# N-channel 600 V, 0.4 Ω typ., 11 A, MDmesh™ II Power MOSFETs in D²PAK and TO-220 packages

TAB

TAB

**D²PAK**

**TO-220**

D(2, TAB)

G(1)

S(3)

AM01475v1_noZen
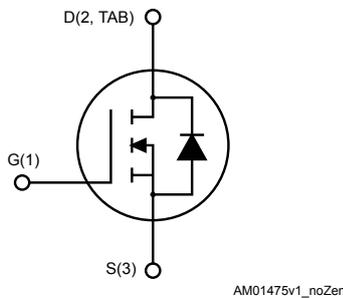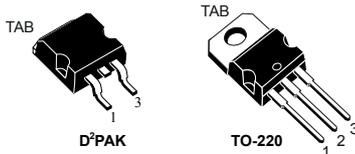
## Features

| Order codes | $V_{DSS}$ (@ $T_{Jmax}$) | $R_{DS(on)}$ max. | $I_D$ | Package |
|---|---|---|---|---|
| STB11NM60T4 | 650 V | 0.45 Ω | 11 A | D²PAK |
| STP11NM60 | | | | TO-220 |

- 100% avalanche tested
- Low input capacitance and gate charge
- Low gate input resistance

## Applications

- Switching applications

## Description

These devices are N-channel Power MOSFETs developed using the second generation of MDmesh™ technology. These revolutionary Power MOSFETs associate a vertical structure to the company's strip layout to yield one of the world's lowest on-resistance and gate charge. They are therefore suitable for the most demanding high-efficiency converters.

| Product status link |
|---|
| STB11NM60T4 |
| STP11NM60 |

| Product summary | |
|---|---|
| Order code | **STB11NM60T4** |
| **Marking** | B11NM60 |
| **Package** | D²PAK |
| **Packing** | Tape and reel |
| Order code | **STP11NM60** |
| **Marking** | P11NM60 |
| **Package** | TO-220 |
| **Packing** | Tube |

**DS3653 - Rev 7 - October 2018**
For further information contact your local STMicroelectronics sales office.

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# 1 Electrical ratings

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{DS}$ | Gate-source voltage | 600 | V |
| $V_{GS}$ | Gate- source voltage | ±30 | V |
| $I_D$ | Drain current (continuous) at $T_C$ = 25 °C | 11 | A |
| $I_D$ | Drain current (continuous) at $T_C$= 100 °C | 7 | |
| $I_{DM}$ [1] | Drain current (pulsed) | 44 | A |
| $P_{TOT}$ | Total dissipation at $T_C$ = 25 °C | 160 | W |
| dv/dt [2] | Peak diode recovery voltage slope | 15 | V/ns |
| $T_{stg}$ | Storage temperature range | -65 to 150 | °C |
| $T_j$ | Operating junction temperature range | | |

1. *Pulse width limited by safe operating area.*
2. *$I_{SD} ≤ 11 A$, $di/dt ≤ 400 A/µs$, $V_{DD} ≤ V_{(BR)DSS}$, $T_j ≤ T_{JMAX}$.*

**Table 2. Thermal data**

| Symbol | Parameter | Value | | Unit |
|---|---|---|---|---|
| | | D²PAK | TO-220 | |
| $R_{thj-case}$ | Thermal resistance junction-case | 0.78 | | °C/W |
| $R_{thj-amb}$ | Thermal resistance junction-ambient | | 62.5 | |
| $R_{thj-pcb}$ [1] | Thermal resistance junction-pcb | 35 | | |

1. *When mounted on 1inch² FR-4 board, 2 oz Cu.*

**Table 3. Avalanche characteristics**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $I_{AR}$ | Avalanche current, repetitive or non-repetitive (pulse width limited by $T_{jmax}$) | 5.5 | A |
| $E_{AS}$ | Single pulse avalanche energy (starting $T_j$ = 25 °C, $I_D$ = $I_{AR}$, $V_{DD}$ = 50 V) | 350 | mJ |

# 2 Electrical characteristics

($T_C$ = 25 °C unless otherwise specified).

**Table 4. On/off states**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $V_{GS}$ = 0 V, $I_D$ = 250 µA | 600 | | | V |
| $I_{DSS}$ | Zero gate voltage drain current | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V | | | 1 | µA |
| | | $V_{GS}$ = 0 V, $V_{DS}$ = 600 V, $T_C$ = 125 °C[1] | | | 10 | µA |
| $I_{GSS}$ | Gate-body leakage current | $V_{DS}$ = 0 V, $V_{GS}$ = ±30 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, $I_D$ = 5.5 A | | 0.4 | 0.45 | Ω |

1. Defined by design, not subject to production test.

**Table 5. Dynamic**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $C_{iss}$ | Input capacitance | | - | 1000 | - | pF |
| $C_{oss}$ | Output capacitance | $V_{DS}$= 25 V, f = 1 MHz, $V_{GS}$ = 0 V | - | 230 | - | pF |
| $C_{rss}$ | Reverse transfer capacitance | | - | 25 | - | pF |
| $C_{oss\ eq.}$ [1] | Equivalent output capacitance | $V_{DS}$ = 0 V to 480 V, $V_{GS}$ = 0 V | - | 100 | - | pF |
| $R_G$ | Intrinsic gate resistance | f = 1 MHz open drain | - | 1.6 | - | Ω |
| $Q_g$ | Total gate charge | $V_{DD}$ = 480 V, $I_D$ = 11 A, | - | 30 | - | nC |
| $Q_{gs}$ | Gate-source charge | $V_{GS}$ = 0 to 10 V | - | 10 | - | nC |
| $Q_{gd}$ | Gate-drain charge | (see Figure 12. Test circuit for gate charge behavior) | - | 15 | - | nC |

1. $C_{oss\ eq.}$ is defined as a constant equivalent capacitance giving the same charging time as $C_{oss}$ when $V_{DS}$ increases from 0 to 80% $V_{DSS}$

**Table 6. Switching times**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | $V_{DD}$ = 300 V, $I_D$ = 5.5 A, | - | 20 | - | ns |
| $t_r$ | Rise time | $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see Figure 11. Test circuit for resistive load switching times and Figure 16. Switching time waveform) | - | 20 | - | ns |
| $t_{r(Voff)}$ | Off-voltage rise time | $V_{DD}$ = 480 V, $I_D$ = 11 A, | - | 6 | - | ns |
| $t_f$ | Fall time | $R_G$ = 4.7 Ω, $V_{GS}$ = 10 V (see Figure 13. Test circuit for inductive load switching and diode recovery times and Figure 16. Switching time waveform) | - | 11 | - | ns |
| $t_c$ | Cross-over time | | - | 19 | - | ns |

**Table 7. Source drain diode**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------|-----------|-----------------|------|------|------|------|
| $I_{SD}$ | Source-drain current | | - | | 11 | A |
| $I_{SDM}$[1] | Source-drain current (pulsed) | | - | | 44 | A |
| $V_{SD}$ [2] | Forward on voltage | $V_{GS}$ = 0 V, $I_{SD}$ = 11 A | - | | 1.5 | V |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 11 A, di/dt = 100 A/μs, | - | 390 | | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_{DD}$ = 100 V | - | 3.8 | | μC |
| $I_{RRM}$ | Reverse recovery current | (see Figure 13. Test circuit for inductive load switching and diode recovery times) | - | 19.5 | | A |
| $t_{rr}$ | Reverse recovery time | $I_{SD}$ = 11 A, di/dt = 100 A/μs, | - | 570 | | ns |
| $Q_{rr}$ | Reverse recovery charge | $V_{DD}$ = 100 V, $T_j$ = 150 °C | - | 5.7 | | μC |
| $I_{RRM}$ | Reverse recovery current | (see Figure 13. Test circuit for inductive load switching and diode recovery times) | - | 20 | | A |

1.  *Pulse width is limited by safe operating area*

2.  *Pulse test: pulse duration = 300 μs, duty cycle 1.5%*

## 2.1 Electrical characteristics (curves)

**Figure 1. Safe operating area**
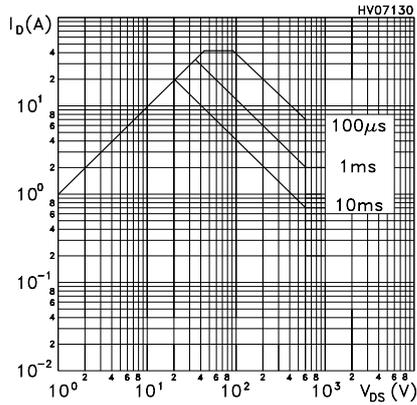


**Figure 2. Thermal impedance**
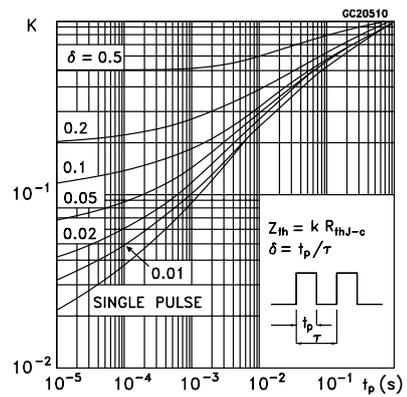


**Figure 3. Output characteristics**
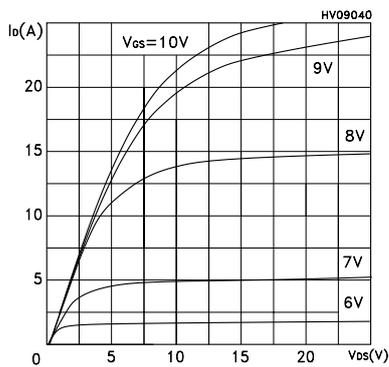


**Figure 4. Transfer characteristics**
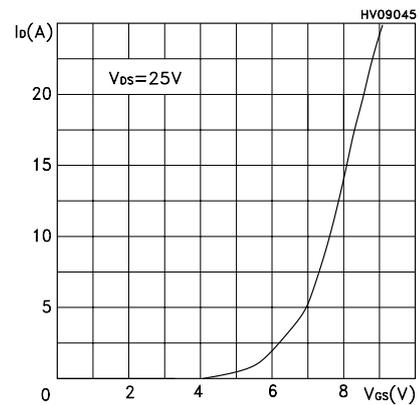


**Figure 5. Normalized gate threshold voltage vs temperature**
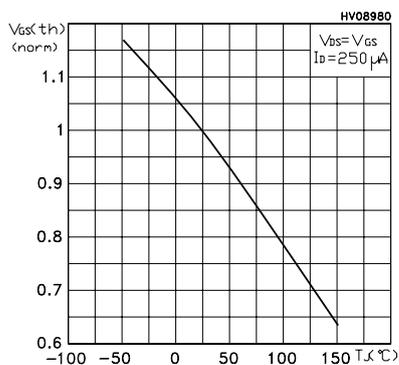


**Figure 6. Static drain-source on-resistance**
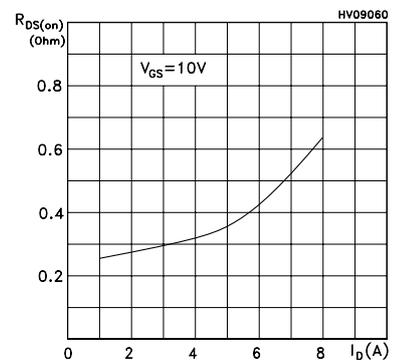
**Figure 7. Normalized on-resistance vs temperature**
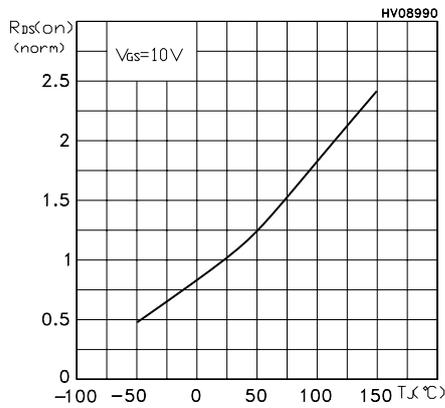


**Figure 8. Gate charge vs gate-source voltage**
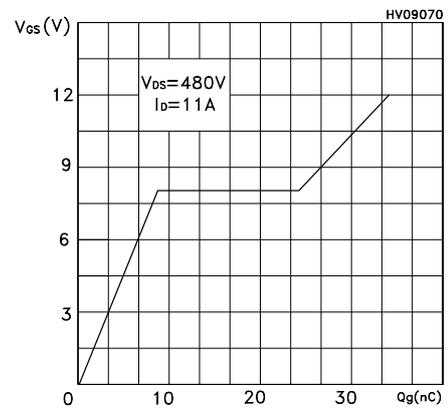


**Figure 9. Capacitance variations**
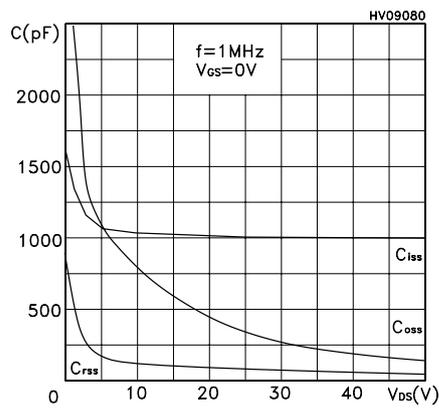


**Figure 10. Source-drain diode forward characteristics**
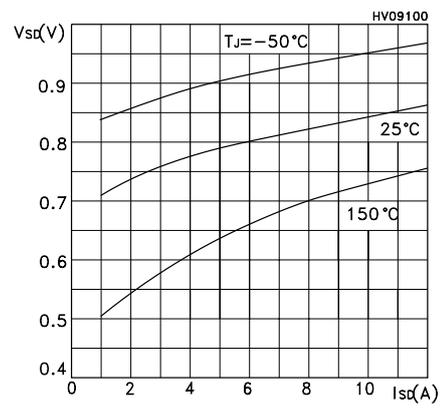
# 3 Test circuits

**Figure 11. Test circuit for resistive load switching times**
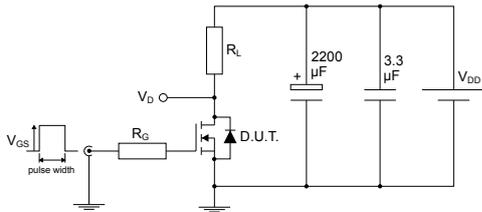


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**Figure 12. Test circuit for gate charge behavior**
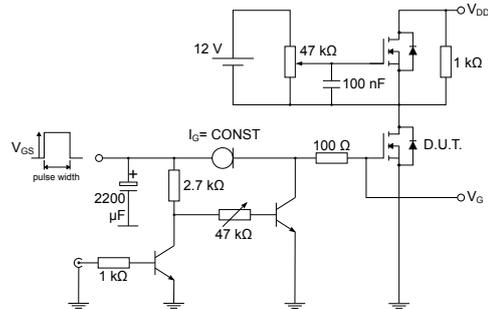


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**Figure 13. Test circuit for inductive load switching and diode recovery times**
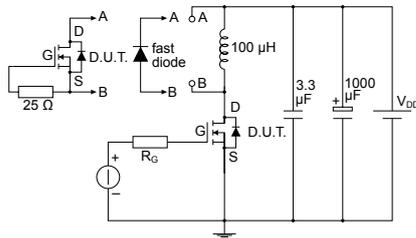


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**Figure 14. Unclamped inductive load test circuit**
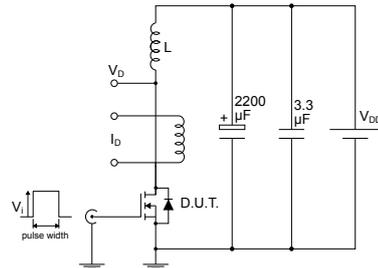


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**Figure 15. Unclamped inductive waveform**
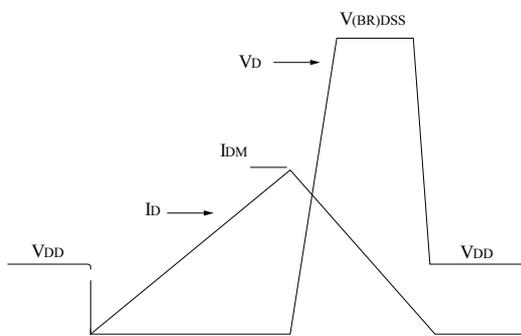


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**Figure 16. Switching time waveform**
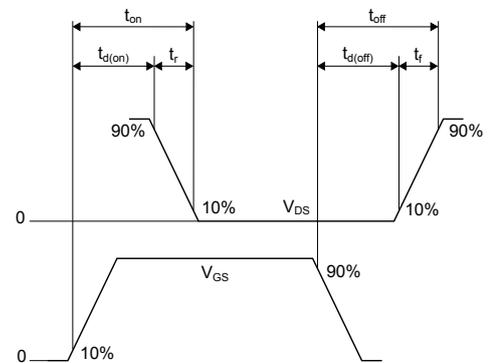


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# 4    Package information

In order 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 17. D²PAK (TO-263) type A package outline**
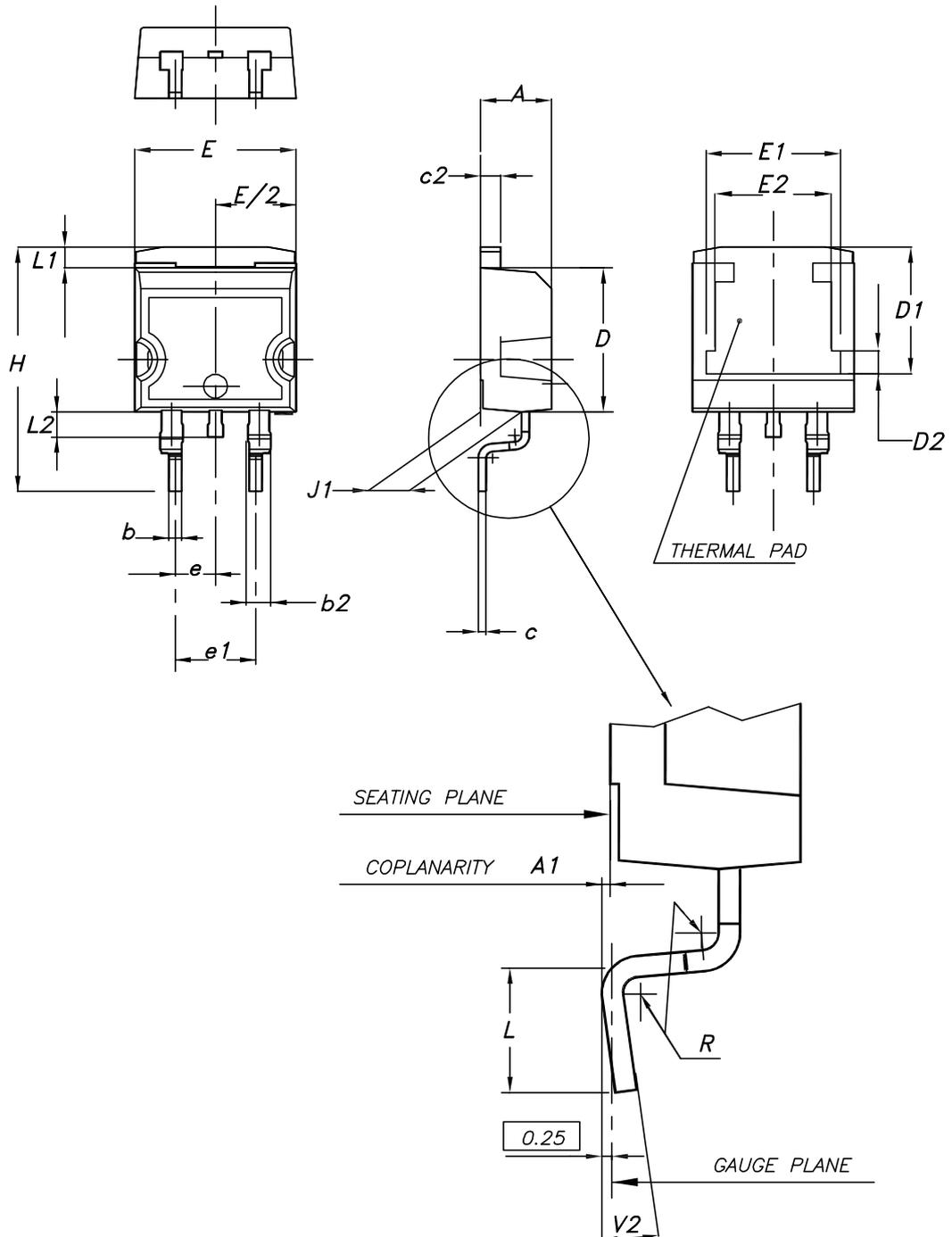


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**Table 8. D²PAK (TO-263) type A package mechanical data**

| 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° |

## 4.2 D²PAK packing information

**Figure 18. D²PAK tape outline**
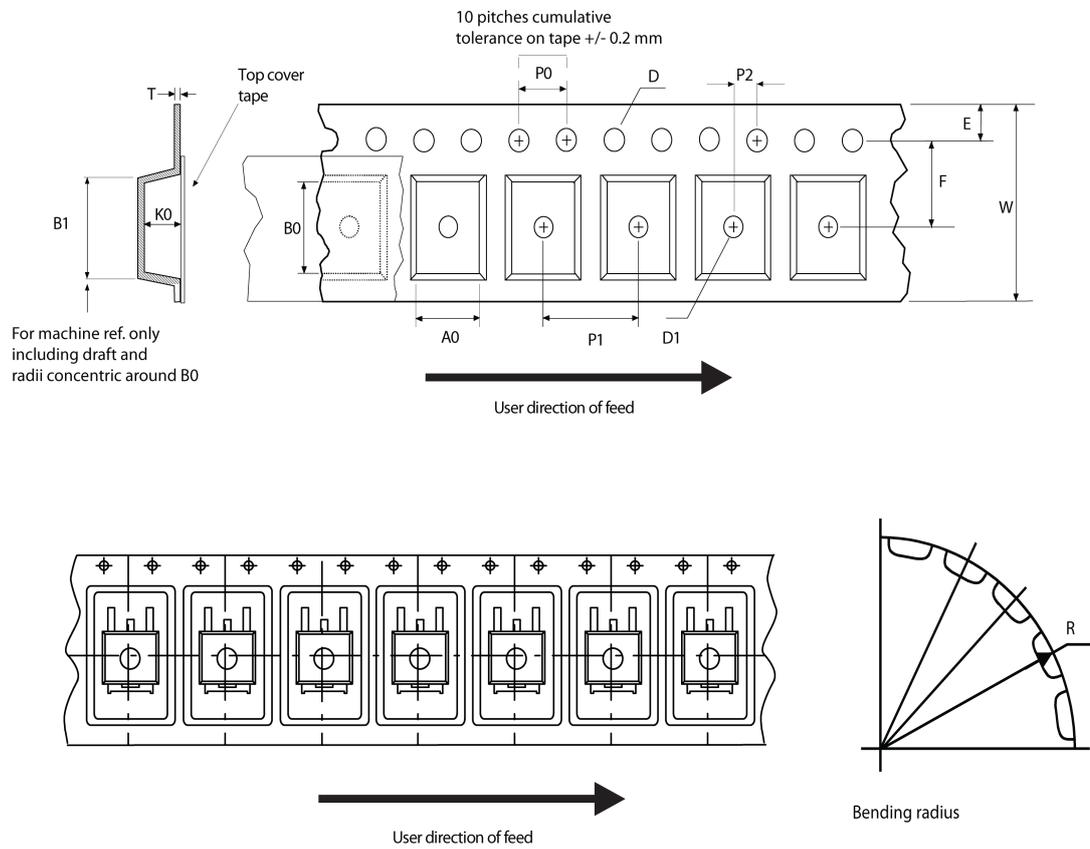


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**Figure 19. D²PAK reel outline**



40mm min. access hole at slot location

Tape slot in core for tape start 2.5mm min.width

Full radius

G measured at hub
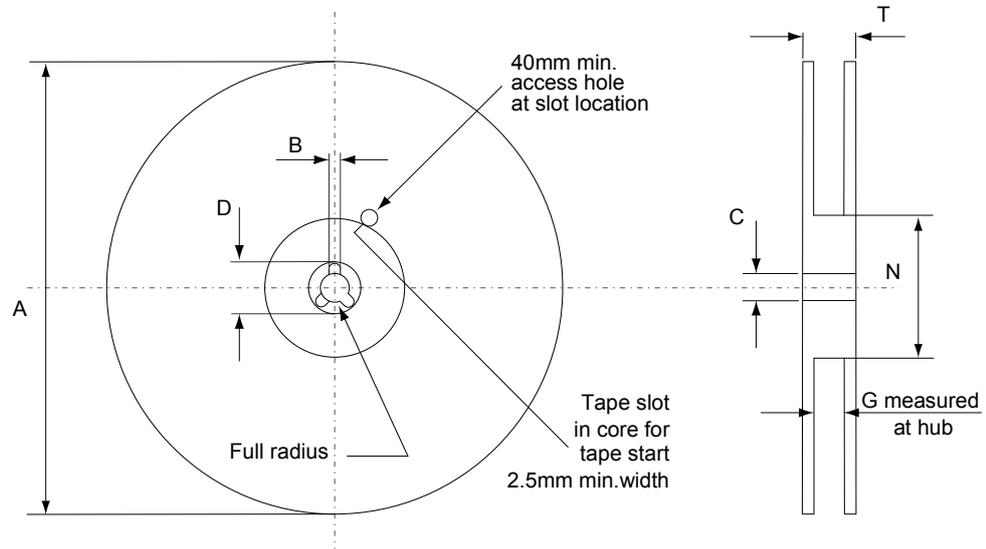
AM06038v1

**Table 9. D²PAK tape and reel mechanical data**

| Tape | | | Reel | | |
|---|---|---|---|---|---|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 10.5 | 10.7 | A | | 330 |
| B0 | 15.7 | 15.9 | B | 1.5 | |
| D | 1.5 | 1.6 | C | 12.8 | 13.2 |
| D1 | 1.59 | 1.61 | D | 20.2 | |
| E | 1.65 | 1.85 | G | 24.4 | 26.4 |
| F | 11.4 | 11.6 | N | 100 | |
| K0 | 4.8 | 5.0 | T | | 30.4 |
| P0 | 3.9 | 4.1 | | | |
| P1 | 11.9 | 12.1 | Base quantity | | 1000 |
| P2 | 1.9 | 2.1 | Bulk quantity | | 1000 |
| R | 50 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 23.7 | 24.3 | | | |

## 4.3    D²PAK (TO-263) type B package information

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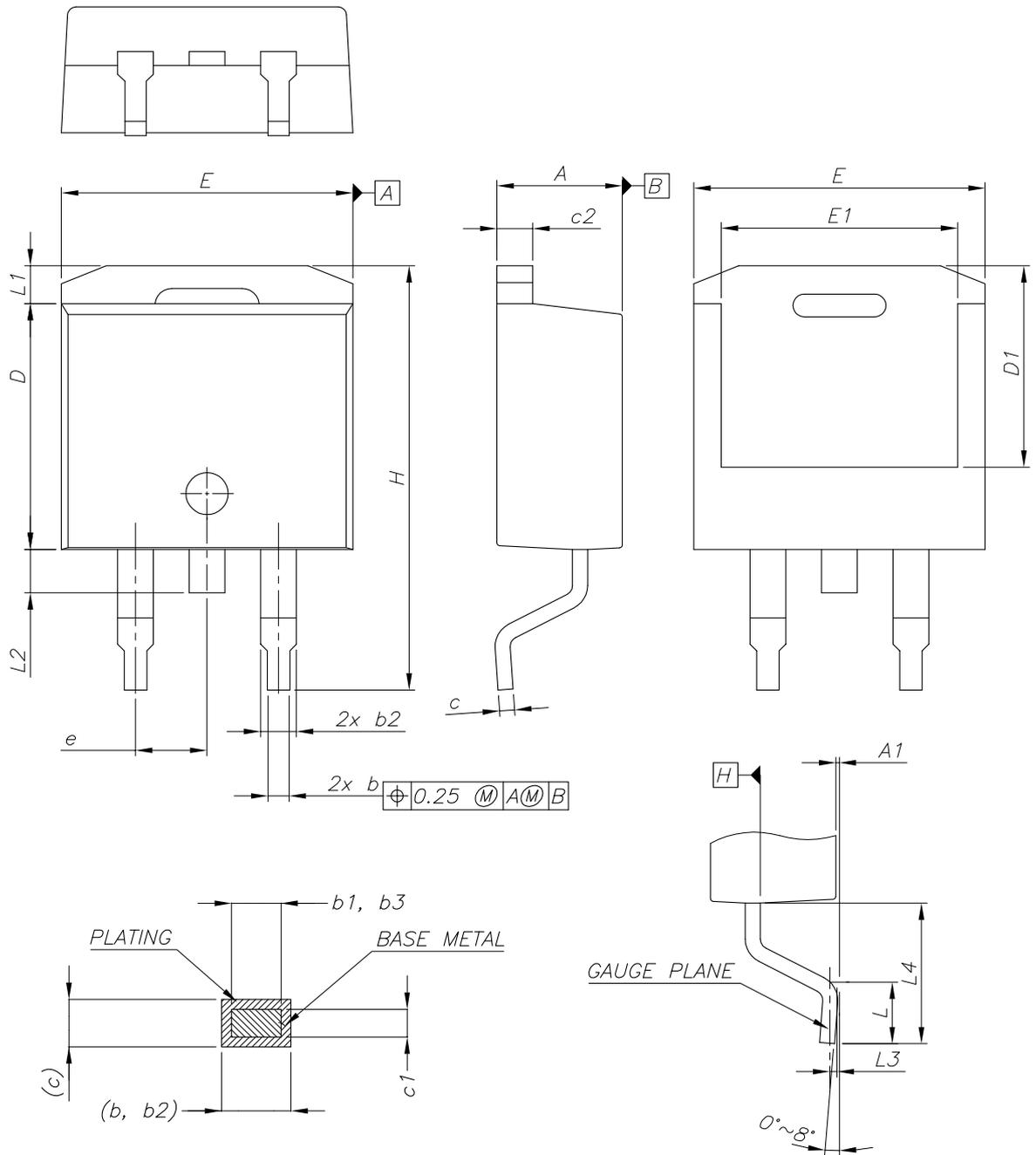


0079457_25_B

**Table 10. D²PAK (TO-263) type B mechanical data**

| Dim. | mm | | |
|---|---|---|---|
| | Min. | Typ. | Max. |
| A | 4.36 | | 4.56 |
| A1 | 0 | | 0.25 |
| b | 0.70 | | 0.90 |
| b1 | 0.51 | | 0.89 |
| b2 | 1.17 | | 1.37 |
| b3 | 1.36 | | 1.46 |
| c | 0.38 | | 0.694 |
| c1 | 0.38 | | 0.534 |
| c2 | 1.19 | | 1.34 |
| D | 8.60 | | 9.00 |
| D1 | 6.90 | | 7.50 |
| E | 10.15 | | 10.55 |
| E1 | 8.10 | | 8.70 |
| e | 2.54 BSC | | |
| H | 15.00 | | 15.60 |
| L | 1.90 | | 2.50 |
| L1 | | | 1.65 |
| L2 | | | 1.78 |
| L3 | | 0.25 | |
| L4 | 4.78 | | 5.28 |

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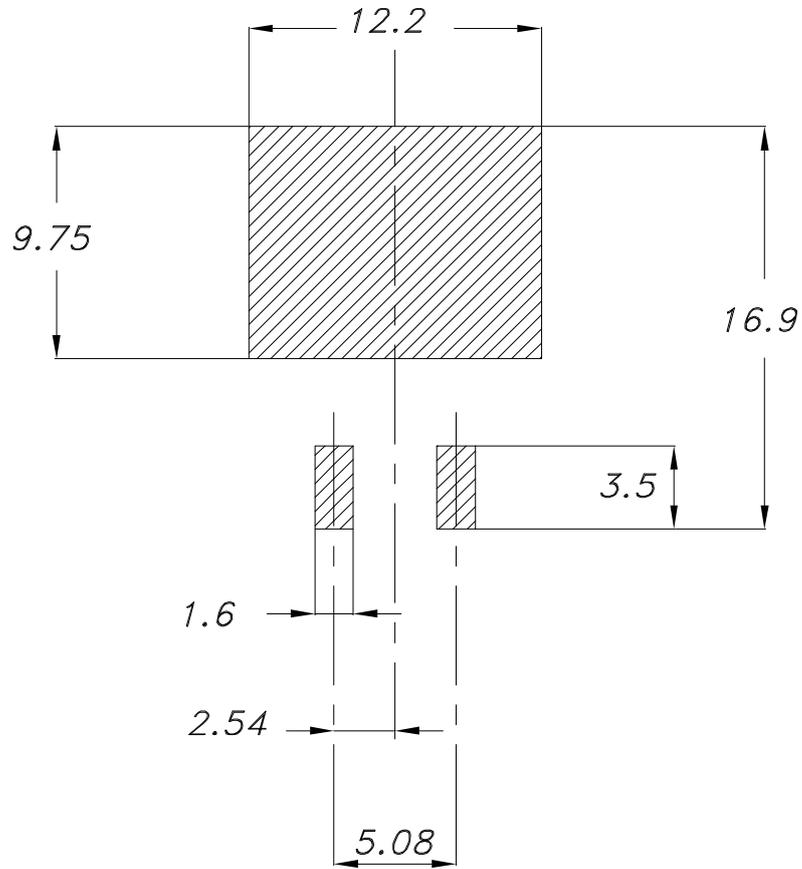


Footprint

## 4.4 D²PAK type B packing information

**Figure 22. D²PAK type B tape outline**
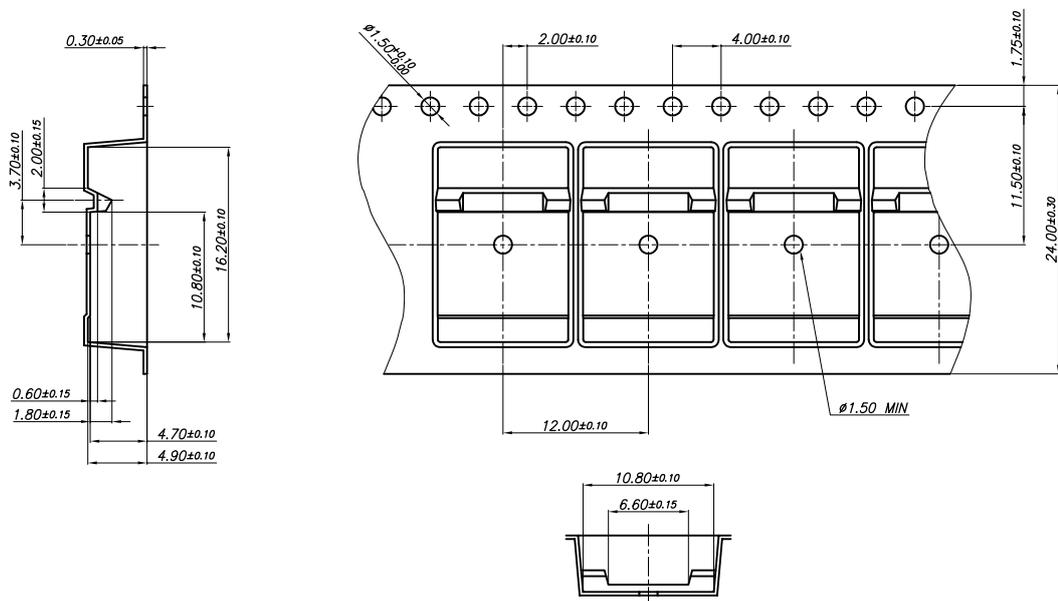
**Figure 23. D²PAK type B reel outline**



40mm min.
access hole
at slot location

B

D

A

Full radius

Tape slot
in core for
tape start
2.5mm min.width

T

C

N

G measured
at hub
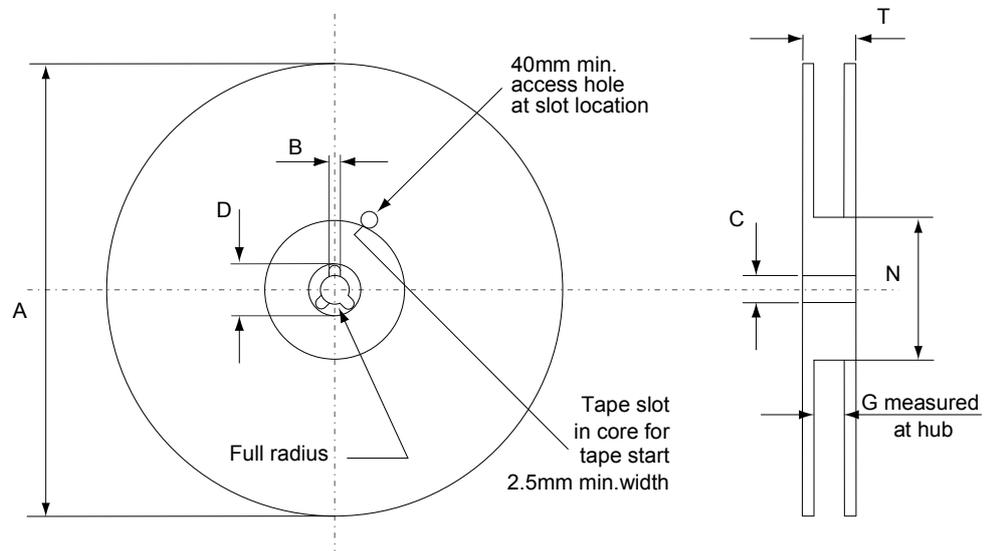
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**Table 11. D²PAK type B reel mechanical data**

| Dim. | mm | |
|---|---|---|
| | Min. | Max. |
| A | | 330 |
| B | 1.5 | |
| C | 12.8 | 13.2 |
| D | 20.2 | |
| G | 24.4 | 26.4 |
| N | 100 | |
| T | | 30.4 |

## 4.5 TO-220 type A package information

**Figure 24. TO-220 type A package outline**
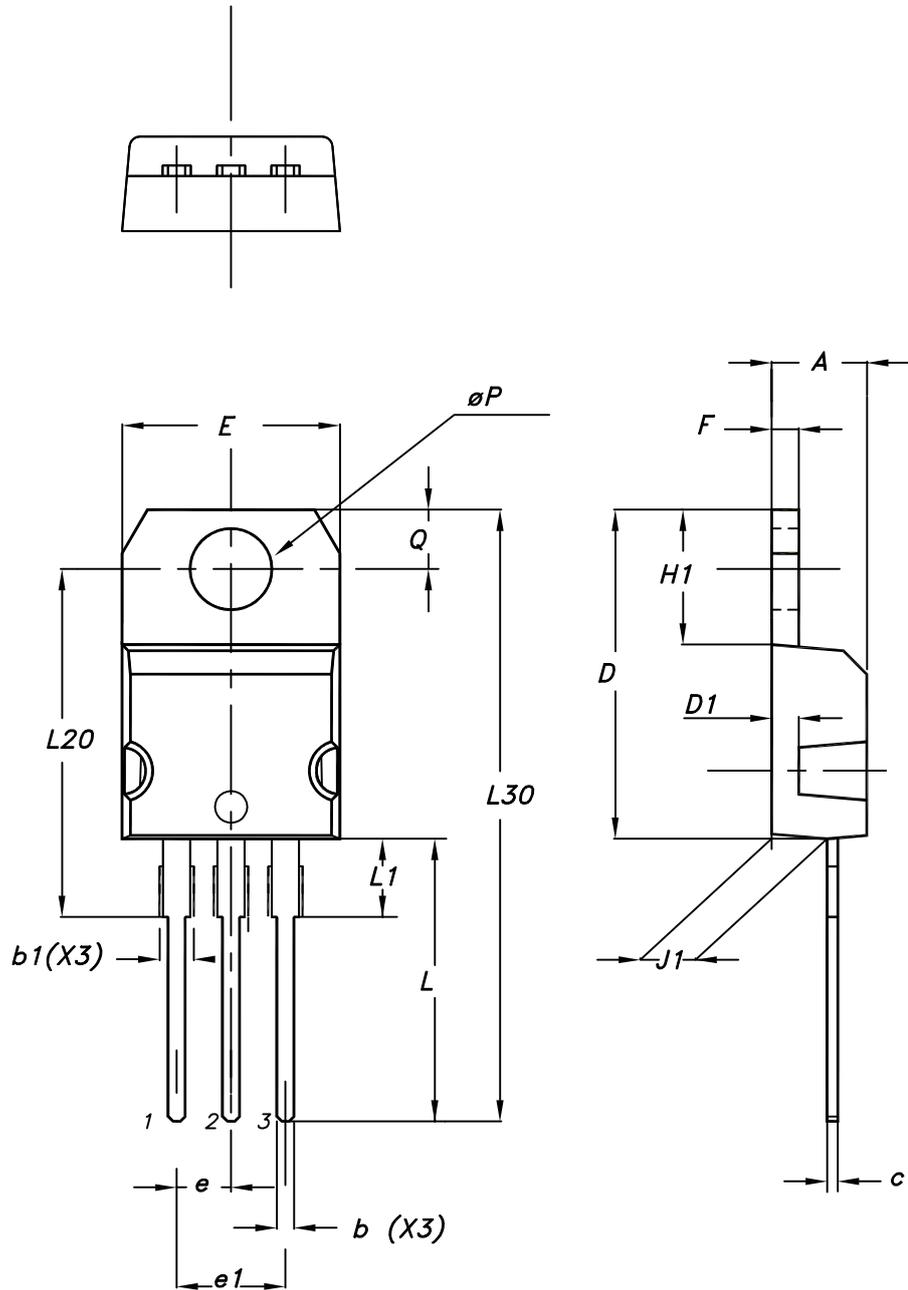


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**Table 12.** TO-220 type A package mechanical data

| 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 |

# Revision history

Table 13. Document revision history

| Date | Version | Changes |
|---|---|---|
| 09-Sep-2004 | 1 | First release |
| 10-Jun-2005 | 2 | Typing error, wrong description |
| 26-Jul-2006 | 3 | The document has been reformatted, no content change |
| 31-Aug-2006 | 4 | Typo mistake on order code |
| 21-Dec-2006 | 5 | Various changes on "Test conditions" for Table 5. and Table 6. |
| 12-Jan-2007 | 6 | Order code has been corrected |
| 01-Oct-2018 | 7 | The part numbers STB11NM60-1 and STP11NM60FP have been moved to a separate datasheet and the document has been updated accordingly. Modified Table 1. Absolute maximum ratings, Table 2. Thermal data and Table 5. Dynamic. Modified Section 2.1 Electrical characteristics (curves). Updated Section 4 Package information. Minor text changes. |

# Contents

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