



2N7000 2N7002

N-channel 60 V, 1.8 Ω , 0.35 A, SOT23-3L, TO-92
STripFET™ Power MOSFET

Features

| Type | V _{DSS} | R _{DS(on)} max | I _D |
|--------|------------------|-------------------------|----------------|
| 2N7000 | 60 V | < 5 Ω (@10V) | 0.35 A |
| 2N7002 | 60 V | < 5 Ω (@10V) | 0.20 A |

- Low Q_g
- Low threshold drive

Application

- Switching applications

Description

This Power MOSFET is the second generation of STMicroelectronics unique “single feature size” strip-based process. The resulting transistor shows extremely high packing density for low on-resistance, rugged avalanche characteristics and less critical alignment steps therefore a remarkable manufacturing reproducibility.

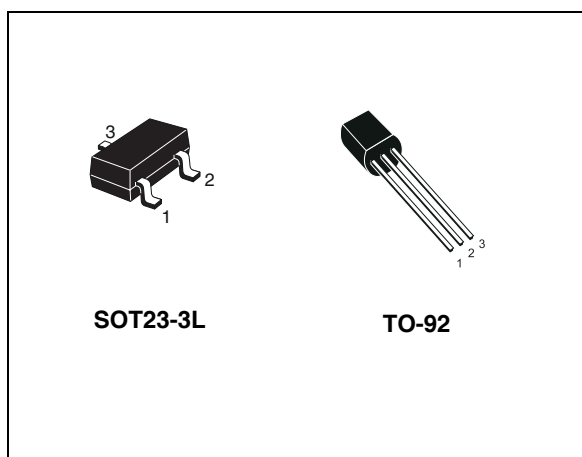


Figure 1. Internal schematic diagram

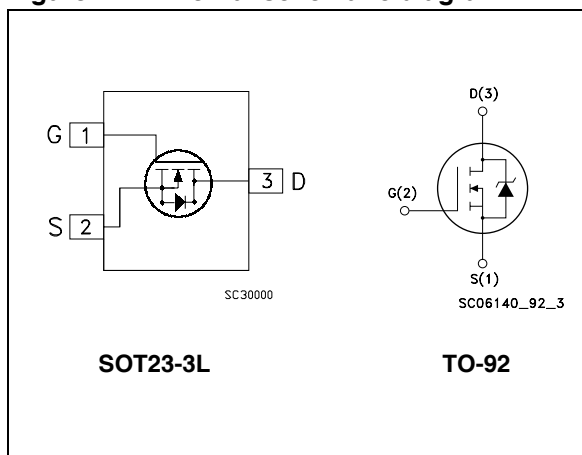


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|---------|----------|---------------|
| 2N7000 | 2N7000G | TO-92 | Bulk |
| 2N7002 | ST2N | SOT23-3L | Tape and reel |

Contents

| | | |
|----------|---|-----------|
| 1 | Electrical ratings | 3 |
| 2 | Electrical characteristics | 4 |
| | 2.1 Electrical characteristics (curves) | 6 |
| 3 | Test circuits | 9 |
| 4 | Package mechanical data | 10 |
| 5 | Revision history | 13 |

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|----------------|---|----------|----------|------|
| | | TO-92 | SOT23-3L | |
| V_{DS} | Drain-source voltage ($V_{GS} = 0$) | 60 | | V |
| V_{DGR} | Drain-gate voltage ($R_{GS} = 20 \text{ k}\Omega$) | 60 | | V |
| V_{GS} | Gate- source voltage | ± 18 | | V |
| I_D | Drain current (continuous) at $T_C = 25 \text{ }^\circ\text{C}$ | 0.35 | 0.20 | A |
| $I_{DM}^{(1)}$ | Drain current (pulsed) | 1.4 | 1 | A |
| P_{TOT} | Total dissipation at $T_C = 25 \text{ }^\circ\text{C}$ | 1 | 0.35 | W |

1. Pulse width limited by safe operating area

Table 3. Thermal data

| Symbol | Parameter | Value | | Unit |
|---------------|---|-------------|----------------------|---------------------------|
| | | TO-92 | SOT23-3L | |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 125 | 357.1 ⁽¹⁾ | $^\circ\text{C}/\text{W}$ |
| T_J | Operating junction temperature | - 55 to 150 | | $^\circ\text{C}$ |
| T_{stg} | Storage temperature | | | |

1. When mounted on 1inch² FR-4, 2 Oz copper board.

2 Electrical characteristics

($T_{CASE} = 25\text{ °C}$ unless otherwise specified)

Table 4. On/off states

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---------------|--|---|------|----------|-----------|--------------------------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 250\ \mu\text{A}$, $V_{GS} = 0$ | 60 | | | V |
| I_{DSS} | Zero gate voltage drain current ($V_{GS} = 0$) | $V_{DS} = \text{max rating}$ $V_{DS} = \text{max rating}$, $T_C = 125\text{ °C}$ | | | 1 10 | μA μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 18\text{ V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\ \mu\text{A}$ | 1 | 2.1 | 3 | V |
| $R_{DS(on)}$ | Static drain-source on resistance | $V_{GS} = 10\text{ V}$, $I_D = 0.5\text{ A}$ $V_{GS} = 4.5\text{ V}$, $I_D = 0.5\text{ A}$ | | 1.8 2 | 5 5.3 | Ω Ω |

Table 5. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------|------------------------------|--|------|------|------|------|
| $g_{fs}^{(1)}$ | Forward transconductance | $V_{DS} = 10\text{ V}$, $I_D = 0.5\text{ A}$ | | 0.6 | | S |
| C_{iss} | Input capacitance | $V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | | 43 | | pF |
| C_{oss} | Output capacitance | | | 20 | | pF |
| C_{rss} | Reverse transfer capacitance | | | 6 | | pF |
| $t_{d(on)}$ | Turn-on delay time | $V_{DD} = 30\text{ V}$, $I_D = 0.5\text{ A}$ $R_G = 4.7\ \Omega$, $V_{GS} = 4.5\text{ V}$ (see Figure 16) | | 5 | | ns |
| t_r | Rise time | | | 15 | | ns |
| $t_{d(off)}$ | Turn-off delay time | | | 7 | | ns |
| t_f | Fall time | | | 8 | | ns |
| Q_g | Total gate charge | $V_{DD} = 30\text{ V}$, $I_D = 1\text{ A}$, $V_{GS} = 5\text{ V}$ (see Figure 17) | | 1.4 | 2 | nC |
| Q_{gs} | Gate-source charge | | | 0.8 | | nC |
| Q_{gd} | Gate-drain charge | | | 0.5 | | nC |

1. Pulsed: Pulse duration = 300 μs , duty cycle 1.5%.

Table 6. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|-----------------------------------|--|--|------|-----------------|--------------|---------------|
| I_{SD} $I_{SDM}^{(1)}$ | Source-drain current Source-drain current (pulsed) | | | | 0.35 1.40 | A A |
| $V_{SD}^{(2)}$ | Forward on voltage | $I_{SD} = 1\text{ A}$, $V_{GS} = 0$ | | | 1.2 | V |
| t_{rr} Q_{rr} I_{RRM} | Reverse recovery time Reverse recovery charge Reverse recovery current | $I_{SD} = 1\text{ A}$, $di/dt = 100\text{ A}/\mu\text{s}$, $V_{DD} = 20\text{ V}$, $T_j = 150\text{ }^\circ\text{C}$ (see Figure 18) | | 32 25 1.6 | | ns nC 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 2. Safe operating area for TO-92

Figure 3. Thermal impedance for TO-92

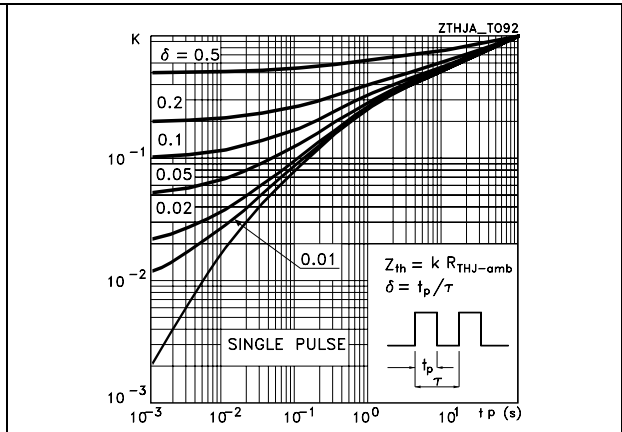
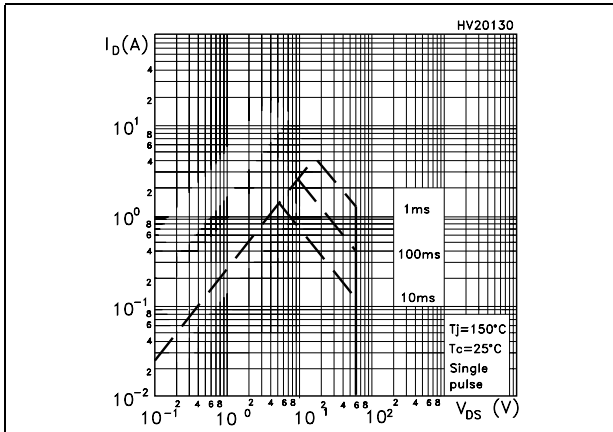


Figure 4. Safe operating area for SOT23-3L

Figure 5. Thermal impedance for SOT23-3L

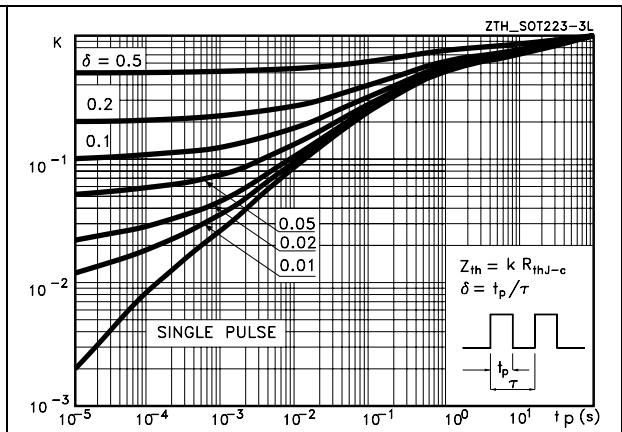
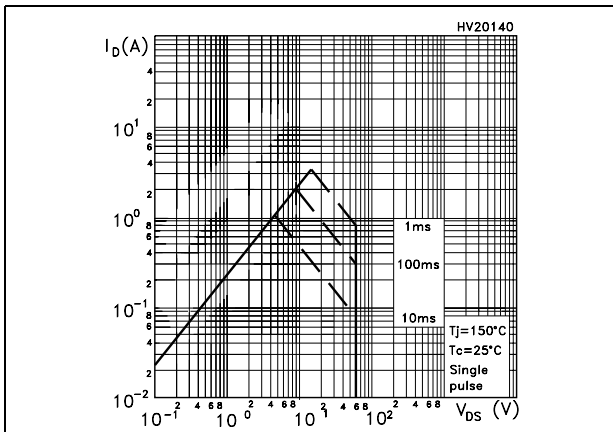


Figure 6. Output characteristics

Figure 7. Transfer characteristics

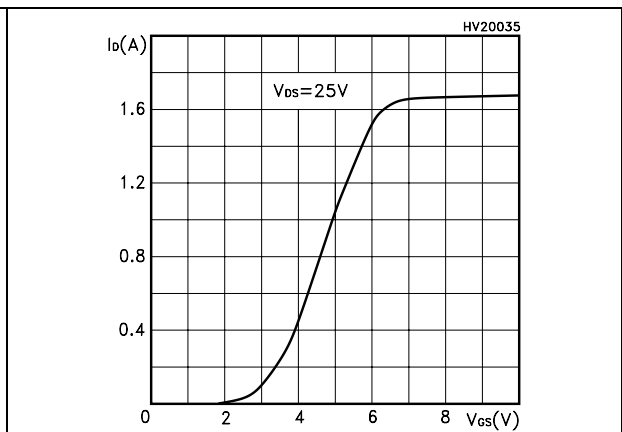
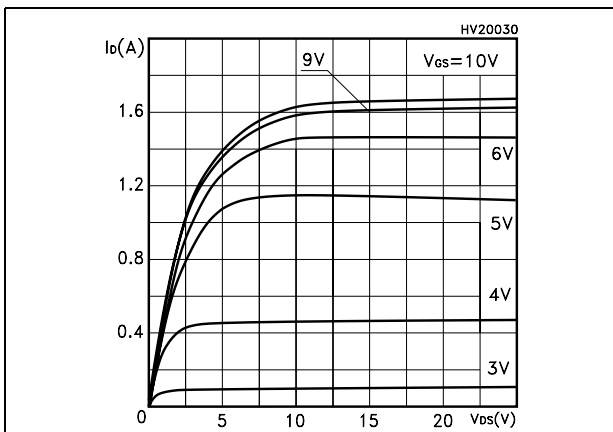


Figure 8. Transconductance

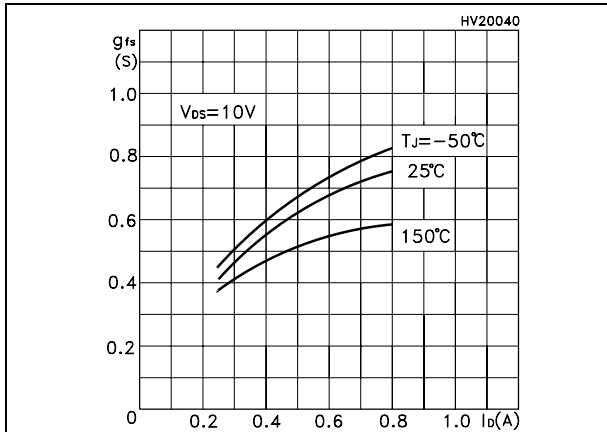


Figure 9. Static drain-source on resistance

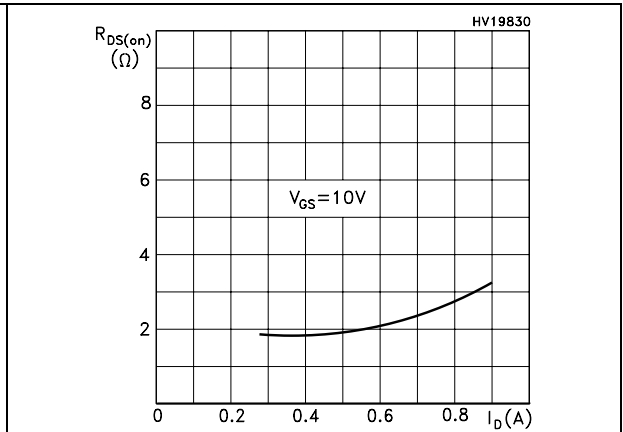


Figure 10. Gate charge vs gate-source voltage Figure 11. Capacitance variations

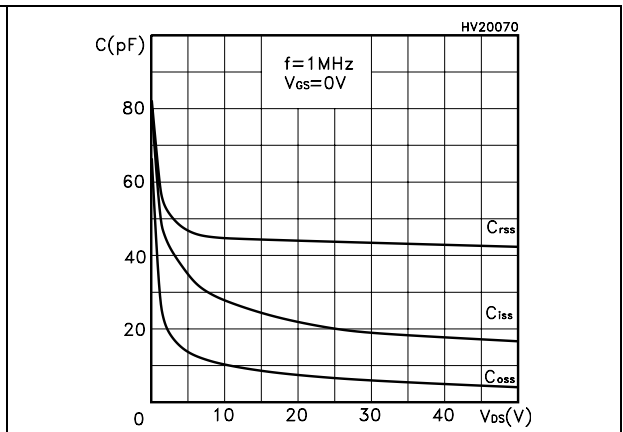
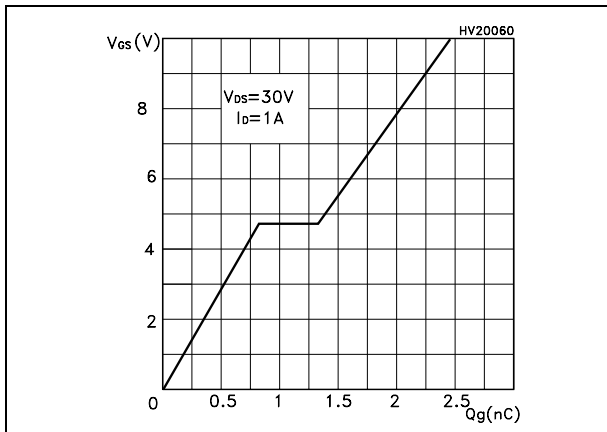


Figure 12. Normalized gate threshold voltage vs temperature

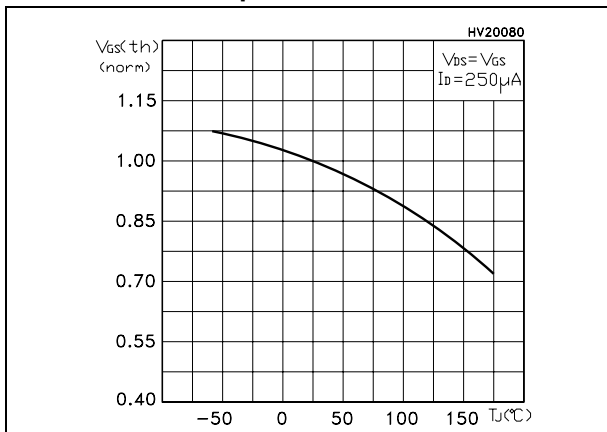


Figure 13. Normalized on resistance vs temperature

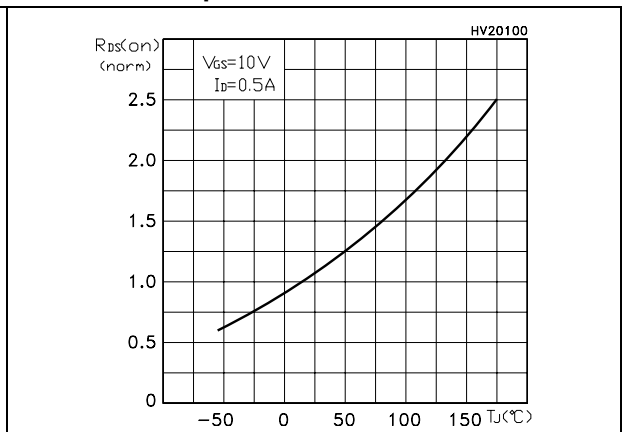


Figure 14. Source-drain diode forward characteristics

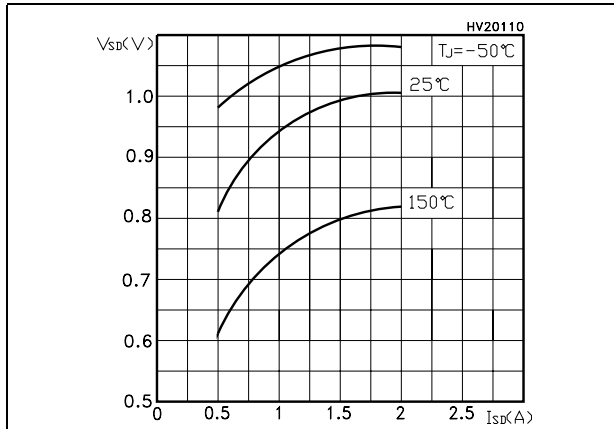
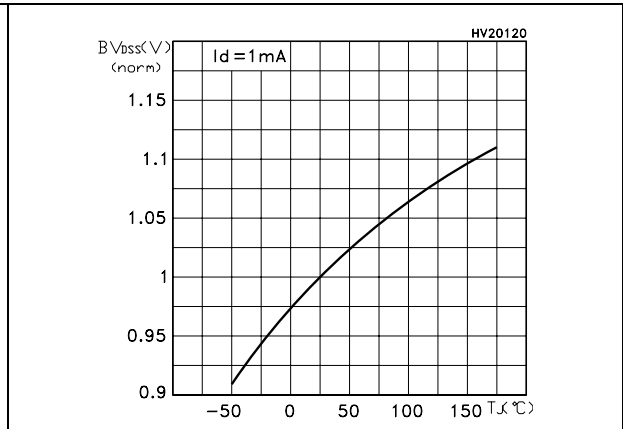


Figure 15. Normalized B_{VDSS} vs temperature



3 Test circuits

Figure 16. Switching times test circuit for resistive load

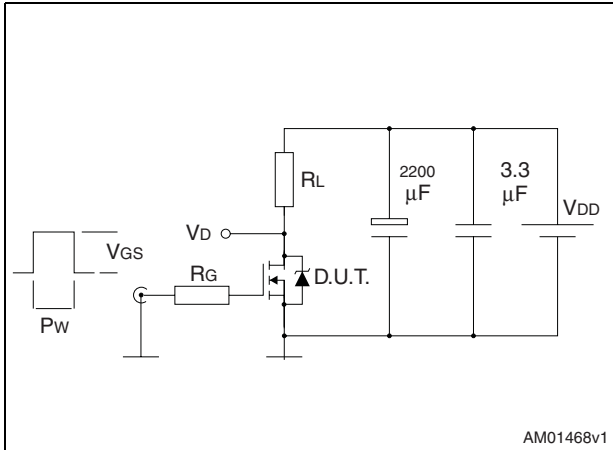


Figure 17. Gate charge test circuit

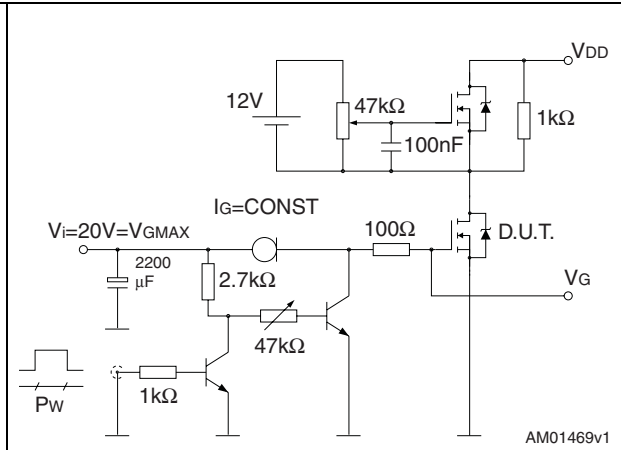


Figure 18. Test circuit for inductive load switching and diode recovery times

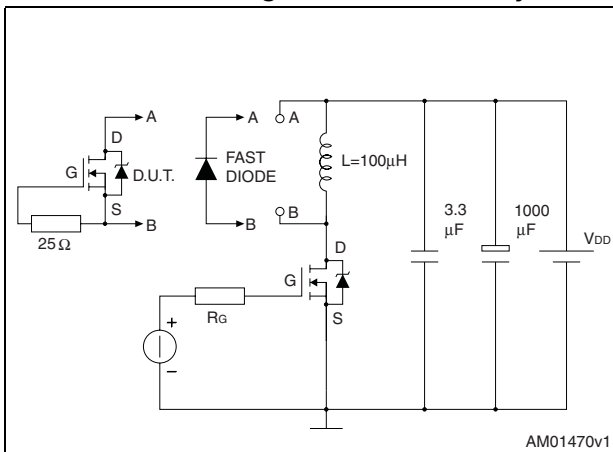


Figure 19. Unclamped Inductive load test circuit

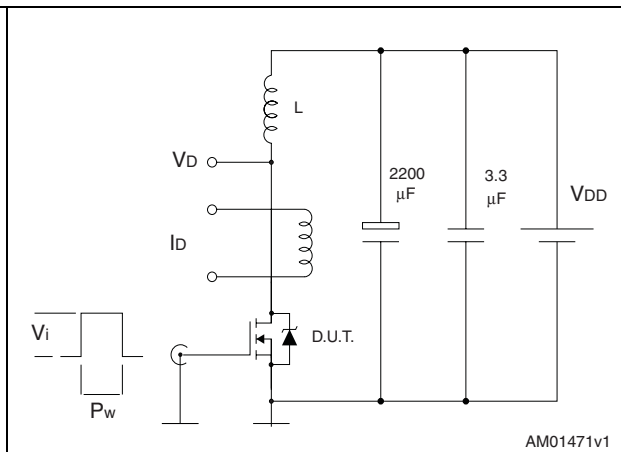


Figure 20. Unclamped inductive waveform

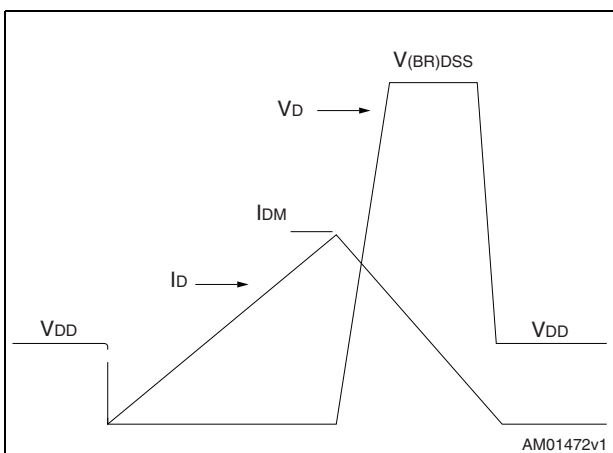
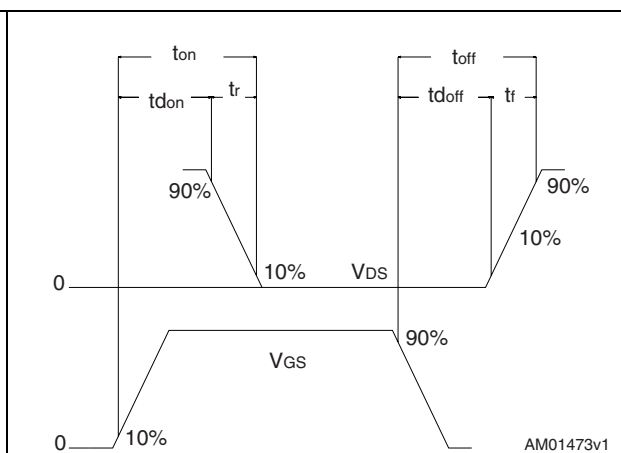


Figure 21. Switching time waveform



4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a Lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com

Table 7. TO-92 mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | 4.32 | | 4.95 |
| b | 0.36 | | 0.51 |
| D | 4.45 | | 4.95 |
| E | 3.30 | | 3.94 |
| e | 2.41 | | 2.67 |
| e1 | 1.14 | | 1.40 |
| L | 12.70 | | 15.49 |
| R | 2.16 | | 2.41 |
| S1 | 0.92 | | 1.52 |
| W | 0.41 | | 0.56 |
| V | | 5° | |

Figure 22. TO-92 drawing

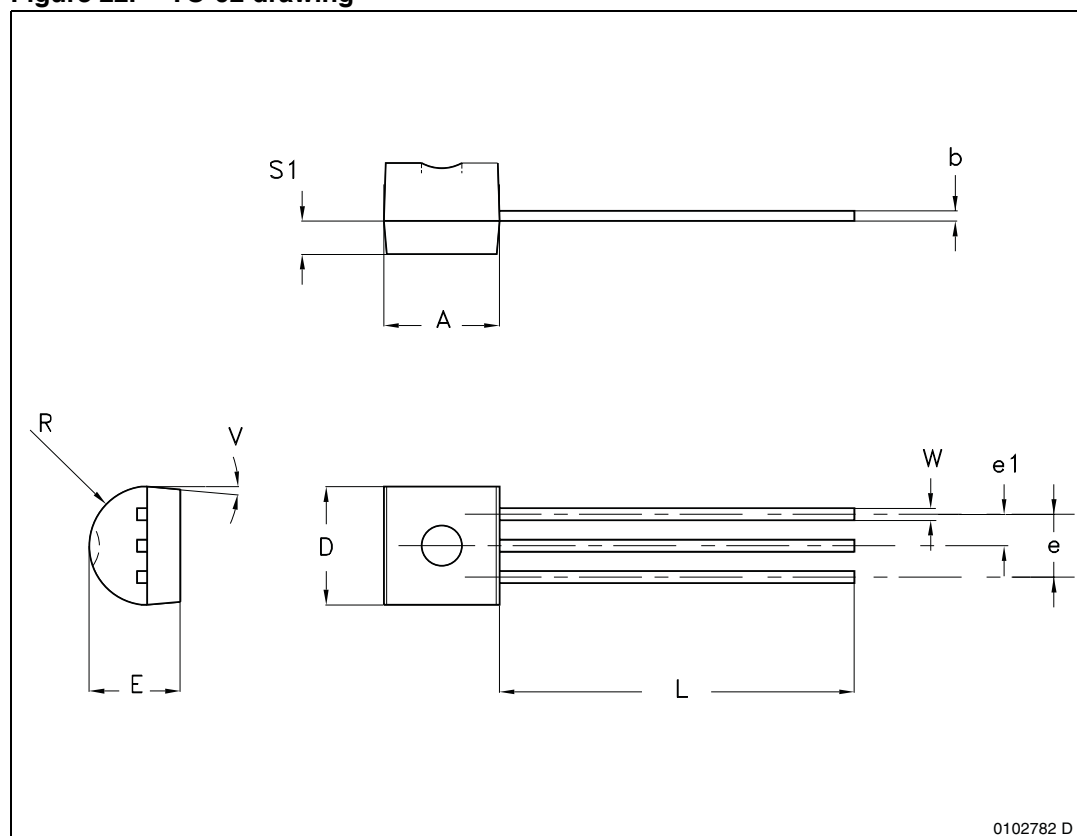
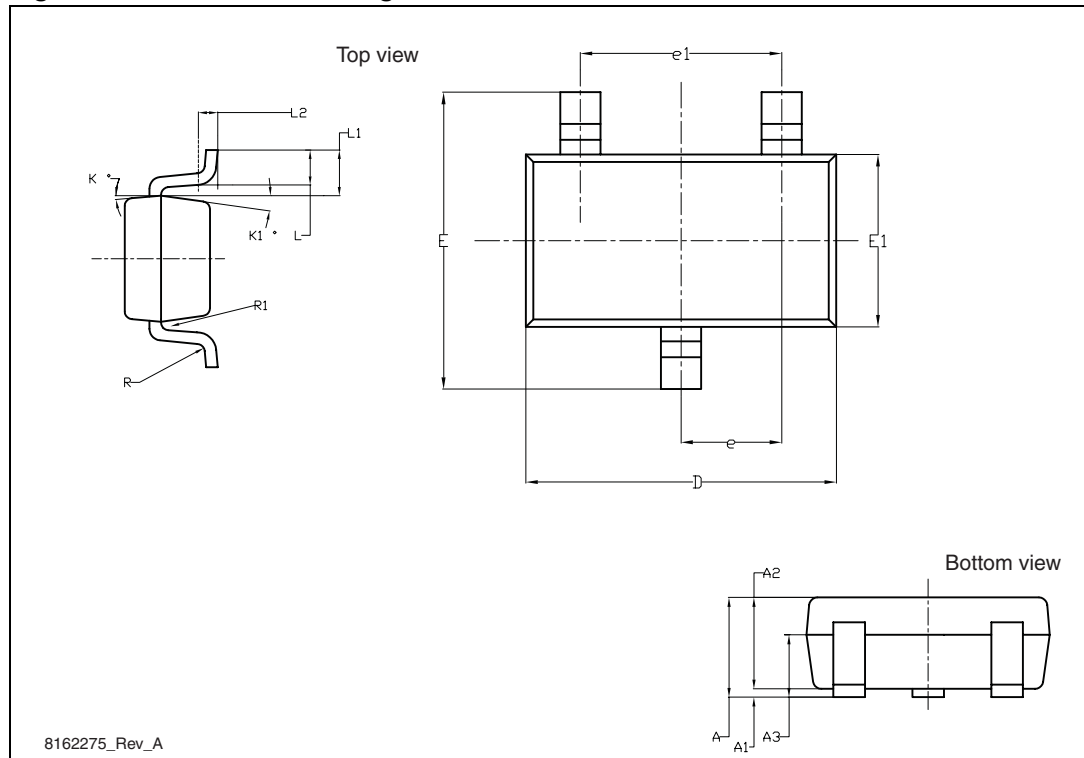


Table 8. SOT23-3L mechanical data

| Dim. | mm | | |
|------|-------|------|-------|
| | Min. | Typ. | Max. |
| A | | | 1.25 |
| A1 | 0 | | 0.15 |
| A2 | 1.00 | | 1.20 |
| A3 | 0.60 | | 0.70 |
| D | 2.826 | | 3.026 |
| E | 2.60 | | 3.00 |
| E1 | 1.526 | | 1.726 |
| e | | 0.95 | |
| e1 | | 1.90 | |
| L | 0.35 | | 0.60 |
| L1 | | 0.59 | |
| L2 | | 0.25 | |
| R | 0.05 | | |
| R1 | 0.05 | | 0.20 |
| K | 3° | | 7° |
| K1 | 6° | | 10° |

Figure 23. SOT23-3L drawing



5 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 09-Oct-2004 | 1 | First document |
| 22-Jun-2004 | 2 | Complete document |
| 06-Apr-2005 | 3 | New typ and max value inserted for Vgs(th) |
| 19-Apr-2005 | 4 | The document has been reformatted |
| 26-Apr-2005 | 5 | New Pin configuration for TO-92 |
| 28-Apr-2005 | 6 | Pin configuration change again |
| 19-Jun-2006 | 7 | New template, no content change |
| 03-Sep-2007 | 8 | Corrected marking on first page |
| 04-Nov-2008 | 9 | <ul style="list-style-type: none"> – Updated <i>Table 7: TO-92 mechanical data</i> and <i>Figure 22: TO-92 drawing</i>. – Updated <i>Table 8: SOT23-3L mechanical data</i> and <i>Figure 23: SOT23-3L drawing</i>. |

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