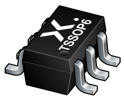


NX6020CAKS

60 V / 50 V, 170 mA / 160 mA N/P-channel Trench MOSFET

18 January 2018 Product data sheet

1. General description

Complementary N/P-channel enhancement mode Field-Effect Transistor (FET) in a very small SOT363 (SC-88) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

2. Features and benefits

- Trench MOSFET technology
- Very fast switching
- ElectroStatic Discharge (ESD) protection

3. Applications

- Relay driver
- High-speed line driver
- Level shifter
- Power supply converter

4. Quick reference data

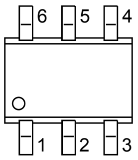
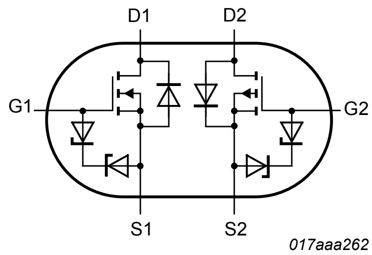
Table 1. Quick reference data

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
TR1 (N-channel)							
V_{DS}	drain-source voltage	T_j = 25 °C		-	-	60	V
I_D	drain current	V_{GS} = 10 V; T_{amb} = 25 °C	[1]	-	-	170	mA
TR1 (N-channel), Static characteristics							
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 100 mA; T_j = 25 °C		-	3	4.5	Ω
TR2 (P-channel)							
V_{DS}	drain-source voltage	T_j = 25 °C		-	-	-50	V
I_D	drain current	V_{GS} = -10 V; T_{amb} = 25 °C	[1]	-	-	-160	mA
TR2 (P-channel), Static characteristics							
R_{DSon}	drain-source on-state resistance	V_{GS} = -10 V; I_D = -100 mA; T_j = 25 °C		-	4.5	7.5	Ω

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and mounting pad for drain 1 cm^2.

5. Pinning information

Table 2. Pinning information

Pin	Symbol	Description	Simplified outline	Graphic symbol
1	S1	source TR1	 TSSOP6 (SOT363)	
2	G1	gate TR1		
3	D2	drain TR2		
4	S2	source TR2		
5	G2	gate TR2		
6	D1	drain TR1		

6. Ordering information

Table 3. Ordering information

Type number	Package		
	Name	Description	Version
NX6020CAKS	TSSOP6	plastic surface-mounted package; 6 leads	SOT363

7. Marking

Table 4. Marking codes

Type number	Marking code[1]
NX6020CAKS	2A%

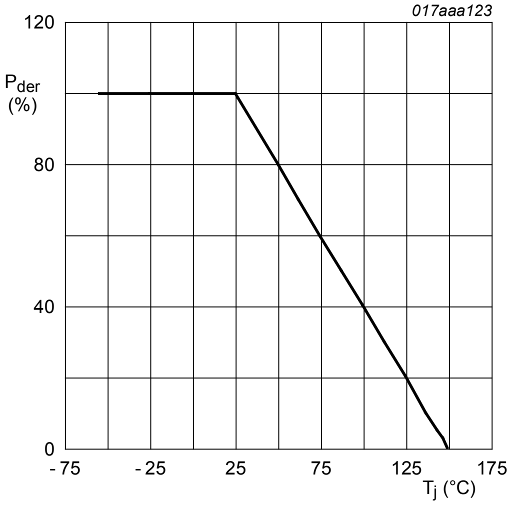
[1] % = placeholder for manufacturing site code

8. Limiting values

Table 5. Limiting values
In accordance with the Absolute Maximum Rating System (IEC 60134).

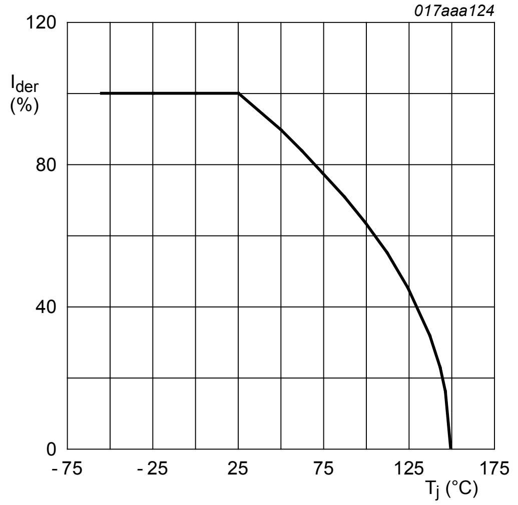
Symbol	Parameter	Conditions		Min	Max	Unit
TR1 (N-channel)						
V_{DS}	drain-source voltage	T_j = 25 °C		-	60	V
V_{GS}	gate-source voltage			-20	20	V
I_D	drain current	V_{GS} = 10 V; T_{amb} = 25 °C	[1]	-	170	mA
		V_{GS} = 10 V; T_{amb} = 100 °C	[1]	-	100	mA
I_{DM}	peak drain current	T_{amb} = 25 °C; single pulse; $t_p \leq$ 10 µs		-	680	mA
P_{tot}	total power dissipation	T_{amb} = 25 °C	[2]	-	220	mW
			[1]	-	255	mW
		T_{sp} = 25 °C		-	1.06	W
TR2 (P-channel)						
V_{DS}	drain-source voltage	T_j = 25 °C		-	-50	V
V_{GS}	gate-source voltage			-20	20	V
I_D	drain current	V_{GS} = -10 V; T_{amb} = 25 °C	[1]	-	-160	mA
		V_{GS} = -10 V; T_{amb} = 100 °C	[1]	-	-100	mA
I_{DM}	peak drain current	T_{amb} = 25 °C; single pulse; $t_p \leq$ 10 µs		-	-640	mA
P_{tot}	total power dissipation	T_{amb} = 25 °C	[2]	-	280	mW
			[1]	-	320	mW
		T_{sp} = 25 °C		-	990	mW
Per device						
P_{tot}	total power dissipation	T_{amb} = 25 °C	[2]	-	330	mW
T_j	junction temperature			-55	150	°C
T_{amb}	ambient temperature			-55	150	°C
T_{stg}	storage temperature			-65	150	°C
TR1 (N-channel), Source-drain diode						
I_S	source current	T_{amb} = 25 °C	[1]	-	170	mA
TR2 (P-channel), Source-drain diode						
I_S	source current	T_{amb} = 25 °C	[1]	-	-160	mA

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and mounting pad for drain 1 cm^2.
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper; tin-plated and standard footprint.



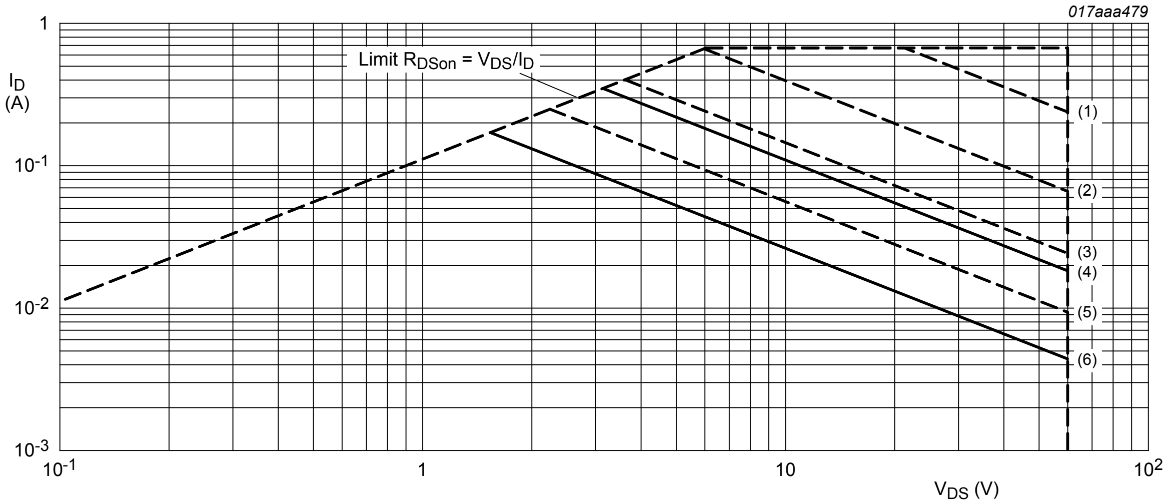
$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\ \%$$

Fig. 1. Normalized total power dissipation as a function of junction temperature



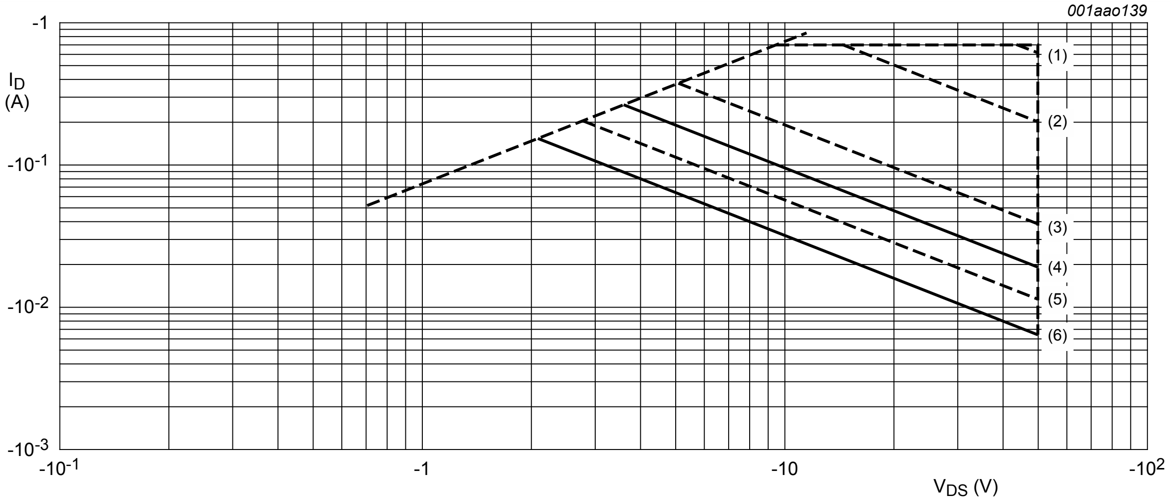
$$I_{der} = \frac{I_D}{I_{D(25°C)}} \times 100\ \%$$

Fig. 2. Normalized continuous drain current as a function of junction temperature



I_{DM} = single pulse
(1) t_p = 100 µs
(2) t_p = 1 ms
(3) t_p = 10 ms
(4) DC; T_{sp} = 25 °C
(5) t_p = 100 ms
(6) DC; T_{amb} = 25 °C; drain mounting pad 1 cm^2

Fig. 3. TR1: Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage



I_{DM} is single pulse
(1) t_p = 100 μs
(2) t_p = 1 ms
(3) t_p = 10 ms
(4) DC; T_{sp} = 25 °C
(5) t_p = 100 ms
(6) DC; T_{amb} = 25 °C; drain mounting pad 1 cm^2

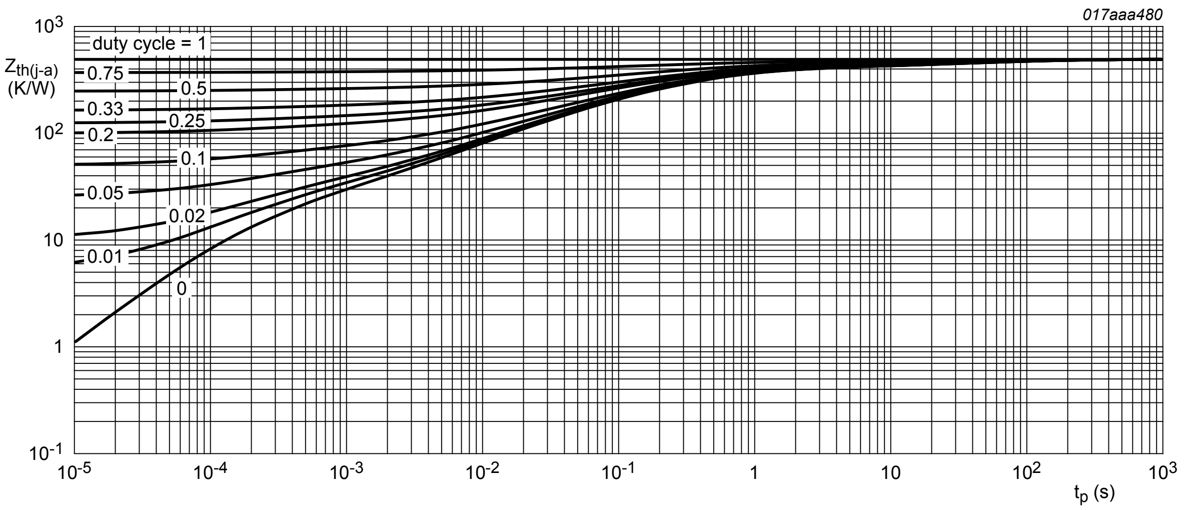
Fig. 4. TR2: Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

9. Thermal characteristics

Table 6. Thermal characteristics

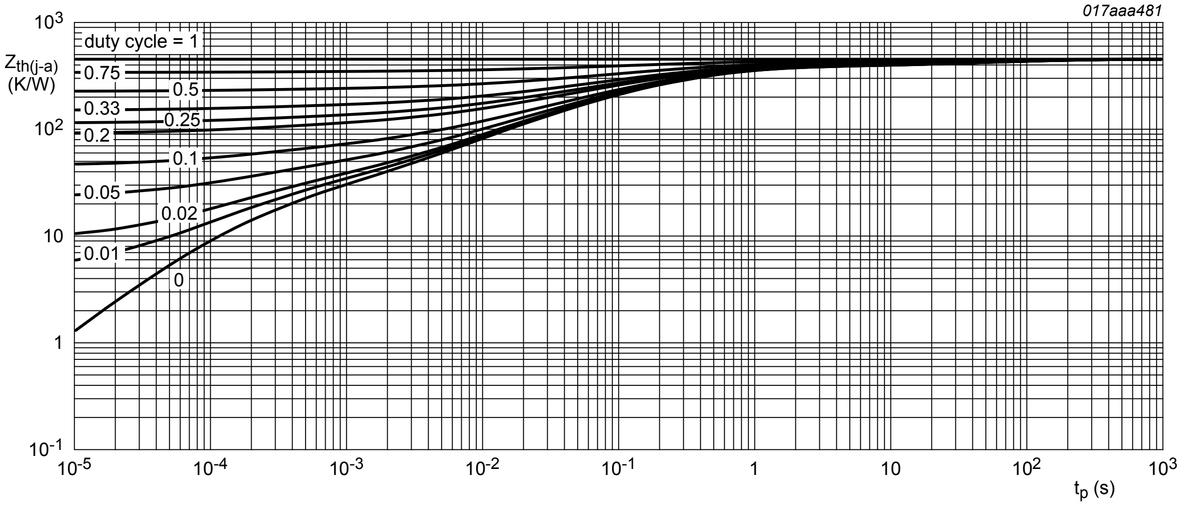
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
TR1 (N-channel)							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	500	560	K/W
			[2]	-	450	480	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	115	K/W
TR2 (P-channel)							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	390	445	K/W
			[2]	-	340	390	K/W
$R_{th(j-sp)}$	thermal resistance from junction to solder point			-	-	130	K/W
Per device							
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	[1]	-	-	300	K/W

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper; tin-plated and standard footprint.
[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated and mounting pad for drain 1 cm^2.



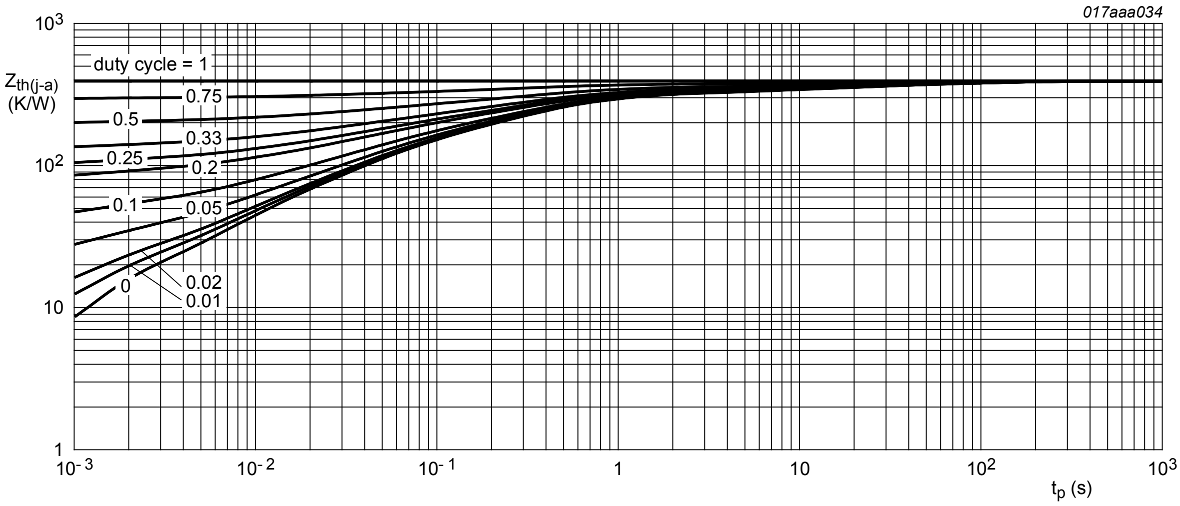
FR4 PCB, standard footprint

Fig. 5. TR1: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values



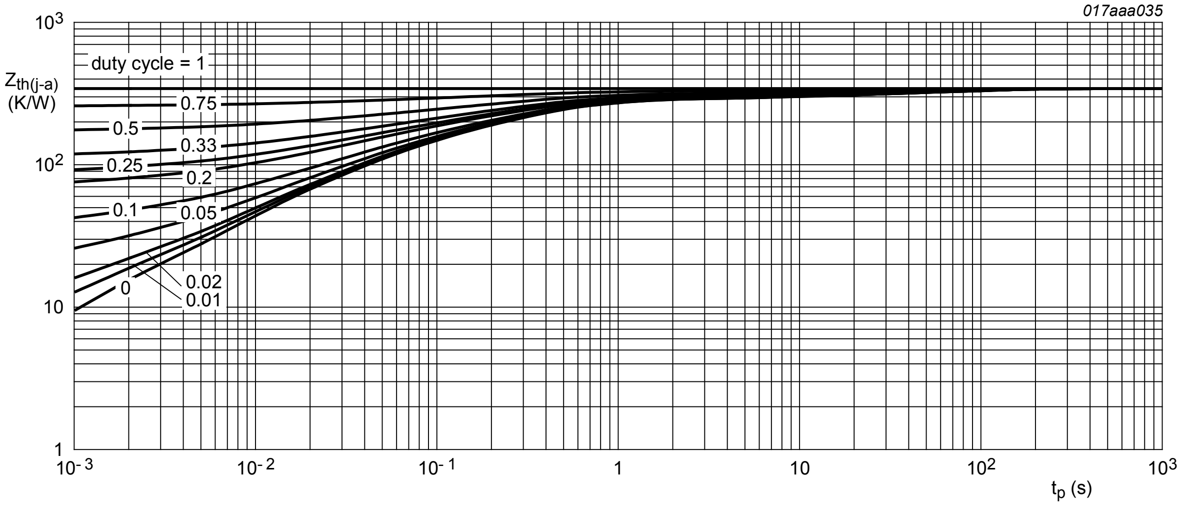
FR4 PCB, mounting pad for drain 1 cm^2

Fig. 6. TR1: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values



FR4 PCB, standard footprint

Fig. 7. TR2: transient thermal impedance from junction to ambient as a function of pulse duration; typical values



FR4 PCB, mounting pad for drain 1 cm^2

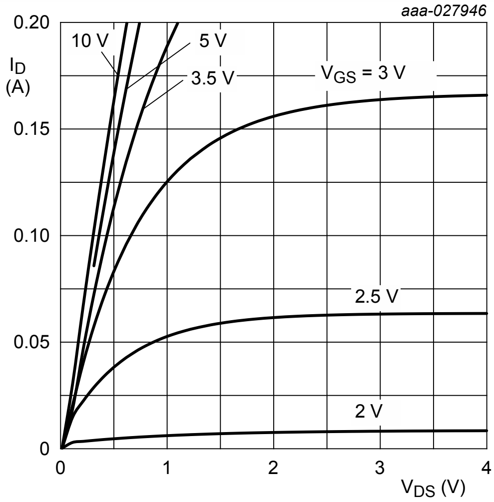
Fig. 8. TR2: transient thermal impedance from junction to ambient as a function of pulse duration; typical values

10. Characteristics

Table 7. Characteristics

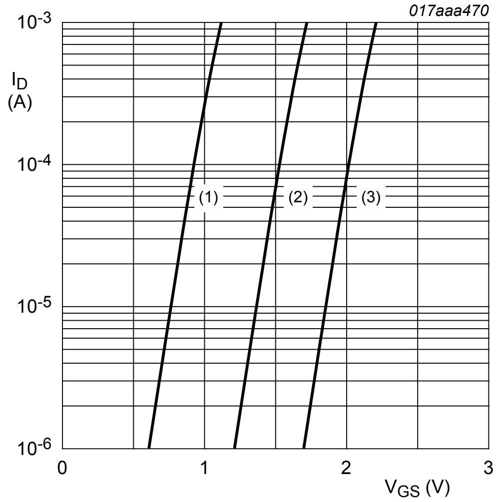
Symbol	Parameter	Conditions		Min	Typ	Max	Unit
TR1 (N-channel), Static characteristics							
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = 250 μA; V_{GS} = 0 V; T_j = 25 °C		60	-	-	V
V_{GSth}	gate-source threshold voltage	I_D = 250 μA; V_{DS}=V_{GS}; T_j = 25 °C		1.1	1.6	2.1	V
I_{DSS}	drain leakage current	V_{DS} = 60 V; V_{GS} = 0 V; T_j = 25 °C		-	-	1	μA
		V_{DS} = 60 V; V_{GS} = 0 V; T_j = 150 °C		-	-	10	μA
I_{GSS}	gate leakage current	V_{GS} = 20 V; V_{DS} = 0 V; T_j = 25 °C		-	-	2	μA
		V_{GS} = -20 V; V_{DS} = 0 V; T_j = 25 °C		-	-	2	μA
		V_{GS} = 10 V; V_{DS} = 0 V; T_j = 25 °C		-	-	0.5	μA
		V_{GS} = -10 V; V_{DS} = 0 V; T_j = 25 °C		-	-	0.5	μA
		V_{GS} = 5 V; V_{DS} = 0 V; T_j = 25 °C		-	-	100	nA
		V_{GS} = -5 V; V_{DS} = 0 V; T_j = 25 °C		-	-	100	nA
R_{DSon}	drain-source on-state resistance	V_{GS} = 10 V; I_D = 100 mA; T_j = 25 °C		-	3	4.5	Ω
		V_{GS} = 10 V; I_D = 100 mA; T_j = 150 °C		-	6.2	9.2	Ω
		V_{GS} = 5 V; I_D = 100 mA; T_j = 25 °C		-	3.7	5.2	Ω
g_{fs}	forward transconductance	V_{DS} = 10 V; I_D = 200 mA; T_j = 25 °C		-	230	-	mS
TR2 (P-channel), Static characteristics							
$V_{(BR)DSS}$	drain-source breakdown voltage	I_D = -10 μA; V_{GS} = 0 V; T_j = 25 °C		-50	-	-	V
V_{GSth}	gate-source threshold voltage	I_D = -250 μA; V_{DS}=V_{GS}; T_j = 25 °C		-1.1	-1.6	-2.1	V
I_{DSS}	drain leakage current	V_{DS} = -50 V; V_{GS} = 0 V; T_j = 25 °C		-	-	-1	μA
		V_{DS} = -50 V; V_{GS} = 0 V; T_j = 150 °C		-	-	-2	μA
I_{GSS}	gate leakage current	V_{GS} = -20 V; V_{DS} = 0 V; T_j = 25 °C		-	-	-10	μA
		V_{GS} = 20 V; V_{DS} = 0 V; T_j = 25 °C		-	-	-10	μA
R_{DSon}	drain-source on-state resistance	V_{GS} = -10 V; I_D = -100 mA; T_j = 25 °C		-	4.5	7.5	Ω
		V_{GS} = -10 V; I_D = -100 mA; T_j = 150 °C		-	8	13.5	Ω
		V_{GS} = -5 V; I_D = -100 mA; T_j = 25 °C		-	5.7	8.5	Ω
g_{fs}	forward transconductance	V_{DS} = -10 V; I_D = -100 mA; T_j = 25 °C		-	150	-	mS
TR1 (N-channel), Dynamic characteristics							
$Q_{G(tot)}$	total gate charge	V_{DS} = 30 V; I_D = 200 mA; V_{GS} = 4.5 V; T_j = 25 °C		-	0.33	0.43	nC
Q_{GS}	gate-source charge			-	0.12	-	nC
Q_{GD}	gate-drain charge			-	0.09	-	nC

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
C_{iss}	input capacitance	V_{DS} = 10 V; f = 1 MHz; V_{GS} = 0 V; T_j = 25 °C		-	11	17	pF
C_{oss}	output capacitance			-	3.4	-	pF
C_{rss}	reverse transfer capacitance			-	1.4	-	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = 40 V; R_L = 250 Ω; V_{GS} = 10 V; $R_{G(ext)}$ = 6 Ω; T_j = 25 °C		-	6	12	ns
t_r	rise time			-	7	-	ns
$t_{d(off)}$	turn-off delay time			-	20	40	ns
t_f	fall time			-	14	-	ns
TR2 (P-channel), Dynamic characteristics							
$Q_{G(tot)}$	total gate charge	V_{DS} = -25 V; I_D = -200 mA; V_{GS} = -5 V; T_j = 25 °C		-	0.26	0.35	nC
Q_{GS}	gate-source charge			-	0.12	-	nC
Q_{GD}	gate-drain charge			-	0.09	-	nC
C_{iss}	input capacitance	V_{DS} = -25 V; f = 1 MHz; V_{GS} = 0 V; T_j = 25 °C		-	24	36	pF
C_{oss}	output capacitance			-	4.5	-	pF
C_{rss}	reverse transfer capacitance			-	1.3	-	pF
$t_{d(on)}$	turn-on delay time	V_{DS} = -30 V; R_L = 250 Ω; V_{GS} = -10 V; $R_{G(ext)}$ = 6 Ω; T_j = 25 °C		-	13	26	ns
t_r	rise time			-	11	-	ns
$t_{d(off)}$	turn-off delay time			-	48	96	ns
t_f	fall time			-	25	-	ns
TR1 (N-channel), Source-drain diode characteristics							
V_{SD}	source-drain voltage	I_S = 115 mA; V_{GS} = 0 V; T_j = 25 °C		0.47	0.7	1.2	V
TR2 (P-channel), Source-drain diode characteristics							
V_{SD}	source-drain voltage	I_S = -115 mA; V_{GS} = 0 V; T_j = 25 °C		-0.48	-0.85	-1.2	V



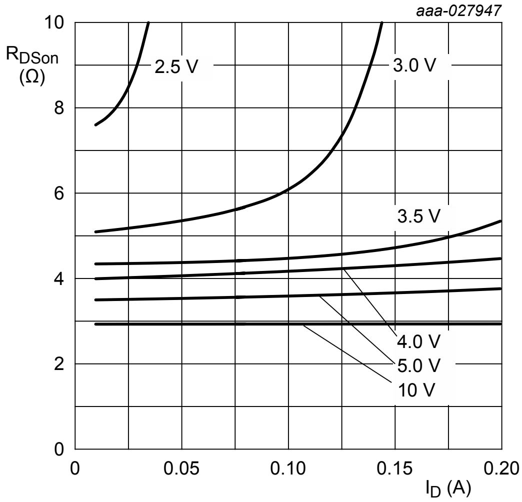
T_j = 25 °C

Fig. 9. TR1: Output characteristics: drain current as a function of drain-source voltage; typical values



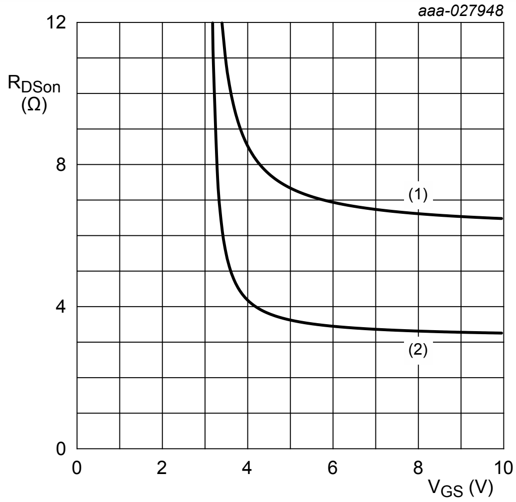
T_j = 25 °C; V_{DS} = 5 V
(1) minimum values
(2) typical values
(3) maximum values

Fig. 10. TR1: Sub-threshold drain current as a function of gate-source voltage



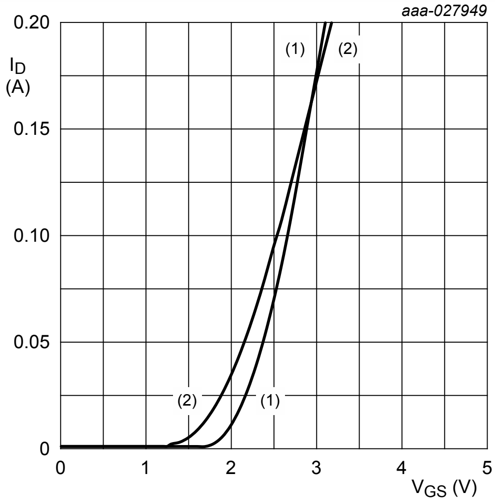
T_j = 25 °C

Fig. 11. TR1: Drain-source on-state resistance as a function of drain current; typical values



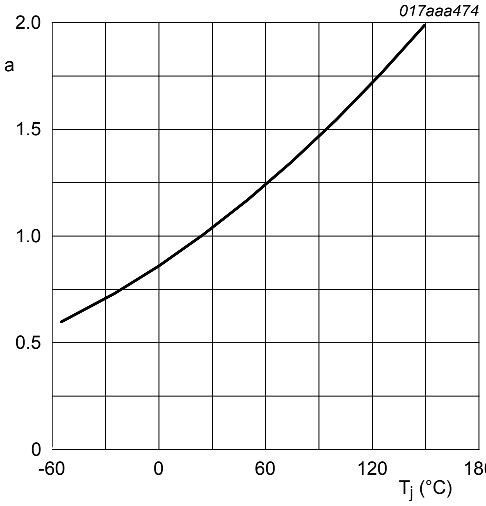
I_D = 0.2 A
(1) T_j = 150 °C
(2) T_j = 25 °C

Fig. 12. TR1: Drain-source on-state resistance as a function of gate-source voltage; typical values



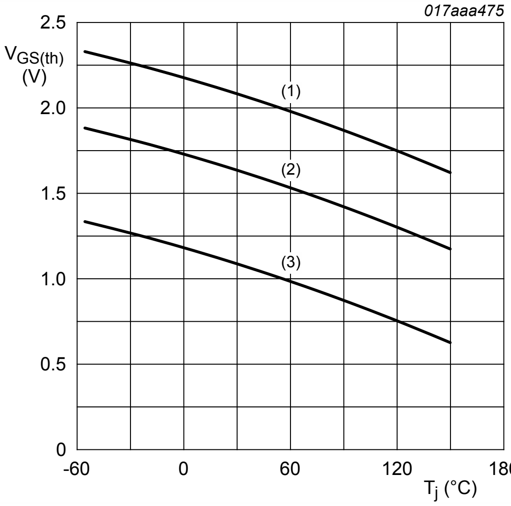
$V_{DS} > I_D \times R_{DSon}$
(1) T_j = 25 °C
(2) T_j = 150 °C

Fig. 13. TR1: Transfer characteristics: drain current as a function of gate-source voltage; typical values



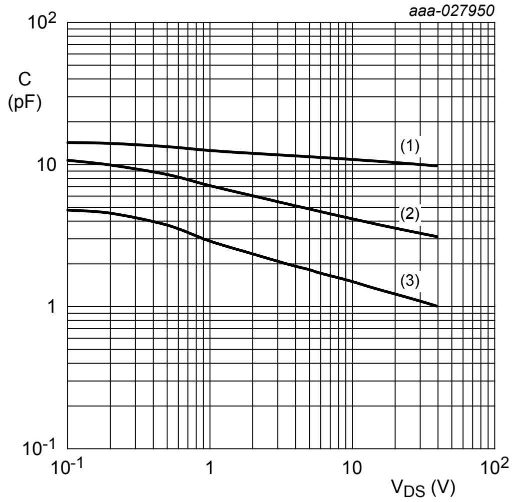
$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

Fig. 14. TR1: Normalized drain-source on-state resistance as a function of junction temperature; typical values



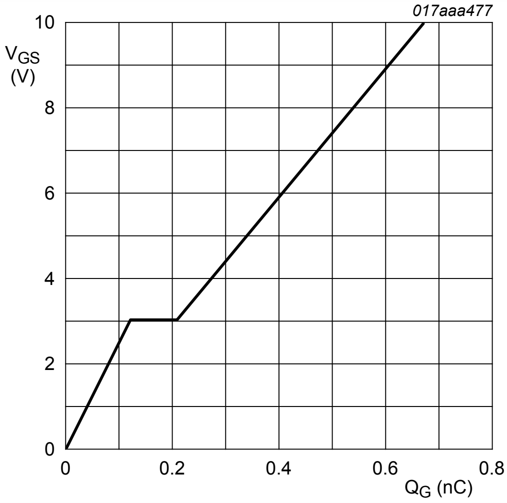
I_D = 0.25 mA; $V_{DS} = V_{GS}$
(1) maximum values
(2) typical values
(3) minimum values

Fig. 15. TR1: Gate-source threshold voltage as a function of junction temperature



f = 1 MHz; V_{GS} = 0 V
(1) C_{iss}
(2) C_{oss}
(3) C_{rss}

Fig. 16. TR1: Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



I_D = 0.2 A; V_{DS} = 30 V; T_{amb} = 25 °C

Fig. 17. TR1: Gate-source voltage as a function of gate charge; typical values

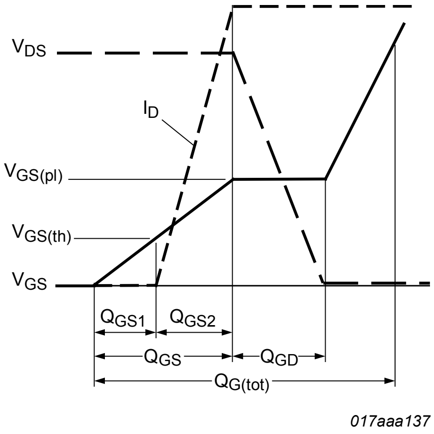
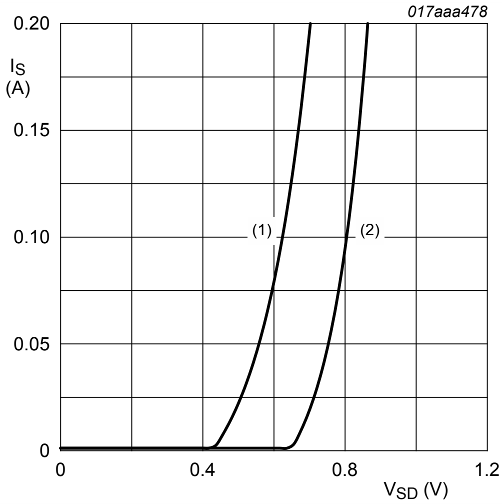
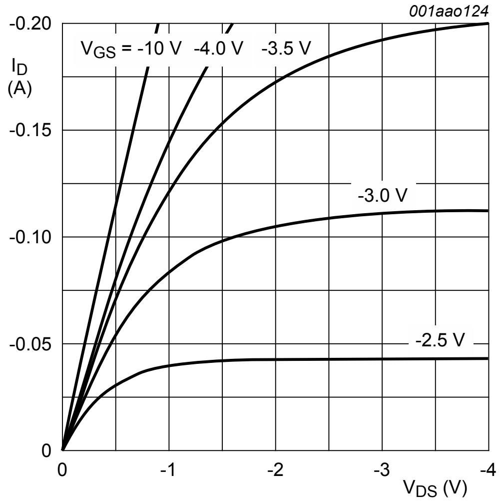


Fig. 18. TR1: Gate charge waveform definitions



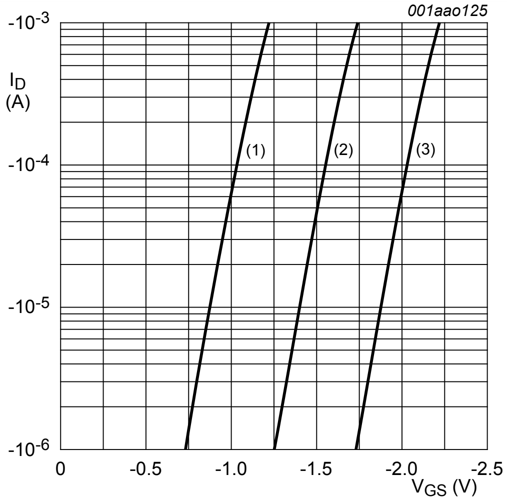
V_{GS} = 0 V
(1) T_j = 150 °C
(2) T_j = 25 °C

Fig. 19. TR1: Source current as a function of source-drain voltage; typical values



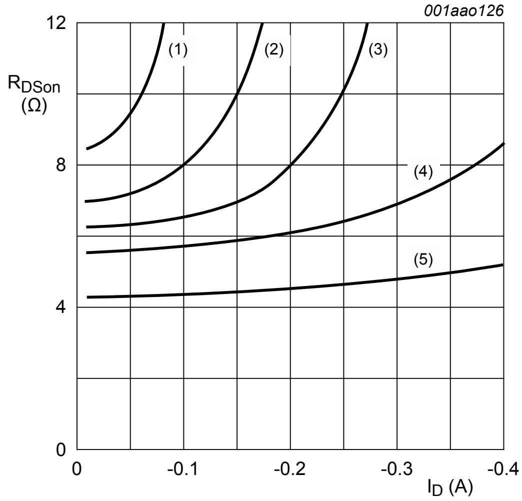
T_j = 25 °C

Fig. 20. TR2: Output characteristics: drain current as a function of drain-source voltage; typical values



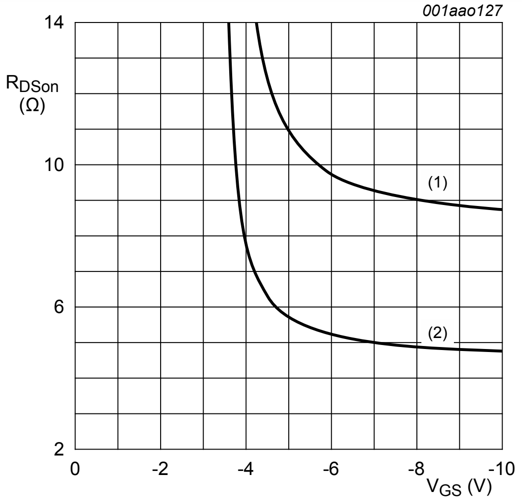
T_j = 25 °C; V_{DS} = -5 V
(1) minimum values
(2) typical values
(3) maximum values

Fig. 21. TR2: Sub-threshold drain current as a function of gate-source voltage



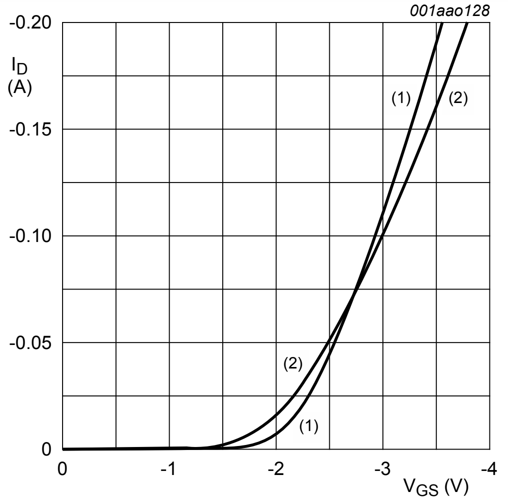
T_j = 25 °C
(1) V_{GS} = -3.0 V
(2) V_{GS} = -3.5 V
(3) V_{GS} = -4.0 V
(4) V_{GS} = -5.0 V
(5) V_{GS} = -10.0 V

Fig. 22. TR2: Drain-source on-state resistance as a function of drain current; typical values



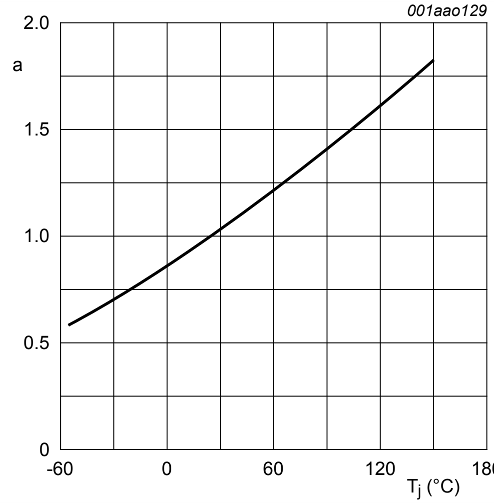
I_D = -200 mA
(1) T_j = 150 °C
(2) T_j = 25 °C

Fig. 23. TR2: Drain-source on-state resistance as a function of gate-source voltage; typical values



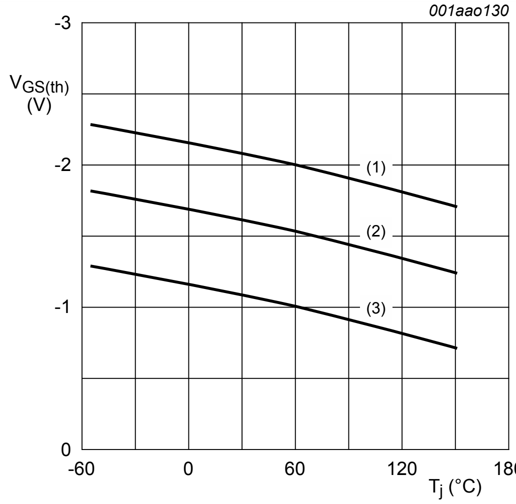
V_{DS} > I_D x R_{DSon}
(1) T_j = 25 °C
(2) T_j = 150 °C

Fig. 24. TR2: Transfer characteristics: drain current as a function of gate-source voltage; typical values



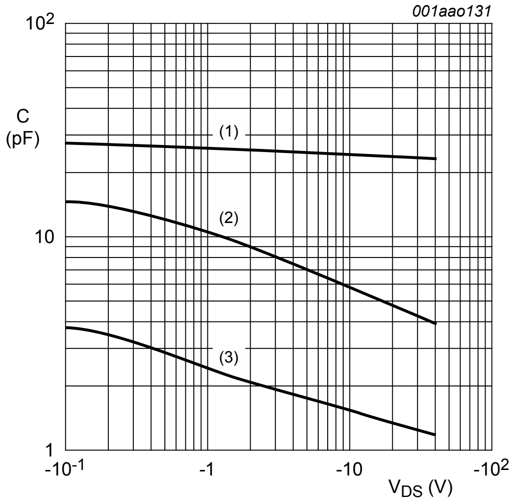
$$a = \frac{R_{DSon}}{R_{DSon(25°C)}}$$

Fig. 25. TR2: Normalized drain-source on-state resistance as a function of junction temperature; typical values



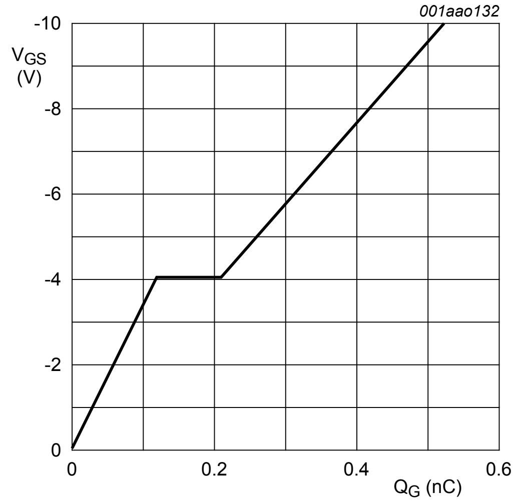
I_D = -0.25 mA; $V_{DS} = V_{GS}$
(1) maximum values
(2) typical values
(3) minimum values

Fig. 26. TR2: Gate-source threshold voltage as a function of junction temperature



f = 1 MHz; V_{GS} = 0 V
(1) C_{iss}
(2) C_{oss}
(3) C_{rss}

Fig. 27. TR2: Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values



I_D = -200 mA; V_{DS} = -25 V; T_{amb} = 25 °C

Fig. 28. TR2: Gate-source voltage as a function of gate charge; typical values

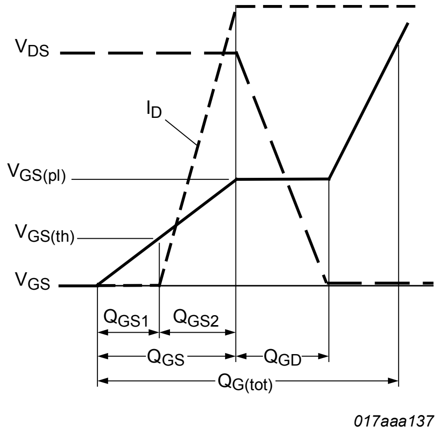
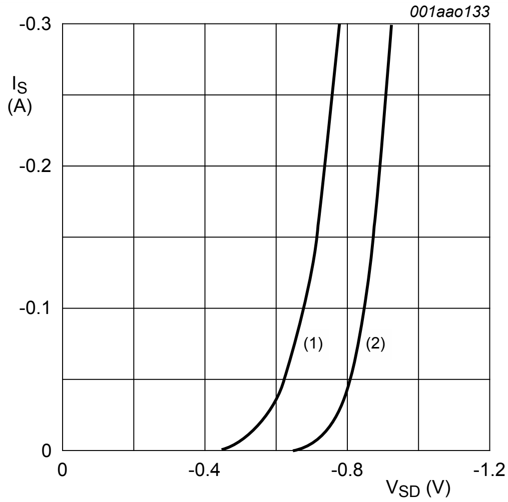


Fig. 29. TR2: Gate charge waveform definitions



V_{GS} = 0 V
(1) T_j = 150 °C
(2) T_j = 25 °C

Fig. 30. TR2: Source current as a function of source-drain voltage; typical values

11. Test information

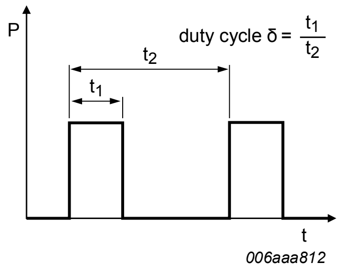
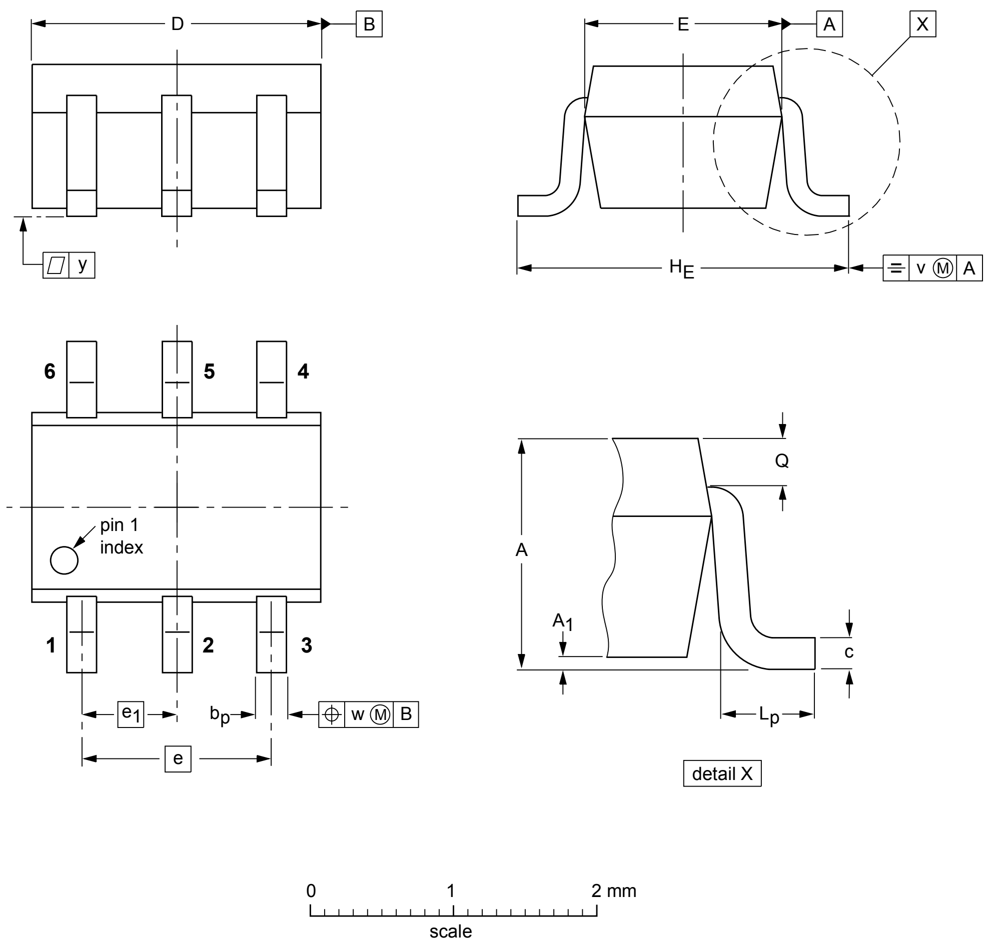


Fig. 31. Duty cycle definition

12. Package outline

Plastic surface-mounted package; 6 leads **SOT363**



DIMENSIONS (mm are the original dimensions)

UNIT	A	A_1 max	b_p	c	D	E	e	e_1	H_E	L_p	Q	v	w	y
mm	1.1 0.8	0.1	0.30 0.20	0.25 0.10	2.2 1.8	1.35 1.15	1.3	0.65	2.2 2.0	0.45 0.15	0.25 0.15	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT363			SC-88			~~04-11-08~~ 06-03-16

Fig. 32. Package outline TSSOP6 (SOT363)

13. Soldering

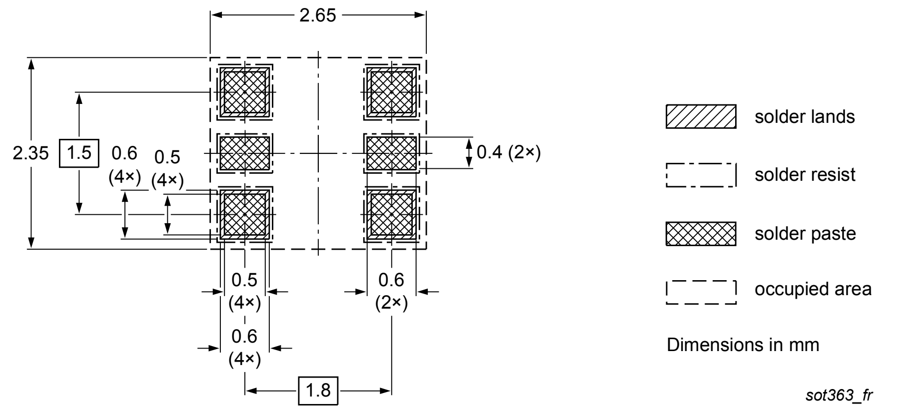


Fig. 33. Reflow soldering footprint for TSSOP6 (SOT363)

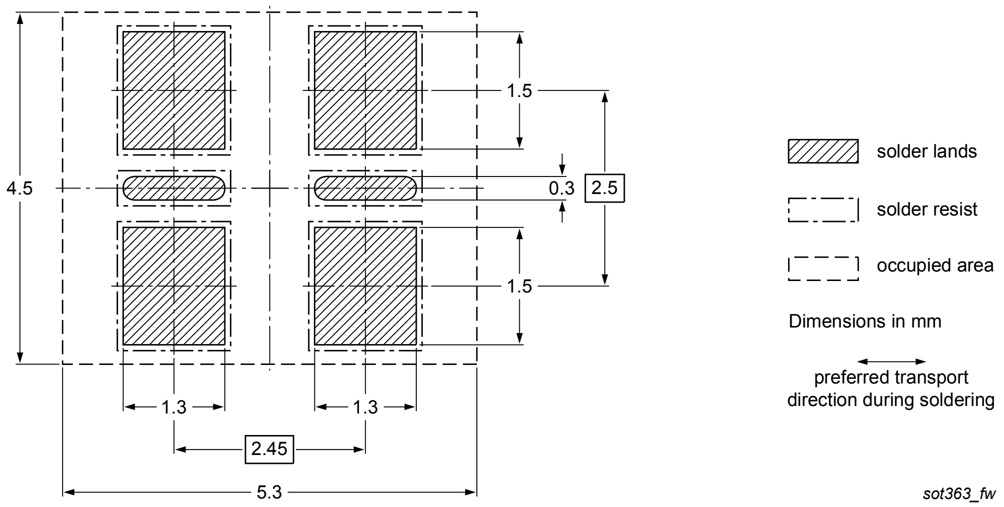


Fig. 34. Wave soldering footprint for TSSOP6 (SOT363)

14. Revision history

Table 8. Revision history

Data sheet ID	Release date	Data sheet status	Change notice	Supersedes
NX6020CAKS v.2	20180118	Product data sheet	-	NX6020CAKS v.1
Modifications:	• Data sheet status changed to Product. • Section: Limiting values, ESD maximum rating removed.			
NX6020CAKS v.1	20171220	Preliminary 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 URL http://www.nexperia.com.

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16. Contents

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Date of release: 18 January 2018