

NSF040120L4A0

1200 V, 40 mΩ, N-channel SiC MOSFET

2 February 2024

Product data sheet

1. General description

The NSF040120L4A0 is a Silicon Carbide based 1200 V power MOSFET in a well-established 4-pin TO-247 plastic package for through hole PCB mounting technology. The excellent R_{DSon} temperature stability combined with its fast switching speed makes it a product of choice in high power and high voltage industrial applications like E-vehicle charging infrastructure, photovoltaic inverters and motor drives.

2. Features and benefits

- Excellent R_{DSon} temperature stability
- Very low switching losses
- Fast reverse recovery
- Fast switching speed
- Temperature independent turn-off switching losses
- Very fast and robust intrinsic body diode
- Faster commutation and improved switching due to the additional Kelvin source pin

3. Applications

- E-vehicle charging infrastructure
- Photovoltaic inverters
- Switch mode power supply
- Uninterruptable power supply
- Motor drives

4. Quick reference data

Table 1. Quick reference data

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DS}	drain-source voltage		-	-	1200	V
V_{GS}	gate-source voltage		[1] -10	-	22	V
I_D	drain current	$T_c = 25\text{ °C}$	[2] -	-	65	A
		$T_c = 100\text{ °C}$	[2] -	-	46	A
I_{DM}	peak drain current	pulsed; t_p limited by T_j (max)	[3] -	-	160	A
Static characteristics						
R_{DSon}	drain-source on-state resistance	$V_{GS} = 15\text{ V}; I_D = 40\text{ A}; T_j = 25\text{ °C}$	-	40	60	mΩ

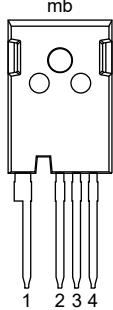
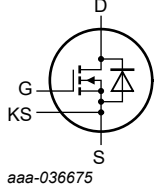
[1] Recommended turn off gate voltage is -5 V. Recommended turn on gate voltage is 15 V. Do not use with $V_{GSon} < 13\text{ V}$.

[2] Limited by T_j (max) and $R_{th(j-c)}$ (max).

[3] Designed value (not tested).

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	D	drain	 <p>TO-247-4 (SOT8071-1)</p>	 <p>aaa-036675</p>
2	S	source		
3	KS	Kelvin source		
4	G	gate		
mb	D	mounting base; connected to drain		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
NSF040120L4A0	TO-247-4	Plastic single-ended through-hole package; heatsink mounted; 1 mounting hole; 4-lead TO-247-4	SOT8071-1

7. Marking

Table 4. Marking codes

Type number	Marking code
NSF040120L4A0	NSF0412A0

8. Limiting values

Table 5. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{DS}	drain-source voltage			-	1200	V
V_{GS}	gate-source voltage		[1]	-10	22	V
I_D	drain current	$T_c = 25\text{ °C}$	[2]	-	65	A
		$T_c = 100\text{ °C}$	[2]	-	46	A
I_{DM}	peak drain current	pulsed; t_p limited by T_j (max)	[3]	-	160	A
P_{tot}	total power dissipation	$T_c = 25\text{ °C}$	[2]	-	306	W
T_j	junction temperature			-55	175	°C
T_{stg}	storage temperature			-55	150	°C
$T_{sld(M)}$	peak soldering temperature			-	260	°C
Source-drain diode						
I_S	source current	$T_c = 25\text{ °C}$	[2]	-	54	A
I_{SM}	peak source current	pulsed; limited by T_j (max)	[3]	-	120	A

[1] Recommended turn off gate voltage is -5 V. Recommended turn on gate voltage is 15 V. Do not use with $V_{GSon} < 13\text{ V}$.

[2] Limited by T_j (max) and $R_{th(j-c)}$ (max).

[3] Designed value (not tested).

9. Thermal characteristics

Table 6. Thermal characteristics

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-c)}$	thermal resistance from junction to case			-	0.41	0.49	K/W

10. Characteristics

Table 7. Characteristics

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
Static characteristics							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 10 \mu A; V_{GS} = 0 V; T_j = 25 \text{ }^\circ C$	1200	-	-	V	
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 4 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ C$	[1]	1.7	2.3	2.9	V
I_{DSS}	drain leakage current	$V_{DS} = 1200 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	-	100	μA	
I_{GSS}	gate leakage current	$V_{GS} = 22 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	-	100	nA	
		$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	-	100	nA	
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 15 \text{ V}; I_D = 40 \text{ A}; T_j = 25 \text{ }^\circ C$	-	40	60	mΩ	
		$V_{GS} = 15 \text{ V}; I_D = 40 \text{ A}; T_j = 125 \text{ }^\circ C$	-	45	-	mΩ	
		$V_{GS} = 15 \text{ V}; I_D = 40 \text{ A}; T_j = 175 \text{ }^\circ C$	-	53	-	mΩ	
		$V_{GS} = 18 \text{ V}; I_D = 40 \text{ A}; T_j = 25 \text{ }^\circ C$	-	31	-	mΩ	
		$V_{GS} = 18 \text{ V}; I_D = 40 \text{ A}; T_j = 175 \text{ }^\circ C$	-	49	-	mΩ	
g_{fs}	forward transconductance	$V_{DS} = 10 \text{ V}; I_D = 40 \text{ A}; T_j = 25 \text{ }^\circ C$	-	19	-	S	
$R_{G(int)}$	internal gate resistance	$f = 0.5 \text{ MHz}; T_j = 25 \text{ }^\circ C$	-	2.3	-	Ω	
Dynamic characteristics							
$Q_{G(tot)}$	total gate charge	$V_{DD} = 800 \text{ V}; I_D = 40 \text{ A}; V_{GS} = -5/+15 \text{ V}; T_j = 25 \text{ }^\circ C$	-	95	-	nC	
Q_{GS}	gate-source charge		-	40	-	nC	
Q_{GD}	gate-drain charge		-	30	-	nC	
C_{iss}	input capacitance	$V_{DD} = 800 \text{ V}; f = 0.5 \text{ MHz}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ C$	-	2600	-	pF	
C_{oss}	output capacitance		-	136	-	pF	
C_{rss}	reverse transfer capacitance		-	6	-	pF	
$t_{d(on)}$	turn-on delay time	$V_{DD} = 800 \text{ V}; I_D = 40 \text{ A}; R_{G(ext)} = 2.2 \text{ } \Omega; L_L = 82 \text{ } \mu H; V_{GS} = -5/+15 \text{ V}; T_j = 25 \text{ }^\circ C$	-	22	-	ns	
t_r	rise time		-	24	-	ns	
$t_{d(off)}$	turn-off delay time		-	22	-	ns	
t_f	fall time		-	8	-	ns	
E_{on}	turn-on switching loss		-	607	-	μJ	
E_{off}	turn-off switching loss		-	100	-	μJ	
Source-drain diode							
V_{SD}	source-drain voltage	$I_S = 40 \text{ A}; V_{GS} = -5 \text{ V}; T_j = 25 \text{ }^\circ C$	-	4.4	-	V	
t_{rr}	reverse recovery time	$V_{DD} = 800 \text{ V}; I_S = 40 \text{ A}; dI_S/dt = 5980 \text{ A}/\mu s; V_{GS} = -5 \text{ V}; T_j = 25 \text{ }^\circ C$	-	8	-	ns	
Q_r	recovered charge		-	103	-	nC	

[1] Measured according to JEP183.

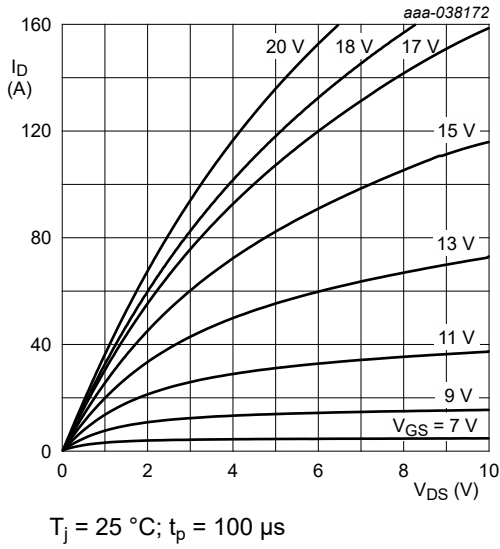


Fig. 1. Output characteristics: drain current as a function of drain-source voltage; typical values

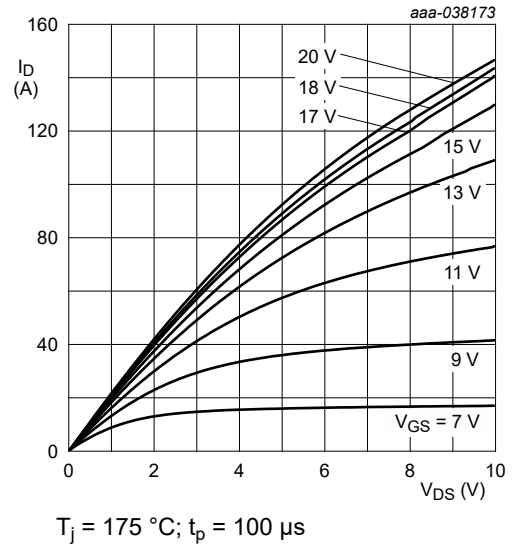


Fig. 2. Output characteristics: drain current as a function of drain-source voltage; typical values

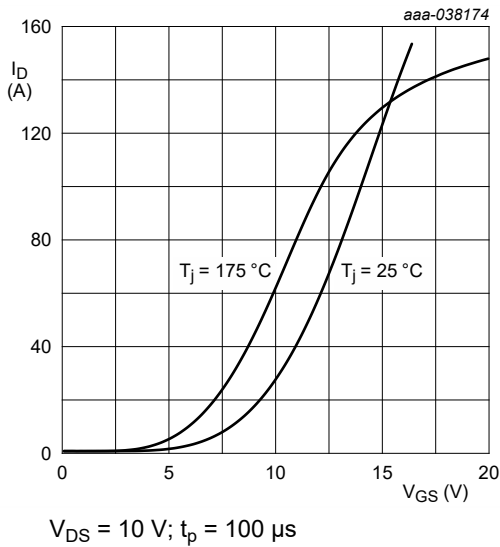


Fig. 3. Transfer characteristics: drain current as a function of gate-source voltage; typical values

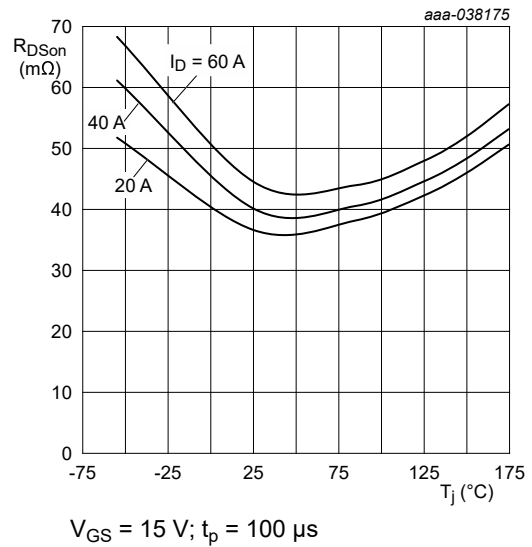


Fig. 4. Drain-source on-state resistance as a function of junction temperature; typical values

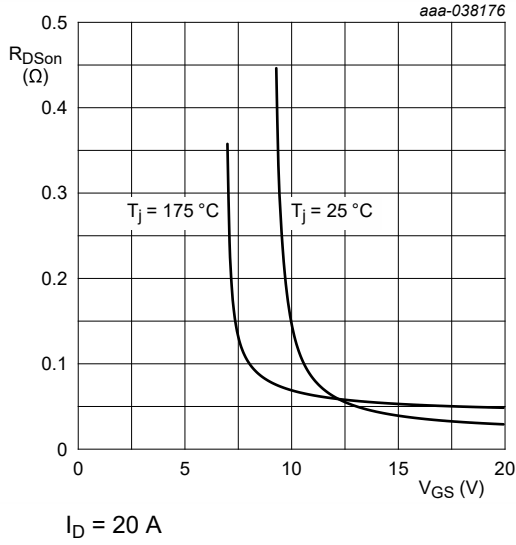


Fig. 5. Drain-source on-state resistance as a function of threshold voltage

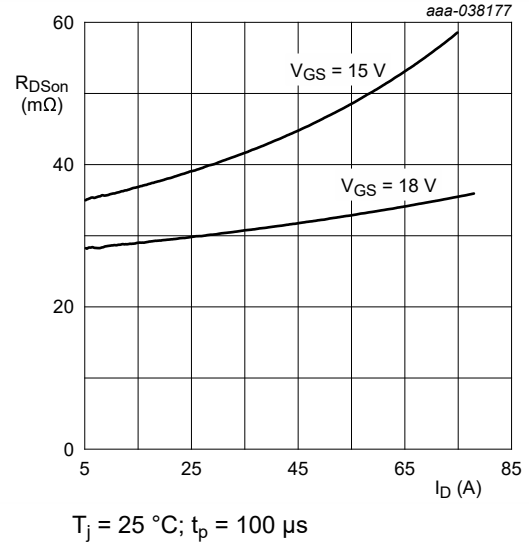


Fig. 6. Drain-source on-state resistance as a function of drain current; typical values

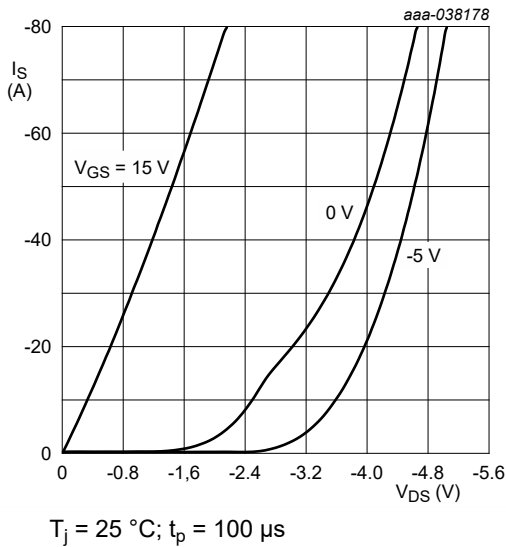


Fig. 7. Source current as a function of source-drain voltage; typical values (third quadrant characteristics)

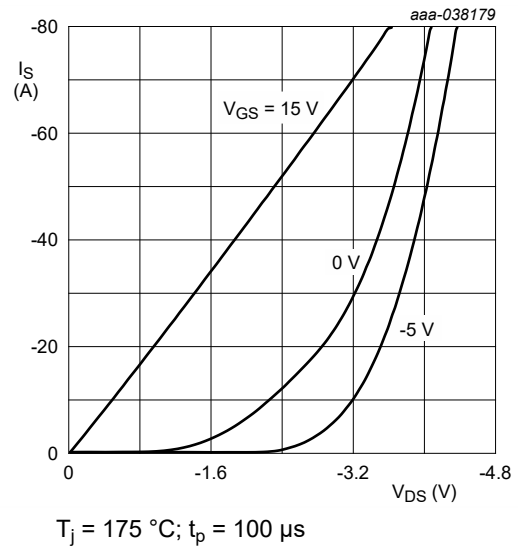


Fig. 8. Source current as a function of source-drain voltage; typical values (third quadrant characteristics)

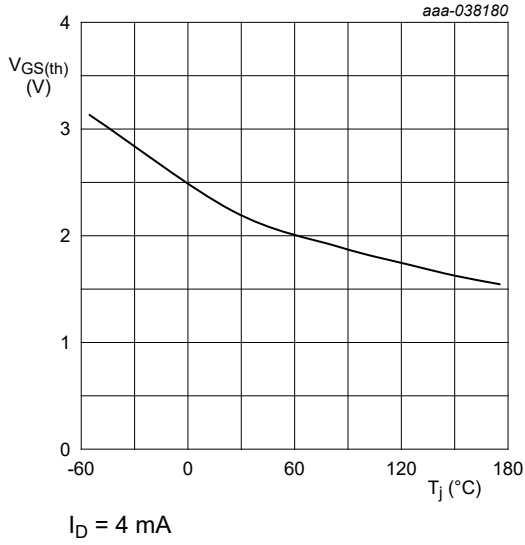


Fig. 9. Gate-source threshold voltage as a function of junction temperature; typical values

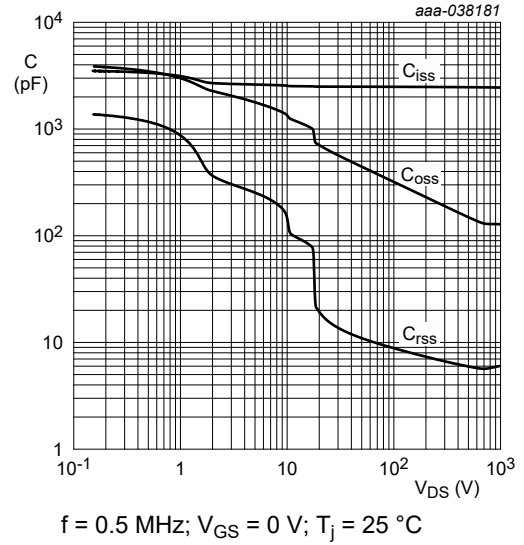


Fig. 10. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

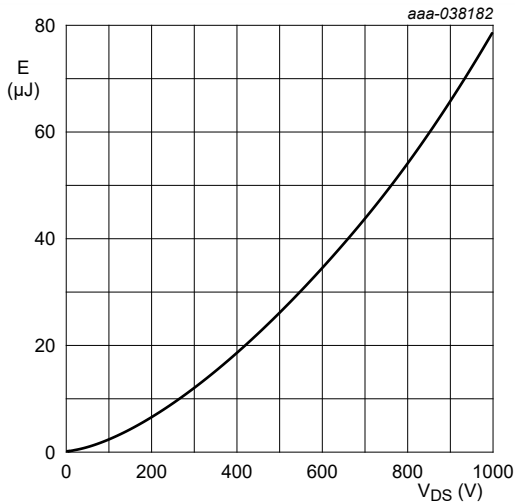


Fig. 11. C_{oss} stored energy as a function of drain-source voltage; typical values

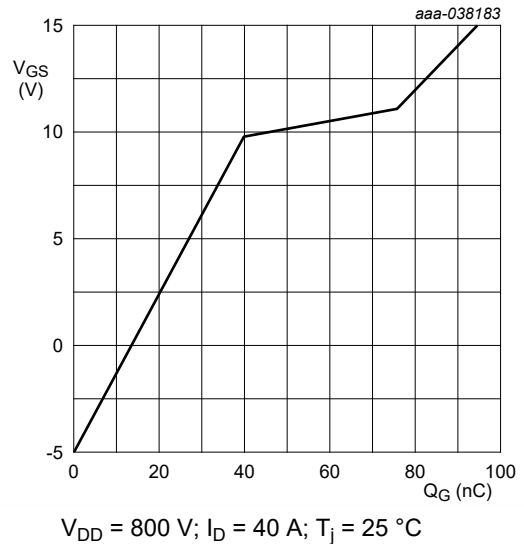
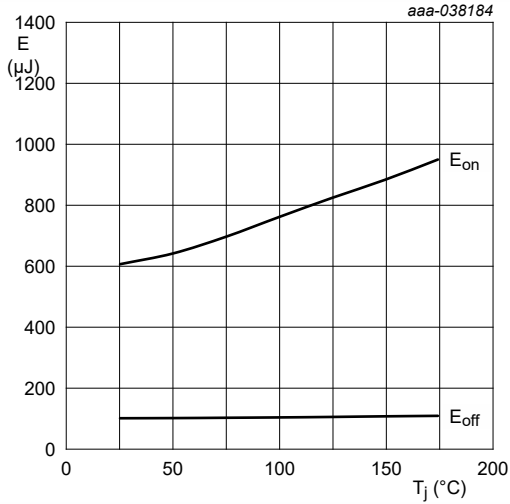
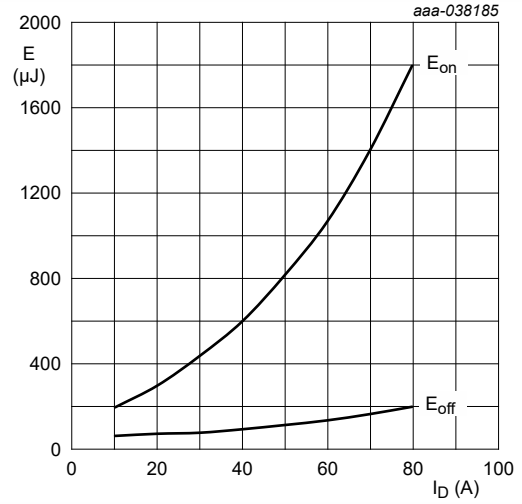


Fig. 12. Gate-source voltage as a function of gate charge; typical values



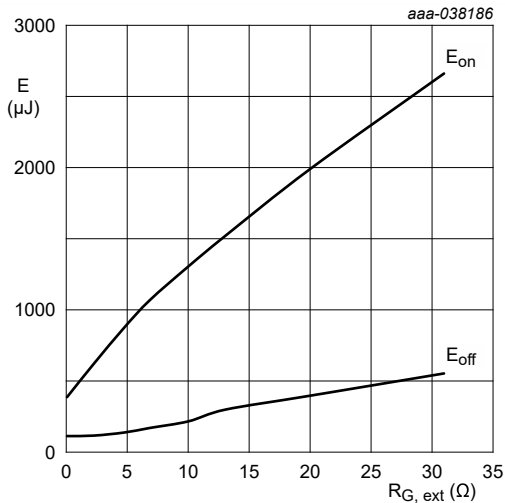
$V_{DD} = 800\text{ V}$; $I_D = 40\text{ A}$; $V_{GS} = -5/15\text{ V}$; $R_{G, ext} = 2.2\ \Omega$; $L = 82\ \mu\text{H}$

Fig. 13. Switching loss as a function of junction temperature; typical values



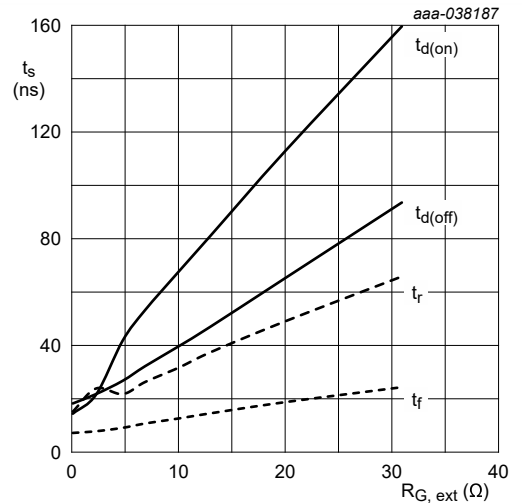
$V_{DD} = 800\text{ V}$; $V_{GS} = -5/15\text{ V}$; $R_{G, ext} = 2.2\ \Omega$; $L = 82\ \mu\text{H}$; $T_j = 25\text{ °C}$

Fig. 14. Switching loss as a function of drain current; typical values



$V_{DD} = 800\text{ V}$; $I_D = 40\text{ A}$; $V_{GS} = -5/15\text{ V}$; $L = 82\ \mu\text{H}$; $T_j = 25\text{ °C}$

Fig. 15. Switching loss as a function of external gate resistance; typical values



$V_{DD} = 800\text{ V}$; $I_D = 40\text{ A}$; $V_{GS} = -5/15\text{ V}$; $L = 82\ \mu\text{H}$; $T_j = 25\text{ °C}$

Fig. 16. Switching times as a function of external gate resistance; typical values

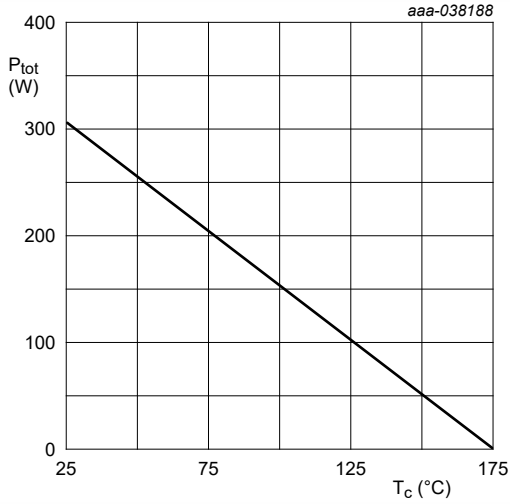


Fig. 17. Power dissipation derating as a function of case temperature; maximum values

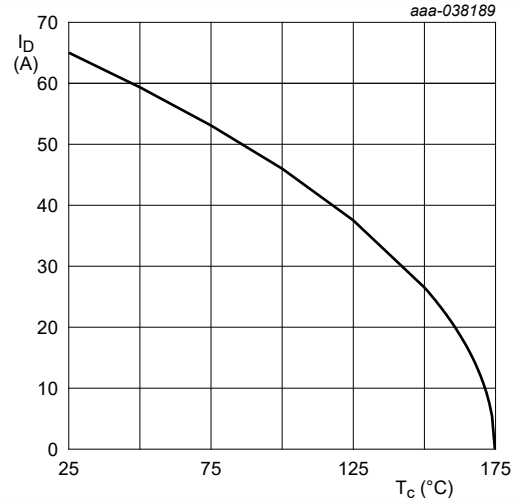
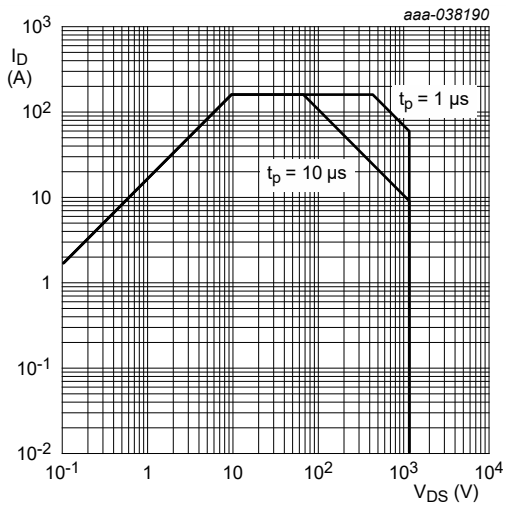


Fig. 18. Continuous drain current as a function of case temperature; maximum values



single pulse; $T_c = 25 \text{ °C}$

Fig. 19. Maximum safe operating area (SOA)

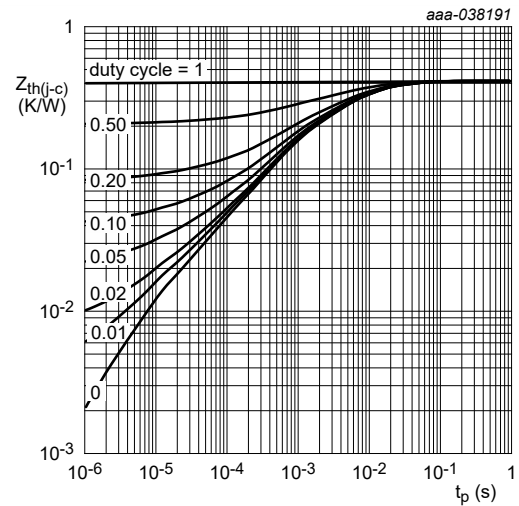


Fig. 20. Transient thermal impedance from junction to case as a function of pulse duration; typical values

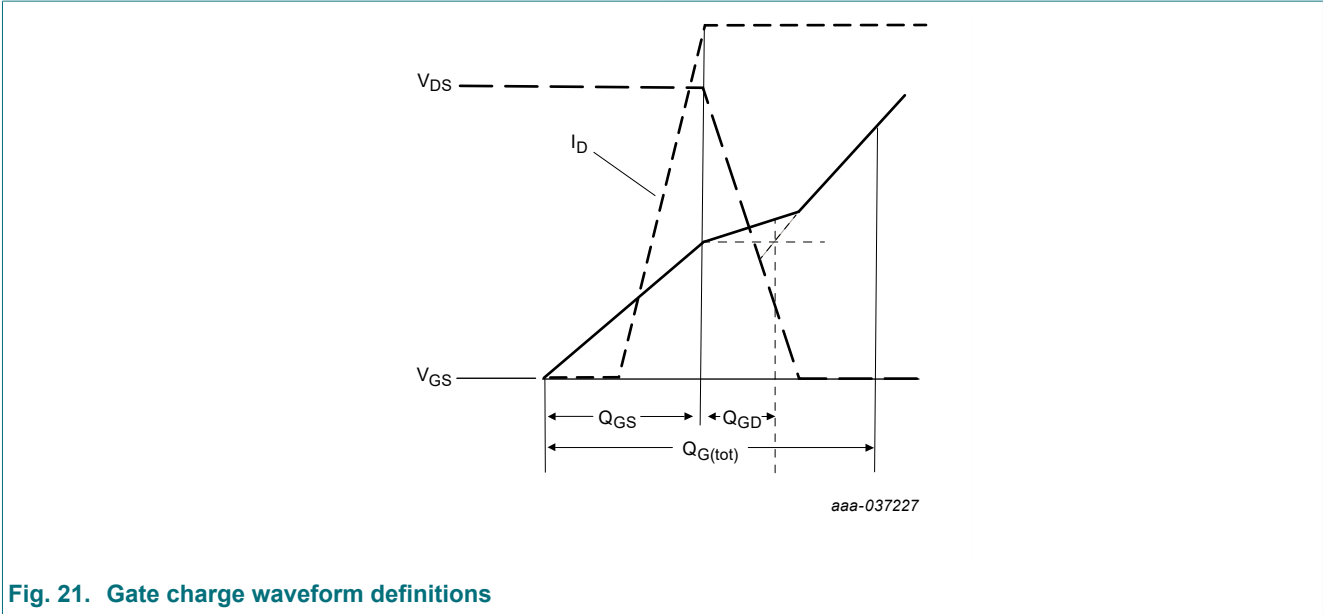


Fig. 21. Gate charge waveform definitions

11. Test information

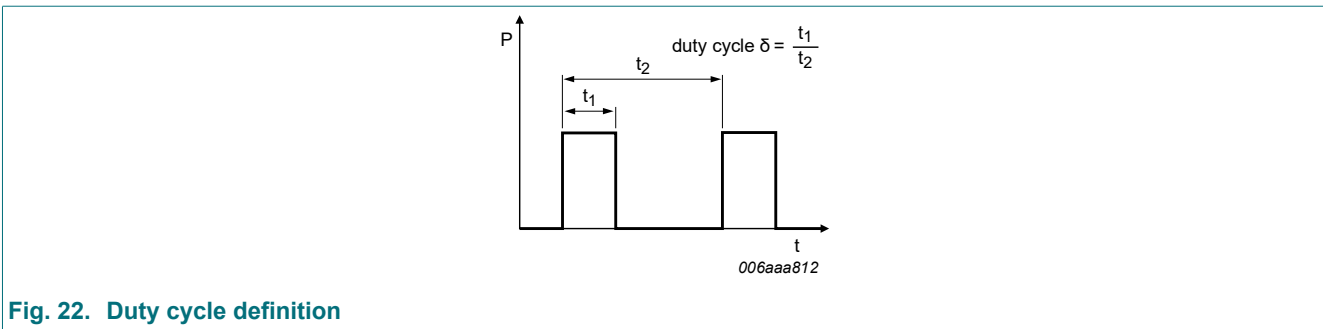


Fig. 22. Duty cycle definition

12. Package outline

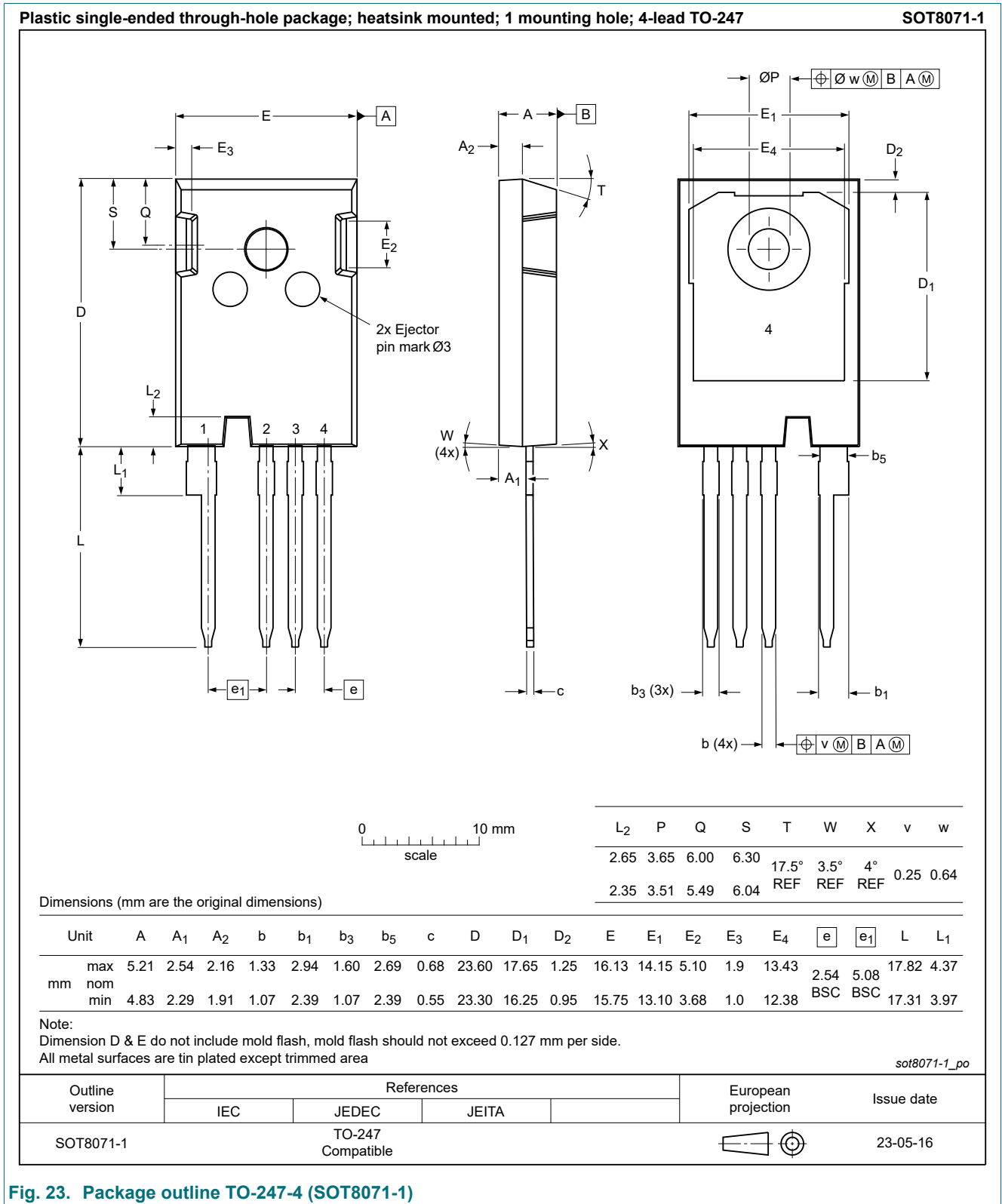


Fig. 23. Package outline TO-247-4 (SOT8071-1)

13. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NSF040120L4A0 v.4	20240202	Product data sheet	-	NSF040120L4A0 v.3
Modifications:	• Product status changed			
NSF040120L4A0 v.3	20231228	Preliminary data sheet	-	NSF040120L4A0 v.2
NSF040120L4A0 v.2	20230905	Objective data sheet	-	NSF040120L4A0 v.1
NSF040120L4A0 v.1	20230607	Objective data sheet	-	-

14. Legal information

Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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