

# NSF040120L4A0

1200 V, 40 mΩ, N-channel SiC MOSFET

28 December 2023

Preliminary 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
<b>Static characteristics</b>						
$R_{DSon}$	drain-source on-state resistance	$V_{GS} = 15\text{ V}; I_D = 40\text{ A}; T_j = 25\text{ °C}$	-	40	60	mΩ

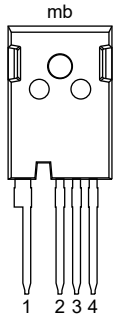
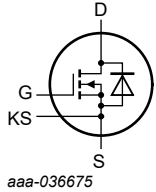
[1] Recommended turn off gate voltage is -5 V. Recommended turn on gate voltage is 15 V. Do not use with  $V_{GSon} < 13\text{ V}$ .

[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
<a href="#">NSF040120L4A0</a>	TO-247-4	Plastic single-ended through-hole package; heatsink mounted; 1 mounting hole; 4-lead TO-247-4	<a href="#">SOT8071-1</a>

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

[1] Measured according to JEP183.

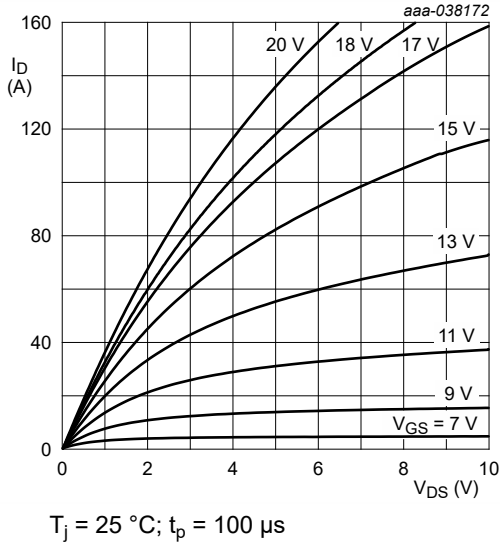


Fig. 1. Output characteristics: drain current as a function of drain-source voltage; typical values

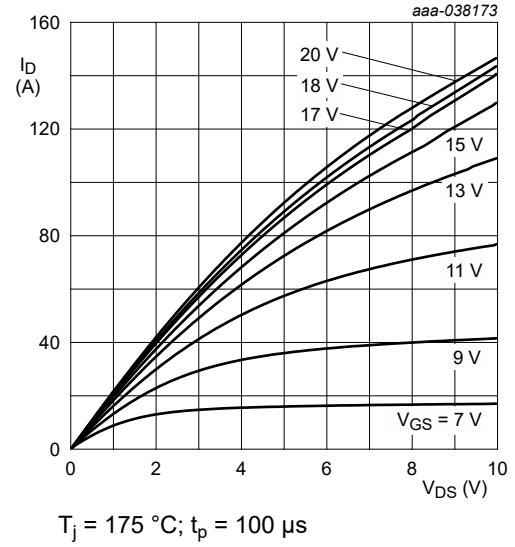


Fig. 2. Output characteristics: drain current as a function of drain-source voltage; typical values

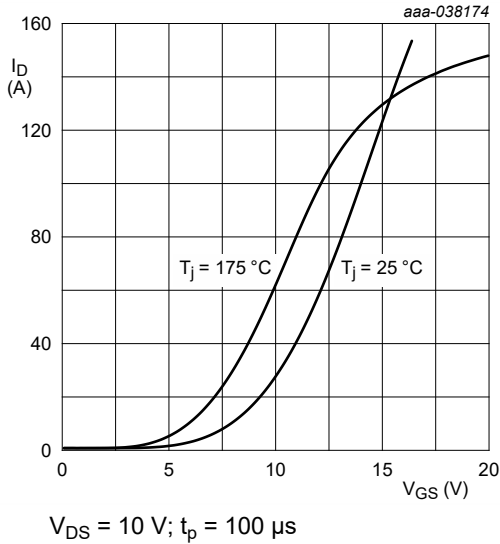


Fig. 3. Transfer characteristics: drain current as a function of gate-source voltage; typical values

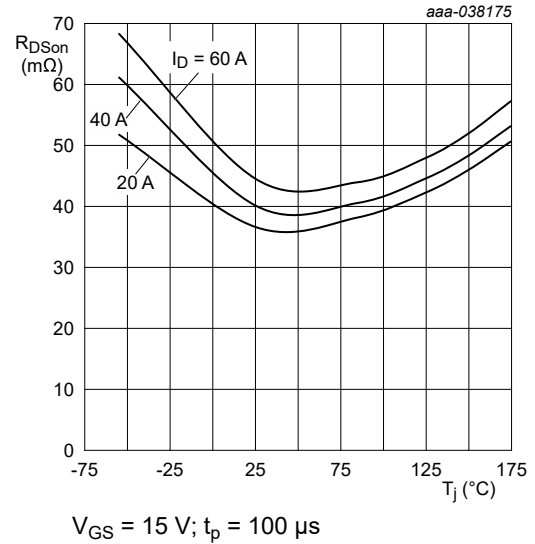
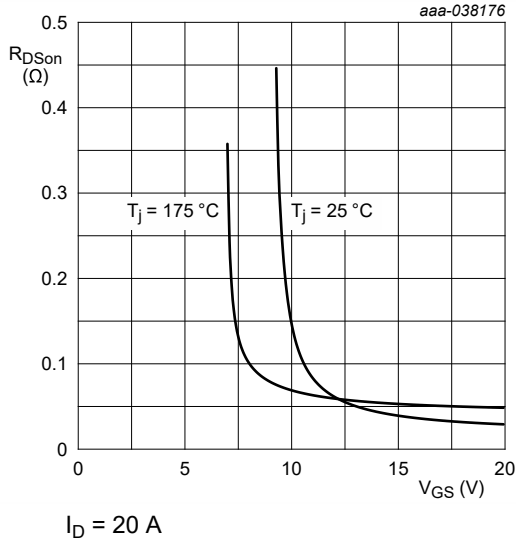
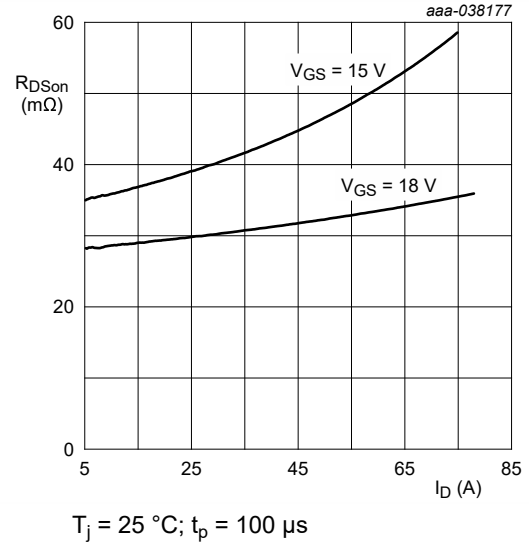


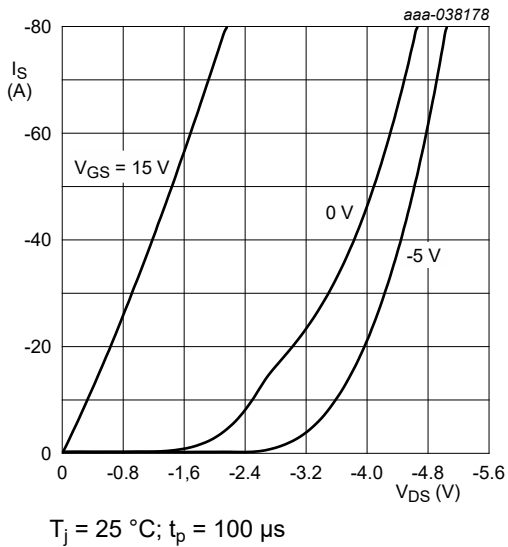
Fig. 4. Drain-source on-state resistance as a function of junction temperature; typical values



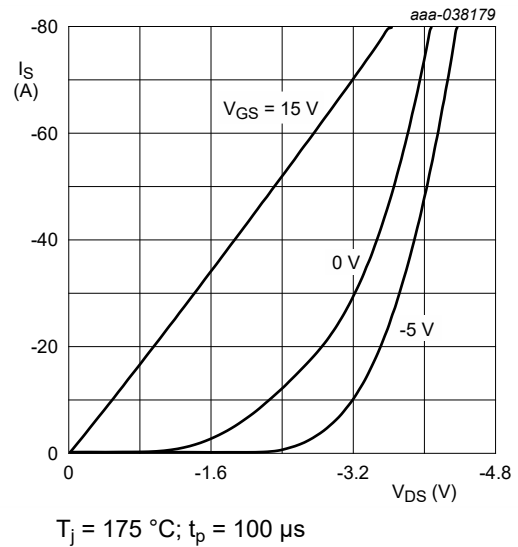
**Fig. 5. Drain-source on-state resistance as a function of threshold voltage**



**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)**

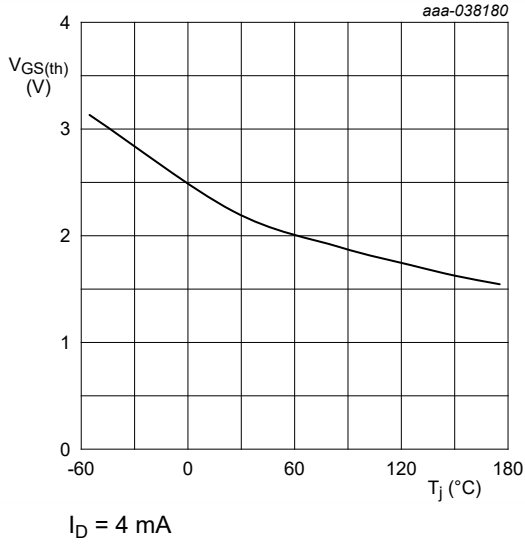


Fig. 9. Gate-source threshold voltage as a function of junction temperature; typical values

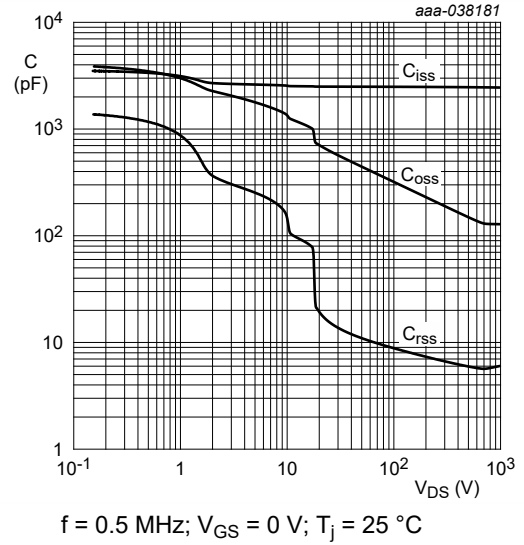


Fig. 10. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

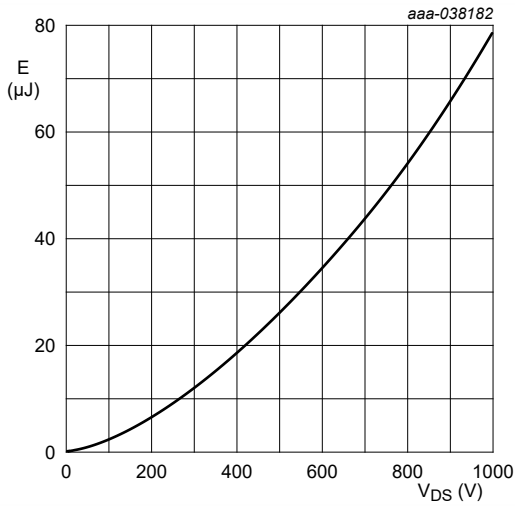


Fig. 11.  $C_{oss}$  stored energy as a function of drain-source voltage; typical values

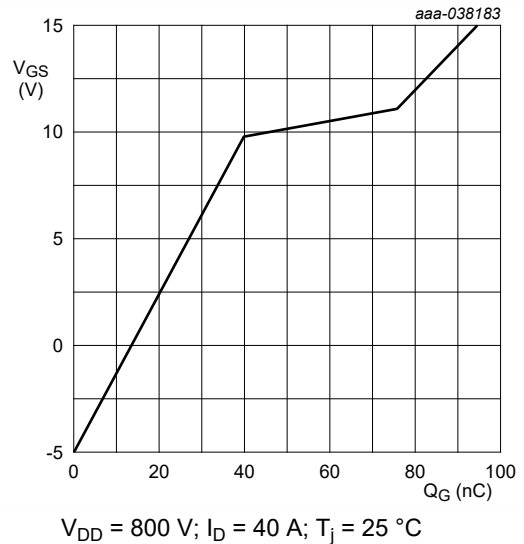
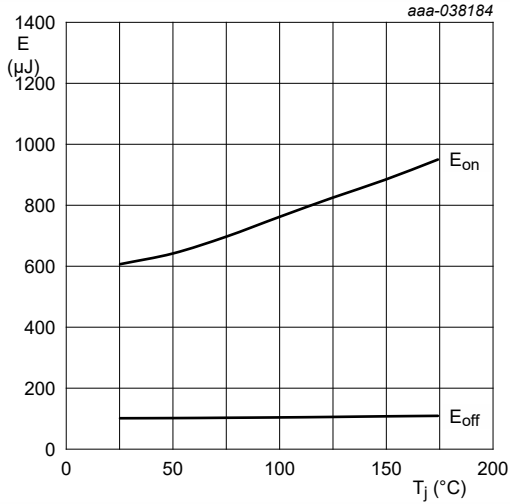
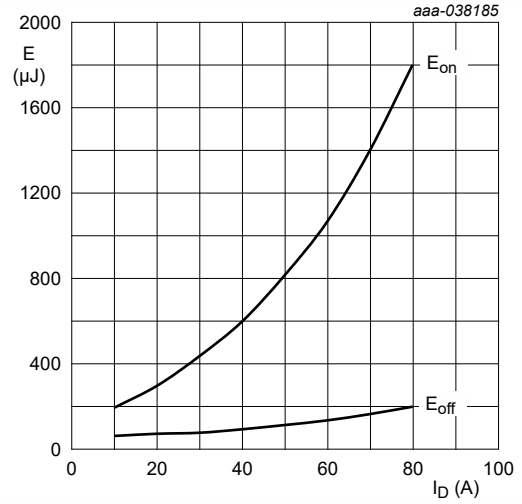


Fig. 12. Gate-source voltage as a function of gate charge; typical values



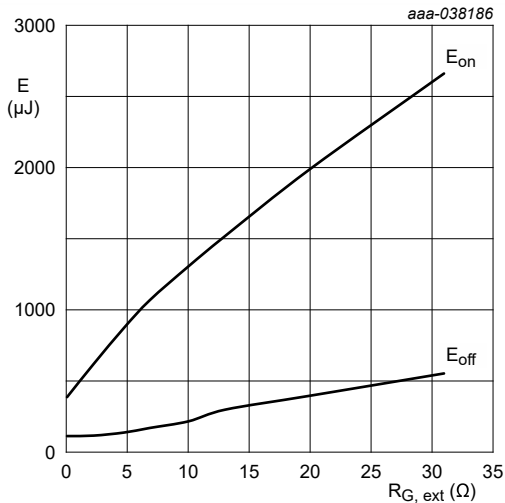
$V_{DD} = 800\text{ V}$ ;  $I_D = 40\text{ A}$ ;  $V_{GS} = -5/15\text{ V}$ ;  $R_{G, ext} = 2.2\ \Omega$ ;  $L = 82\ \mu\text{H}$

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



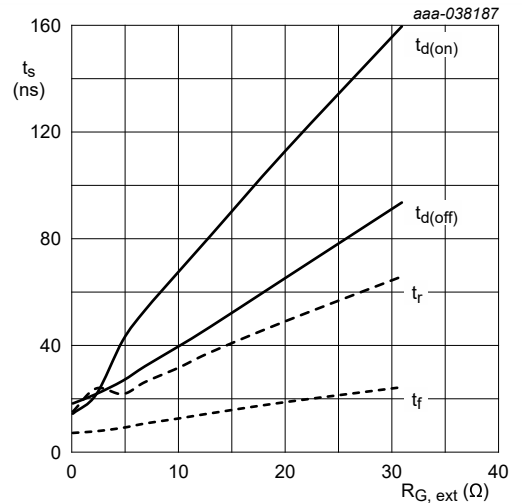
$V_{DD} = 800\text{ V}$ ;  $V_{GS} = -5/15\text{ V}$ ;  $R_{G, ext} = 2.2\ \Omega$ ;  $L = 82\ \mu\text{H}$ ;  $T_j = 25\text{ °C}$

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

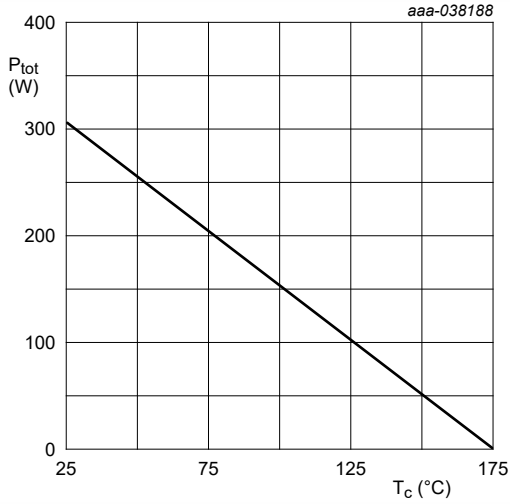


Fig. 17. Power dissipation derating as a function of case temperature; maximum values

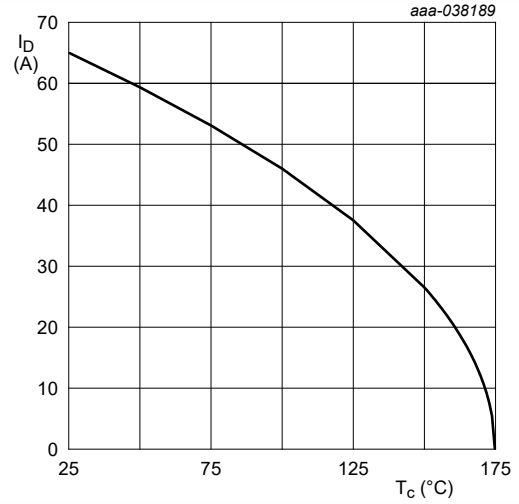
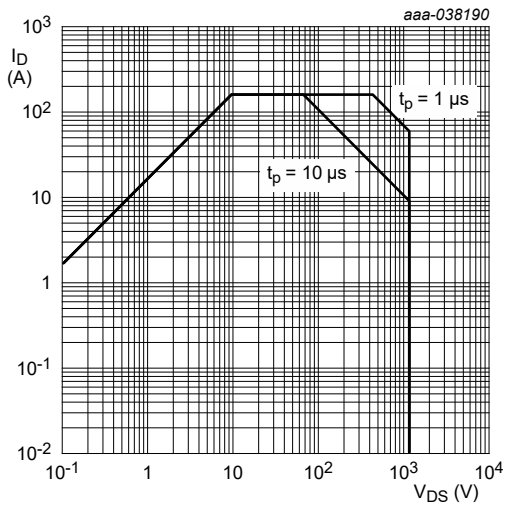


Fig. 18. Continuous drain current as a function of case temperature; maximum values



single pulse;  $T_c = 25 \text{ °C}$

Fig. 19. Maximum safe operating area (SOA)

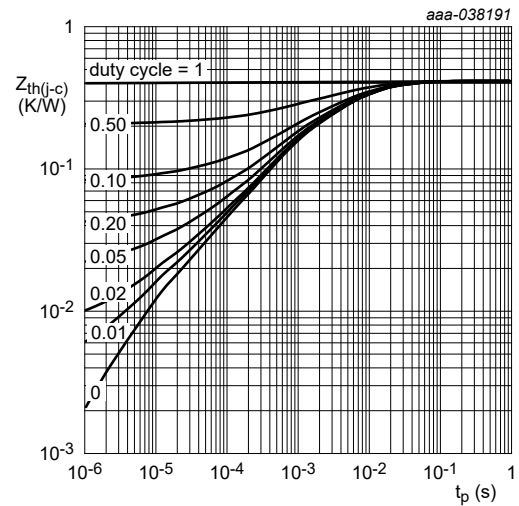


Fig. 20. Transient thermal impedance from junction to case as a function of pulse duration; typical values

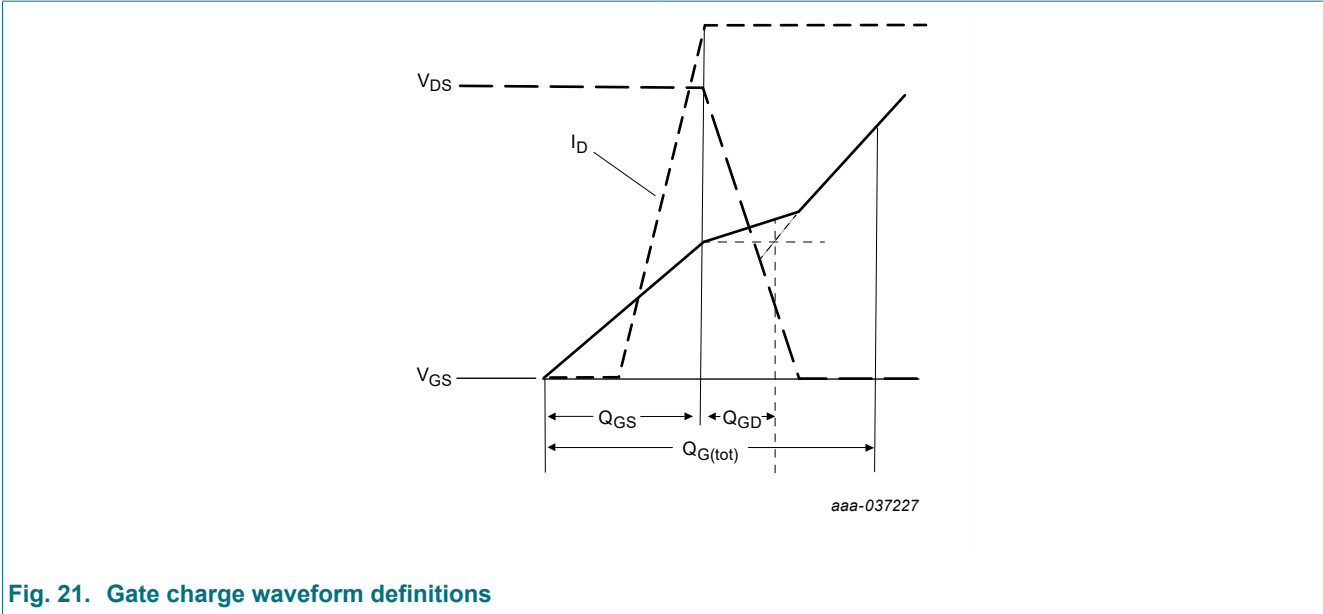


Fig. 21. Gate charge waveform definitions

## 11. Test information

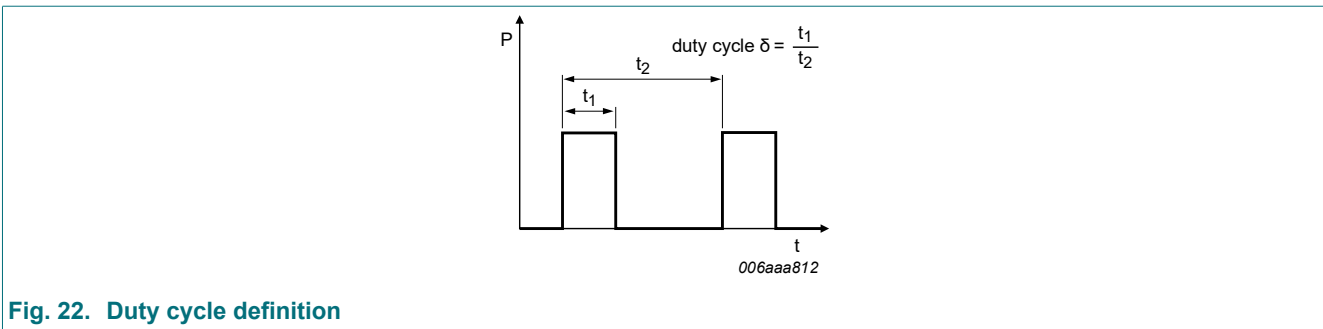


Fig. 22. Duty cycle definition

12. Package outline

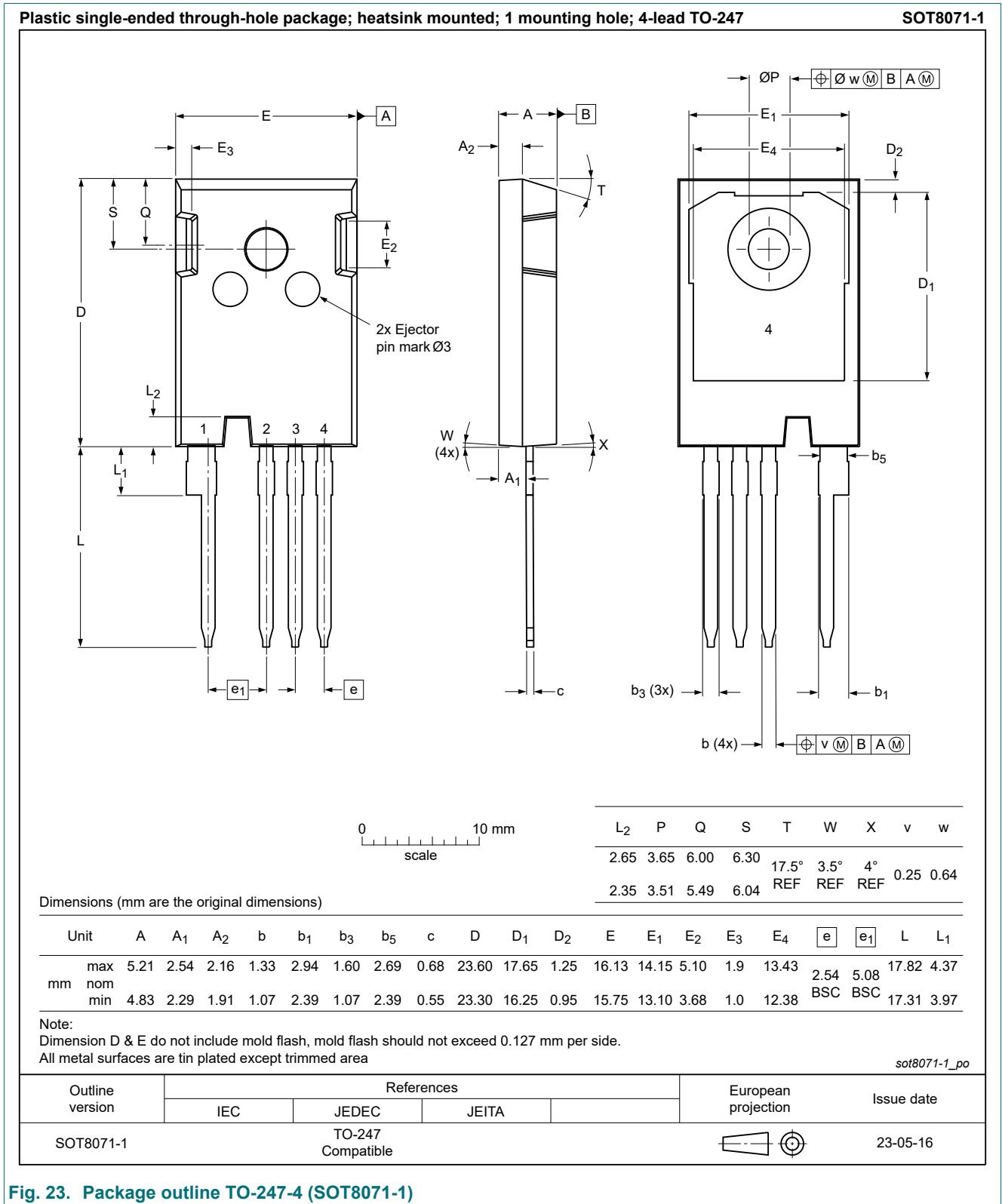


Fig. 23. Package outline TO-247-4 (SOT8071-1)

## 13. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NSF040120L4A0 v.3	20231228	Preliminary data sheet	-	NSF040120L4A0 v.2
Modifications:	<ul style="list-style-type: none"><li>• Product status changed</li><li>• Values and graphs changed</li></ul>			
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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## Contents

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1. General description.....	1
2. Features and benefits.....	1
3. Applications.....	1
4. Quick reference data.....	1
5. Pinning information.....	2
6. Ordering information.....	2
7. Marking.....	2
8. Limiting values.....	3
9. Thermal characteristics.....	3
10. Characteristics.....	4
11. Test information.....	10
12. Package outline.....	11
13. Revision history.....	12
14. Legal information.....	13

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