1. **Product profile**

1.1 **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.

1.2 **Features and benefits**

- Trench MOSFET technology
- Very fast switching
- Small and leadless ultra thin SMD plastic package: 2 x 2 x 0.65 mm
- Exposed drain pad for excellent thermal conduction
- Tin-plated 100 % solderable side pads for optical solder inspection

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

<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_{DS} )</td>
<td>drain-source voltage</td>
<td>( T_j = 25 , ^\circ \text{C} )</td>
<td>-</td>
<td>-</td>
<td>30</td>
<td>V</td>
</tr>
<tr>
<td>( V_{GS} )</td>
<td>gate-source voltage</td>
<td>( V_{GS} = 4.5 , \text{V} ); ( T_{amb} = 25 , ^\circ \text{C} ); ( t \leq 5 , \text{s} )</td>
<td>-12</td>
<td>-</td>
<td>12</td>
<td>V</td>
</tr>
<tr>
<td>( I_D )</td>
<td>drain current</td>
<td>( V_{GS} = 4.5 , \text{V} ); ( T_{amb} = 25 , ^\circ \text{C} ); ( t \leq 5 , \text{s} )</td>
<td>-</td>
<td>-</td>
<td>5.5</td>
<td>A</td>
</tr>
</tbody>
</table>

**Static 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_{DSon} )</td>
<td>drain-source on-state resistance</td>
<td>( V_{GS} = 4.5 , \text{V} ); ( I_D = 4.3 , \text{A} ); ( T_j = 25 , ^\circ \text{C} )</td>
<td>-</td>
<td>37</td>
<td>47</td>
<td>mΩ</td>
</tr>
</tbody>
</table>

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

Table 2. Pinning information

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

3. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Package</th>
<th>Description</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMPB33XN</td>
<td>DFN2020MD-6</td>
<td>plastic thermal enhanced ultra thin small outline package; no leads; 6 terminals</td>
<td>SOT1220</td>
</tr>
</tbody>
</table>

4. Marking

Table 4. Marking codes

<table>
<thead>
<tr>
<th>Type number</th>
<th>Marking code</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMPB33XN</td>
<td>1P</td>
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5. 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_GS</td>
<td>drain-source voltage</td>
<td>T_j = 25 °C</td>
<td>-</td>
<td>30</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 °C; t ≤ 5 s</td>
<td>[1]</td>
<td>5.5</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_GS = 4.5 V; T_amb = 25 °C</td>
<td>[1]</td>
<td>4.3</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>V_GS = 4.5 V; T_amb = 100 °C</td>
<td>[1]</td>
<td>2.7</td>
<td>A</td>
</tr>
<tr>
<td>I_DM</td>
<td>peak drain current</td>
<td>T_amb = 25 °C; single pulse; t_p ≤ 10 μs</td>
<td>-</td>
<td>17</td>
<td>A</td>
</tr>
<tr>
<td>P_tot</td>
<td>total power dissipation</td>
<td>T_amb = 25 °C</td>
<td>[1]</td>
<td>1.5</td>
<td>W</td>
</tr>
</tbody>
</table>
### Symbol Table

<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>$T_{\text{amb}}$</td>
<td>ambient temperature</td>
<td>$T_{\text{amb}} = 25 ^\circ \text{C}; t \leq 5 \text{ s}$</td>
<td>-55</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{\text{sp}}$</td>
<td></td>
<td>$T_{\text{sp}} = 25 ^\circ \text{C}$</td>
<td>-55</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{\text{j}}$</td>
<td>junction temperature</td>
<td></td>
<td>-65</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{\text{stg}}$</td>
<td>storage temperature</td>
<td></td>
<td>-65</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

### Source-drain Diode

<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>$I_S$</td>
<td>source current</td>
<td>$T_{\text{amb}} = 25 ^\circ \text{C}$</td>
<td>-</td>
<td>1.7</td>
<td>A</td>
</tr>
</tbody>
</table>

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

![Graph](image1.png)  
**Fig. 1.** Normalized total power dissipation as a function of junction temperature  
$$P_{\text{der}} = \frac{P_{\text{tot}}}{P_{\text{tot}25^\circ \text{C}}} \times 100 \%$$

![Graph](image2.png)  
**Fig. 2.** Normalized continuous drain current as a function of junction temperature  
$$I_{\text{der}} = \frac{I_D}{I_D25^\circ \text{C}} \times 100 \%$$
6. 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></td>
<td></td>
<td></td>
<td>K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[1]</td>
<td>245</td>
<td>280</td>
<td></td>
<td>K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[2]</td>
<td>74</td>
<td>85</td>
<td></td>
<td>K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[3]</td>
<td>45</td>
<td>52</td>
<td></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></td>
<td></td>
<td></td>
<td>K/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-</td>
<td>10</td>
<td>15</td>
<td></td>
<td>K/W</td>
</tr>
</tbody>
</table>

[3] Device mounted on an FR4 PCB, single-sided copper, tin-plated, mounting pad for drain 6 cm², t ≤ 5 s
7. 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>$V_{BR\text{DSS}}$</td>
<td>drain-source breakdown voltage</td>
<td>$I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_j = 25 ^\circ C$</td>
<td>30</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS\text{th}}$</td>
<td>gate-source threshold voltage</td>
<td>$I_D = 250 \mu A; V_{DS} = V_{GS}; T_j = 25 \text{ ^\circ C}$</td>
<td>0.45</td>
<td>0.8</td>
<td>1.2</td>
<td>V</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>drain leakage current</td>
<td>$V_{DS} = 30 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 25 \text{ ^\circ C}$</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DS} = 30 \text{ V}; V_{GS} = 0 \text{ V}; T_j = 150 \text{ ^\circ C}$</td>
<td>-</td>
<td>-</td>
<td>100</td>
<td>$\mu A$</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
### Symbol | Parameter | Conditions | Min | Typ | Max | Unit
--- | --- | --- | --- | --- | --- | ---
$I_{GSS}$ | gate leakage current | $V_{GS} = 12$ V; $V_{DS} = 0$ V; $T_J = 25$ °C | - | - | 100 | nA
 |  | $V_{GS} = -12$ V; $V_{DS} = 0$ V; $T_J = 25$ °C | - | - | 100 | nA
$R_{DSon}$ | drain-source on-state resistance | $V_{GS} = 4.5$ V; $I_D = 4.3$ A; $T_J = 25$ °C | - | 37 | 47 | mΩ
 |  | $V_{GS} = 4.5$ V; $I_D = 4.3$ A; $T_J = 150$ °C | - | 63 | 80 | mΩ
 |  | $V_{GS} = 2.5$ V; $I_D = 1$ A; $T_J = 25$ °C | - | 55 | 76 | mΩ
$g_{fs}$ | forward transconductance | $V_{DS} = 10$ V; $I_D = 4.3$ A; $T_J = 25$ °C | - | 20 | - | S
$R_G$ | gate resistance | $f = 1$ MHz | - | 9.8 | - | Ω

### Dynamic characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
--- | --- | --- | --- | --- | --- | --- |
$Q_{G(tot)}$ | total gate charge | $V_{DS} = 15$ V; $I_D = 4.3$ A; $V_{GS} = 4.5$ V; $T_J = 25$ °C | - | 5.1 | 7.6 | nC |
$Q_{GS}$ | gate-source charge |  | - | 1 | - | nC |
$Q_{GD}$ | gate-drain charge |  | - | 1.3 | - | nC |
$C_{iss}$ | input capacitance | $V_{DS} = 15$ V; $f = 1$ MHz; $V_{GS} = 0$ V; $T_J = 25$ °C | - | 505 | - | pF |
$C_{oss}$ | output capacitance |  | - | 57 | - | pF |
$C_{rss}$ | reverse transfer capacitance |  | - | 48 | - | pF |
$t_{(on)}$ | turn-on delay time | $V_{GS} = 15$ V; $I_D = 4.3$ A; $V_{GS} = 4.5$ V; $R_{G(ex)} = 6$ Ω; $T_J = 25$ °C | - | 6 | - | ns |
$t_r$ | rise time |  | - | 17 | - | ns |
$t_{(off)}$ | turn-off delay time |  | - | 21 | - | ns |
$t_f$ | fall time |  | - | 20 | - | ns |

### Source-drain diode

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
--- | --- | --- | --- | --- | --- | --- |
$V_{SD}$ | source-drain voltage | $I_S = 1.7$ A; $V_{GS} = 0$ V; $T_J = 25$ °C | - | 0.8 | 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
30 V single N-channel Trench MOSFET

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

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

$V_{DS} > I_D \times R_{DSon}$
Fig. 12. Gate-source threshold voltage as a function of junction temperature

\[ V_{GS(th)}(V) \]

\[ T_j (^\circ C) \]

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

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

\[ C(pF) \]

\[ V_{DS}(V) \]

\[ f = 1 \text{ MHz}; V_{GS} = 0 \text{ V} \]

\[ C_{iss} \]

\[ C_{oss} \]

\[ C_{rss} \]

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

\[ V_{GS}(V) \]

\[ Q_G(nC) \]

\[ I_D = 4.3 \text{ A}; V_{DS} = 15 \text{ V}; T_{amb} = 25 ^\circ \text{C} \]

Fig. 15. Gate charge waveform definitions

\[ V_{DS} \]

\[ I_D \]

\[ V_{GS(toh)} \]

\[ V_{GS(th)} \]

\[ Q_{GS1}, Q_{GS2}, Q_G \]

\[ Q_{GS} \]

\[ Q_{GS(toh)} \]
8. Test information

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

Fig. 17. Duty cycle definition

9. Package outline

Fig. 18. DFN2020MD-6 (SOT1220)
10. Soldering

Footprint information for reflow soldering of DFN2020MD-6 package

---

**Fig. 19. Reflow soldering footprint for SOT1220 (DFN2020MD-6)**

---
## 11. 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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<tbody>
<tr>
<td>PMPB33XN v.1</td>
<td>20120706</td>
<td>Product data sheet</td>
<td>-</td>
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12. Legal information

12.1 Data sheet status

<table>
<thead>
<tr>
<th>Document status</th>
<th>Product status</th>
<th>Definition</th>
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</thead>
<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".
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