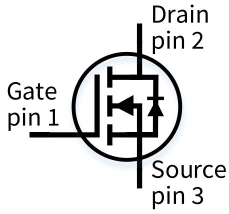
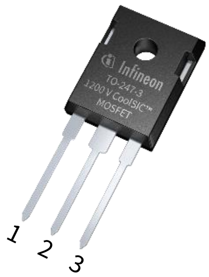
IMW120R045M1

CoolSiC™ 1200V SiC Trench MOSFET
Silicon Carbide MOSFET



Features

- Very low switching losses
- Threshold-free on state characteristic
- Wide gate-source voltage range
- Benchmark gate threshold voltage, $V_{GS(th)}$ = 4.5V
- 0V turn-off gate voltage
- 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

- Energy generation
  - Solar string inverter and solar optimizer
- Industrial power supplies
  - Industrial UPS
  - Industrial SMPS
- Infrastructure – Charge
  - Charger

Product validation

Qualified for industrial applications according to the relevant tests of JEDEC 47/20/22

Table 1 Key Performance and Package Parameters

Type	V_{DS}	I_D (T_C = 25°C, $R_{th(j-c,max)}$)	$R_{DS(on)}$ (T_{vj} = 25°C, I_D = 20A, V_{GS} = 15V)	$T_{j,max}$	Marking	Package
IMW120R045M1	1200V	52A	45mΩ	175°C	120M1045	PG-TO247-3

Table of contents

1 Maximum ratings

For optimum lifetime and reliability, Infineon recommends operating conditions that do not exceed 80% of the maximum ratings stated in this datasheet.

Table 2 Maximum ratings

Parameter	Symbol	Value	Unit
Drain-source voltage, $T_{vj} \geq 25°C$	V_{DSS}	1200	V
DC drain current for $R_{th(j\text{-}c,max)}$, limited by T_{vjmax}, $V_{GS} = 15V$, $T_C = 25°C$ $T_C = 100°C$	I_D	 52 36	A
Pulsed drain current, t_p limited by T_{vjmax}, $V_{GS} = 15V$	$I_{D,pulse}$[1]	130	A
DC body diode forward current for $R_{th(j\text{-}c,max)}$, limited by T_{vjmax}, $V_{GS} = 0V$ $T_C = 25°C$ $T_C = 100°C$	I_{SD}	 52 28	A
Pulsed body diode current, t_p limited by T_{vjmax}	$I_{SD,pulse}$[1]	130	A
Gate-source voltage[2] Max transient voltage, < 1% duty cycle Recommended turn-on gate voltage Recommended turn-off gate voltage	 V_{GSS} $V_{GSS,on}$ $V_{GSS,off}$	 -10… 20 15 0	V
Short-circuit withstand time $V_{DD} = 800V$, $V_{DS,peak} < 1200V$, $V_{GS,on} = 15V$, $T_{j,start} = 25°C$	t_{SC}	3	µs
Power dissipation, limited by T_{vjmax} $T_C = 25°C$ $T_C = 100°C$	P_{tot}	 228 114	W
Virtual junction temperature	T_{vj}	-55… 175	°C
Storage temperature	T_{stg}	-55… 150	°C
Soldering temperature, wavesoldering only allowed at leads, 1.6mm (0.063 in.) from case for 10 s	T_{sold}	260	°C
Mounting torque, M3 screw Maximum of mounting processes: 3	M	0.6	Nm

[1] verified by design
[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.

2 Thermal resistances

Table 3

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET/body diode thermal resistance, junction – case	$R_{th(j-c)}$		-	0.51	0.66	K/W
Thermal resistance, junction – ambient	$R_{th(j-a)}$	leaded	-	-	62	K/W

3 Electrical Characteristics

3.1 Static characteristics

Table 4 Static characteristics (at T_{vj} = 25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Drain-source on-state resistance	$R_{DS(on)}$	V_{GS} = 15V, I_D = 20A,				mΩ
		T_{vj} = 25°C	-	45	59	
		T_{vj} = 100°C	-	55	-	
		T_{vj} = 175°C	-	75	-	
Body diode forward voltage	V_{SD}	V_{GS} = 0V, I_{SD} = 20A				V
		T_{vj} = 25°C	-	4.1	5.2	
		T_{vj} = 100°C	-	4.0	-	
		T_{vj} = 175°C	-	3.9	-	
Gate-source threshold voltage	$V_{GS(th)}$	*(tested after 1 ms pulse at V_{GS} = 20V)*				V
		I_D = 10mA, V_{DS} = V_{GS}				
		T_{vj} = 25°C	3.5	4.5	5.7	
		T_{vj} =175°C	-	3.6	-	
Zero gate voltage drain current	I_{DSS}	V_{GS} = 0V, V_{DS} = 1200V				µA
		T_{vj}=25°C	-	2	200	
		T_{vj}=175°C	-	4	-	
Gate-source leakage current	I_{GSS}	V_{GS} = 20V, V_{DS} = 0V	-	-	120	nA
		V_{GS} = -10V, V_{DS} = 0V	-	-	-120	nA
Transconductance	g_{fs}	V_{DS} = 20V, I_D = 20A	-	11.1	-	S
Internal gate resistance	$R_{G,int}$	f = 1MHz, V_{AC} = 25mV	-	4	-	Ω

3.2 Dynamic characteristics

Table 5 Dynamic characteristics (at T_{vj} = 25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
Input capacitance	C_{iss}	V_{DD} = 800V, V_{GS} = 0V, f = 1MHz, V_{AC} = 25mV	-	1900	-	pF
Output capacitance	C_{oss}		-	115	-	
Reverse capacitance	C_{rss}		-	13	-	
C_{oss} stored energy	E_{oss}		-	44	-	µJ
Total gate charge	Q_G	V_{DD} = 800V, I_D = 20A, V_{GS} = 0/15V, turn-on pulse	-	52	-	nC
Gate to source charge	$Q_{GS,pl}$		-	15	-	
Gate to drain charge	Q_{GD}		-	13	-	

3.3 Switching characteristics

Table 6 Switching characteristics, Inductive load [4]

Parameter	Symbol	Conditions	Value			Unit
			min.	typ.	max.	
MOSFET Characteristics, T_{vj} = 25°C						
Turn-on delay time	$t_{d(on)}$	V_{DD} = 800V, I_D = 20A, V_{GS} = 0/15V, $R_{G,ext}$ = 2Ω, L_σ = 40nH, diode: body diode at V_{GS} = 0V see Fig. E	-	9	-	ns
Rise time	t_r		-	24	-	
Turn-off delay time	$t_{d(off)}$		-	17	-	
Fall time	t_f		-	13	-	
Turn-on energy	E_{on}		-	350	-	µJ
Turn-off energy	E_{off}		-	70	-	
Total switching energy	E_{tot}		-	420	-	
Body Diode Characteristics, T_{vj} = 25°C						
Diode reverse recovery charge	Q_{rr}	V_{DD} = 800V, I_{SD} = 20A, V_{GS} at diode = 0V, di_f/dt = 1000A/µs, Q_{rr} includes also Q_C, see Fig. C	-	0.15	-	µC
Diode peak reverse recovery current	I_{rrm}		-	8	-	A

MOSFET Characteristics, T_{vj} = 175°C						
Turn-on delay time	$t_{d(on)}$	V_{DD} = 800V, I_D = 20A, V_{GS} = 0/15V, $R_{G,ext}$ = 2Ω, L_σ = 40nH, diode: body diode at V_{GS} = 0V see Fig. E	-	9	-	ns
Rise time	t_r		-	24	-	
Turn-off delay time	$t_{d(off)}$		-	20	-	
Fall time	t_f		-	14	-	
Turn-on energy	E_{on}		-	380	-	µJ
Turn-off energy	E_{off}		-	75	-	
Total switching energy	E_{tot}		-	455	-	
Body Diode Characteristics, T_{vj} = 175°C						
Diode reverse recovery charge	Q_{rr}	V_{DD} = 800V, I_{SD} = 20A, V_{GS} at diode = 0V, di_f/dt = 1000A/µs, Q_{rr} includes also Q_C, see Fig. C	-	0.25	-	µC
Diode peak reverse recovery current	I_{rrm}		-	10	-	A

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

4 Electrical characteristic diagrams

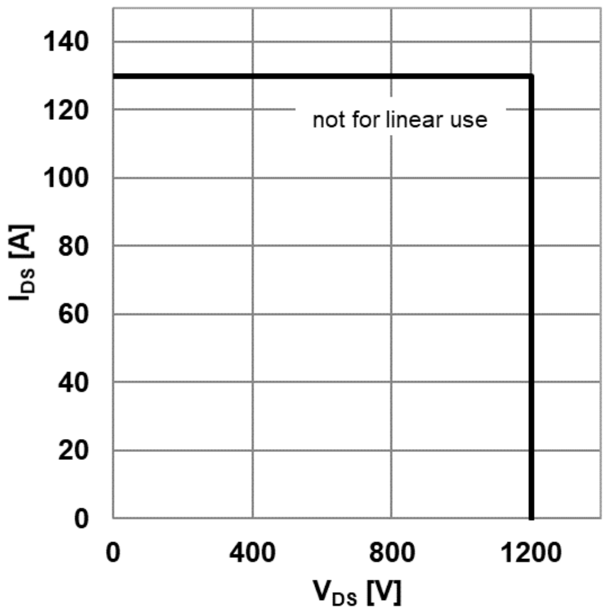


Figure 1 **Reverse bias safe operating area (RBSOA)** (V_{gs} = 0/15V, T_c = 25°C, T_j < 175°C)

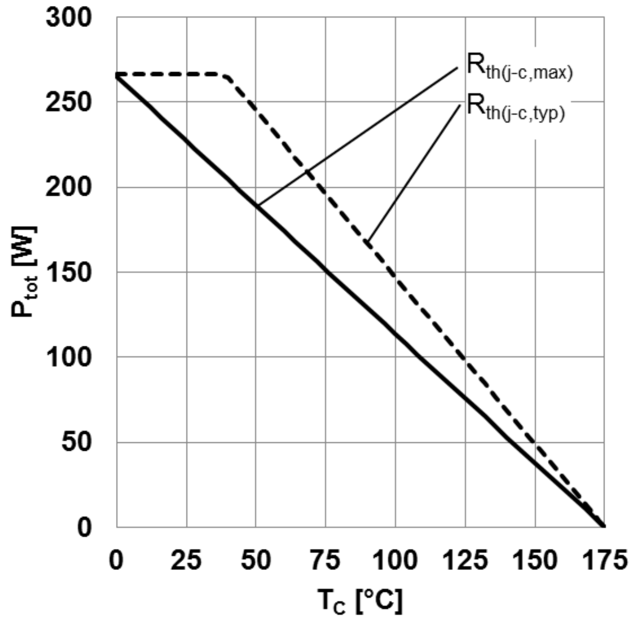


Figure 2 **Power dissipation as a function of case temperature limited by bond wire** (P_{tot} = f(T_C))

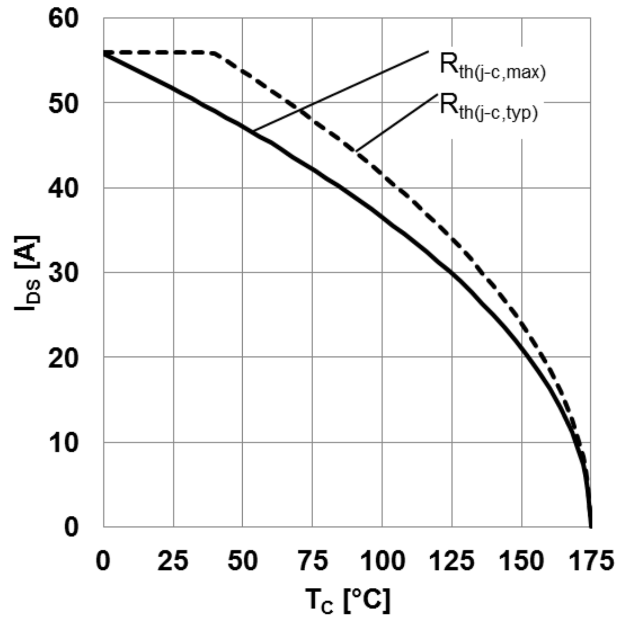


Figure 3 **Maximum DC drain to source current as a function of case temperature limited by bond wire** (I_{DS} = f(T_C))

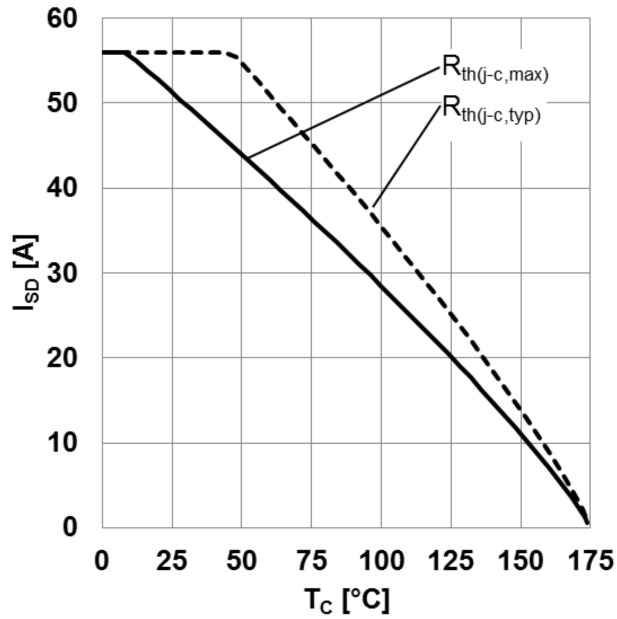


Figure 4 **Maximum source to drain current as a function of case temperature limited by bond wire** (I_{SD} = f(T_C), V_{GS} = 0V)

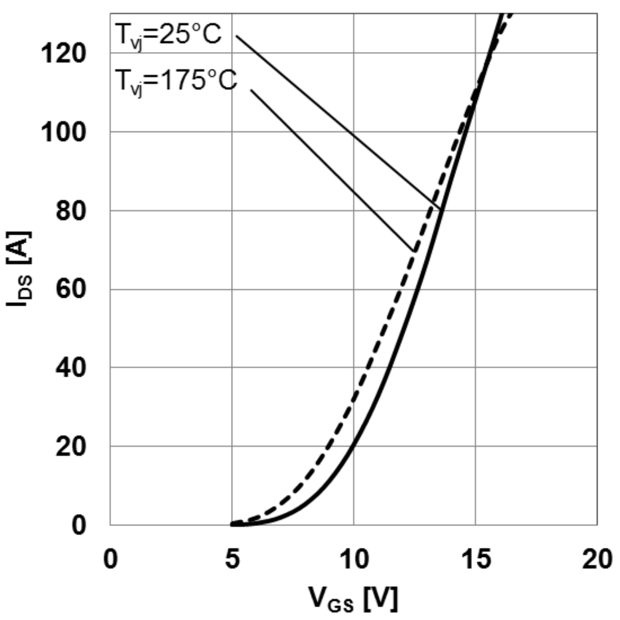


Figure 5 **Typical transfer characteristic**
(I_{DS} = f(V_{GS}), V_{DS} = 20V, t_P = 20µs)

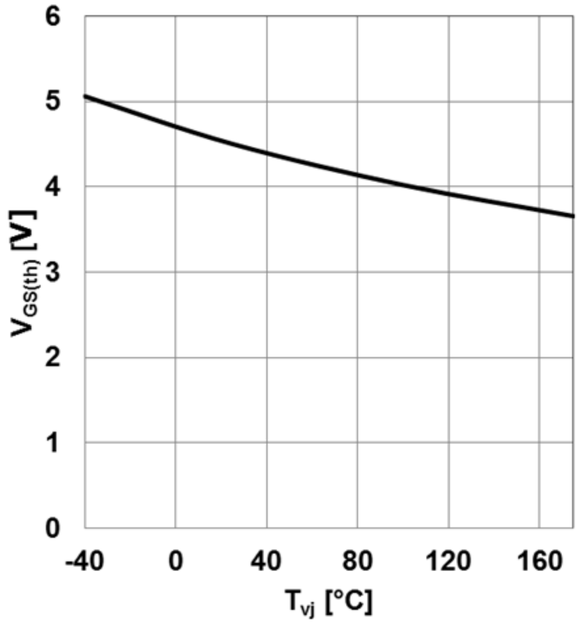


Figure 6 **Typical gate-source threshold voltage as a function of junction temperature**
($V_{GS(th)}$ = f(T_{vj}), I_{DS} = 10mA, V_{GS} = V_{DS})

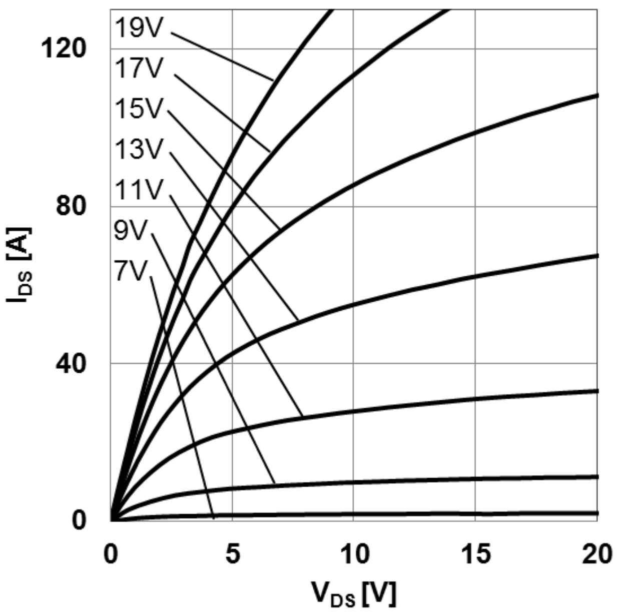


Figure 7 **Typical output characteristic, V_{GS} as parameter** (I_{DS} = f(V_{DS}), T_{vj}=25°C, t_P = 20µs)

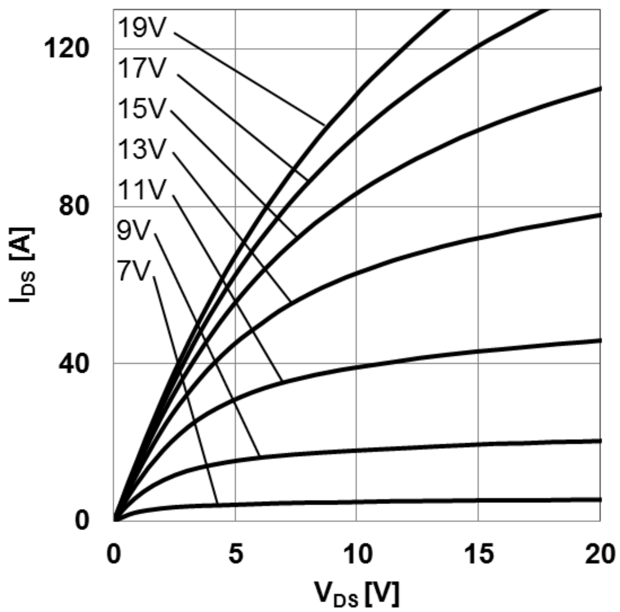


Figure 8 **Typical output characteristic, V_{GS} as parameter** (I_{DS} = f(V_{DS}), T_{vj}=175°C, t_P = 20µs)

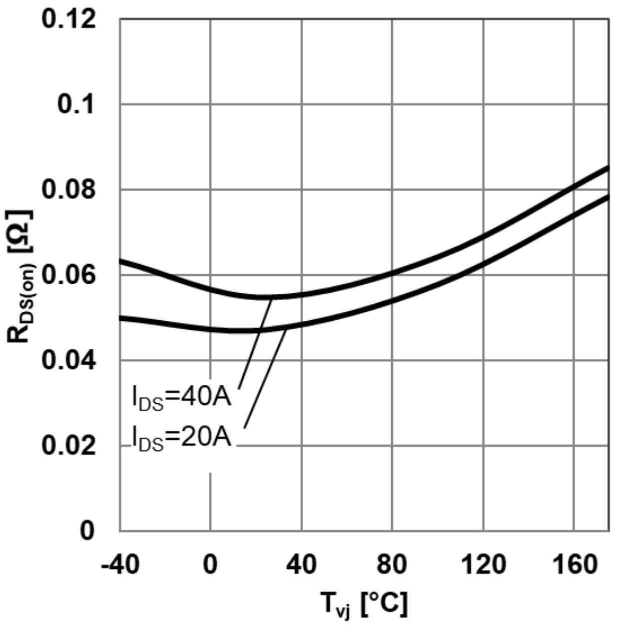


Figure 9 **Typical on-resistance as a function of junction temperature**
($R_{DS(on)}$ = f(T_{vj}), V_{GS}=15V)

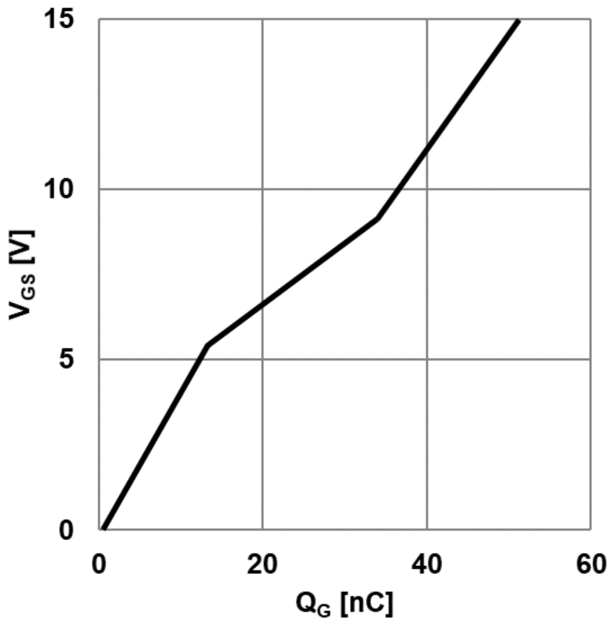


Figure 10 **Typical gate charge** (V_{GS} = f(Q_G), I_{DS} = 20A, V_{DS} = 800V, turn-on pulse)

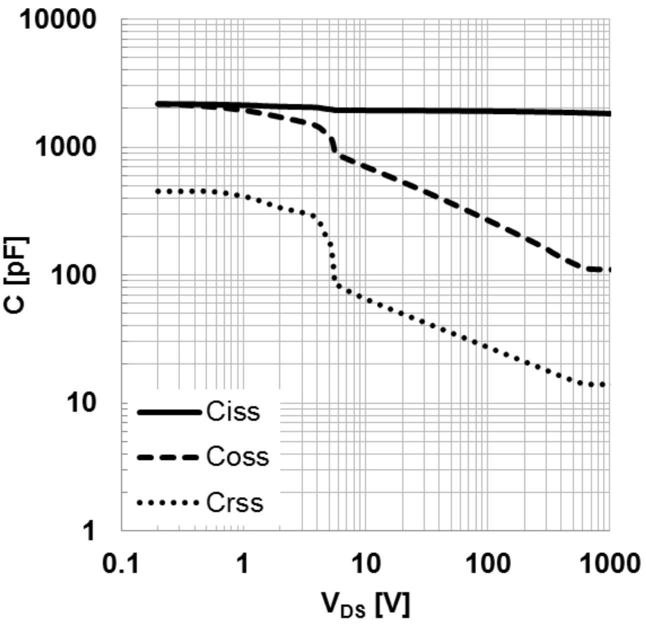


Figure 11 **Typical capacitance as a function of drain-source voltage**
(C = f(V_{DS}), V_{GS} = 0V, f = 1MHz)

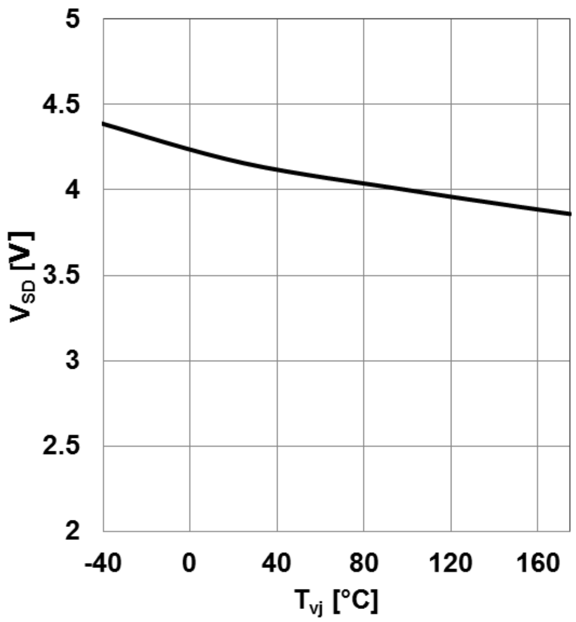


Figure 12 **Typical body diode forward voltage as function of junction temperature**
(V_{SD}=f(T_{vj}), V_{GS}=0V, I_{SD}=20A)

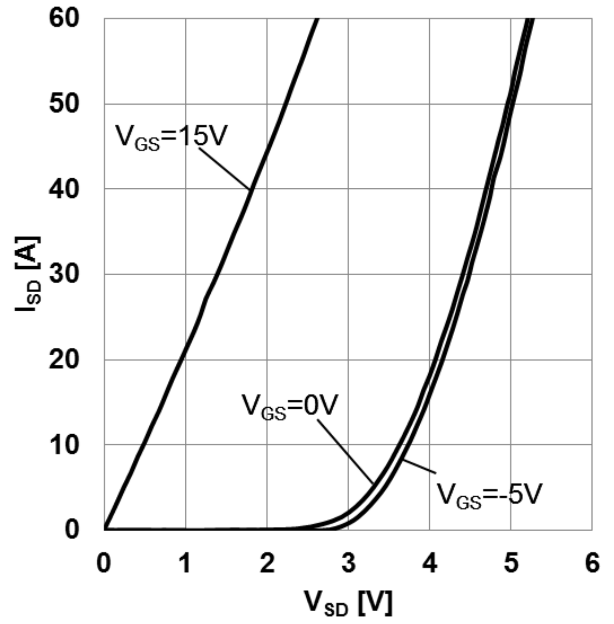


Figure 13 Typical body diode forward current as function of forward voltage, V_{GS} as parameter
(I_{SD} = f(V_{SD}), T_{vj} = 25°C, t_P = 20µs)

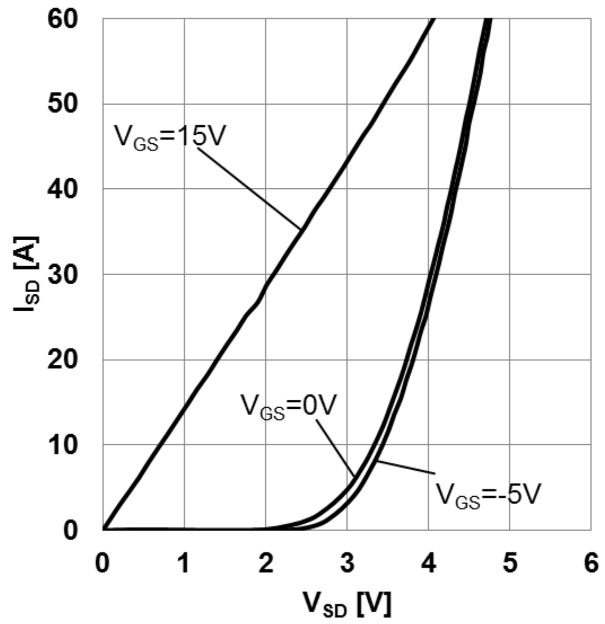


Figure 14 Typical body diode forward current as function of forward voltage, V_{GS} as parameter
(I_{SD} = f(V_{SD}), T_{vj} = 175°C, t_P = 20µs)

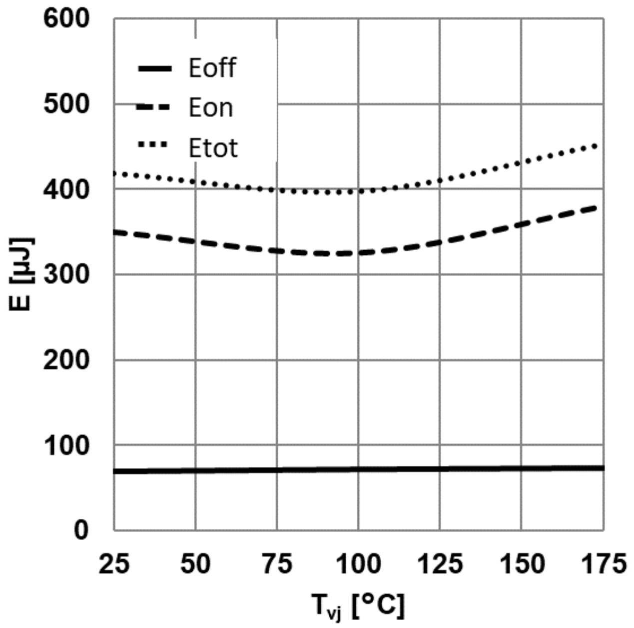


Figure 15 Typical switching energy losses as a function of junction temperature
(E = f(T_{vj}), V_{DD} = 800V, V_{GS} = 0V/15V, $R_{G,ext}$ = 2Ω, I_D = 20A, ind. load, test circuit in Fig. E, diode: body diode)

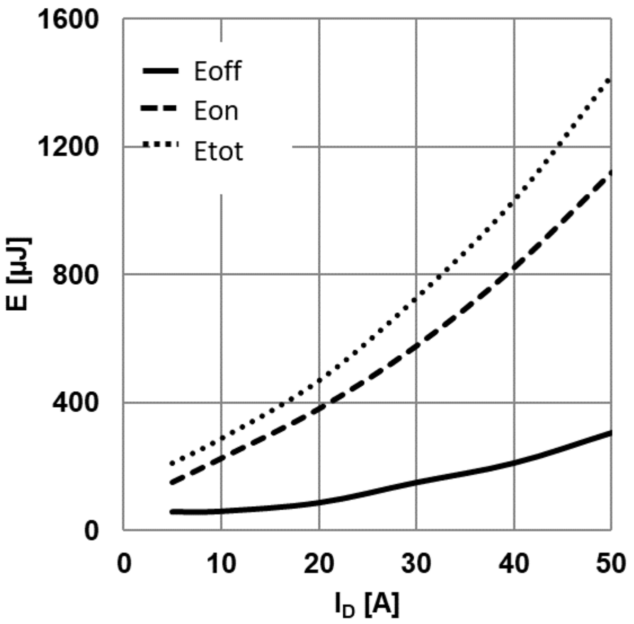


Figure 16 Typical switching energy losses as a function of drain-source current
(E = f(I_{DS}), V_{DD} = 800V, V_{GS} = 0V/15V, $R_{G,ext}$ = 2Ω, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode)

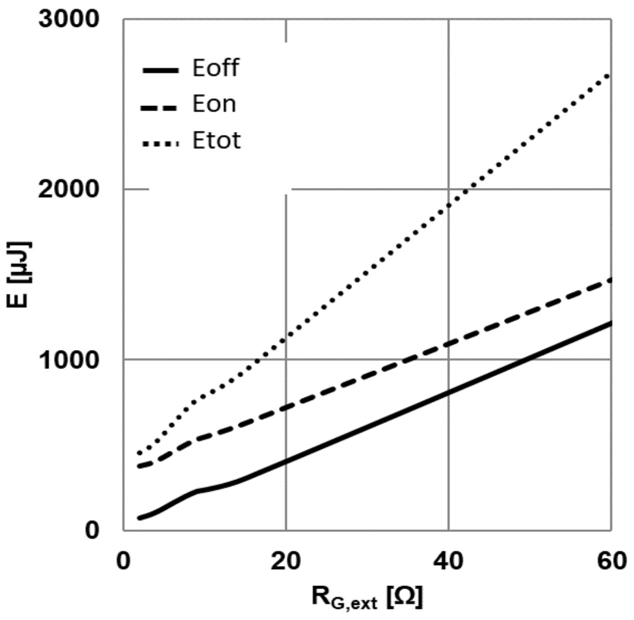


Figure 17 **Typical switching energy losses as a function of gate resistance**
(E = f($R_{G,ext}$), V_{DD} = 800V, V_{GS} = 0V/15V, I_D = 20A, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode)

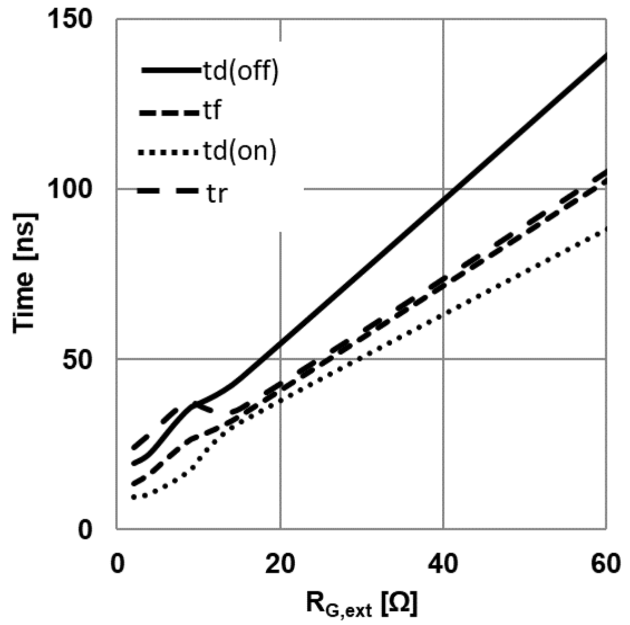


Figure 18 **Typical switching times as a function of gate resistor**
(t = f($R_{G,ext}$), V_{DD} = 800V, V_{GS} = 0V/15V, I_D = 20A, T_{vj} = 175°C, ind. load, test circuit in Fig. E, diode: body diode)

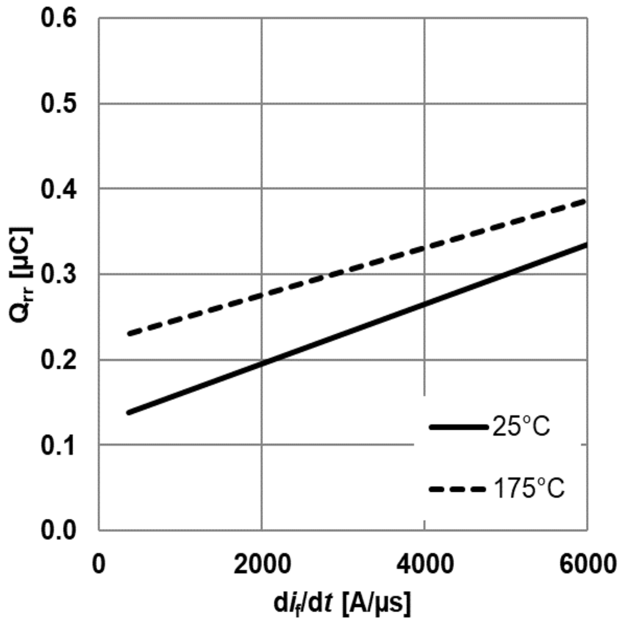


Figure 19 **Typical reverse recovery charge as a function of diode current slope**
(Q_{rr} = f(di_f/dt), V_{DD} = 800V, I_D = 20A, ind. load, test circuit in Fig.E)

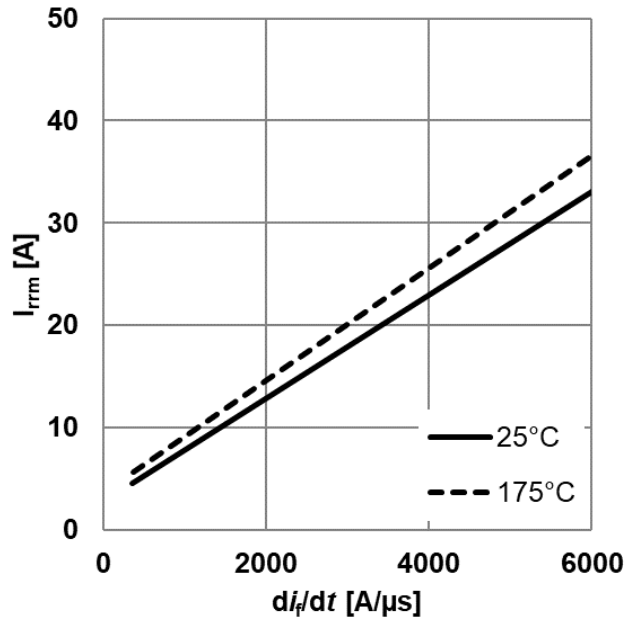


Figure 20 **Typical reverse recovery current as a function of diode current slope**
(I_{rrm} = f(di_f/dt), V_{DD} = 800V, I_D = 20A, ind. load, test circuit in Fig.E)

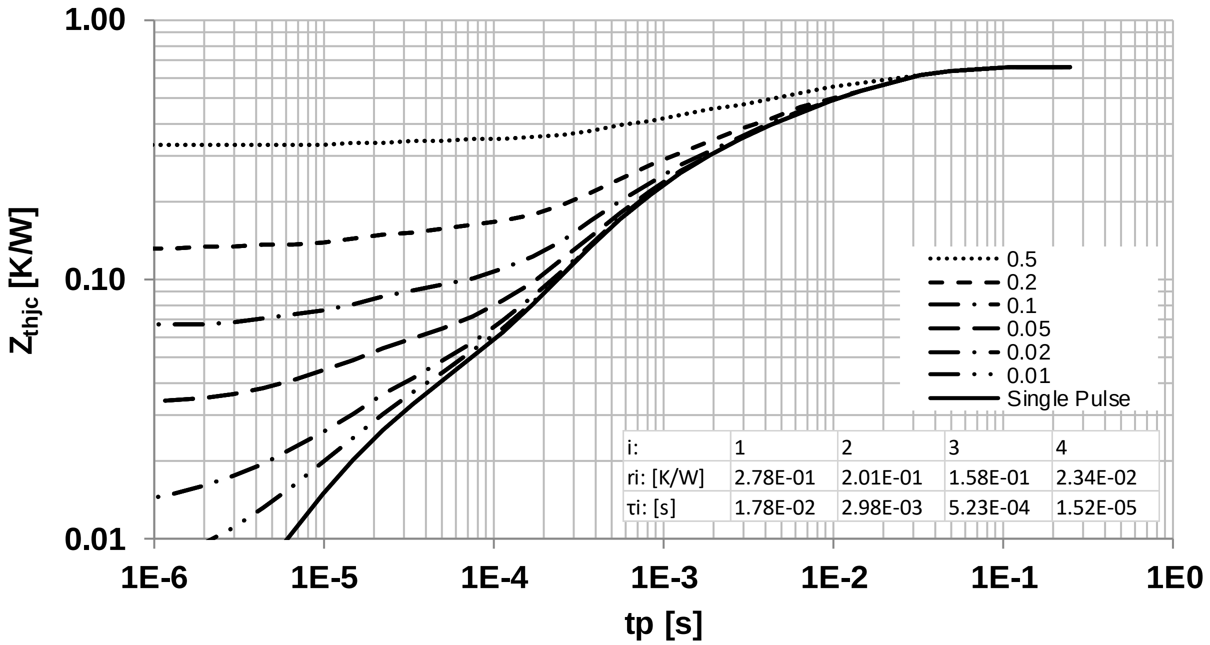
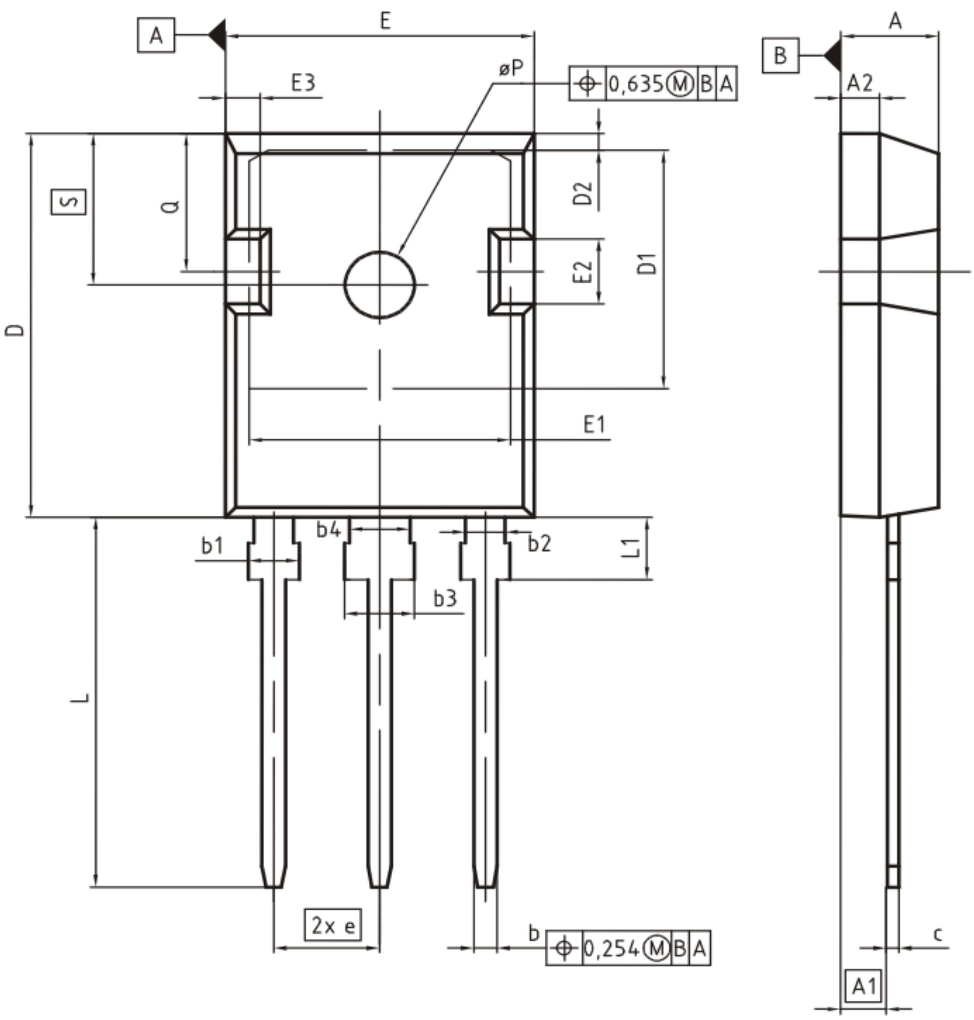


Figure 21 Max. transient thermal resistance (MOSFET/diode)
($Z_{th(j\text{-}c,max)}$ = f(t_P)), parameter $D = t_p/T$, thermal equivalent circuit in Fig. D)

5 Package drawing

PG-TO247-3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.27	2.54	0.089	0.100
A2	1.85	2.16	0.073	0.085
b	1.07	1.33	0.042	0.052
b1	1.90	2.41	0.075	0.095
b2	1.90	2.16	0.075	0.085
b3	2.87	3.38	0.113	0.133
b4	2.87	3.13	0.113	0.123
c	0.55	0.68	0.022	0.027
D	20.80	21.10	0.819	0.831
D1	16.25	17.65	0.640	0.695
D2	0.95	1.35	0.037	0.053
E	15.70	16.13	0.618	0.635
E1	13.10	14.15	0.516	0.557
E2	3.68	5.10	0.145	0.201
E3	1.00	2.60	0.039	0.102
e	5.44 (BSC)		0.214 (BSC)	
N	3		3	
L	19.80	20.32	0.780	0.800
L1	4.10	4.47	0.161	0.176
øP	3.50	3.70	0.138	0.146
Q	5.49	6.00	0.216	0.236
S	6.04	6.30	0.238	0.248

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Figure 22 Package drawing

6 Test conditions

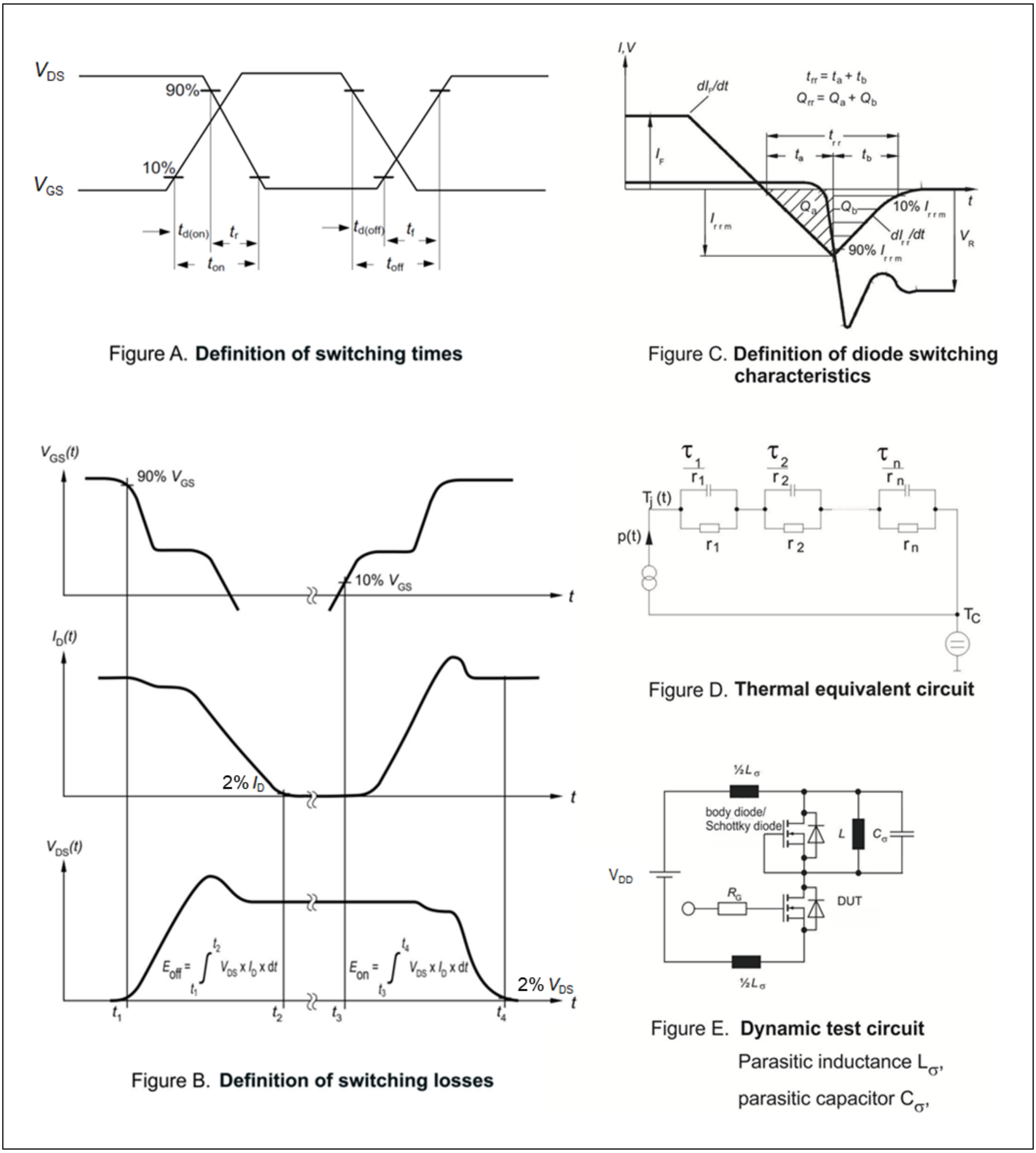

Figure A. **Definition of switching times**

Figure C. **Definition of diode switching characteristics**

Figure B. **Definition of switching losses**

$E_{off} = \int_{t_1}^{t_2} V_{DS} \times I_D \times dt$

$E_{on} = \int_{t_3}^{t_4} V_{DS} \times I_D \times dt$

Figure D. **Thermal equivalent circuit**

Figure E. **Dynamic test circuit**
Parasitic inductance L_{σ},
parasitic capacitor C_{σ},

Figure 23 Test conditions

Revision history

Major changes since the last revision

Document version	Date of release	Description of changes
2.1	2018-03-01	Initial version
2.2	2018-05-30	Important footnote update in chapter 1 Change of conditions for switching dynamic characteristics in chapter 3.2 and 3.3 Additional figures for V_{GS}=0V/15V in chapter 4
2.3	2019-04-18	Add Recommended gate voltage in chapter 1 Add SOA figure in chapter 4 Figures removed for V_{GS}=-5V/15V in chapter 4
2.4	2019-12-10	Move the short circuit time from dynamic characteristics table 5 to maximum ratings table 2. Update the Figure 21 Zth curve.
2.5	2020-06-12	Correction of marking letters in table 1
2.6	2020-12-11	Correction of circuit symbol on page 1

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