



## N-Channel Super Junction MOSFET, 600V, 2.1Ω

### General Description

The VAS60R2K1 Super Junction (SJ) Power MOSFETs is designed to provide best cost-performance switch solution for various application fields, such as consumer and lighting markets. It is available in DPAK, IPAK and SOT223 packages.

### Features

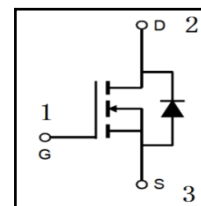
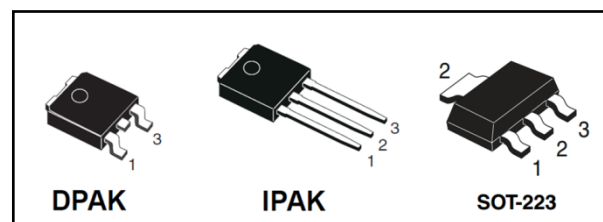
- High Efficiency
- Low Gate Charge
- High Body Diode Ruggedness
- 100% EAS Guaranteed
- Halogen-Free

### Application

Adapter, TV, LED Lighting, PFC stages, hard switching PWM stages and resonant switching stages.

### Product Summary

|                          |        |
|--------------------------|--------|
| $V_{DS}@T_{j,max}$       | 600 V  |
| $R_{DS(on)}@V_{GS}=10V$  | 2.1 Ω  |
| $I_D$ Continuous Current | 4 A    |
| $V_{(GS)th}$             | 3.0 V  |
| $Q_{g,typ}$              | 6.7 nC |



### Absolute Maximum Ratings

| Parameter                               | Symbol         | Value    | Unit | Condition                                 |
|---|----------------|----------|------|---|
| Drain-Source Voltage                    | $V_{DS}$       | 600      | V    |   |
| Continuous drain current <sup>(1)</sup> | $I_D$          | 4<br>2.9 | A    | $T_C=25^\circ C$<br>$T_C=100^\circ C$     |
| Gate-Source Voltage                     | $V_{GS}$       | $\pm 20$ | V    | Static                                    |
| Pulsed drain current <sup>(2)</sup>     | $I_{DM}$       | 6        | A    | $T_C=25^\circ C$                          |
| Avalanche energy, single pulse          | $E_{AS}$       | 11       | mJ   | $I_D=0.4A$ ; $V_{DD}=50V$ ; see Figure 13 |
| Avalanche energy, repetitive            | $E_{AR}$       | 0.06     | mJ   | $I_D=0.4A$ ; $V_{DD}=50V$ ; see Figure 13 |
| Avalanche current, repetitive           | $I_{AR}$       | 0.4      | A    |   |
| Power dissipation TO-252, TO-251        | $P_{tot\_TO}$  | 38       | W    | $T_C=25^\circ C$                          |
| Power dissipation SOT223                | $P_{tot\_sot}$ | 5        | W    | $T_C=25^\circ C$                          |
| Continuous diode forward current        | $I_S$          | 2.7      | A    | $T_C=25^\circ C$                          |
| Diode pulse current <sup>(2)</sup>      | $I_{S,pulse}$  | 6        | A    | $T_C=25^\circ C$                          |

(1) Limited by  $T_{j,max}$ . Maximum duty cycle  $D=0.4$

(2) Pulse width  $T_p$  limited by  $T_{j,max}$



### Thermal characteristics

| Symbol         | Parameter                                 | Value  |        |                   | Unit |
|----------------|---|--------|--------|-------------------|------|
|                |   | TO-252 | TO-251 | SOT223            |      |
| $R_{thj-case}$ | Thermal resistance, junction-case, max    | 3.26   | 3.26   | 25                | °C/W |
| $R_{thJA}$     | Thermal resistance, junction-ambient, max | 62     | 62     | 75 <sup>(3)</sup> | °C/W |
| $T_{sold}$     | Soldering temperature, max                | 260    | 260    | 260               | °C   |

(3) Device on 40mm\*40mm\*1.5mm epoxy PCB FR4 with 6cm<sup>2</sup> (one layer, 70µm thickness) copper area for drain connection and cooling. PCB is vertical without air stream cooling.

### Package and Ordering Information

| Device     | Package | Marking    |
|------------|---------|------------|
| VAS60R2K1D | TO-252  | VAS60R2K1D |
| VAS60R2K1I | TO-251  | VAS60R2K1I |
| VAS60R2K1S | SOT223  | VAS60R2K1S |



**Electrical Characteristics** ( $T_j=25^{\circ}\text{C}$ , unless otherwise specified)

| Parameter                           | Symbol        | Min | Typ  | Max | Unit          | Test Condition   |
|-------------------------------------|---------------|-----|------|-----|---------------|--|
| <b>Static Characteristic</b>        |               |     |      |     |               |  |
| Drain-Source breakdown Voltage      | $V_{(BR)DSS}$ | 600 |      |     | V             | $V_{GS}=0\text{V}, I_D=0.25\text{mA}$  |
| Gate Threshold Voltage              | $V_{(GS)th}$  | 2.5 | 3.0  | 3.5 | V             | $V_{DS}=V_{GS}, I_D=0.06\text{mA}$   |
| Drain-Source on resistance          | $R_{(DS)on}$  |     | 1.8  | 2.1 | $\Omega$      | $V_{GS}=10\text{V}, I_D=0.76\text{A}, T_j=25^{\circ}\text{C}$                            |
|                                     |               |     | 4.68 |     | $\Omega$      | $V_{GS}=10\text{V}, I_D=0.76\text{A}, T_j=150^{\circ}\text{C}$                           |
| Zero gate voltage drain current     | $I_{DSS}$     |     |      | 1   | $\mu\text{A}$ | $V_{DS}=600\text{V}, V_{GS}=0\text{V}, T_j=25^{\circ}\text{C}$                           |
|                                     |               |     | 10   |     | $\mu\text{A}$ | $V_{DS}=600\text{V}, V_{GS}=0\text{V}, T_j=150^{\circ}\text{C}$                          |
| Gate-Source leakage current         | $I_{GSS}$     |     |      | 100 | nA            | $V_{GS}=20\text{V}, V_{DS}=0\text{V}$  |
| Gate resistance                     | $R_g$         |     | 12   |     | $\Omega$      | $f=1\text{MHz}$ , open drain   |
| <b>Dynamic Characteristic</b>       |               |     |      |     |               |  |
| Input Capacitance                   | $C_{iss}$     |     | 140  |     | pF            | $V_{GS}=0\text{V}, V_{DS}=100\text{V}, f=1\text{MHz}$                                    |
| Output Capacitance                  | $C_{oss}$     |     | 12   |     | pF            | $V_{GS}=0\text{V}, V_{DS}=100\text{V}, f=1\text{MHz}$                                    |
| Turn-on delay time                  | $T_{d(on)}$   |     | 7    |     | nS            | $V_{DD}=400\text{V}, V_{GS}=10\text{V}, I_D=0.9\text{A}, R_G=12.2\Omega$ ; See Figure 14 |
| Rise time                           | $T_r$         |     | 7    |     | nS            |  |
| Turn-off delay time                 | $T_{d(off)}$  |     | 30   |     | nS            |  |
| Fall time                           | $T_f$         |     | 50   |     | nS            |  |
| <b>Gate Charge Characteristic</b>   |               |     |      |     |               |  |
| Gate to source charge               | $Q_{gs}$      |     | 0.8  |     | nC            | $V_{DD}=480\text{V}, I_D=0.9\text{A}, V_{GS}=0\text{ to }10\text{V}$                     |
| Gate to drain charge                | $Q_{gd}$      |     | 3.6  |     | nC            |  |
| Gate charge total                   | $Q_g$         |     | 6.7  |     | nC            |  |
| Gate plateau voltage                | $V_{plateau}$ |     | 5.4  |     | V             |  |
| <b>Reverse diode characteristic</b> |               |     |      |     |               |  |
| Diode forward voltage               | $V_{FD}$      |     | 0.9  |     | V             | $V_{GS}=0\text{V}, I_F=0.9\text{A}, T_j=25^{\circ}\text{C}$                              |
| Reverse recovery time               | $t_{rr}$      |     | 180  |     | nS            | $V_R=400\text{V}, I_F=0.9\text{A}, dI_F/dt=100\text{A}/\mu\text{S}$                      |
| Reverse recovery charge             | $Q_{rr}$      |     | 0.67 |     | $\mu\text{C}$ |  |
| Peak reverse recovery current       | $I_{rrm}$     |     | 7.1  |     | A             |  |



### Electrical Characteristic Diagrams

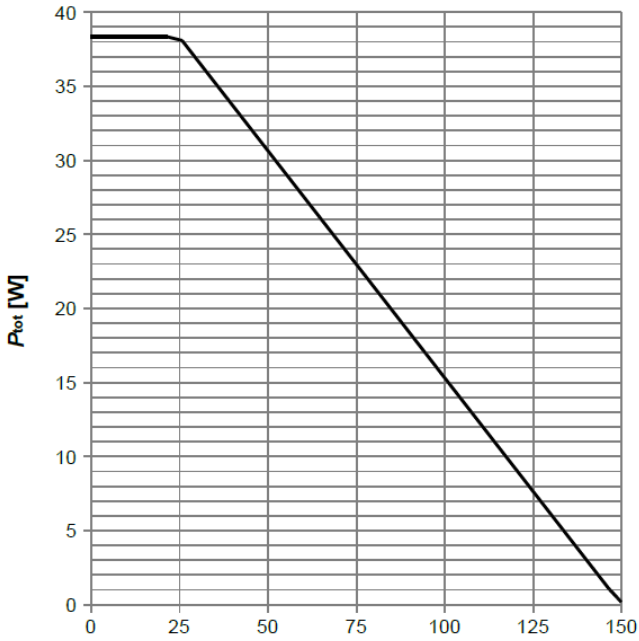


Figure 1 Power Dissipation

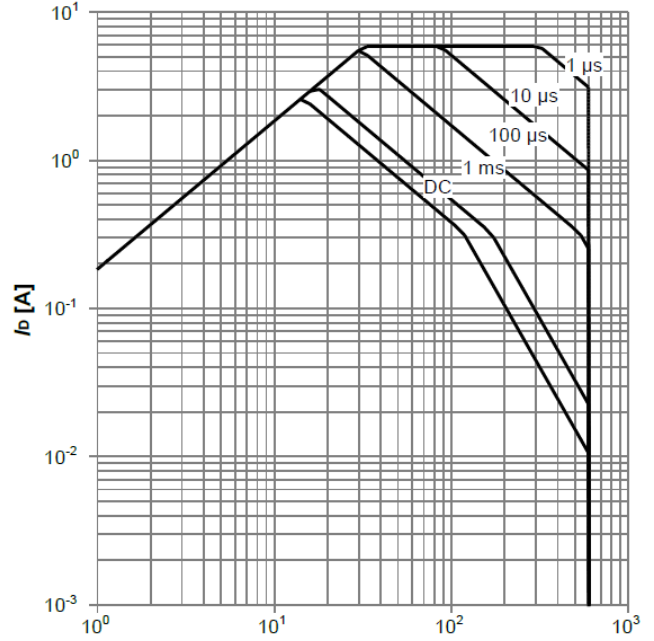


Figure 2 Safe Operation Area @T<sub>c</sub>=25 °C

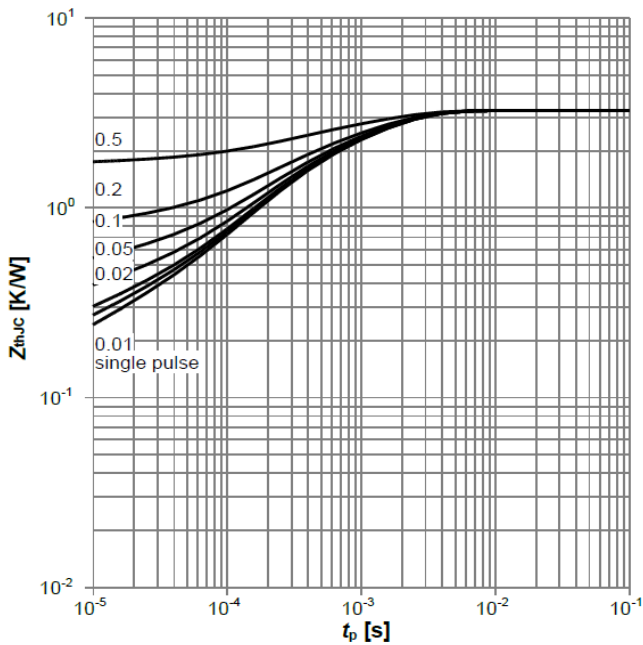


Figure 3 Maximum Transient thermal impedance

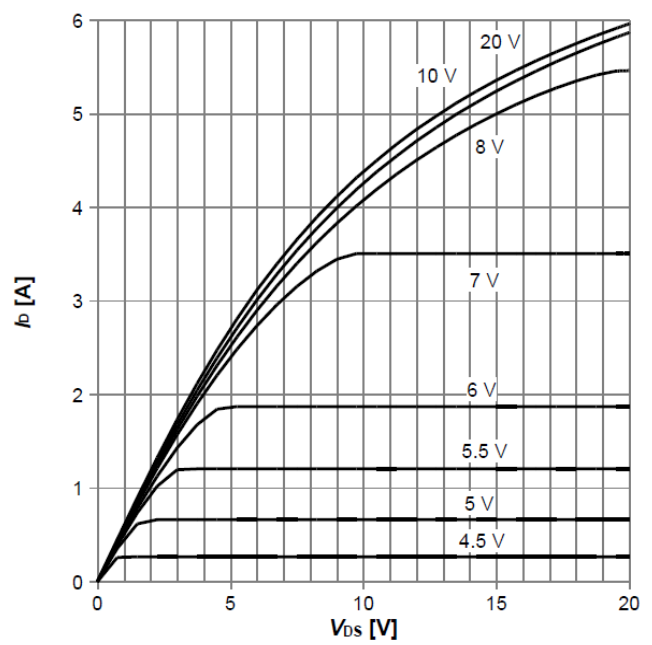


Figure 4 Typical Output Characteristics @T<sub>c</sub>=25 °C

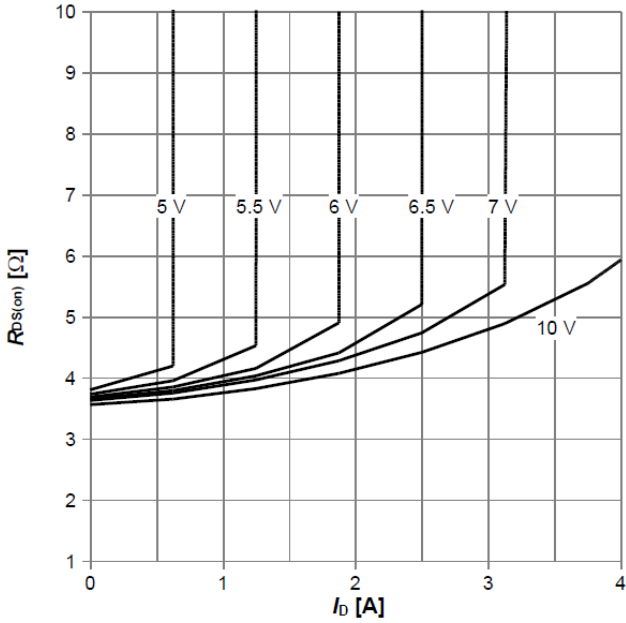


Figure 5 Typical Drain-Source on resistance @  $T_j=125^\circ\text{C}$

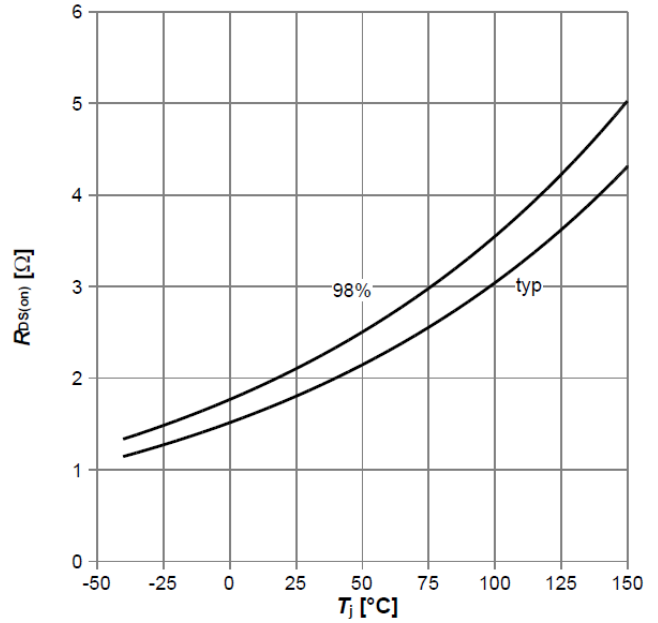


Figure 6 On resistance Temp Characteristic

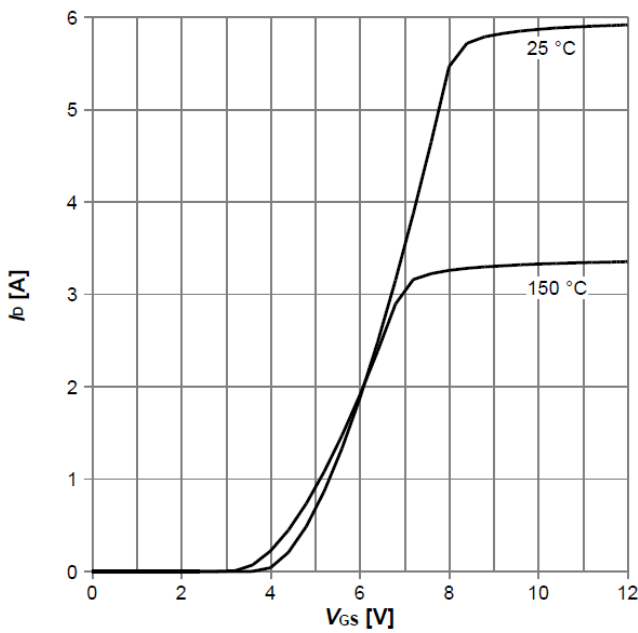


Figure 7 Typical Transfer characteristic @  $V_{DS}=20\text{V}$

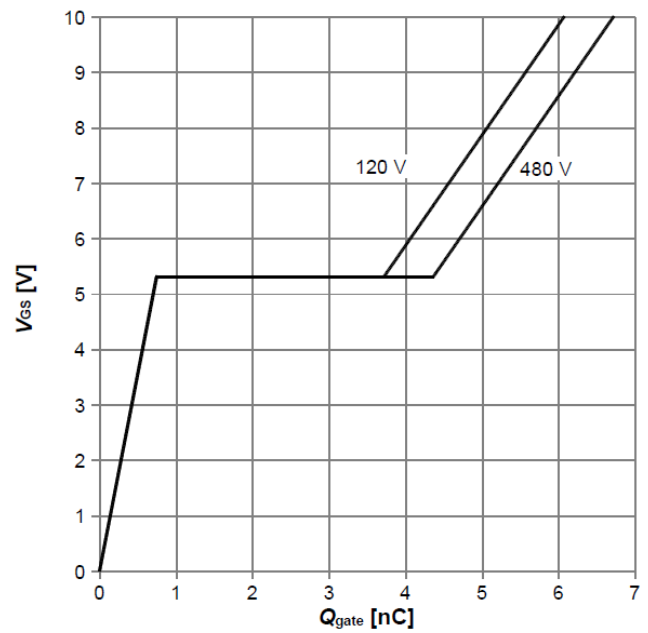


Figure 8 Typical Gate charge plot @  $I_D=0.9\text{A}$

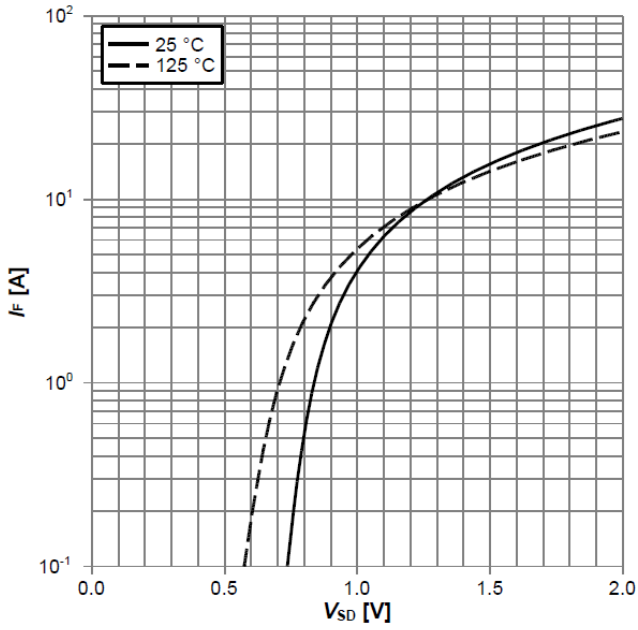


Figure 9 Reverse diode forward characteristic

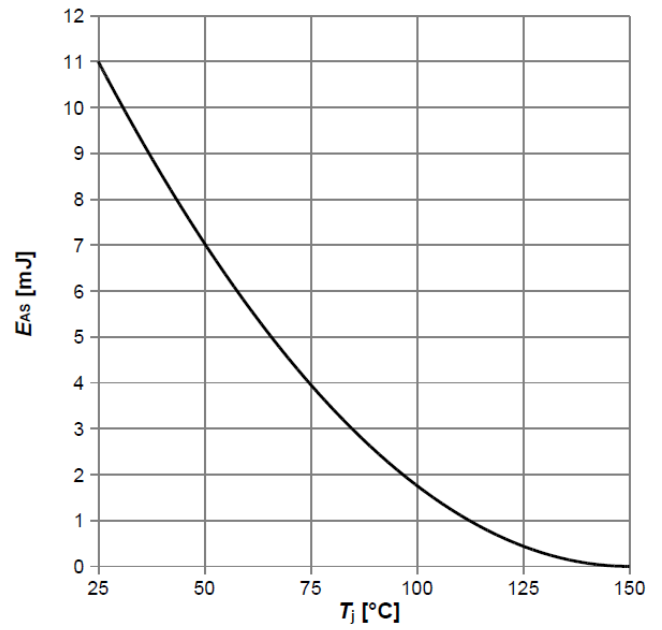


Figure 10 Avalanche Energy @  $V_{DD}=50V$

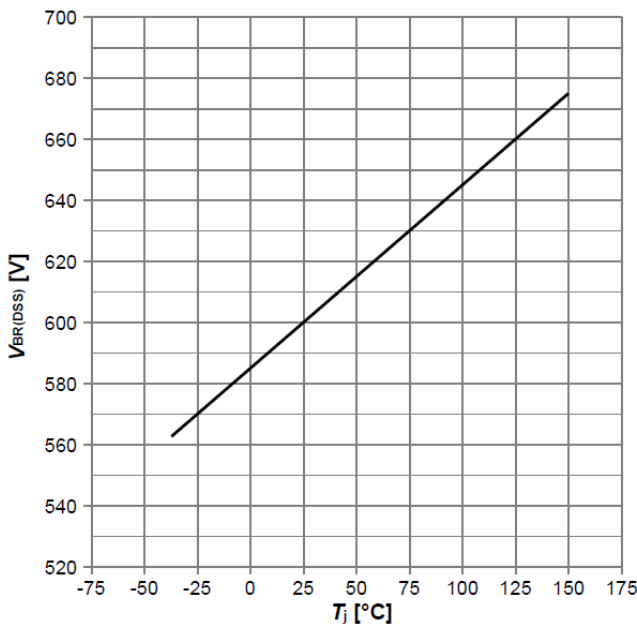


Figure 11 Drain-Source breakdown voltage

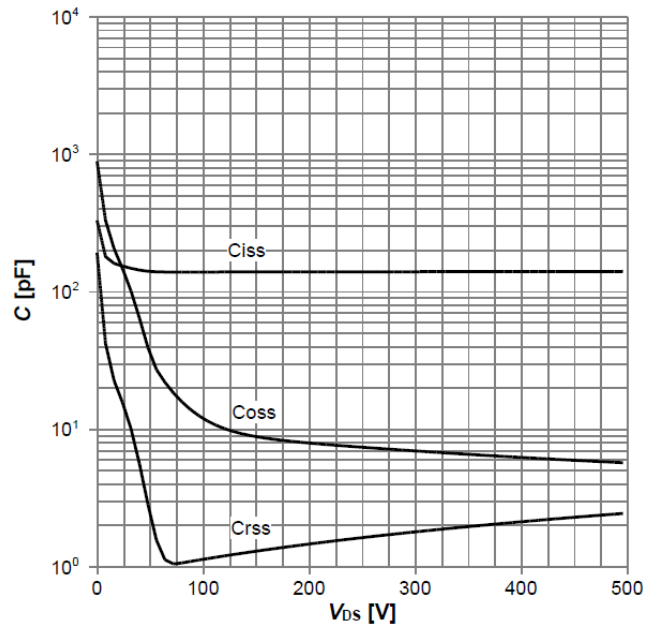


Figure 12 Capacitance characteristics

### Parameter Test Circuits

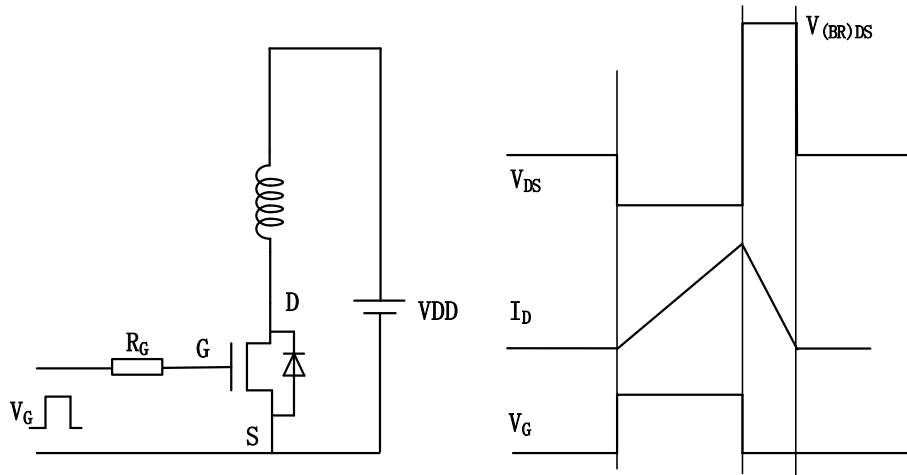


Figure 13 Unclamped Inductive Switching (UIS) Test circuit and waveforms

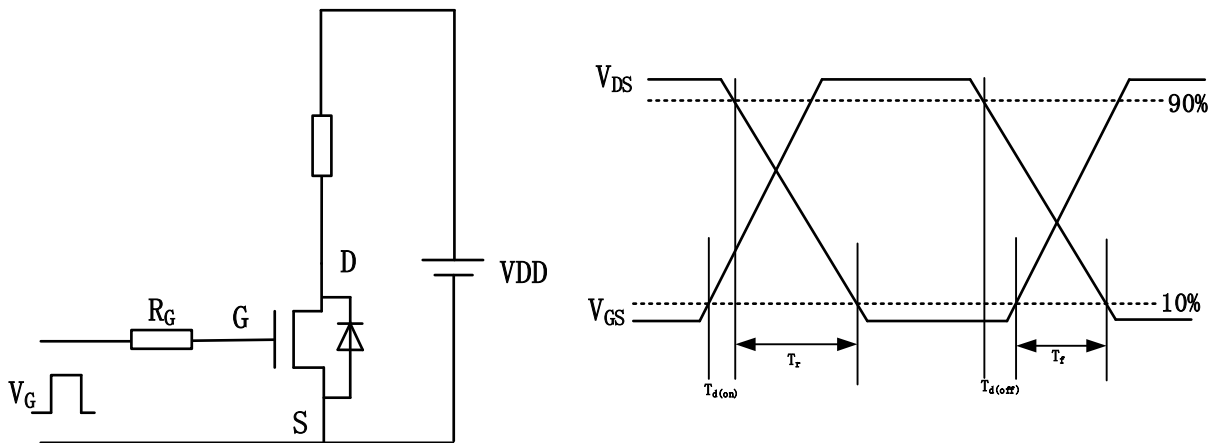


Figure 14 Resistive Switching time Test circuit and waveforms

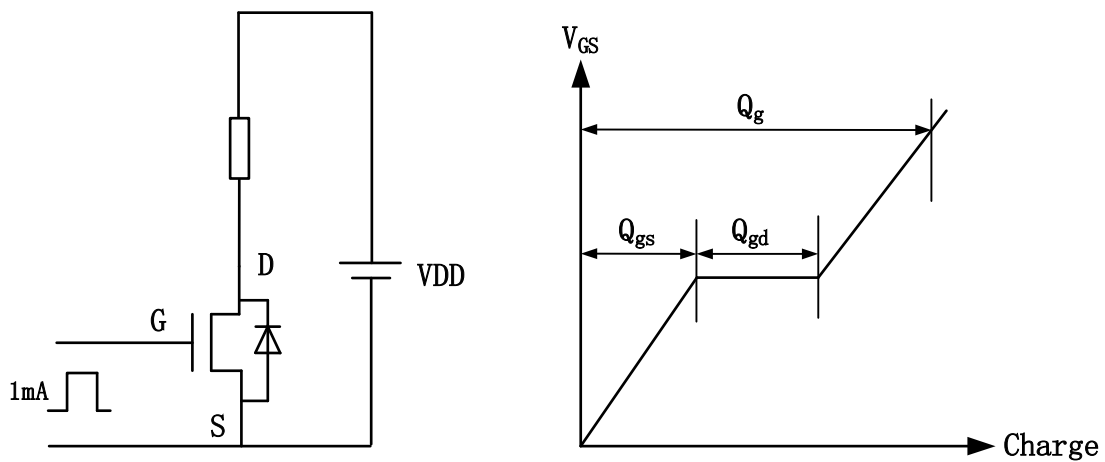
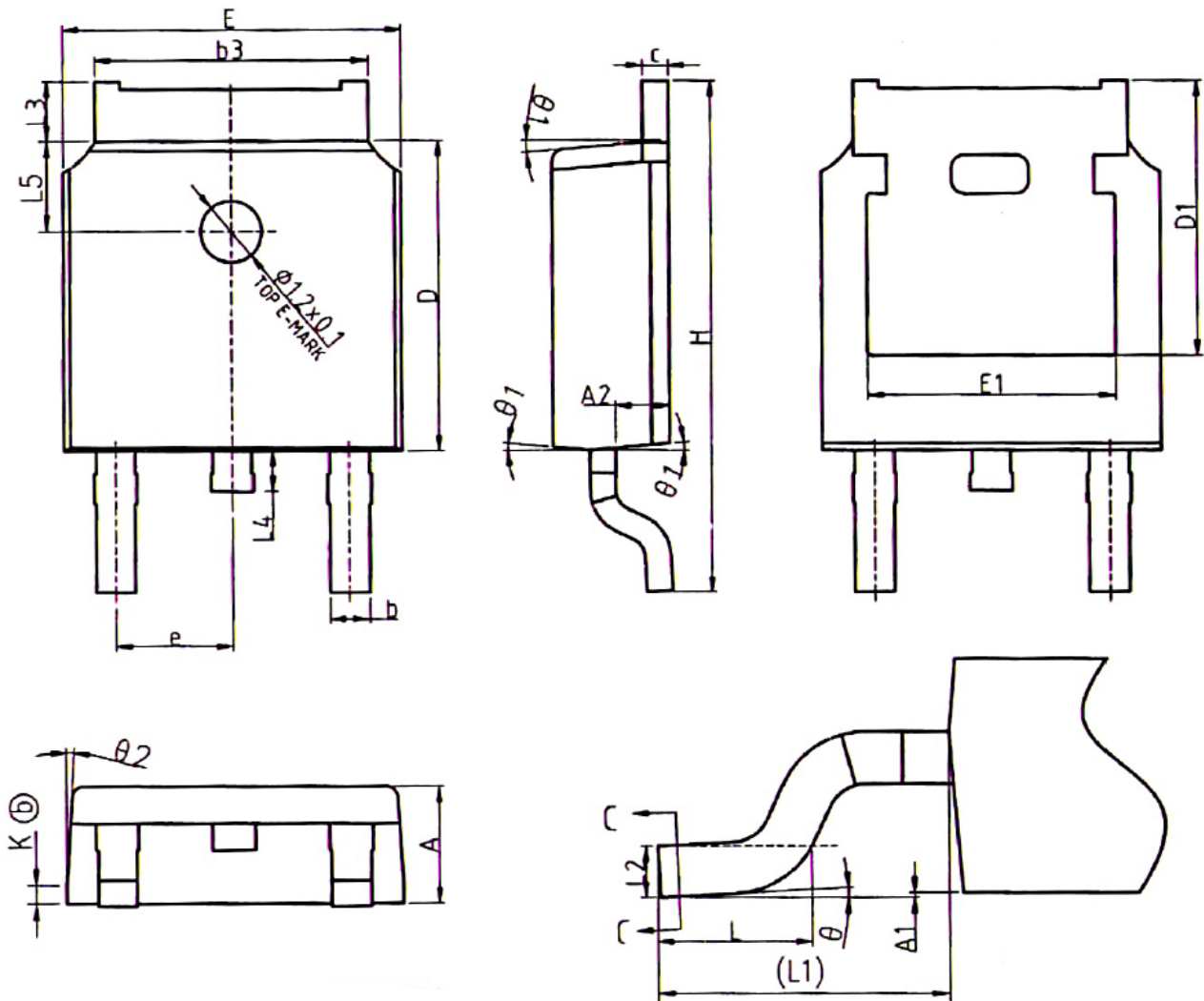


Figure 15 Gate charge Test circuit and waveforms

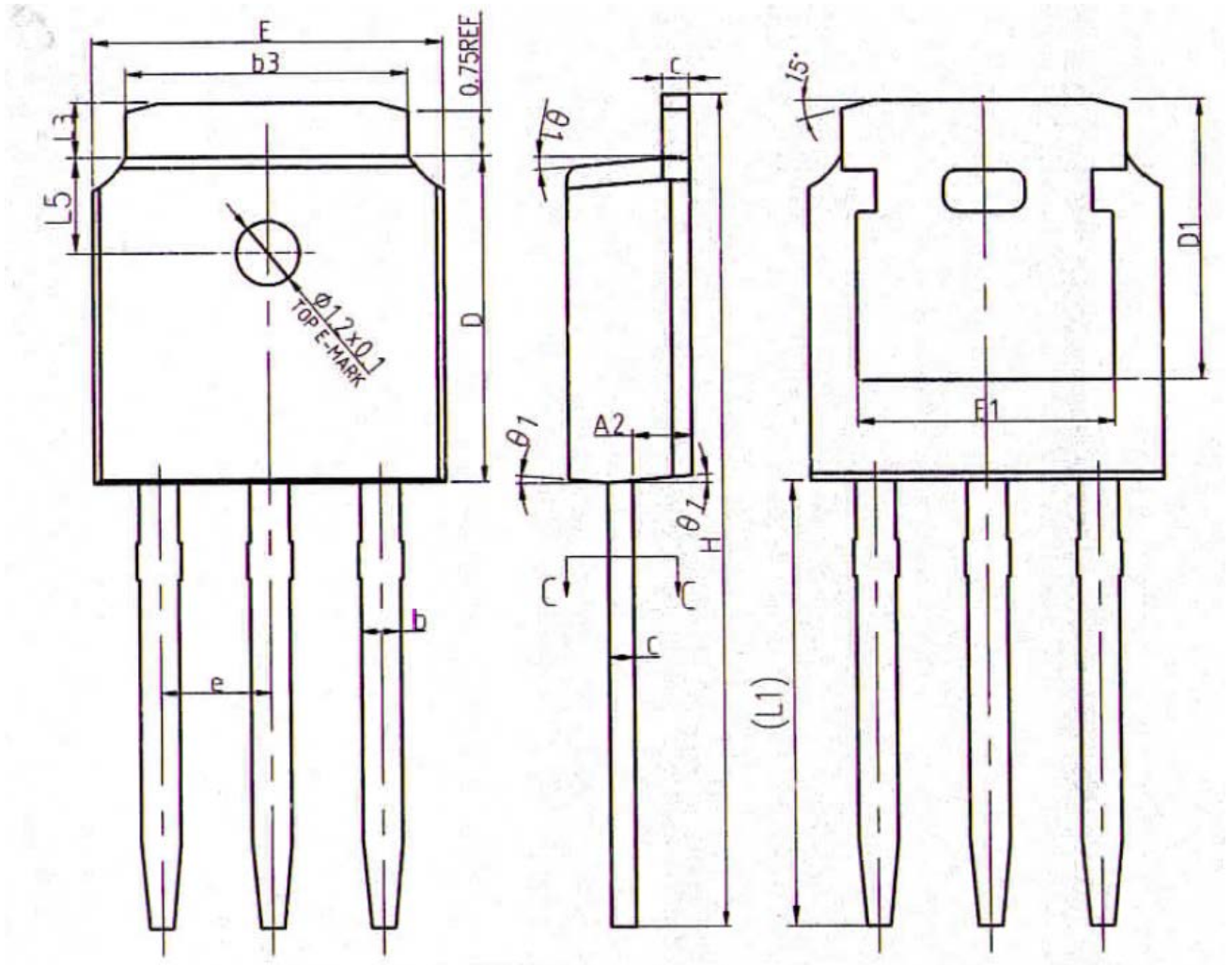


Package Information



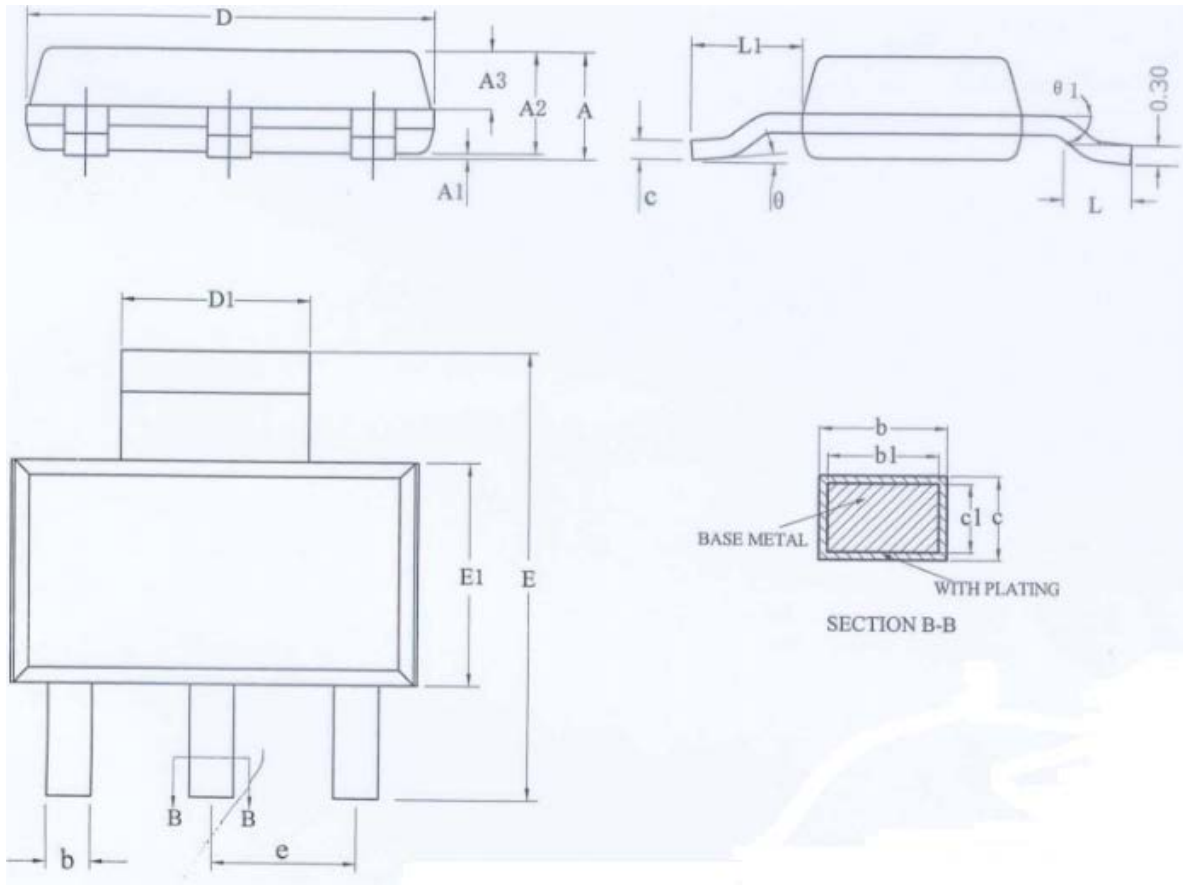
| TO-252 Common dimensions |          |      |      |            |          |       |       |
|--------------------------|----------|------|------|------------|----------|-------|-------|
| SYMBOL                   | Unit: mm |      |      | SYMBOL     | Unit: mm |       |       |
|                          | MIN      | NOM  | MAX  |            | MIN      | NOM   | MAX   |
| A                        | 2.20     | 2.30 | 2.38 | e          | 2.286BSC |       |       |
| A1                       | 0.00     | -    | 0.10 | H          | 9.90     | 10.10 | 10.30 |
| A2                       | 0.97     | 1.07 | 1.17 | L          | 1.40     | 1.50  | 1.70  |
| b                        | 0.72     | 0.78 | 0.85 | L1         | 2.90REF  |       |       |
| b1                       | 0.71     | 0.76 | 0.81 | L2         | 0.51BSC  |       |       |
| b3                       | 5.23     | 5.33 | 5.46 | L3         | 0.90     |       | 1.25  |
| c                        | 0.47     | 0.53 | 0.58 | L4         | 0.60     | 0.80  | 1.00  |
| c1                       | 0.46     | 0.51 | 0.56 | L5         | 1.70     | 1.80  | 1.90  |
| D                        | 6.00     | 6.10 | 6.20 | $\theta$   | 0°       |       | 8°    |
| D1                       | 5.30REF  |      |      | $\theta_1$ | 5°       | 7°    | 9°    |
| E                        | 6.50     | 6.60 | 6.70 | $\theta_2$ | 5°       | 7°    | 9°    |
| E1                       | 4.70     | 4.83 | 4.92 | K          | 0.40REF  |       |       |





TO-251 Common dimensions

| SYMBOL | Unit: mm |      |      | SYMBOL | Unit: mm |       |       |
|--------|----------|------|------|--------|----------|-------|-------|
|        | MIN      | NOM  | MAX  |        | MIN      | NOM   | MAX   |
| A      | 2.20     | 2.30 | 2.38 | e      | 2.286BSC |       |       |
| A2     | 0.97     | 1.07 | 1.17 | H      | 16.10    | 16.40 | 16.60 |
| b      | 0.72     | 0.78 | 0.85 | L1     | 9.20     | 9.40  | 9.60  |
| b1     | 0.71     | 0.76 | 0.81 | L3     | 0.90     | 1.02  | 1.25  |
| b3     | 5.23     | 5.33 | 5.46 | L5     | 1.70     | 1.80  | 1.90  |
| c      | 0.47     | 0.53 | 0.58 | θ1     | 5°       | 7°    | 9°    |
| c1     | 0.46     | 0.51 | 0.56 | θ2     | 5°       | 7°    | 9°    |
| D      | 6.00     | 6.10 | 6.20 | K      | 0.40REF  |       |       |
| D1     | 5.30REF  |      |      |        |          |       |       |
| E      | 6.50     | 6.60 | 6.70 |        |          |       |       |
| E1     | 4.70     | 4.83 | 4.92 |        |          |       |       |



| SOT223 Common dimensions |          |      |      |        |          |     |     |
|--------------------------|----------|------|------|--------|----------|-----|-----|
| SYMBOL                   | Unit: mm |      |      | SYMBOL | Unit: mm |     |     |
|                          | MIN      | NOM  | MAX  |        | MIN      | NOM | MAX |
| A                        | 1.50     | 1.65 | 1.80 | e      | 2.30BSC  |     |     |
| A1                       | 0.03     | 0.06 | 0.09 | L1     | 1.75BSC  |     |     |
| A2                       | 1.45     | 1.60 | 1.75 | theta  | 0        |     | 7°  |
| A3                       | 0.80     | 0.90 | 1.00 | theta1 | 37.5 REF |     |     |
| b                        | 0.69     |      | 0.78 |        |          |     |     |
| b1                       | 0.68     | 0.71 | 0.74 |        |          |     |     |
| c                        | 0.30     |      | 0.35 |        |          |     |     |
| c1                       | 0.29     | 0.30 | 0.31 |        |          |     |     |
| D                        | 6.30     | 6.50 | 6.70 |        |          |     |     |
| D1                       | 3.00REF  |      |      |        |          |     |     |
| E                        | 6.80     | 7.00 | 7.20 |        |          |     |     |
| E1                       | 3.40     | 3.50 | 3.60 |        |          |     |     |

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