

NSF040120D7A1-Q

1200 V, 40 mΩ, N-channel SiC MOSFET for automotive applications

30 April 2025

Product data sheet

1. General description

The NSF040120D7A1-Q 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 automotive applications like E-vehicle onboard charger, DC-DC converter and auxiliary 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
- Qualified for automotive applications, based on AEC-Q101

3. Applications

- Onboard charger
- DC-DC converter
- Auxiliary 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] -	-	54	A
		$T_c = 100\text{ °C}$	[2] -	-	38	A
I_{DM}	peak drain current	pulsed; t_p limited by T_j (max)	[3] -	-	120	A
Static characteristics						
R_{DSon}	drain-source on-state resistance	$V_{GS} = 18\text{ V}; I_D = 30\text{ A}; T_j = 25\text{ °C}$	-	40	60	mΩ

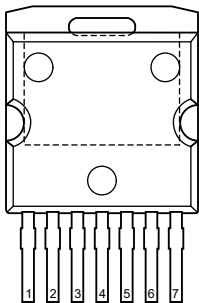
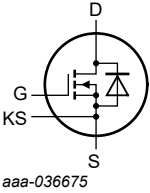
[1] Recommended turn off gate voltage is -5 V to 0 V. Recommended turn on gate voltage is 15 V. Do not use with $V_{GSon} < 13\text{ V}$.

[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	 TO-263-7 (SOT8070-1)	 aaa-036675
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
NSF040120D7A1-Q	TO-263-7	plastic single-ended surface-mounted package; 7 leads	SOT8070-1

7. Marking

Table 4. Marking codes

Type number	Marking code
NSF040120D7A1-Q	4012D7A1Q

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 °C	[2]	-	54	A
		T _c = 100 °C	[2]	-	38	A
I _{DM}	peak drain current	pulsed; t _p limited by T _j (max)	[3]	-	120	A
P _{tot}	total power dissipation	T _c = 25 °C	[2]	-	250	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 °C	[2]	-	44	A
I _{SM}	peak source current	pulsed; limited by T _j (max)	[3]	-	90	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 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			-	0.5	0.6	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 = 1 mA; V _{GS} = 0 V; T _j = 25 °C		1200	-	-	V
V _{GS(th)}	gate-source threshold voltage	I _D = 3 mA; V _{DS} = V _{GS} ; T _j = 25 °C	[1]	1.7	2.3	2.9	V
		I _D = 15 mA; V _{DS} = V _{GS} ; T _j = 25 °C	[1]	-	2.77	-	V
I _{DSS}	drain leakage current	V _{DS} = 1200 V; V _{GS} = 0 V; T _j = 25 °C		-	-	100	μA
I _{GSS}	gate leakage current	V _{GS} = 22 V; V _{DS} = 0 V; T _j = 25 °C		-	-	100	nA
		V _{GS} = -10 V; V _{DS} = 0 V; T _j = 25 °C		-	-	100	nA
R _{DSon}	drain-source on-state resistance	V _{GS} = 15 V; I _D = 30 A; T _j = 25 °C		-	53	-	mΩ
		V _{GS} = 15 V; I _D = 30 A; T _j = 175 °C		-	70	-	mΩ
		V _{GS} = 18 V; I _D = 30 A; T _j = 25 °C		-	40	60	mΩ
		V _{GS} = 18 V; I _D = 30 A; T _j = 175 °C		-	65	-	mΩ
R _{G(int)}	internal gate resistance	f = 0.5 MHz; T _j = 25 °C		-	2	-	Ω
Dynamic characteristics							
Q _{G(tot)}	total gate charge	V _{DD} = 800 V; I _D = 30 A; V _{GS} = -5/+18 V; T _j = 25 °C		-	81	-	nC
Q _{GS}	gate-source charge			-	35	-	nC
Q _{GD}	gate-drain charge			-	21	-	nC
C _{iss}	input capacitance	V _{DD} = 800 V; f = 0.5 MHz; V _{GS} = 0 V; T _j = 25 °C		-	1980	-	pF
C _{oss}	output capacitance			-	109	-	pF
C _{rss}	reverse transfer capacitance			-	3	-	pF
t _{d(on)}	turn-on delay time	V _{DD} = 800 V; I _D = 30 A; R _{G(ext)} = 2.2 Ω; L _L = 82 μH; V _{GS} = -5/+18 V; T _j = 25 °C		-	14	-	ns
t _r	rise time			-	13	-	ns
t _{d(off)}	turn-off delay time			-	19	-	ns
t _f	fall time			-	7	-	ns
E _{on}	turn-on switching loss			-	348	-	μJ
E _{off}	turn-off switching loss			-	44	-	μJ
Source-drain diode							
V _{SD}	source-drain voltage	I _S = 30 A; V _{GS} = -5 V; T _j = 25 °C		-	4.4	-	V
t _{rr}	reverse recovery time	V _{DD} = 800 V; I _S = 30 A; V _{GS} = -5 V; dI _S /dt = 2908 A/μs; T _j = 25 °C		-	27	-	ns
Q _r	recovered charge			-	225	-	nC

[1] Measured according to JEP183.

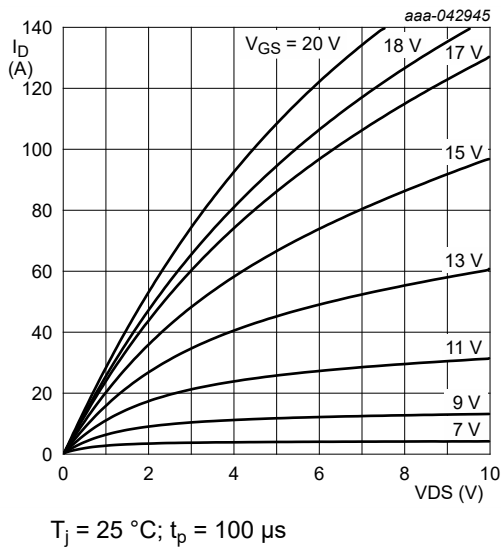


Fig. 1. Output characteristics: drain current as a function of drain-source voltage; typical values

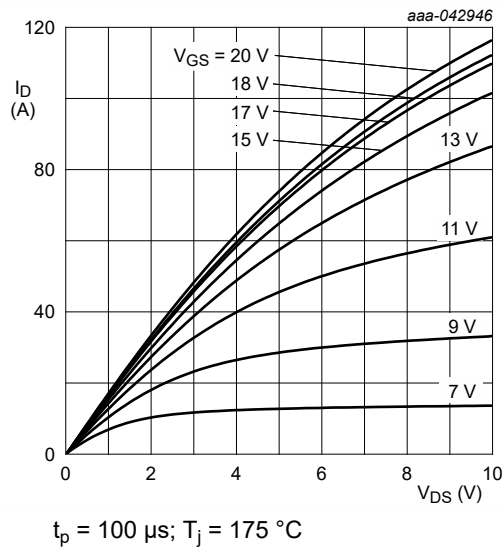


Fig. 2. Output characteristics: drain current as a function of drain-source voltage; typical values

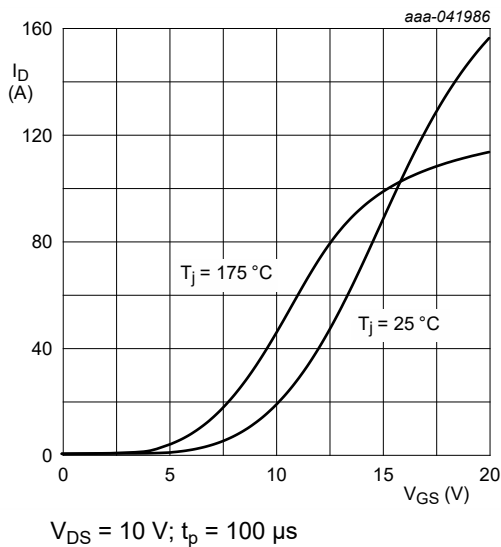


Fig. 3. Transfer characteristics: drain current as a function of gate-source voltage; typical values

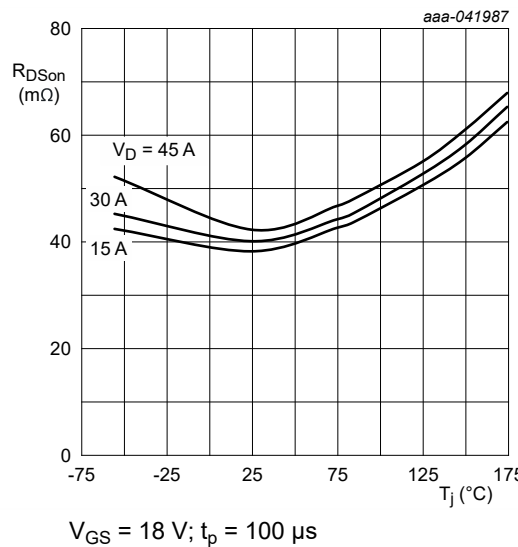


Fig. 4. Drain-source on-state resistance as a function of junction temperature; typical values

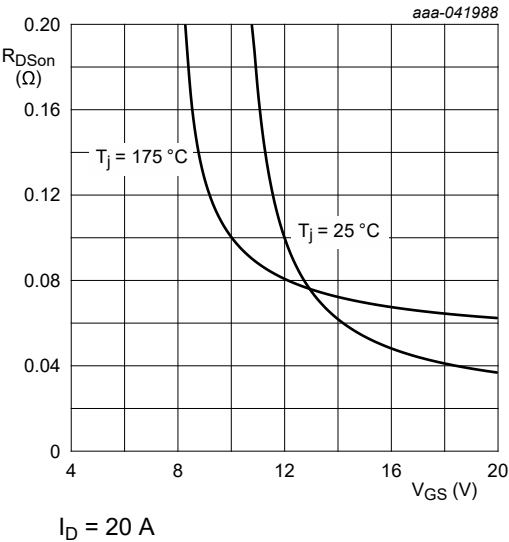


Fig. 5. Drain-source on-state resistance as a function of threshold voltage

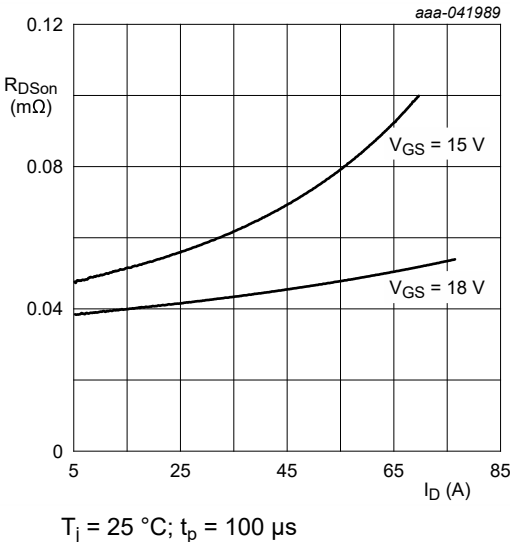


Fig. 6. Drain-source on-state resistance as a function of drain current; typical values

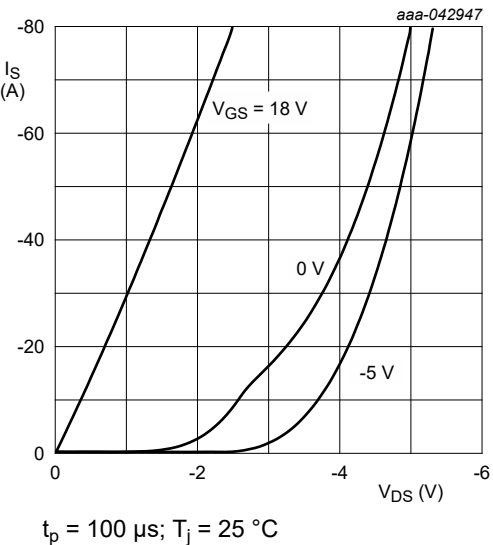


Fig. 7. Source current as a function of source-drain voltage; typical values (third quadrant characteristics)

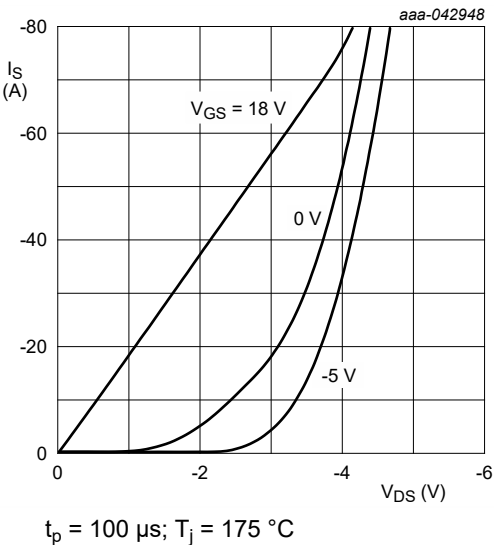


Fig. 8. Source current as a function of source-drain voltage; typical values (third quadrant characteristics)

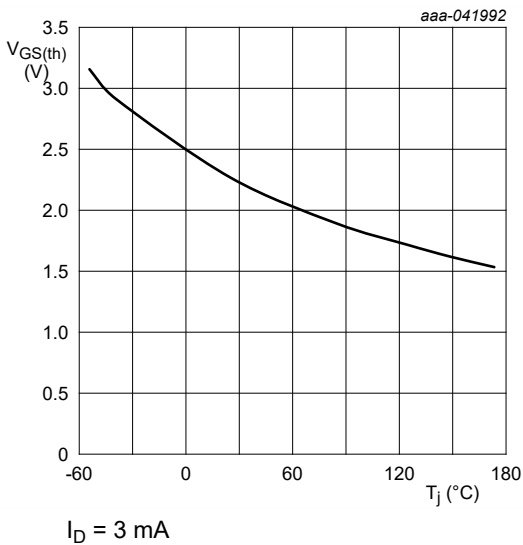


Fig. 9. Gate-source threshold voltage as a function of junction temperature; typical values

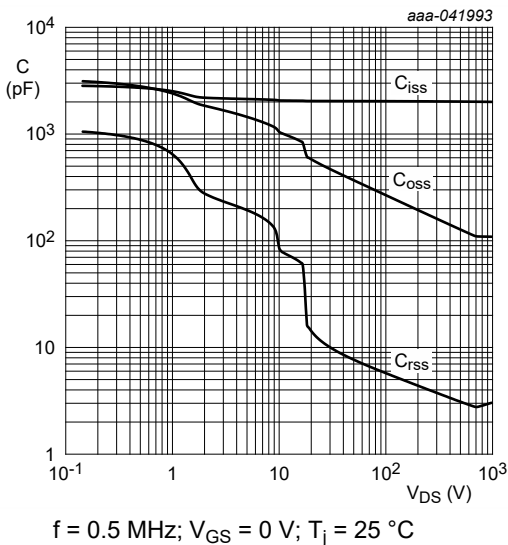


Fig. 10. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

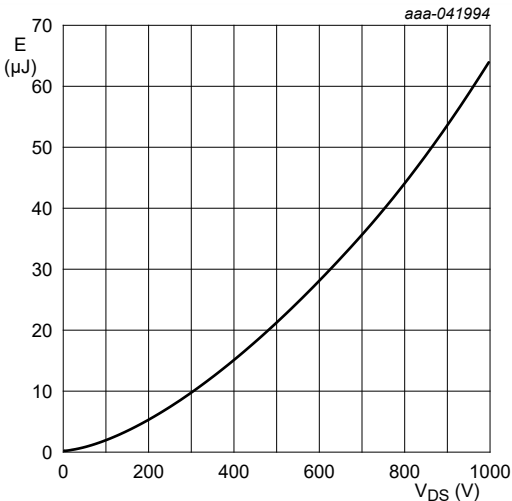


Fig. 11. C_{oss} stored energy as a function of drain-source voltage; typical values

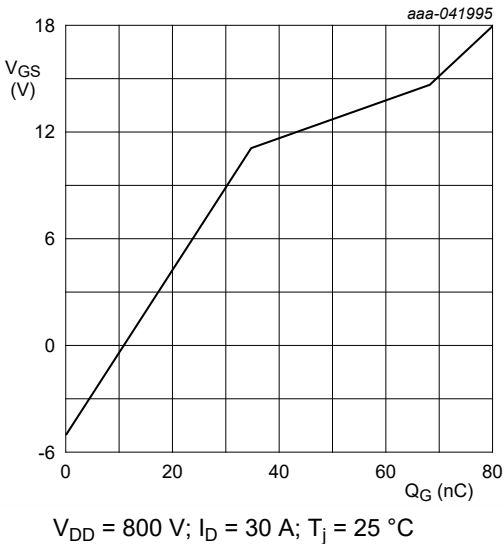


Fig. 12. Gate-source voltage as a function of gate charge; typical values

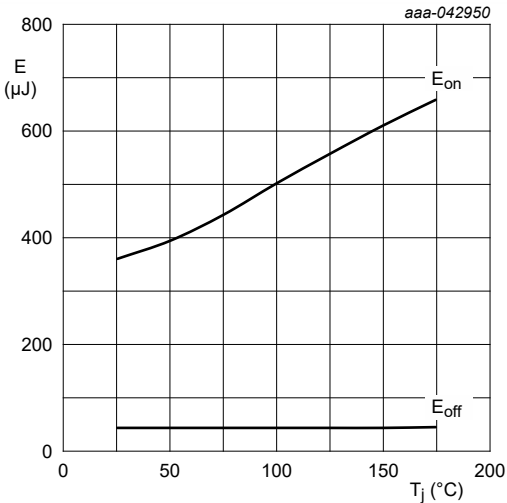


Fig. 13. Switching loss as a function of junction temperature; typical values

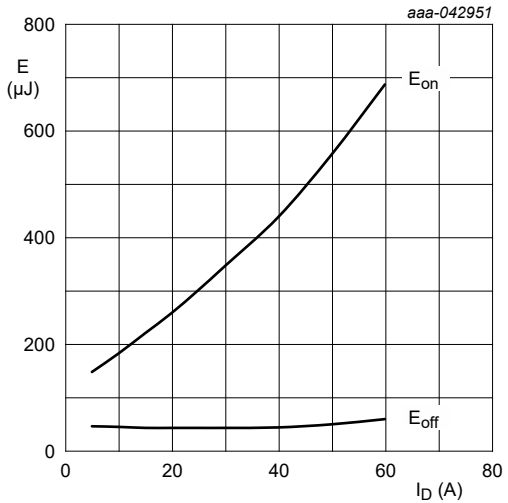


Fig. 14. Switching loss as a function of drain current; typical values

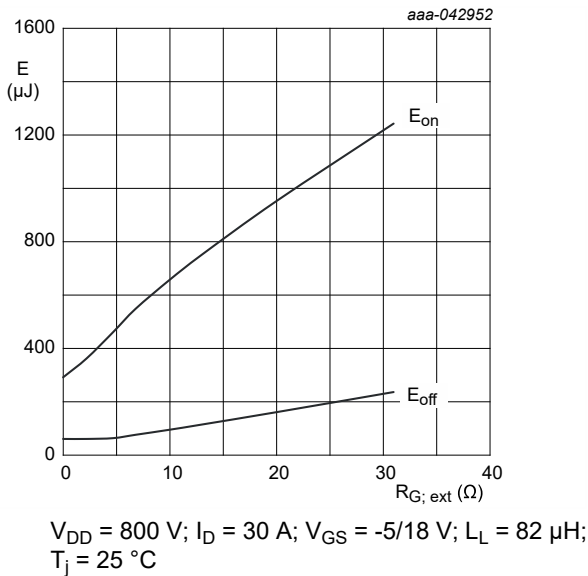


Fig. 15. Switching loss as a function of external gate resistance; typical values

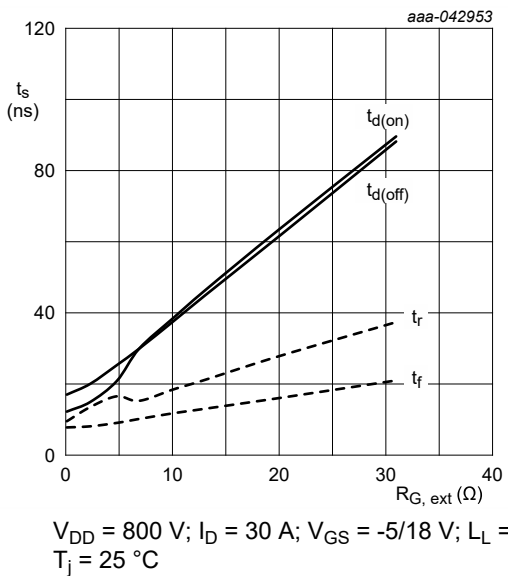


Fig. 16. Switching times as a function of external gate resistance; typical values

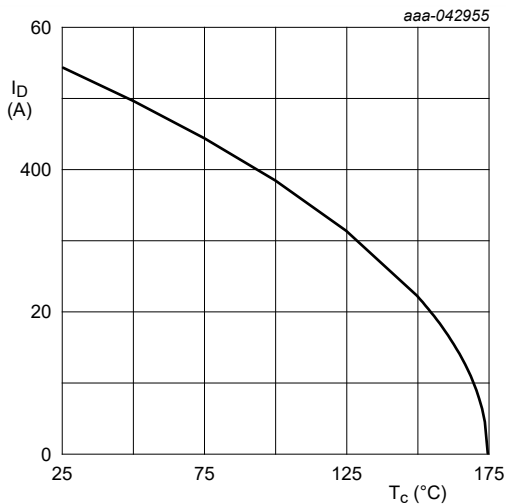


Fig. 17. Power dissipation derating as a function of case temperature; maximum values

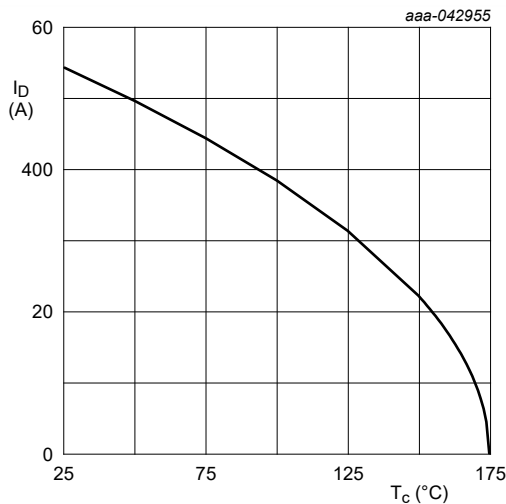
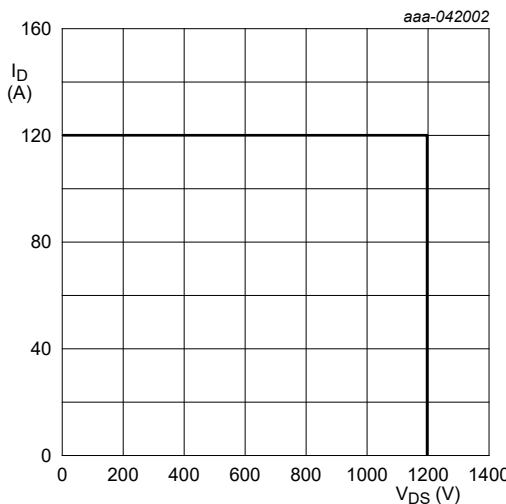


Fig. 18. Continuous drain current as a function of case temperature; maximum values



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

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

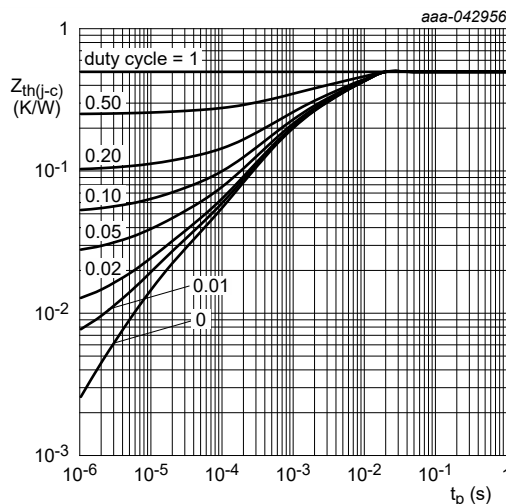


Fig. 20. Transient thermal impedance from junction to case as a function of pulse duration; typical values

11. Test information

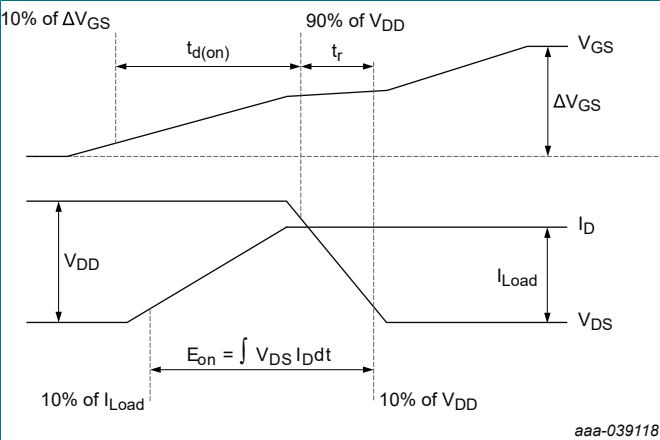


Fig. 21. Definition of switching times and losses during channel turn-on

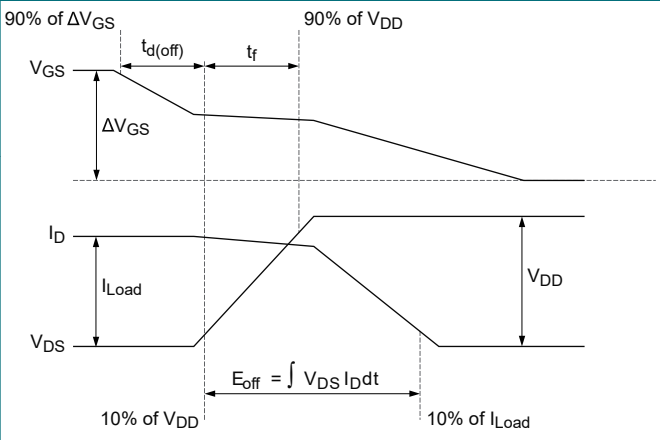


Fig. 22. Definition of switching times and losses during channel turn-off

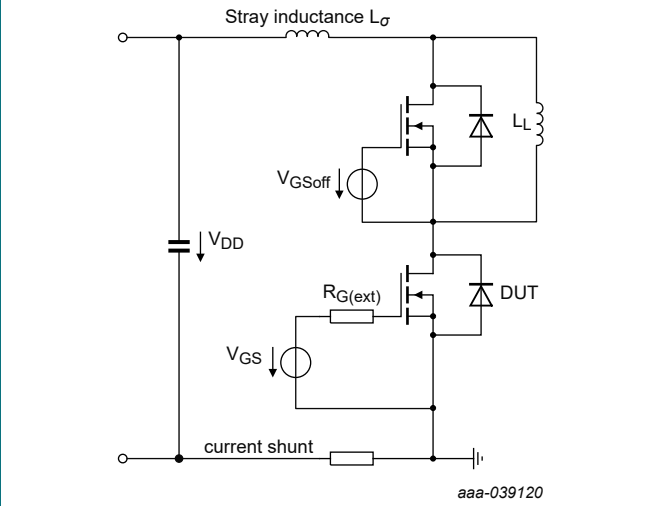


Fig. 23. Test circuit for dynamic characterization of channel and gate charge characteristics

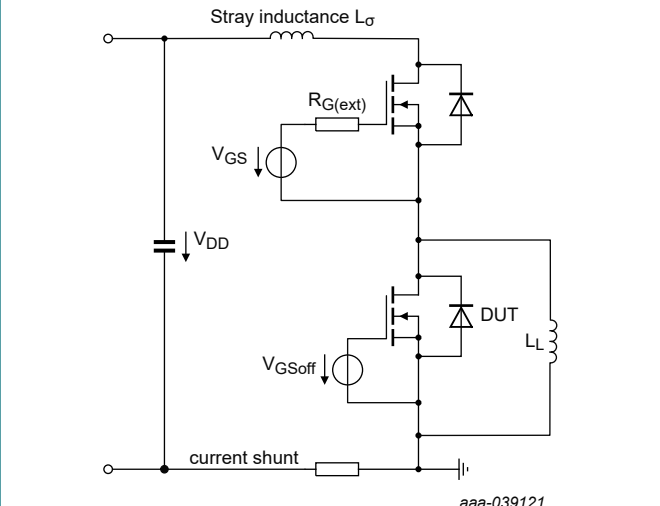


Fig. 24. Test circuit for dynamic characterization of body diode

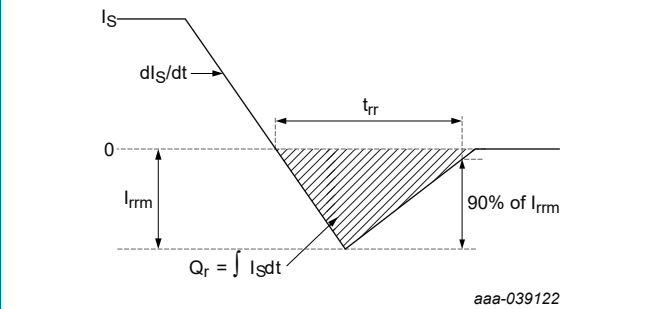


Fig. 25. Definition of dynamic characteristics of body diode

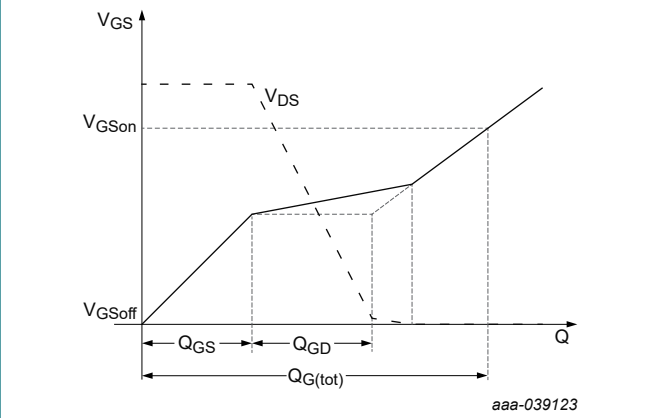


Fig. 26. Definition of gate charge characteristics

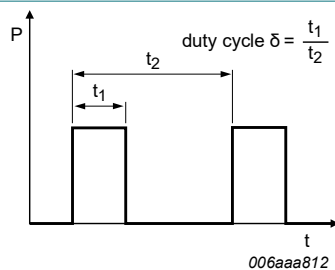


Fig. 27. Duty cycle definition

Quality information

This product has been qualified based on the Automotive Electronics Council (AEC) standard *Q101 - Stress test qualification for discrete semiconductors*, and is suitable for use in automotive applications.

SOT8070-1

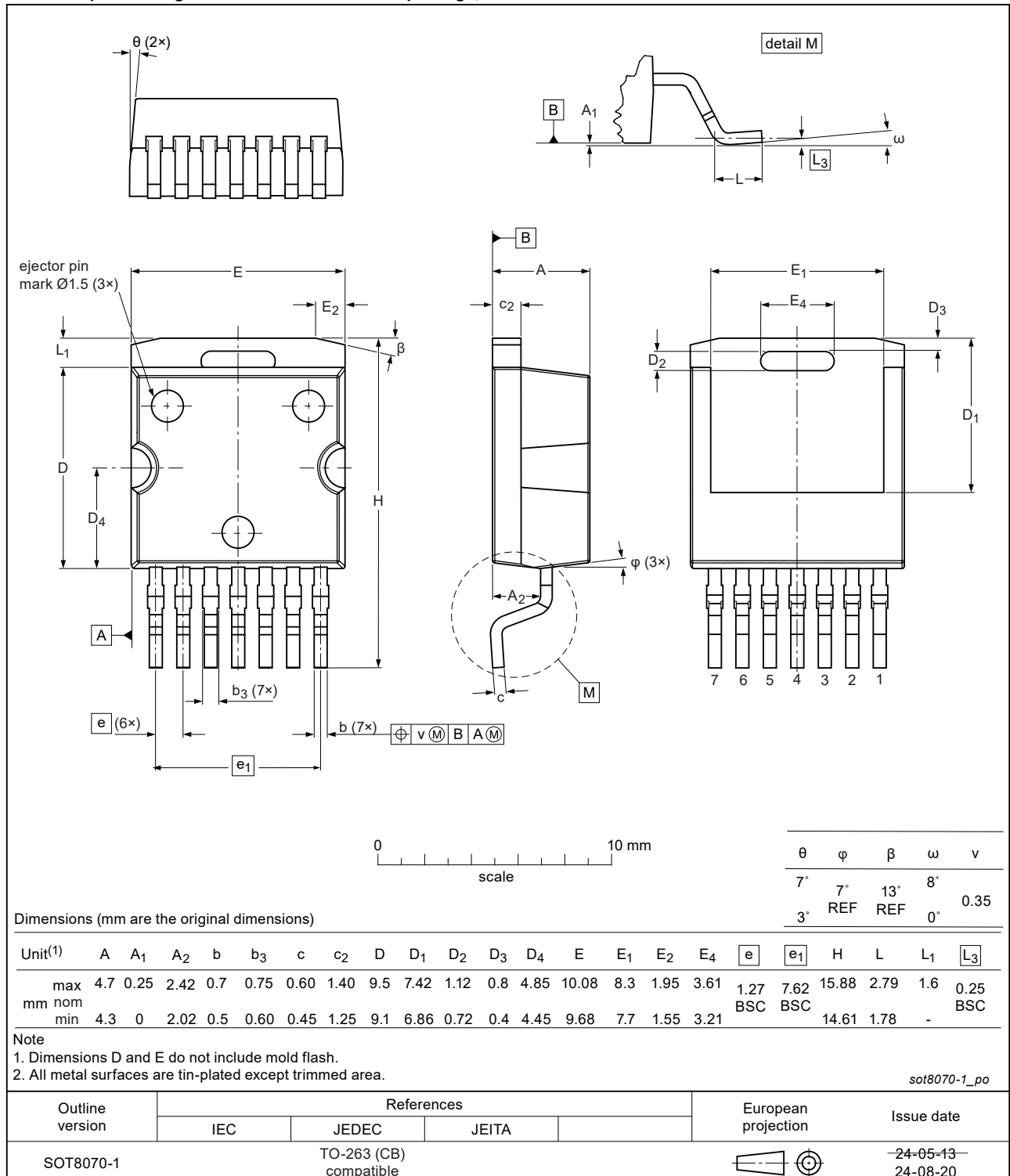


Fig. 28. Package outline TO-263-7 (SOT8070-1)

13. Soldering

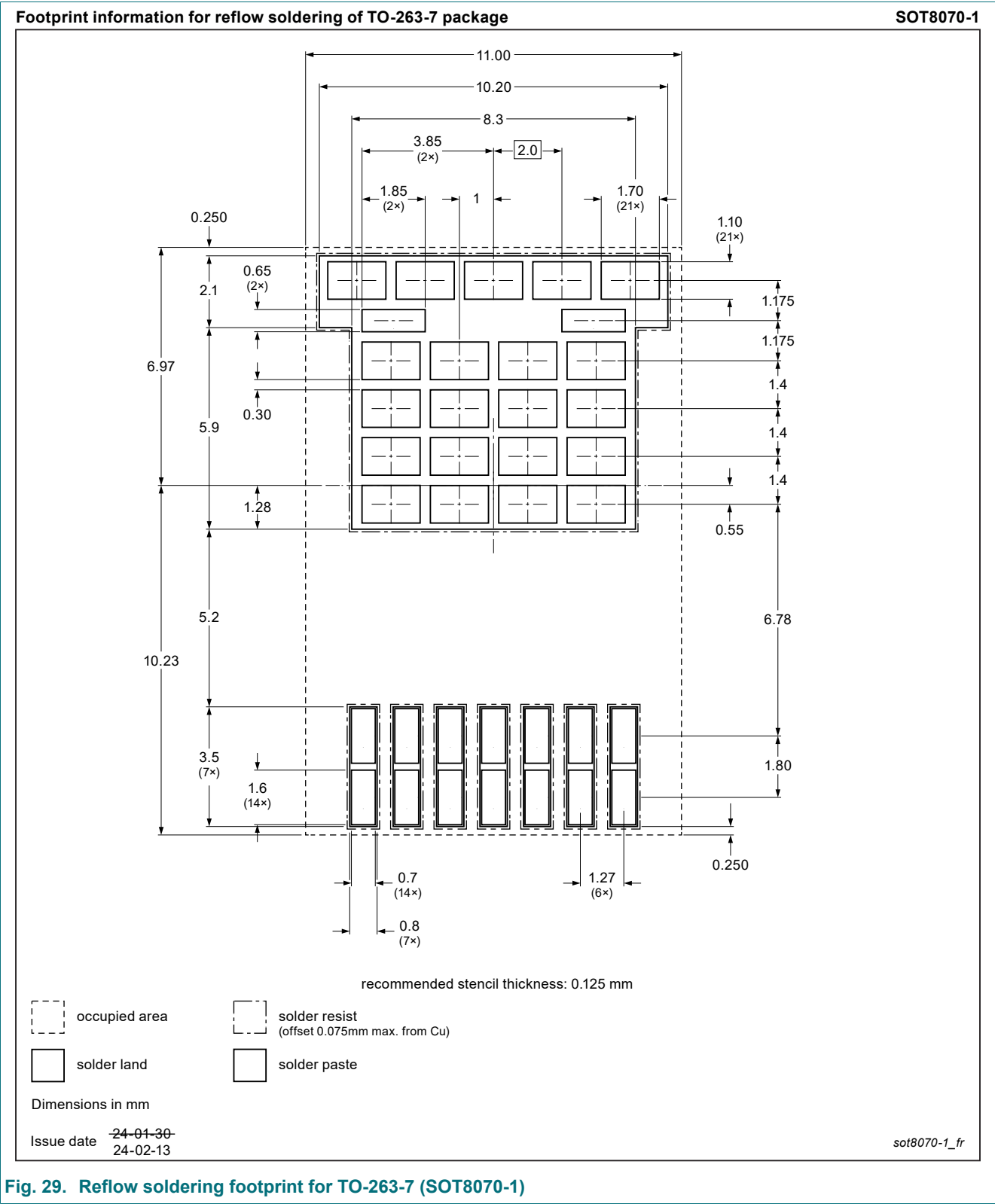


Fig. 29. Reflow soldering footprint for TO-263-7 (SOT8070-1)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NSF040120D7A1-Q v.2	20250430	Product data sheet	-	NSF040120D7A1-Q v.1
Modifications:	• Product status changed			
NSF040120D7A1-Q v.1	20240925	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.

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- [2] The term 'short data sheet' is explained in section "Definitions".
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