

# RTQ120N040S2

## 1200V N-Channel Silicon Carbide Power MOSFET

### 1. Applications

Asymmetrical Bridge  
Converter  
Inverter  
Single Switch Forward  
Flyback



### 2. Features

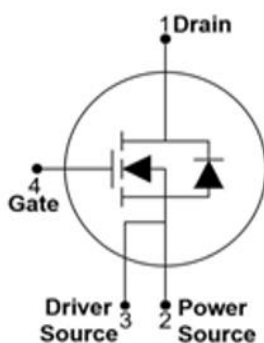
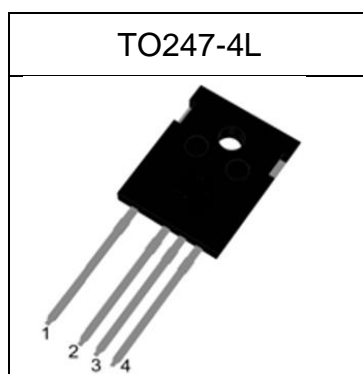
Low drain-source on-resistance:  $R_{DS(ON)} = 40\text{m}\Omega$  (typ.)  
Easy to control Gate switching  
Enhancement mode:  $V_{th} = 2$  to  $4\text{ V}$

**Table 1 Key Performance Parameters**

Parameter	Value	Unit
$V_{DS} @ T_{j,max}$	1200	V
$R_{DS(on),max}$	45	$\text{m}\Omega$
$Q_{g,typ}$	103	nC
$I_{D,pulse}$	182	A

### 3. Packaging and Internal Circuit

Part Name	Package	Marking
RTQ120N040S2	TO-247-4L	RTQ120N040S2



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## 1 Maximum ratings

at  $T_j = 25^\circ\text{C}$ , 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	A	$T_C=25^\circ\text{C}$
		-	-	50	A	$T_C=100^\circ\text{C}$
Avalanche energy, single pulse	$E_{AS}$	-	-	840	mJ	$T_C=25^\circ\text{C}, V_{DD}=50\text{V}, L=1\text{mH}, R_G=25\Omega$
Gate source voltage (static)	$V_{GS}$	-5	-	20	V	static;
Power dissipation	$P_{tot}$	-	-	247	W	$T_C=25^\circ\text{C}$
Derating factor above $25^\circ\text{C}$		-	-	2.1	W/ $^\circ\text{C}$	
Storage temperature	$T_{stg}$	-55	-	175	$^\circ\text{C}$	
Operating junction temperature	$T_j$	-55	-	175	$^\circ\text{C}$	
Soldering Temperature Distance of 1.6mm from case for 10s	$T_L$			300	$^\circ\text{C}$	
Transconductance	GFS	-	6.3	-	S	VDS=20V IDS=20A
		-	5.1	-		VDS=20V IDS=20A, $T_j=150^\circ\text{C}$

<sup>1)</sup> Limited by  $T_{j,max}$ . Maximum Duty Cycle  $D = 0.50$

<sup>2)</sup> Pulse width  $t_p$  limited by  $T_{j,max}$

<sup>3)</sup> Identical low side and high side switch with identical  $R_G$

## 2 Thermal characteristics

Table 3 Thermal characteristics

### TO247

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Thermal resistance, junction - case	$R_{thJC}$	-	0.62	0.8	°C/W	-
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	40	°C/W	device on PCB, minimal footprint

## 3 Electrical characteristics

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

**Table 4 Static characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Drain-source breakdown voltage	$V_{(BR)DSS}$	1200	-	-	V	$V_{GS}=0V, I_D=1mA$
Gate threshold voltage	$V_{(GS)th}$	2.0	2.8	4.0	V	$V_{DS}=V_{GS}, I_D=10mA$
Zero gate voltage drain current	$I_{DSS}$	-	-	1	$\mu\text{A}$	$V_{DS}=1200V, V_{GS}=0V$
Gate-source leakage current	$I_{GSS+}$	-	-	100	nA	$V_{GS}=20V, V_{DS}=0V$
Gate-source leakage current	$I_{GSS-}$	-	-	-100	nA	$V_{GS}=-5V, V_{DS}=0V$
Drain-source on-state resistance	$R_{DS(on)}$	-	40	45	$m\Omega$	$V_{GS}=20V, I_D=20A, T_j=25^\circ\text{C}$
			46			$V_{GS}=20V, I_D=20A, T_j=150^\circ\text{C}$
Gate resistance (Intrinsic)	$R_G$	-	2.1	-	$\Omega$	$f=1\text{MHz}$ , open drain

**Table 5 Dynamic characteristics**

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Input capacitance	$C_{iss}$	-	2479	-	pF	$V_{GS}=0V, V_{DS}=1000V, f=200\text{KHz}$
Output capacitance	$C_{oss}$	-	112	-	pF	$V_{GS}=0V, V_{DS}=1000V, f=200\text{KHz}$
Reverse transfer capacitance	$C_{rss}$	-	7	-	pF	$V_{GS}=0V, V_{DS}=1000V, f=200\text{KHz}$
Turn-on delay time	$t_{d(on)}$	-	16	-	ns	$V_{DD}=800V, V_{GS}=20V, I_D=20A, R_G=0\Omega; T_j=25^\circ\text{C}$
Rise time	$t_r$	-	9	-	ns	
Turn-off delay time	$t_{d(off)}$	-	25	-	ns	
Fall time	$t_f$	-	15	-	ns	
Turn-on Switching Energy	$E_{on}$		1496		$\mu\text{J}$	
Turn-off Switching Energy	$E_{off}$		92		$\mu\text{J}$	

**Table 6 Gate charge characteristics**

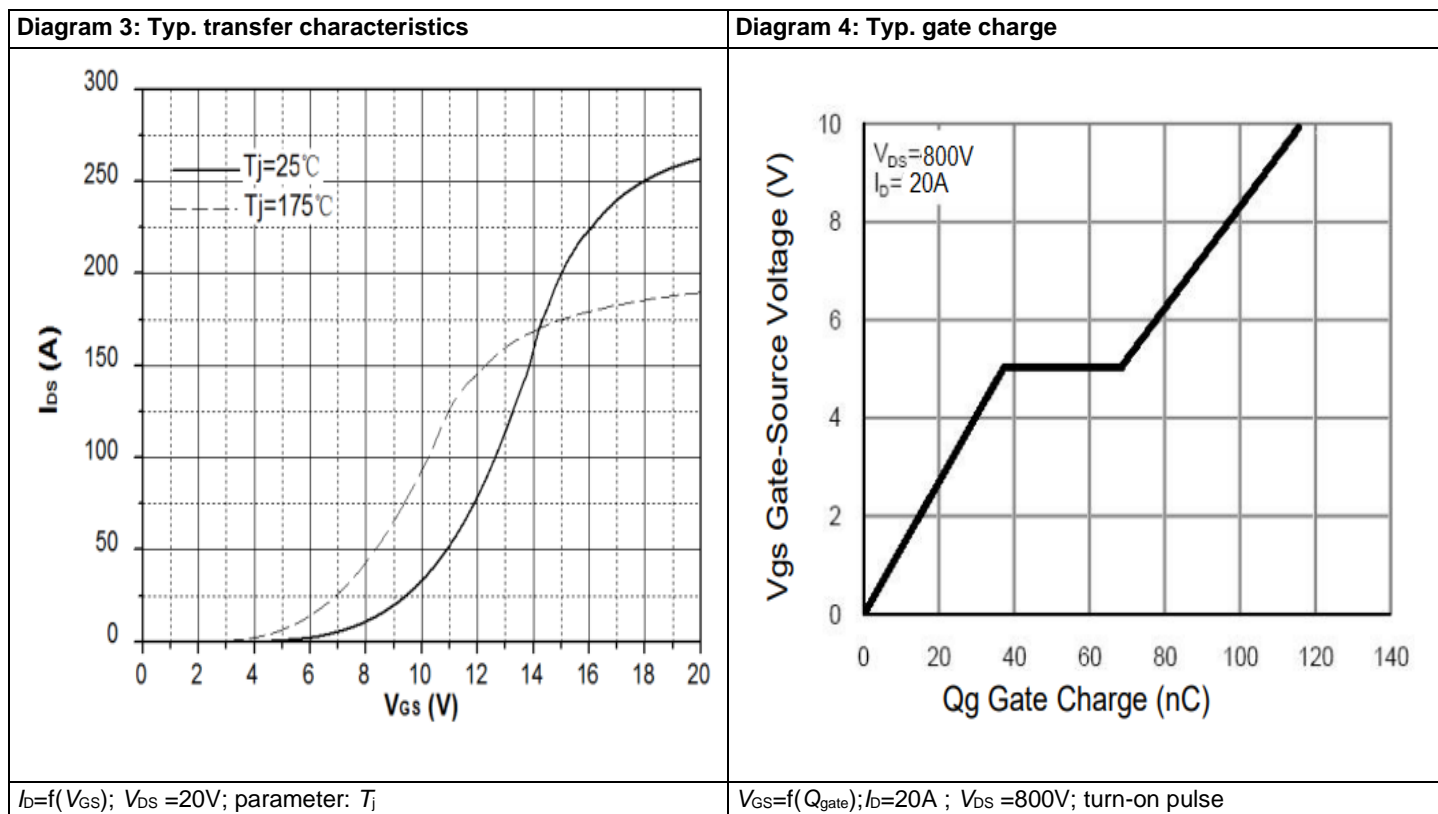
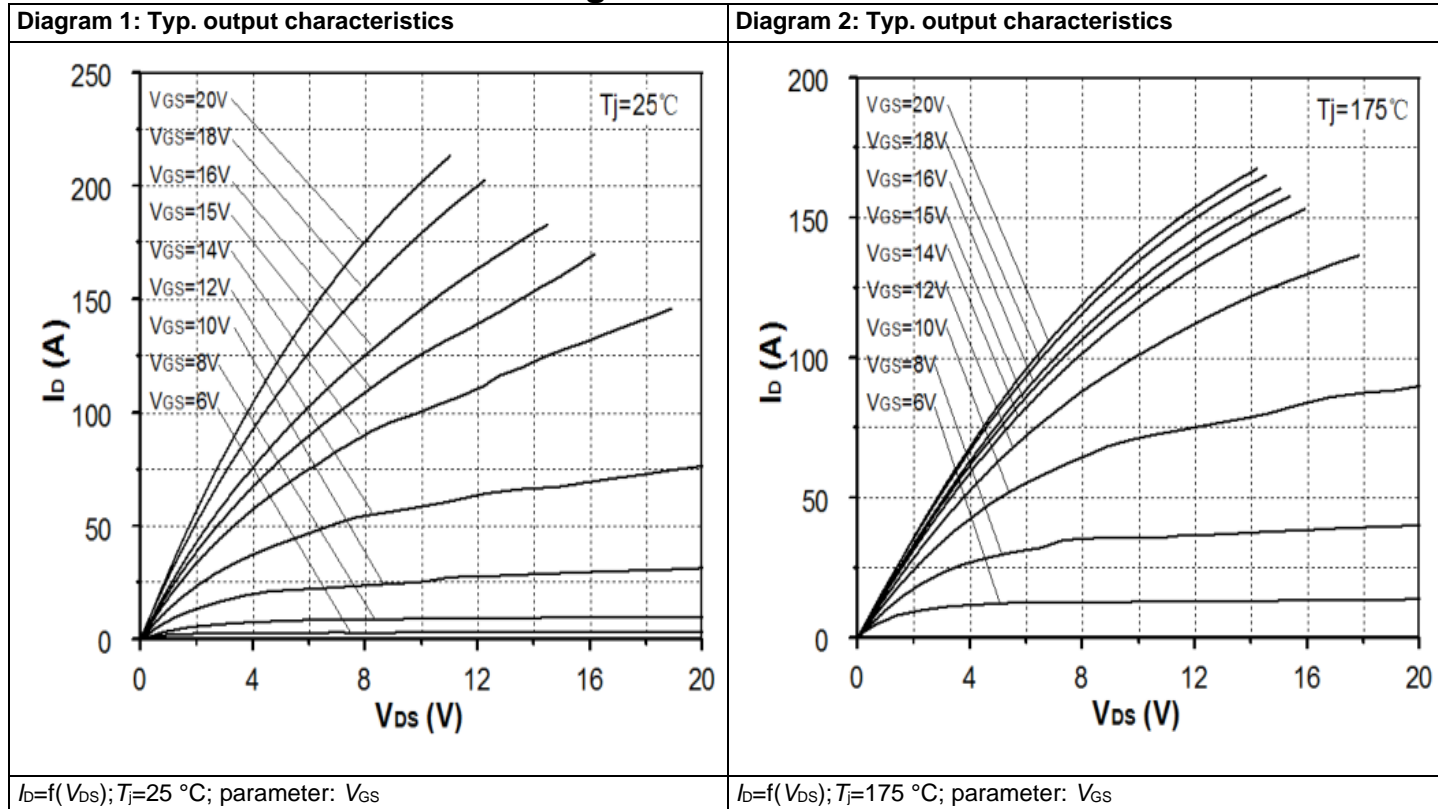
Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Gate to source charge	$Q_{gs}$	-	35	-	nC	$V_{DD}=800V, I_D=20A, V_{GS}=20V$
Gate to drain charge	$Q_{gd}$	-	32	-	nC	$V_{DD}=800V, I_D=20A, V_{GS}=20V$
Gate charge total	$Q_g$	-	103	-	nC	$V_{DD}=800V, I_D=20A, V_{GS}=20V$

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**Table 7 Reverse diode characteristics**

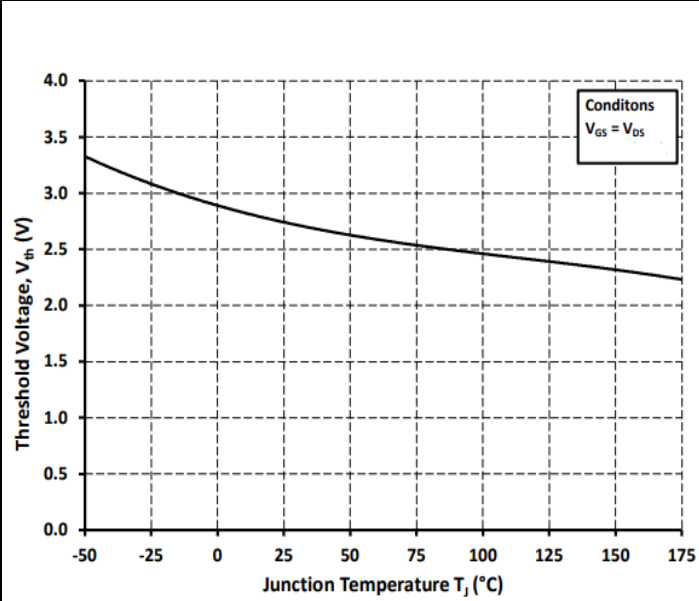
Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Continuous Source Current	$I_{SD}$	-	-	68	A	
Diode forward voltage	$V_{SD}$	-	3.0	-	V	$I_S = 10A, V_{GS} = 0V, T_J = 25^\circ C$
Reverse recovery time	$t_{rr}$	-	91	-	ns	$V_{DD} = 800V, I_D = 20A, +V_{GS} = +15V, -V_{GS} = -4V$ $L_{Load} = 500\mu H, R_g = 0\Omega, T_J = 25^\circ C$
Reverse recovery charge	$Q_{rr}$	-	312	-	nC	
Peak reverse recovery current	$I_{rrm}$	-	10.8	-	A	

### 4 Electrical characteristics diagram



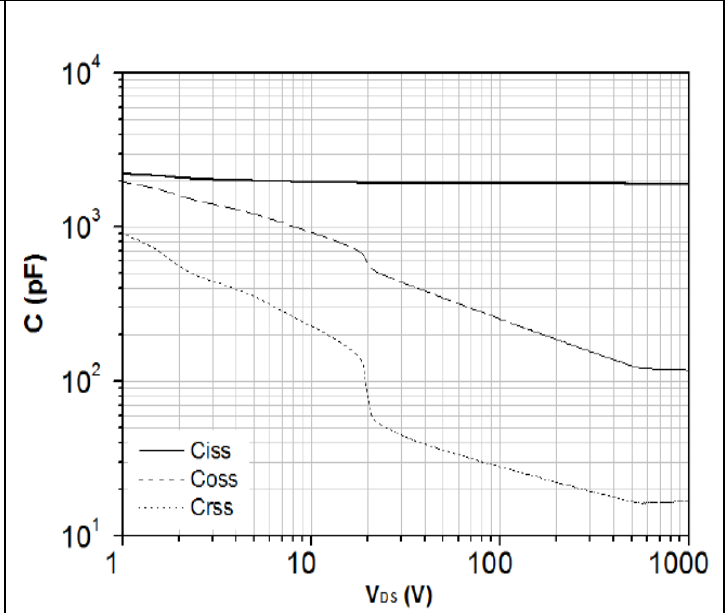
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Diagram 5: Typical gate-source threshold voltage as a function of junction temperature



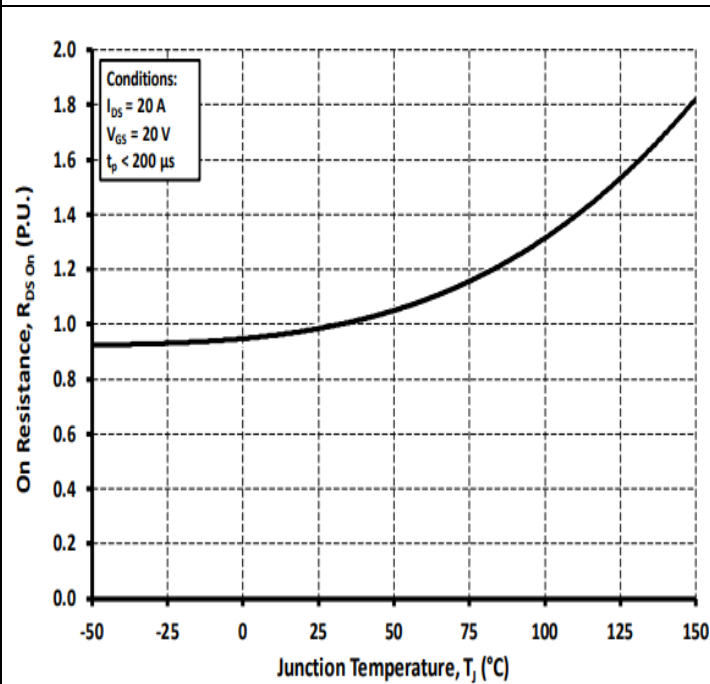
$V_{GS(th)}=f(T_j)$ ;  $I_{DS}=10\text{mA}$ ;  $V_{GS}=V_{DS}$

Diagram 6: Typ. Capacitance as a function of drain-source voltage



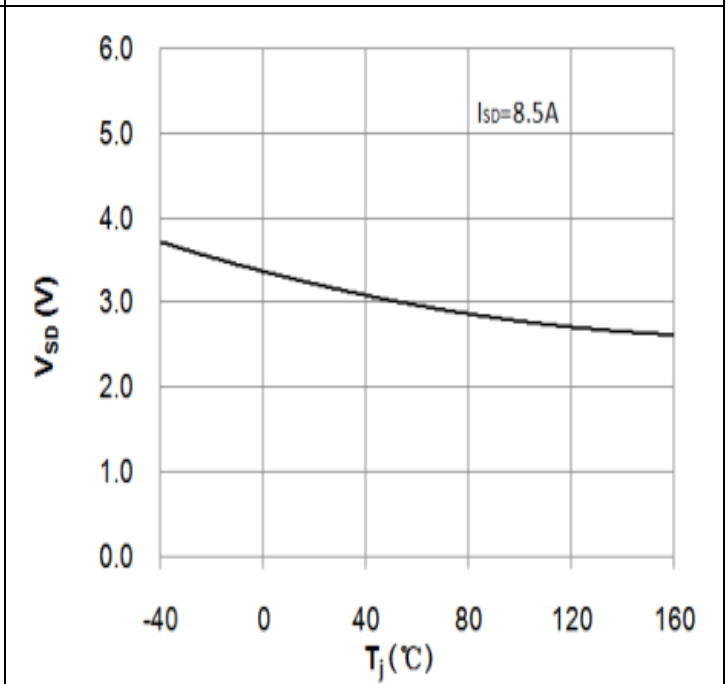
$C=f(V_{DS})$ ;  $V_{GS}=0\text{V}$ ;  $f=1\text{MHz}$

Diagram 7: Normalized on-resistance as a function of junction temperature



$R_{DS(ON)}=f(T_j)$ ;  $I_{DS}=20\text{A}$

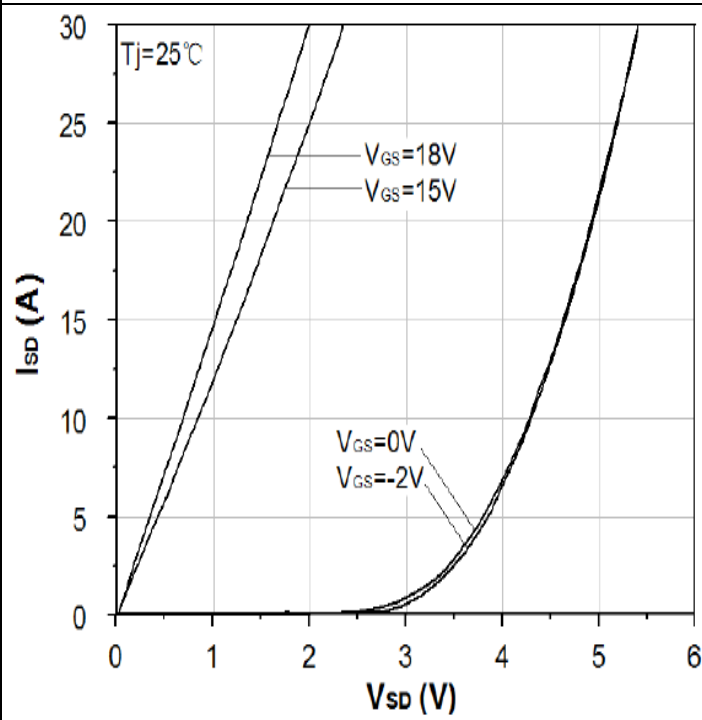
Diagram 8: Typical body diodes forward voltage as function of junction temperature



$V_{SD}=f(T_j)$ ;  $V_{GS}=0\text{V}$ ;  $I_{SD}=10\text{A}$

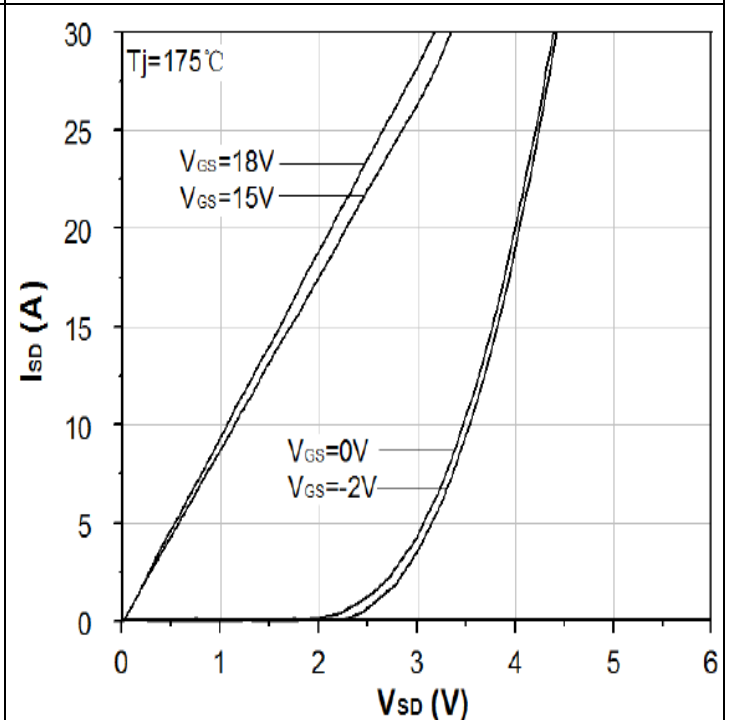
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Diagram 9: Typical body diodes forward current as function of forward voltage,  $V_{GS}$  as parameter



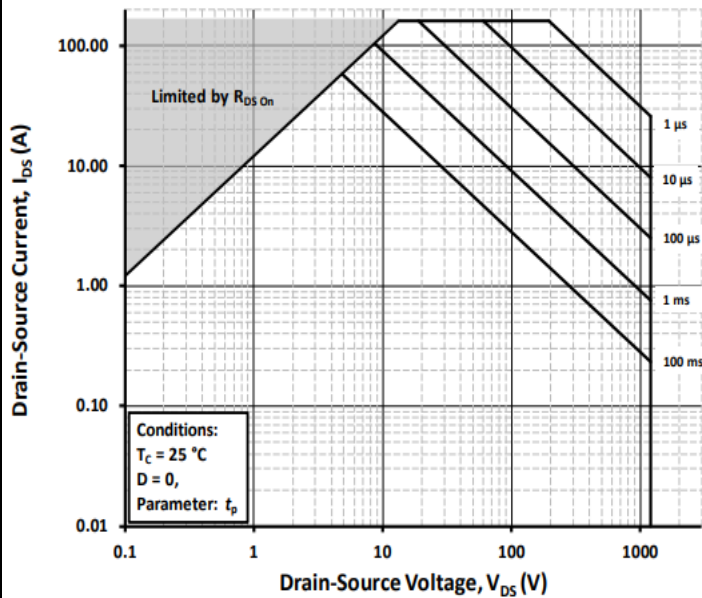
$$I_{SD} = f(V_{SD}); T_J = 25^\circ\text{C}$$

Diagram 10: Typical body diodes forward current as function of forward voltage,  $V_{GS}$  as parameter



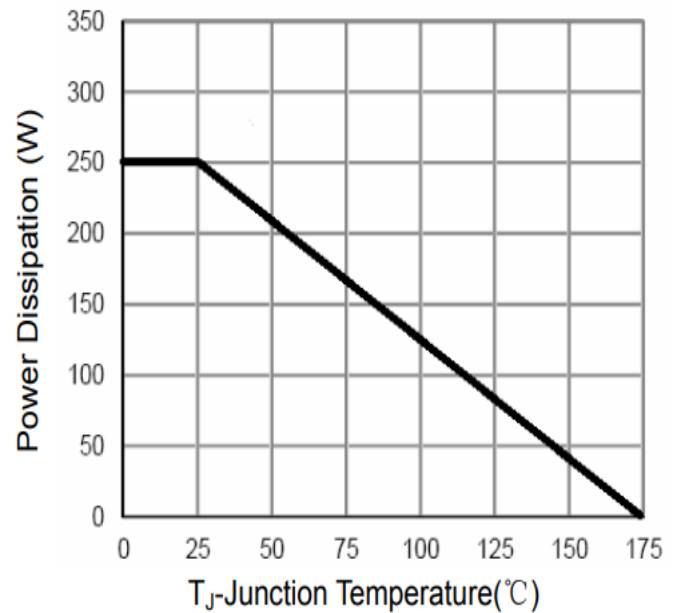
$$I_{SD} = f(V_{SD}); T_J = 175^\circ\text{C}$$

Diagram 11: Safe operating area(SOA)



$$V_{GS} = 0/18\text{V}; T_C = 25^\circ\text{C}; T_J < 175^\circ\text{C}$$

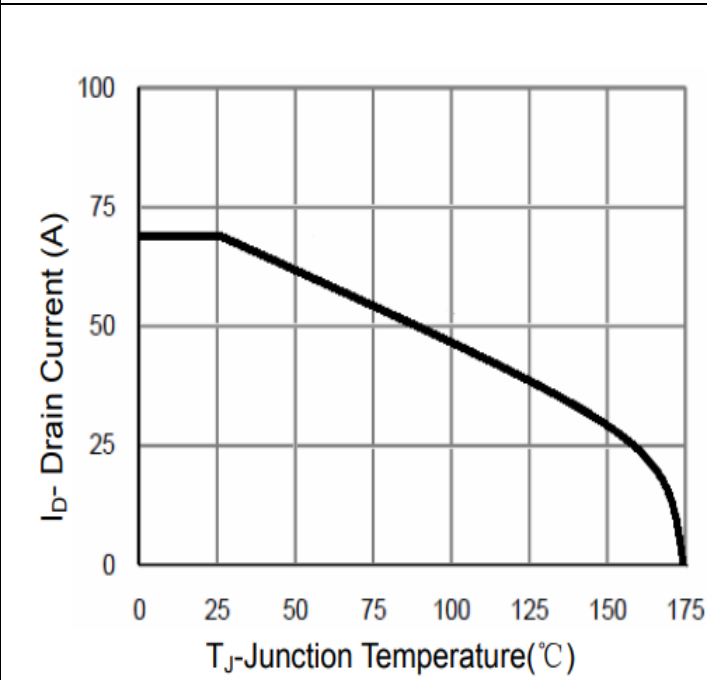
Diagram 12: Power dissipation as a function of case temperature limited by bond wire



$$P_{tot} = f(T_C)$$

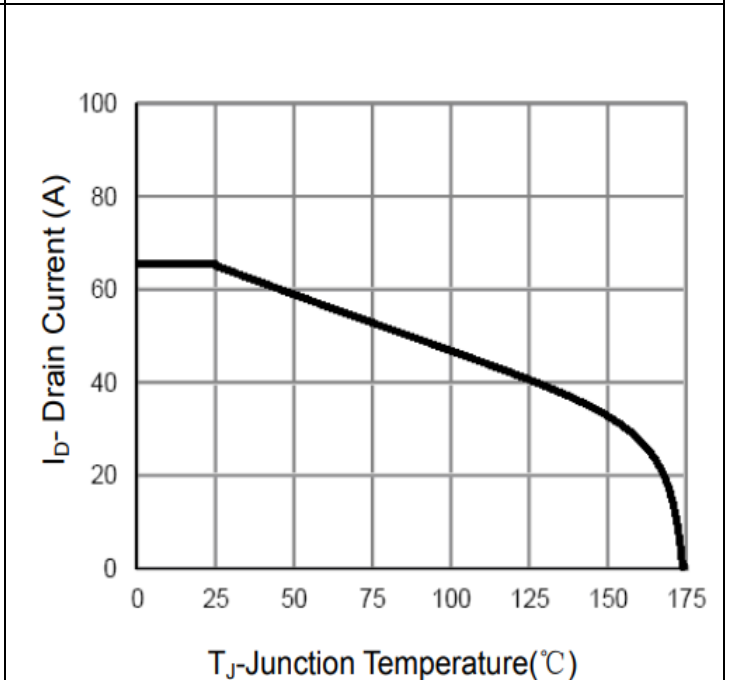
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Diagram 13: Maximum DC drain to source current as a function of case temperature limited by bond wire



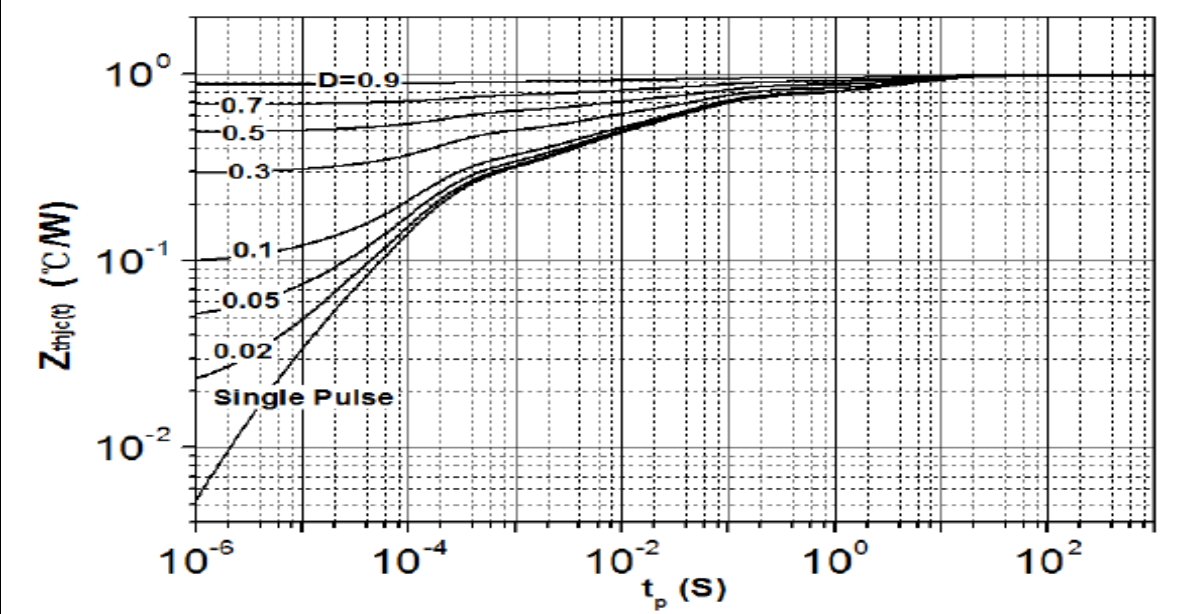
$$I_{DS} = f(T_C)$$

Diagram 14: Maximum source to drain current as a function of case temperature limited by bond wire



$$I_{SD} = f(T_C), V_{GS} = 0V$$

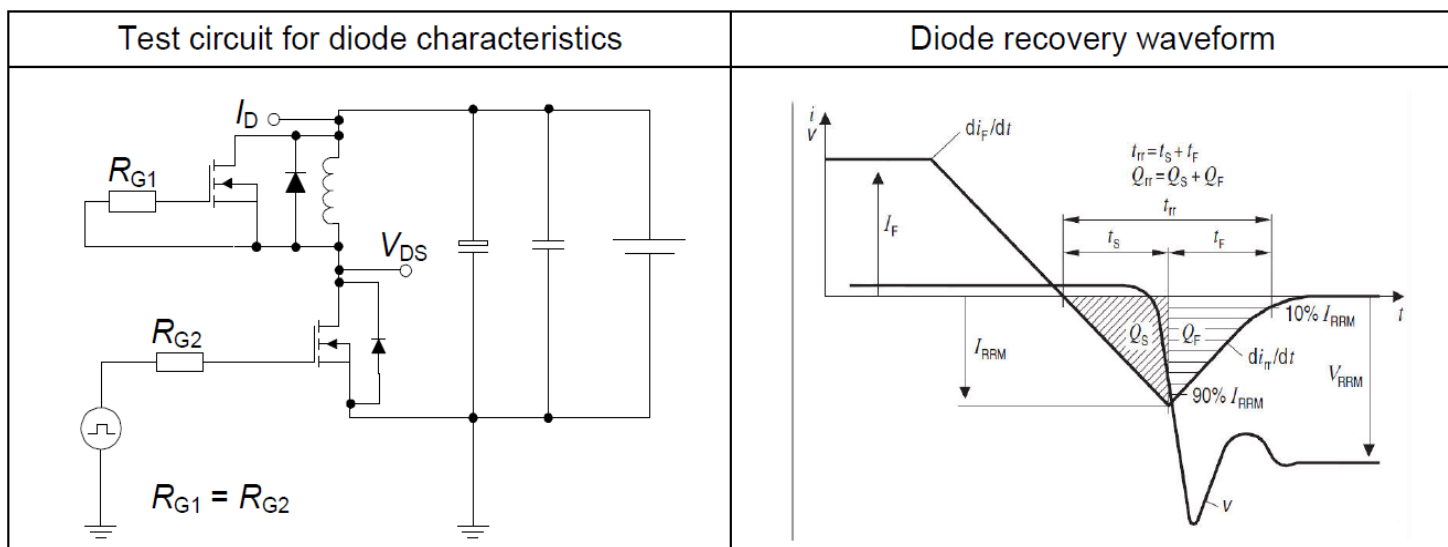
Diagram 15: Max. transient thermal resistance(MOSFET/diodes)



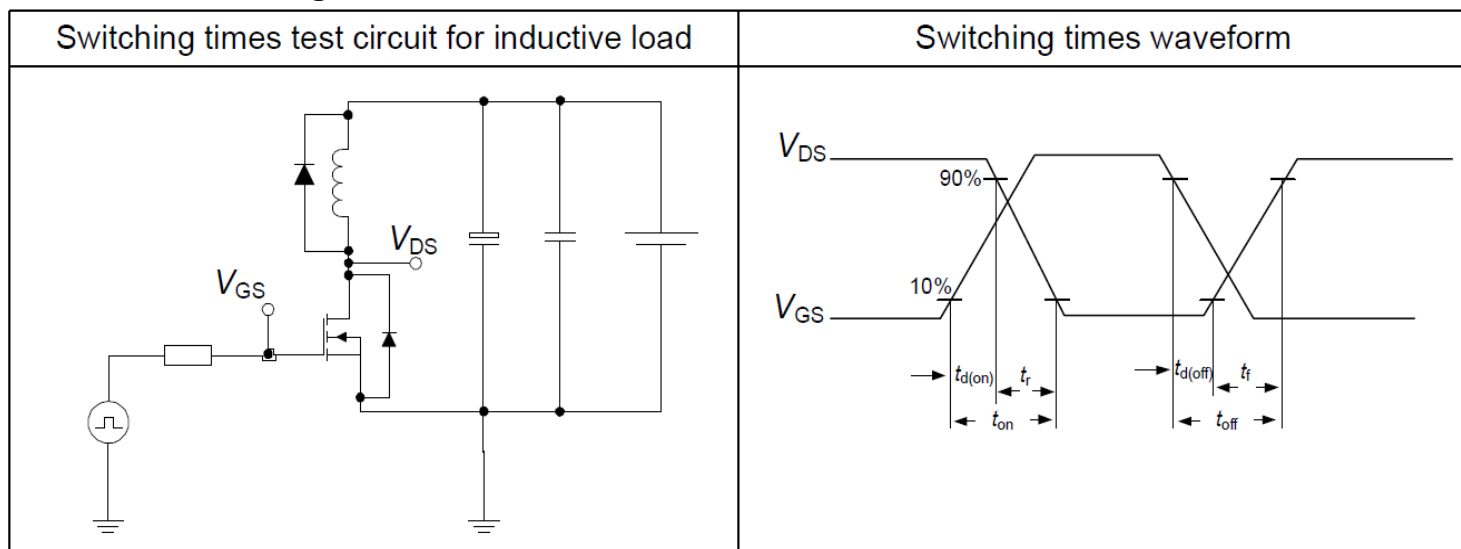
$$Z_{th(j-c,max)} = f(t_p), \text{parameter } D = t_p / T$$

## 5 Test Circuits

**Table 8 Diode characteristics**

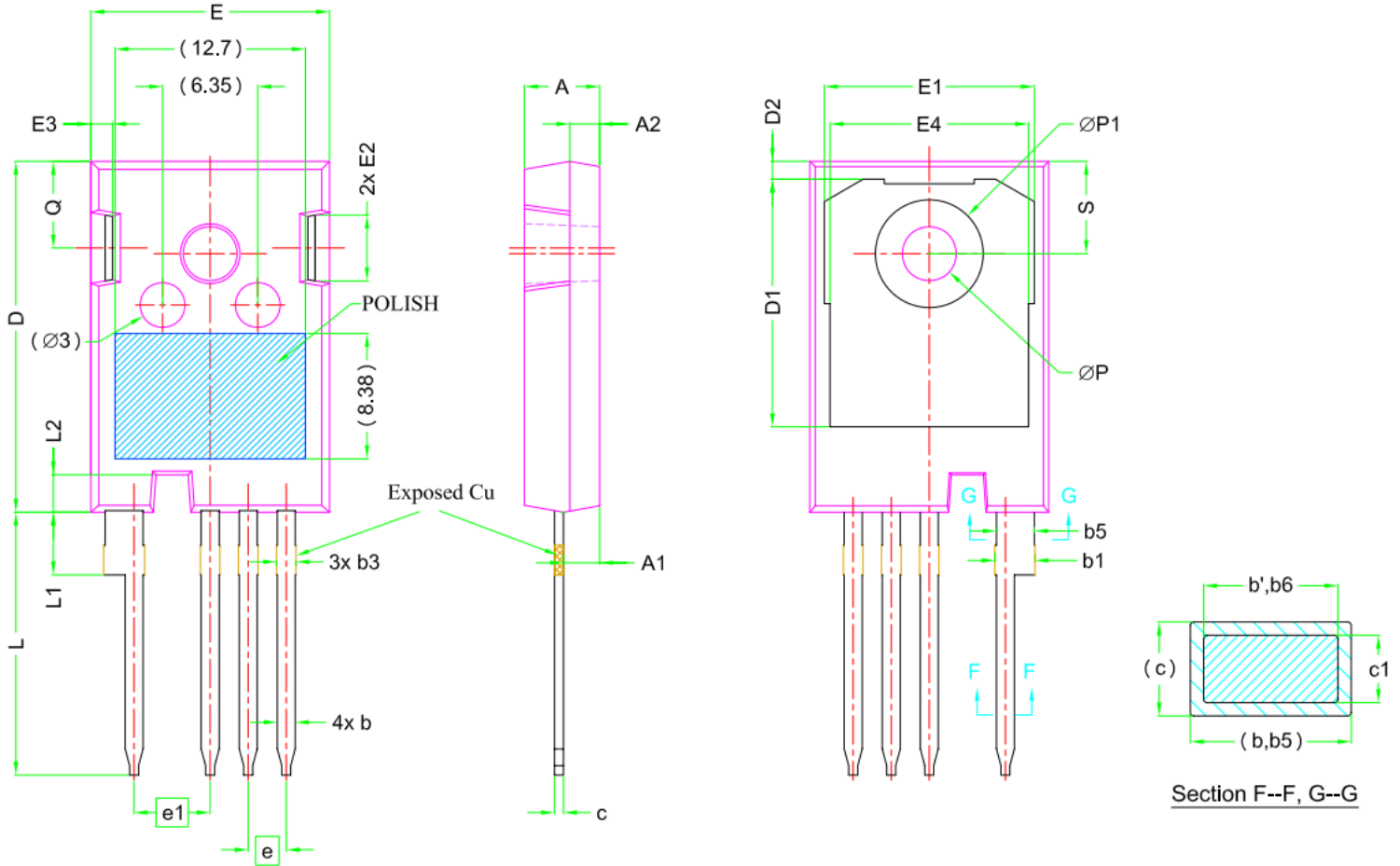


**Table 9 Switching times**



## 6 Package Outlines

TO-247-4L



SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	4.83	5.02	5.21
A1	2.29	2.41	2.54
A2	1.91	2.00	2.16
b'	1.07	1.20	1.28
b	1.07	1.20	1.33
b1	2.39	2.67	2.94
b3	1.07	1.30	1.60
b5	2.39	2.53	2.69
b6	2.39	2.53	2.64
c	0.55	0.60	0.68
c1	0.55	0.60	0.65
D	23.30	23.45	23.60
D1	16.25	16.55	17.65
D2	0.95	1.19	1.25
E	15.75	15.94	16.13
E1	13.10	14.02	14.15
E2	3.68	4.40	5.10
E3	1.00	1.45	1.90
E4	12.38	13.26	13.43
e	2.54 BSC		
e1	5.08 BSC		
L	17.31	17.57	17.82
L1	3.97	4.19	4.37
L2	2.35	2.50	2.65
ØP	3.51	3.61	3.65
ØP1	7.19 REF.		
Q	5.49	5.79	6.00
S	6.04	6.17	6.30

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## Revision History

Revision	Date	Subjects (major changes since last revision)
1.0	2022-10-21	Preliminary version