## Final datasheet

## EasyPACK™ 1B module with CoolMOS™ CFD7A Automotive MOSFET and PressFIT / NTC

### Features

Typical appearance

- Electrical features
  - $V_{DSS}$ = 650 V
  - $I_{DN}$ = 35 A / $I_{DRM}$ = 70 A
  - Low switching losses
  - Low inductive design
  - Integrated snubber
- Mechanical features
  - PressFIT contact technology
  - Integrated NTC temperature sensor
  - Rugged mounting due to integrated mounting clamps

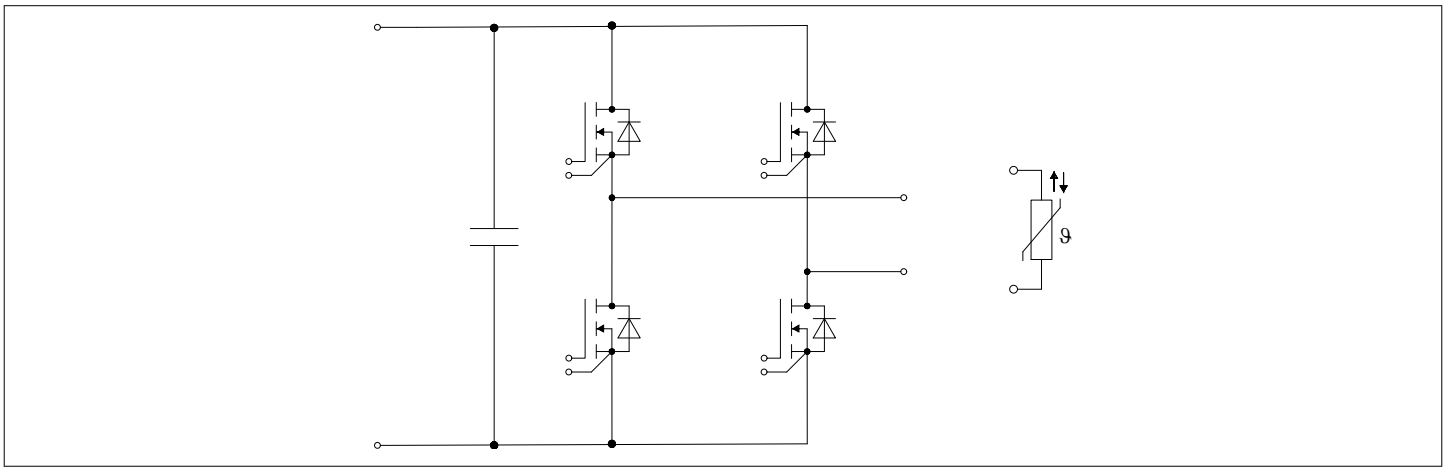
### Potential applications

- Automotive auxillary applications
- DC charger for EV
- High-frequency switching application

### Product validation

- Qualified according to AQG 324, release no.: 02.1/2019

### Description



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# 1 Package

**Table 1 Insulation coordination**

| Parameter | Symbol | Note or test condition | Values | Unit |
|---|---|---|---|---|
| Isolation test voltage | $V_{ISOL}$ | RMS, f = 50 Hz, *t* = 1 min | 2.5 | kV |
| Internal isolation | | basic insulation (class 1, IEC 61140) | $Al_2O_3$ | |
| Creepage distance | $d_{Creep}$ | terminal to heatsink | 11.5 | mm |
| Creepage distance | $d_{Creep}$ | terminal to terminal | 6.3 | mm |
| Clearance | $d_{Clear}$ | terminal to heatsink | 10.0 | mm |
| Clearance | $d_{Clear}$ | terminal to terminal | 4.2 | mm |
| Comparative tracking index | *CTI* | | > 200 | |
| Relative thermal index (electrical) | *RTI* | housing | 140 | °C |

**Table 2 Characteristic values**

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Module lead resistance, terminals - chip | $R_{CC'+EE'}$ | $T_H$ = 25 °C, per switch | | 3.3 | | mΩ |
| Storage temperature | $T_{stg}$ | | -40 | | 125 | °C |
| Mounting force per clamp | *F* | | 20 | | 50 | N |
| Weight | *G* | | | 24 | | g |

*Note: The current under continuous operation is limited to 25 A rms per connector pin.*

# 2 MOSFET

**Table 3 Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| Drain-source voltage | $V_{DSS}$ | | $T_{vj}$ = 25 °C | 650 | V |
| | | | $T_{vj}$ = -40 °C | 605 | |
| Implemented drain current | $I_{DN}$ | | | 35 | A |
| Continuous DC drain current | $I_{DDC}$ | $T_{vj}$ = 150 °C, $V_{GS}$ = 10 V | $T_H$ = 65 °C | 30 | A |
| Repetitive peak drain current | $I_{DRM}$ | verified by design, $t_p$ limited by $T_{vjmax}$ | | 70 | A |
| Gate-source voltage, max. transient voltage | $V_{GS}$ | $f_{repetition}$ ≤ 100 kHz, $t_{pulse}$ ≤ 2 ns | | ±30 | V |

**(table continues...)**

**Table 3 (continued) Maximum rated values**

| Parameter | Symbol | Note or test condition | Values | Unit |
|---|---|---|---|---|
| Gate-source voltage, max. static voltage | $V_{GS}$ | | ±20 | V |
| dv/dt ruggedness | $dv/dt$ | $V_{DS}$ = 0...400 V | 120 | V/ns |

**Table 4 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Drain-source on-resistance | $R_{DS(on)}$ | $I_D$ = 35 A | $V_{GS}$ = 10 V, $T_{vj}$ = 25 °C | | 30 | 39.4 | mΩ |
| | | | $V_{GS}$ = 10 V, $T_{vj}$ = 125 °C | | 53 | | |
| | | | $V_{GS}$ = 10 V, $T_{vj}$ = 150 °C | | 61 | | |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D$ = 1.74 mA, $V_{DS}$ = $V_{GS}$, $T_{vj}$ = 25 °C | | 3.55 | 4 | 4.45 | V |
| Total gate charge | $Q_G$ | $V_{DD}$ = 400 V, $V_{GS}$ = 10 V | | | 0.141 | | µC |
| Internal gate resistor | $R_{Gint}$ | $T_{vj}$ = 25 °C | | | 3.8 | | Ω |
| Input capacitance | $C_{ISS}$ | $f$ = 100 kHz, $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | 6.95 | | nF |
| Output capacitance | $C_{OSS}$ | $f$ = 100 kHz, $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | 0.092 | | nF |
| Reverse transfer capacitance | $C_{rss}$ | $f$ = 100 kHz, $V_{DS}$ = 400 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | 0.021 | | nF |
| $C_{OSS}$ stored energy | $E_{OSS}$ | $V_{DS}$ = 400 V, $V_{GS}$ = 10 V, $T_{vj}$ = 25 °C | | | 17.9 | | µJ |
| Drain-source leakage current | $I_{DSS}$ | $V_{DS}$ = 650 V, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | | 10 | µA |
| Gate-source leakage current | $I_{GSS}$ | $V_{DS}$ = 0 V, $T_{vj}$ = 25 °C | $V_{GS}$ = 20 V | | | 100 | nA |
| Turn-on delay time (inductive load) | $t_{d\,on}$ | $I_D$ = 35 A, $R_{Gon}$ = 12 Ω, $V_{DD}$ = 400 V, $V_{GS}$ = 0/10 V | $T_{vj}$ = 25 °C | | 146 | | ns |
| | | | $T_{vj}$ = 125 °C | | 145 | | |
| | | | $T_{vj}$ = 150 °C | | 145 | | |
| Rise time (inductive load) | $t_r$ | $I_D$ = 35 A, $R_{Gon}$ = 12 Ω, $V_{DD}$ = 400 V, $V_{GS}$ = 0/10 V | $T_{vj}$ = 25 °C | | 11.5 | | ns |
| | | | $T_{vj}$ = 125 °C | | 12.4 | | |
| | | | $T_{vj}$ = 150 °C | | 12.8 | | |
| Turn-off delay time (inductive load) | $t_{d\,off}$ | $I_D$ = 35 A, $R_{Goff}$ = 0 Ω, $V_{DD}$ = 400 V, $V_{GS}$ = 0/10 V | $T_{vj}$ = 25 °C | | 106 | | ns |
| | | | $T_{vj}$ = 125 °C | | 114 | | |
| | | | $T_{vj}$ = 150 °C | | 117 | | |

**(table continues...)**

**Table 4 (continued) Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Fall time (inductive load) | $t_f$ | $I_D$ = 35 A, $R_{Goff}$ = 0 Ω, $V_{DD}$ = 400 V, $V_{GS}$ = 0/10 V | $T_{vj}$ = 25 °C | | 4.7 | | ns |
| | | | $T_{vj}$ = 125 °C | | 5.6 | | |
| | | | $T_{vj}$ = 150 °C | | 5.9 | | |
| Thermal resistance, junction to heat sink | $R_{thJH}$ | per MOSFET, $\lambda_{grease}$ = 1 W/(m·K) | | | 0.992 | | K/W |
| Temperature under switching conditions | $T_{vj\,op}$ | | | -40 | | 150 | °C |

# 3 Body diode (MOSFET)

**Table 5 Maximum rated values**

| Parameter | Symbol | Note or test condition | | Values | Unit |
|---|---|---|---|---|---|
| DC body diode forward current | $I_{SD}$ | $T_{vj}$ = 25 °C, $V_{GS}$ = 0 V | $T_H$ = 65 °C | 35 | A |
| dv/dt ruggedness | $dv/dt$ | $V_{DS}$ = 0...400 V, $I_{SD}$ ≤ 35 A | $T_{vj}$ = 25 °C | 70 | V/ns |
| di/dt ruggedness | $di/dt$ | $V_{DS}$ = 0...400 V, $I_{SD}$ ≤ 35 A | $T_{vj}$ = 25 °C | 1300 | A/µs |

**Table 6 Characteristic values**

| Parameter | Symbol | Note or test condition | | Values | | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | |
| Forward voltage | $V_{SD}$ | $I_{SD}$ = 35 A, $V_{GS}$ = 0 V | $T_{vj}$ = 25 °C | | 1.05 | 1.35 | V |
| | | | $T_{vj}$ = 125 °C | | 0.92 | | |
| | | | $T_{vj}$ = 150 °C | | 0.88 | | |

# 4 Capacitor

**Table 7 Characteristic values**

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Rated DC voltage | $V_{DC}$ | $T$ = 25 °C | | 630 | | V |
| Capacitance value | $C_{nom}$ | $T$ = 25 °C | | 66 | | nF |
| Temperature range | $T_{cap}$ | | -40 | | 125 | °C |

# 5 NTC-Thermistor

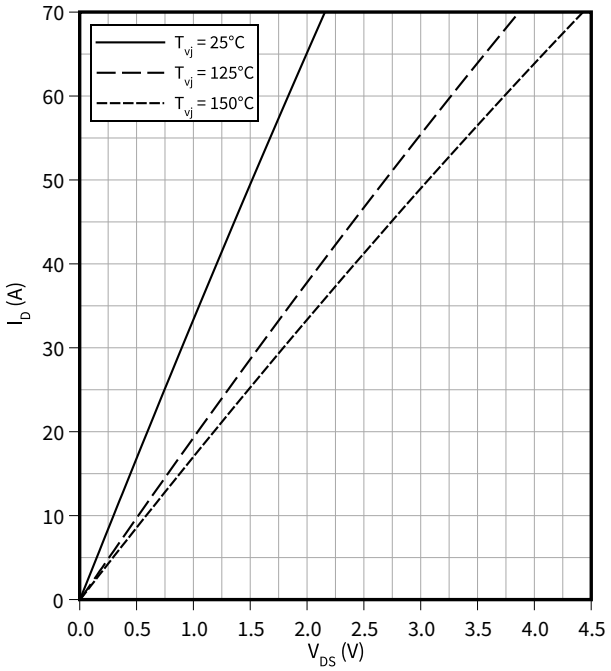
**Table 8 Characteristic values**

| Parameter | Symbol | Note or test condition | Values | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Rated resistance | $R_{25}$ | $T_{NTC}$ = 25 °C | 9.7 | 10 | 10.3 | kΩ |
| Power dissipation | $P_{25}$ | $T_{NTC}$ = 25 °C | | | 20 | mW |
| B-value | $B_{25/50}$ | $R_2 = R_{25} \exp[B_{25/50}(1/T_2\text{-}1/(298{,}15\ K))]$ | | 3447 | | K |
| B-value | $B_{25/80}$ | $R_2 = R_{25} \exp[B_{25/80}(1/T_2\text{-}1/(298{,}15\ K))]$ | | 3487 | | K |
| B-value | $B_{25/100}$ | $R_2 = R_{25} \exp[B_{25/100}(1/T_2\text{-}1/(298{,}15\ K))]$ | | 3510 | | K |

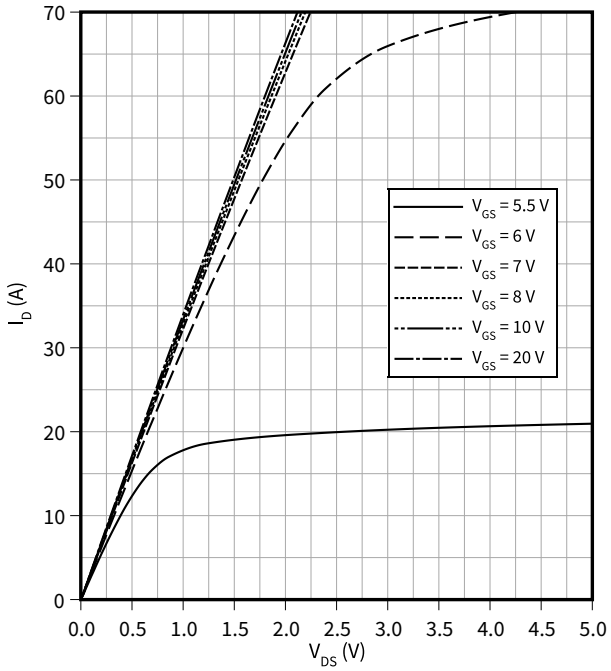
*Note: For an analytical description of the NTC characteristics please refer to AN2009-10, chapter 4*

# 6 Characteristics diagrams

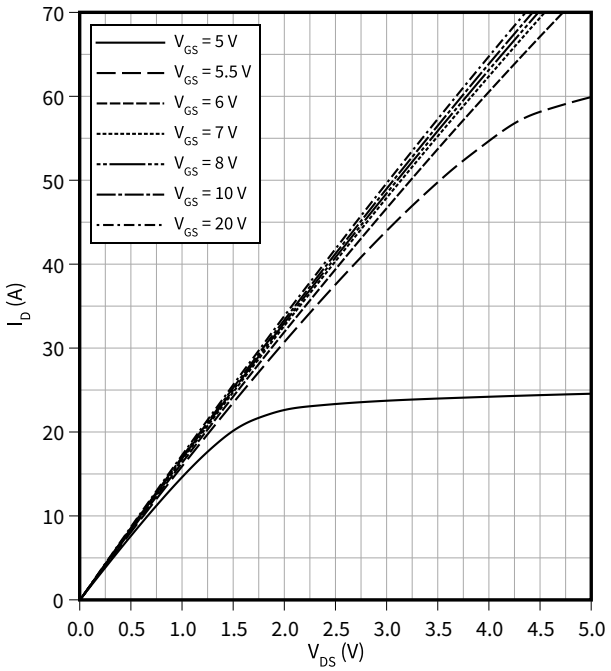
**Output characteristic (typical), MOSFET**
$I_D = f(V_{DS})$
$V_{GS} = 10$ V



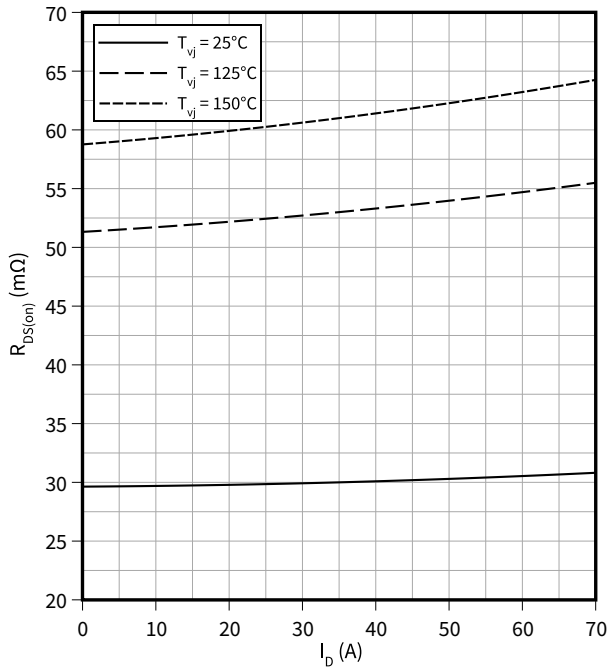

**Output characteristic field (typical), MOSFET**
$I_D = f(V_{DS})$
$T_{vj} = 25$ °C




**Output characteristic field (typical), MOSFET**
$I_D = f(V_{DS})$
$T_{vj} = 150$ °C

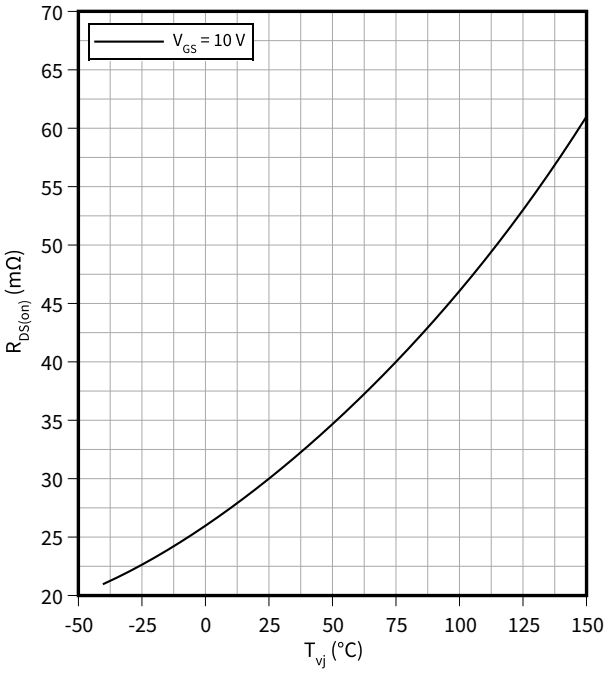



**Drain source on-resistance (typical), MOSFET**
$R_{DS(on)} = f(I_D)$
$V_{GS} = 10$ V



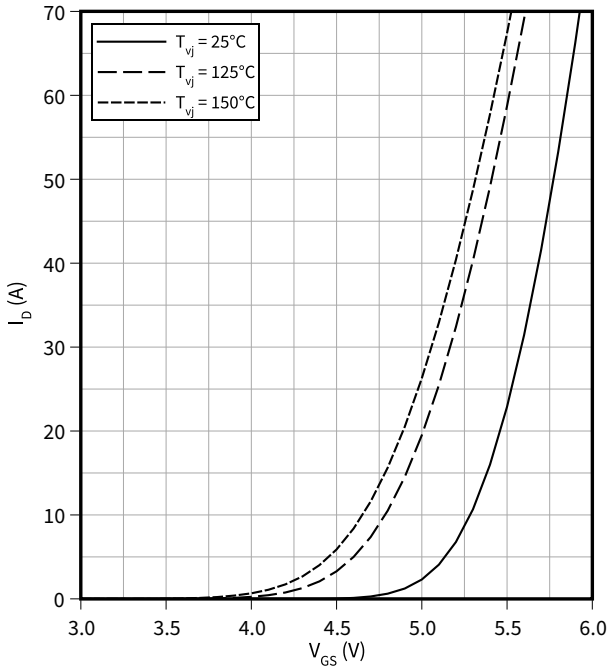
### Drain source on-resistance (typical), MOSFET

$R_{DS(on)} = f(T_{vj})$
$I_D = 35$ A



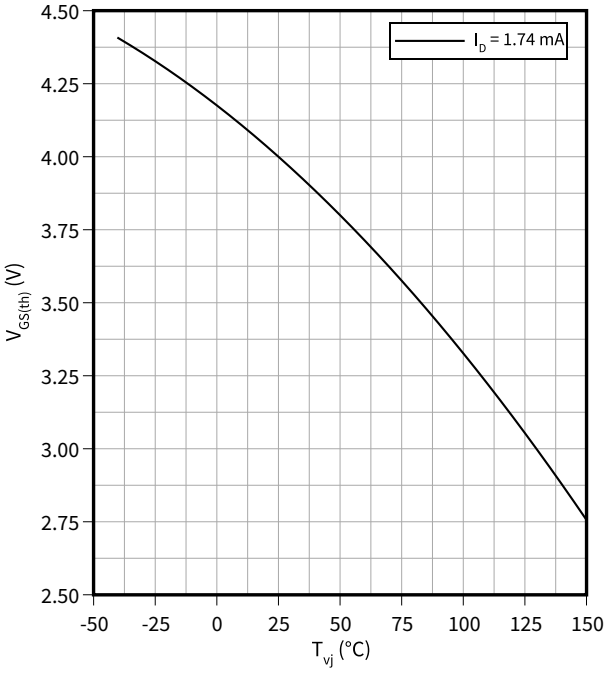

### Transfer characteristic (typical), MOSFET

$I_D = f(V_{GS})$
$V_{DS} = 20$ V



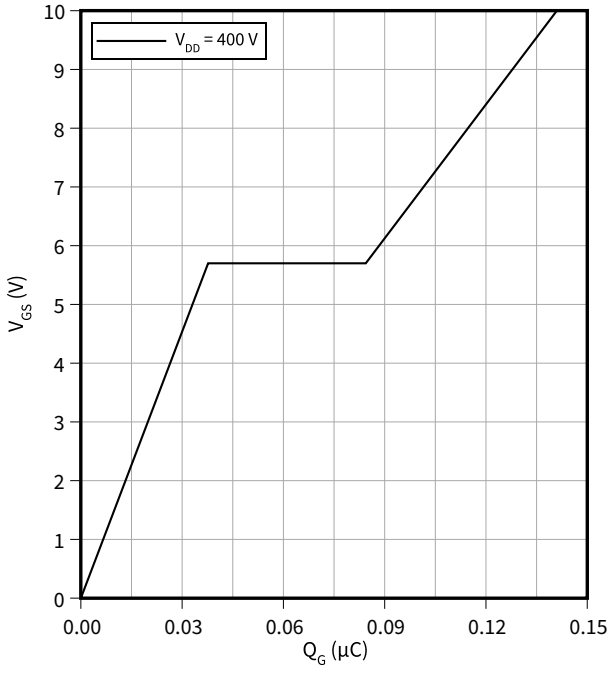

### Gate-source threshold voltage (typical), MOSFET

$V_{GS(th)} = f(T_{vj})$
$V_{GS} = V_{DS}$




### Gate charge characteristic (typical), MOSFET

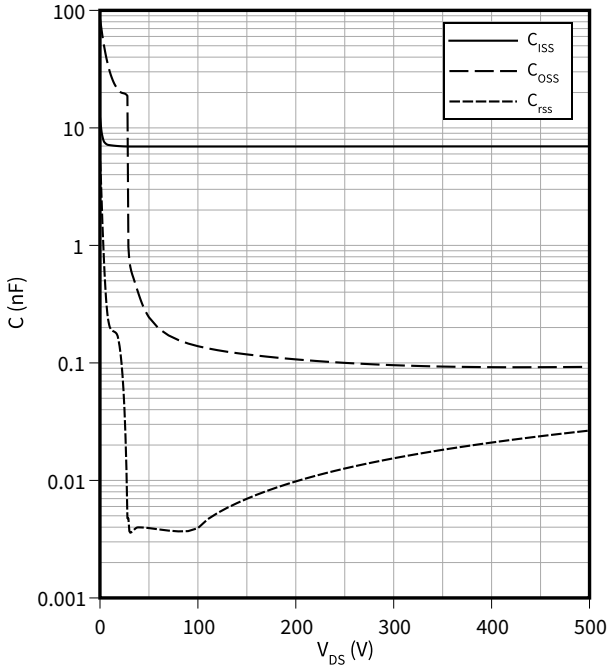
$V_{GS} = f(Q_G)$
$I_D = 35$ A, $T_{vj} = 25$ °C



### Capacity characteristic (typical), MOSFET

$C = f(V_{DS})$

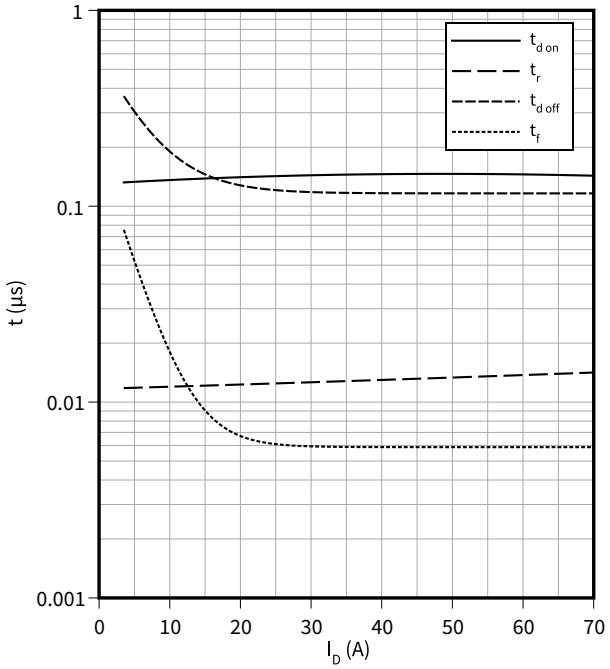
$T_{vj}$ = 25 °C, f = 100 kHz, $V_{GS}$ = 0 V




### Switching times (typical), MOSFET

$t = f(I_D)$

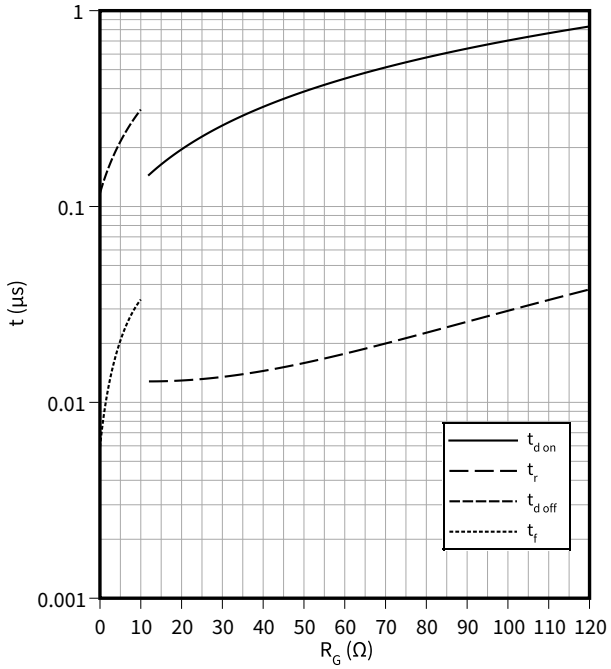
$R_{Goff}$ = 0 Ω, $R_{Gon}$ = 12 Ω, $V_{DD}$ = 400 V, $T_{vj}$ = 150 °C, $V_{GS}$ = 0/10 V




### Switching times (typical), MOSFET

$t = f(R_G)$

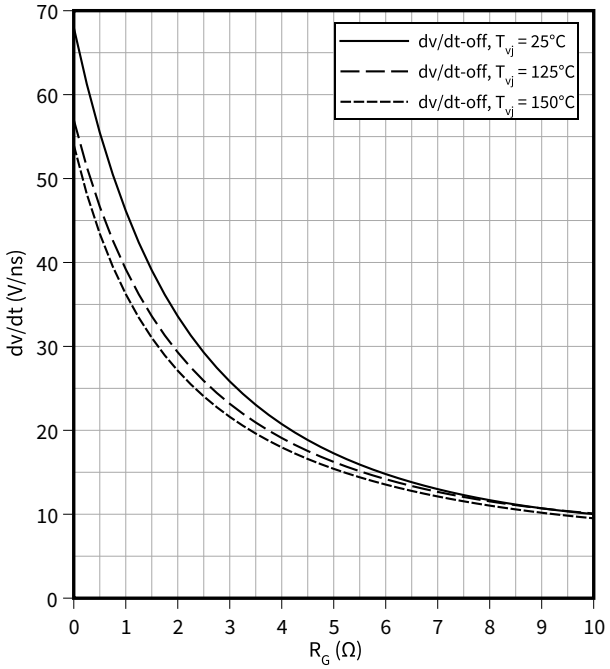
$V_{DD}$ = 400 V, $I_D$ = 35 A, $T_{vj}$ = 150 °C, $V_{GS}$ = 0/10 V




### Voltage slope (typical), MOSFET

$dv/dt = f(R_G)$

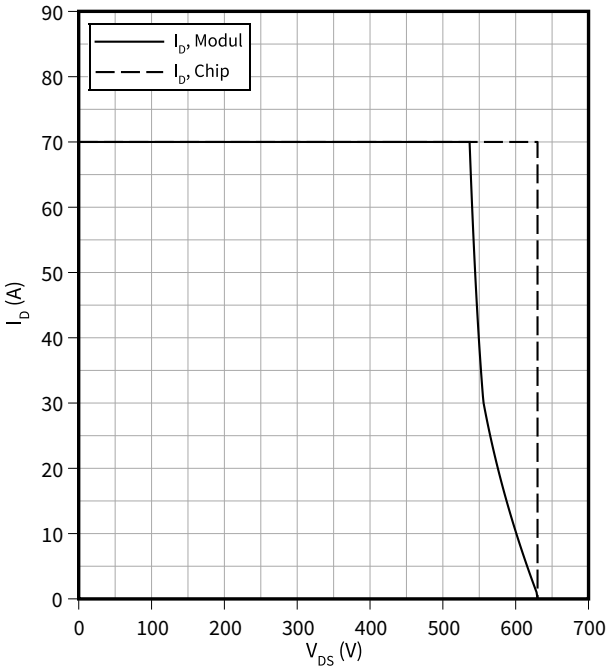
$V_{DD}$ = 400 V, $I_D$ = 35 A, $V_{GS}$ = 0/10 V



### Reverse bias safe operating area (RBSOA), MOSFET

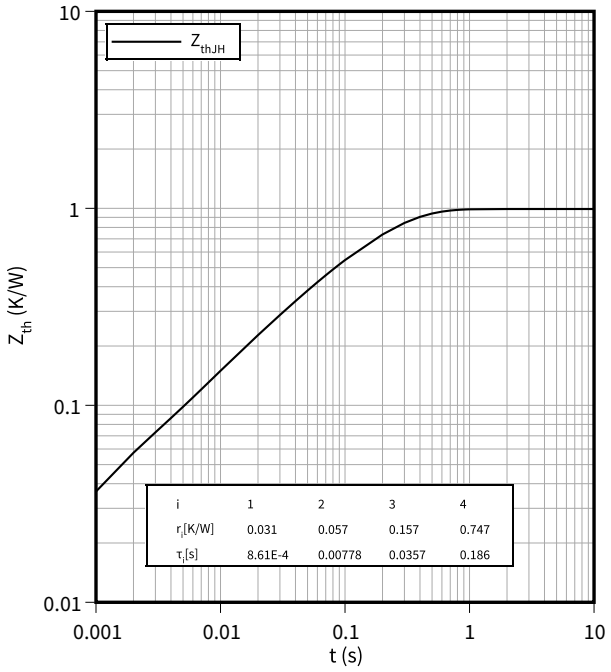
$I_D = f(V_{DS})$

$R_{Goff} = 0\ \Omega$, $T_{vj} = 150\ °C$, $V_{GS} = 0/10\ V$




### Transient thermal impedance, MOSFET

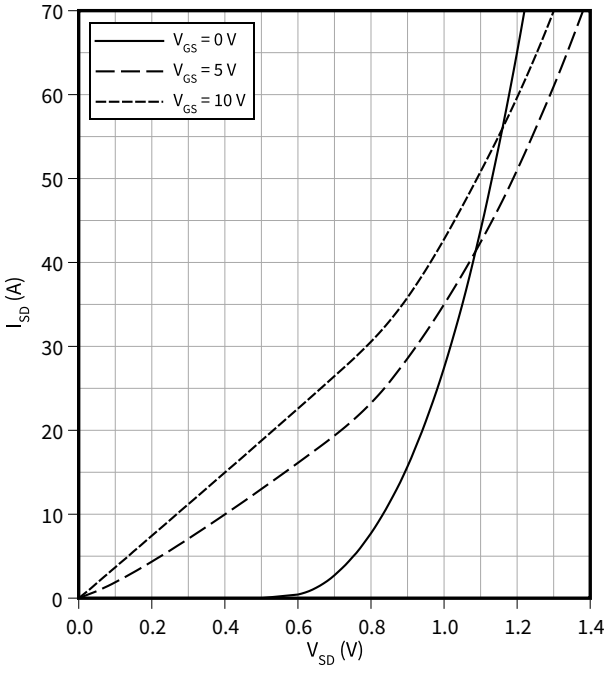
$Z_{th} = f(t)$




### Forward characteristic body diode (typical), MOSFET

$I_{SD} = f(V_{SD})$

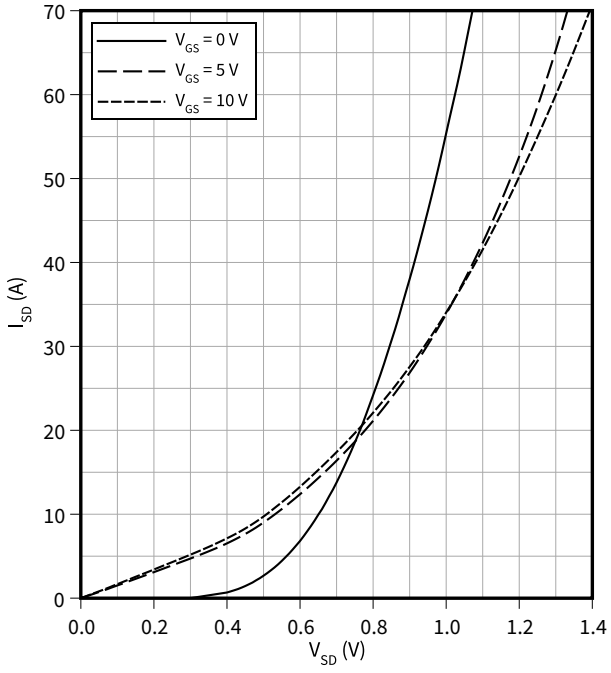
$T_{vj} = 25\ °C$




### Forward characteristic body diode (typical), MOSFET

$I_{SD} = f(V_{SD})$

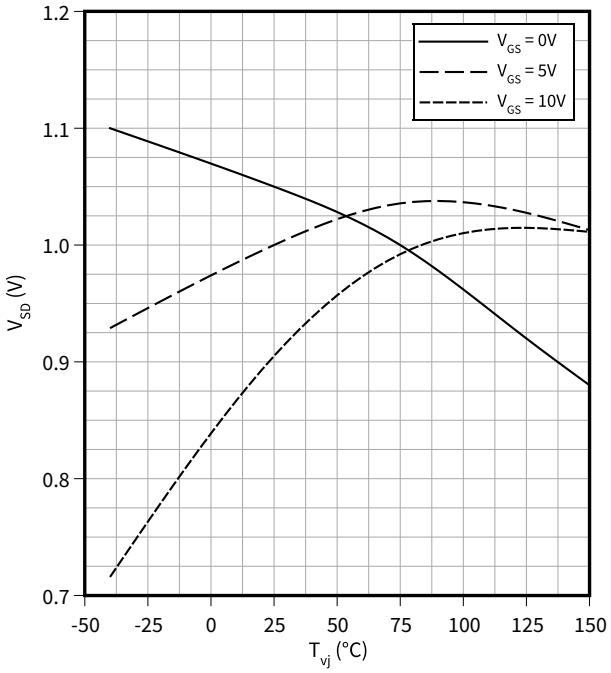
$T_{vj} = 150\ °C$



**Forward voltage of body diode (typical), MOSFET**

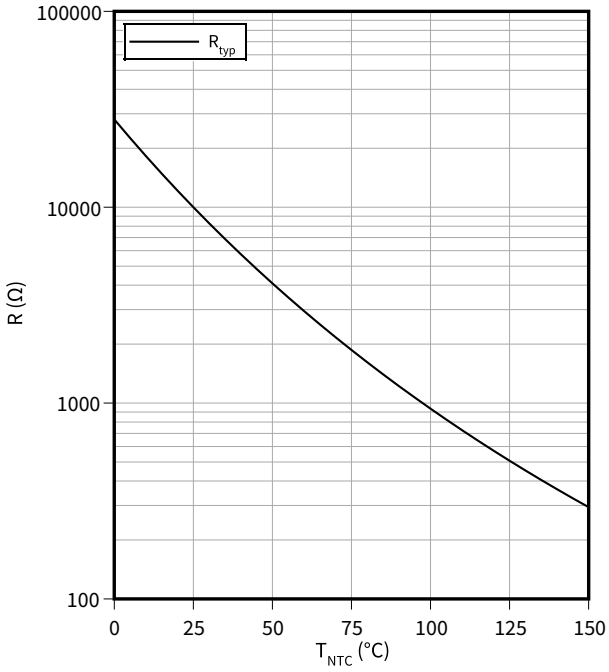
$V_{SD} = f(T_{vj})$

$I_{SD} = 35$ A




**Temperature characteristic (typical), NTC-Thermistor**

$R = f(T_{NTC})$



# 7 Circuit diagram

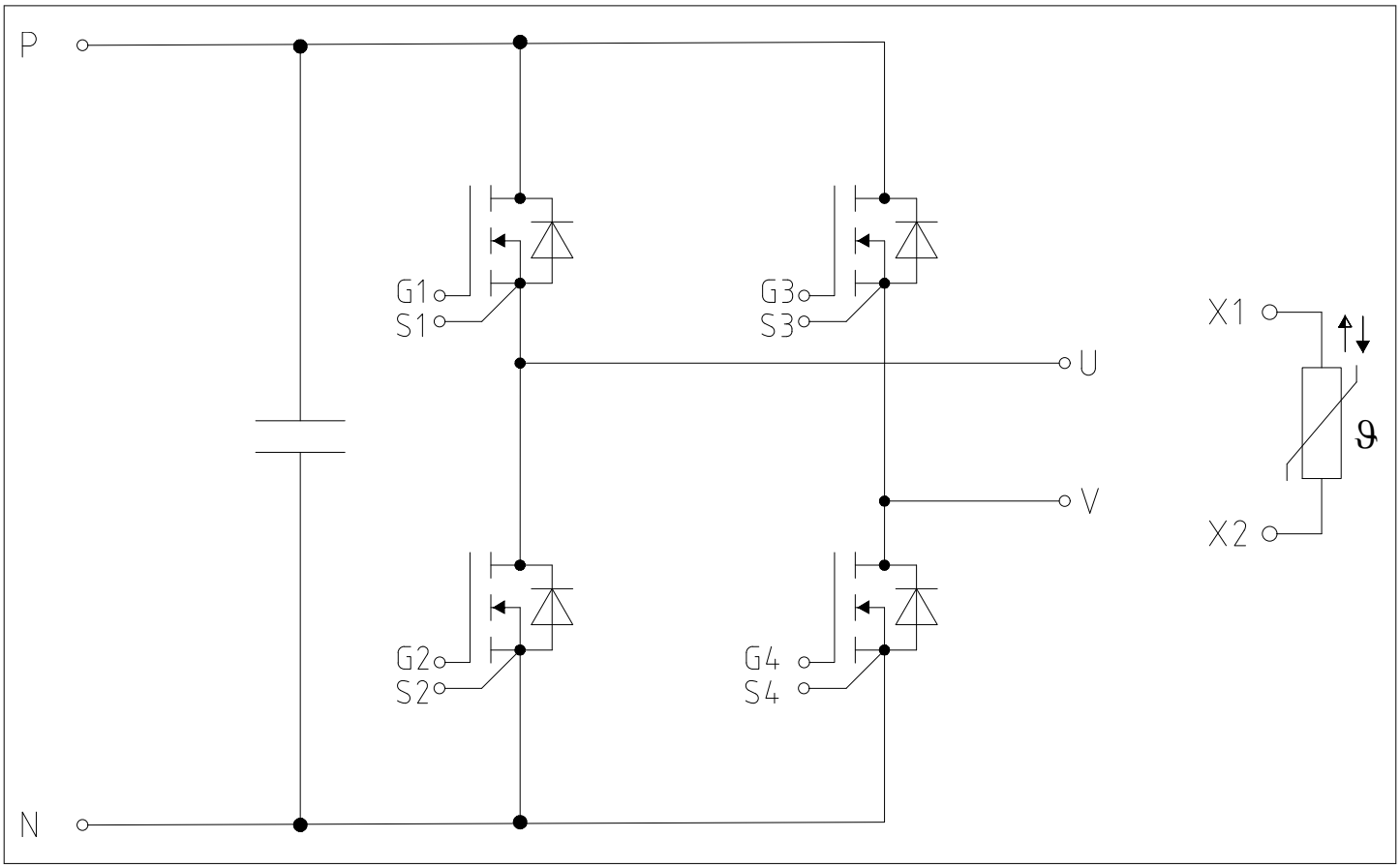



**Figure 1**

# 8 Package outlines

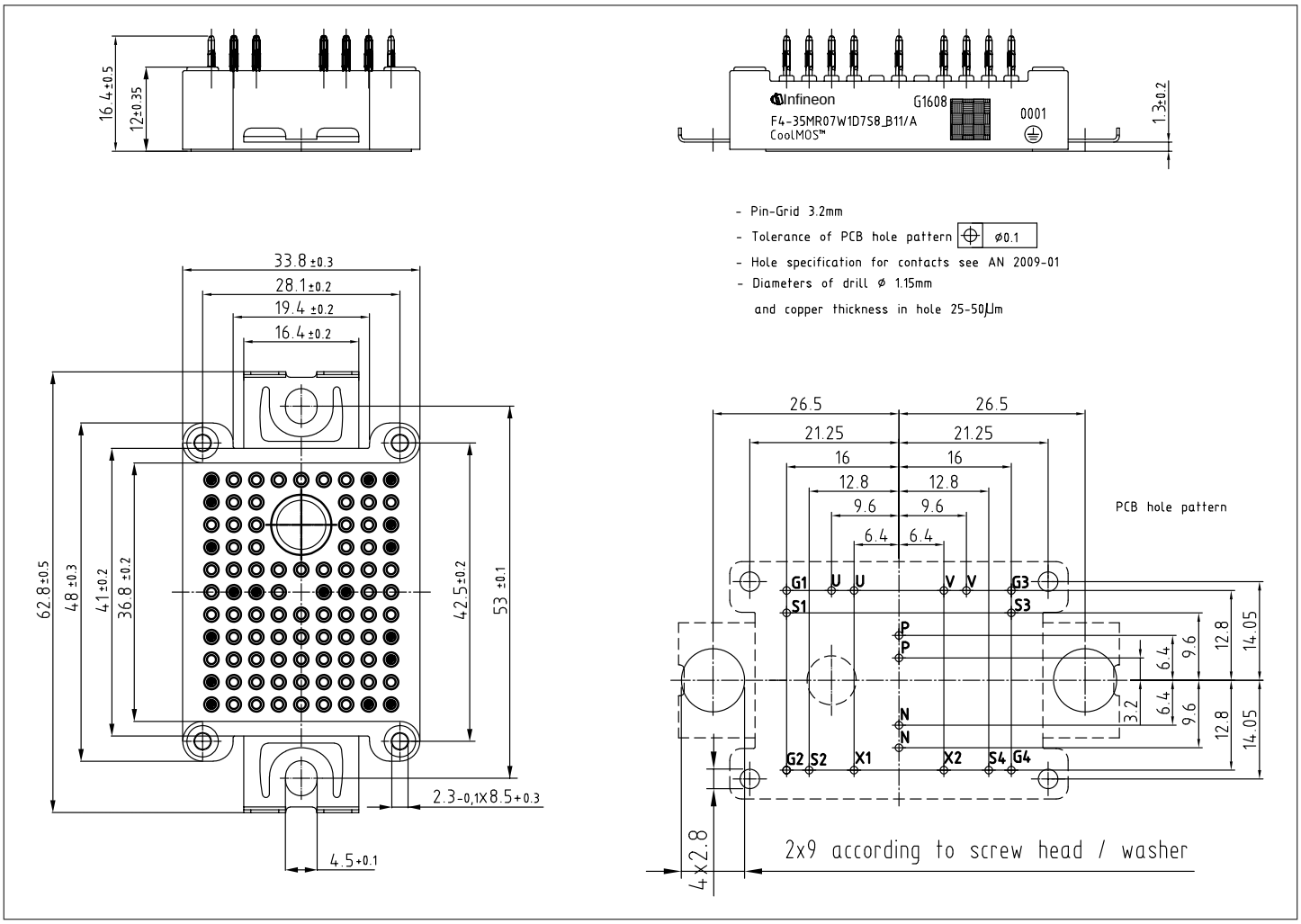



**Figure 2**

# 9 Module label code

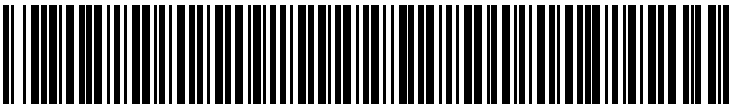
| Module label code | | | |
|---|---|---|---|
| Code format | Data Matrix | | Barcode Code128 |
| Encoding | ASCII text | | Code Set A |
| Symbol size | 16x16 | | 23 digits |
| Standard | IEC24720 and IEC16022 | | IEC8859-1 |
| Code content | *Content*<br>Module serial number<br>Module material number<br>Production order number<br>Date code (production year)<br>Date code (production week) | *Digit*<br>1 – 5<br>6 - 11<br>12 - 19<br>20 – 21<br>22 – 23 | *Example*<br>71549<br>142846<br>55054991<br>15<br>30 |
| Example |  715491428465505499115 30 | |  715491428465505499115 30 |

**Figure 3**

# Revision history

| Document revision | Date of release | Description of changes |
|---|---|---|
| 0.10 | 2022-03-17 | Initial version |
| 0.20 | 2022-06-20 | Preliminary datasheet |
| 1.00 | 2022-06-21 | Final datasheet |
| 1.10 | 2023-08-22 | 10424AERRA |

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