



# BUK6D210-60E

60 V, N-channel Trench MOSFET

17 April 2019

Product data sheet

## 1. General description

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

## 2. Features and benefits

- Extended temperature range  $T_j = 175\text{ }^{\circ}\text{C}$
- Side wettable flanks for optical solder inspection
- ElectroStatic Discharge (ESD) protection  $> 2\text{ kV HBM (class H2)}$
- Trench MOSFET technology
- AEC-Q101 qualified

## 3. Applications

- LED lighting
- High-speed line driver
- Low-side load switch
- Switching circuits

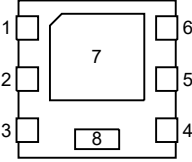
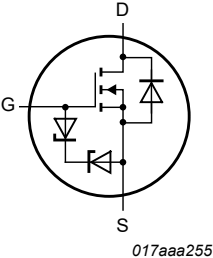
## 4. Quick reference data

Table 1. Quick reference data

| Symbol                        | Parameter                        | Conditions                                                                   | Min | Typ | Max | Unit       |
|-------------------------------|----------------------------------|------------------------------------------------------------------------------|-----|-----|-----|------------|
| $V_{DS}$                      | drain-source voltage             | $T_j = 25\text{ }^{\circ}\text{C}$                                           | -   | -   | 60  | V          |
| $V_{GS}$                      | gate-source voltage              |                                                                              | -20 | -   | 20  | V          |
| $I_D$                         | drain current                    | $V_{GS} = 10\text{ V}; T_{sp} = 25\text{ }^{\circ}\text{C}$                  | -   | -   | 5.7 | A          |
| $P_{tot}$                     | total power dissipation          | $T_{sp} = 25\text{ }^{\circ}\text{C}$                                        | -   | -   | 15  | W          |
| <b>Static characteristics</b> |                                  |                                                                              |     |     |     |            |
| $R_{DSon}$                    | drain-source on-state resistance | $V_{GS} = 10\text{ V}; I_D = 2.1\text{ A}; T_j = 25\text{ }^{\circ}\text{C}$ | -   | 160 | 210 | m $\Omega$ |

5. Pinning information

Table 2. Pinning information

| Pin | Symbol | Description | Simplified outline                                                                                                                      | Graphic symbol                                                                      |
|-----|--------|-------------|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| 1   | D      | drain       |  <p>Transparent top view<br/>DFN2020MD-6 (SOT1220)</p> |  |
| 2   | D      | drain       |                                                                                                                                         |                                                                                     |
| 3   | G      | gate        |                                                                                                                                         |                                                                                     |
| 4   | S      | source      |                                                                                                                                         |                                                                                     |
| 5   | D      | drain       |                                                                                                                                         |                                                                                     |
| 6   | D      | drain       |                                                                                                                                         |                                                                                     |
| 7   | D      | drain       |                                                                                                                                         |                                                                                     |
| 8   | S      | source      |                                                                                                                                         |                                                                                     |

6. Ordering information

Table 3. Ordering information

| Type number  | Package     |                                                                                                                             |         |
|--------------|-------------|-----------------------------------------------------------------------------------------------------------------------------|---------|
|              | Name        | Description                                                                                                                 | Version |
| BUK6D210-60E | DFN2020MD-6 | plastic, leadless thermal enhanced ultra thin small outline package; 6 terminals; 0.65 mm pitch; 2 mm x 2 mm x 0.65 mm body | SOT1220 |

7. Marking

Table 4. Marking codes

| Type number  | Marking code |
|--------------|--------------|
| BUK6D210-60E | 5G           |

## 8. Limiting values

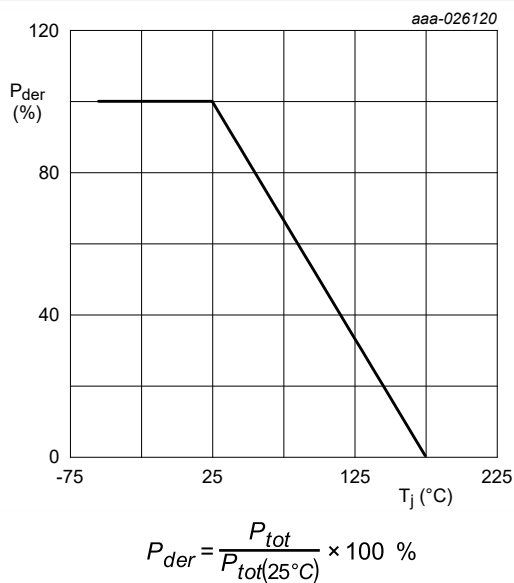
**Table 5. Limiting values**

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

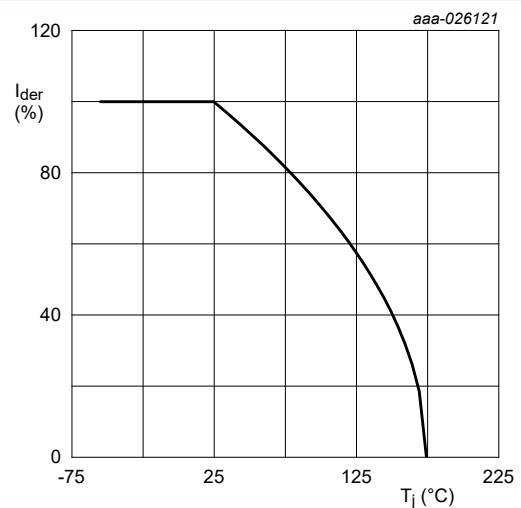
| Symbol                      | Parameter                                    | Conditions                                                                             |     | Min | Max  | Unit |
|-----------------------------|----------------------------------------------|----------------------------------------------------------------------------------------|-----|-----|------|------|
| V <sub>DS</sub>             | drain-source voltage                         | T <sub>j</sub> = 25 °C                                                                 |     | -   | 60   | V    |
| V <sub>GS</sub>             | gate-source voltage                          |                                                                                        |     | -20 | 20   | V    |
| I <sub>D</sub>              | drain current                                | V <sub>GS</sub> = 10 V; T <sub>sp</sub> = 25 °C                                        |     | -   | 5.7  | A    |
|                             |                                              | V <sub>GS</sub> = 10 V; T <sub>sp</sub> = 100 °C                                       |     | -   | 4.1  | A    |
|                             |                                              | V <sub>GS</sub> = 10 V; T <sub>amb</sub> = 25 °C                                       | [1] | -   | 2.1  | A    |
| I <sub>DM</sub>             | peak drain current                           | T <sub>sp</sub> = 25 °C; single pulse; t <sub>p</sub> ≤ 10 μs                          |     | -   | 23   | A    |
| P <sub>tot</sub>            | total power dissipation                      | T <sub>sp</sub> = 25 °C                                                                |     | -   | 15   | W    |
|                             |                                              | T <sub>amb</sub> = 25 °C                                                               | [1] | -   | 2    | W    |
| T <sub>j</sub>              | junction temperature                         |                                                                                        |     | -55 | 175  | °C   |
| T <sub>amb</sub>            | ambient temperature                          |                                                                                        |     | -55 | 175  | °C   |
| T <sub>stg</sub>            | storage temperature                          |                                                                                        |     | -65 | 175  | °C   |
| <b>Source-drain diode</b>   |                                              |                                                                                        |     |     |      |      |
| I <sub>S</sub>              | source current                               | T <sub>sp</sub> = 25 °C                                                                |     | -   | 5.7  | A    |
|                             |                                              | T <sub>amb</sub> = 25 °C                                                               | [1] | -   | 2    | A    |
| I <sub>SM</sub>             | peak source current                          | single pulse; t <sub>p</sub> ≤ 10 μs; T <sub>sp</sub> = 25 °C                          |     | -   | 23   | A    |
| <b>ESD maximum rating</b>   |                                              |                                                                                        |     |     |      |      |
| V <sub>ESD</sub>            | electrostatic discharge voltage              | HBM                                                                                    | [2] | -   | 2000 | V    |
| <b>Avalanche ruggedness</b> |                                              |                                                                                        |     |     |      |      |
| E <sub>DS(AL)S</sub>        | non-repetitive drain-source avalanche energy | T <sub>j(initial)</sub> = 25 °C; I <sub>D</sub> = 0.17 A; DUT in avalanche (unclamped) |     | -   | 5.3  | mJ   |

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

[2] Measured between all pins.



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



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

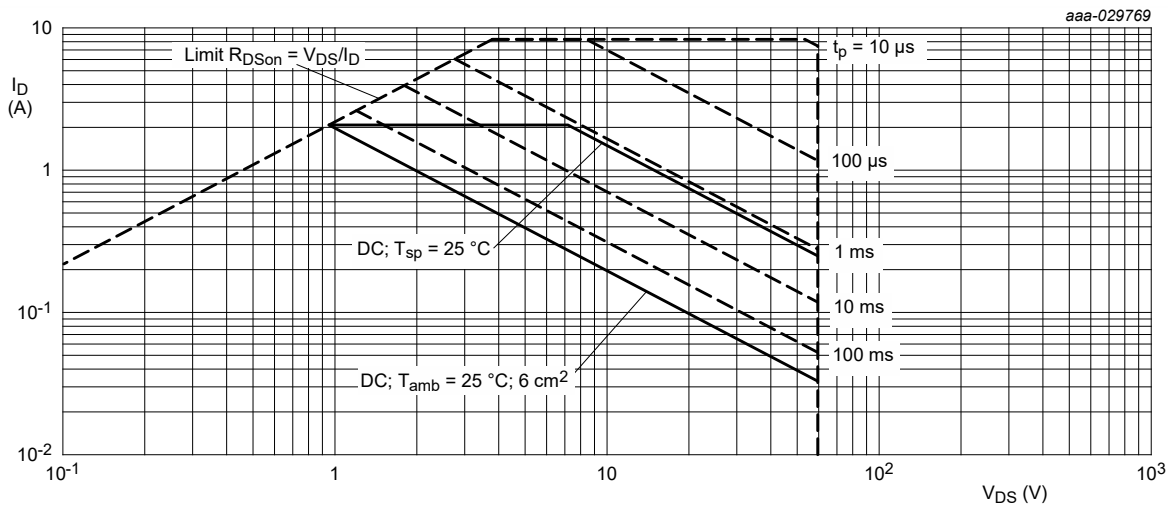


Fig. 3. Safe operating area; junction to ambient; continuous and peak drain currents as a function of drain-source voltage

9. Thermal characteristics

Table 6. Thermal characteristics

| Symbol         | Parameter                                        | Conditions  |     | Min | Typ | Max | Unit |
|----------------|--------------------------------------------------|-------------|-----|-----|-----|-----|------|
| $R_{th(j-a)}$  | thermal resistance from junction to ambient      | in free air | [1] | -   | 66  | 76  | K/W  |
| $R_{th(j-sp)}$ | thermal resistance from junction to solder point |             |     | -   | 5   | 10  | K/W  |

[1] Device mounted on an FR4 PCB, single-sided copper, tin-plated and mounting pad for drain 6 cm<sup>2</sup>.

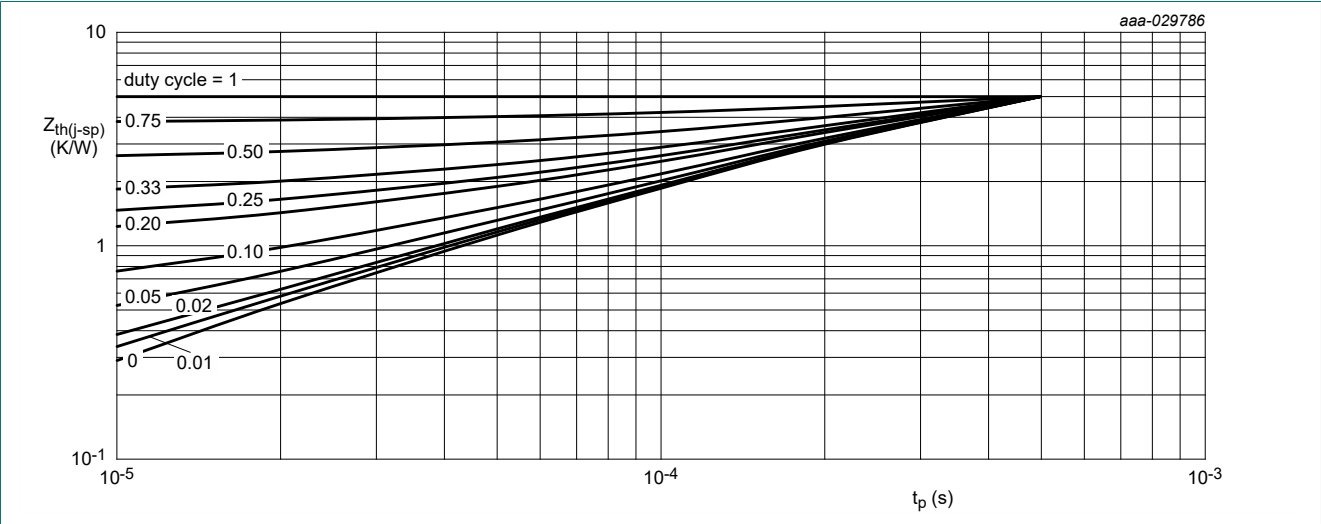


Fig. 4. Transient thermal impedance from junction to solder point as a function of pulse duration; typical values

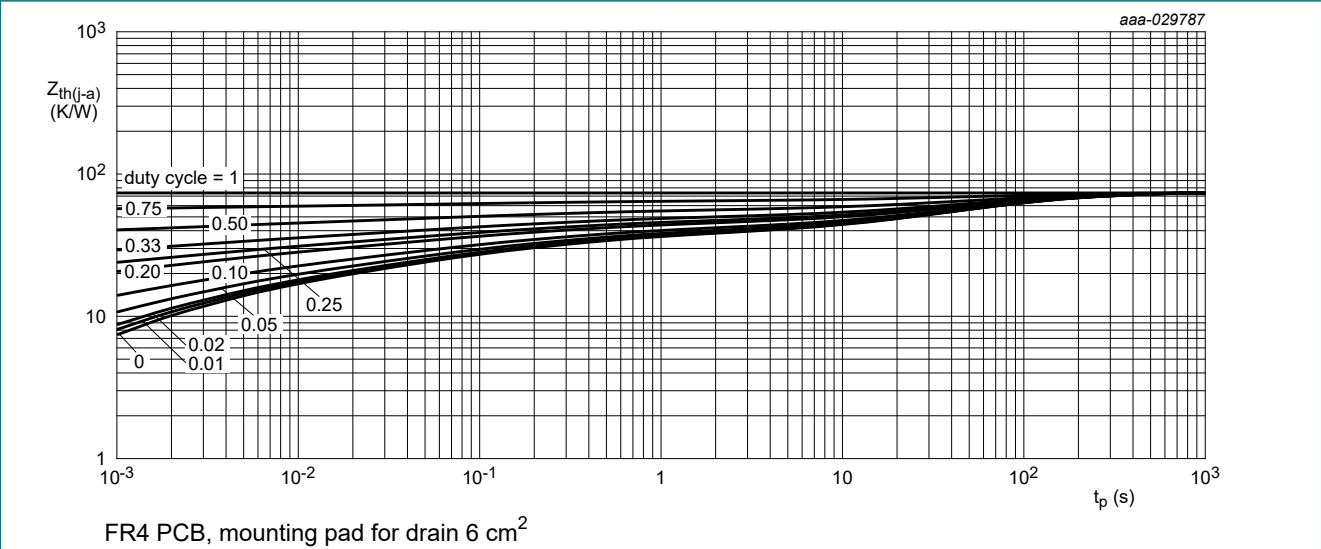


Fig. 5. Transient thermal impedance from junction to ambient as a function of pulse duration; typical values

## 10. Characteristics

Table 7. Characteristics

| Symbol                  | Parameter                        | Conditions                                                                                                                     |  | Min | Typ  | Max | Unit |
|-------------------------|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------|--|-----|------|-----|------|
| Static characteristics  |                                  |                                                                                                                                |  |     |      |     |      |
| V <sub>(BR)DSS</sub>    | drain-source breakdown voltage   | I <sub>D</sub> = 250 μA; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                         |  | 60  | -    | -   | V    |
| V <sub>GSth</sub>       | gate-source threshold voltage    | I <sub>D</sub> = 250 μA; V <sub>DS</sub> = V <sub>GS</sub> ; T <sub>j</sub> = 25 °C                                            |  | 1.3 | 1.7  | 2.7 | V    |
| I <sub>DSS</sub>        | drain leakage current            | V <sub>DS</sub> = 60 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                          |  | -   | -    | 1   | μA   |
|                         |                                  | V <sub>DS</sub> = 60 V; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 125 °C                                                         |  | -   | -    | 4   | μA   |
| I <sub>GSS</sub>        | gate leakage current             | V <sub>GS</sub> = 20 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                          |  | -   | -    | 10  | μA   |
|                         |                                  | V <sub>GS</sub> = -20 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                         |  | -   | -    | -10 | μA   |
|                         |                                  | V <sub>GS</sub> = 10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                          |  | -   | -    | 1   | μA   |
|                         |                                  | V <sub>GS</sub> = -10 V; V <sub>DS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                         |  | -   | -    | -1  | μA   |
| R <sub>DSon</sub>       | drain-source on-state resistance | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 2.1 A; T <sub>j</sub> = 25 °C                                                         |  | -   | 160  | 210 | mΩ   |
|                         |                                  | V <sub>GS</sub> = 10 V; I <sub>D</sub> = 2.1 A; T <sub>j</sub> = 175 °C                                                        |  | -   | 347  | 456 | mΩ   |
|                         |                                  | V <sub>GS</sub> = 4.5 V; I <sub>D</sub> = 1.9 A; T <sub>j</sub> = 25 °C                                                        |  | -   | 196  | 262 | mΩ   |
| g <sub>fs</sub>         | forward transconductance         | V <sub>DS</sub> = 10 V; I <sub>D</sub> = 2 A; T <sub>j</sub> = 25 °C                                                           |  | -   | 4    | -   | S    |
| R <sub>G</sub>          | gate resistance                  | f = 1 MHz                                                                                                                      |  | -   | 13.2 | -   | Ω    |
| Dynamic characteristics |                                  |                                                                                                                                |  |     |      |     |      |
| Q <sub>G(tot)</sub>     | total gate charge                | V <sub>DS</sub> = 30 V; I <sub>D</sub> = 2.1 A; V <sub>GS</sub> = 10 V; T <sub>j</sub> = 25 °C                                 |  | -   | 2.5  | 3.8 | nC   |
| Q <sub>GS</sub>         | gate-source charge               |                                                                                                                                |  | -   | 0.3  | -   | nC   |
| Q <sub>GD</sub>         | gate-drain charge                |                                                                                                                                |  | -   | 0.7  | -   | nC   |
| C <sub>iss</sub>        | input capacitance                | V <sub>DS</sub> = 30 V; f = 1 MHz; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                               |  | -   | 110  | -   | pF   |
| C <sub>oss</sub>        | output capacitance               |                                                                                                                                |  | -   | 16   | -   | pF   |
| C <sub>rss</sub>        | reverse transfer capacitance     |                                                                                                                                |  | -   | 11   | -   | pF   |
| t <sub>d(on)</sub>      | turn-on delay time               | V <sub>DS</sub> = 30 V; I <sub>D</sub> = 2.1 A; V <sub>GS</sub> = 10 V; R <sub>G(ext)</sub> = 6 Ω; T <sub>j</sub> = 25 °C      |  | -   | 2    | -   | ns   |
| t <sub>r</sub>          | rise time                        |                                                                                                                                |  | -   | 5    | -   | ns   |
| t <sub>d(off)</sub>     | turn-off delay time              |                                                                                                                                |  | -   | 7    | -   | ns   |
| t <sub>f</sub>          | fall time                        |                                                                                                                                |  | -   | 3    | -   | ns   |
| Source-drain diode      |                                  |                                                                                                                                |  |     |      |     |      |
| V <sub>SD</sub>         | source-drain voltage             | I <sub>S</sub> = 2 A; V <sub>GS</sub> = 0 V; T <sub>j</sub> = 25 °C                                                            |  | -   | 0.8  | 1.2 | V    |
| t <sub>rr</sub>         | reverse recovery time            | I <sub>S</sub> = 0.8 A; dI <sub>S</sub> /dt = -100 A/μs; V <sub>GS</sub> = 0 V; V <sub>DS</sub> = 30 V; T <sub>j</sub> = 25 °C |  | -   | 10   | -   | ns   |
| Q <sub>r</sub>          | recovered charge                 |                                                                                                                                |  | -   | 3    | -   | nC   |

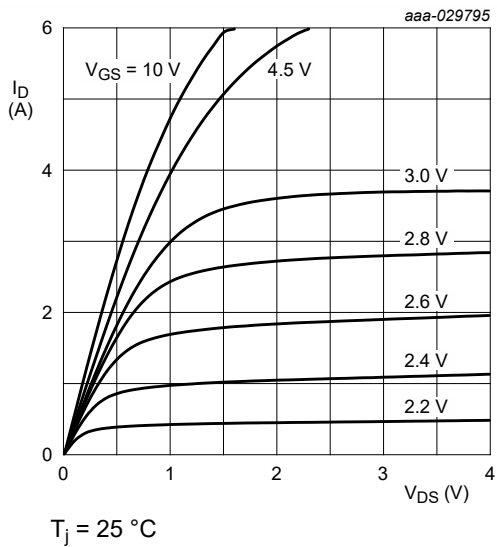


Fig. 6. Output characteristics: drain current as a function of drain-source voltage; typical values

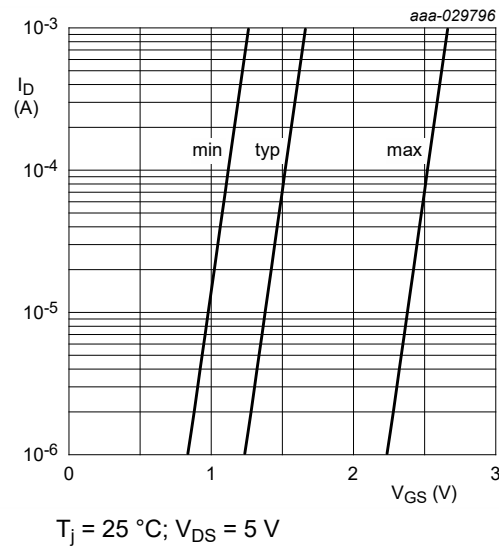


Fig. 7. Sub-threshold drain current as a function of gate-source voltage

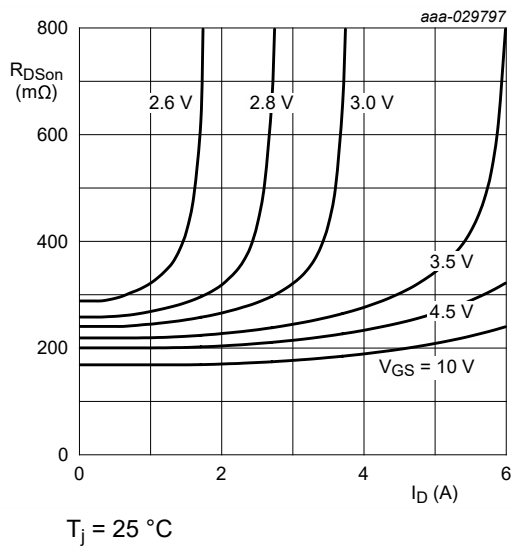


Fig. 8. Drain-source on-state resistance as a function of drain current; typical values

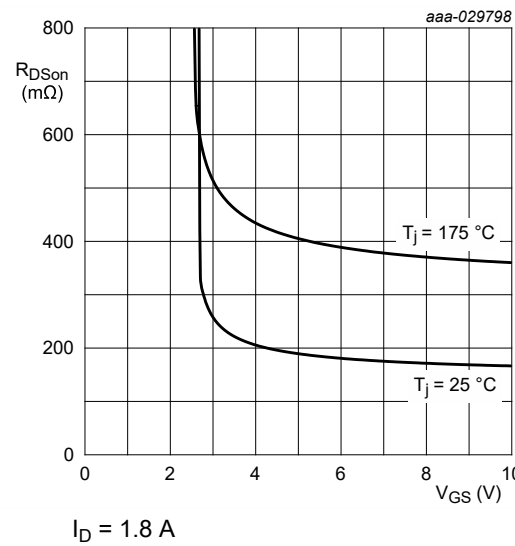


Fig. 9. Drain-source on-state resistance as a function of gate-source voltage; typical values

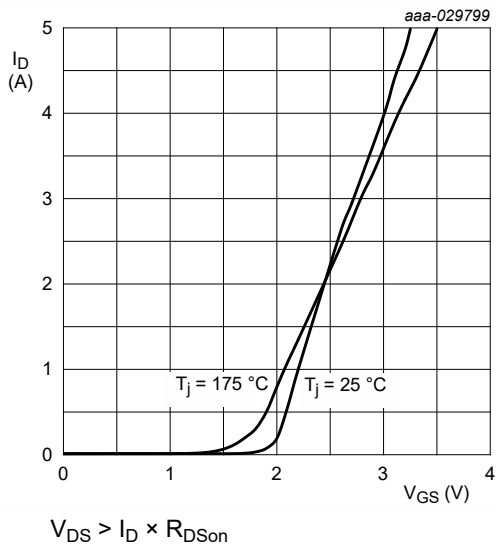


Fig. 10. Transfer characteristics: drain current as a function of gate-source voltage; typical values

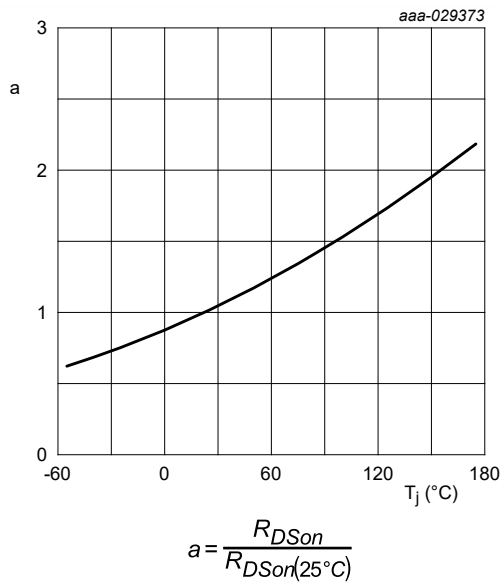


Fig. 11. Normalized drain-source on-state resistance as a function of junction temperature; typical values

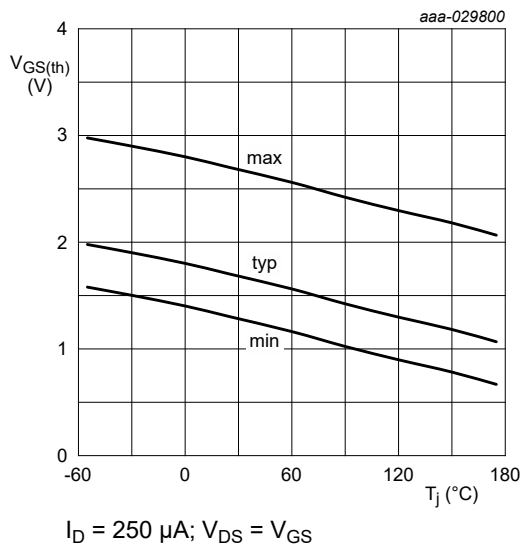


Fig. 12. Gate-source threshold voltage as a function of junction temperature

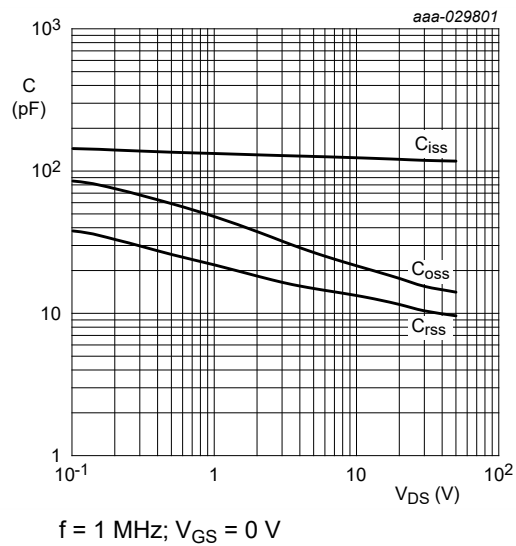


Fig. 13. Input, output and reverse transfer capacitances as a function of drain-source voltage; typical values

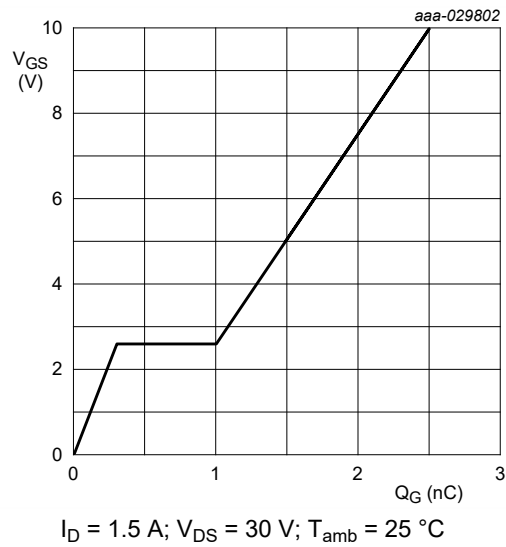


Fig. 14. Gate-source voltage as a function of gate charge; typical values

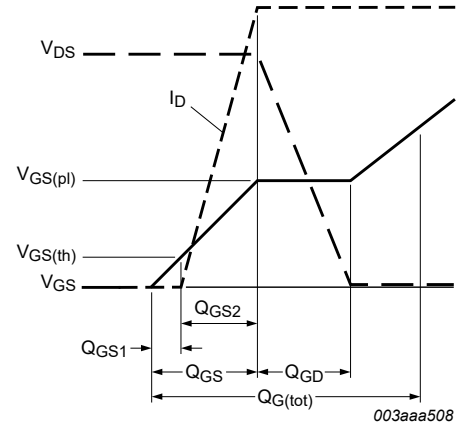


Fig. 15. Gate charge waveform definitions

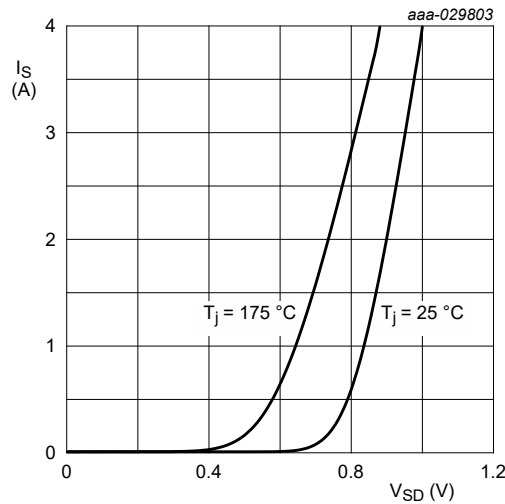


Fig. 16. Source current as a function of source-drain voltage; typical values

## 11. Test information

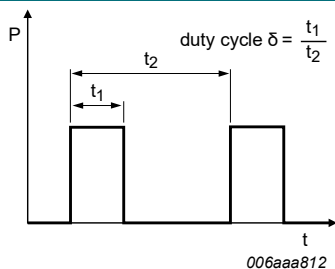


Fig. 17. Duty cycle definition

### 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

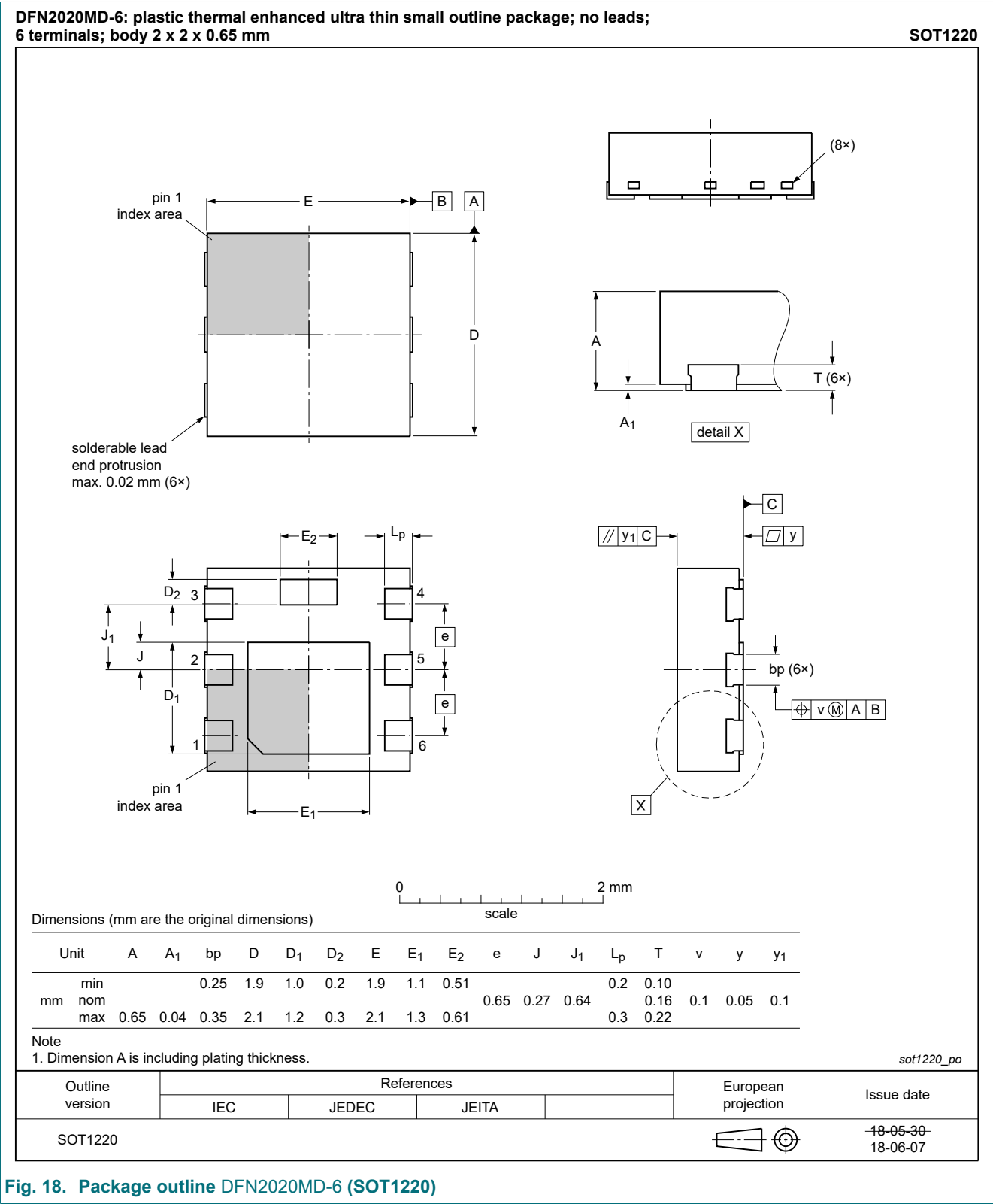


Fig. 18. Package outline DFN2020MD-6 (SOT1220)

13. Soldering

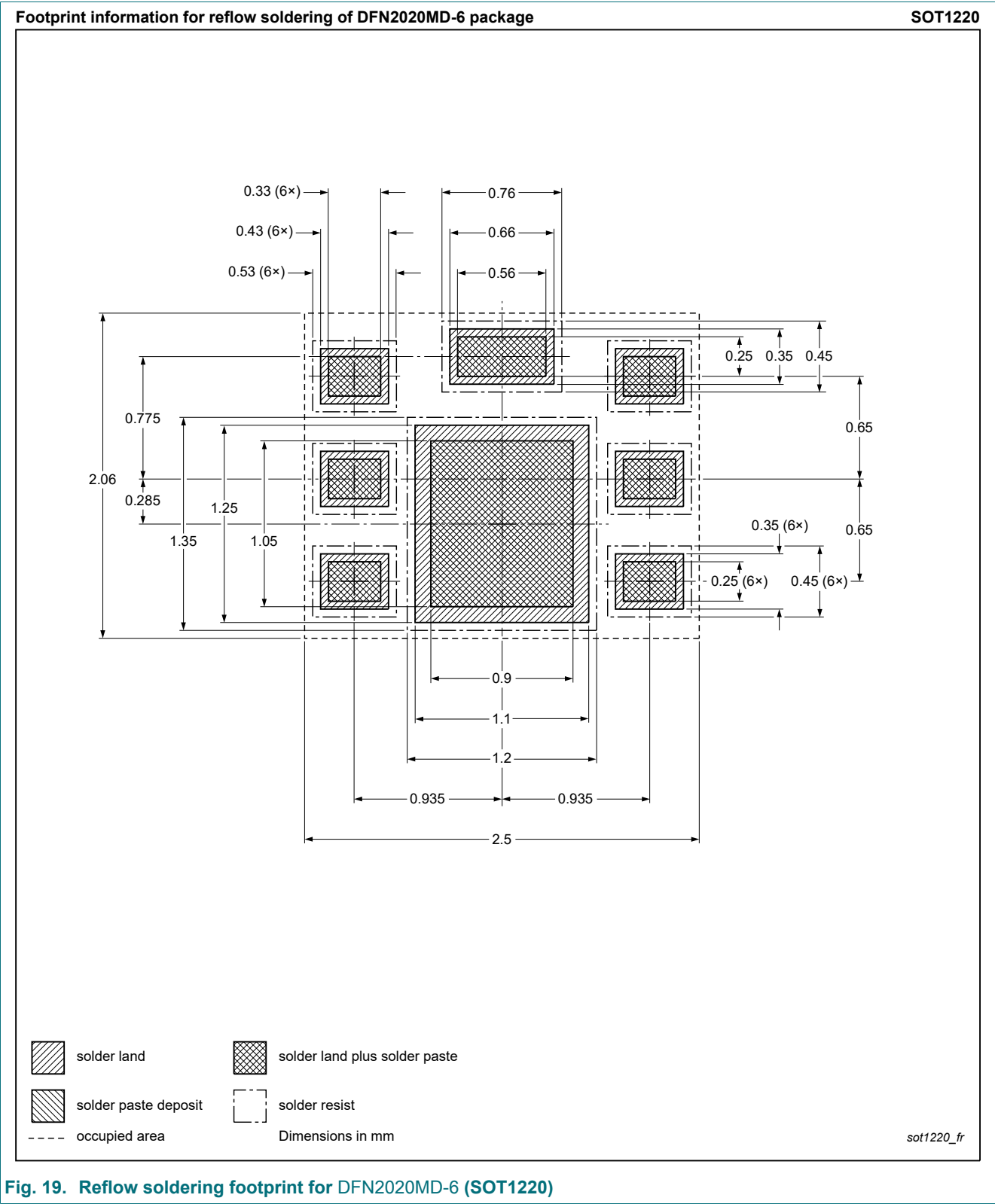


Fig. 19. Reflow soldering footprint for DFN2020MD-6 (SOT1220)

14. Revision history

Table 8. Revision history

| Data sheet ID    | Release date | Data sheet status  | Change notice | Supersedes |
|------------------|--------------|--------------------|---------------|------------|
| BUK6D210-60E v.1 | 20190417     | Product data sheet | -             | -          |

## 15. Legal information

### Data sheet status

| Document status<br>[1][2]      | Product status [3] | Definition                                                                            |
|--------------------------------|--------------------|---------------------------------------------------------------------------------------|
| Objective [short] data sheet   | Development        | This document contains data from the objective specification for product development. |
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Date of release: 17 April 2019

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