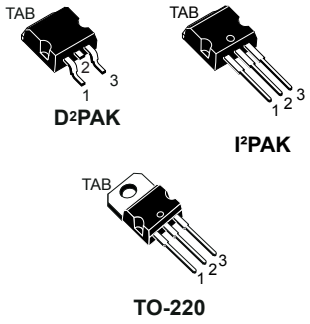
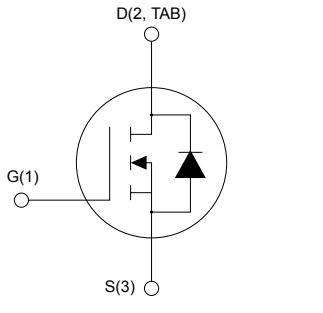
# STB20N65M5, STI20N65M5, STP20N65M5

Datasheet

## N-channel 650 V, 160 mΩ typ., 18 A MDmesh M5 Power MOSFETs in a D²PAK, I²PAK and TO-220 packages




## Features

| Order code | $V_{DS}$ | $R_{DS(on)}$ max. | $I_D$ |
|---|---|---|---|
| STB20N65M5 | 650 V | 190 mΩ | 18 A |
| STI20N65M5 | | | |
| STP20N65M5 | | | |

- Higher $V_{DSS}$ rating
- Higher dv/dt capability
- Excellent switching performance
- Extremely low $R_{DS(on)}$
- 100% avalanche tested

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs based on the MDmesh M5 innovative vertical process technology combined with the well-known PowerMESH horizontal layout. The resulting products offer extremely low on-resistance, making them particularly suitable for applications requiring high power and superior efficiency.

| Product status links |
|---|
| STB20N65M5 |
| STI20N65M5 |
| STP20N65M5 |

# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{GS}$ | Gate-source voltage | ±25 | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 18 | A |
| $I_D$ | Drain current (continuous) at $T_C$ = 100 °C | 11.3 | A |
| $I_{DM}$(1) | Drain current (pulsed) | 72 | A |
| $P_{TOT}$ | Total power dissipation at $T_C$ = 25 °C | 130 | W |
| dv/dt(2) | Peak diode recovery voltage slope | 15 | V/ns |
| $T_{stg}$ | Storage temperature range | -55 to 150 | °C |
| $T_J$ | Operating junction temperature range | | °C |

1. *Pulse width limited by safe operating area.*
2. *$I_{SD}$ ≤ 18 A, di/dt ≤ 400 A/µs; $V_{DS}$ (peak) < $V_{(BR)DSS}$, $V_{DD}$ = 400 V.*

**Table 2. Thermal data**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | $D^2PAK$ | $I^2PAK$ TO-220 | |
| $R_{thJC}$ | Thermal resistance, junction-to-case | 0.96 | | °C/W |
| $R_{thJA}$ | Thermal resistance, junction-to-ambient | 30(1) | 62.5 | °C/W |

1. *When mounted on a standard 1 inch$^2$ area of FR-4 PCB with 2-oz copper.*

**Table 3. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or not-repetitive (pulse width limited by $T_J$ max.) | 4 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 270 | mJ |

# 2 Electrical characteristics

$T_C$ = 25 °C unless otherwise specified.

**Table 4. On/off states**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D$ = 1 mA, $V_{GS}$ = 0 V | 650 | - | - | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 650 V | - | - | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 650 V, $T_C$ = 125 °C(1) | - | - | 100 | µA |
| $I_{GSS}$ | Gate body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±25 V | - | - | ±100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS}$ = $V_{GS}$, $I_D$ = 250 µA | 3 | 4 | 5 | V |
| $R_{DS(on)}$ | Static drain-source on-resistance | $V_{GS}$ = 10 V, $I_D$ = 9 A | - | 160 | 190 | mΩ |

1. *Specified by design, not tested in production.*

**Table 5. Dynamic**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $C_{iss}$ | Input capacitance | $V_{DS}$ = 100 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 1434 | - | pF |
| $C_{oss}$ | Output capacitance | | - | 38 | - | |
| $C_{rss}$ | Reverse transfer capacitance | | - | 3.7 | - | |
| $C_{o(tr)}$(1) | Equivalent output capacitance time related | $V_{DS}$ = 0 to 520 V, $V_{GS}$ = 0 V | - | 118 | - | pF |
| $C_{o(er)}$(2) | Equivalent output capacitance energy related | | - | 35 | - | pF |
| $R_g$ | Gate input resistance | f = 1 MHz open drain | - | 3.5 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 520 V, $I_D$ = 9 A, $V_{GS}$ = 0 to 10 V (see the Figure 15. Test circuit for gate charge behavior) | - | 36 | - | nC |
| $Q_{gs}$ | Gate-source charge | | - | 7.5 | - | |
| $Q_{gd}$ | Gate-drain charge | | - | 18 | - | |

1. *$C_{o(tr)}$ is an equivalent capacitance that provides the same charging time as Coss while $V_{DS}$ is rising from 0 V to the stated value.*
2. *$C_{o(er)}$ is an equivalent capacitance that provides the same stored energy as $C_{oss}$ while $V_{DS}$ is rising from 0 V to the stated value.*

**Table 6. Switching times**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $t_{d(off)}$ | Turn-off delay time | $V_{DD}$ = 400 V, $I_D$ = 12 A, $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see the Figure 16. Test circuit for inductive load switching and diode recovery times and Figure 19. Switching time waveform) | - | 43 | - | ns |
| $t_{r(v)}$ | Voltage rise time | | - | 7.5 | - | |
| $t_{c(off)}$ | Crossing time off | | - | 11.5 | - | |
| $t_{f(i)}$ | Current fall time | | - | 7.5 | - | |

**Table 7. Source-drain diode**

| Symbol | Parameter | Test condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $I_{SD}$ | Source-drain current | | - | - | 18 | A |
| $I_{SDM}$(1) | Source-drain current (pulsed) | | - | - | 72 | |
| $V_{SD}$(2) | Forward on voltage | $I_{SD}$ = 18 A, $V_{GS}$ = 0 V | - | - | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 18 A, di/dt = 100 A/µs<br>$V_{DD}$ = 100 V<br>(see the Figure 16. Test circuit for inductive load switching and diode recovery times) | - | 288 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 4 | - | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 27 | - | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 18 A, di/dt = 100 A/µs<br>$V_{DD}$ = 100 V, $T_J$ = 150 °C<br>(see the Figure 16. Test circuit for inductive load switching and diode recovery times) | - | 342 | - | ns |
| $Q_{rr}$ | Reverse recovery charge | | - | 4.7 | - | µC |
| $I_{RRM}$ | Reverse recovery current | | - | 28 | - | A |

1. *Pulse width limited by safe operating area.*
2. *Pulsed: pulse duration = 300 µs, duty cycle 1.5%.*

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area**

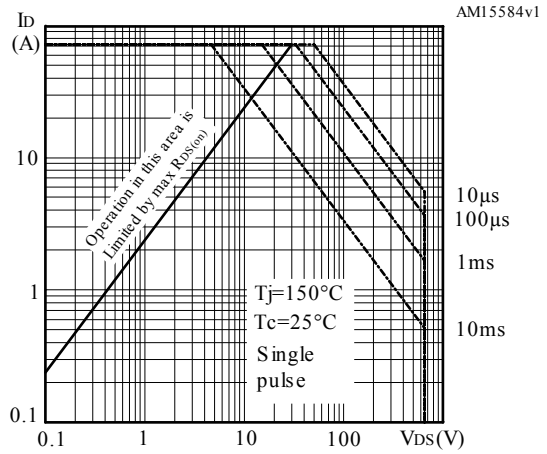



**Figure 2. Normalized transient thermal impedance**

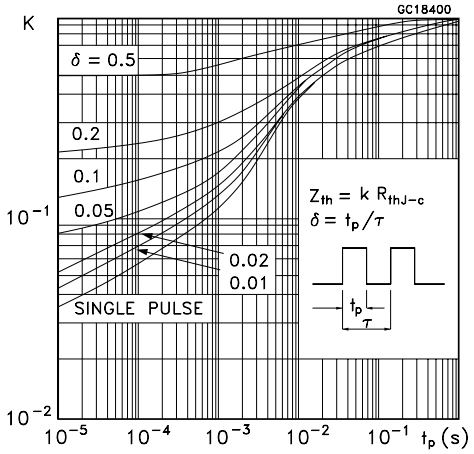



**Figure 3. Output characterisics**

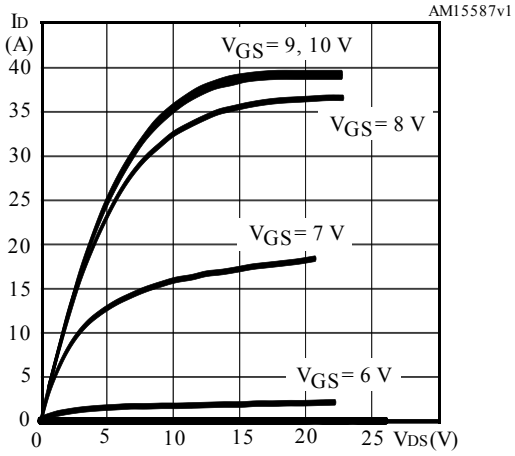



**Figure 4. Transfer characteristics**

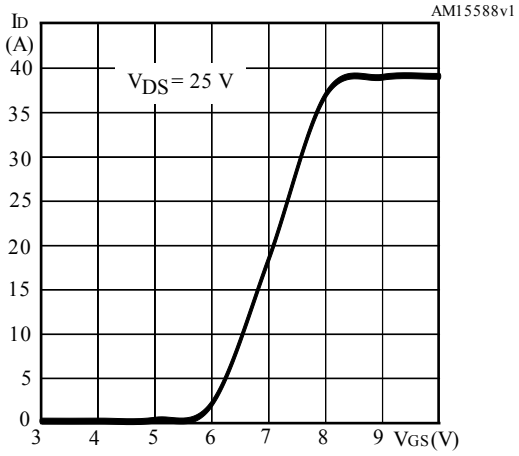



**Figure 5. Gate charge vs gate-source voltage**

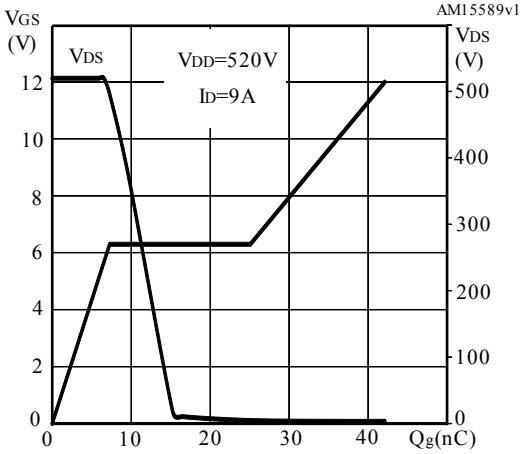



**Figure 6. Static drain-source on-resistance**

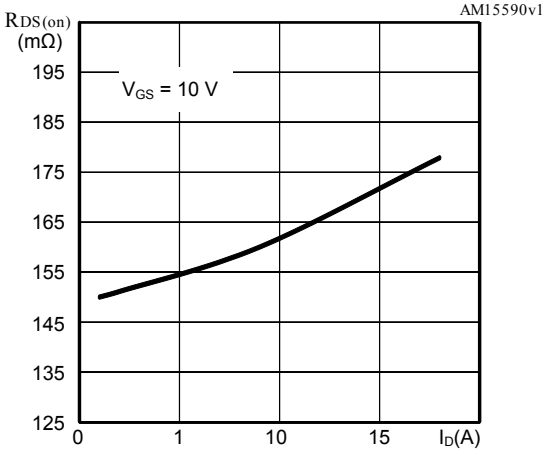


**Figure 7. Capacitance variations**

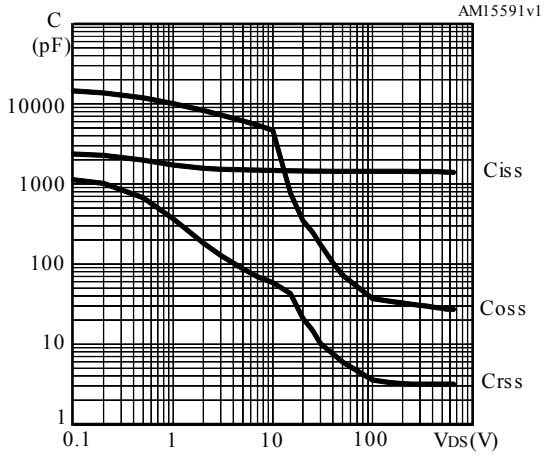



**Figure 8. Output capacitance stored energy**

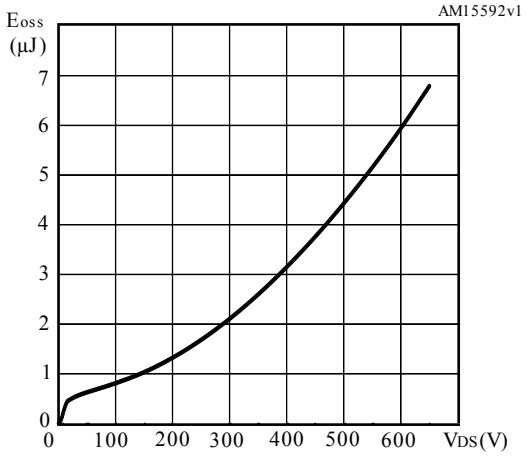



**Figure 9. Normalized gate threshold voltage vs temperature**

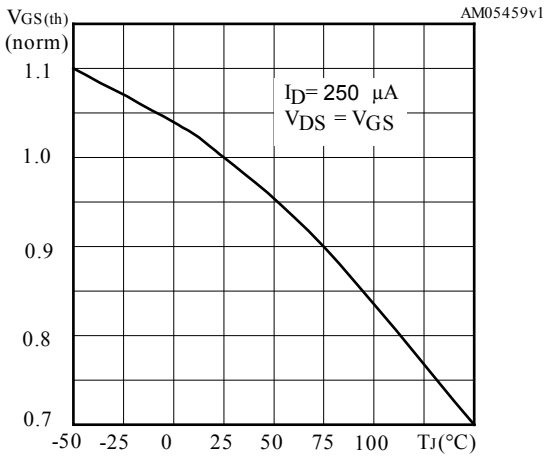



**Figure 10. Normalized on-resistance vs temperature**

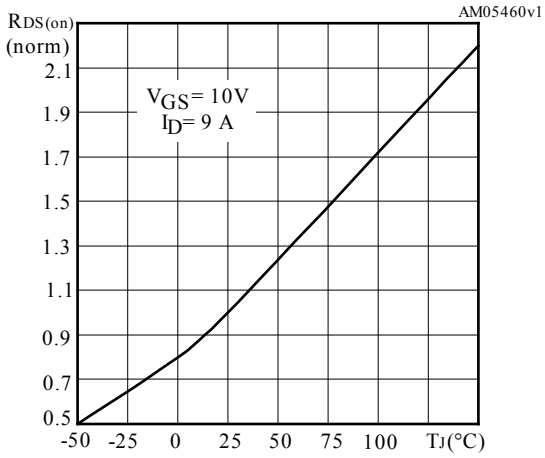



**Figure 11. Normalized $V_{(BR)DSS}$ vs temperature**

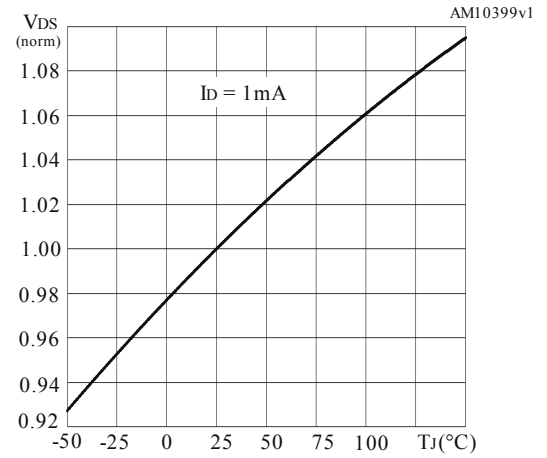



**Figure 12. Drain-source diode forward characteristics**

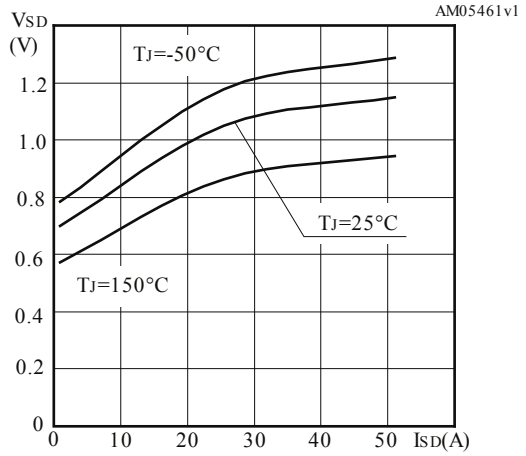
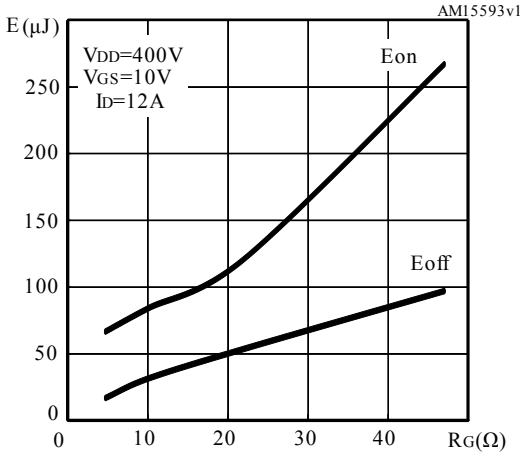


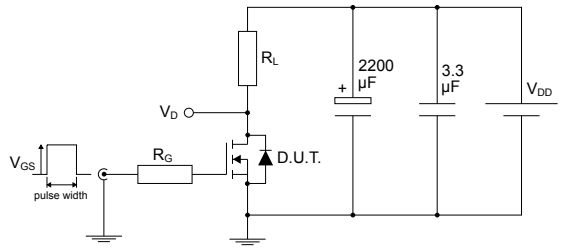
**Figure 13. Switching energy vs gate resistance**




*Note: $E_{on}$ including reverse recovery of a SiC diode.*

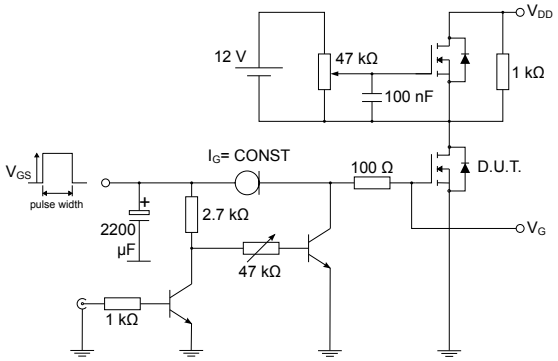
# 3 Test circuits

**Figure 14. Test circuit for resistive load switching times**



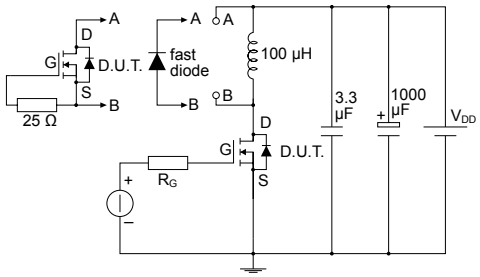

AM01468v1

**Figure 15. Test circuit for gate charge behavior**



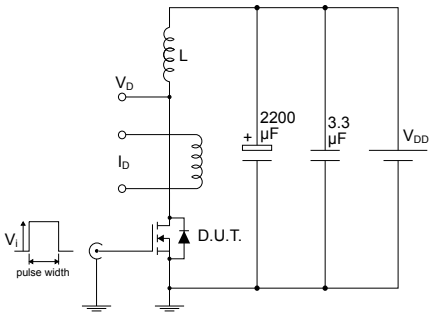

AM01469v1

**Figure 16. Test circuit for inductive load switching and diode recovery times**



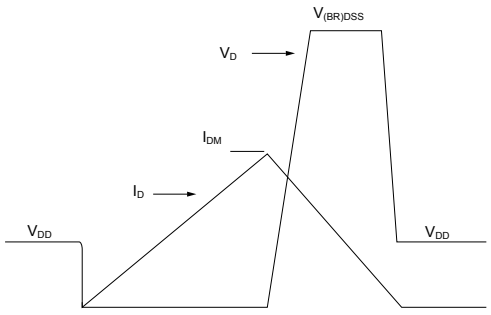

AM01470v1

**Figure 17. Unclamped inductive load test circuit**



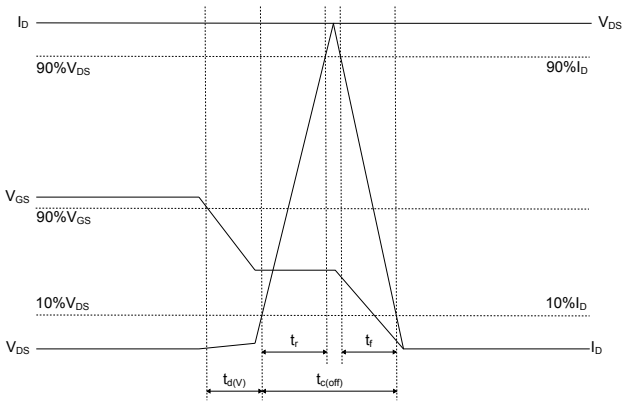

AM01471v1

**Figure 18. Unclamped inductive waveform**




AM01472v1

**Figure 19. Switching time waveform**




AM05540v2

# 4 Package information

To meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions, and product status are available at: www.st.com. ECOPACK is an ST trademark.

## 4.1 D²PAK (TO-263) type A package information

Figure 20. **D²PAK (TO-263) type A package outline**

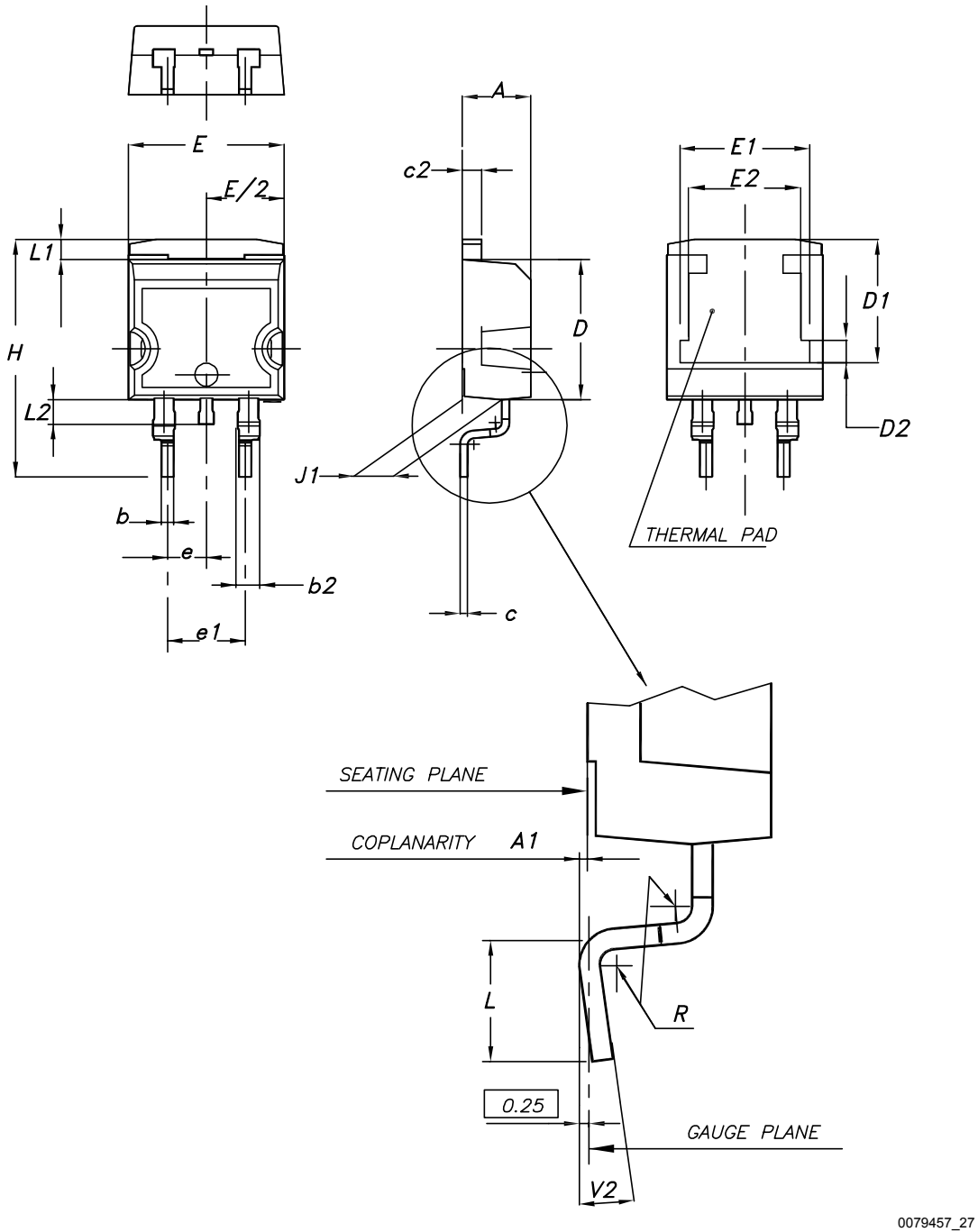
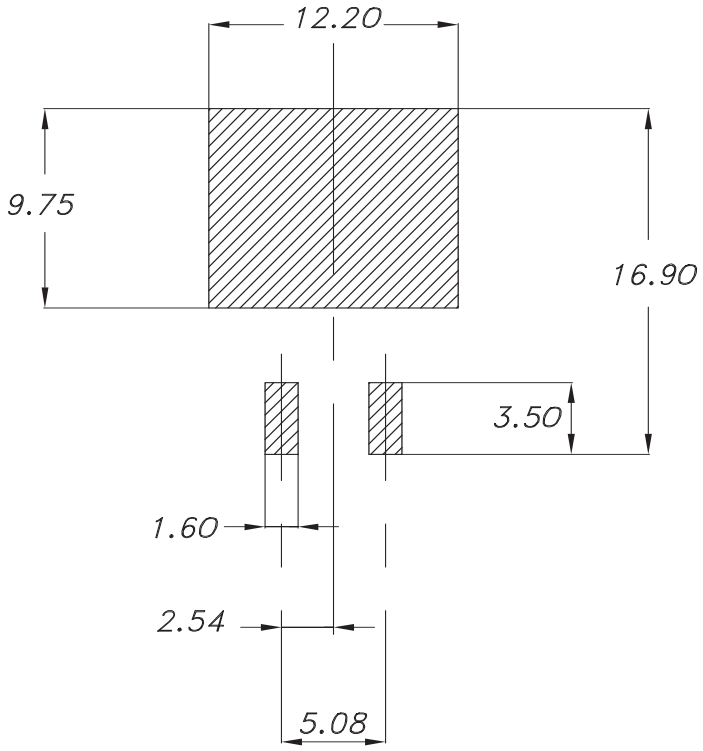


Table 8. D²PAK (TO-263) type A package mechanical data

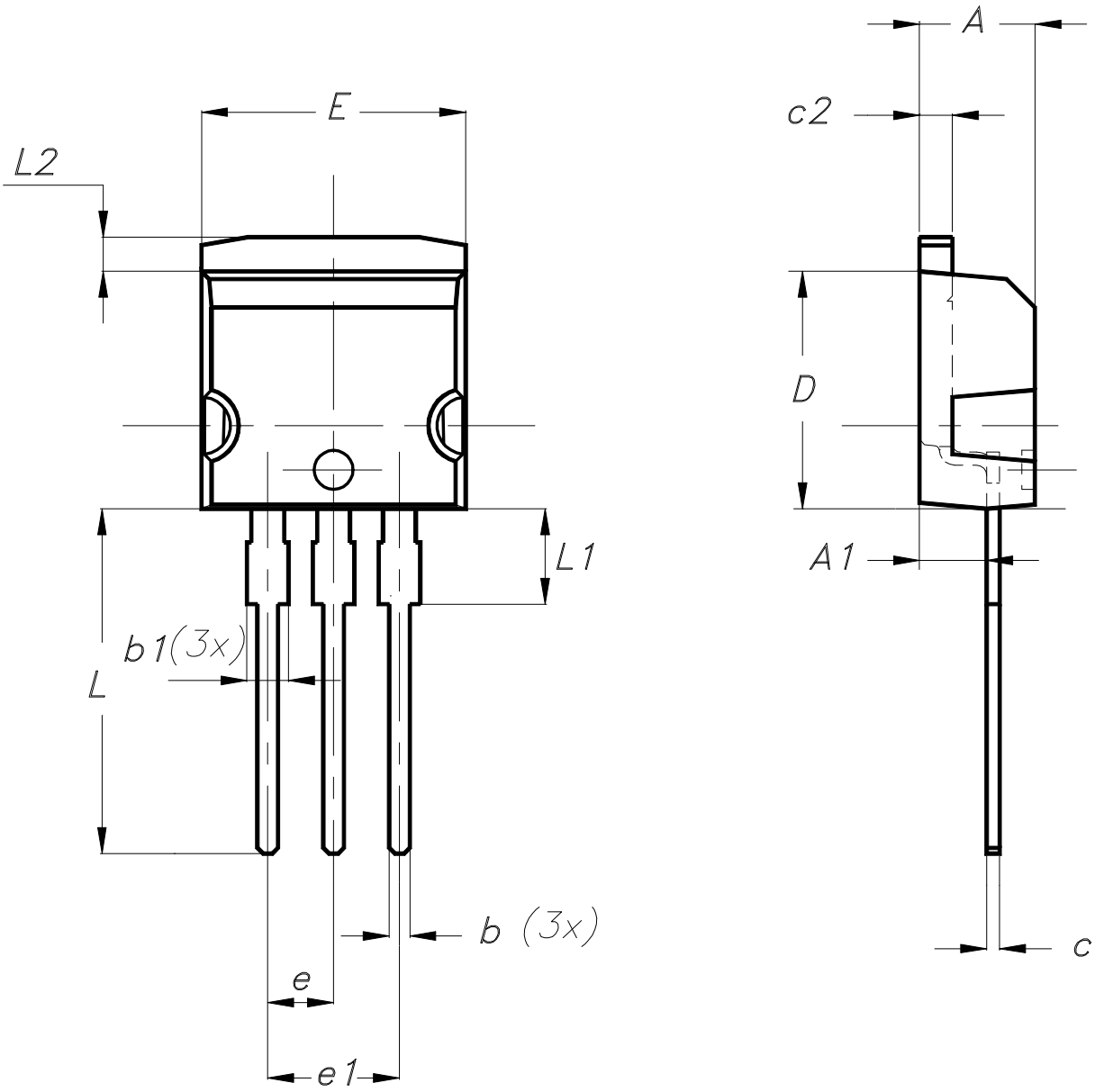
| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| A1 | 0.03 | | 0.23 |
| b | 0.70 | | 0.93 |
| b2 | 1.14 | | 1.70 |
| c | 0.45 | | 0.60 |
| c2 | 1.23 | | 1.36 |
| D | 8.95 | | 9.35 |
| D1 | 7.50 | 7.75 | 8.00 |
| D2 | 1.10 | 1.30 | 1.50 |
| E | 10.00 | | 10.40 |
| E1 | 8.30 | 8.50 | 8.70 |
| E2 | 6.85 | 7.05 | 7.25 |
| e | | 2.54 | |
| e1 | 4.88 | | 5.28 |
| H | 15.00 | | 15.85 |
| J1 | 2.49 | | 2.69 |
| L | 2.29 | | 2.79 |
| L1 | 1.27 | | 1.40 |
| L2 | 1.30 | | 1.75 |
| R | | 0.40 | |
| V2 | 0° | | 8° |

Figure 21. D²PAK (TO-263) recommended footprint (dimensions are in mm)



## 4.2 I²PAK package information

Figure 22. I²PAK package outline




0004982_Rev_10

Table 9. I²PAK package mechanical data

| Dim. | mm | |
|---|---|---|
| | Min. | Max. |
| A | 4.40 | 4.60 |
| A1 | 2.40 | 2.72 |
| b | 0.61 | 0.88 |
| b1 | 1.14 | 1.70 |
| c | 0.49 | 0.70 |
| c2 | 1.23 | 1.32 |
| D | 8.95 | 9.35 |
| e | 2.40 | 2.70 |
| e1 | 4.95 | 5.15 |
| E | 10.00 | 10.40 |
| L | 13.00 | 14.00 |
| L1 | 3.50 | 3.93 |
| L2 | 1.27 | 1.40 |

## 4.3 TO-220 type A package information

Figure 23. **TO-220 type A package outline**

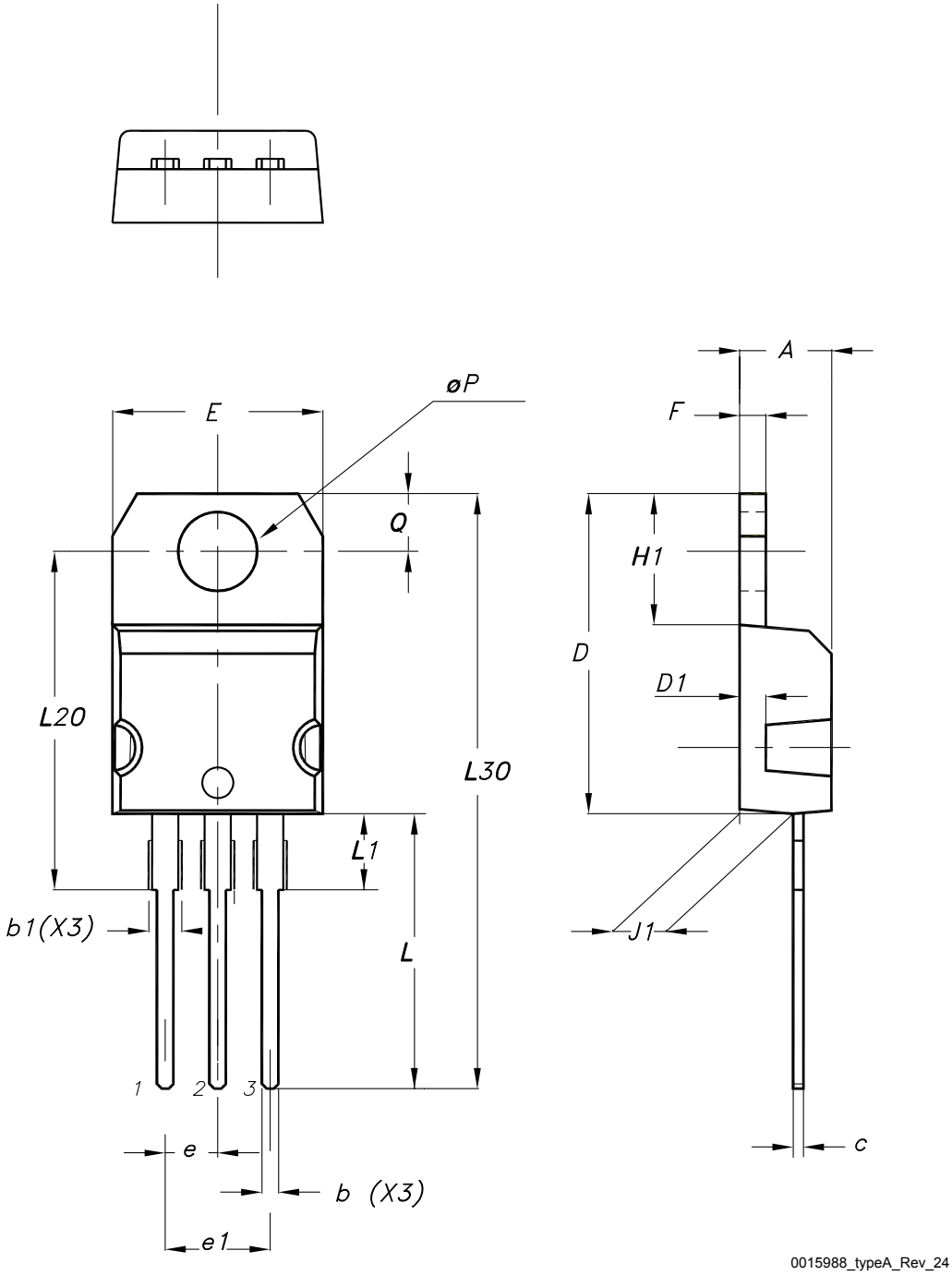
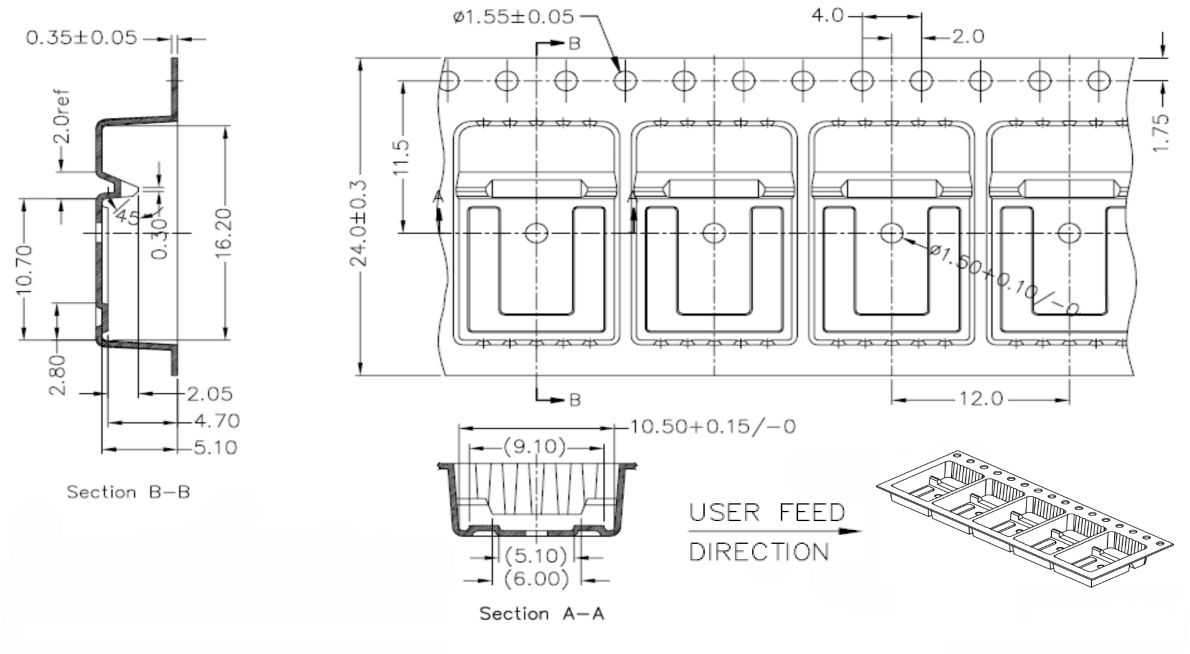


Table 10. **TO-220 type A package mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.40 | | 4.60 |
| b | 0.61 | | 0.88 |
| b1 | 1.14 | | 1.55 |
| c | 0.48 | | 0.70 |
| D | 15.25 | | 15.75 |
| D1 | | 1.27 | |
| E | 10.00 | | 10.40 |
| e | 2.40 | | 2.70 |
| e1 | 4.95 | | 5.15 |
| F | 1.23 | | 1.32 |
| H1 | 6.20 | | 6.60 |
| J1 | 2.40 | | 2.72 |
| L | 13.00 | | 14.00 |
| L1 | 3.50 | | 3.93 |
| L20 | | 16.40 | |
| L30 | | 28.90 | |
| øP | 3.75 | | 3.85 |
| Q | 2.65 | | 2.95 |
| Slug flatness | | 0.03 | 0.10 |

## 4.4 D²PAK packing information

Figure 24. **D²PAK tape drawing (dimensions are in mm)**




DM01095771_2

# 5 Ordering information

Table 11. **Order codes**

| Order codes | Marking | Package | Packing |
|---|---|---|---|
| STB20N65M5 | 20N65M5 | D²PAK | Tape and reel |
| STI20N65M5 | | I²PAK | Tube |
| STP20N65M5 | | TO-220 | |

## Revision history

Table 12. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 06-Mar-2012 | 1 | First release. |
| 01-Feb-2013 | 2 | The part numbers STF20N65M5 and STFI20N65M5 have been moved to a separate datasheet.<br>Added: part numbers STB20N65M5 and STI20N65M5.<br>Modified: *note1* on *Table 2*, *Table 4* values and typical values of *Table 5*, *6*, *7*, *8*.<br>Added: $R_{thj\text{-}pcb}$ and *note1* on *Table 3*.<br>Updated: *Section 4: Package mechanical data*.<br>Added: *Section 2.1: Electrical characteristics (curves)*. |
| 25-Jul-2025 | 3 | Removed order code STW20N65M5.<br>Updated Section 4: Package information.<br>Minor text changes. |

# Contents