

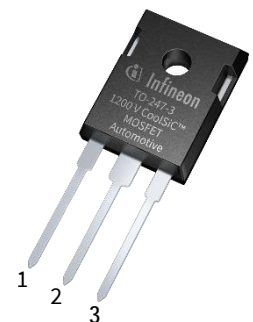
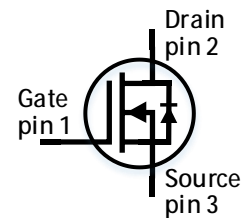
AIMW120R080M1

CoolSiC™ Automotive 1200V SiC Trench MOSFET 1200V G1

Silicon Carbide MOSFET

Features

- Revolutionary semiconductor material - Silicon Carbide
- Very low switching losses
- Threshold-free on state characteristic
- IGBT-compatible driving voltage (15V for turn-on)
- 0V turn-off gate voltage
- Benchmark gate threshold voltage, $V_{GS(th)}=4.5V$
- Fully controllable dv/dt
- Commutation robust body diode, ready for synchronous rectification
- Temperature independent turn-off switching losses



Benefits

- Efficiency improvement
- Enabling higher frequency
- Increased power density
- Cooling effort reduction
- Reduction of system complexity and cost

Potential Applications

- On-board Charger/PFC
- Booster/DC-DC Converter



Product validation

Qualified for Automotive Applications. Product Validation according to AEC-Q100/101

Table 1 Key Performance and Package Parameters

Type	V_{DS}	I_D ($T_C=25^\circ C, R_{th(j-c,max)}$)	$R_{DS(on),typ}$ ($T_{vj} = 25^\circ C, I_D = 13A,$ $V_{GS} = 15V$)	T_{vjmax}	Marking	Package
AIMW120R080M1	1200V	33A	80m Ω	175°C	A120M1080	PG-TO247-3-41

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1200V SiC Trench MOSFET

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Maximum ratings

1 Maximum ratings

Table 2 Maximum ratings¹

Parameter	Symbol	Value	Unit
Drain-source voltage, $T_{vj} \geq 25^\circ\text{C}$	V_{DS}	1200	V
DC drain current for $R_{th(j-c,max)}$, limited by $T_{vj,max}$, $V_{GS} = 15\text{V}$, $T_C = 25^\circ\text{C}$	I_D	33	A
$T_C = 100^\circ\text{C}$		24	
Pulsed drain current, t_p limited by $T_{vj,max}$, $V_{GS} = 15\text{V}$	$I_{D,pulse}^1$	74	A
DC body diode forward current for $R_{th(j-c,max)}$, limited by $T_{vj,max}$, $V_{GS} = 0\text{V}$	I_{SD}	36	A
$T_C = 100^\circ\text{C}$		22	
Pulsed body diode current, t_p limited by $T_{vj,max}$	$I_{SD,pulse}^1$	38	A
Gate-source voltage ²			
Max transient voltage, < 1% duty cycle	V_{GS}	-7... 20	V
Recommended turn-on gate voltage	$V_{GS,on}$	15	
Recommended turn-off gate voltage	$V_{GS,off}$	0	
Power dissipation, limited by $T_{vj,max}$	P_{tot}	150	W
$T_C = 100^\circ\text{C}$		75	
Virtual junction temperature	T_{vj}	-55... 175	$^\circ\text{C}$
Storage temperature	T_{stg}	-55... 150	$^\circ\text{C}$
Soldering temperature, wave soldering only allowed at leads, 1.6mm (0.063 in.) from case for 10 s	T_{sold}	260	$^\circ\text{C}$
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

¹ Not subject to production test. Parameter verified by design/characterization.

² **Important note:** The selection of positive and negative gate-source voltages impacts the long-term behavior of the device. The design guidelines described in [Application Note AN2018-09](#) must be considered to ensure sound operation of the device over the planned lifetime.

Thermal resistances

2 Thermal resistances

Table 3 Thermal resistances¹

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET/body diode thermal resistance, junction – case	$R_{th(j-c)}$		-	0.8	1	K/W
Thermal resistance, junction – ambient	$R_{th(j-a)}$	leaded	-	-	62	K/W

¹ Not subject to production test. Parameter verified by design/characterization.

3 Electrical Characteristics

3.1 Static characteristics

Table 4 Static characteristics (at $T_{vj} = 25^\circ\text{C}$, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Drain-source on-state resistance ²	$R_{DS(on)}$	$V_{GS} = 15\text{V}, I_D = 13\text{A},$ $T_{vj} = 25^\circ\text{C}$	-	80	104	mΩ
		$T_{vj} = 100^\circ\text{C}$	-	98	-	
		$T_{vj} = 175^\circ\text{C}$	-	135	-	
Body diode forward voltage	V_{SD}	$V_{GS} = 0\text{V}, I_{SD} = 13\text{A}$ $T_{vj} = 25^\circ\text{C}$	-	3.8	5.2	V
		$T_{vj} = 100^\circ\text{C}$	-	3.7	-	
		$T_{vj} = 175^\circ\text{C}$	-	3.6	-	
Gate-source threshold voltage	$V_{GS(th)}$	<i>(tested after 1 ms pulse at</i> $V_{GS} = 20\text{V})$ $I_D = 5,6\text{mA}, V_{DS} = V_{GS}$ $T_{vj} = 25^\circ\text{C}$	3.5	4.5	5.7	V
		$T_{vj} = 175^\circ\text{C}$	-	3.6	-	
Zero gate voltage drain current	I_{DSS}	$V_{GS} = 0\text{V}, V_{DS} = 1200\text{V}$ $T_{vj} = 25^\circ\text{C}$	-	1	180	μA
		$T_{vj} = 175^\circ\text{C}$	-	30	-	
Gate-source leakage current	I_{GSS}	$V_{GS} = 20\text{V}, V_{DS} = 0\text{V}$	-	-	100	nA
		$V_{GS} = -7\text{V}, V_{DS} = 0\text{V}$	-	-	-100	nA
Transconductance	g_{fs}	$V_{DS} = 20\text{V}, I_D = 13\text{A}$	-	7	-	S
Internal gate resistance	$R_{G,int}$	$f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	6	-	Ω

² **Important note:** The selection of positive and negative gate-source voltages impacts the long-term behavior of the device. The design guidelines described in [Application Note AN2018-09](#) must be considered to ensure sound operation of the device over the planned lifetime.

3.2 Dynamic characteristics

Table 5 Dynamic characteristics (at $T_{vj} = 25^{\circ}\text{C}$, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Input capacitance	C_{iss}	$V_{DD} = 800\text{V}, V_{GS} = 0\text{V},$ $f = 1\text{MHz}, V_{AC} = 25\text{mV}$	-	1060	-	pF
Output capacitance	C_{oss}		-	58	-	
Reverse capacitance	C_{rss}		-	6.5	-	
C_{oss} stored energy	E_{oss}		-	22	-	
Total gate charge	Q_G	$V_{DD} = 800\text{V}, I_D = 13\text{A},$ $V_{GS} = 0/15\text{V}, \text{turn-on pulse}$	-	28	-	nC
Gate to source charge	$Q_{GS,pl}$		-	9	-	
Gate to drain charge	Q_{GD}		-	7	-	
Short-circuit withstand time ³	t_{SC}	$V_{DD} = 800\text{V}, L_{\sigma} = 80\text{nH},$ $R_{G,ext} = 90\text{ohm}, T_{vj} = 175^{\circ}\text{C}$ $V_{GS,on} = 15\text{V}$	-	3	-	μs

³ Verified by design for single short circuit event at $V_{GS,on} = 15\text{V}$.

Electrical Characteristics

3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load ⁴

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET Characteristics, $T_{vj} = 25^{\circ}\text{C}$						
Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{V}, I_D = 13\text{A},$ $V_{GS} = 0/15\text{V}, R_{G,ext} = 2\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	10	-	ns
Rise time	t_r		-	22	-	
Turn-off delay time	$t_{d(off)}$		-	14	-	
Fall time	t_f		-	13	-	
Turn-on energy	E_{on}	body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	210	-	μJ
Turn-off energy	E_{off}		-	82	-	
Total switching energy	E_{tot}		-	292	-	
Body Diode Characteristics, $T_{vj} = 25^{\circ}\text{C}$						
Diode reverse recovery charge	Q_{rr}	$V_{DD} = 800\text{V}, I_{SD} = 13\text{A},$ V_{GS} at diode = $0\text{V},$ $di_f/dt = 1000\text{A}/\mu\text{s},$ Q_{rr} includes also $Q_C,$ see Fig. C	-	100	-	nC
Diode peak reverse recovery current	I_{rrm}		-	5	-	A

MOSFET Characteristics, $T_{vj} = 175^{\circ}\text{C}$

Turn-on delay time	$t_{d(on)}$	$V_{DD} = 800\text{V}, I_D = 13\text{A},$ $V_{GS} = 0/15\text{V}, R_{G,ext} = 2\Omega,$ $L_{\sigma} = 40\text{nH},$ diode: body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	10	-	ns
Rise time	t_r		-	22	-	
Turn-off delay time	$t_{d(off)}$		-	16	-	
Fall time	t_f		-	14	-	
Turn-on energy	E_{on}	body diode at $V_{GS} = 0\text{V}$ see Fig. E	-	300	-	μJ
Turn-off energy	E_{off}		-	100	-	
Total switching energy	E_{tot}		-	400	-	

Body Diode Characteristics, $T_{vj} = 175^{\circ}\text{C}$

Diode reverse recovery charge	Q_{rr}	$V_{DD} = 800\text{V}, I_{SD} = 13\text{A},$ V_{GS} at diode = $0\text{V},$ $di_f/dt = 1000\text{A}/\mu\text{s},$ Q_{rr} includes also $Q_C,$ see Fig. C	-	230	-	nC
Diode peak reverse recovery current	I_{rrm}		-	7	-	A

⁴ The chip technology was characterized up to 200 kV/ μs . The measured dV/dt was limited by measurement test setup and package.

Electrical characteristic diagrams

4 Electrical characteristic diagrams

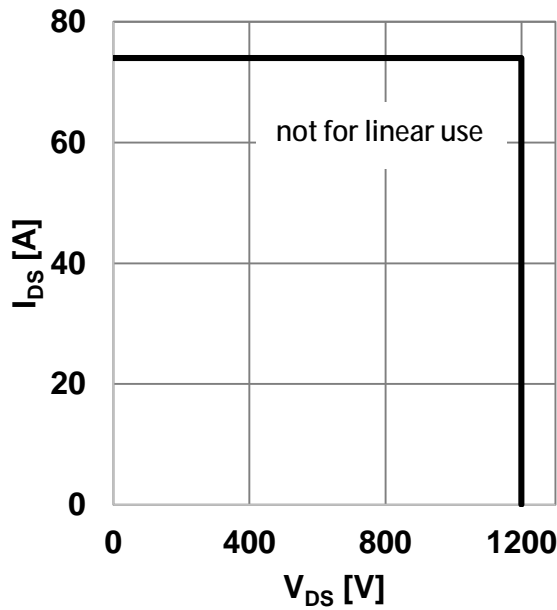


Figure 1 Safe operating area (SOA)
($V_{GS} = 0/15V$, $T_C = 25^\circ C$, $T_j \leq 175^\circ C$)

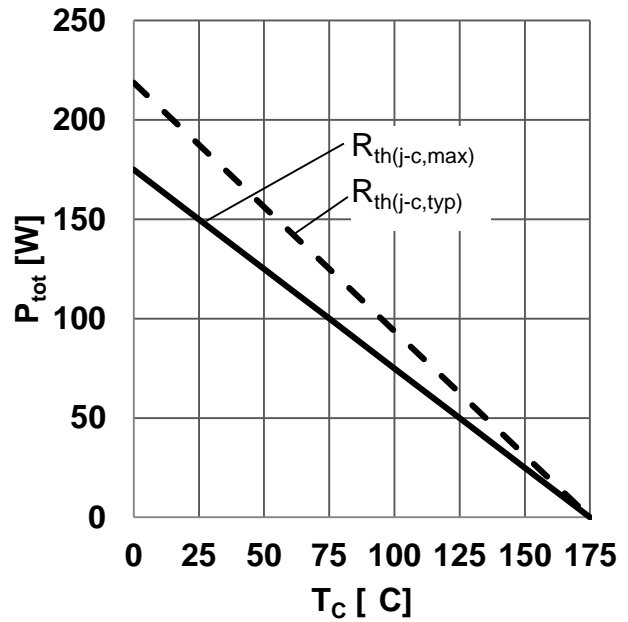


Figure 2 Power dissipation as a function of case temperature limited by bond wire
($P_{tot} = f(T_C)$)

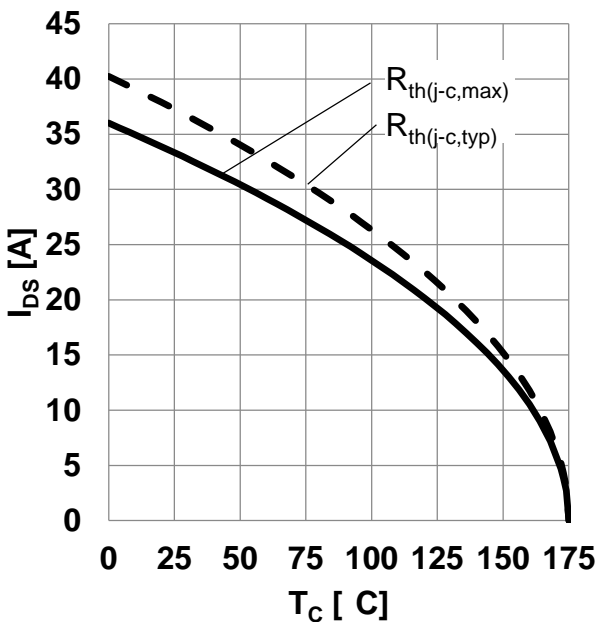


Figure 3 Maximum DC drain to source current as a function of case temperature limited by bond wire ($I_{DS} = f(T_C)$)

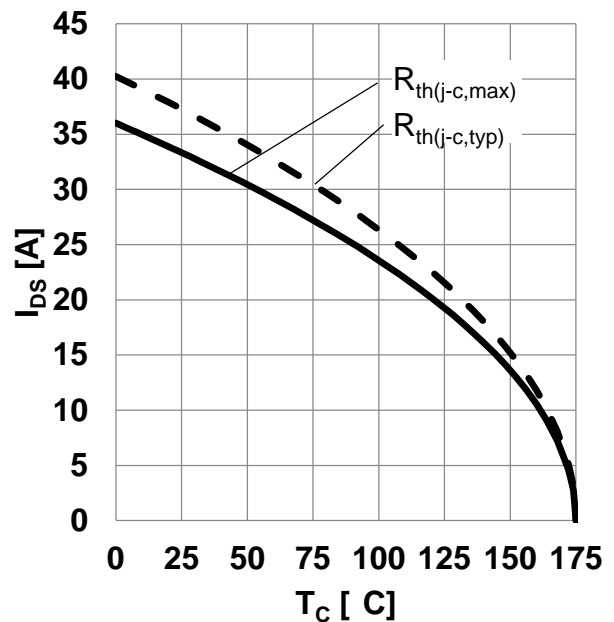


Figure 4 Maximum source to drain current as a function of case temperature limited by bond wire ($I_{SD} = f(T_C)$, $V_{GS} = 0V$)

Electrical characteristic diagrams

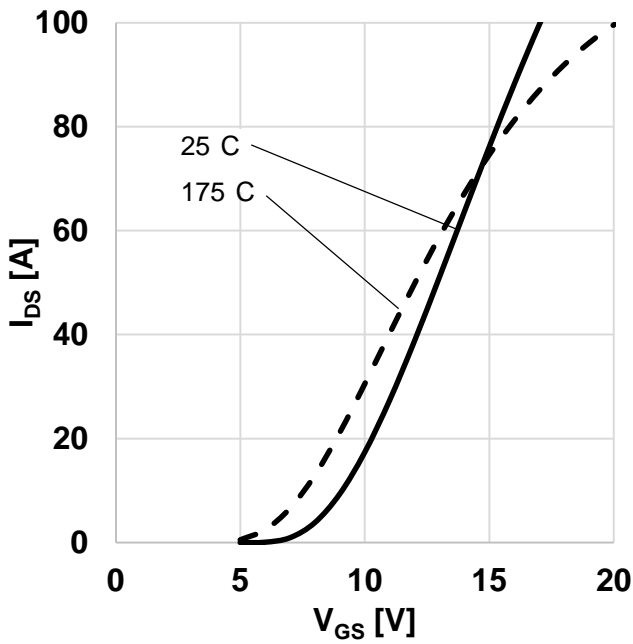


Figure 5 Typical transfer characteristic
 $(I_{DS} = f(V_{GS}), V_{DS} = 20V, t_p = 20\mu s)$

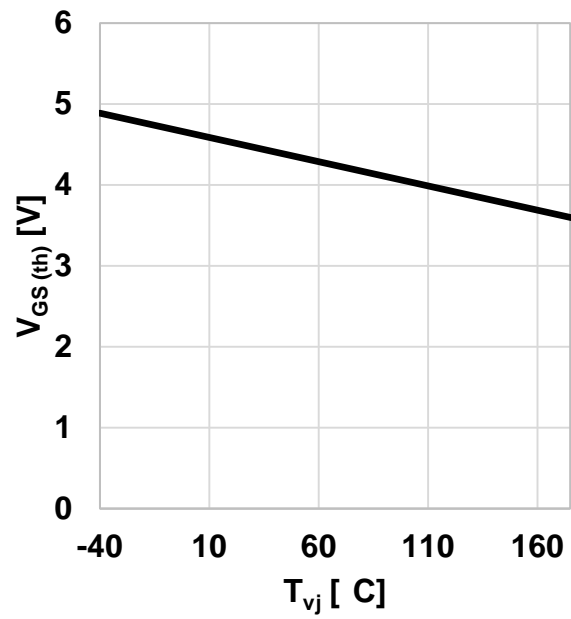


Figure 6 Typical gate-source threshold voltage as a function of junction temperature
 $(V_{GS(th)} = f(T_{vj}), I_{DS} = 5,6mA, V_{GS} = V_{DS})$

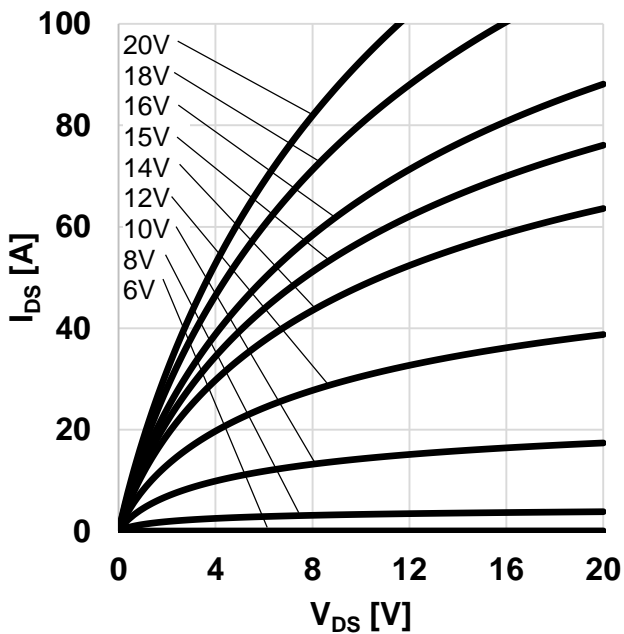


Figure 7 Typical output characteristic, V_{GS} as parameter
 $(I_{DS} = f(V_{DS}), T_{vj} = 25^\circ C, t_p = 20\mu s)$

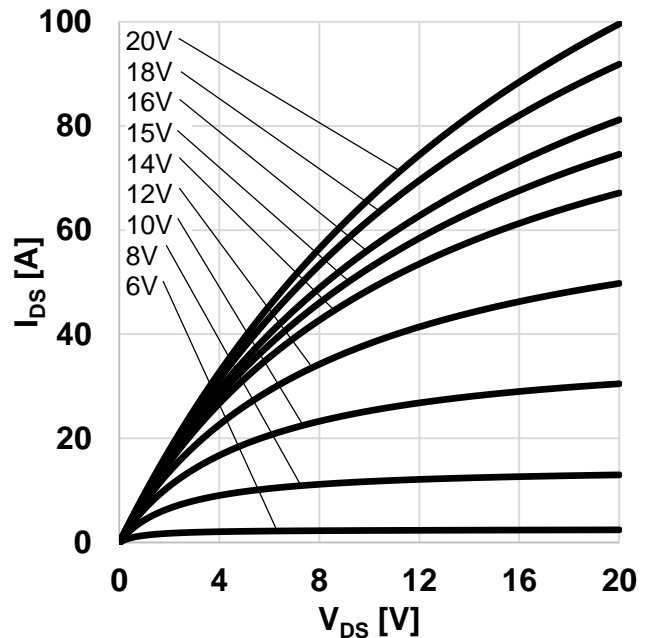


Figure 8 Typical output characteristic, V_{GS} as parameter
 $(I_{DS} = f(V_{DS}), T_{vj} = 175^\circ C, t_p = 20\mu s)$

Electrical characteristic diagrams

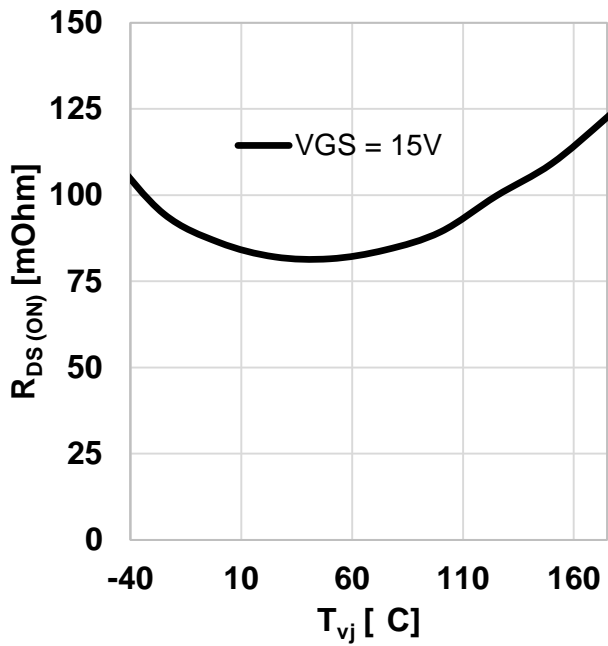


Figure 9 Typical on-resistance as a function of junction temperature
 ($R_{DS(on)} = f(T_{vj})$, $I_{DS} = 13A$)

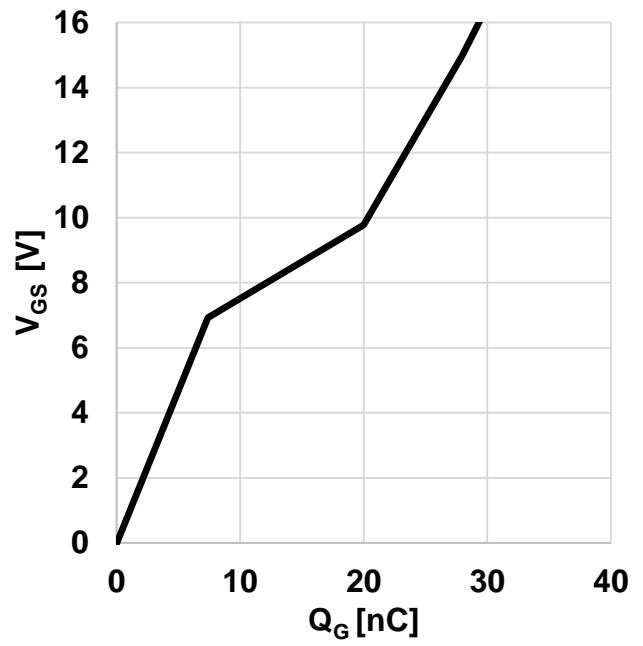


Figure 10 Typical gate charge
 ($V_{GS} = f(Q_G)$, $I_{BS} = 13A$, $V_{DS} = 800V$, turn-on pulse)

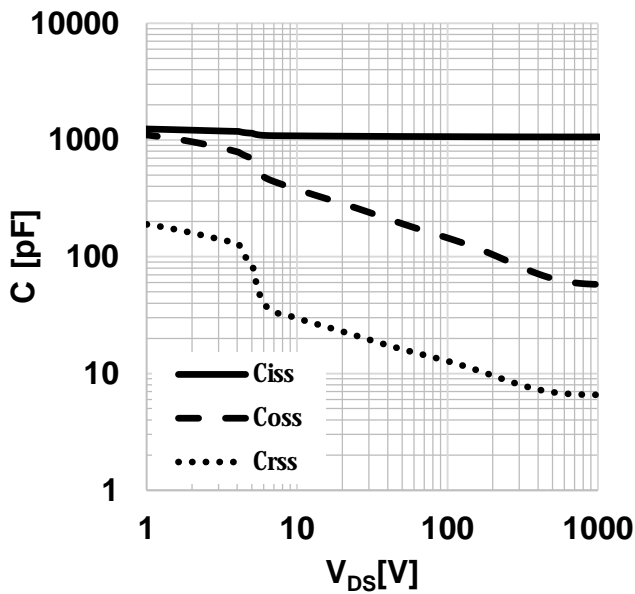


Figure 11 Typical capacitance as a function of drain-source voltage
 ($C = f(V_{DS})$, $V_{GS} = 0V$, $f = 1MHz$)

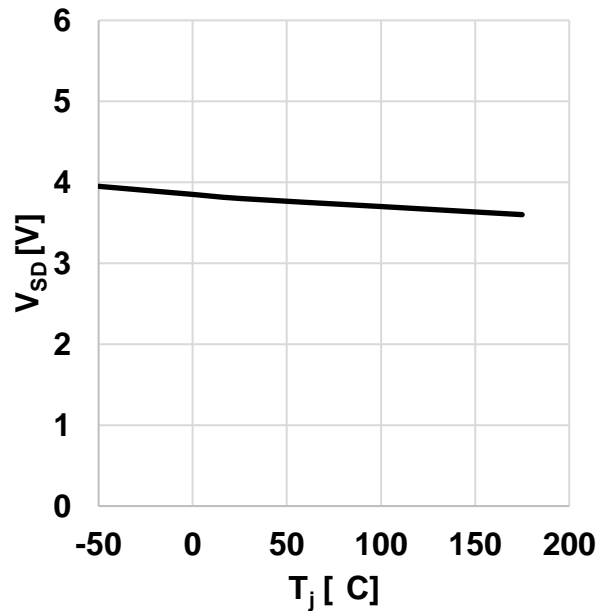


Figure 12 Typical body diode forward voltage as function of junction temperature
 ($V_{SD} = f(T_{vj})$, $V_{GS} = 0V$, $I_{SD} = 13A$)

Electrical characteristic diagrams

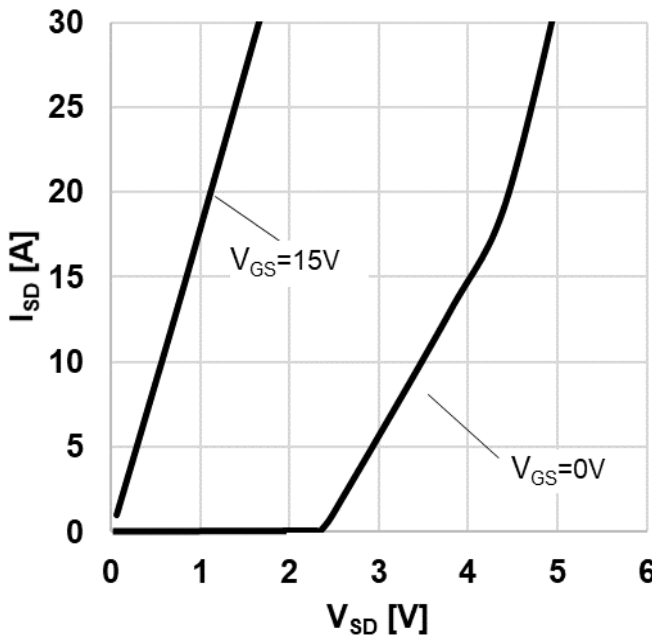


Figure 13 Typical body diode forward current as function of forward voltage, V_{GS} as parameter
($I_{SD} = f(V_{SD})$, $T_{vj} = 25^{\circ}C$, $t_p = 20\mu s$)

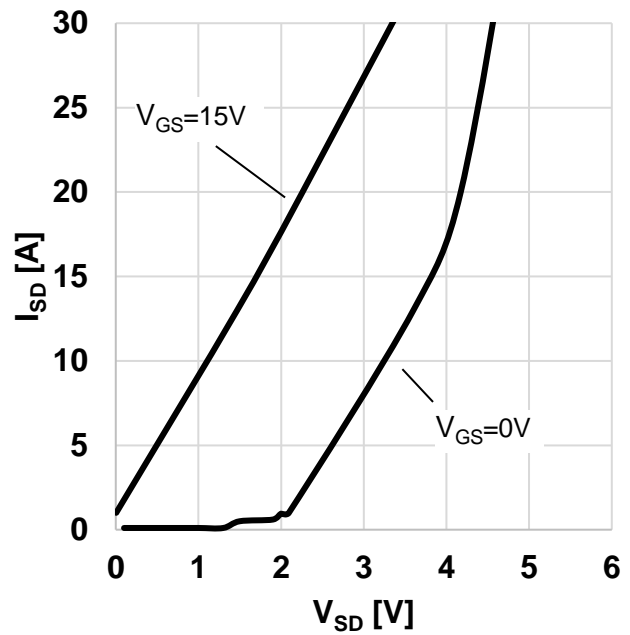


Figure 14 Typical body diode forward current as function of forward voltage, V_{GS} as parameter
($I_{SD} = f(V_{SD})$, $T_{vj} = 175^{\circ}C$, $t_p = 20\mu s$)

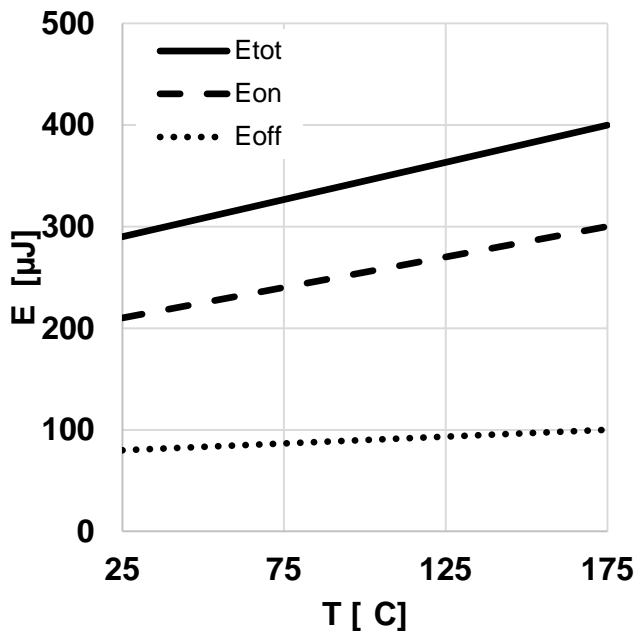


Figure 15 Typical switching energy losses as a function of junction temperature
($E = f(T_{vj})$, $V_{DD} = 800V$, $V_{GS} = 0V/15V$, $R_{G,ext} = 2\Omega$, $I_D = 13A$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

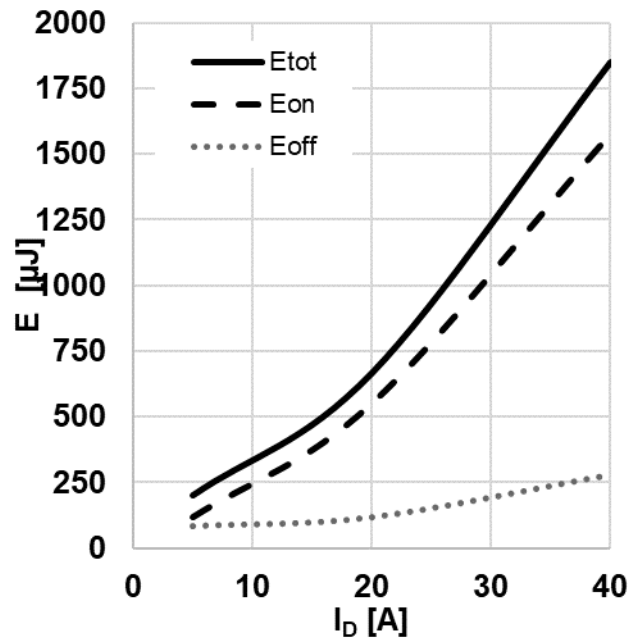


Figure 16 Typical switching energy losses as a function of drain-source current
($E = f(I_{DS})$, $V_{DD} = 800V$, $V_{GS} = 0V/15V$, $R_{G,ext} = 2\Omega$, $T_{vj} = 175^{\circ}C$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

Electrical characteristic diagrams

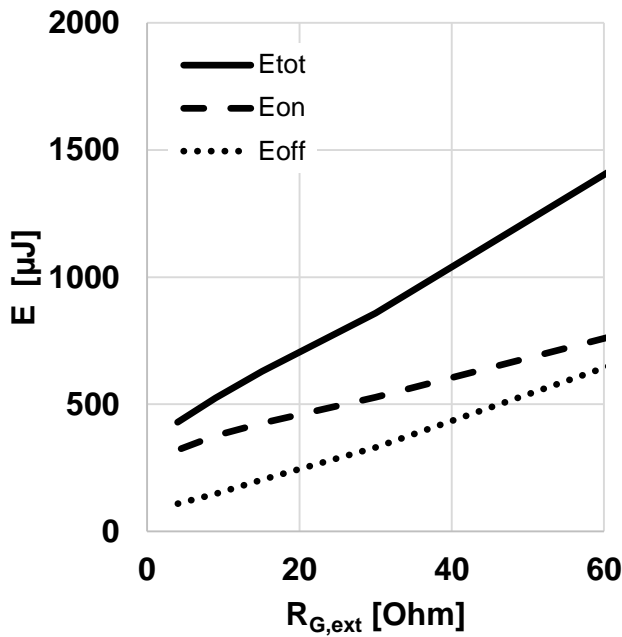


Figure 17 Typical switching energy losses as a function of gate resistance
($E = f(R_{G,ext})$, $V_{DD} = 800V$, $V_{GS} = 0V/15V$, $I_D = 13A$, $T_{vj} = 175^\circ C$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

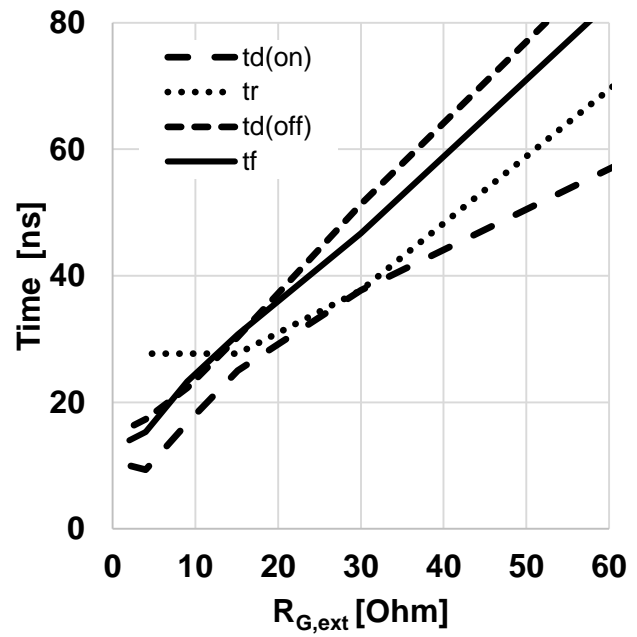


Figure 18 Typical switching times as a function of gate resistor
($t = f(R_{G,ext})$, $V_{DD} = 800V$, $V_{GS} = 0V/15V$, $I_D = 13A$, $T_{vj} = 175^\circ C$, ind. load, test circuit in Fig. E, diode: body diode at $V_{GS} = 0V$)

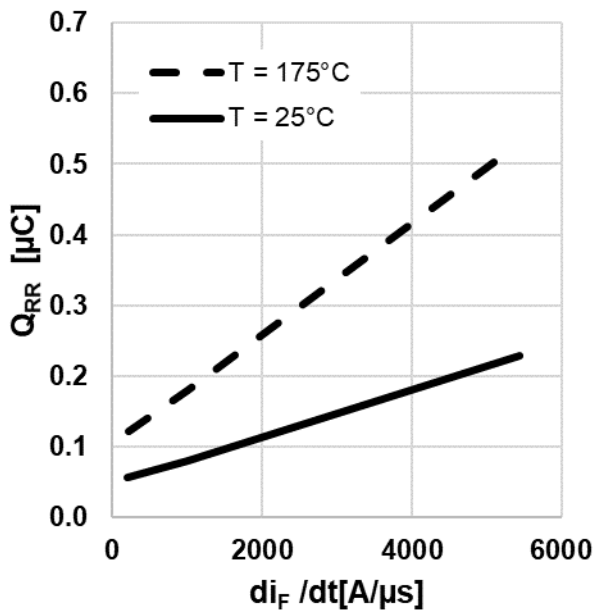


Figure 19 Typical reverse recovery charge as a function of diode current slope
($Q_{rr} = f(di_f/dt)$, $V_{DD} = 800V$, $V_{GS} = 0V/15V$, $I_D = 13A$, ind. load, test circuit in Fig.E, body diode at $V_{GS} = 0V$)

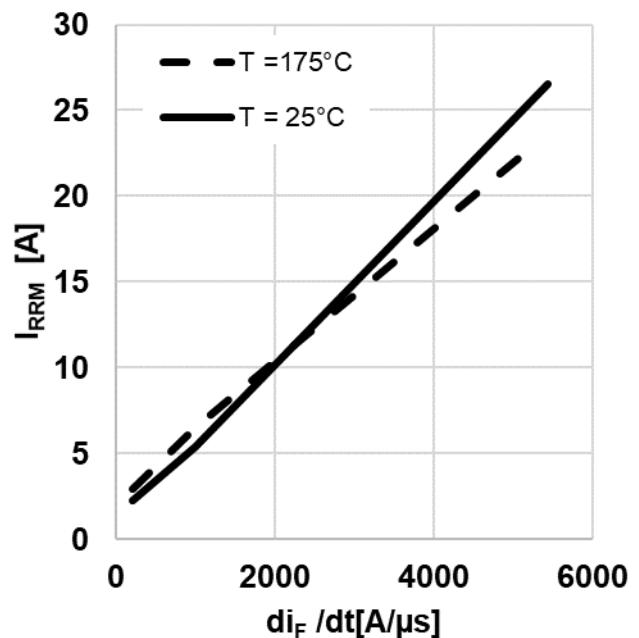


Figure 20 Typical reverse recovery current as a function of diode current slope
($I_{rrm} = f(di_f/dt)$, $V_{DD} = 800V$, $V_{GS} = 0V/15V$, $I_D = 13A$, ind. load, test circuit in Fig.E, body diode at $V_{GS} = 0V$)

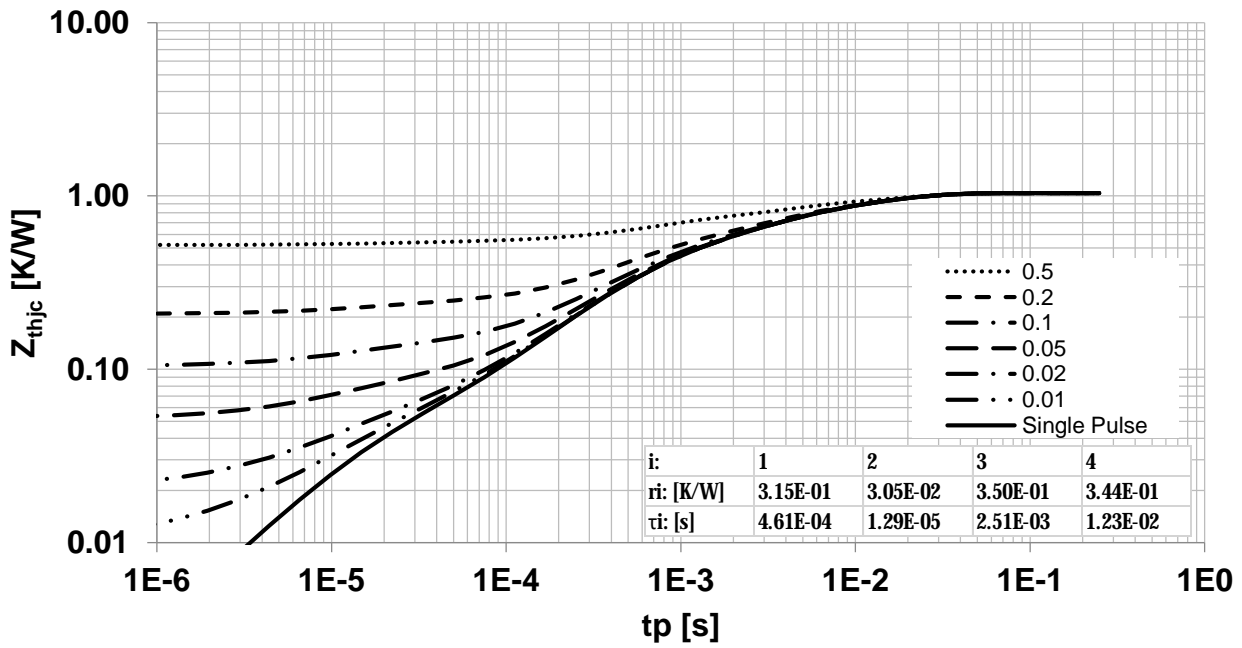


Figure 21 Max. transient thermal resistance (MOSFET/diode)
 ($Z_{th(j-c,max)} = f(t_p)$, parameter $D = t_p/T$, thermal equivalent circuit in Fig. D)

5 Package drawing

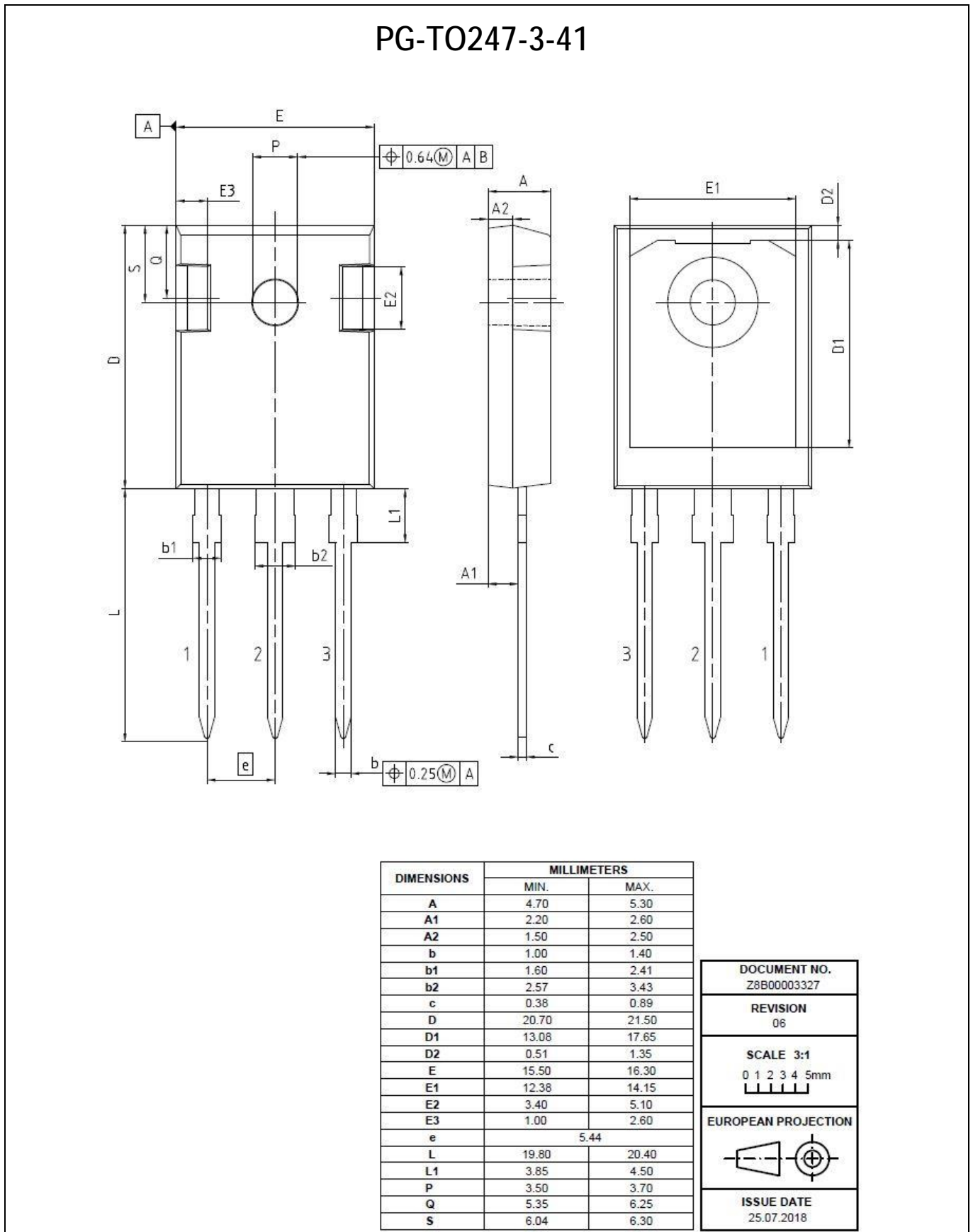


Figure 22 Package drawing

Test conditions

6 Test conditions

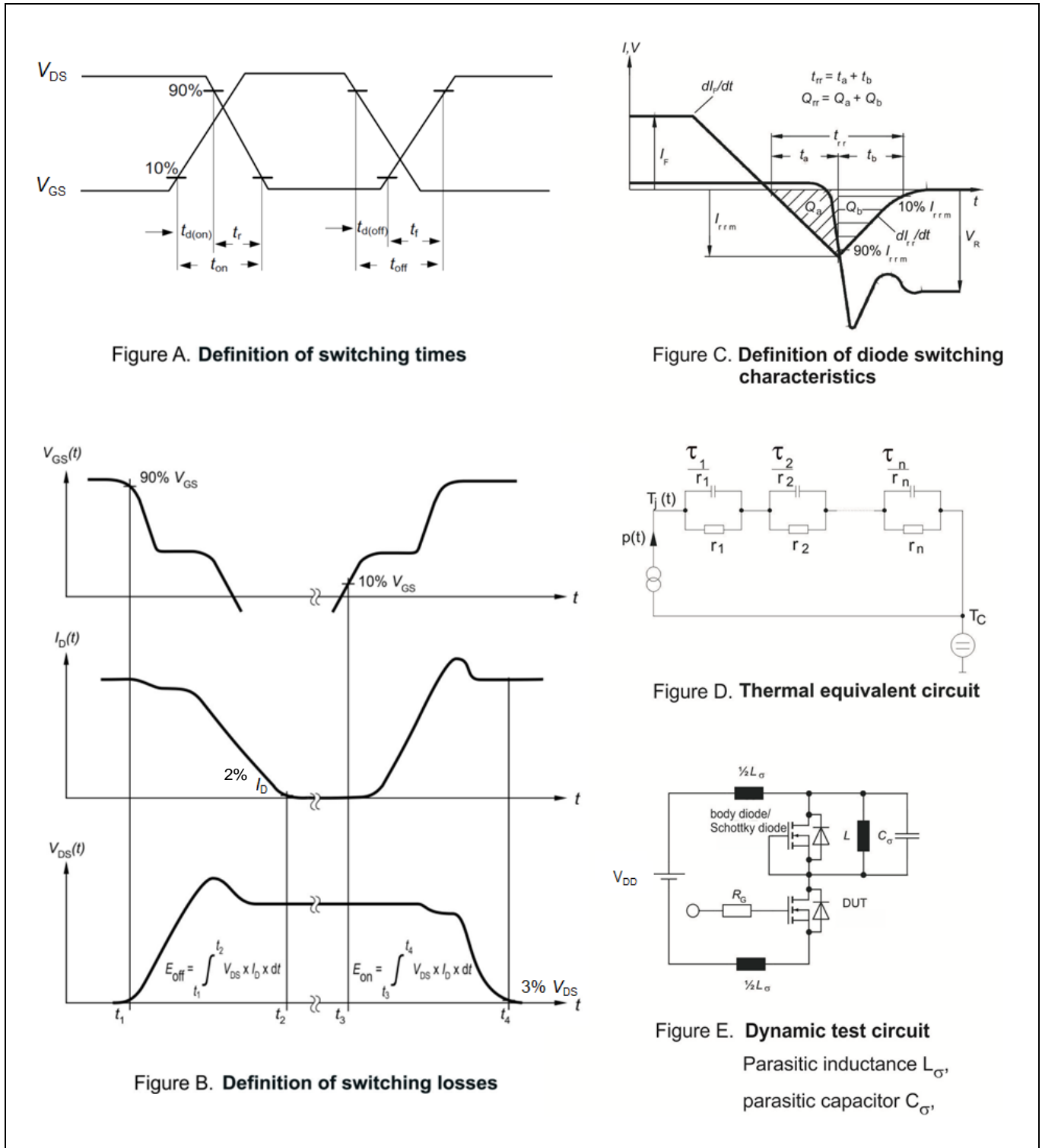


Figure 23 Test conditions

Revision history

Revision history

Document version	Date of release	Description of changes
V01_00	2021-03-09	-
V01_10	2023-01-18	$I_{SD,pulse}$ value adjusted

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