1. General description

Single, logic level, N-channel MOSFET in LFPAK56 using Application specific (ASFET) Enhanced SOA technology. This product has been designed and qualified to AEC-Q101 for use in linear mode in airbag applications.

2. Features and benefits

- Fully automotive qualified to AEC-Q101 at 175 °C
- Enhanced SOA technology for improved linear mode performance
- LFPAK copper clip package technology:
  - High robustness and current handling capability
  - Gull wing leads for easy AOI inspection and exceptional board level reliability

3. Applications

- 12 V automotive systems
- Airbag squib voltage regulator MOSFET

4. 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>25 °C ≤ $T_j$ ≤ 175 °C</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$I_D$</td>
<td>drain current</td>
<td>$V_{GS} = 10$ V; $T_{mb} = 25$ °C; <strong>Fig. 2</strong></td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>A</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{mb} = 25$ °C; <strong>Fig. 1</strong></td>
<td>-</td>
<td>-</td>
<td>95</td>
<td>W</td>
</tr>
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</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>$V_{GS} = 10$ V; $I_D = 10$ A; $T_j = 25$ °C; <strong>Fig. 13</strong></td>
<td>8.3</td>
<td>11.8</td>
<td>14.8</td>
<td>mΩ</td>
</tr>
</tbody>
</table>

**Dynamic 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>$Q_{GD}$</td>
<td>gate-drain charge</td>
<td>$I_D = 10$ A; $V_{DS} = 48$ V; $V_{GS} = 4.5$ V; $T_j = 25$ °C; <strong>Fig. 15, Fig. 16</strong></td>
<td>-</td>
<td>6.9</td>
<td>13.7</td>
<td>nC</td>
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</tbody>
</table>

[1] 50 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.
5. Pinning information

Table 2. Pinning information

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>Description</th>
<th>Simplified outline</th>
<th>Graphic symbol</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>S</td>
<td>source</td>
<td>mb 1 2 3 4</td>
<td>LFPAK56; Power-SO8 (SOT669)</td>
</tr>
<tr>
<td>2</td>
<td>S</td>
<td>source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>S</td>
<td>source</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>G</td>
<td>gate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mb</td>
<td>D</td>
<td>mounting base; connected to drain</td>
<td></td>
<td></td>
</tr>
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</table>

6. Ordering information

Table 3. Ordering information

<table>
<thead>
<tr>
<th>Type number</th>
<th>Name</th>
<th>Description</th>
<th>Version</th>
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</thead>
<tbody>
<tr>
<td>BUK9Y22-60EL</td>
<td>LFPAK56; Power-SO8</td>
<td>plastic, single-ended surface-mounted package; 4 terminals</td>
<td>SOT669</td>
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7. Marking

Table 4. Marking codes

<table>
<thead>
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<th>Type number</th>
<th>Marking code</th>
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<tbody>
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<td>BUK9Y22-60EL</td>
<td>92260EL</td>
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8. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). $T_j = 25 \, ^\circ C$ unless otherwise stated.

<table>
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<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>$25 , ^\circ C \leq T_j \leq 175 , ^\circ C$</td>
<td>-</td>
<td>60</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS}$</td>
<td>gate-source voltage</td>
<td>DC; $T_j \leq 175 , ^\circ C$</td>
<td>-10</td>
<td>10</td>
<td>V</td>
</tr>
<tr>
<td>$P_{tot}$</td>
<td>total power dissipation</td>
<td>$T_{mb} = 25 , ^\circ C$; [Fig. 1]</td>
<td>-</td>
<td>95</td>
<td>W</td>
</tr>
<tr>
<td>$I_D$</td>
<td>drain current</td>
<td>$V_{GS} = 10 , V$; $T_{mb} = 25 , ^\circ C$; [Fig. 2]; $V_{GS} = 10 , V$; $T_{mb} = 100 , ^\circ C$; [Fig. 2]</td>
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<td>$I_{DM}$</td>
<td>peak drain current</td>
<td>pulsed; $t_p \leq 10 , \mu s$; $T_{mb} = 25 , ^\circ C$; [Fig. 3]; [Fig. 4]</td>
<td>-</td>
<td>212</td>
<td>A</td>
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<tr>
<td>$T_{stg}$</td>
<td>storage temperature</td>
<td>-55</td>
<td>175</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>$T_j$</td>
<td>junction temperature</td>
<td>-55</td>
<td>175</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

**Source-drain diode**

| $I_S$ | source current | $T_{mb} = 25 \, ^\circ C$ | -   | 50  | A    |
| $I_{SM}$ | peak source current | pulsed; $t_p \leq 10 \, \mu s$; $T_{mb} = 25 \, ^\circ C$ | -   | 212 | A    |

**Avalanche ruggedness**

| $E_{DS(AL)S}$ | non-repetitive drain-source avalanche energy | $I_D = 34 \, A$; $V_{sup} \leq 60 \, V$; $R_{GS} = 50 \, \Omega$; $V_{GS} = 10 \, V$; $T_{j(init)} = 25 \, ^\circ C$; unclamped; $t_p = 49 \, \mu s$; [Fig. 5] | [2] [3] | 66  | mJ   |
**Symbol** | **Parameter** | **Conditions** | **Min** | **Max** | **Unit**
---|---|---|---|---|---
$I_{AS}$ | non-repetitive avalanche current | $V_{sup} \leq 60 \text{ V}; \ V_{GS} = 10 \text{ V}; \ T_{j(init)} = 25 ^\circ \text{C}; \ R_{GS} = 50 \Omega; \ \text{Fig. 5}$ | [2] [3] | 34 | A

[1] 50 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

[2] Single-pulse avalanche rating limited by maximum junction temperature of 175 °C.


[4] Protected by 100% test.

---

**Fig. 1.** Normalized total power dissipation as a function of mounting base temperature

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

---

**Fig. 2.** Continuous drain current as a function of mounting base temperature

$V_{GS} \geq 10 \text{ V}$

(1) 50 A continuous current has been successfully demonstrated during application tests. Practically the current will be limited by PCB, thermal design and operating temperature.

---

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

$T_{mb} = 25 ^\circ \text{C}; \ \text{I}_{DM} \text{ is a single pulse}$
Single N-channel 60 V, 15 mOhm logic level MOSFET in LFPAK56 using Enhanced SOA technology

Fig. 4. Safe operating area; continuous and peak drain currents as a function of drain-source voltage

Fig. 5. Avalanche rating; avalanche current as a function of avalanche time

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>$R_{th(j-mb)}$</td>
<td>thermal resistance from junction to mounting base</td>
<td>Fig. 6</td>
<td>-</td>
<td>1.44</td>
<td>1.58</td>
<td>K/W</td>
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</table>
## 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>$I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_J = 25 \text{ °C}$</td>
<td>60</td>
<td>66</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_J = -40 \text{ °C}$</td>
<td>-</td>
<td>63.5</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 250 \mu A; V_{GS} = 0 \text{ V}; T_J = -55 \text{ °C}$</td>
<td>54</td>
<td>62.5</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$V_{GS(th)}$</td>
<td>gate-source threshold voltage</td>
<td>$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_J = 25 \text{ °C}; \text{Fig. 11}; \text{Fig. 12}$</td>
<td>1.4</td>
<td>1.77</td>
<td>2.1</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_J = -55 \text{ °C}; \text{Fig. 12}$</td>
<td>-</td>
<td>-</td>
<td>2.45</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_D = 1 \text{ mA}; V_{DS}=V_{GS}; T_J = 175 \text{ °C}; \text{Fig. 12}$</td>
<td>0.5</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>$I_{DSS}$</td>
<td>drain leakage current</td>
<td>$V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_J = 25 \text{ °C}$</td>
<td>-</td>
<td>0.01</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DS} = 60 \text{ V}; V_{GS} = 0 \text{ V}; T_J = 175 \text{ °C}$</td>
<td>-</td>
<td>30</td>
<td>500</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{GSS}$</td>
<td>gate leakage current</td>
<td>$V_{GS} = 10 \text{ V}; V_{DS} = 0 \text{ V}; T_J = 25 \text{ °C}$</td>
<td>-</td>
<td>2</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = -10 \text{ V}; V_{DS} = 0 \text{ V}; T_J = 25 \text{ °C}$</td>
<td>-</td>
<td>2</td>
<td>100</td>
<td>nA</td>
</tr>
<tr>
<td>$R_{DS(on)}$</td>
<td>drain-source on-state resistance</td>
<td>$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_J = 25 \text{ °C}; \text{Fig. 13}$</td>
<td>8.3</td>
<td>11.8</td>
<td>14.8</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_J = 105 \text{ °C}; \text{Fig. 14}$</td>
<td>12.6</td>
<td>18.5</td>
<td>24</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_J = 125 \text{ °C}; \text{Fig. 14}$</td>
<td>13.8</td>
<td>20.4</td>
<td>26.6</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 10 \text{ V}; I_D = 10 \text{ A}; T_J = 175 \text{ °C}; \text{Fig. 14}$</td>
<td>17.1</td>
<td>25.8</td>
<td>33.9</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_J = 25 \text{ °C}; \text{Fig. 13}$</td>
<td>12</td>
<td>17.2</td>
<td>23</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_J = 105 \text{ °C}; \text{Fig. 14}$</td>
<td>17.8</td>
<td>26.4</td>
<td>36.6</td>
<td>mΩ</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_J = 125 \text{ °C}; \text{Fig. 14}$</td>
<td>19.4</td>
<td>29</td>
<td>40.5</td>
<td>mΩ</td>
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<tr>
<td></td>
<td></td>
<td>$V_{GS} = 4.5 \text{ V}; I_D = 10 \text{ A}; T_J = 175 \text{ °C}; \text{Fig. 14}$</td>
<td>23.6</td>
<td>36</td>
<td>51</td>
<td>mΩ</td>
</tr>
</tbody>
</table>

Fig. 6. Transient thermal impedance from junction to mounting base as a function of pulse duration
## Nexperia

**BUK9Y22-60EL**

Single N-channel 60 V, 15 mOhm logic level MOSFET in LFPAK56 using Enhanced SOA technology

---

### Symbol | Parameter | Conditions | Min | Typ | Max | Unit
--- | --- | --- | --- | --- | --- | ---
$R_G$ | gate resistance | $f = 1$ MHz; $T_j = 25$ °C | - | 1.81 | - | Ω

### Dynamic characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
--- | --- | --- | --- | --- | --- | ---|
$Q_{G(tot)}$ | total gate charge | $I_D = 10$ A; $V_{DS} = 48$ V; $V_{GS} = 10$ V; $T_j = 25$ °C; *Fig. 15; Fig. 16* | - | 34 | 48 | nC
$Q_{GS}$ | gate-source charge | $T_j = 25$ °C; *Fig. 15; Fig. 16* | - | 4.6 | 23.2 | nC
$Q_{GD}$ | gate-drain charge | - | 6.9 | 13.7 | nC
$C_{iss}$ | input capacitance | $V_{DS} = 25$ V; $V_{GS} = 0$ V; $f = 1$ MHz; $T_j = 25$ °C; *Fig. 17* | - | 1852 | 2592 | pF
$C_{oss}$ | output capacitance | $T_j = 25$ °C; *Fig. 17* | - | 182 | 218 | pF
$C_{rss}$ | reverse transfer capacitance | - | 96 | 132 | pF
$t_{d(on)}$ | turn-on delay time | $V_{DS} = 48$ V; $R_G = 5$ Ω; $V_{GS} = 5$ V; $R_{G(\text{ext})} = 5$ Ω; $T_j = 25$ °C | - | 10 | - | ns
$t_r$ | rise time | - | 22 | - | ns
$t_{d(off)}$ | turn-off delay time | - | 22 | - | ns
$t_f$ | fall time | - | 17 | - | ns
$g_{fs}$ | transfer conductance | $V_{DS} = 8$ V; $I_D = 10$ A; $T_j = 25$ °C; *Fig. 9* | - | 25.5 | - | S

### Source-drain diode

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
--- | --- | --- | --- | --- | --- | ---|
$V_{SD}$ | source-drain voltage | $I_S = 10$ A; $V_{GS} = 0$ V; $T_j = 25$ °C; *Fig. 18* | - | 0.81 | 1 | V
$t_{rr}$ | reverse recovery time | $I_S = 10$ A; $dI_S/dt = -100$ A/µs; $V_{GS} = 0$ V; $V_{DS} = 30$ V; $T_j = 25$ °C; *Fig. 19* | - | 26 | - | ns
$Q_r$ | recovered charge | - | 26 | - | nC

[1] includes capacitive recovery

---

**Fig. 7.** Output characteristics; drain current as a function of drain-source voltage; typical values

**Fig. 8.** Drain-source on-state resistance as a function of gate-source voltage; typical values
Single N-channel 60 V, 15 mOhm logic level MOSFET in LFPAK56 using Enhanced SOA technology

Fig. 9. Forward transconductance as a function of drain current; typical values

Fig. 10. Transfer characteristics; drain current as a function of gate-source voltage; typical values

Fig. 11. Sub-threshold drain current as a function of gate-source voltage

Fig. 12. Gate-source threshold voltage as a function of junction temperature
**Single N-channel 60 V, 15 mOhm logic level MOSFET in LFPAK56 using Enhanced SOA technology**

**Fig. 13.** Drain-source on-state resistance as a function of drain current; typical values

\[ R_{DS(on)}(m\Omega) \]

- 3 V
- 3.5 V
- 2.8 V
- 4.5 V

\[ V_{GS} = 10 \text{ V} \]

\[ T_j = 25 ^\circ \text{C} \]

**Fig. 14.** Normalized drain-source on-state resistance factor as a function of junction temperature

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

**Fig. 15.** Gate-source voltage as a function of gate charge; typical values

\[ V_{GS(\text{pl})} \]

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

\[ V_{GS} \]

\[ V_{DS} \]

\[ Q_{G1} \]

\[ Q_{G2} \]

\[ Q_{GD} \]

\[ Q_{G(tot)} \]

**Fig. 16.** Gate charge waveform definitions

\[ Q_{G1} \]

\[ Q_{G2} \]

\[ Q_{GD} \]

\[ Q_{G(tot)} \]

- 2.8 V
- 4.5 V
- 48 V
- 48 V
- 14 V

\[ Q_G \]

\[ V_{GS(\text{pl})} = 14 \text{ V} \]

\[ V_{GS(\text{th})} = 10 \text{ V} \]

\[ V_{GS} = 4.5 \text{ V} \]

\[ T_j = 25 ^\circ \text{C}; I_D = 10 \text{ A} \]
Single N-channel 60 V, 15 mOhm logic level MOSFET in LFPAK56 using Enhanced SOA technology

Fig. 17. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

VGS = 0 V; f = 1 MHz

Fig. 18. Source-drain (diode forward) current as a function of source-drain (diode forward) voltage; typical values

VGS = 0 V

Fig. 19. Reverse recovery timing definition
11. Package outline

Plastic single-ended surface-mounted package (LFPAK56; Power-SO8); 4 leads

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

<table>
<thead>
<tr>
<th>Unit</th>
<th>A</th>
<th>A₁</th>
<th>A₂</th>
<th>A₃</th>
<th>b</th>
<th>b₂</th>
<th>b₃</th>
<th>b₄</th>
<th>c</th>
<th>c₂</th>
<th>D(1)</th>
<th>D₁(1)</th>
<th>E(1)</th>
<th>E₁(1)</th>
<th>e</th>
<th>H</th>
<th>L</th>
<th>L₁</th>
<th>L₂</th>
<th>w</th>
<th>y</th>
</tr>
</thead>
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<tr>
<td>max</td>
<td>1.20</td>
<td>0.15</td>
<td>1.10</td>
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<td>4.41</td>
<td>2.2</td>
<td>0.9</td>
<td>0.25</td>
<td>0.30</td>
<td>4.10</td>
<td>4.20</td>
<td>5.0</td>
<td>3.3</td>
<td>1.27</td>
<td>6.2</td>
<td>0.85</td>
<td>1.3</td>
<td>1.3</td>
<td>0.25</td>
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</tr>
<tr>
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<td>0.00</td>
<td>0.95</td>
<td>0.25</td>
<td>3.62</td>
<td>2.0</td>
<td>0.7</td>
<td>0.19</td>
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<td>3.80</td>
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<td>4.8</td>
<td>3.1</td>
<td>5.8</td>
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<td>0.8</td>
<td>0.8</td>
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</table>

Note
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

Fig. 20. Package outline LFPAK56; Power-SO8 (SOT669)
12. Legal information

Data sheet status

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<tbody>
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<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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Single N-channel 60 V, 15 mOhm logic level MOSFET in LFPAK56 using Enhanced SOA technology

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Date of release: 25 April 2022