1. General description

N-channel enhancement mode Field-Effect Transistor (FET) in a leadless medium power DFN2020MD-6 (SOT1220) Surface-Mounted Device (SMD) plastic package using Trench MOSFET technology.

2. Features and benefits

- Low threshold voltage
- Very fast switching
- Trench MOSFET technology
- ElectroStatic Discharge (ESD) protection > 2 kV HBM
- AEC-Q101 qualified

3. Applications

- Relay driver
- High-speed line driver
- Low-side load switch
- Switching circuits

4. Quick reference data

<table>
<thead>
<tr>
<th><strong>Table 1. Quick reference data</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Symbol</strong></td>
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<tr>
<td>V_Ds</td>
</tr>
<tr>
<td>V_Gs</td>
</tr>
<tr>
<td>I_D</td>
</tr>
<tr>
<td>R_Dson</td>
</tr>
</tbody>
</table>

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and mounting pad for drain 6 cm².
### 5. Pinning information

Table 2. Pinning information

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
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<td>1</td>
<td>D</td>
<td>drain</td>
</tr>
<tr>
<td>2</td>
<td>D</td>
<td>drain</td>
</tr>
<tr>
<td>3</td>
<td>G</td>
<td>gate</td>
</tr>
<tr>
<td>4</td>
<td>S</td>
<td>source</td>
</tr>
<tr>
<td>5</td>
<td>D</td>
<td>drain</td>
</tr>
<tr>
<td>6</td>
<td>D</td>
<td>drain</td>
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<td>7</td>
<td>D</td>
<td>drain</td>
</tr>
<tr>
<td>8</td>
<td>S</td>
<td>source</td>
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</table>

Simplified outline and Graphic symbol:

- **DFN2020MD-6 (SOT1220)**

### 6. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Description</th>
<th>Version</th>
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</thead>
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<tr>
<td>PMPB20XNEA</td>
<td>DFN2020MD-6</td>
<td>DFN2020MD-6: plastic thermal enhanced ultra thin small outline package; no leads; 6 terminals</td>
<td>SOT1220</td>
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### 7. Marking

Table 4. Marking codes

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<tr>
<td>PMPB20XNEA</td>
<td>3J</td>
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</table>
8. Limiting values

Table 5. Limiting values

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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{DS}$</td>
<td>drain-source voltage</td>
<td>$T_j = 25 , ^\circ C$</td>
<td>-</td>
<td>20</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS}$</td>
<td>gate-source voltage</td>
<td></td>
<td>-12</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>drain current</td>
<td>$V_{GS} = 4.5 , V; , T_{amb} = 25 , ^\circ C$</td>
<td>[1]</td>
<td>-</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 , V; , T_{amb} = 100 , ^\circ C$</td>
<td>[1]</td>
<td>-</td>
<td>4.8</td>
</tr>
<tr>
<td>$I_{DM}$</td>
<td>peak drain current</td>
<td>$T_{amb} = 25 , ^\circ C$; single pulse; $t_p \leq 10 , \mu s$</td>
<td>-</td>
<td>30</td>
<td>A</td>
</tr>
<tr>
<td>$E_{DS(Al)S}$</td>
<td>non-repetitive drain-source avalanche energy</td>
<td>$T_{j(init)} = 25 , ^\circ C$; $I_D = 1.3 , A$; DUT in avalanche (unclamped)</td>
<td>-</td>
<td>13</td>
<td>mJ</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{amb} = 25 , ^\circ C$</td>
<td>[2]</td>
<td>-</td>
<td>460</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$T_{sp} = 25 , ^\circ C$</td>
<td>[1]</td>
<td>-</td>
<td>1.65</td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td></td>
<td>-55</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{amb}$</td>
<td>ambient temperature</td>
<td></td>
<td>-55</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>storage temperature</td>
<td></td>
<td>-65</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

Source-drain diode

| $I_S$   | source current                         | $T_{amb} = 25 \, ^\circ C$                         | [1] | -   | 1.65 | A   |

ESD maximum rating

| $V_{ESD}$ | electrostatic discharge voltage        | HBM                                               | [3] | -   | 2000 | V   |

[1] Device mounted on an FR4 Printed-Circuit Board (PCB), single-sided copper, tin-plated and mounting pad for drain 6 cm².
Fig. 1. Normalized total power dissipation as a function of junction temperature

\[ P_{\text{der}} = \frac{P_{\text{tot}}}{P_{\text{tot}(25^\circ\text{C})}} \times 100\% \]

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

\[ I_{\text{der}} = \frac{I_D}{I_D(25^\circ\text{C})} \times 100\% \]

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

\[ \text{Limit } R_{\text{DS(on)}} = \frac{V_{\text{DS}}}{I_D} \]

Here, \( I_D \) is the drain current, \( V_{\text{DS}} \) is the drain-source voltage, and \( R_{\text{DS(on)}} \) is the on-state resistance. The plots illustrate the relationship between these parameters under different conditions, including DC and transient responses.
9. Thermal characteristics

Table 6. Thermal characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{th(j-a)}$</td>
<td>thermal resistance from junction to ambient</td>
<td>in free air</td>
<td>[1]</td>
<td>235</td>
<td>270</td>
<td>K/W</td>
</tr>
<tr>
<td>$R_{th(j-sp)}$</td>
<td>thermal resistance from junction to solder point</td>
<td></td>
<td>[2]</td>
<td>67</td>
<td>74</td>
<td>K/W</td>
</tr>
</tbody>
</table>


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

Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values
# 10. Characteristics

## Table 7. Characteristics

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{(BR)DSS}$</td>
<td>drain-source breakdown voltage</td>
<td>$I_D = 250 \mu A; V_{GS} = 0 V; T_J = 25 ^\circ C$</td>
<td>20</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>gate-source threshold voltage</td>
<td>$I_D = 250 \mu A; V_{DS}=V_{GS}; T_J = 25 ^\circ C$</td>
<td>0.75</td>
<td>1</td>
<td>1.25</td>
<td>V</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>drain leakage current</td>
<td>$V_{DS} = 20 V; V_{GS} = 0 V; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>gate leakage current</td>
<td>$V_{GS} = 12 V; V_{DS} = 0 V; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = -12 V; V_{DS} = 0 V; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>-10</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 V; V_{DS} = 0 V; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = -4.5 V; V_{DS} = 0 V; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>-5</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 2.5 V; V_{DS} = 0 V; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$R_{DS(on)}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{GS} = -2.5 V; V_{DS} = 0 V; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>-</td>
<td>-100</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 V; I_D = 7.5 A; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>16</td>
<td>20</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 V; I_D = 7.5 A; T_J = 150 ^\circ C$</td>
<td>-</td>
<td>24</td>
<td>30</td>
<td>mΩ</td>
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<tr>
<td></td>
<td></td>
<td>$V_{GS} = 2.5 V; I_D = 6.1 A; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>24</td>
<td>30</td>
<td>mΩ</td>
</tr>
<tr>
<td>$g_f$</td>
<td>forward transconductance</td>
<td>$V_{DS} = 10 V; I_D = 7.5 A; T_J = 25 ^\circ C$</td>
<td>-</td>
<td>26.8</td>
<td>-</td>
<td>S</td>
</tr>
<tr>
<td>$R_G$</td>
<td>gate resistance</td>
<td>$f = 1 MHz$</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>Ω</td>
</tr>
</tbody>
</table>

## Dynamic characteristics

| $Q_{G(tot)}$ | total gate charge | $V_{DS} = 10 V; I_D = 7.5 A; V_{GS} = 4.5 V; T_J = 25 ^\circ C$ | - | 9.9 | 15 | nC |
| $Q_{GS}$ | gate-source charge | $V_{DS} = 10 V; V_{GS} = 0 V; T_J = 25 ^\circ C$ | - | 1.4 | - | nC |
| $Q_{GD}$ | gate-drain charge | $V_{DS} = 10 V; V_{GS} = 0 V; T_J = 25 ^\circ C$ | - | 3.1 | - | nC |
| $C_{iss}$ | input capacitance | $V_{DS} = 10 V; f = 1 MHz; V_{GS} = 0 V; T_J = 25 ^\circ C$ | - | 930 | - | pF |
| $C_{oss}$ | output capacitance | $V_{DS} = 10 V; f = 1 MHz; V_{GS} = 0 V; T_J = 25 ^\circ C$ | - | 178 | - | pF |
| $C_{rss}$ | reverse transfer capacitance | $V_{DS} = 10 V; I_D = 7.5 A; V_{GS} = 4.5 V; T_J = 25 ^\circ C$ | - | 144 | - | pF |
| $t_{d(on)}$ | turn-on delay time | $R_{G(\text{exi})} = 6 \Omega; T_J = 25 ^\circ C$ | - | 16 | - | ns |
| $t_r$ | rise time | $V_{DS} = 10 V; I_D = 7.5 A; V_{GS} = 4.5 V; R_{G(\text{exi})} = 6 \Omega; T_J = 25 ^\circ C$ | - | 40 | - | ns |
| $t_{d(off)}$ | turn-off delay time | $V_{DS} = 10 V; I_D = 7.5 A; V_{GS} = 4.5 V; T_J = 25 ^\circ C$ | - | 44 | - | ns |
| $t_f$ | fall time | $I_S = 1.65 A; V_{GS} = 0 V; T_J = 25 ^\circ C$ | - | 22 | - | ns |

## Source-drain diode

| $V_{SD}$ | source-drain voltage | $I_S = 1.65 A; V_{GS} = 0 V; T_J = 25 ^\circ C$ | - | 0.7 | 1.2 | V |
Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

Fig. 7. Sub-threshold drain current as a function of gate-source voltage

Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values
Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

\[ V_{DS} > I_D \times R_{DS\text{on}} \]

Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

\[ a = \frac{R_{DS\text{on}}}{R_{DS\text{on}(25^\circ C)}} \]

Fig. 12. Gate-source threshold voltage as a function of junction temperature

\[ I_D = 0.25 \text{ mA}; V_{DS} = V_{GS} \]

Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

\[ f = 1 \text{ MHz}; V_{GS} = 0 \text{ V} \]
I_D = 7.53 A; V_DS = 10 V; T_amb = 25 °C

**Fig. 14.** Gate-source voltage as a function of gate charge; typical values

V_GS = 0 V

**Fig. 16.** Source current as a function of source-drain voltage; typical values

11. Test information

**Fig. 17.** Duty cycle definition
11.1 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.
12. Package outline

DFN2020MD-6: plastic thermal enhanced ultra thin small outline package; no leads; 6 terminals; body 2 x 2 x 0.65 mm

Dimensions (mm are the original dimensions)

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<thead>
<tr>
<th>Unit</th>
<th>A</th>
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<th>bp</th>
<th>D</th>
<th>D₁</th>
<th>D₂</th>
<th>E</th>
<th>E₁</th>
<th>E₂</th>
<th>e</th>
<th>J</th>
<th>J₁</th>
<th>Lₚ</th>
<th>v</th>
<th>y</th>
<th>y₁</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>0.25</td>
<td>1.9</td>
<td>1.0</td>
<td>0.2</td>
<td>1.9</td>
<td>1.1</td>
<td>0.51</td>
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<td>0.65</td>
<td>0.27</td>
<td>0.64</td>
<td>0.2</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>max</td>
<td>0.65</td>
<td>0.04</td>
<td>0.35</td>
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<td>2.1</td>
<td>1.3</td>
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<td>0.65</td>
<td>0.05</td>
<td>0.1</td>
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Note
1. Dimension A is including plating thickness.

Fig. 18. Package outline DFN2020MD-6 (SOT1220)
13. Soldering

Footprint information for reflow soldering of DFN2020MD-6 package

Fig. 19. Reflow soldering footprint for DFN2020MD-6 (SOT1220)
# 14. Revision history

<table>
<thead>
<tr>
<th>Data sheet ID</th>
<th>Release date</th>
<th>Data sheet status</th>
<th>Change notice</th>
<th>Supersedes</th>
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<td>20160222</td>
<td>Product data sheet</td>
<td>-</td>
<td>-</td>
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15. Legal information

15.1 Data sheet status

<table>
<thead>
<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Objective [short] data sheet</td>
<td>Development</td>
<td>This document contains data from the objective specification for product development.</td>
</tr>
<tr>
<td>Preliminary [short] data sheet</td>
<td>Qualification</td>
<td>This document contains data from the preliminary specification.</td>
</tr>
<tr>
<td>Product [short] data sheet</td>
<td>Production</td>
<td>This document contains the product specification.</td>
</tr>
</tbody>
</table>

[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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<td>1</td>
</tr>
<tr>
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<td>1</td>
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