

# NSF040120D7A0

1200 V, 40 mΩ, N-channel SiC MOSFET

14 May 2024

Product data sheet

## 1. General description

The NSF040120D7A0 is a Silicon Carbide based 1200 V power MOSFET in a well-established 7-pin TO-263 plastic package for surface mounting PCB 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

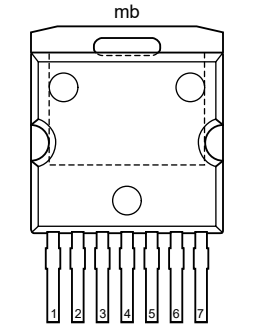
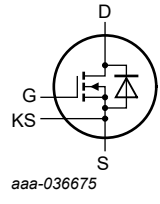
[1] Recommended turn off gate voltage is -5 V to 0 V. Recommended turn on gate voltage is 15 V. Do not use with  $V_{GSon} < 13\text{ V}$ .

[2] Limited by the maximum values of  $T_j$ ,  $R_{th(j-c)}$  and  $R_{DSon}(T_j)$ .

[3] Designed value (not tested).

## 5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	G	gate	 <p>TO-263-7 (SOT8070-1)</p>	 <p>aaa-036675</p>
2	KS	kelvin source		
3 to 7	S	source		
mb	D	mounting base; connected to drain		

## 6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
<a href="#">NSF040120D7A0</a>	TO-263-7	plastic single-ended surface-mounted package; 7 leads	<a href="#">SOT8070-1</a>

## 7. Marking

Table 4. Marking codes

Type number	Marking code
NSF040120D7A0	40120D7A0

## 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 to 0 V. Recommended turn on gate voltage is 15 V. Do not use with  $V_{GSon} < 13\text{ V}$ .

[2] Limited by the maximum values of  $T_j$ ,  $R_{th(j-c)}$  and  $R_{DSon}(T_j)$ .

[3] Designed value (not tested).

## 9. Thermal characteristics

**Table 6. Thermal characteristics**

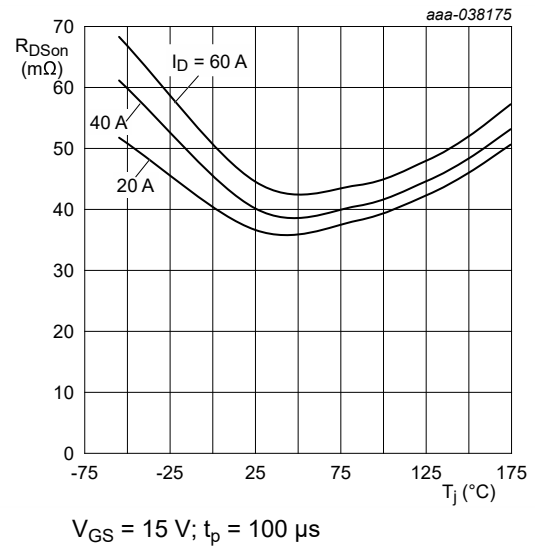
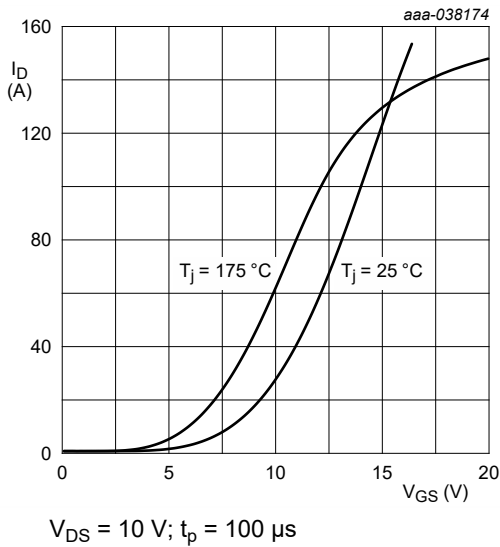
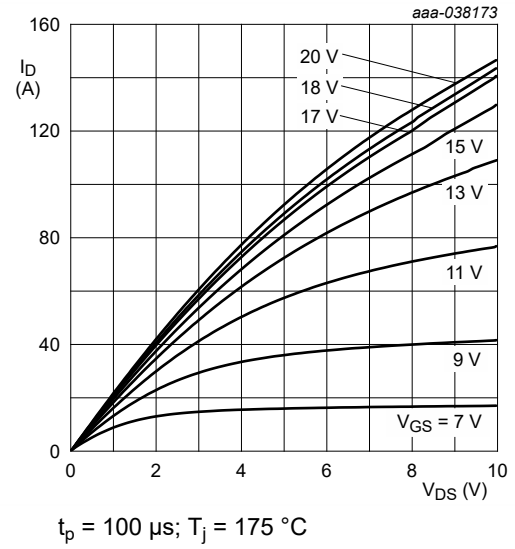
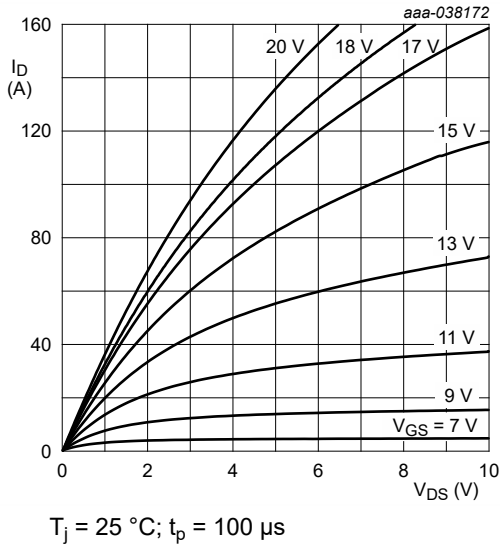
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
$R_{th(j-c)}$	thermal resistance from junction to case			-	0.4	0.49	K/W

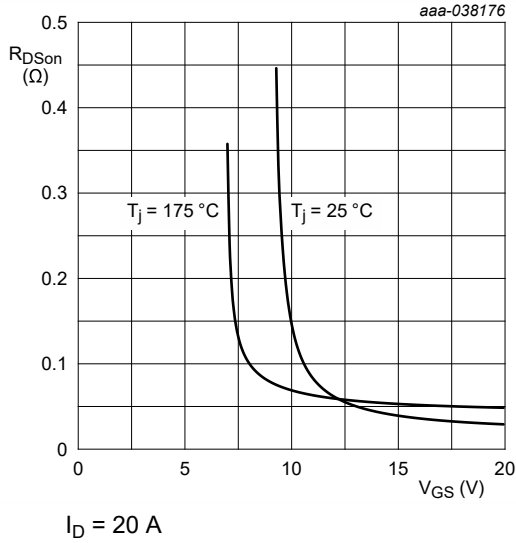
## 10. Characteristics

Table 7. Characteristics

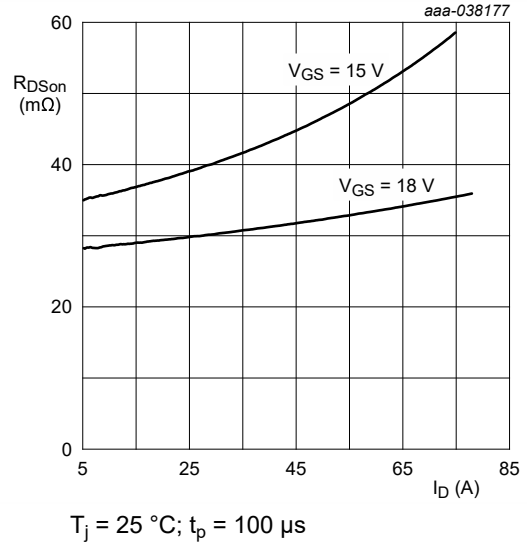
Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
<b>Static characteristics</b>							
$V_{(BR)DSS}$	drain-source breakdown voltage	$I_D = 1 \text{ mA}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	1200	-	-	V	
$V_{GS(th)}$	gate-source threshold voltage	$I_D = 4 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C}$	[1]	1.7	2.3	2.9	V
		$I_D = 20 \text{ mA}; V_{DS} = V_{GS}; T_j = 25 \text{ }^\circ\text{C}$	[1]	-	2.77	-	V
$I_{DSS}$	drain leakage current	$V_{DS} = 1200 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	-	100	$\mu\text{A}$	
$I_{GSS}$	gate leakage current	$V_{GS} = 22 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	-	100	nA	
		$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	-	100	nA	
$R_{DS(on)}$	drain-source on-state resistance	$V_{GS} = 15 \text{ V}; I_D = 40 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$	-	40	60	mΩ	
		$V_{GS} = 15 \text{ V}; I_D = 40 \text{ A}; T_j = 175 \text{ }^\circ\text{C}$	-	53	-	mΩ	
		$V_{GS} = 18 \text{ V}; I_D = 40 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$	-	31	-	mΩ	
		$V_{GS} = 18 \text{ V}; I_D = 40 \text{ A}; T_j = 175 \text{ }^\circ\text{C}$	-	49	-	mΩ	
$g_{fs}$	forward transconductance	$V_{DS} = 10 \text{ V}; I_D = 40 \text{ A}; T_j = 25 \text{ }^\circ\text{C}$	-	19	-	S	
$R_{G(int)}$	internal gate resistance	$f = 0.5 \text{ MHz}; T_j = 25 \text{ }^\circ\text{C}$	-	2.3	-	Ω	
<b>Dynamic characteristics</b>							
$Q_{G(tot)}$	total gate charge	$V_{DD} = 800 \text{ V}; I_D = 40 \text{ A}; V_{GS} = -5/+15 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	95	-	nC	
$Q_{GS}$	gate-source charge		-	40	-	nC	
$Q_{GD}$	gate-drain charge		-	30	-	nC	
$C_{iss}$	input capacitance	$V_{DD} = 800 \text{ V}; f = 0.5 \text{ MHz}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	2600	-	pF	
$C_{oss}$	output capacitance		-	136	-	pF	
$C_{rss}$	reverse transfer capacitance		-	6	-	pF	
$t_{d(on)}$	turn-on delay time		$V_{DD} = 800 \text{ V}; I_D = 40 \text{ A}; R_{G(ext)} = 2.2 \text{ }^\circ\Omega; L_L = 82 \text{ }^\circ\mu\text{H}; V_{GS} = -5/+15 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	21	-	ns
$t_r$	rise time	-		23	-	ns	
$t_{d(off)}$	turn-off delay time	-		20	-	ns	
$t_f$	fall time	-		8	-	ns	
$E_{on}$	turn-on switching loss	-		551	-	$\mu\text{J}$	
$E_{off}$	turn-off switching loss	-		97	-	$\mu\text{J}$	
<b>Source-drain diode</b>							
$V_{SD}$	source-drain voltage	$I_S = 40 \text{ A}; V_{GS} = -5 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	4.4	-	V	
$t_{rr}$	reverse recovery time	$V_{DD} = 800 \text{ V}; I_S = 40 \text{ A}; dI_S/dt = 6670 \text{ A}/\mu\text{s}; V_{GS} = -5 \text{ V}; T_j = 25 \text{ }^\circ\text{C}$	-	8	-	ns	
$Q_r$	recovered charge		-	117	-	nC	

[1] Measured according to JEP183.

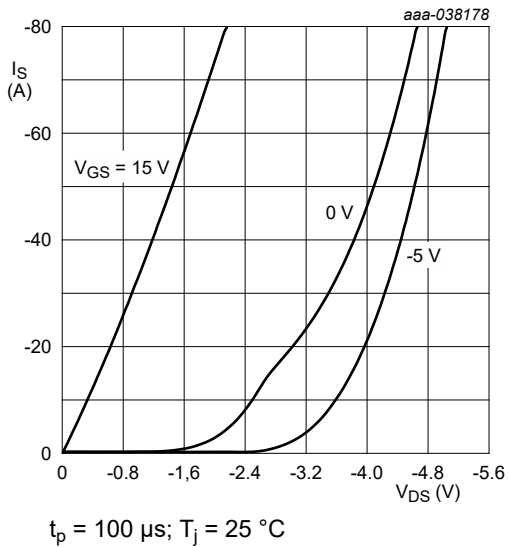




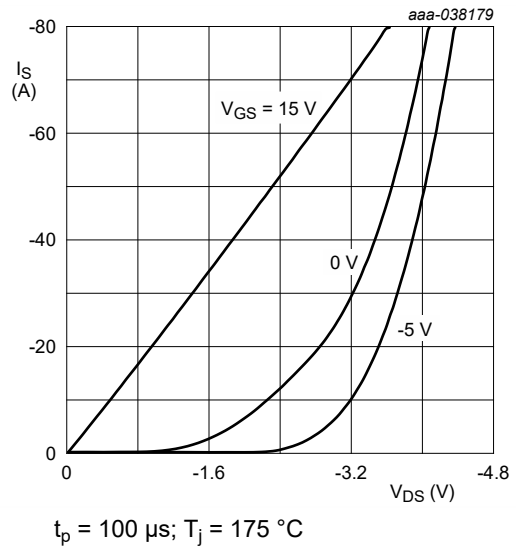
**Fig. 5. Drain-source on-state resistance as a function of threshold voltage**



**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)**

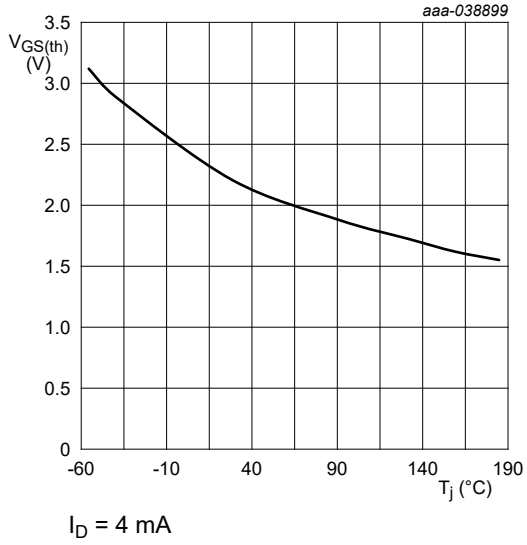


Fig. 9. Gate-source threshold voltage as a function of junction temperature; typical values

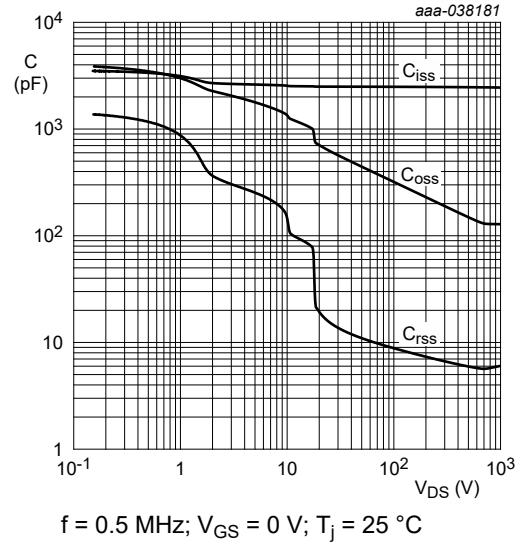


Fig. 10. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

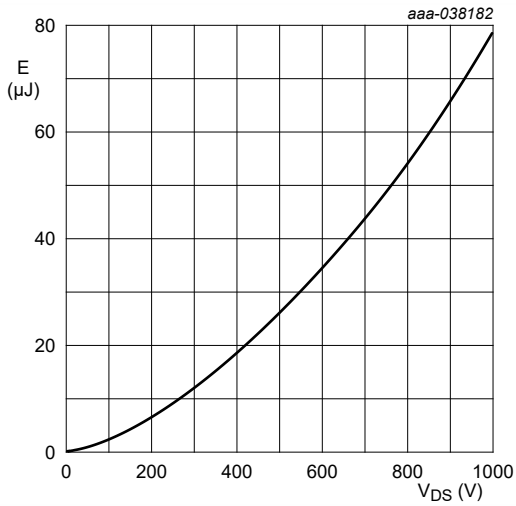


Fig. 11.  $C_{oss}$  stored energy as a function of drain-source voltage; typical values

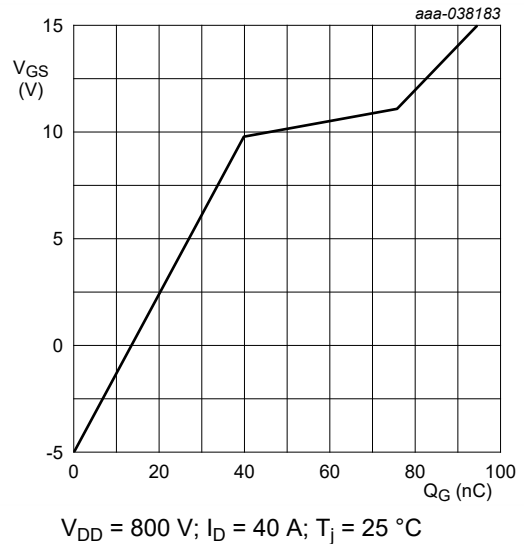
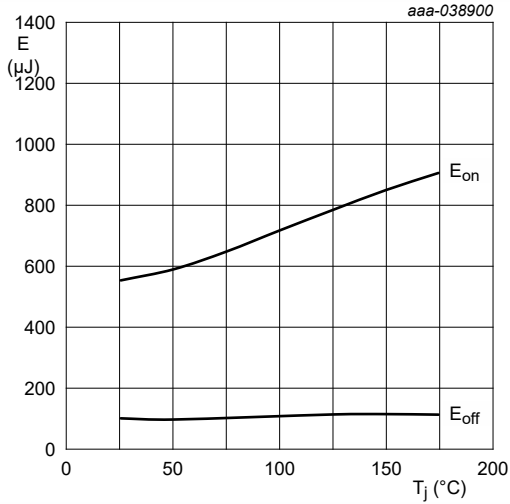
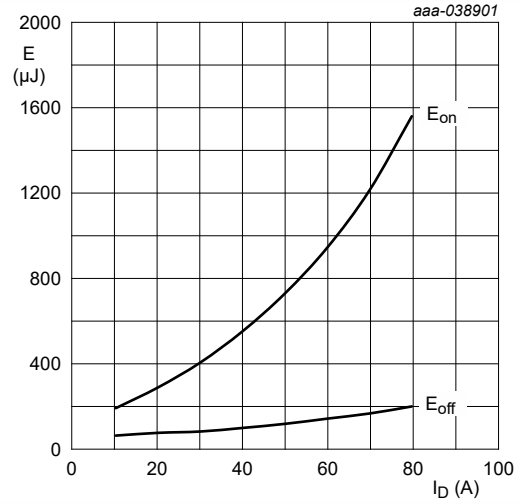


Fig. 12. Gate-source voltage as a function of gate charge; typical values



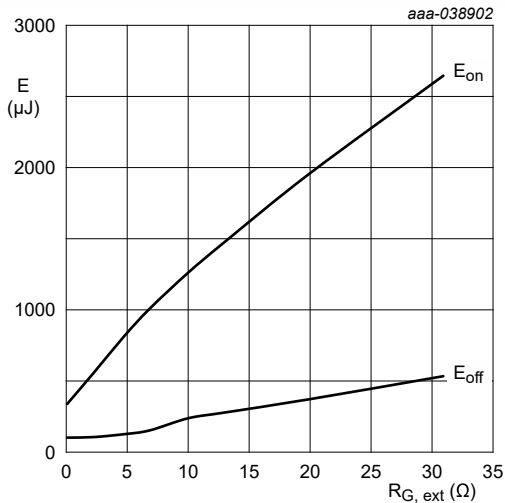
$V_{\text{DD}} = 800 \text{ V}$ ;  $I_{\text{D}} = 40 \text{ A}$ ;  $V_{\text{GS}} = -5/15 \text{ V}$ ;  $R_{\text{G, ext}} = 2.2 \text{ }\Omega$ ;  $L_{\text{L}} = 82 \text{ }\mu\text{H}$

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



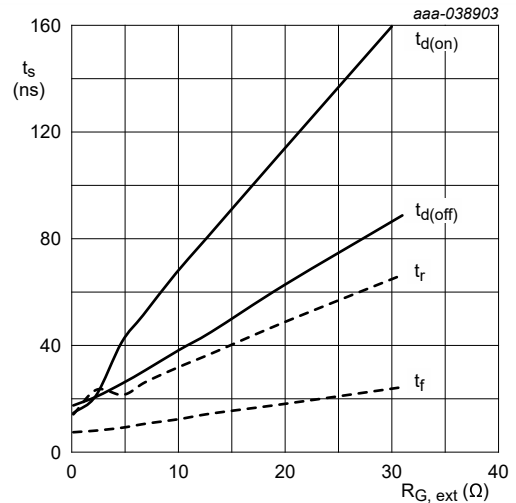
$V_{\text{DD}} = 800 \text{ V}$ ;  $V_{\text{GS}} = -5/15 \text{ V}$ ;  $R_{\text{G, ext}} = 2.2 \text{ }\Omega$ ;  $L_{\text{L}} = 82 \text{ }\mu\text{H}$ ;  $T_j = 25 \text{ }^{\circ}\text{C}$

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



$V_{\text{DD}} = 800 \text{ V}$ ;  $I_{\text{D}} = 40 \text{ A}$ ;  $V_{\text{GS}} = -5/15 \text{ V}$ ;  $L_{\text{L}} = 82 \text{ }\mu\text{H}$ ;  $T_j = 25 \text{ }^{\circ}\text{C}$

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



$V_{\text{DD}} = 800 \text{ V}$ ;  $I_{\text{D}} = 40 \text{ A}$ ;  $V_{\text{GS}} = -5/15 \text{ V}$ ;  $L_{\text{L}} = 82 \text{ }\mu\text{H}$ ;  $T_j = 25 \text{ }^{\circ}\text{C}$

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



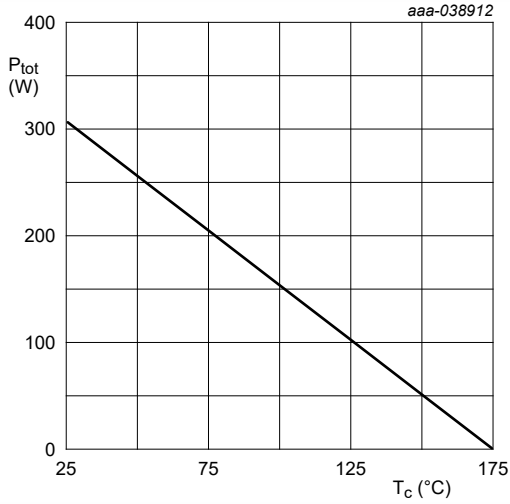


Fig. 17. Power dissipation derating as a function of case temperature; maximum values

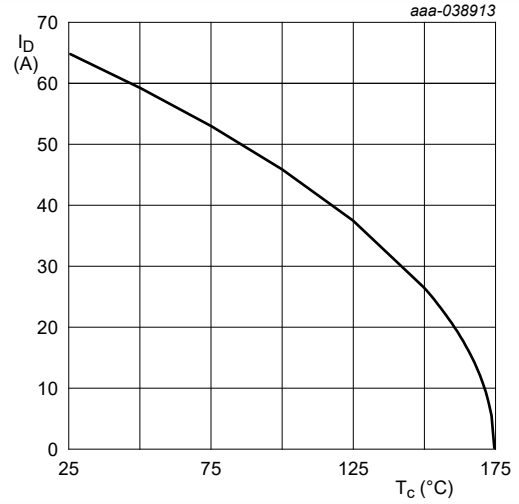
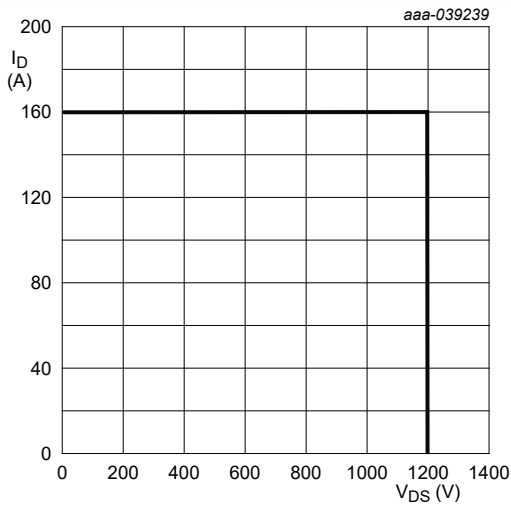


Fig. 18. Continuous drain current as a function of case temperature; maximum values



$V_{GS} = -5/+18$  V;  $T_c = 25$  °C;  $T_j \leq 175$  °C; not for linear use

Fig. 19. Reverse bias safe operating area (RBSOA)

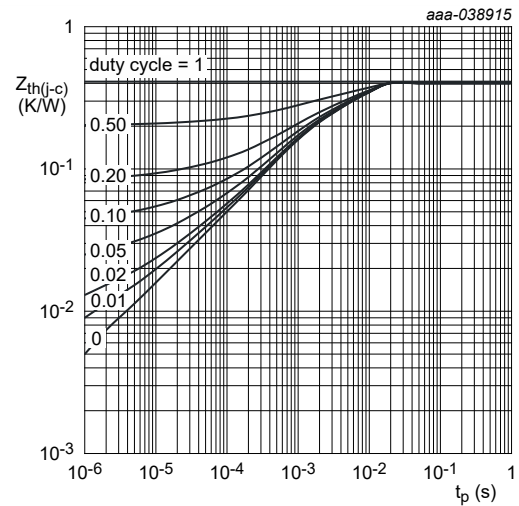


Fig. 20. Transient thermal impedance from junction to case as a function of pulse duration; typical values

### 11. Test information

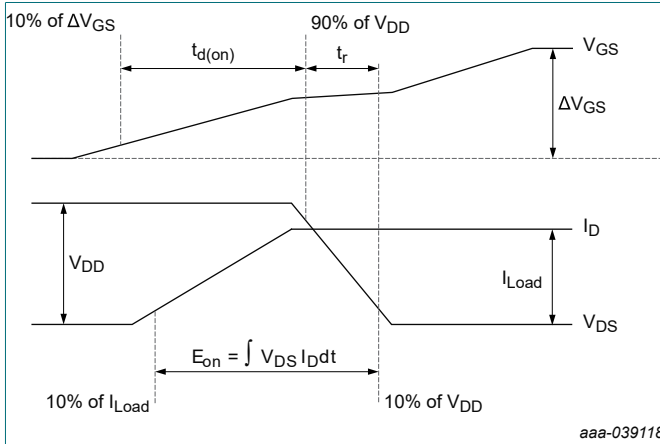


Fig. 21. Definition of switching times and losses during channel turn-on

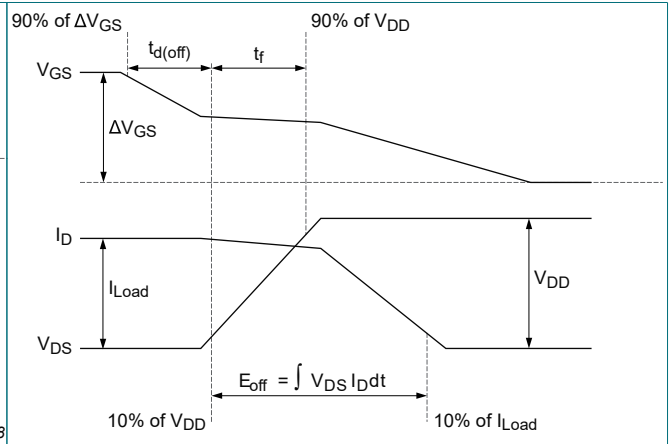


Fig. 22. Definition of switching times and losses during channel turn-off

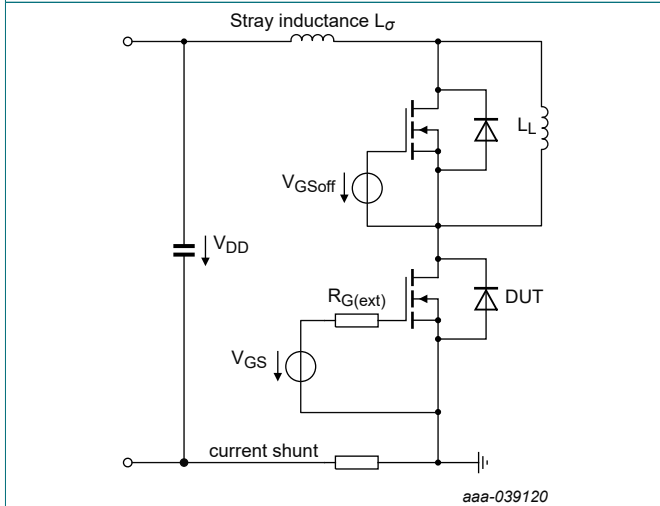


Fig. 23. Test circuit for dynamic characterization of channel and gate charge characteristics

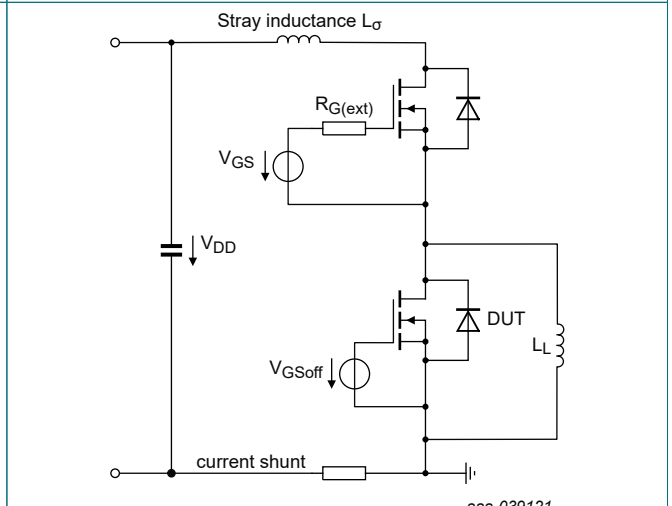


Fig. 24. Test circuit for dynamic characterization of body diode

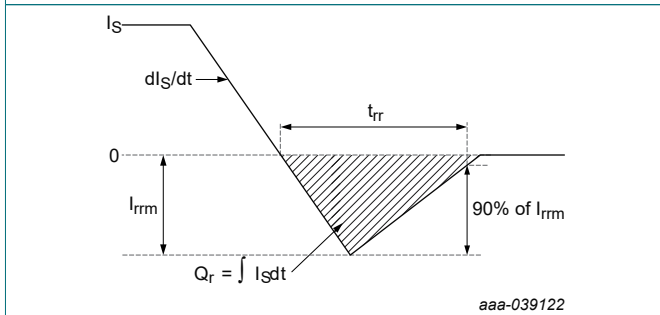


Fig. 25. Definition of dynamic characteristics of body diode

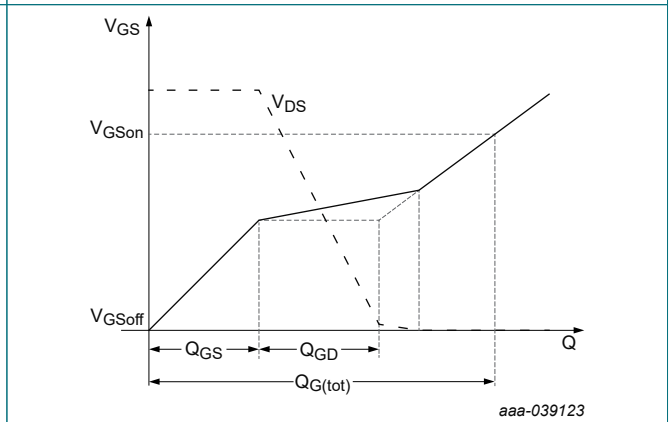
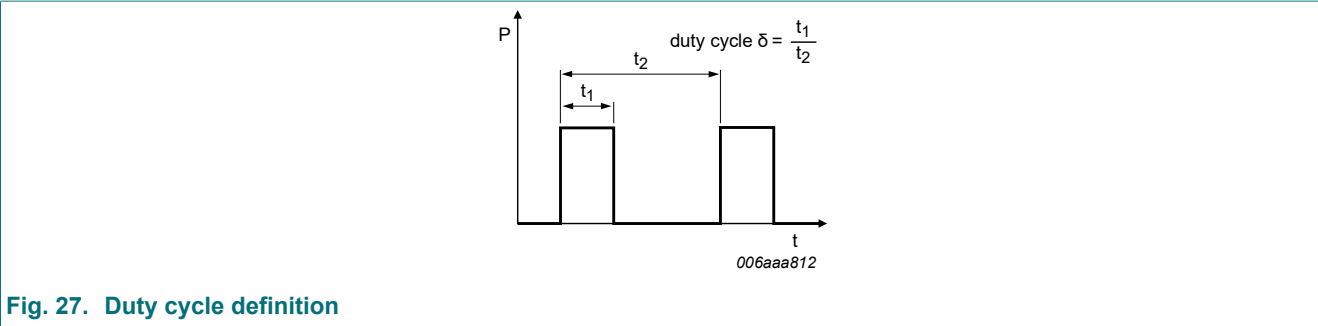


Fig. 26. Definition of gate charge characteristics



12. Package outline

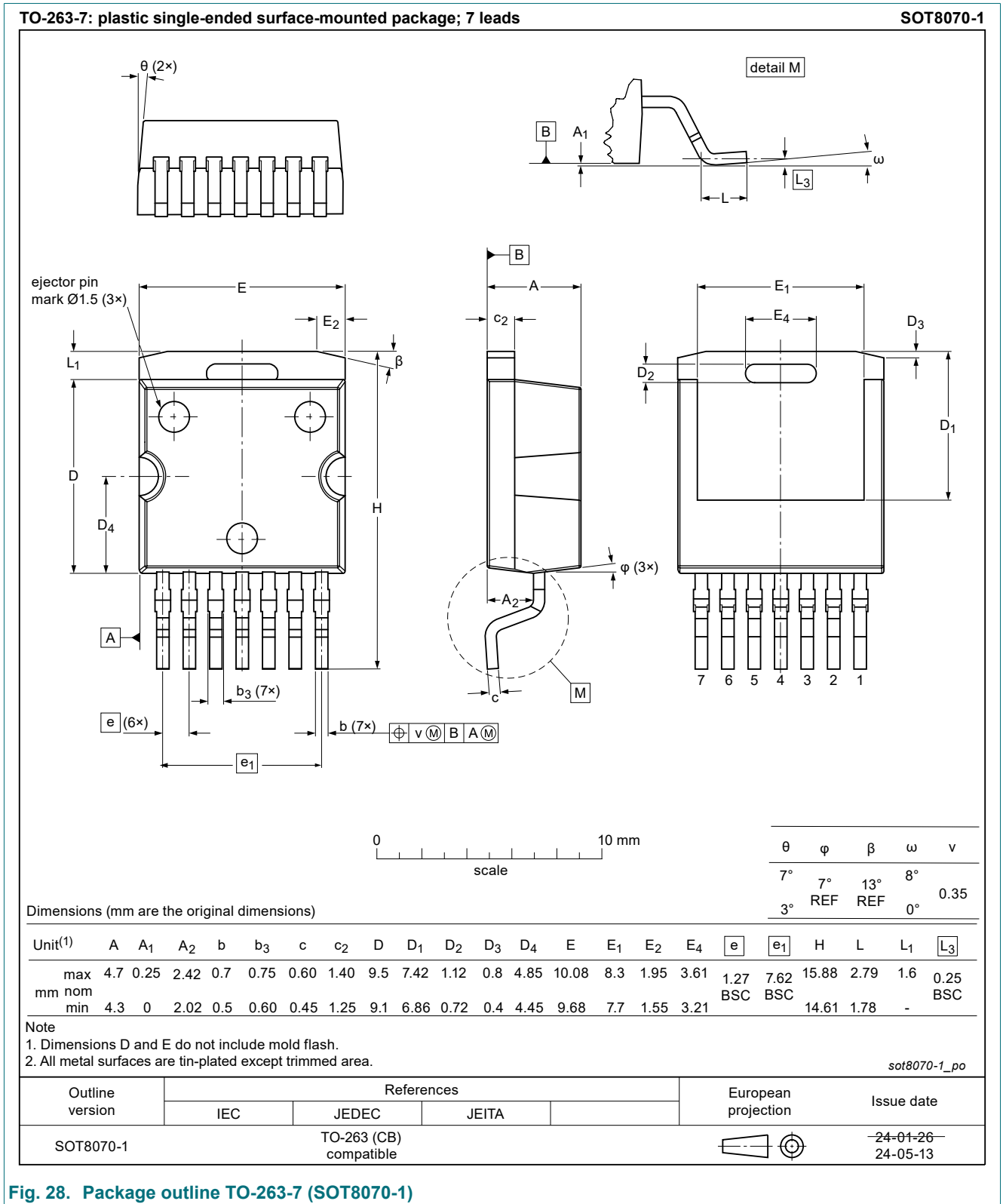
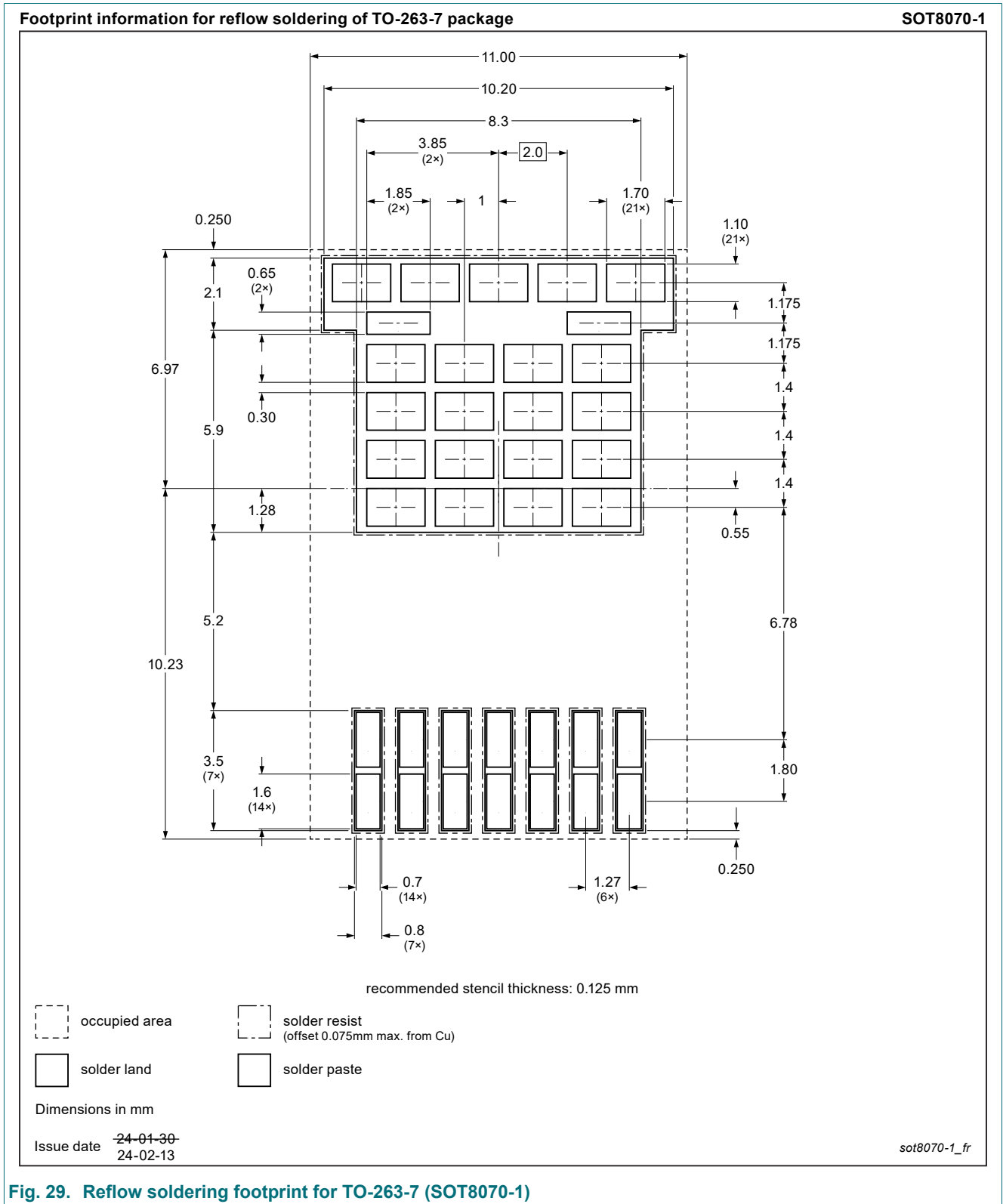


Fig. 28. Package outline TO-263-7 (SOT8070-1)

### 13. Soldering



**Fig. 29. Reflow soldering footprint for TO-263-7 (SOT8070-1)**

## 14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NSF040120D7A0 v.3	20240514	Product data sheet	-	NSF040120D7A0 v.2
Modifications:	• Product status changed			
NSF040120D7A0 v.2	20240319	Preliminary data sheet	-	NSF040120D7A0 v.1
NSF040120D7A0 v.1	20240131	Objective data sheet	-	-

## 15. 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".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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