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Team Nexperia

# PMFPB6545UP

## 20 V, 3.5 A / 440 mV $V_F$ P-channel MOSFET-Schottky combination

Rev. 2 — 4 June 2012 Product data sheet

## 1. Product profile

### 1.1 General description

Small-signal P-channel enhancement mode Field-Effect Transistor (FET) using Trench MOSFET technology and ultra low $V_F$ Maximum Efficiency General Application (MEGA) Schottky diode combined in a small and leadless ultra thin DFN2020-6 (SOT1118) Surface-Mounted Device (SMD) plastic package.

### 1.2 Features and benefits

- Trench MOSFET technology
- Integrated ultra low $V_F$ MEGA Schottky diode
- 1 kV ElectroStatic Discharge (ESD) protection
- Small and leadless ultra thin SMD plastic package: $2 \times 2 \times 0.65$ mm
- Exposed drain pad for excellent thermal conduction

### 1.3 Applications

- Charging switch for portable devices
- DC-to-DC converters
- Power management in battery-driven portables
- Hard disk and computing power management

### 1.4 Quick reference data

**Table 1. Quick reference data**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **MOSFET transistor** | | | | | | | |
| $V_{DS}$ | drain-source voltage | $T_{amb}$ = 25 °C | | - | - | –20 | V |
| $V_{GS}$ | gate-source voltage | $T_{amb}$ = 25 °C | | - | - | ±8 | V |
| $I_D$ | drain current | $T_{amb}$ = 25 °C; $V_{GS}$ = –4.5 V | [1] | - | - | –3.5 | A |
| $R_{DSon}$ | drain-source on-state resistance | $T_j$ = 25 °C; $V_{GS}$ = –4.5 V; $I_D$ = –1 A | [2] | - | 58 | 70 | mΩ |

**Table 1. Quick reference data** *...continued*

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Schottky diode** | | | | | | |
| $I_F$ | forward current | $T_{sp} \leq 105$ °C | - | - | 2 | A |
| $V_R$ | reverse voltage | $T_{amb} = 25$ °C | - | - | 30 | V |
| $V_F$ | forward voltage | $T_{amb} = 25$ °C; $I_F = 1$ A | - | 440 | 520 | mV |

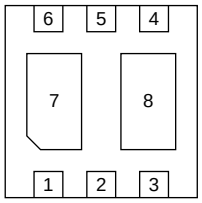
[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated, mounting pad for drain 6 $cm^2$.

[2] Pulse test: $t_p \leq 300$ µs; $\delta \leq 0.01$.

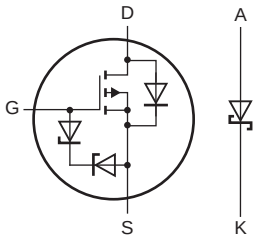
## 2. Pinning information

**Table 2. Pinning**

| Pin | Symbol | Description | Simplified outline | Graphic symbol |
|---|---|---|---|---|
| 1 | A | anode | | |
| 2 | n.c. | not connected | | |
| 3 | D | drain | | |
| 4 | S | source | | |
| 5 | G | gate | | |
| 6 | K | cathode | | |
| 7 | K | cathode | | |
| 8 | D | drain | | |




Transparent top view

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## 3. Ordering information

**Table 3. Ordering information**

| Type number | Package | | |
|---|---|---|---|
| | Name | Description | Version |
| PMFPB6545UP | DFN2020-6 | plastic thermal enhanced ultra thin small outline package; no leads; 6 terminals; body 2 × 2 × 0.65 mm | SOT1118 |

## 4. Marking

**Table 4. Marking codes**

| Type number | Marking code |
|---|---|
| PMFPB6545UP | 1A |

## 5. Limiting values

**Table 5. Limiting values**

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

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| **MOSFET transistor** | | | | | | |
| $V_{DS}$ | drain-source voltage | $T_{amb}$ = 25 °C | | - | –20 | V |
| $V_{GS}$ | gate-source voltage | $T_{amb}$ = 25 °C | | - | ±8 | V |
| $I_D$ | drain current | $V_{GS}$ = –4.5 V | [1] | | | |
| | | $T_{amb}$ = 25 °C | | - | –3.5 | A |
| | | $T_{amb}$ = 100 °C | | - | –2.7 | A |
| $I_{DM}$ | peak drain current | $T_{amb}$ = 25 °C; single pulse; $t_p \leq 10$ µs | | - | –20 | A |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C | [2] | - | 520 | mW |
| | | | [1] | - | 1.25 | W |
| | | $T_{sp}$ = 25 °C | | - | 8.3 | W |
| Source-drain diode | | | | | | |
| $I_S$ | source current | $T_{amb}$ = 25 °C | [1] | - | –1.4 | A |
| ESD maximum rating | | | | | | |
| $V_{ESD}$ | electrostatic discharge voltage | human body model; C = 100 pF; R = 1.5 kΩ | [3] | - | 1000 | V |
| **Schottky diode** | | | | | | |
| $V_R$ | reverse voltage | $T_{amb}$ = 25 °C | | - | 30 | V |
| $I_F$ | forward current | $T_{sp} \leq 105$ °C | | - | 2 | A |
| $I_{FRM}$ | repetitive peak forward current | $t_p \leq 1$ ms; $\delta \leq 0.25$; $T_{amb}$ = 25 °C | | - | 7 | A |
| $I_{FSM}$ | non-repetitive peak forward current | $t_p$ = 8 ms; square wave | [4] | - | 18 | A |
| | | $t_p$ = 8 ms; half-sine wave | [5] | - | 25 | A |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = 25 °C | [2] | - | 480 | mW |
| | | | [1] | - | 1190 | mW |
| | | $T_{sp}$ = 25 °C | | - | 8.3 | W |
| **Per device** | | | | | | |
| $T_j$ | junction temperature | | | - | 150 | °C |
| $T_{amb}$ | ambient temperature | | | –55 | +150 | °C |
| $T_{stg}$ | storage temperature | | | –65 | +150 | °C |

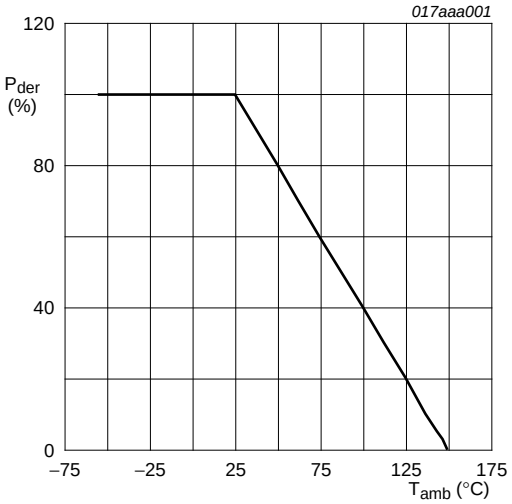
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 $cm^2$.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[3] Measured between all pins.

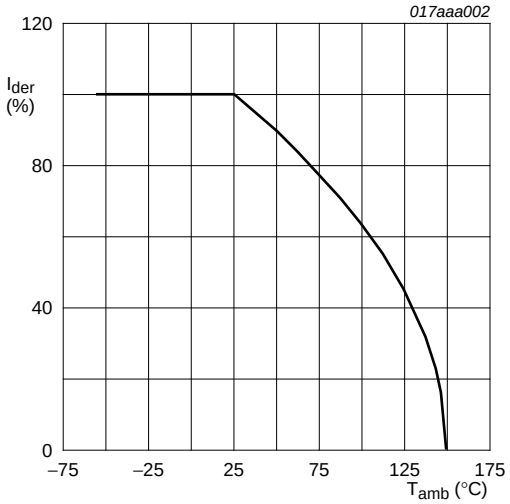
[4] $T_j$ = 25 °C prior to surge.

[5] Calculated from square-wave measurements; $T_j$ = 25 °C prior to surge.



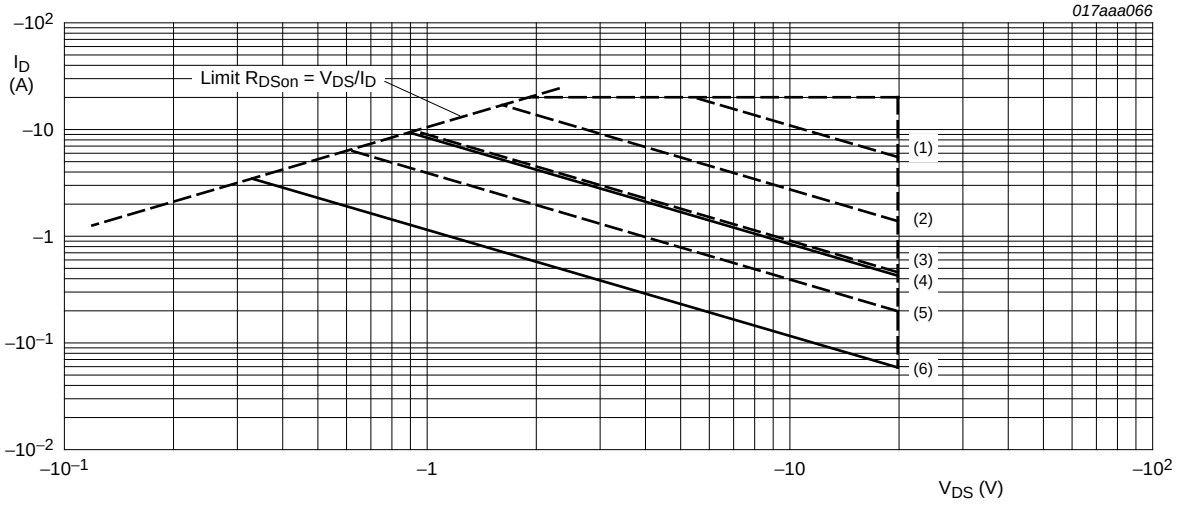

$$P_{der} = \frac{P_{tot}}{P_{tot(25°C)}} \times 100\ \%$$

**Fig 1. MOSFET transistor: Normalized total power dissipation as a function of ambient temperature**




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

**Fig 2. MOSFET transistor: Normalized continuous drain current as a function of ambient 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 6 $cm^2$

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

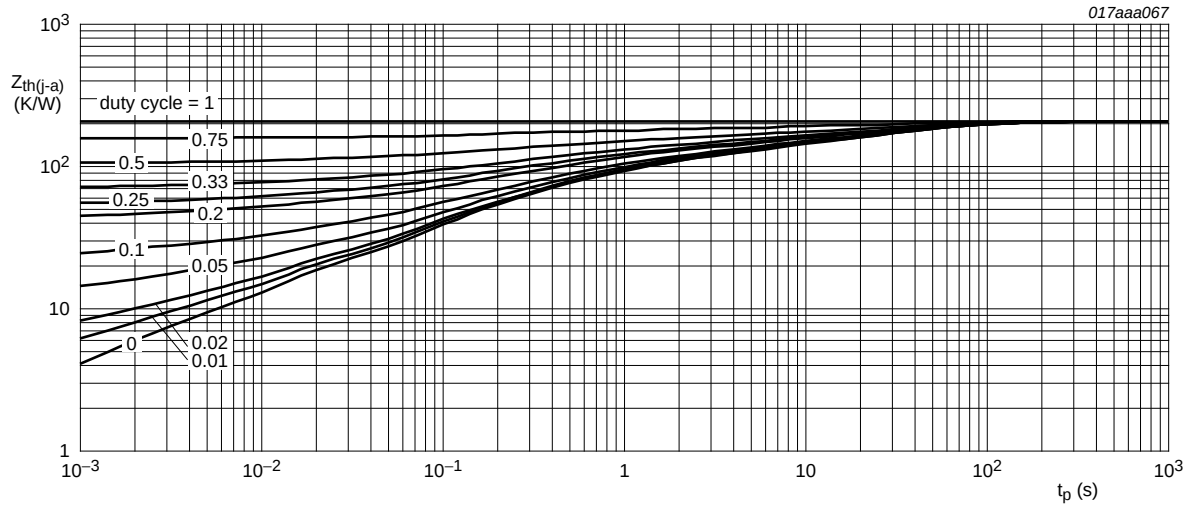
# 6. Thermal characteristics

**Table 6. Thermal characteristics**

| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **MOSFET transistor** | | | | | | | |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | - | 240 | K/W |
| | | | [2] | - | - | 100 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 15 | K/W |
| **Schottky diode** | | | | | | | |
| $R_{th(j-a)}$ | thermal resistance from junction to ambient | in free air | [1] | - | - | 260 | K/W |
| | | | [2] | - | - | 105 | K/W |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point | | | - | - | 15 | K/W |

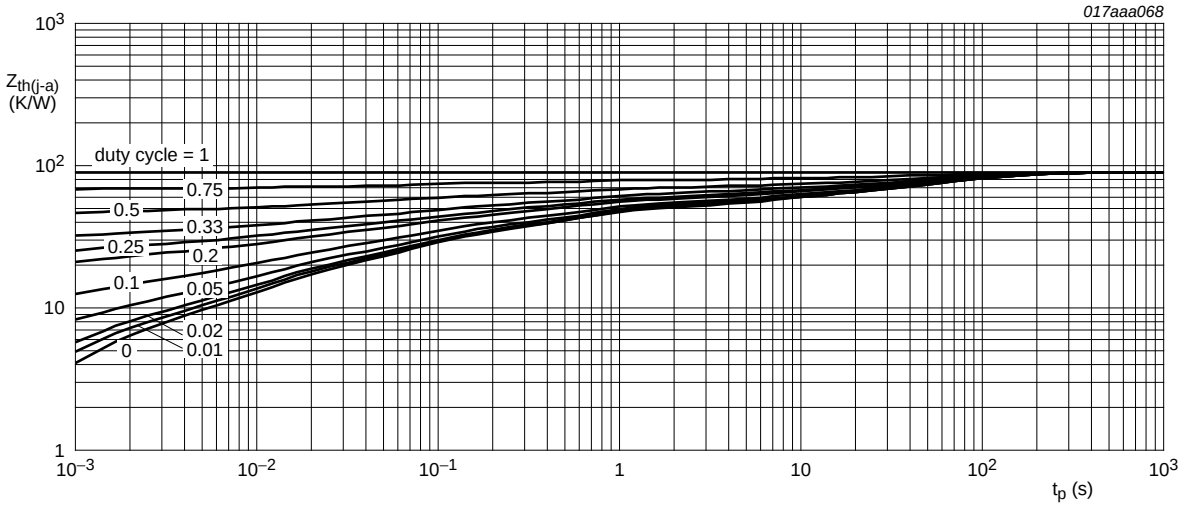
[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and standard footprint.

[2] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 $cm^2$.



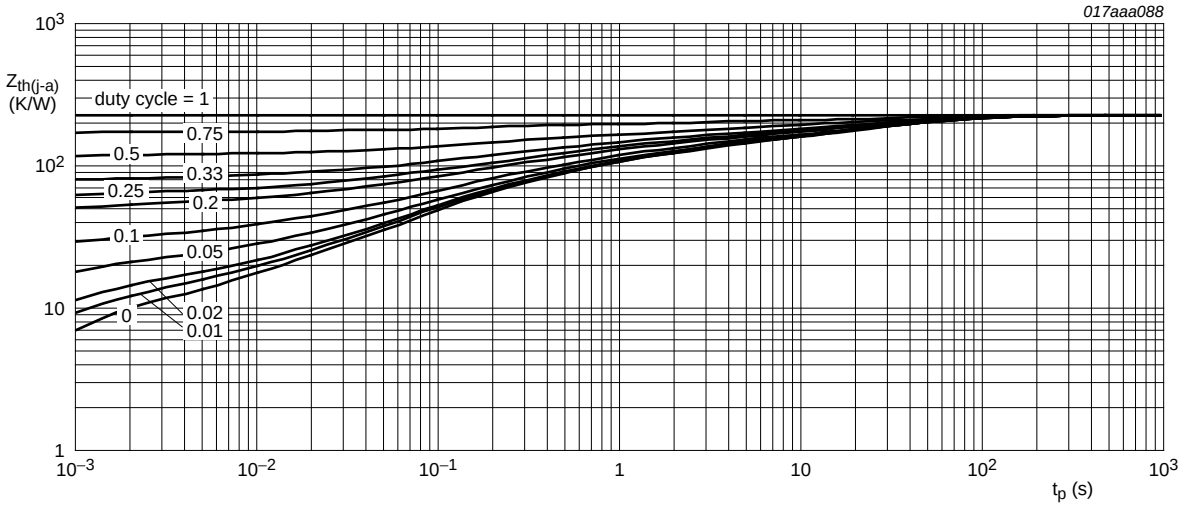

FR4 PCB, standard footprint

**Fig 4. MOSFET transistor: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**



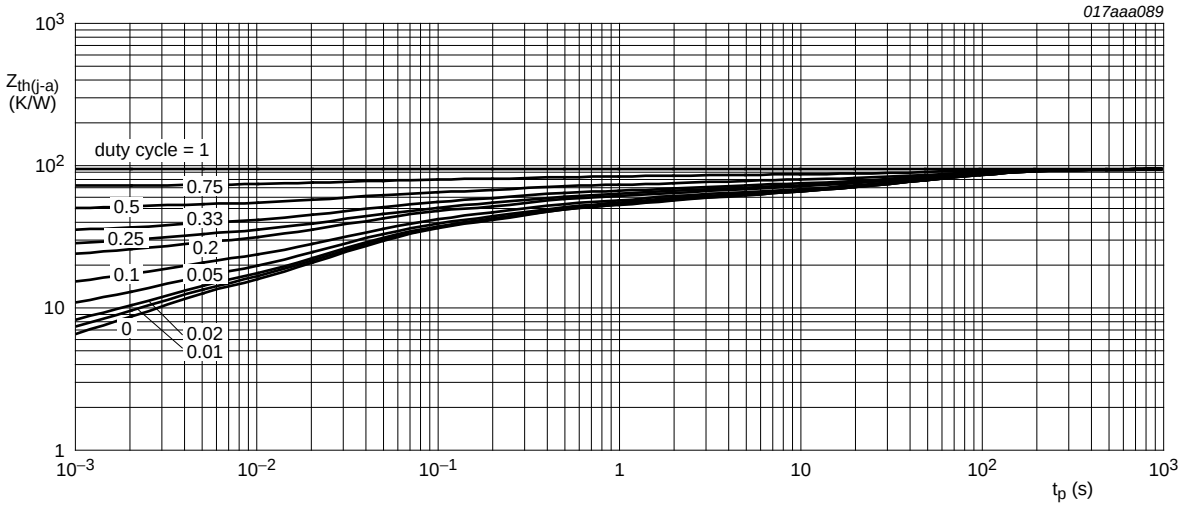

FR4 PCB, mounting pad for drain 6 $cm^2$

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




FR4 PCB, standard footprint

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




FR4 PCB, mounting pad for cathode 6 $cm^2$

**Fig 7. Schottky diode: Transient thermal impedance from junction to ambient as a function of pulse duration; typical values**

# 7. Characteristics

**Table 7. Characteristics**

*$T_j$ = 25 °C unless otherwise specified.*

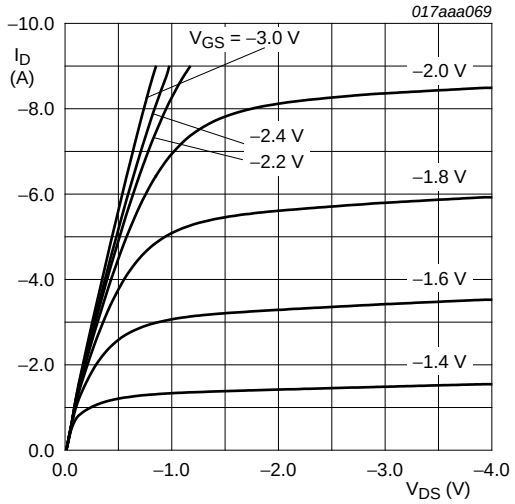
| Symbol | Parameter | Conditions | | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|
| **MOSFET transistor** | | | | | | | |
| Static characteristics | | | | | | | |
| $V_{(BR)DSS}$ | drain-source breakdown voltage | $I_D$ = –250 µA; $V_{GS}$ = 0 V | | –20 | - | - | V |
| $V_{GS(th)}$ | gate-source threshold voltage | $I_D$ = –250 µA; $V_{DS}$ = $V_{GS}$ | | –0.4 | –0.7 | –1 | V |
| $I_{DSS}$ | drain leakage current | $V_{DS}$ = –16 V; $V_{GS}$ = 0 V | | | | | |
| | | $T_j$ = 25 °C | | - | - | –1 | µA |
| | | $T_j$ = 150 °C | | - | - | –10 | µA |
| $I_{GSS}$ | gate leakage current | $V_{GS}$ = ±8 V; $V_{DS}$ = 0 V | | - | 1 | ±10 | µA |
| $R_{DSon}$ | drain-source on-state resistance | | [1] | | | | |
| | | $V_{GS}$ = –4.5 V; $I_D$ = –1 A | | - | 58 | 70 | mΩ |
| | | $V_{GS}$ = –4.5 V; $I_D$ = –1 A; $T_j$ = 125 °C | | - | 80 | 100 | mΩ |
| | | $V_{GS}$ = –2.5 V; $I_D$ = –1 A | | - | 72 | 90 | mΩ |
| | | $V_{GS}$ = –1.8 V; $I_D$ = –0.5 A | | - | 100 | 165 | mΩ |
| $g_{fs}$ | forward transconductance | $V_{DS}$ = –5 V; $I_D$ = –1 A | [1] | - | 8 | - | S |

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

*$T_j$ = 25 °C unless otherwise specified.*

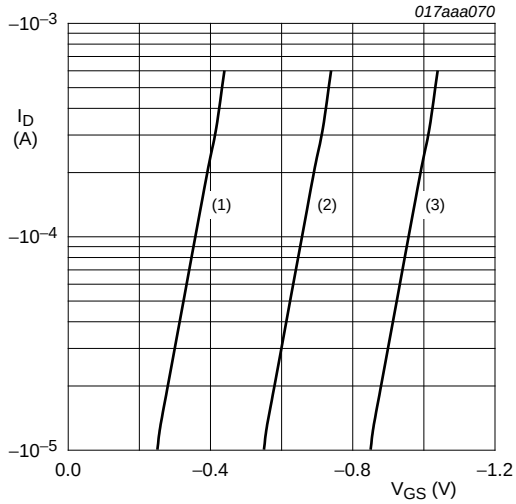
| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Dynamic characteristics | | | | | | |
| $Q_{G(tot)}$ | total gate charge | $I_D$ = –3.3 A; $V_{DS}$ = –10 V; $V_{GS}$ = –4.5 V | - | 4.5 | 6 | nC |
| $Q_{GS}$ | gate-source charge | | - | 0.8 | - | nC |
| $Q_{GD}$ | gate-drain charge | | - | 1 | - | nC |
| $C_{iss}$ | input capacitance | $V_{GS}$ = 0 V; $V_{DS}$ = –10 V; f = 1 MHz | - | 380 | - | pF |
| $C_{oss}$ | output capacitance | | - | 72 | - | pF |
| $C_{rss}$ | reverse transfer capacitance | | - | 61 | - | pF |
| $t_{d(on)}$ | turn-on delay time | $V_{DS}$ = –15 V; $R_L$ = 15 Ω; $V_{GS}$ = –10 V; $R_G$ = 6 Ω | - | 5 | - | ns |
| $t_r$ | rise time | | - | 10 | - | ns |
| $t_{d(off)}$ | turn-off delay time | | - | 57 | - | ns |
| $t_f$ | fall time | | - | 35 | - | ns |
| Source-drain diode | | | | | | |
| $V_{SD}$ | source-drain voltage | $I_S$ = –1.3 A; $V_{GS}$ = 0 V | - | –0.75 | –1 | V |
| **Schottky diode** | | | | | | |
| $V_F$ | forward voltage | $I_F$ = 100 mA | - | 330 | 390 | mV |
| | | $I_F$ = 500 mA | - | 400 | 460 | mV |
| | | $I_F$ = 1 A | - | 440 | 520 | mV |
| $I_R$ | reverse current | $V_R$ = 5 V | - | 1 | 3.5 | µA |
| | | $V_R$ = 5 V; $T_j$ = 125 °C | - | 0.33 | 1.2 | mA |
| | | $V_R$ = 10 V | - | 1.5 | 5 | µA |
| | | $V_R$ = 20 V | - | 4 | 15 | µA |
| | | $V_R$ = 30 V | - | 8 | 30 | µA |
| $C_d$ | diode capacitance | $V_R$ = 5 V; f = 1 MHz | - | 45 | 55 | pF |

[1] Pulse test: $t_p \leq 300$ µs; $\delta \leq 0.01$.




$T_{amb}$ = 25 °C

**Fig 8. MOSFET transistor: Output characteristics: drain current as a function of drain-source voltage; typical values**



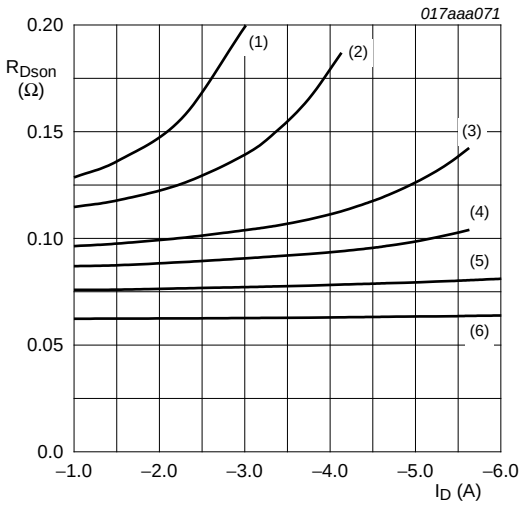

$T_{amb}$ = 25 °C; $V_{DS}$ = −5 V

(1) minimum values

(2) typical values

(3) maximum values

**Fig 9. MOSFET transistor: Sub-threshold drain current as a function of gate-source voltage**




$T_{amb}$ = 25 °C

(1) $V_{GS}$ = −1.5 V

(2) $V_{GS}$ = −1.6 V

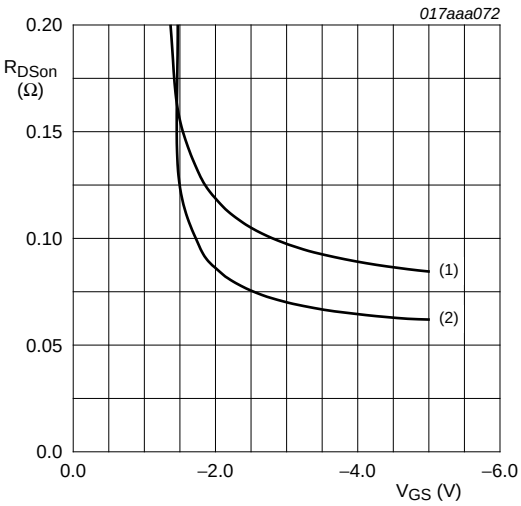
(3) $V_{GS}$ = −1.8 V

(4) $V_{GS}$ = −2 V

(5) $V_{GS}$ = −2.5 V

(6) $V_{GS}$ = −4.5 V

**Fig 10. MOSFET transistor: Drain-source on-state resistance as a function of drain current; typical values**

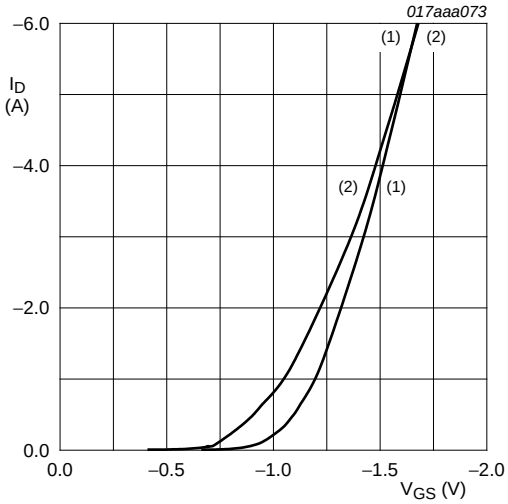



$I_D$ = −1 A

(1) $T_{amb}$ = 150 °C

(2) $T_{amb}$ = 25 °C

**Fig 11. MOSFET transistor: Drain-source on-state resistance as a function of gate-source voltage; typical values**

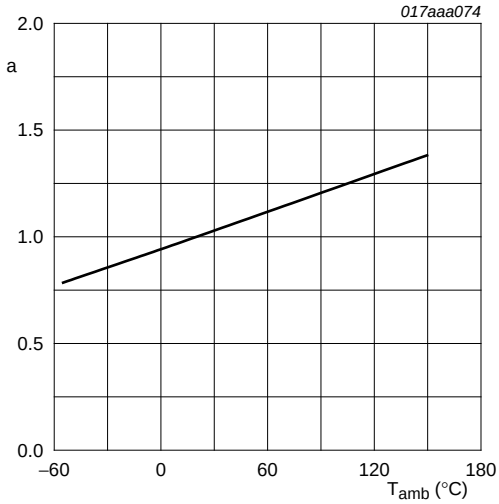



$V_{DS} > I_D \times R_{DSon}$

(1) $T_{amb}$ = 25 °C

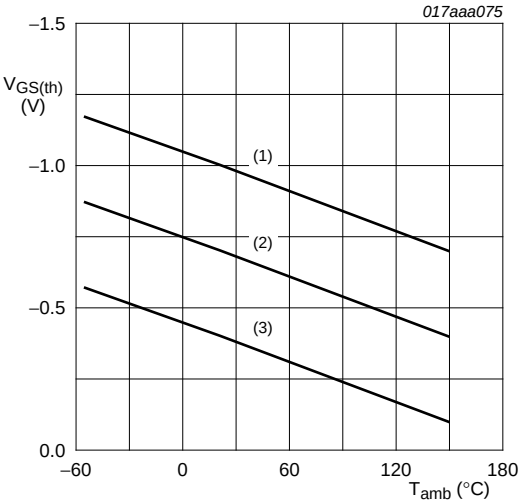
(2) $T_{amb}$ = 150 °C

**Fig 12. MOSFET transistor: Transfer characteristics: drain current as a function of gate-source voltage; typical values**




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

**Fig 13. MOSFET transistor: Normalized drain-source on-state resistance as a function of ambient temperature; typical values**



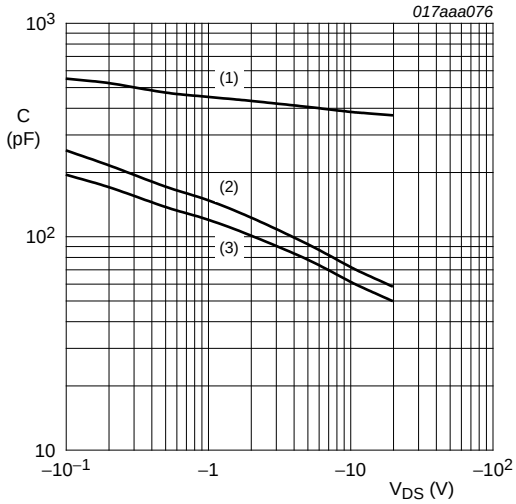

$I_D$ = −0.25 mA; $V_{DS} = V_{GS}$

(1) maximum values

(2) typical values

(3) minimum values

**Fig 14. MOSFET transistor: Gate-source threshold voltage as a function of ambient temperature**



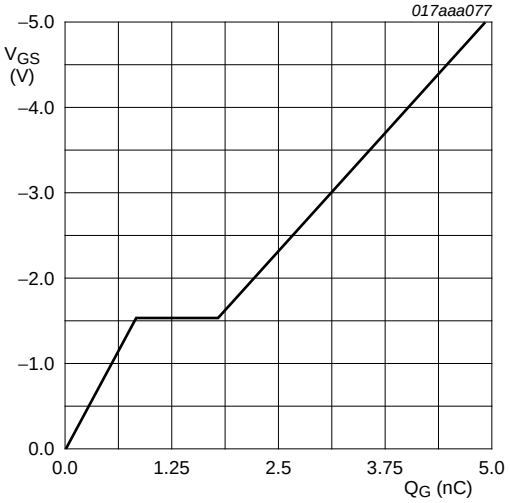

f = 1 MHz; $V_{GS}$ = 0 V

(1) $C_{iss}$

(2) $C_{oss}$

(3) $C_{rss}$

**Fig 15. MOSFET transistor: Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values**




$I_D$ = −3.3 A; $V_{DS}$ = −10 V; $T_{amb}$ = 25 °C

**Fig 16. MOSFET transistor: Gate-source voltage as a function of gate charge; typical values**

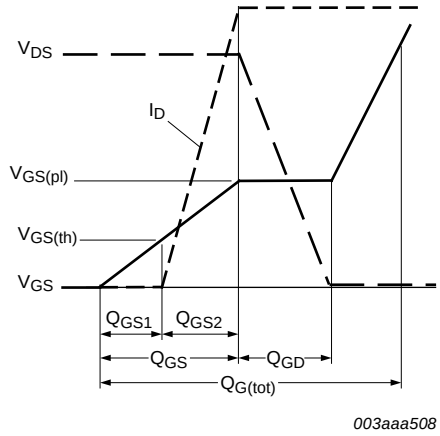
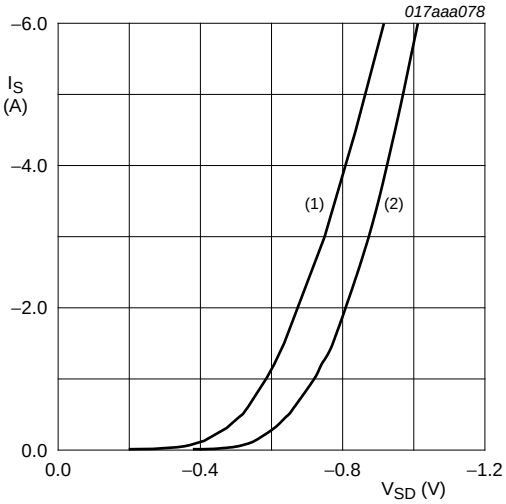



**Fig 17. MOSFET transistor: Gate charge waveform definitions**

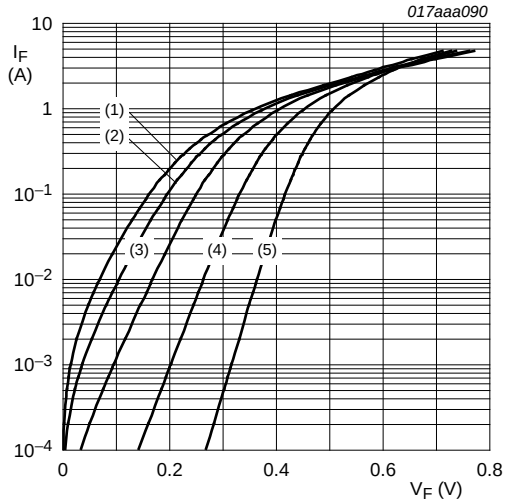



$V_{GS}$ = 0 V

(1) $T_{amb}$ = 150 °C

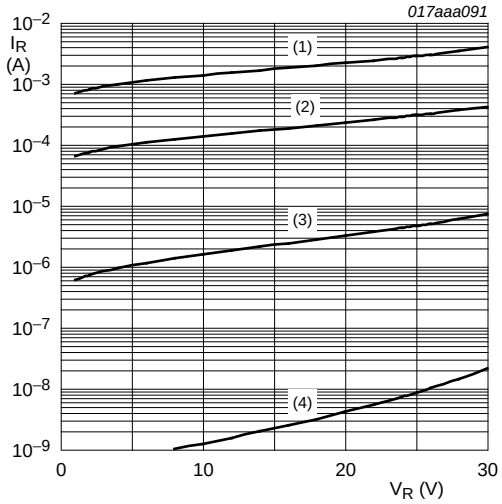
(2) $T_{amb}$ = 25 °C

**Fig 18. MOSFET transistor: Source current as a function of source-drain voltage; typical values**



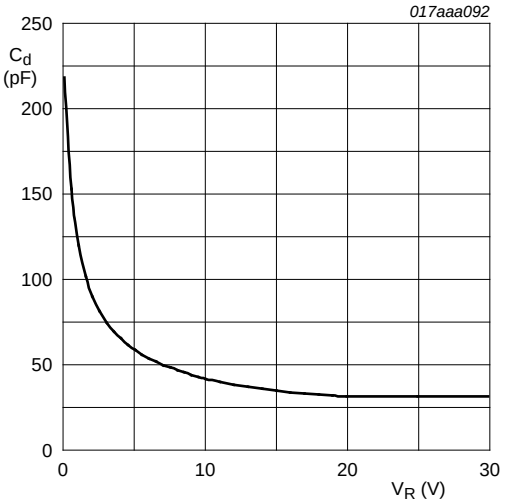

(1) $T_j$ = 150 °C
(2) $T_j$ = 125 °C
(3) $T_j$ = 85 °C
(4) $T_j$ = 25 °C
(5) $T_j$ = –40 °C

**Fig 19. Schottky diode: Forward current as a function of forward voltage; typical values**



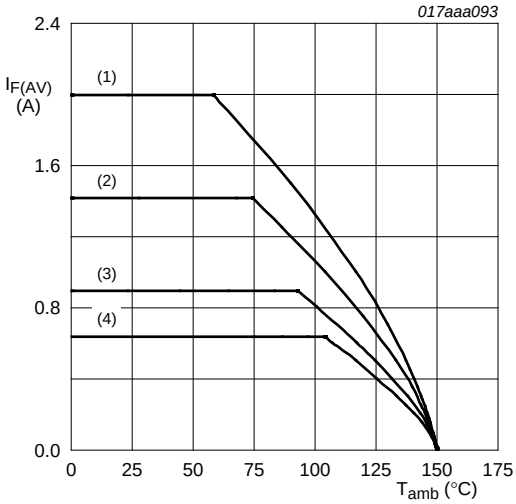

(1) $T_j$ = 125 °C
(2) $T_j$ = 85 °C
(3) $T_j$ = 25 °C
(4) $T_j$ = –40 °C

**Fig 20. Schottky diode: Reverse current as a function of reverse voltage; typical values**




f = 1 MHz; $T_{amb}$ = 25 °C

**Fig 21. Schottky diode: Diode capacitance as a function of reverse voltage; typical values**




FR4 PCB, mounting pad for cathode 6 $cm^2$

$T_j$ = 150 °C

(1) δ = 1; DC
(2) δ = 0.5; f = 20 kHz
(3) δ = 0.2; f = 20 kHz
(4) δ = 0.1; f = 20 kHz

**Fig 22. Schottky diode: Average forward current as a function of ambient temperature; typical values**

## 8. Test information

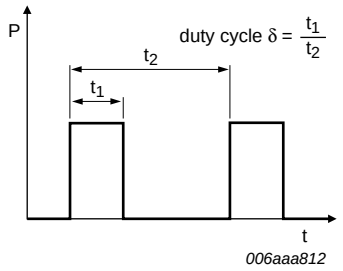



**Fig 23. Duty cycle definition**

## 9. Package outline

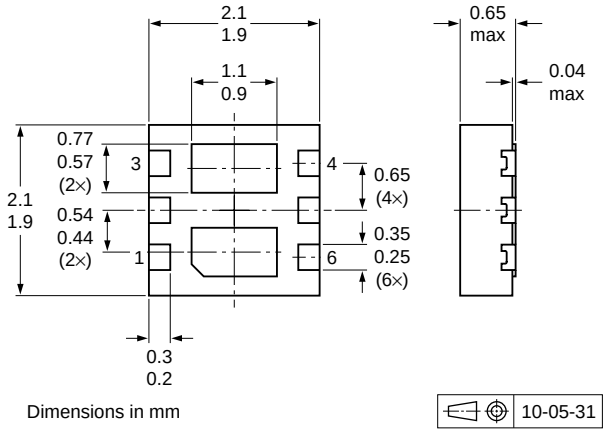



**Fig 24. Package outline DFN2020-6 (SOT1118)**

## 10. Soldering

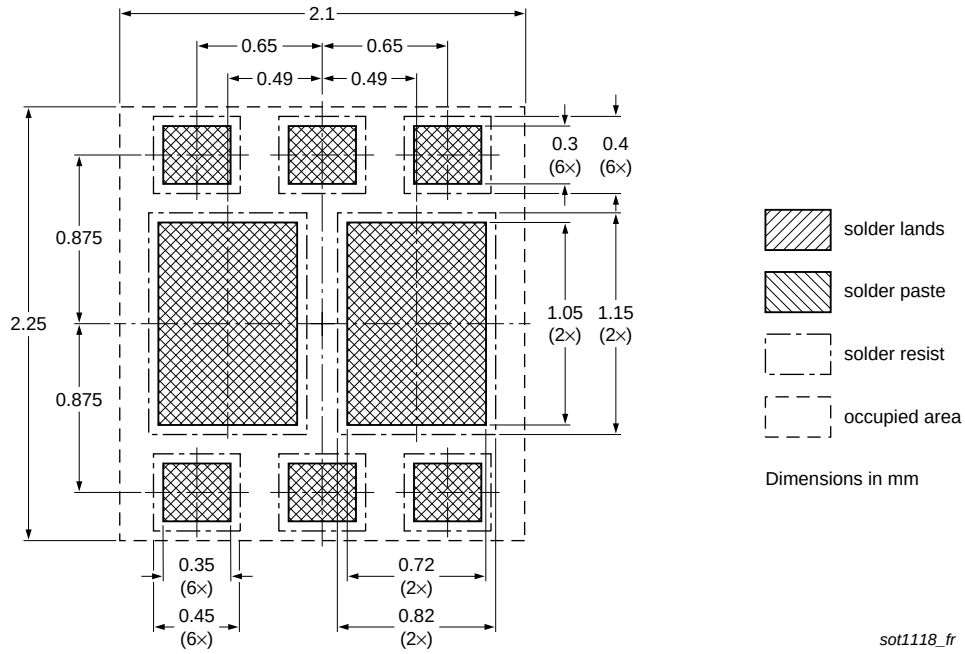



**Fig 25. Reflow soldering footprint DFN2020-6 (SOT1118)**

## 11. Revision history

**Table 8. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| PMFPB6545UP v.2 | 20120604 | Product data sheet | - | PMFPB6545UP v.1 |
| Modifications: | • Section 1.1 “General description”: updated<br>• Table 2 “Pinning”: graphic symbol drawing updated<br>• Figure 24: replaced with minimized package outline drawing | | | |
| PMFPB6545UP v.1 | 20110308 | 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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