

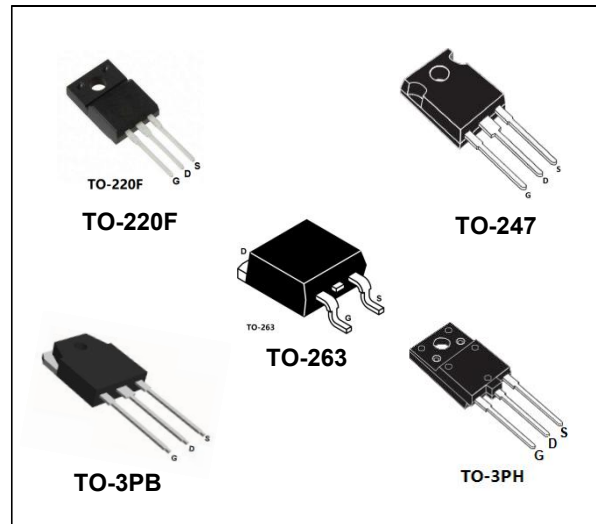
MS4N1350 MS4N1350E MS4N1350B MS4N1350W MS4N1350S

N-channel 1500 V, 6 Ω , 4 A, Power MOSFET
in TO-263, TO-247, TO-220F, TO-3PB, TO-3PH

Features

| Type | V _{DSS} | R _{DS(on)} | I _D | P _{TOT} |
|-----------|------------------|---------------------|----------------|------------------|
| | | max. | | |
| MS4N1350S | 1500 V | < 9 Ω | 4 A | 63 W |
| MS4N1350 | 1500 V | < 9 Ω | 4 A | 140 W |
| MS4N1350B | 1500 V | < 9 Ω | 4 A | 140 W |
| MS4N1350E | 1500 V | < 9 Ω | 4 A | 80 W |
| MS4N1350W | 1500 V | < 9 Ω | 4 A | 140 W |

- 100% avalanche tested
- Intrinsic capacitances and Q_g minimized
- High speed switching



Application

Switching applications

Description

MasPower has designed an advanced family of very high voltage Power MOSFETs with outstanding performances. The strengthened layout coupled with the company's proprietary edge termination structure, gives the lowest R_{DS(on)} per area, unrivalled gate charge and switching characteristics.

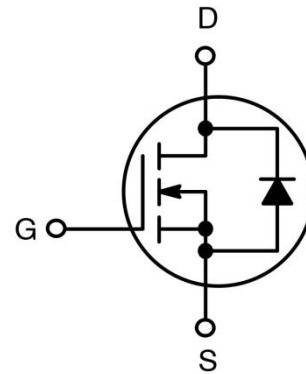


Table 1. Device summary

| Order codes | Marking | Package | Packaging |
|-------------|-----------|---------|-----------|
| MS4N1350 | MS4N1350 | TO-3PH | Tube |
| MS4N1350S | MS4N1350S | TO-220F | Tube |
| MS4N1350E | MS4N1350E | TO-263 | Tube |
| MS4N1350B | MS4N1350B | TO-3PB | Tube |
| MS4N1350W | MS4N1350W | TO-247 | Tube |

1 Electrical ratings

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | | Unit |
|-----------------|--|---------------------|--------------------|---------------------|
| | | TO-3P,TO-3PH,TO-247 | TO-220F | |
| V_{DS} | Drain-source voltage ($V_{GS} = 0$) | 1500 | | V |
| V_{GS} | Gate-source voltage | ± 30 | | V |
| I_D | Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$ | 4 | 4 ⁽¹⁾ | A |
| I_D | Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$ | 2.6 | 2.6 ⁽¹⁾ | A |
| I_{DM} (1) | Drain current (pulsed) | 10 | 10 ⁽¹⁾ | A |
| P_{TOT} | Total dissipation at $T_C = 25\text{ }^\circ\text{C}$ | 140 | 63 | W |
| V_{ISO} | Insulation with stand voltage (RMS) from all three leads to external heat sink ($t=1\text{ s}; T_C=25\text{ }^\circ\text{C}$) | | 3500 | V |
| | Derating factor | 1.18 | 0.63 | W/ $^\circ\text{C}$ |
| T_{stg} | storage temperature | -50 to 150 | | $^\circ\text{C}$ |
| T_j | Max. operating junction temperature | 150 | | $^\circ\text{C}$ |

1. Pulse width limited by safe operating area

Table 3. Thermal data

| Symbol | Parameter | TO-3P | TO-247 | TO-263 | TO-3PH,TO-220F | Unit |
|----------------|--|-------|--------|--------|----------------|---------------------------|
| $R_{thj-case}$ | Thermal resistance junction-case max | 0.9 | | 0.63 | 2 | $^\circ\text{C}/\text{W}$ |
| $R_{thj-amb}$ | Thermal resistance junction-ambient max | 63.5 | 50 | 35 | 50 | $^\circ\text{C}/\text{W}$ |
| T_j | Maximum lead temperature for soldering purpose | 300 | | | | $^\circ\text{C}$ |

Table 4. Avalanche characteristics

| Symbol | Parameter | Max 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 $T_j = 25\text{ }^\circ\text{C}$, $I_D = I_{AR}$, $V_{DD} = 50\text{ V}$) | 510 | mJ |

2 Electrical characteristics ($T_{\text{case}} = 25\text{ }^{\circ}\text{C}$ unless otherwise specified)

Table 5. On /off states

| Symbol | Parameter | Testconditions | Min. | Typ. | Max. | Unit |
|---------------|--|---|------|------|-----------|---------------|
| $V_{(BR)DSS}$ | Drain-source breakdown voltage | $I_D = 1\text{ mA}$, $V_{GS} = 0$ | 1500 | | | V |
| I_{DSS} | Zero gate voltage | $V_{DS} = \text{Max rating}$ | | | 10 | μA |
| | drain current ($V = 0$) | $V = \text{Max rating}$, $T = 125\text{ }^{\circ}\text{C}$ | | | 500 | μA |
| I_{GSS} | Gate-body leakage current ($V_{DS} = 0$) | $V_{GS} = \pm 30\text{ V}$ | | | ± 100 | nA |
| $V_{GS(th)}$ | Gate threshold voltage | $V_{DS} = V_{GS}$, $I_D = 250\text{ }\mu\text{A}$ | 3.2 | 4.5 | 6 | V |
| $R_{DS(on)}$ | static drain-source on resistance | $V_{GS} = 10\text{ V}$, $I_D = 1.3\text{ A}$ | | 5.8 | 9 | Ω |

Table 6. Dynamic

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------------------|-------------------------------|---|------|------|------|---------------|
| g_{fs} (1) | Forward transconductance | $V_{DS} = 30\text{ V}$, $I_D = 1.3\text{ A}$ | - | 2.6 | - | S |
| C_{iss} | Input capacitance | $V_{DS} = 25\text{ V}$, $f = 1\text{ MHz}$, $V_{GS} = 0$ | - | 1408 | - | μF |
| C_{oss} | Output capacitance | | | 153 | | μF |
| C_{rss} | Reverse transfer capacitance | | | 19.8 | | μF |
| $C_{oss\text{ eq.}}$ (2) | Equivalent output capacitance | $V_{DS}=0$ to 1200 V , $V_{GS} = 0$ | - | 138 | - | μF |
| R_g | Gate input resistance | $f=1\text{ MHz}$ Gate DC Bias=0 Test signal level=20 mV open drain | - | 5.3 | - | Ω |
| Q_g | Total gate charge | $V_{DD} = 1200\text{ V}$, $I_D = 4\text{ A}$, $V_{GS} = 10\text{ V}$ (see Figure 19) | - | 44 | - | nC |
| Q_{gs} | Gate-source charge | | | 6.9 | | nC |
| Q_{gd} | Gate-drain charge | | | 23.8 | | nC |

1. Pulsed: Pulse duration = 300 μs , duty cycle 1.5%
2. $C_{oss\text{ eq.}}$ 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 7. Switching times

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------|---------------------|--|------|------|------|------|
| $t_{d(on)}$ | Turn-on delay time | V = 800 V, I = 1.25 A, R _G = 4.8 Ω, V _{GS} = 10 V | | 26 | | ns |
| t_r | Rise time | | | 51 | | ns |
| $t_{d(off)}$ | Turn-off-delay time | | - | 48 | - | ns |
| t_f | Fall time | | | 69 | | ns |

Table 8. Source drain diode

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|----------------------|-------------------------------|---|------|------|------|------|
| I _{SD} | Source-drain current | | | | 4 | A |
| I _{SDM} (1) | Source-drain current (pulsed) | | - | | 10 | A |
| V _{SD} (2) | Forward on voltage | I _{SD} = 4 A, V _{GS} = 0 | - | | 1.63 | V |
| t_{rr} | Reverse recovery time | I _{SD} = 4 A, di/dt = 100 A/μs V _{DD} = 60 V | | 390 | | ns |
| Q _{rr} | Reverse recovery charge | | | 2.2 | | μc |
| I _{RRM} | Reverse recovery current | | - | 12.6 | | A |
| t_{rr} | Reverse recovery time | I _{SD} = 4 A, di/dt = 100 A/μs V _{DD} = 60 V, T _j = 150 °C | | 510 | | ns |
| Q _{rr} | Reverse recovery charge | | | 3.8 | | μc |
| I _{RRM} | Reverse recovery current | | - | 13.2 | | 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-3PH

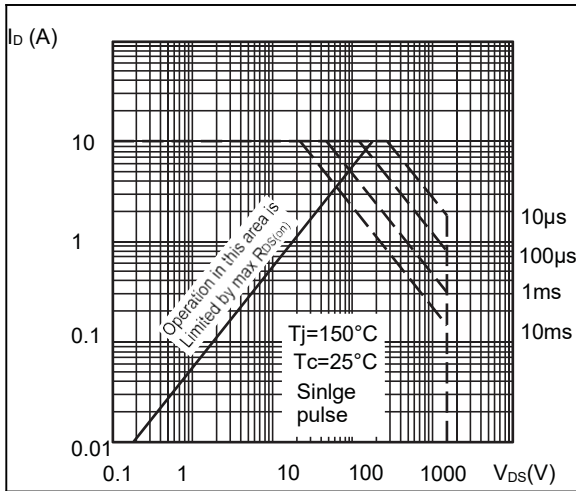


Figure 3. Thermal impedance for TO-3PH

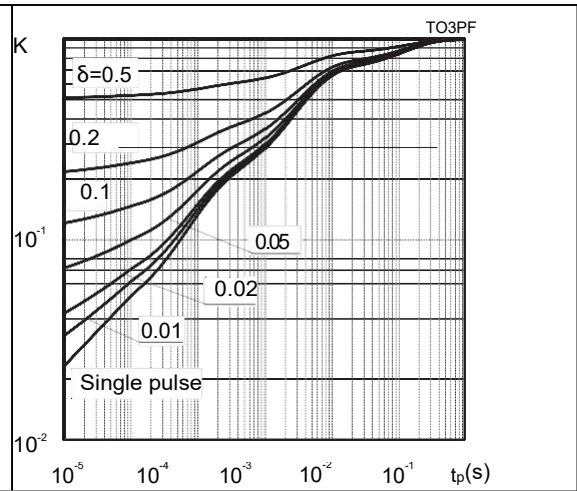


Figure 4. Safe operating area for TO-220

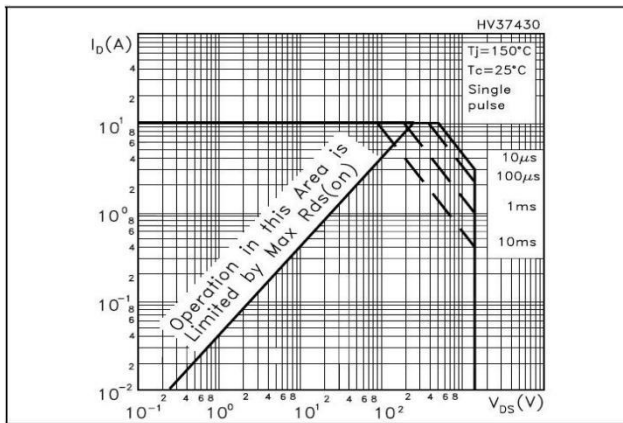


Figure 5. Thermal impedance for TO-220

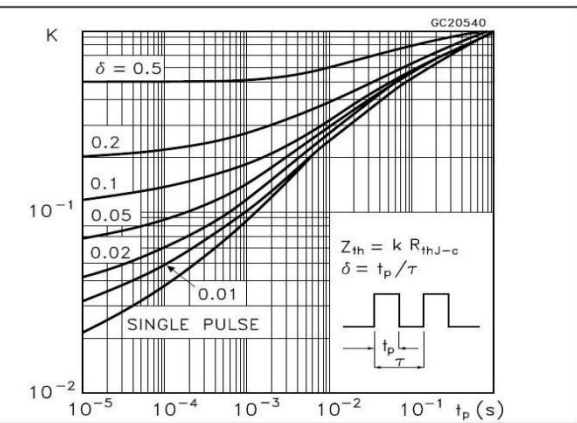


Figure 6. Safe operating area for TO-247

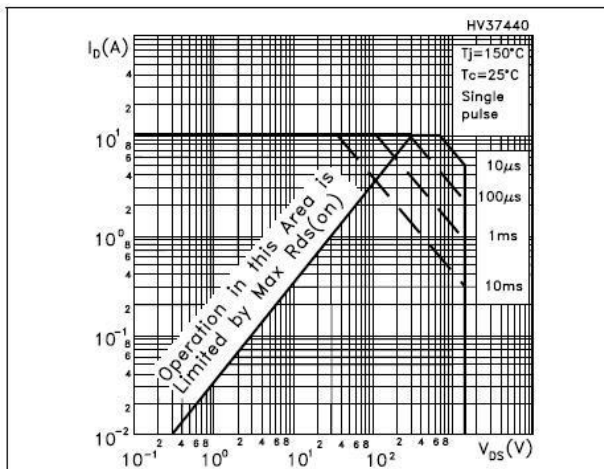


Figure 7. Thermal impedance for TO-247

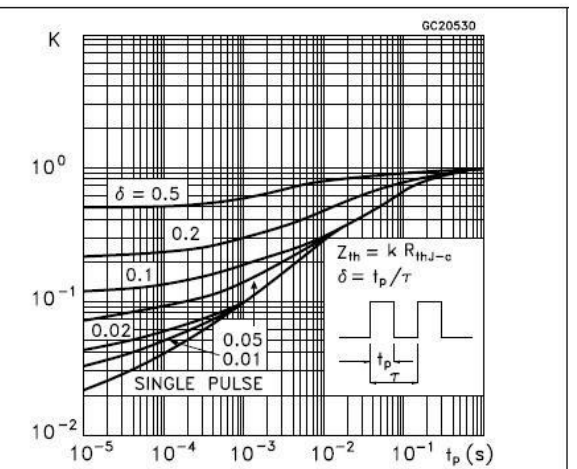


Figure 8. Output characteristics

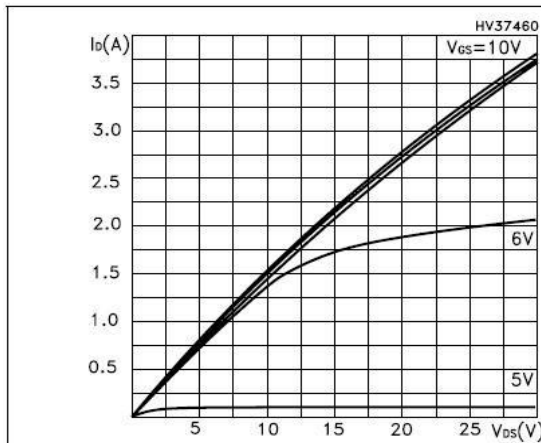


Figure 9. Transfer characteristics

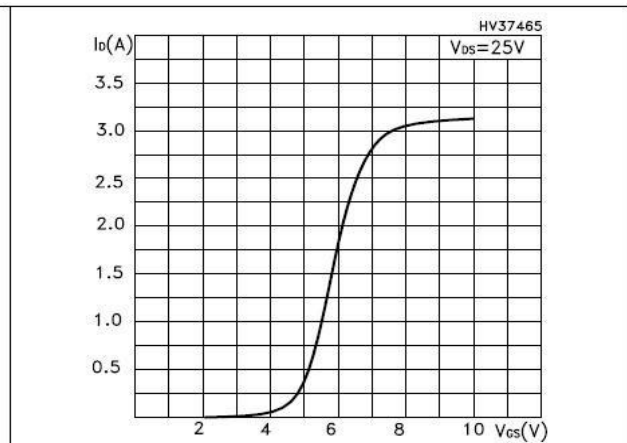


Figure 10. Normalized BV_{DSS} vs. temperature

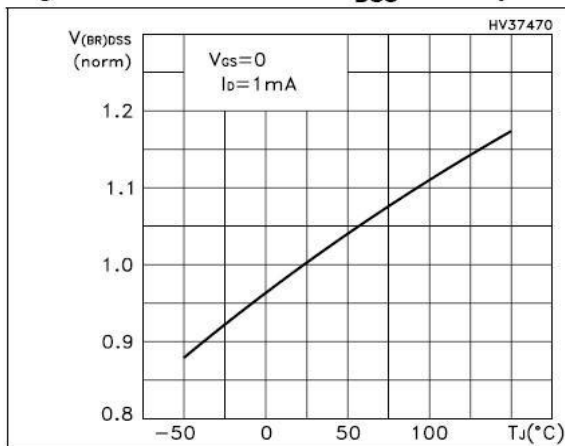


Figure 11. Static drain-source on resistance

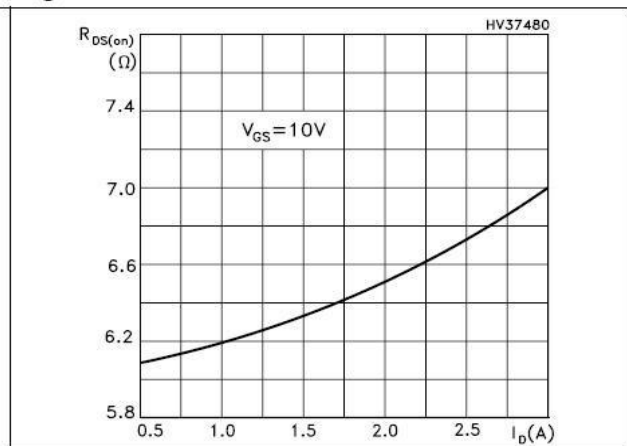


Figure 12. Gate charge vs. gate-source voltage

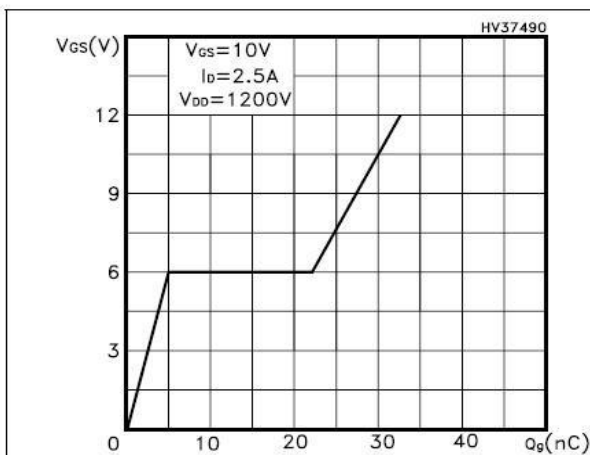


Figure 13. Capacitance variations

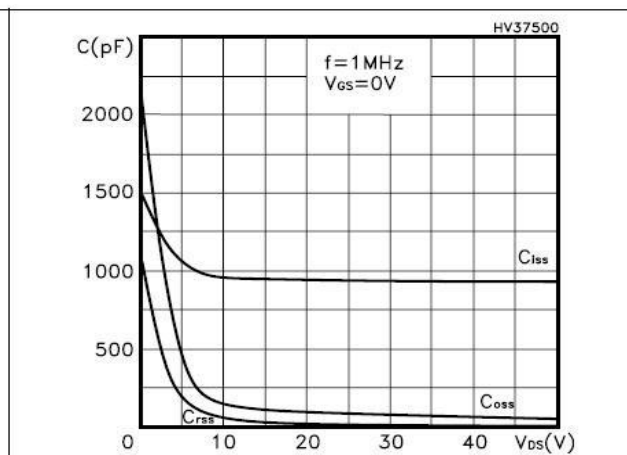


Figure 14. Normalized gate threshold voltage vs. temperature

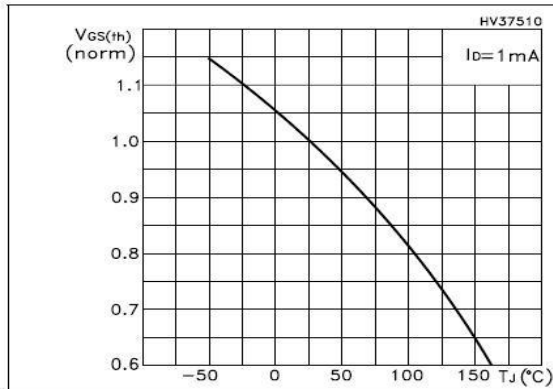


Figure 15. Normalized on resistance vs. temperature

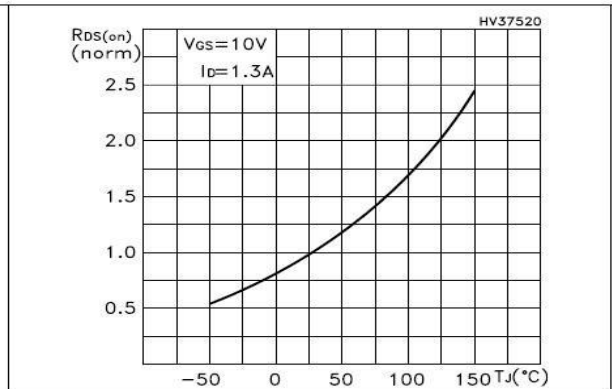


Figure 16. Source-drain diode forward characteristics

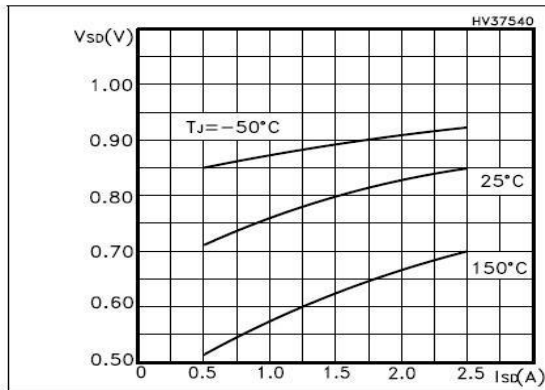
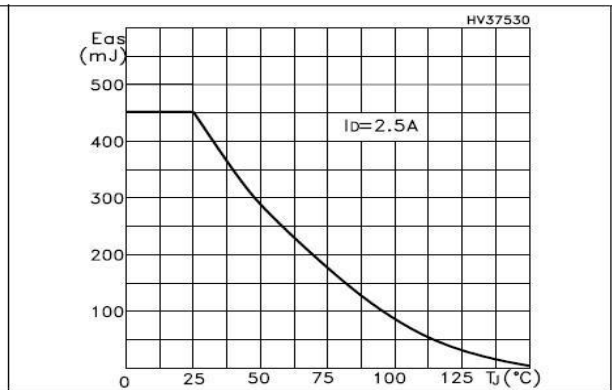


Figure 17. Maximum avalanche energy vs Tj



3 Test circuits

Figure 18. Switching times test circuit for resistive load

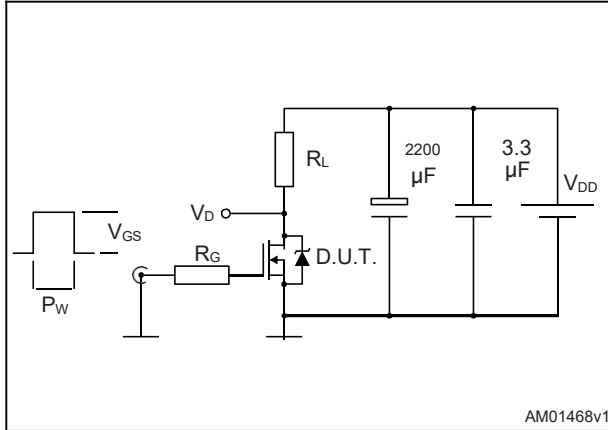


Figure 19. Gate charge test circuit

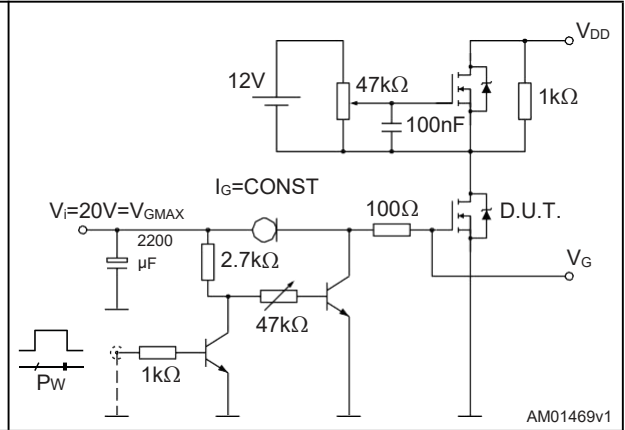


Figure 20. Test circuit for inductive load switching and diode recovery times

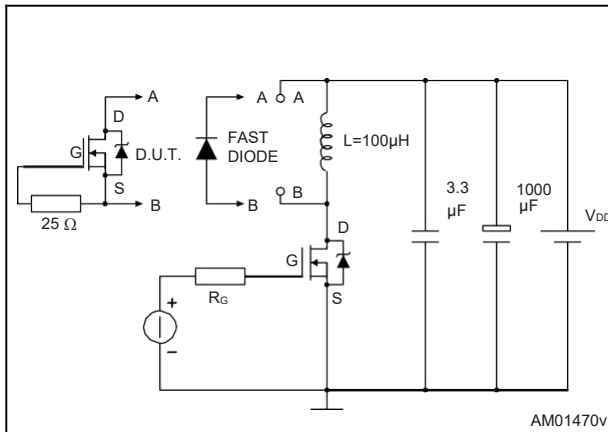


Figure 21. Unclamped inductive load test circuit

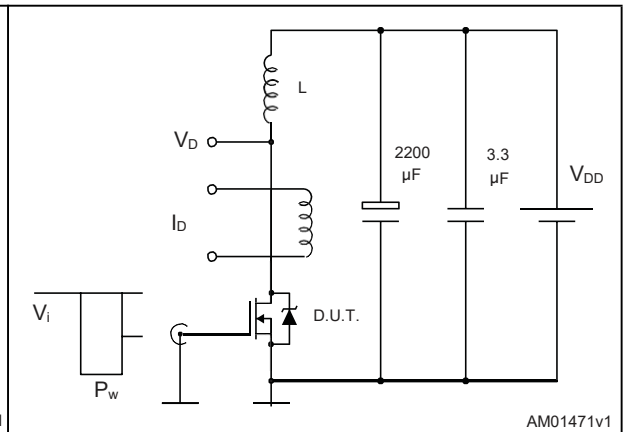


Figure 22. Unclamped inductive waveform

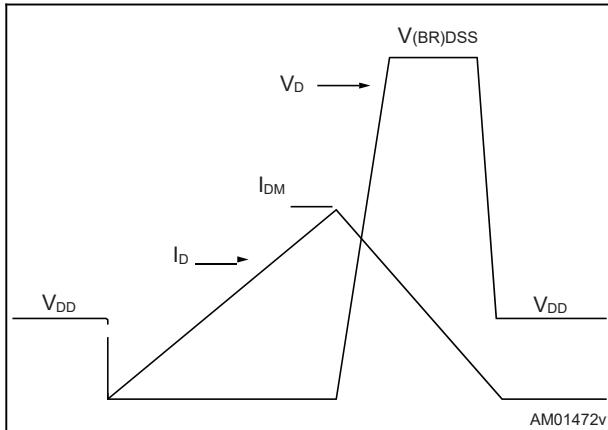
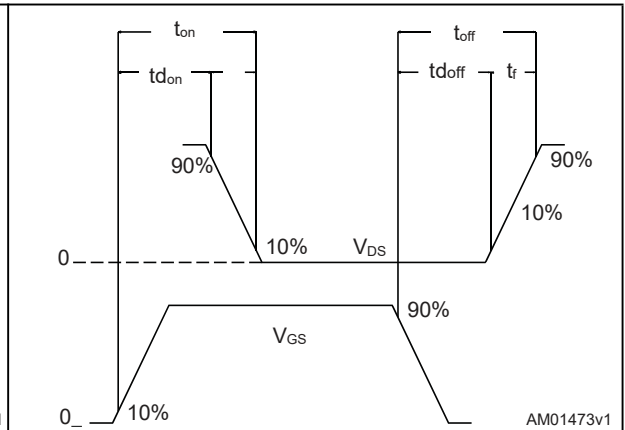


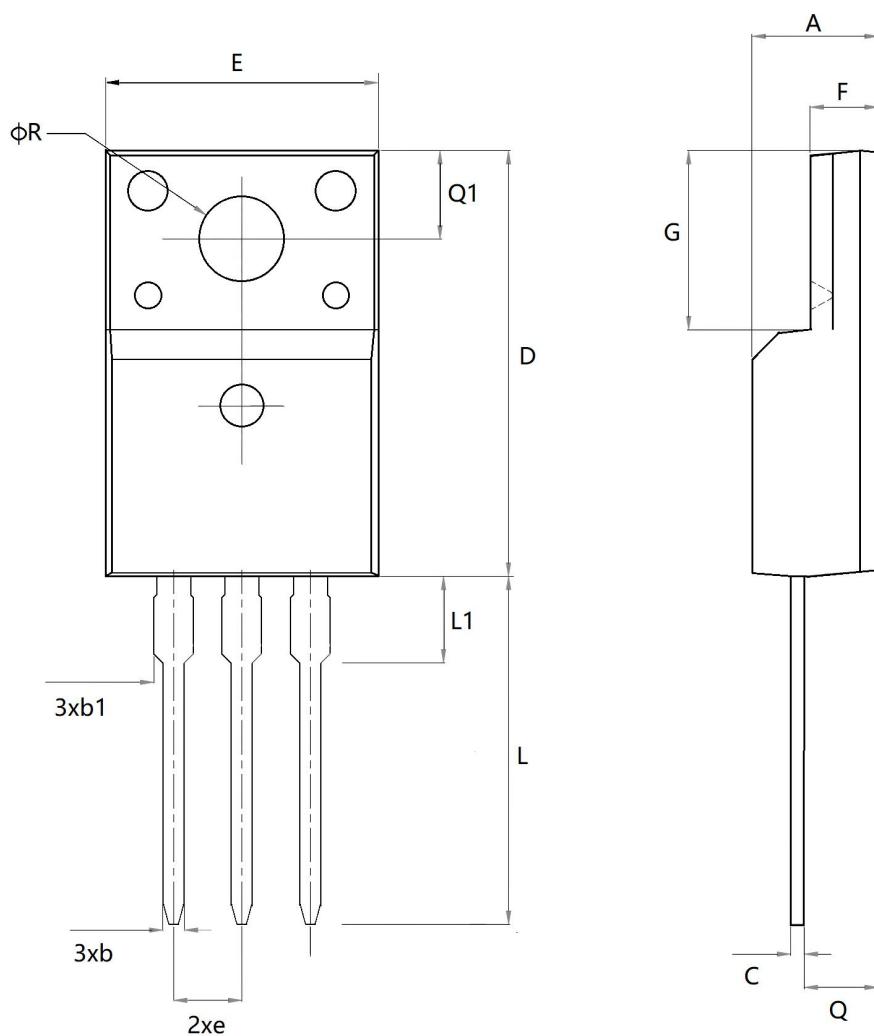
Figure 23. Switching time waveform



4 Package mechanical data

TO-220F mechanical

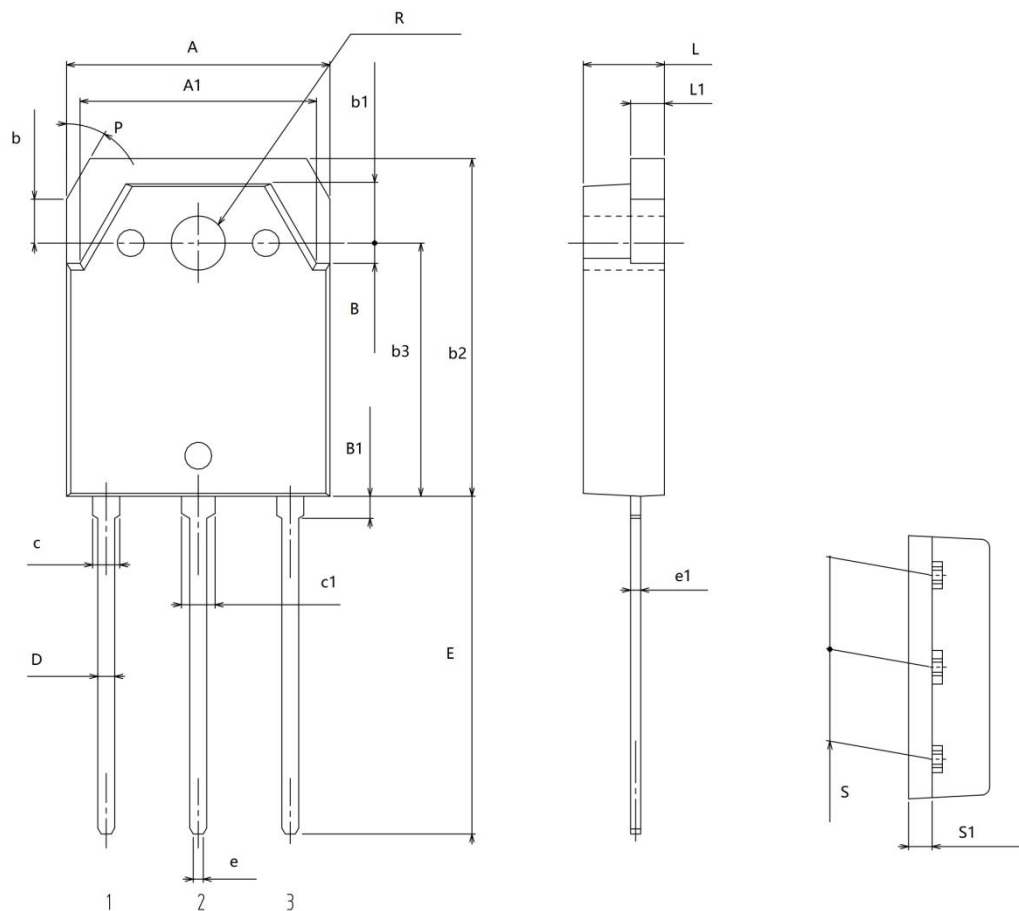
| DIM. | mm. | | |
|------|-------|------|-------|
| | min. | typ | max. |
| A | 4.52 | | 4.82 |
| C | 0.45 | | 0.6 |
| D | 15.67 | | 15.97 |
| Q1 | 3.20 | | 3.41 |
| E | 10.01 | | 10.36 |
| F | 2.34 | | 2.74 |
| L | 12.78 | | 13.18 |
| G | 6.48 | | 6.88 |
| L1 | 3.23 | | 3.43 |
| R | | 3.18 | |



Package mechanical data

TO-3PB Mechanical data

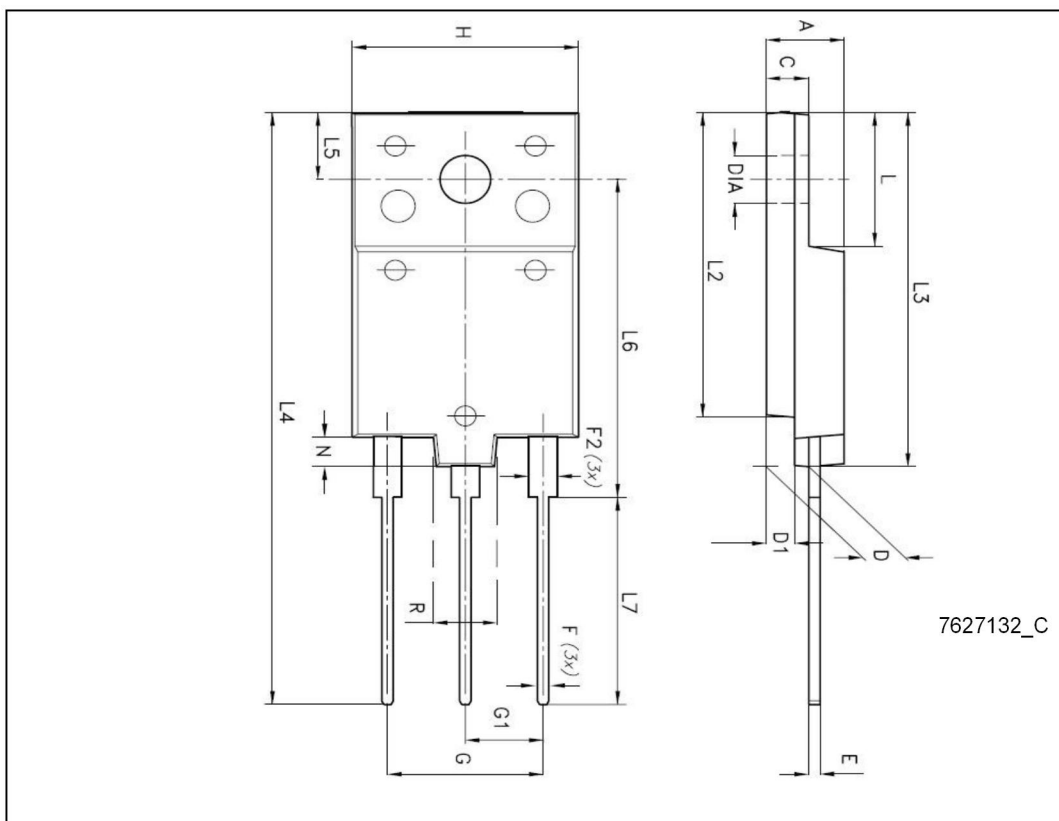
| Dim | mm. | | |
|-----|------|------|------|
| | Min | Typ | Max |
| A | 15.3 | 15.6 | 15.9 |
| A1 | 13.8 | 14 | 14.2 |
| b | 2.4 | 2.6 | 2.8 |
| b1 | 3.3 | 3.5 | 3.7 |
| b2 | 19.7 | 20 | 20.3 |
| b3 | 14.7 | 15 | 15.3 |
| B | 1 | 0.2 | 1.4 |
| B1 | 1 | 1.3 | 1.6 |
| c | 1.3 | 1.6 | 1.9 |
| c1 | 1.7 | 2 | 2.3 |
| D | 0.9 | 1 | 1.3 |
| E | 19.5 | 20 | 20.5 |
| e | 0.4 | 0.6 | 0.8 |
| e1 | - | 0.6 | - |
| L | 4.6 | 4.8 | 5 |
| L1 | 1.8 | 2 | 2.2 |
| P | 30° | | |
| R | - | 3.2 | - |
| S | - | 5.45 | - |
| S1 | - | 1.41 | - |



Package mechanical data

TO-3PH mechanical data

| DIM. | mm. | | |
|------|-------|------|-------|
| | min. | typ | max. |
| A | 5.30 | | 5.70 |
| C | 2.80 | | 3.20 |
| D | 3.10 | | 3.50 |
| D1 | 1.80 | | 2.20 |
| E | 0.80 | | 1.10 |
| F | 0.65 | | 0.95 |
| F2 | 1.80 | | 2.20 |
| G | 10.30 | | 11.50 |
| G1 | | 5.45 | |
| H | 15.30 | | 15.70 |
| L | 9.80 | 10 | 10.20 |
| L2 | 22.80 | | 23.20 |
| L3 | 26.30 | | 26.70 |
| L4 | 43.20 | | 44.40 |
| L5 | 4.30 | | 4.70 |
| L6 | 24.30 | | 24.70 |
| L7 | 14.60 | | 15 |
| N | 1.80 | | 2.20 |
| R | 3.80 | | 4.20 |
| Dia | 3.40 | | 3.80 |

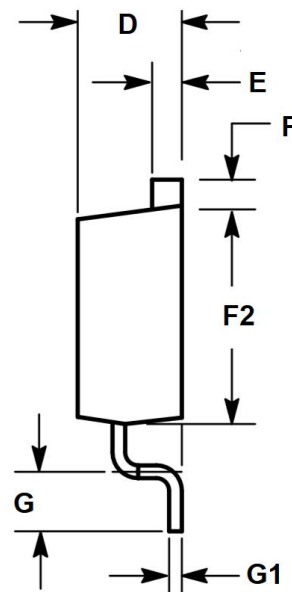
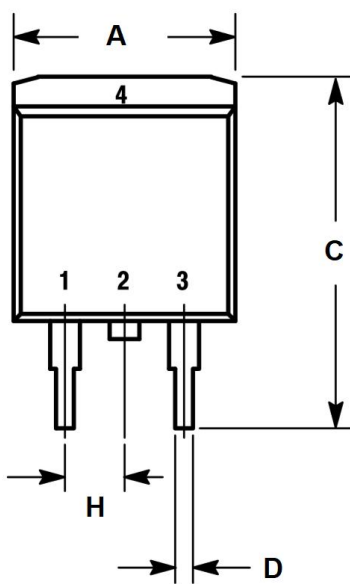


Package mechanical data

TO-263 mechanical data

| DIM. | mm. | | |
|------|------|---------|-------|
| | min. | typ | max. |
| A | 9.65 | | 10.29 |
| C | 14.6 | | 15.88 |
| D | 0.51 | | 0.92 |
| D1 | 4.06 | | 4.83 |
| E | 1.14 | | 1.40 |
| F | 1.14 | | 1.40 |
| F2 | 8.64 | | 9.64 |
| G | 2.29 | | 2.79 |
| G1 | 0.46 | | 0.64 |
| H | | 2.54BSC | |

TO-263/D2PAK



TO-247 mechanical data

| DIM. | mm. | | |
|------|---------|-----|-------|
| | min. | typ | max. |
| A | 4.7 | | 5.31 |
| A1 | 2.21 | | 2.59 |
| A2 | 1.5 | | 2.49 |
| b | 1 | | 1.4 |
| b2 | 1.65 | | 2.39 |
| b4 | 2.59 | | 3.43 |
| c | 0.38 | | 0.89 |
| D | 20.8 | | 21.46 |
| D1 | 13.08 | | - |
| D2 | 0.51 | | 1.35 |
| E | 15.49 | | 16.26 |
| E1 | 13.46 | | - |
| E2 | 4.32 | | 5.49 |
| e | 5.46BSC | | |
| L | 19.81 | | 20.32 |
| L1 | - | | 4.5 |
| P | 3.56 | | 3.66 |
| Q | 5.38 | | 6.2 |
| S | 6.15BSC | | |

