



STD5N52U STF5N52U, STI5N52U

N-channel 525 V, 1.28 Ω , 4.4 A, DPAK, TO-220FP, I²PAK
UltraFASTmesh™ Power MOSFET

Features

| Type | V _{DSS} | R _{DS(on) max} | I _D | P _w |
|----------|------------------|-------------------------|----------------|----------------|
| STD5N52U | 525 V | < 1.5 Ω | 4.4 A | 70 W |
| STF5N52U | | | | 25 W |
| STI5N52U | | | | 70 W |

- 100% avalanche tested
- Outstanding dv/dt capability
- Gate charge minimized
- Very low intrinsic capacitances
- Very low R_{DS(on)}
- Extremely low t_{rr}

Applications

- Switching applications
 - High voltage inverters specific fo LCD TV
 - Lighting full bridge topology
 - Motor control

Description

These devices are N-channel Power MOSFETs developed using UltraFASTmesh™ technology, which combines the advantages of reduced on-resistance, Zener gate protection and very high dv/dt capability with an enhanced fast body-drain recovery diode.

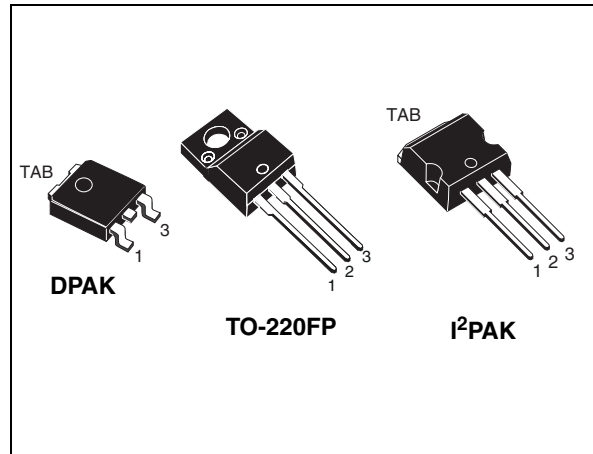


Figure 1. Internal schematic diagram

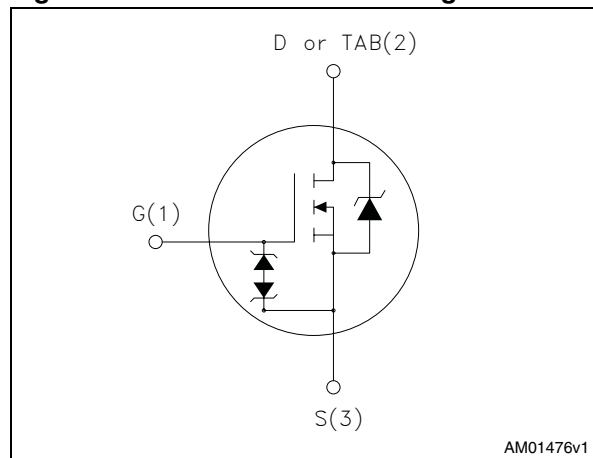


Table 1. Device summary

| Order code | Marking | Package | Packaging |
|------------|---------|--------------------|---------------|
| STD5N52U | 5N52U | DPAK | Tape and reel |
| STF5N52U | 5N52U | TO-220FP | Tube |
| STI5N52U | 5N52U | I ² PAK | Tube |

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1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | | Unit |
|------------------------------------|--|------------|----------|--------------------|------|
| | | DPAK | TO-220FP | I ² PAK | |
| V _{GS} | Gate- source voltage | ± 30 | | | V |
| I _D | Drain current (continuous) at T _C = 25 °C | 4.4 | | | A |
| I _D | Drain current (continuous) at T _C = 100 °C | 2.8 | | | A |
| I _{DM} ⁽¹⁾ | Drain current (pulsed) | 17.6 | | | A |
| P _{TOT} | Total dissipation at T _C = 25 °C | 70 | 25 | 70 | W |
| I _{AR} | Avalanche current, repetitive or not-repetitive (pulse width limited by T _J max) | 4.4 | | | A |
| E _{AS} | Single pulse avalanche energy (starting T _J = 25 °C, I _D = I _{AR} , V _{DD} = 50 V) | 170 | | | mJ |
| dv/dt ⁽²⁾ | Peak diode recovery voltage slope | 20 | | | V/ns |
| V _{ESD(G-S)} | G-S ESD (HBM C=100 pF; R=1.5 kΩ) | 2800 | | | V |
| V _{ISO} | Insulation withstand voltage (RMS) from all three leads to external heat sink (t=1 s; T _C =25 °C) | | 2500 | | V |
| T _J T _{stg} | Operating junction temperature Storage temperature | -55 to 150 | | | °C |

1. Pulse width limited by safe operating area.
2. I_{SD} ≤ 4.4 A, di/dt ≤ 400 A/μs, peak V_{DS} ≤ V_{(BR)DSS}

Table 3. Thermal data

| Symbol | Parameter | Value | | | Unit |
|-----------------------|---|-------|----------|--------------------|------|
| | | DPAK | TO-220FP | I ² PAK | |
| R _{thj-case} | Thermal resistance junction-case max | 1.78 | 5 | 1.78 | °C/W |
| R _{thj-amb} | Thermal resistance junction-ambient max | | 62.5 | 100 | °C/W |
| R _{thj-pcb} | Thermal resistance junction-pcb | 50 | | | °C/W |

2 Electrical characteristics

(T_{case} = 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) | I _D = 1 mA | 525 | | | V |
| I _{DSS} | Zero gate voltage drain current (V _{GS} = 0) | V _{DS} = 525 V V _{DS} = 525 V, T _C = 125 °C | | | 10 500 | μA μA |
| I _{GSS} | Gate-body leakage current (V _{DS} = 0) | V _{GS} = ± 20 V | | | 10 | μA |
| V _{GS(th)} | Gate threshold voltage | V _{DS} = V _{GS} , I _D = 50 μA | 3 | 3.75 | 4.5 | V |
| R _{DS(on)} | Static drain-source on resistance | V _{GS} = 10 V, I _D = 2.2 A | | 1.28 | 1.5 | Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|-------------------------------------|---|------|------|------|------|
| C _{iss} | Input capacitance | V _{DS} = 25 V, f = 1 MHz, V _{GS} = 0 | - | 529 | - | pF |
| C _{oss} | Output capacitance | | | 71 | | pF |
| C _{rss} | Reverse transfer capacitance | | | 13.4 | | pF |
| C _{o(tr)} ⁽¹⁾ | Equivalent capacitance time related | V _{DS} = 0 to 420 V, V _{GS} = 0 | - | 11 | - | pF |
| R _g | Gate input resistance | f = 1 MHz open drain | - | 6 | - | Ω |
| Q _g | Total gate charge | V _{DD} = 416 V, I _D = 4.4 A, | - | 16.9 | - | nC |
| Q _{gs} | Gate-source charge | V _{GS} = 10 V | | 4.2 | | nC |
| Q _{gd} | Gate-drain charge | (see Figure 17) | | 8.4 | | nC |

1. C_{oss,eq} time related 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} = 260 V, I _D = 2.2 A, R _G = 4.7 Ω, V _{GS} = 10 V (see Figure 16) | - | 11.4 | - | ns |
| t _r | Rise time | | | 13.6 | | ns |
| t _{d(off)} | Turn-off-delay time | | | 23.1 | | ns |
| t _f | Fall time | | | 15 | | ns |

Table 7. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------|-------------------------------|---|------|------|------|---------------|
| I_{SD} | Source-drain current | | - | | 4.4 | A |
| $I_{SDM}^{(1)}$ | Source-drain current (pulsed) | | | | 17.6 | A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 4.4 \text{ A}, V_{GS} = 0$ | - | | 1.6 | V |
| t_{rr} | Reverse recovery time | $I_{SD} = 4.4 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ | | 55 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 60 \text{ V}$ | - | 95 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 18) | | 3.5 | | A |
| t_{rr} | Reverse recovery time | $I_{SD} = 4.4 \text{ A}, di/dt = 100 \text{ A}/\mu\text{s}$ | | 120 | | ns |
| Q_{rr} | Reverse recovery charge | $V_{DD} = 60 \text{ V } T_J = 150 \text{ }^\circ\text{C}$ | - | 266 | | μC |
| I_{RRM} | Reverse recovery current | (see Figure 18) | | 4.5 | | A |

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

Table 8. Gate-source Zener diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|------------|-------------------------------|--|------|------|------|------|
| BV_{GSO} | Gate-source breakdown voltage | $I_{GS} = \pm 1 \text{ mA (open drain)}$ | 30 | - | - | V |

The built-in back-to-back Zener diodes have specifically been designed to enhance not only the device’s ESD capability, but also to make them safely absorb possible voltage transients that may occasionally be applied from gate to source. In this respect the Zener voltage is appropriate to achieve an efficient and cost-effective intervention to protect the device’s integrity. These integrated Zener diodes thus avoid the usage of external components.

2.1 Electrical characteristics (curves)

Figure 2. Safe operating area for DPAK and I²PAK

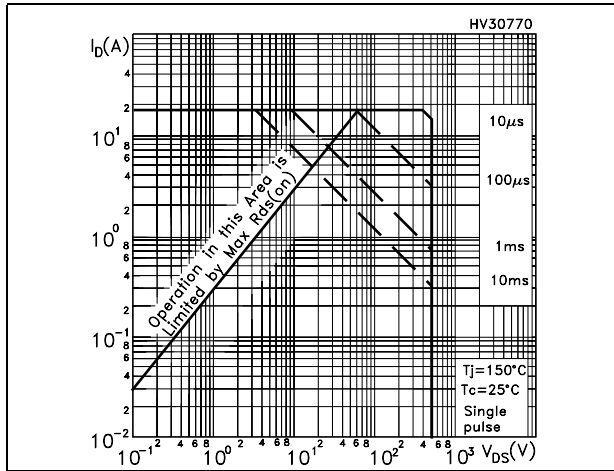


Figure 3. Thermal impedance for DPAK and I²PAK

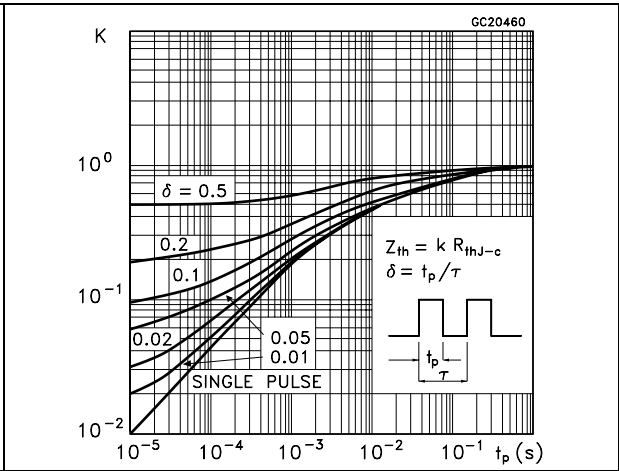


Figure 4. Safe operating area for TO-220FP

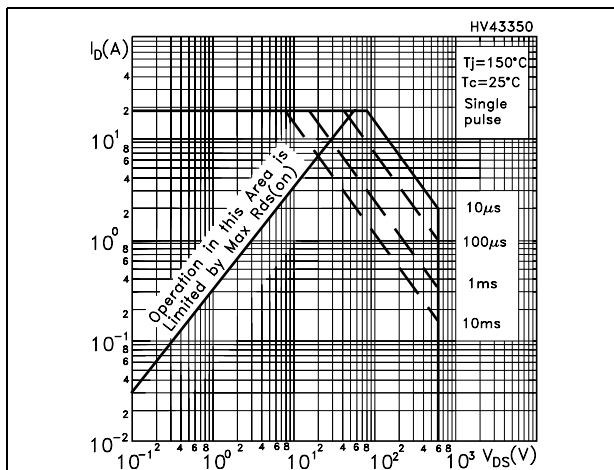


Figure 5. Thermal impedance for TO-220FP

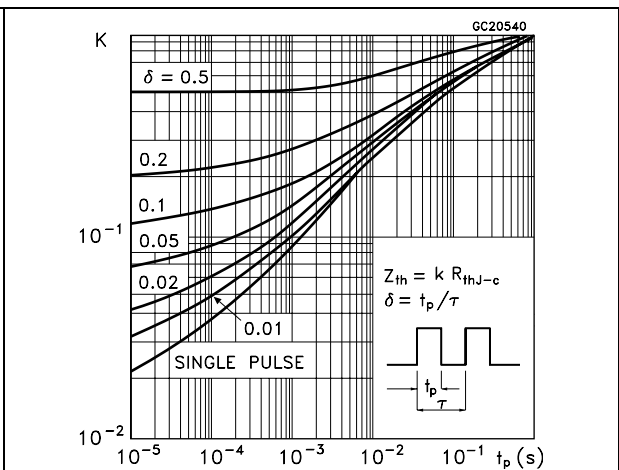


Figure 6. Output characteristics

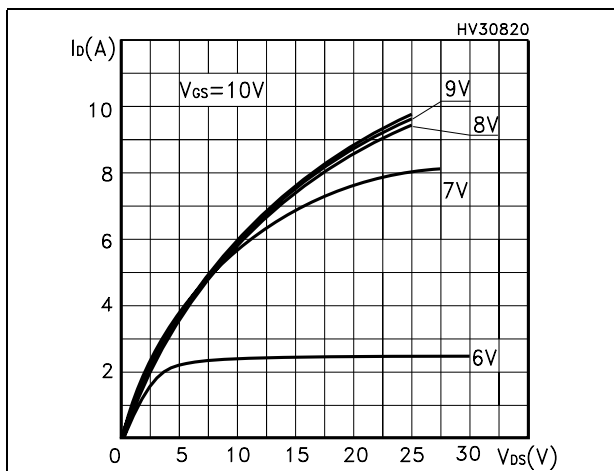


Figure 7. Transfer characteristics

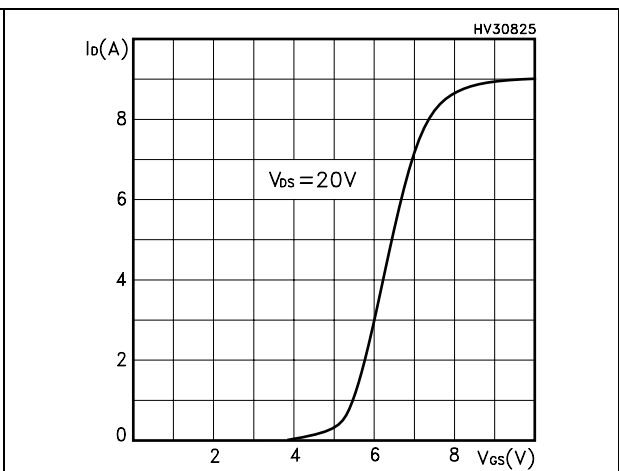


Figure 8. Normalized BV_{DSS} vs temperature Figure 9. Static drain-source on resistance

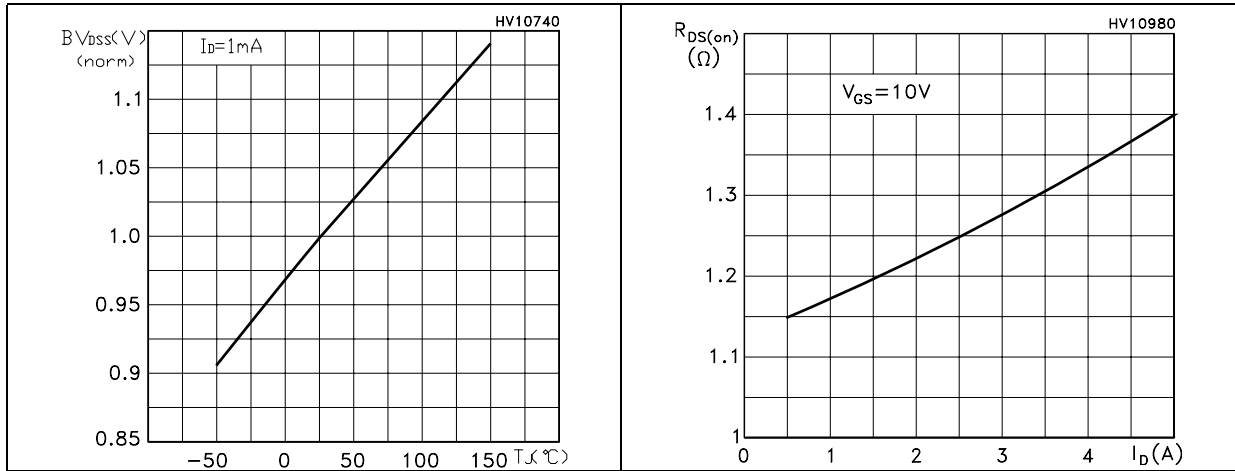


Figure 10. Gate charge vs gate-source voltage Figure 11. Capacitance variations

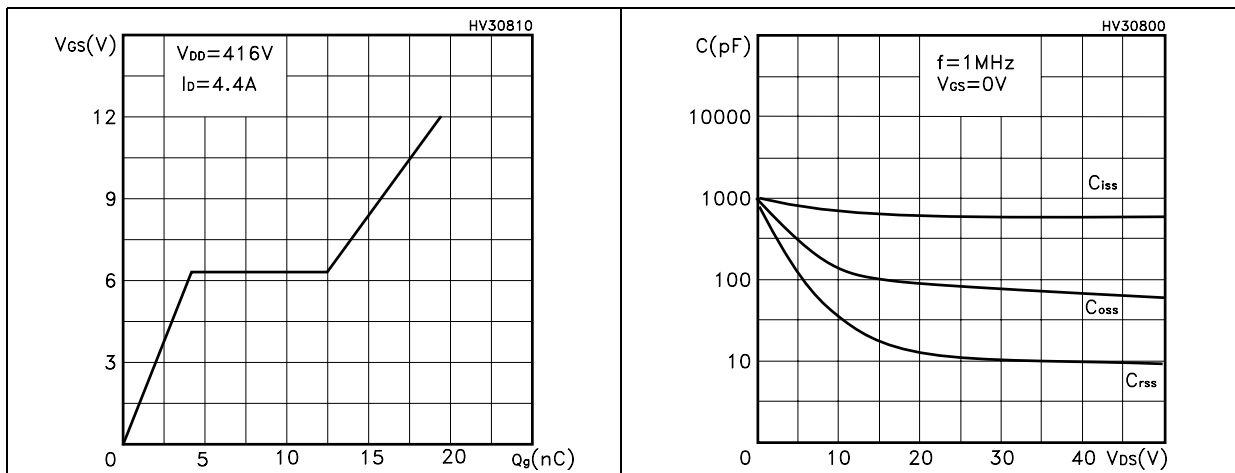


Figure 12. Normalized gate threshold voltage vs temperature Figure 13. Normalized on resistance vs temperature

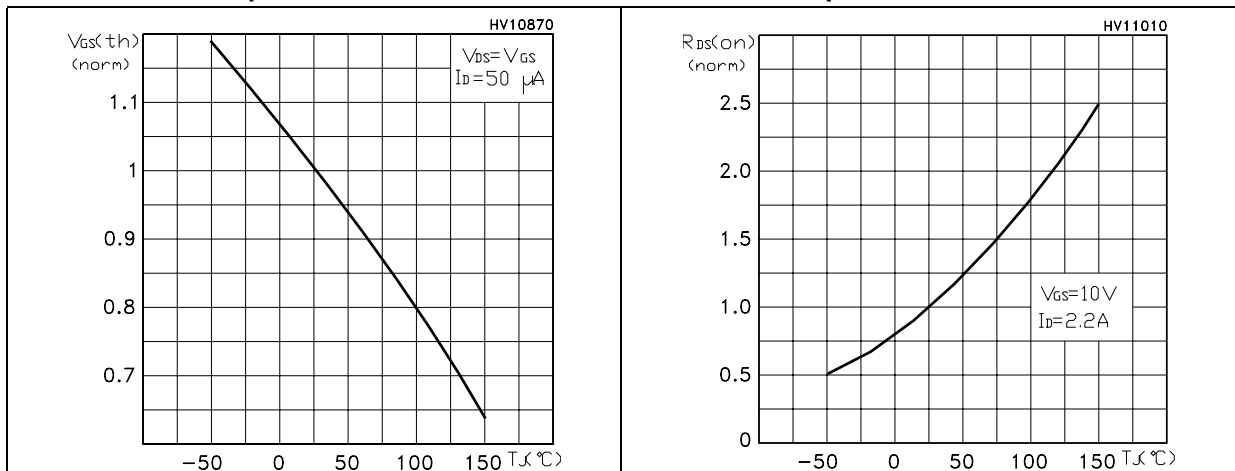


Figure 14. Source-drain diode forward characteristics

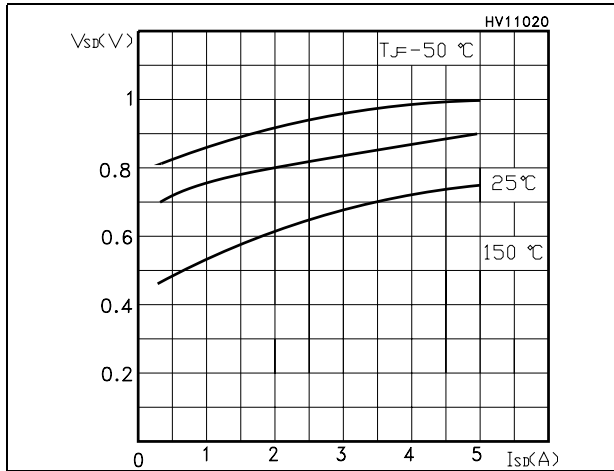
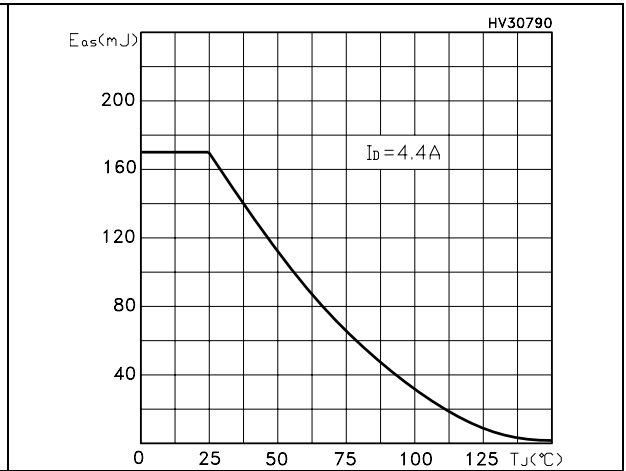


Figure 15. Maximum avalanche energy vs temperature



3 Test circuits

Figure 16. Switching times test circuit for resistive load



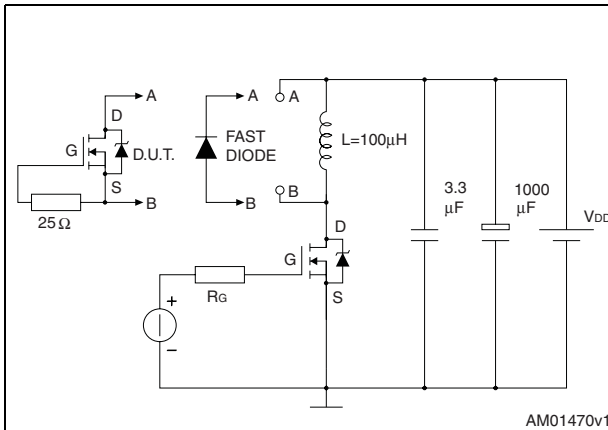
AM01468v1

Figure 17. Gate charge test circuit



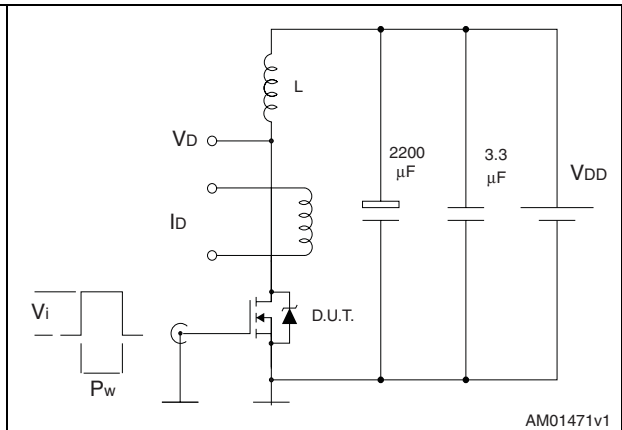
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Figure 18. Test circuit for inductive load switching and diode recovery times



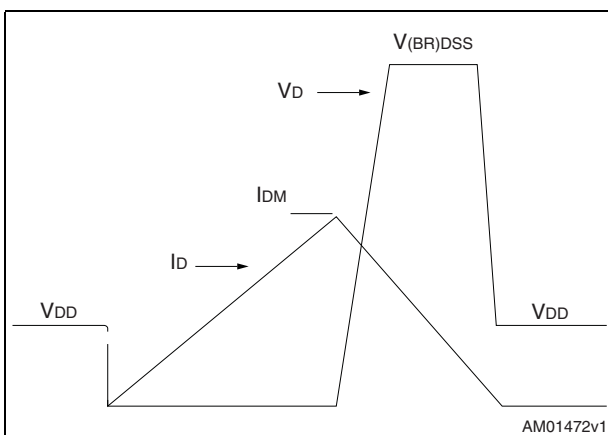
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Figure 19. Unclamped inductive load test circuit



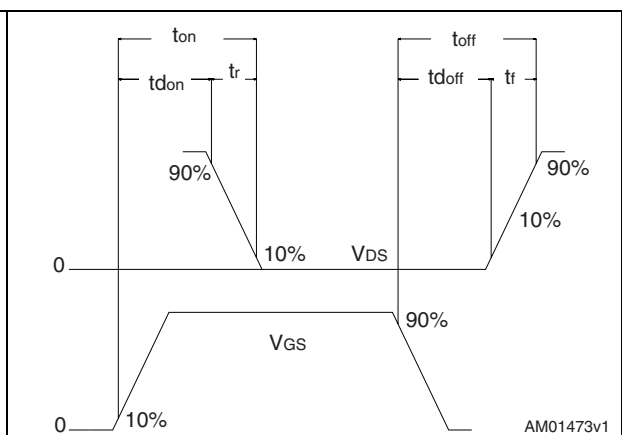
AM01471v1

Figure 20. Unclamped inductive waveform



AM01472v1

Figure 21. Switching time waveform



AM01473v1

Table 9. DPAK (TO-252) mechanical data

| Dim. | mm | | |
|------|------|------|-------|
| | Min. | Typ. | Max. |
| A | 2.20 | | 2.40 |
| A1 | 0.90 | | 1.10 |
| A2 | 0.03 | | 0.23 |
| b | 0.64 | | 0.90 |
| b4 | 5.20 | | 5.40 |
| c | 0.45 | | 0.60 |
| c2 | 0.48 | | 0.60 |
| D | 6.00 | | 6.20 |
| D1 | | 5.10 | |
| E | 6.40 | | 6.60 |
| E1 | | 4.70 | |
| e | | 2.28 | |
| e1 | 4.40 | | 4.60 |
| H | 9.35 | | 10.10 |
| L | 1 | | 1.50 |
| L1 | | 2.80 | |
| L2 | | 0.80 | |
| L4 | 0.60 | | 1 |
| R | | 0.20 | |
| V2 | 0° | | 8° |

Figure 22. DPAK (TO-252) drawing

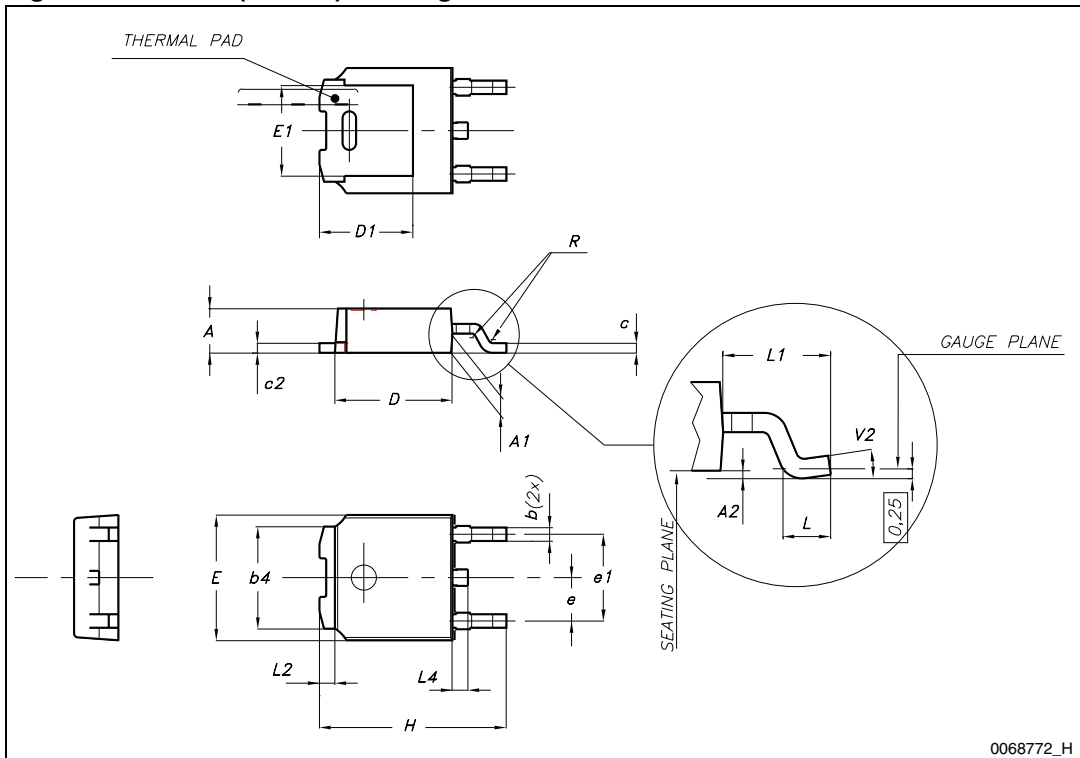
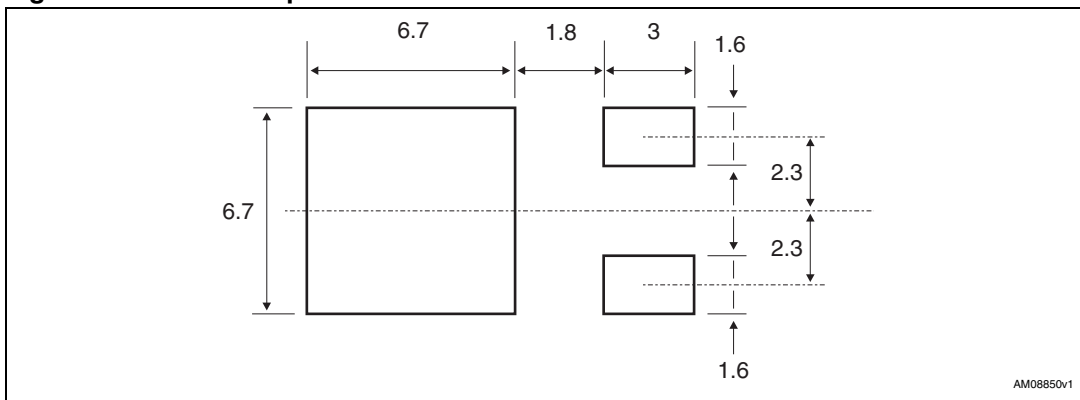


Figure 23. DPAK footprint^(a)

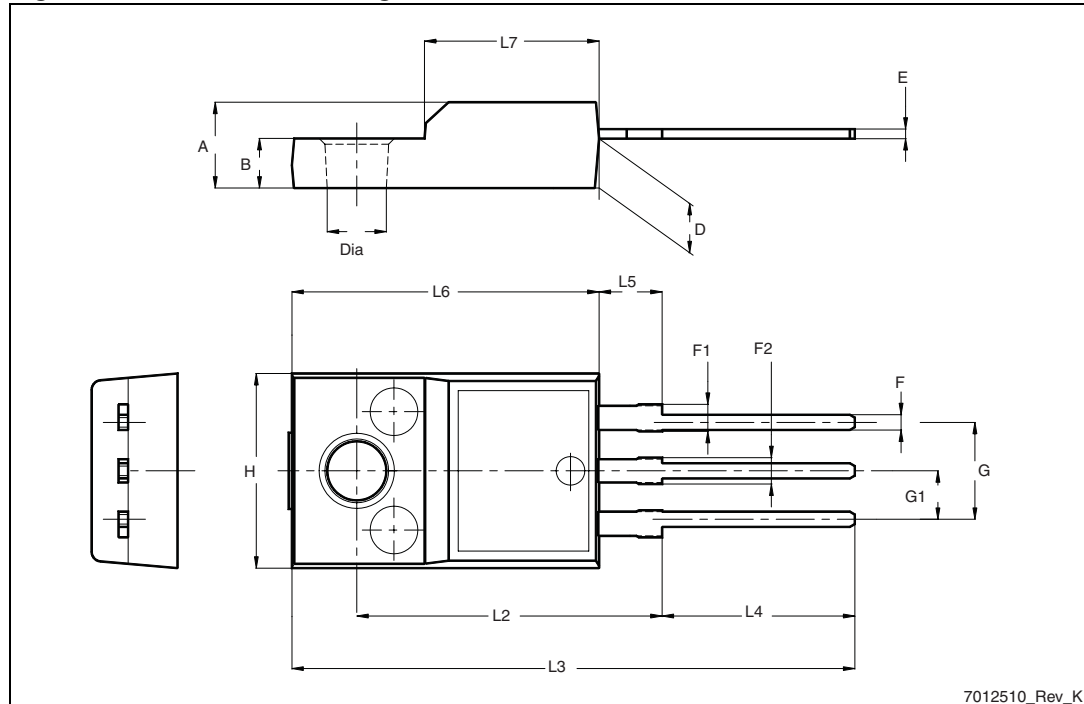


a. All dimension are in millimeters

Table 10. TO-220FP mechanical data

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | 4.4 | | 4.6 |
| B | 2.5 | | 2.7 |
| D | 2.5 | | 2.75 |
| E | 0.45 | | 0.7 |
| F | 0.75 | | 1 |
| F1 | 1.15 | | 1.70 |
| F2 | 1.15 | | 1.70 |
| G | 4.95 | | 5.2 |
| G1 | 2.4 | | 2.7 |
| H | 10 | | 10.4 |
| L2 | | 16 | |
| L3 | 28.6 | | 30.6 |
| L4 | 9.8 | | 10.6 |
| L5 | 2.9 | | 3.6 |
| L6 | 15.9 | | 16.4 |
| L7 | 9 | | 9.3 |
| Dia | 3 | | 3.2 |

Figure 24. TO-220FP drawing

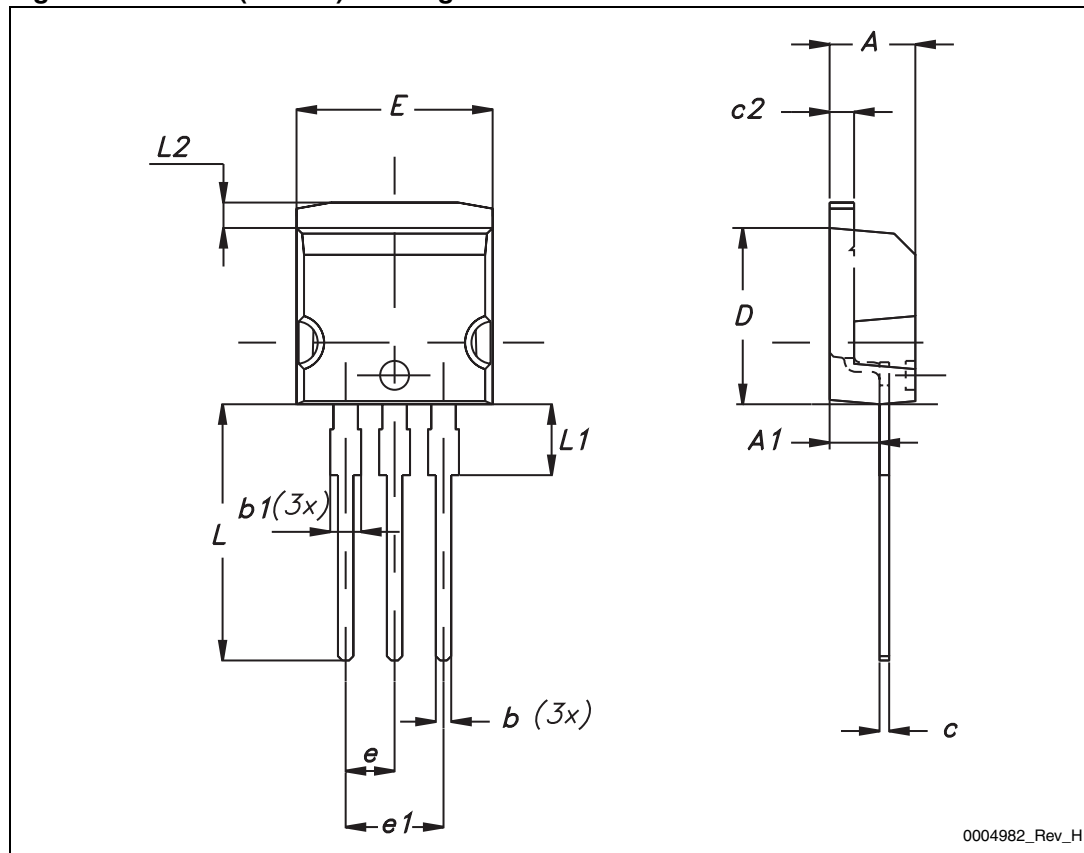


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Table 11. I²PAK (TO-262) mechanical data

| DIM. | mm. | | |
|------|------|-----|-------|
| | min. | typ | 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 | | 10.40 |
| L | 13 | | 14 |
| L1 | 3.50 | | 3.93 |
| L2 | 1.27 | | 1.40 |

Figure 25. I²PAK (TO-262) drawing



5 Packaging mechanical data

Table 12. DPAK (TO-252) tape and reel mechanical data

| Tape | | | Reel | | |
|------|------|------|-----------|------|------|
| Dim. | mm | | Dim. | mm | |
| | Min. | Max. | | Min. | Max. |
| A0 | 6.8 | 7 | A | | 330 |
| B0 | 10.4 | 10.6 | B | 1.5 | |
| B1 | | 12.1 | C | 12.8 | 13.2 |
| D | 1.5 | 1.6 | D | 20.2 | |
| D1 | 1.5 | | G | 16.4 | 18.4 |
| E | 1.65 | 1.85 | N | 50 | |
| F | 7.4 | 7.6 | T | | 22.4 |
| K0 | 2.55 | 2.75 | | | |
| P0 | 3.9 | 4.1 | Base qty. | | 2500 |
| P1 | 7.9 | 8.1 | Bulk qty. | | 2500 |
| P2 | 1.9 | 2.1 | | | |
| R | 40 | | | | |
| T | 0.25 | 0.35 | | | |
| W | 15.7 | 16.3 | | | |

Figure 26. Tape for DPAK (TO-252)

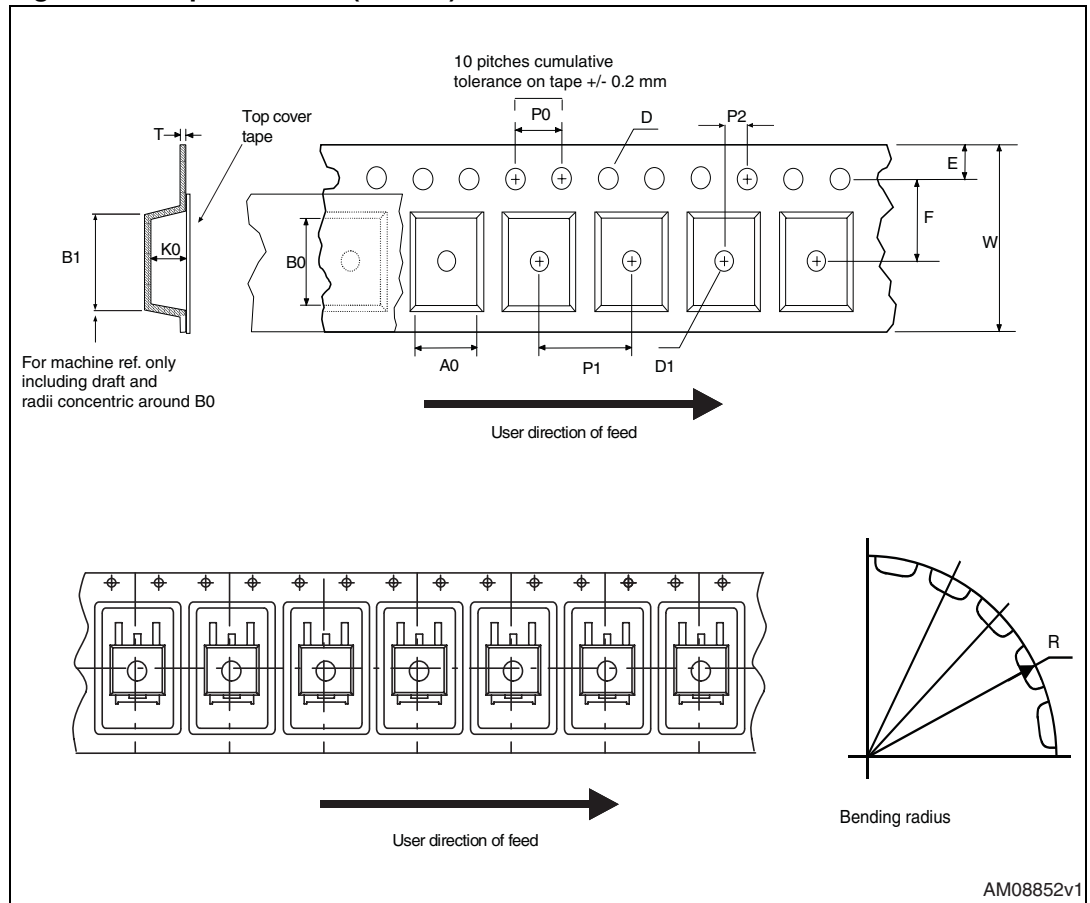
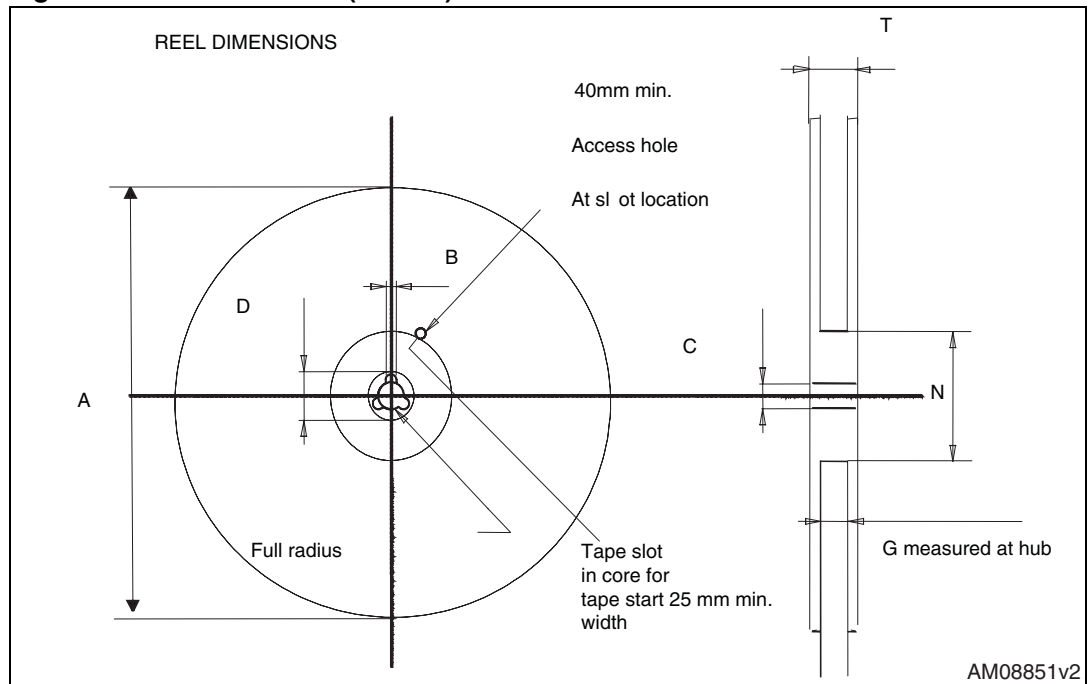


Figure 27. Reel for DPAK (TO-252)



6 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 06-May-2009 | 1 | First release. |
| 28-Sep-2011 | 2 | Inserted new device in I ² PAK. Updated tables 1 , 2 and 3 with the new package. Updated Section 4: Package mechanical data with the new package and Section 5: Packaging mechanical data . Minor text changes. |

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