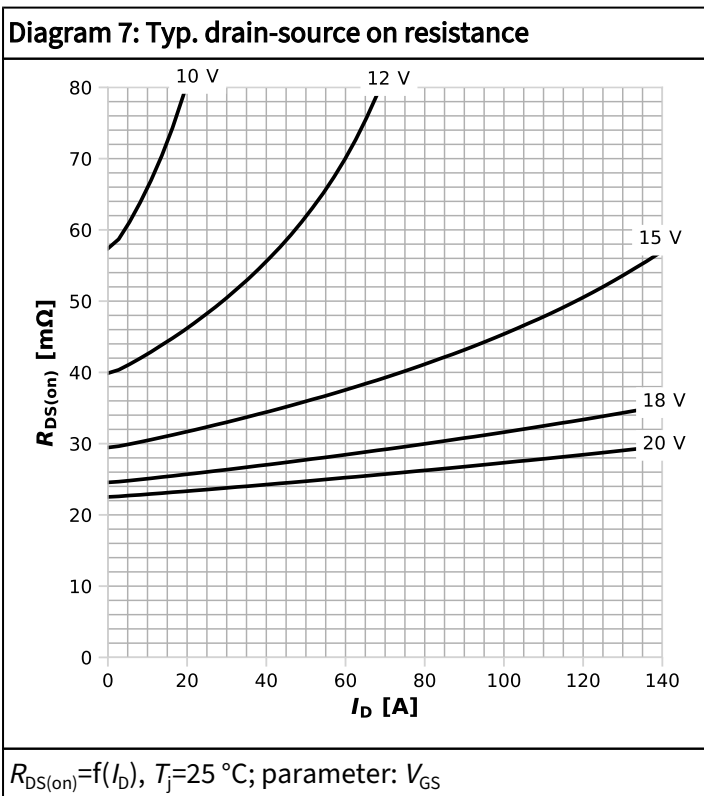
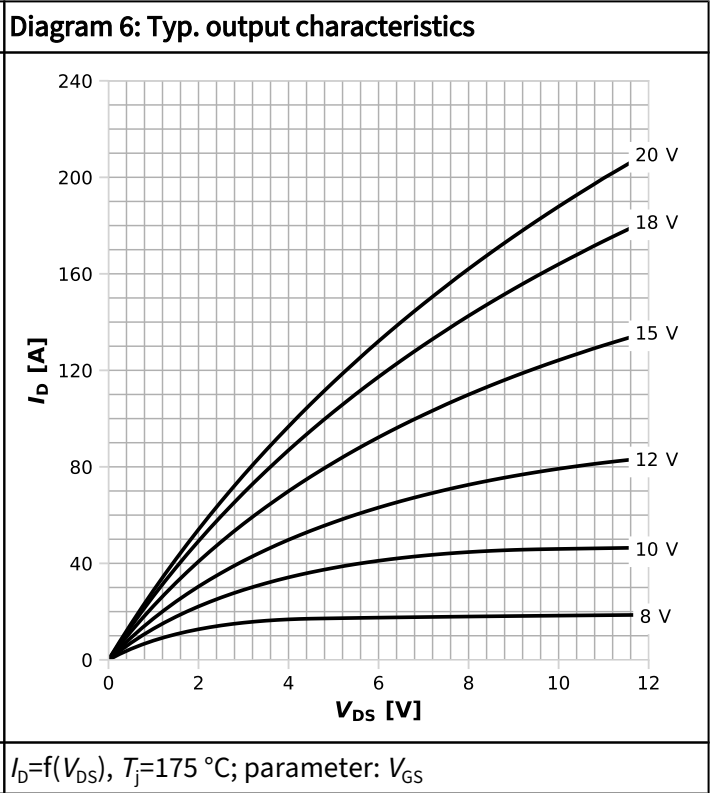
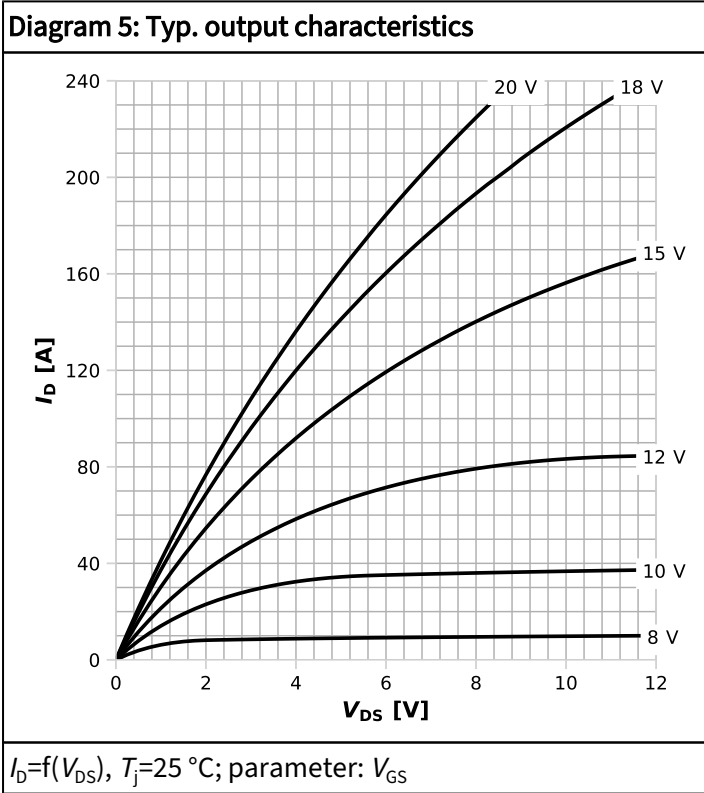
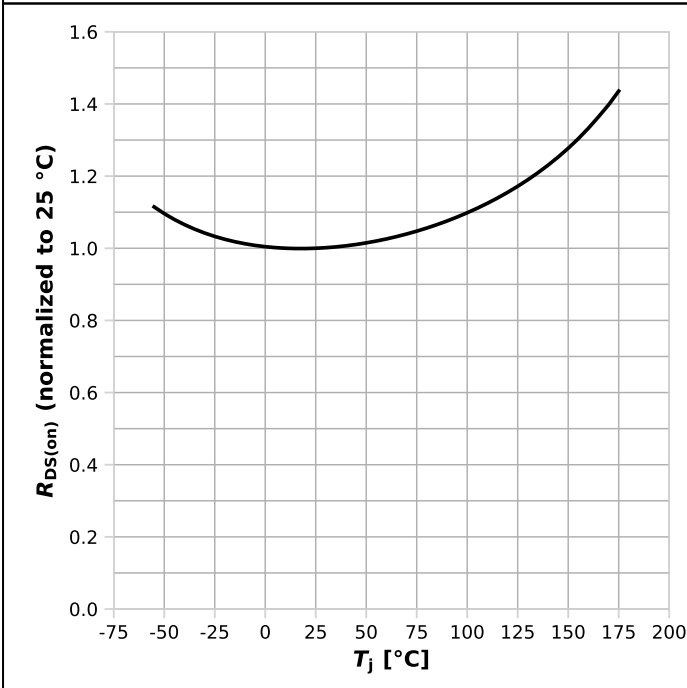


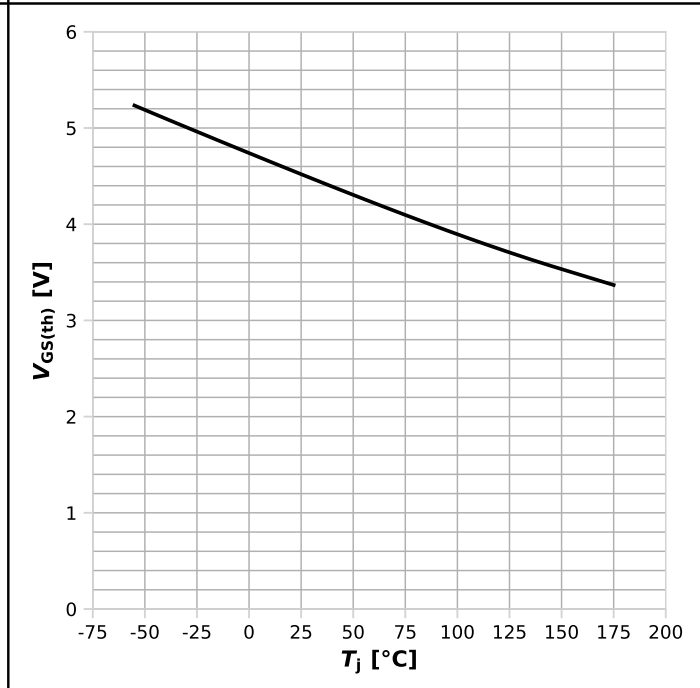


Diagram 9: Normalized drain-source on resistance



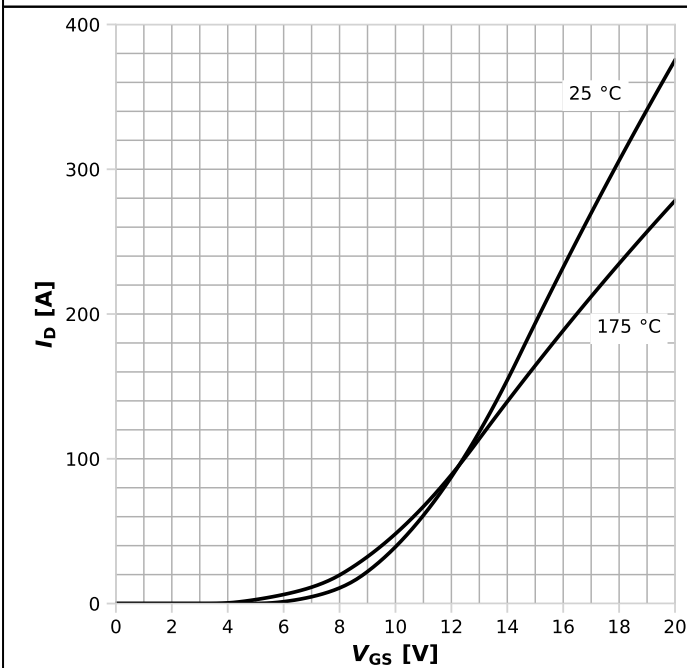
$$R_{DS(on)} = f(T_j), I_D = 15.7 \text{ A}, V_{GS} = 18 \text{ V}$$

Diagram 10: Typ. gate threshold voltage



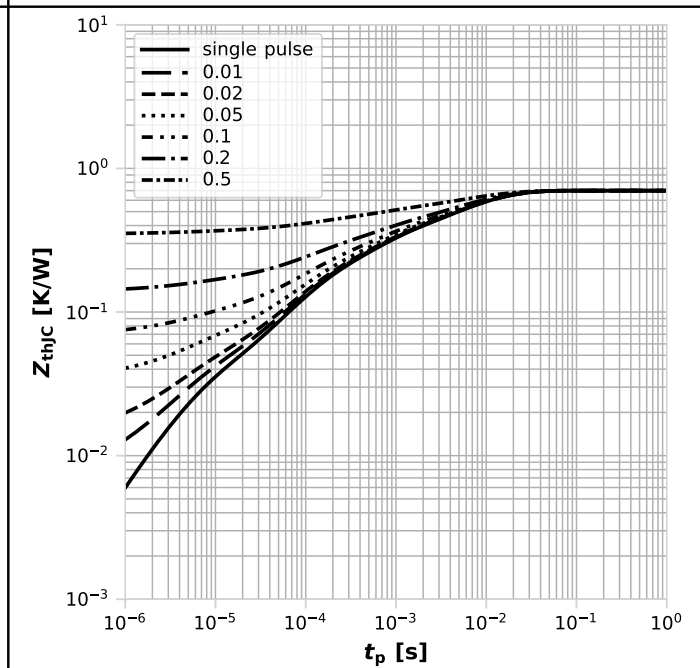
$$V_{GS(th)} = f(T_j), V_{GS} = V_{DS}, I_D = 5.6 \text{ mA}$$

Diagram 11: Typ. transfer characteristics



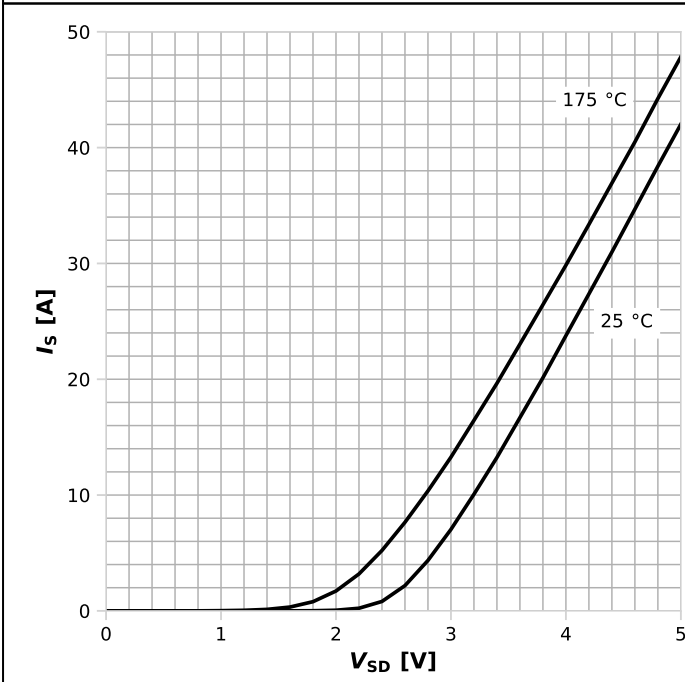
$$I_D = f(V_{GS}), |V_{DS}| > 2|I_D|R_{DS(on)max}; \text{ parameter: } T_j$$

Diagram 12: Max. transient thermal impedance



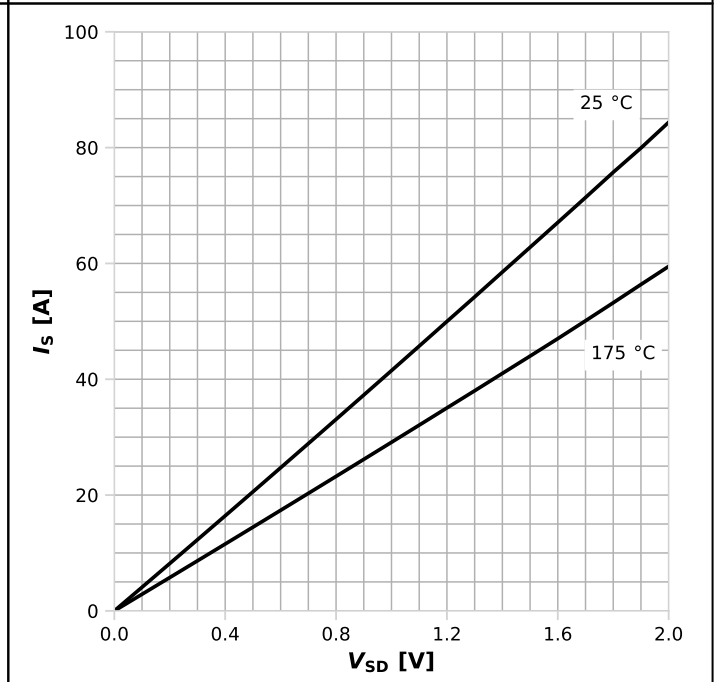
$$Z_{thJC} = f(t_p); \text{ parameter: } D = t_p / T$$

**Diagram 13: Reverse output characteristics**



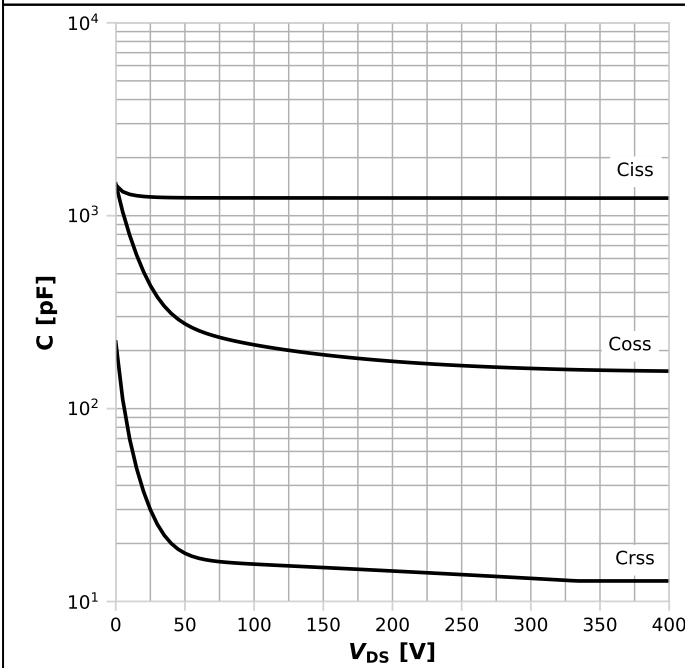
$I_F=f(V_{SD}), V_{GS}=0\text{ V}; \text{parameter: } T_j$

**Diagram 14: Reverse output characteristics**



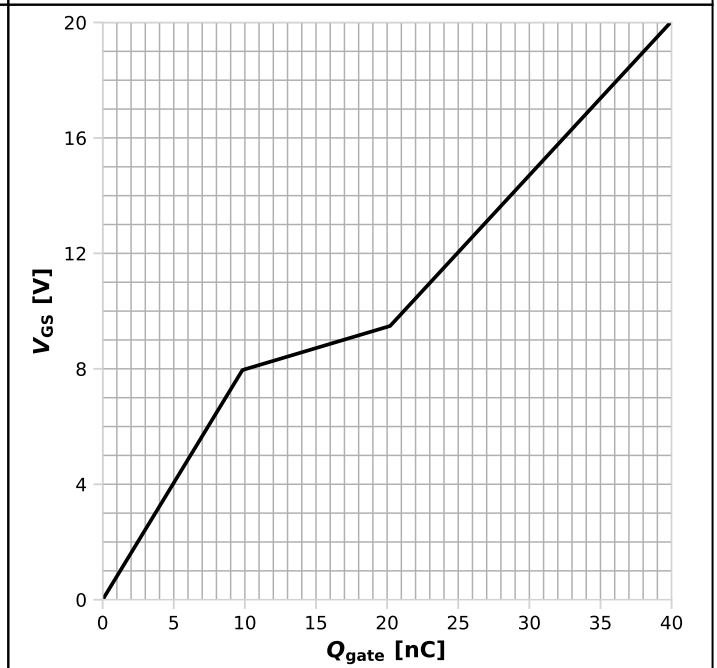
$I_F=f(V_{SD}), V_{GS}=18\text{ V}; \text{parameter: } T_j$

**Diagram 15: Typ. capacitances**



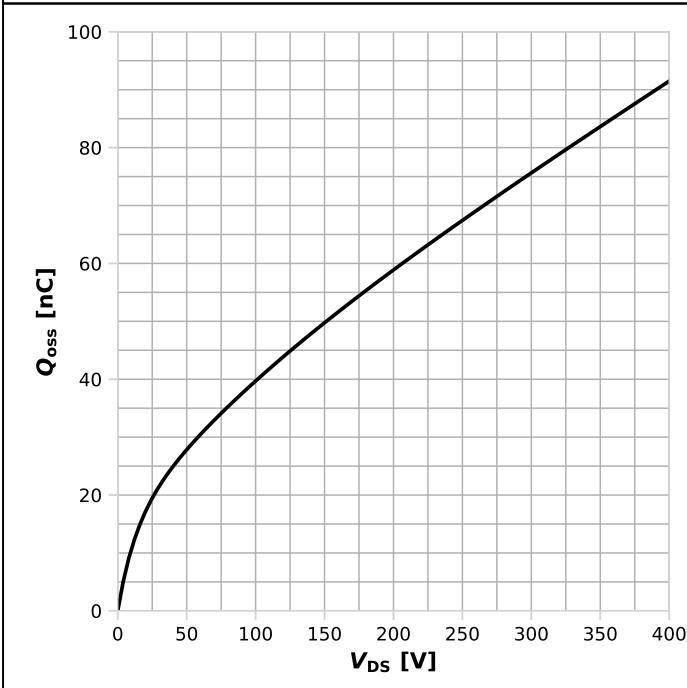
$C=f(V_{DS}); V_{GS}=0\text{ V}; f=1\text{ MHz}$

**Diagram 16: Typ. gate charge**



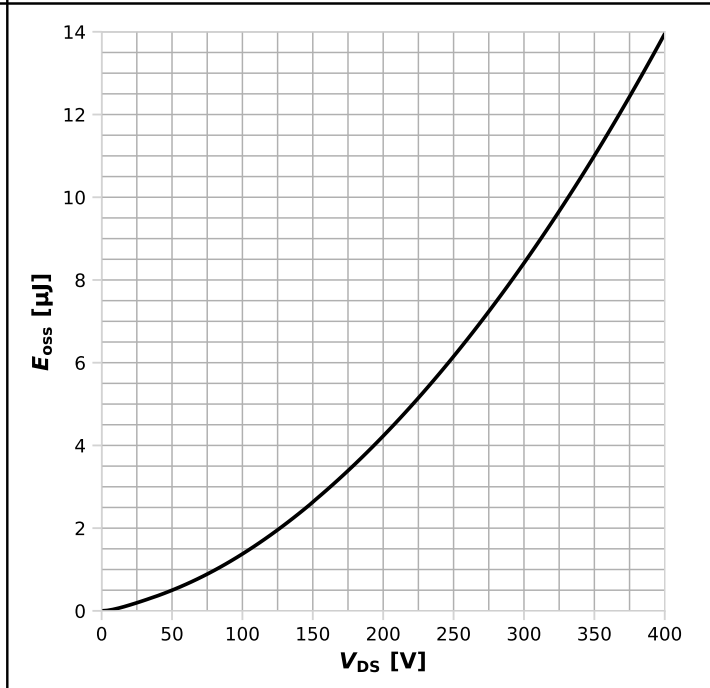
$V_{GS}=f(Q_{gate}), V_{DD}=200\text{ V}, I_D=15.7\text{ A pulsed}, T_j=25\text{ °C}$

**Diagram 17: Typ. output charge**



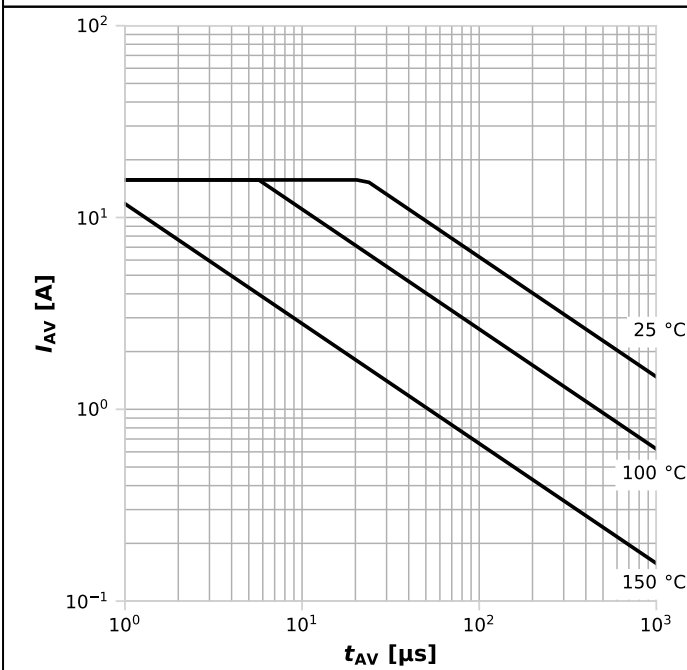
$Q_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$

**Diagram 18: Typ. output energy**



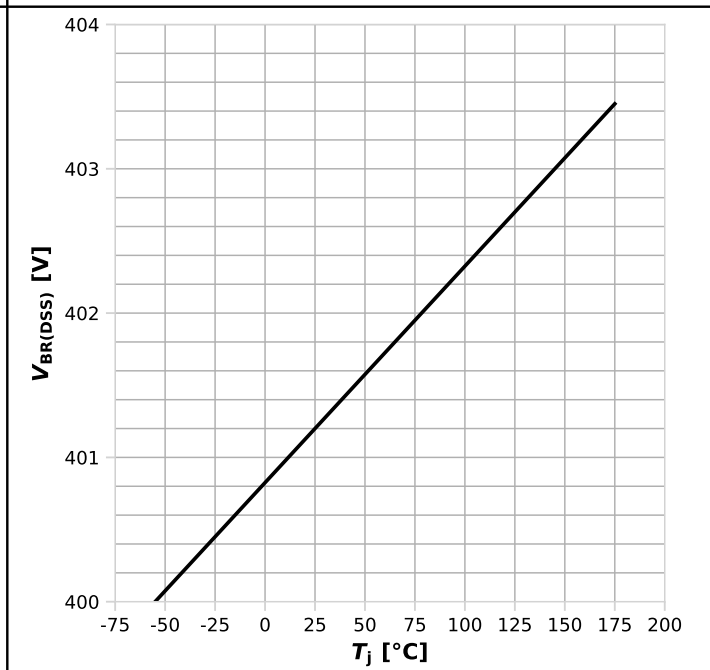
$E_{oss}=f(V_{DS}), V_{GS}=0\text{ V}$

**Diagram 19: Avalanche characteristics**

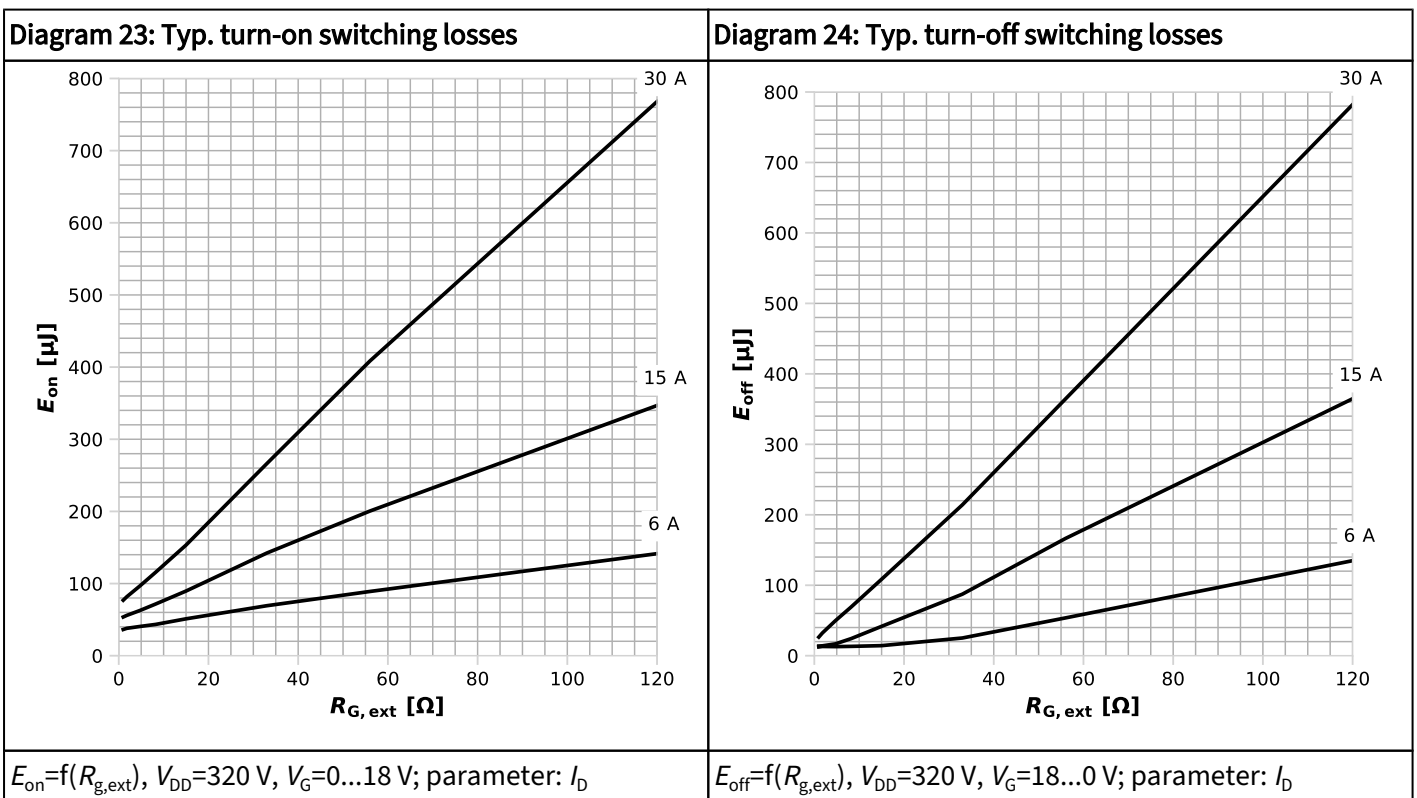
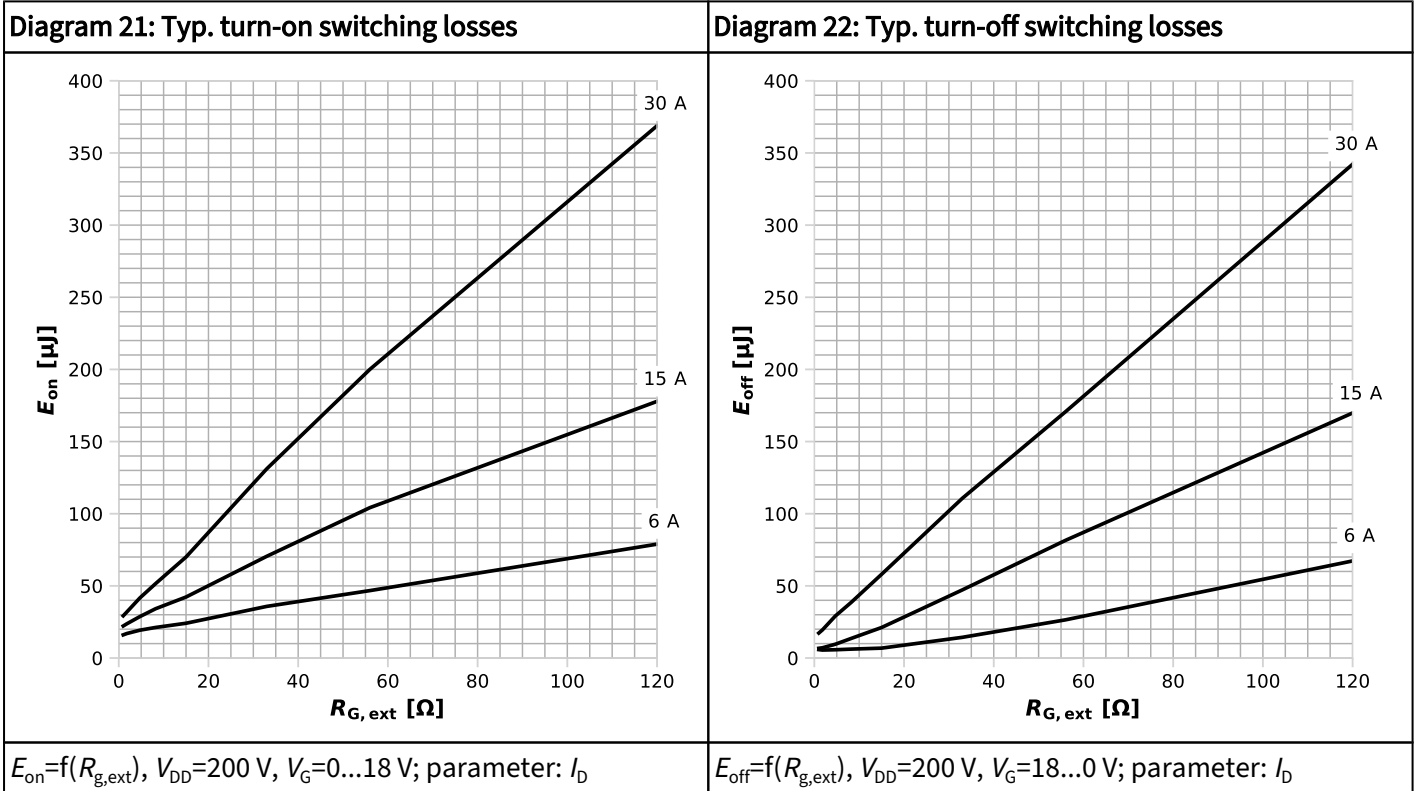


$I_{AS}=f(t_{AV}); R_{GS}=25\ \Omega; \text{parameter: } T_{j,\text{start}}$

**Diagram 20: Min. drain-source breakdown voltage**

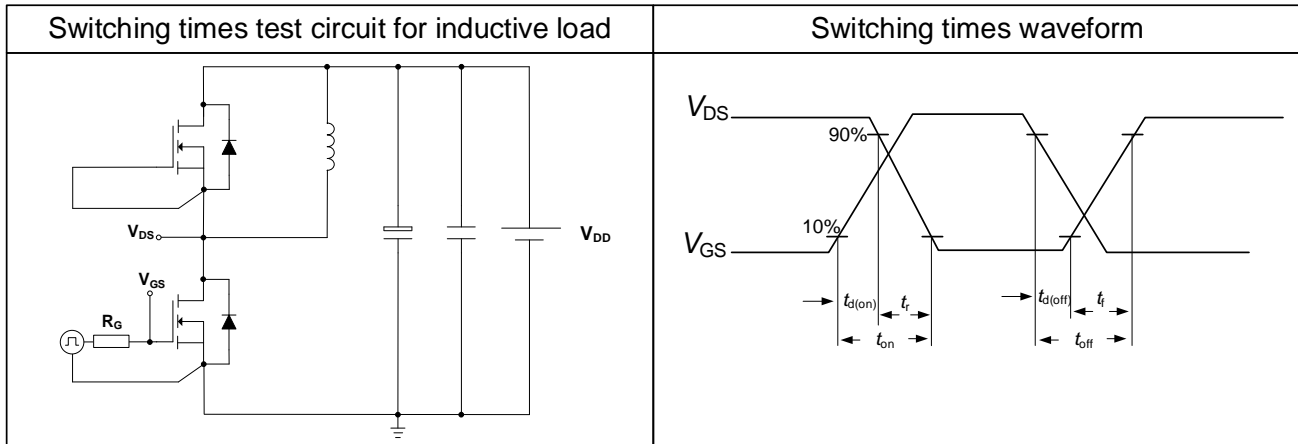


$V_{BR(DSS)}=f(T_j); I_D=0.56\text{ mA}$

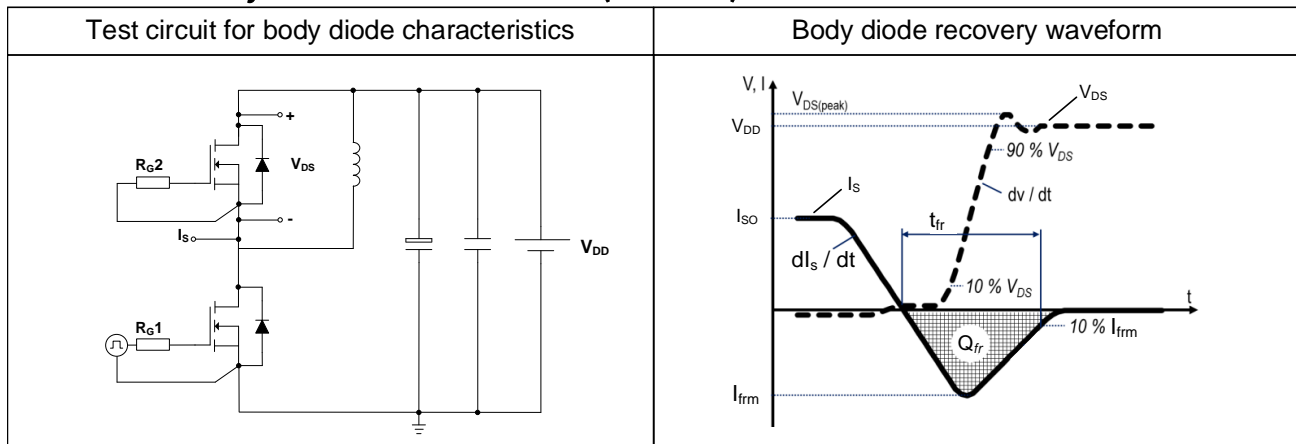


## 6 Test Circuits

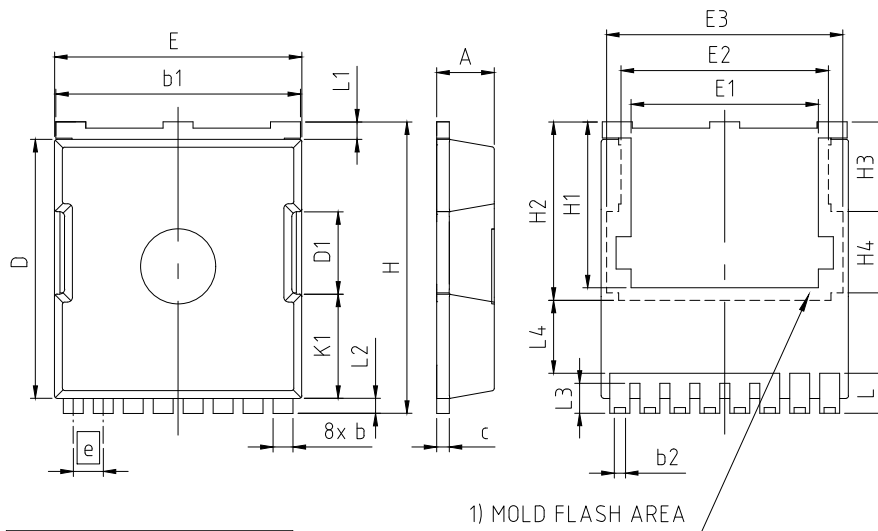
**Table 9 Switching times (CoolSiC)**



**Table 10 Body diode characteristics (CoolSiC)**



## 7 Package Outlines



PACKAGE - GROUP NUMBER: <b>PG-HSOF-8-U02</b>		
DIMENSIONS	MILLIMETERS	
	MIN.	MAX.
<b>A</b>	2.20	2.40
<b>b</b>	0.70	0.90
<b>b1</b>	9.70	9.90
<b>b2</b>	0.42	0.50
<b>c</b>	0.40	0.60
<b>D</b>	10.28	10.58
<b>D1</b>	3.30	
<b>E</b>	9.70	10.10
<b>E1</b>	7.50	
<b>E2</b>	8.50	
<b>E3</b>	9.46	
<b>e</b>	1.20 (BSC)	
<b>H</b>	11.48	11.88
<b>H1</b>	6.55	6.95
<b>H2</b>	7.15	
<b>H3</b>	3.59	
<b>H4</b>	3.26	
<b>N</b>	8	
<b>K1</b>	4.18	
<b>L</b>	1.40	1.80
<b>L1</b>	0.50	0.90
<b>L2</b>	0.50	0.70
<b>L3</b>	1.00	1.30
<b>L4</b>	2.62	2.81

1) PARTIALLY COVERED WITH MOLD FLASH

**Figure 1 Outline PG-HSOF-8, dimensions in mm**

## Revision History

IMT40R025M2H

### Revision 2024-04-27, Rev. 2.0

Previous Revision

Revision	Date	Subjects (major changes since last revision)
1.0	2024-04-26	Release of preliminary version
2.0	2024-04-27	Release of final

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