
# NX1029X

## 60 / 50 V, 330 / 170 mA N/P-channel Trench MOSFET

Rev. 1 — 12 August 2011 Product data sheet

## 1. Product profile

### 1.1 General description

Complementary N/P-channel enhancement mode Field-Effect Transistor (FET) in an ultra small and flat lead SOT666 Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

### 1.2 Features and benefits

- Logic-level compatible
- Very fast switching
- Trench MOSFET technology
- ESD protection up to 2 kV (N-channel) and 1 kV (P-channel)
- AEC-Q101 qualified

### 1.3 Applications

- Level shifter
- Power supply converter
- Load switch
- Switching circuits

### 1.4 Quick reference data

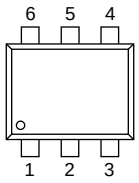
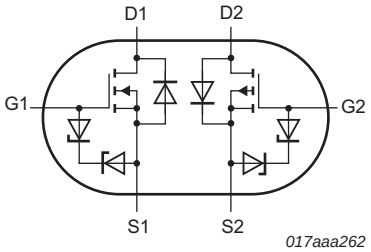
**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **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] | - | - | -170 | mA |
| **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] | - | - | 330 | mA |
| **TR1 (N-channel), Static characteristics** | | | | | | | |
| $R_{DSon}$ | drain-source on-state resistance | $V_{GS}$ = 10 V; $I_D$ = 500 mA; pulsed; $t_p \leq 300$ µs; $\delta \leq 0.01$ ; $T_j$ = 25 °C | | - | 1 | 1.6 | Ω |
| **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 $cm^2$.

## 2. Pinning information

**Table 2. Pinning information**

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



**SOT666 (SOT666)**



*017aaa262*

## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| NX1029X | SOT666 | plastic surface-mounted package; 6 leads | SOT666 |

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code[1] |
|---|---|
| NX1029X | AD |

[1] % = placeholder for manufacturing site code.

## 5. Limiting values

**Table 5. Limiting values**

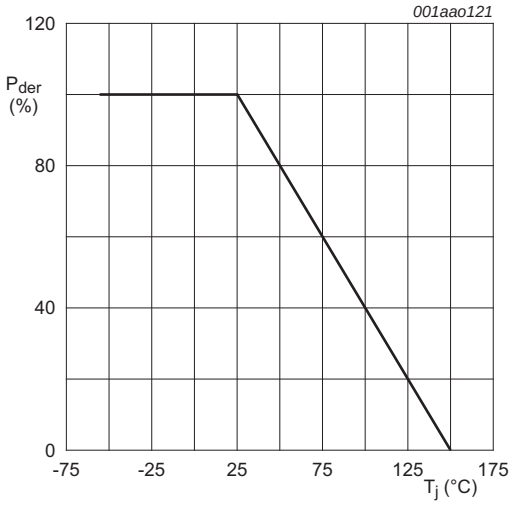
*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| **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] | - | -170 | mA |
| | | $V_{GS}$ = -10 V; $T_{amb}$ = 100 °C | [1] | - | -110 | mA |
| $I_{DM}$ | peak drain current | $T_{amb}$ = 25 °C; single pulse; $t_p \leq 10$ µs | | - | -0.7 | A |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C | [2] | - | 330 | mW |
| | | | [1] | - | 390 | mW |
| | | $T_{sp}$ = 25 °C | | - | 1090 | mW |
| **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] | - | 330 | mA |
| | | $V_{GS}$ = 10 V; $T_{amb}$ = 100 °C | [1] | - | 210 | mA |
| $I_{DM}$ | peak drain current | $T_{amb}$ = 25 °C; single pulse; $t_p \leq 10$ µs | | - | 1.2 | A |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C | [2] | - | 330 | mW |
| | | | [1] | - | 390 | mW |
| | | $T_{sp}$ = 25 °C | | - | 1090 | mW |
| **Per device** | | | | | | |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C | [2] | - | 500 | 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 | [2][1] | - | 330 | mA |
| **TR2 (P-channel), Source-drain diode** | | | | | | |
| $I_S$ | source current | $T_{amb}$ = 25 °C | [1] | - | -170 | mA |
| **TR1 N-channel), ESD maximum rating** | | | | | | |
| $V_{ESD}$ | electrostatic discharge voltage | HBM | [3] | - | 2000 | V |
| **TR2 (P-channel), ESD maximum rating** | | | | | | |
| $V_{ESD}$ | electrostatic discharge voltage | HBM | [3] | - | 1000 | V |

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

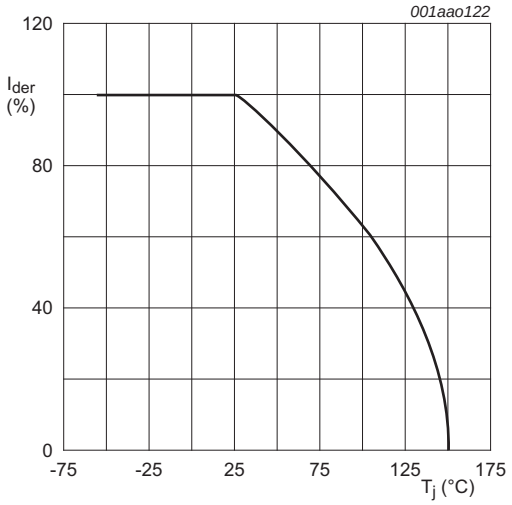
[2] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper; tin-plated and standard footprint.

[3] Measured between all pins.



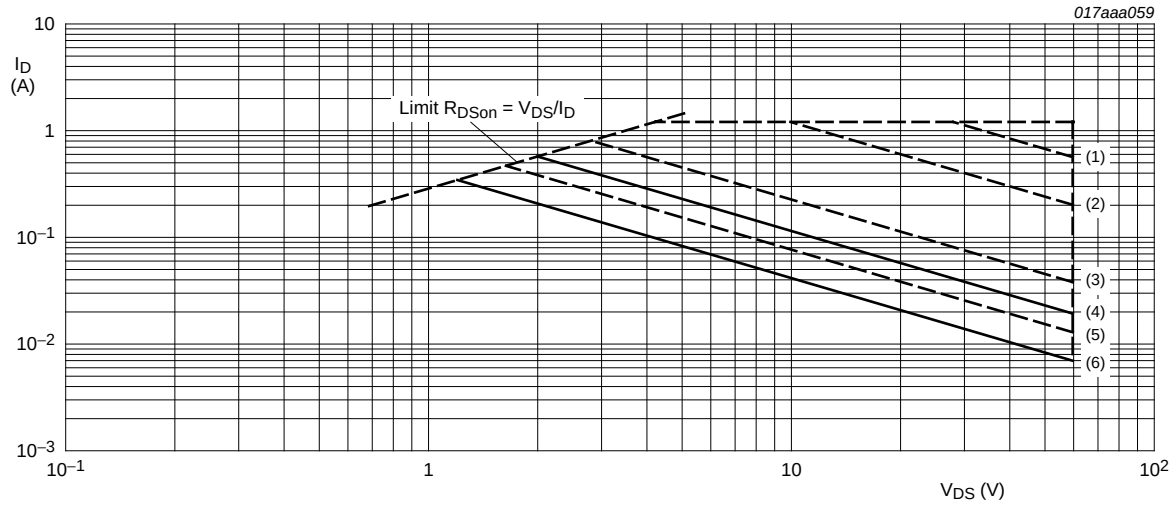

$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\,\%$$

**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

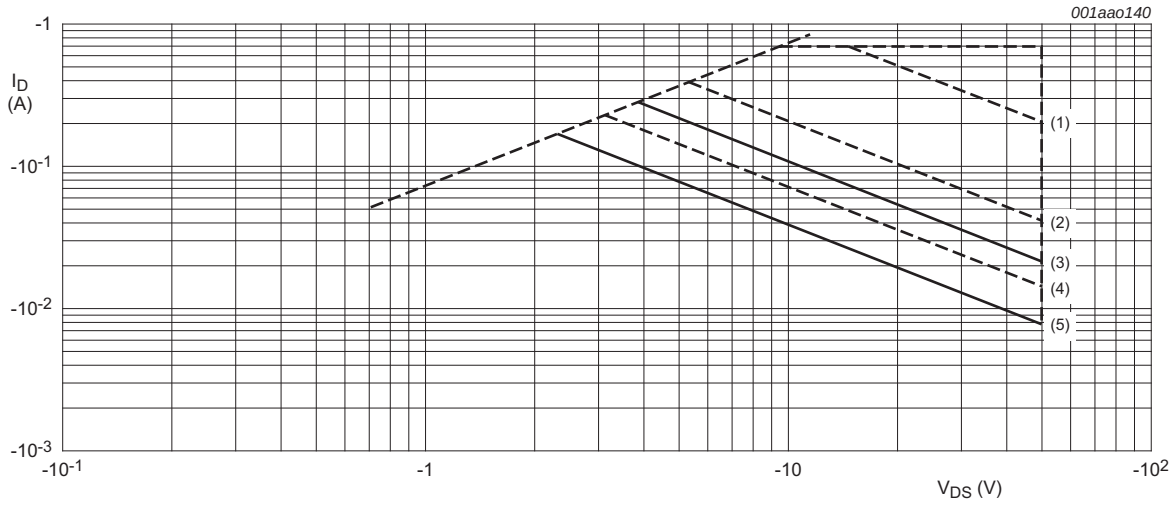
(3) $t_p$ = 10 ms

(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. Safe operating area TR1 (N-channel); junction to ambient; continuous and peak drain currents as a function of drain-source voltage**




$I_{DM}$ is single pulse

(1) $t_p$ = 1 ms

(2) $t_p$ = 10 ms

(3) DC; $T_{sp}$ = 25 °C

(4) $t_p$ = 100 ms

(5) DC; $T_{amb}$ = 25 °C; drain mounting pad 1 $cm^2$

**Fig 4. Safe operating area TR2 (P-channel); junction to ambient; continuous and peak drain currents as a function of drain-source voltage**

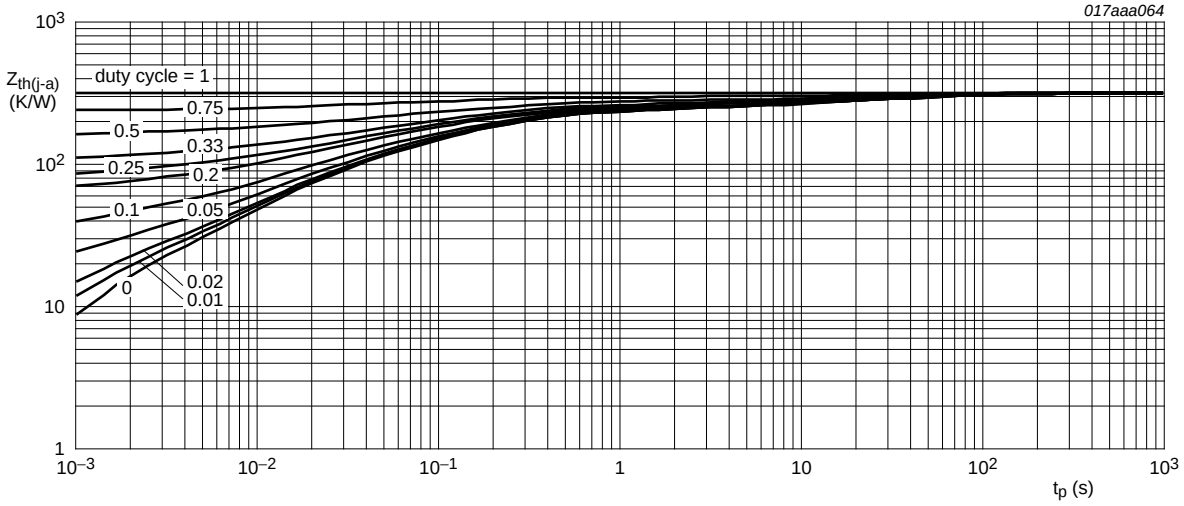
## 6. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **Per device** | | | | | | | |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | - | 250 | K/W |
| **TR1 (N-channel)** | | | | | | | |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | 330 | 380 | K/W |
| | | | [2] | - | 280 | 320 | 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] | - | 330 | 380 | K/W |
| | | | [2] | - | 280 | 320 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 115 | K/W |

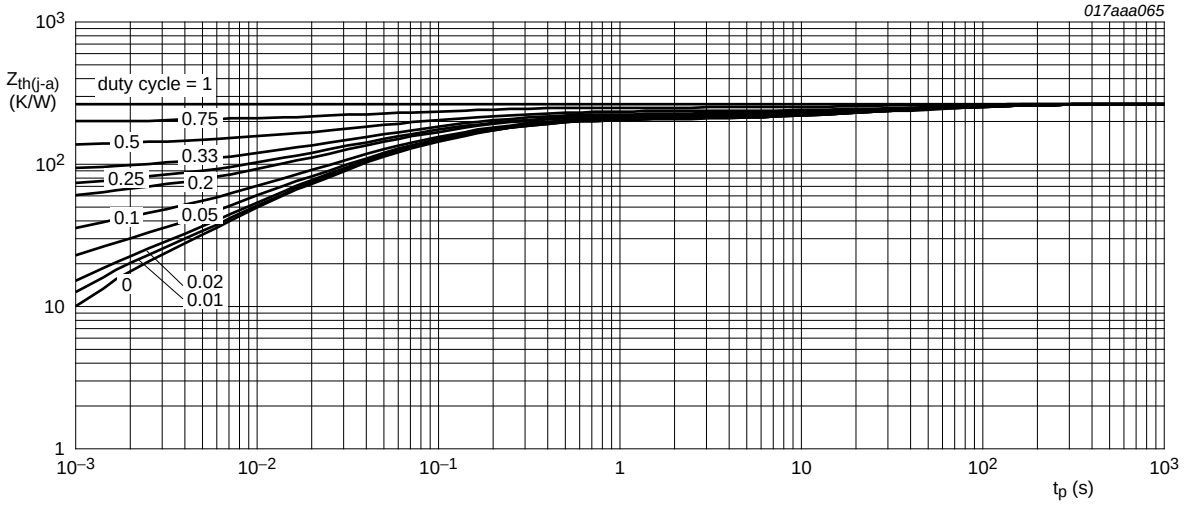
[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper; tin-plated and standard footprint.

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



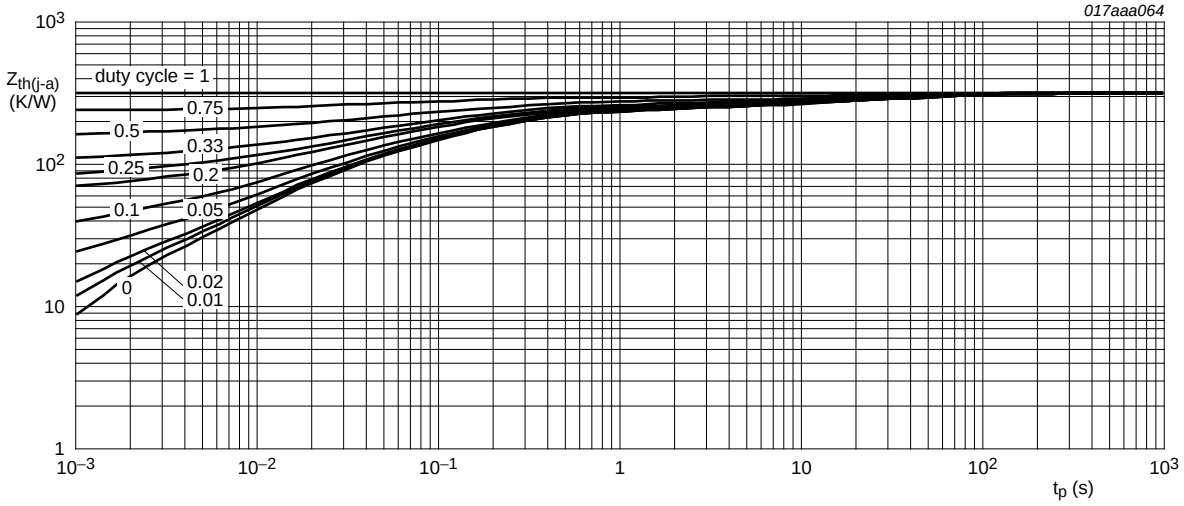

FR4 PCB, standard footprint

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



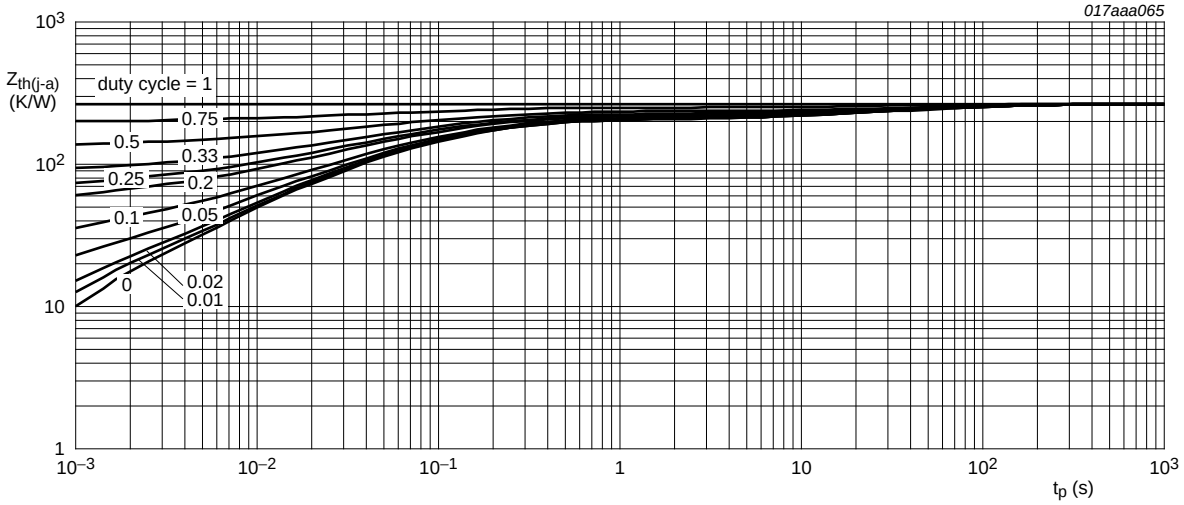

FR4 PCB, mounting pad for drain 1 $cm^2$

**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**

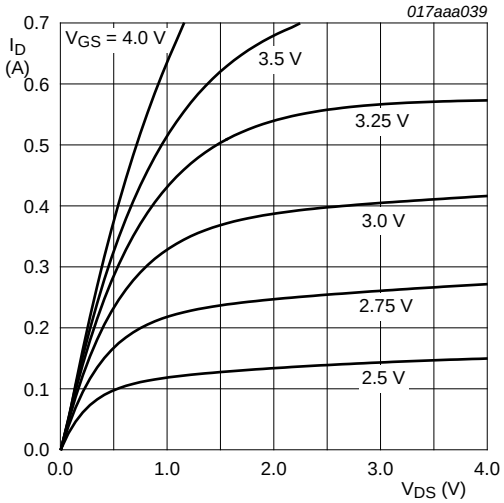
# 7. Characteristics

**Table 7. Characteristics**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **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 | - | 5.1 | 8.5 | Ω |
| $g_{fs}$ | transfer conductance | $V_{DS}$ = -10 V; $I_D$ = -100 mA; $T_j$ = 25 °C | - | 150 | - | mS |
| **TR1 (N-channel), Static characteristics** | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = 10 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 | - | - | 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; $I_D$ = 500 mA; pulsed; $t_p \leq 300$ µs; $\delta \leq 0.01$ ; $T_j$ = 25 °C | - | 1 | 1.6 | Ω |
| | | $V_{GS}$ = 10 V; $I_D$ = 500 mA; pulsed; $t_p \leq 300$ µs; $\delta \leq 0.01$ ; $T_j$ = 150 °C | - | 2.25 | 3.6 | Ω |
| | | $V_{GS}$ = 5 V; $I_D$ = 50 mA; pulsed; $t_p \leq 300$ µs; $\delta \leq 0.01$ ; $T_j$ = 25 °C | - | 1.3 | 2 | Ω |
| $g_{fs}$ | transfer conductance | $V_{DS}$ = 10 V; $I_D$ = 100 mA; $T_j$ = 25 °C | - | 550 | - | mS |
| **TR2 (P-channel), Dynamic characteristics** | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $V_{DS}$ = -25 V; $I_D$ = -180 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 |

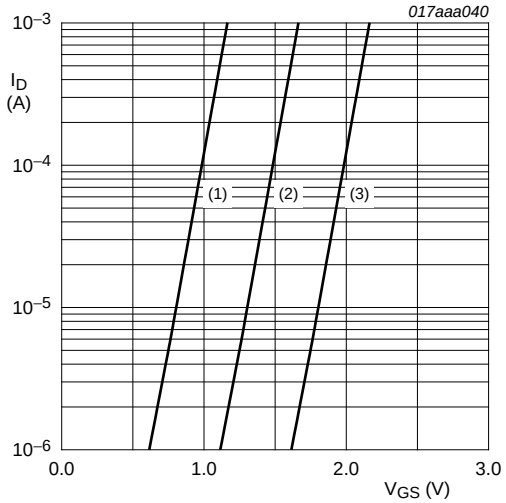
**Table 7. Characteristics** *...continued*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **TR1 (N-channel), Dynamic characteristics** | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $V_{DS}$ = 30 V; $I_D$ = 300 mA; $V_{GS}$ = 4.5 V; $T_j$ = 25 °C | - | 0.5 | 0.6 | nC |
| $Q_{GS}$ | gate-source charge | | - | 0.2 | - | nC |
| $Q_{GD}$ | gate-drain charge | | - | 0.1 | - | nC |
| $C_{iss}$ | input capacitance | $V_{DS}$ = 10 V; f = 1 MHz; $V_{GS}$ = 0 V; $T_j$ = 25 °C | - | 33 | 50 | pF |
| $C_{oss}$ | output capacitance | | - | 7 | - | pF |
| $C_{rss}$ | reverse transfer capacitance | | - | 4 | - | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = 50 V; $R_L$ = 250 Ω; $V_{GS}$ = 10 V; $R_{G(ext)}$ = 6 Ω; $T_j$ = 25 °C | - | 5 | 10 | ns |
| $t_r$ | rise time | | - | 6 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 12 | 24 | ns |
| $t_f$ | fall time | | - | 7 | - | ns |
| **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 |
| **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 | 0.75 | 1.1 | V |




$T_j$ = 25 °C

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



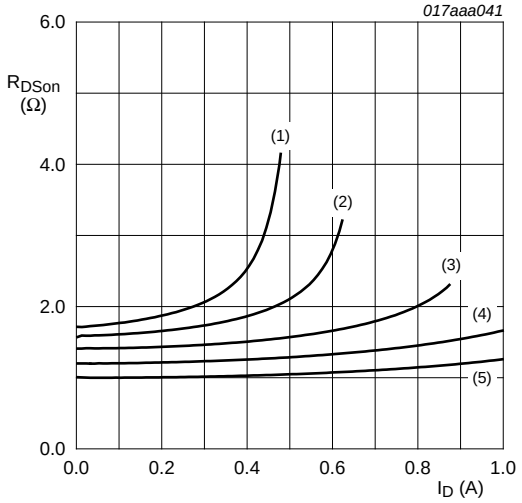

$T_j$ = 25 °C; $V_{DS}$ = 5 V

(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

(1) $V_{GS}$ = 3.25 V

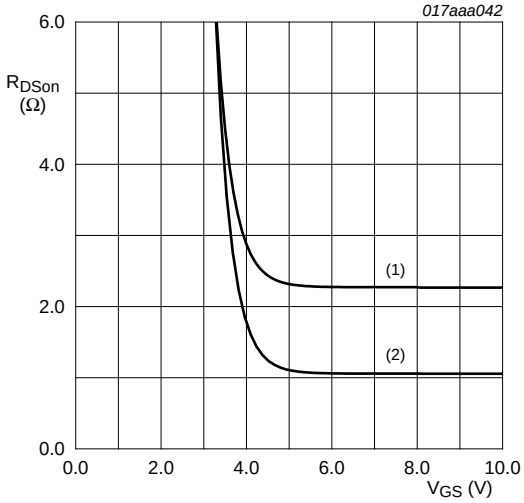
(2) $V_{GS}$ = 3.5 V

(3) $V_{GS}$ = 4 V

(4) $V_{GS}$ = 5 V

(5) $V_{GS}$ = 10 V

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

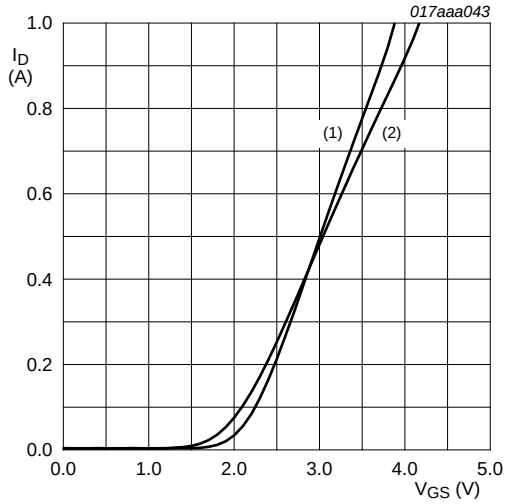



$I_D$ = 500 mA; pulsed; $t_p \leq 300$ µs; $\delta \leq 0.01$

(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**

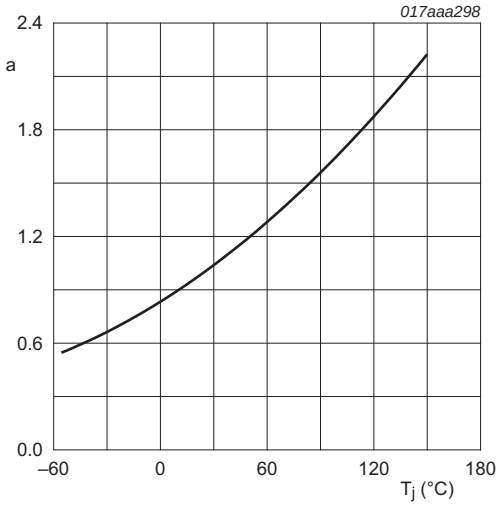



$V_{DS} > I_D \times R_{DSon}$

(1) $T_j$ = 25 °C

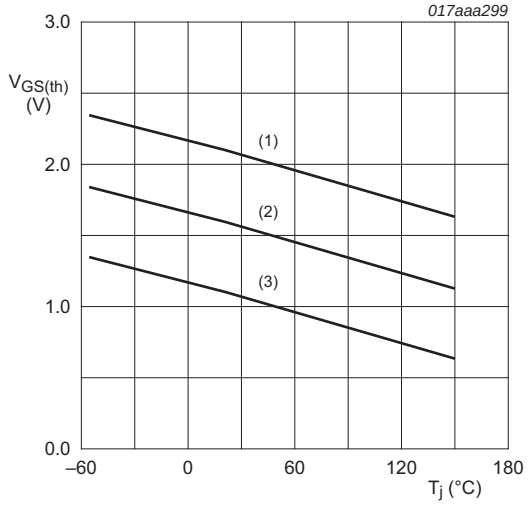
(2) $T_j$ = 150 °C

**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**



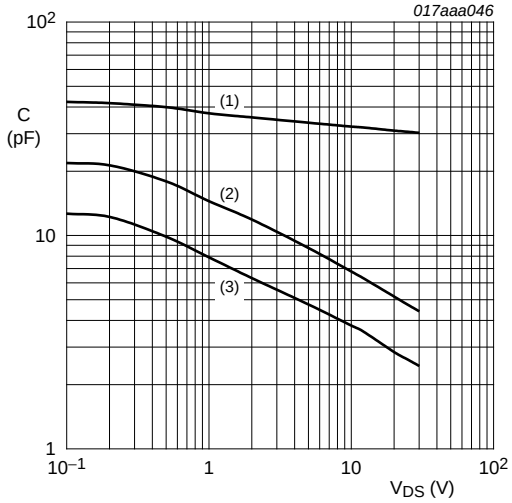

$I_D$ = 0.25 mA; $V_{DS}$ = $V_{GS}$

(1) maximum values

(2) typical values

(3) minimum values

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



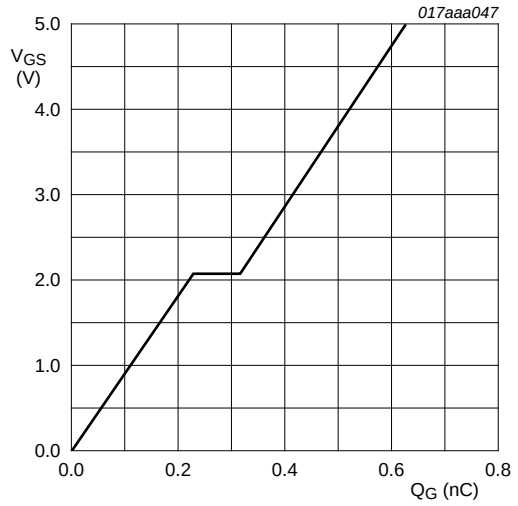

f = 1 MHz; $V_{GS}$ = 0 V

(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**




$I_D$ = 300 mA; $V_{DS}$ = 30 V; $T_{amb}$ = 25 °C

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

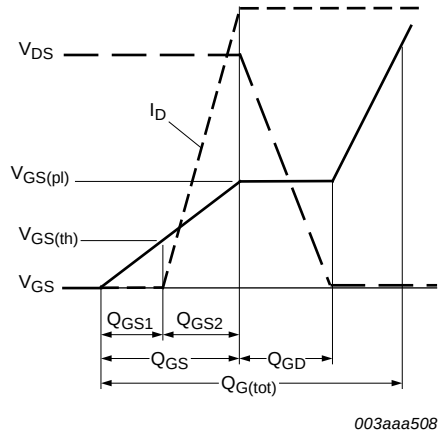
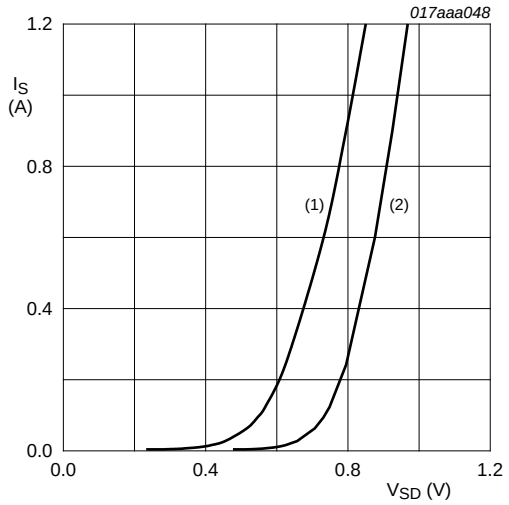



**Fig 18. Gate charge waveform definitions**

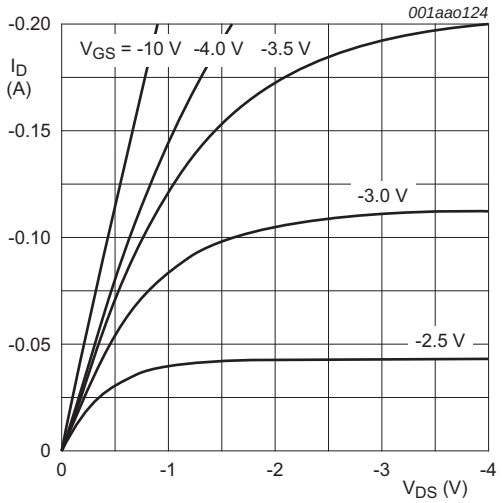



$V_{GS}$ = 0 V

(1) $T_j$ = 150 °C

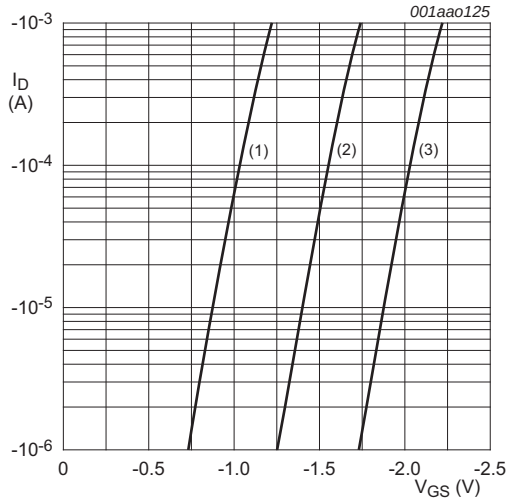
(2) $T_j$ = 25 °C

**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**



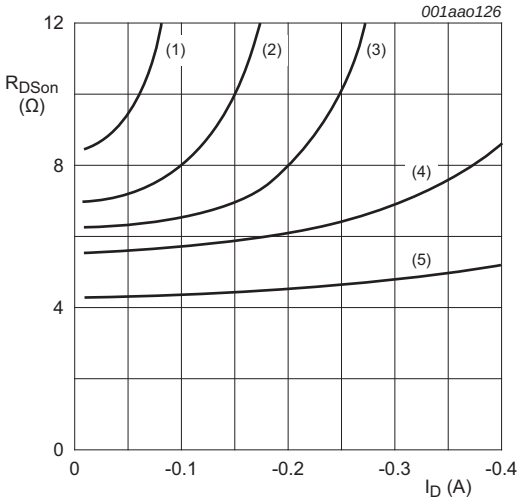

$T_j$ = 25 °C; $V_{DS}$ = -5 V

(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

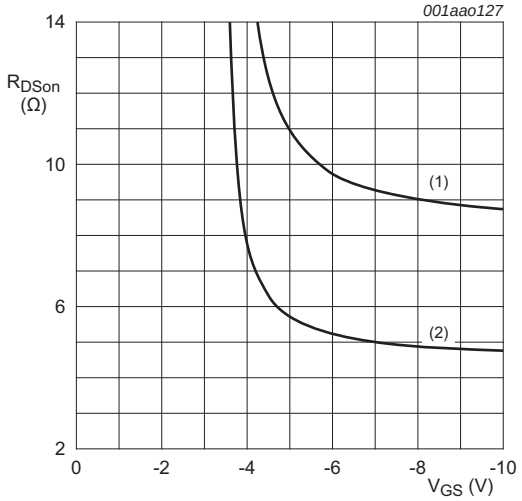
(2) $V_{GS}$ = -3.5 V

(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**

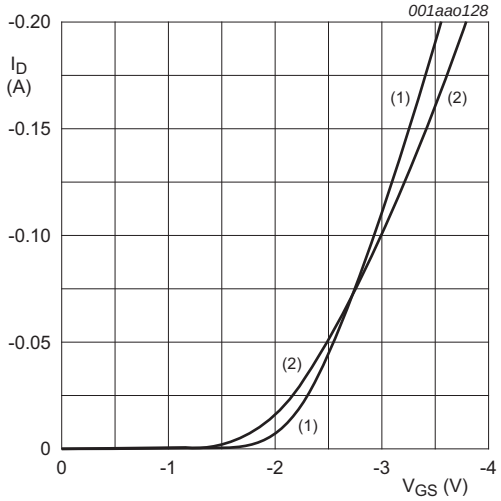



$I_D$ = -200 mA

(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**

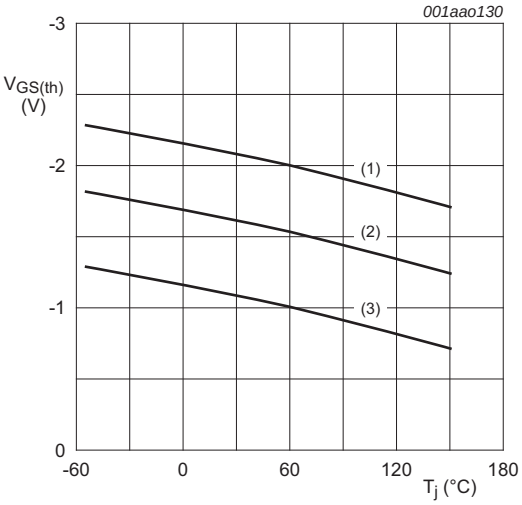



$V_{DS} > I_D \times R_{DSon}$

(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**



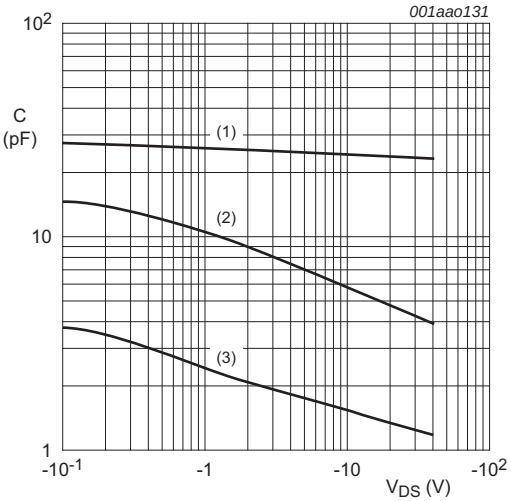

$I_D$ = -0.25 mA; $V_{DS} = V_{GS}$

(1) maximum values

(2) typical values

(3) minimum values

**Fig 25. TR2: Gate-source threshold voltage as a function of junction temperature**



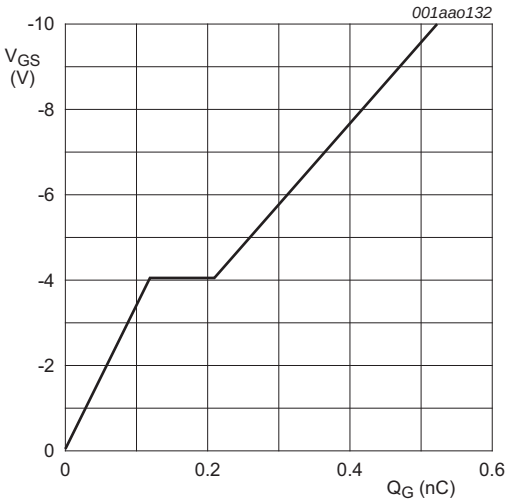

f = 1 MHz; $V_{GS}$ = 0 V

(1) $C_{iss}$

(2) $C_{oss}$

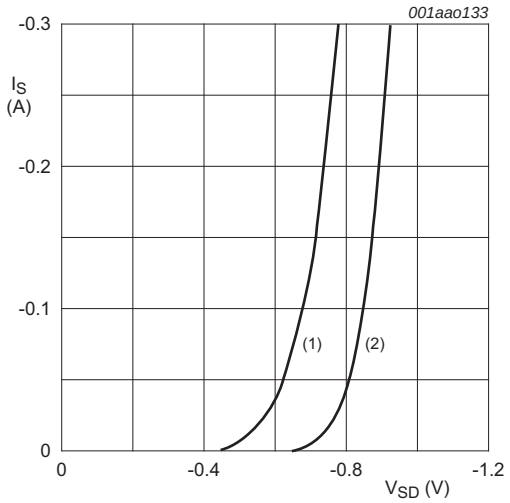
(3) $C_{rss}$

**Fig 26. TR2: Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**




$I_D$ = -180 mA; $V_{DS}$ = -25 V; $T_{amb}$ = 25 °C

**Fig 27. TR2: Gate-source voltage as a function of gate charge; typical values**




$V_{GS}$ = 0 V

(1) $T_j$ = 150 °C

(2) $T_j$ = 25 °C

**Fig 28. TR2: Source current as a function of source-drain voltage; typical values**

# 8. Test information

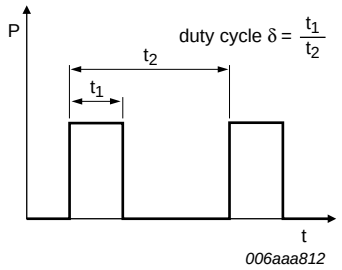


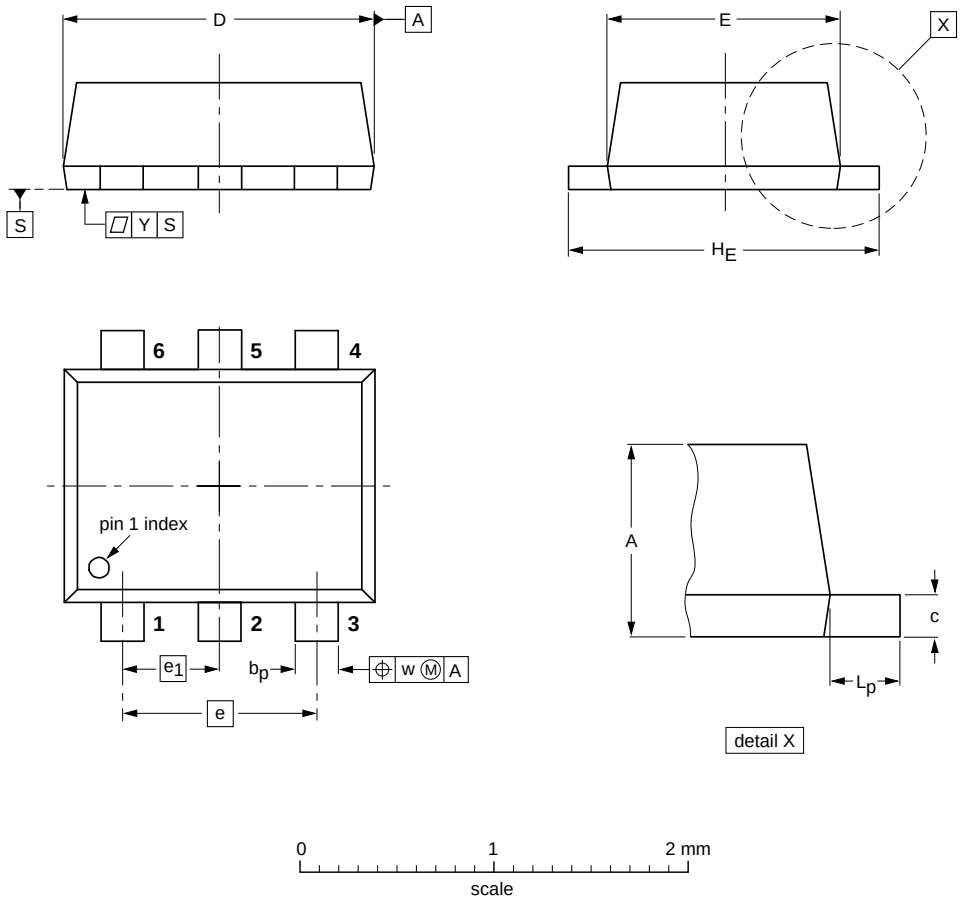

**Fig 29. Duty cycle definition**

## 8.1 Quality information

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

# 9. Package outline

**Plastic surface-mounted package; 6 leads** **SOT666**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $b_p$ | c | D | E | e | $e_1$ | $H_E$ | $L_p$ | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 0.6<br>0.5 | 0.27<br>0.17 | 0.18<br>0.08 | 1.7<br>1.5 | 1.3<br>1.1 | 1.0 | 0.5 | 1.7<br>1.5 | 0.3<br>0.1 | 0.1 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT666 | | | | | | ~~04-11-08~~<br>06-03-16 |

**Fig 30. Package outline SOT666 (SOT666)**

## 10. Soldering

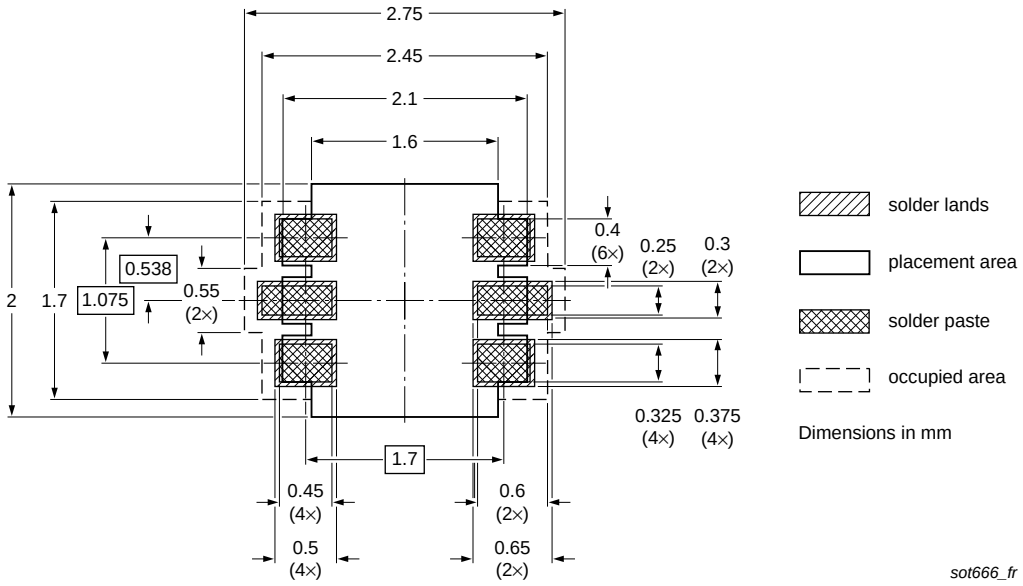



**Fig 31. Reflow soldering footprint for SOT666 (SOT666)**

## 11. Revision history

**Table 8. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| NX1029X v.1 | 20110812 | Product data sheet | - | - |

# 12. Legal information

## 12.1 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.nxp.com.

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## 14. Contents





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