

# Enhancement Mode N-Channel Power MOSFET

## Features

- ◆ Low  $R_{DS(on)}$  & FOM
- ◆ Extremely low switching loss
- ◆ Excellent stability and uniformity
- ◆ Easy to drive

## Applications

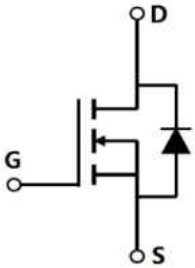






- ◆ Lighting
- ◆ Hard switching PWM
- ◆ Server power supply
- ◆ Charger

## General Description

OSG65R380xF use advanced GreenMOSTM technology to provide low  $R_{DS(ON)}$ , low gate charge, fast switching and excellent avalanche characteristics. This device is suitable for active power factor correction and switching mode power supply applications.

|                                   |         |
|-----------------------------------|---------|
| ◆ $V_{DS, min@Tjmax}$             | 700 V   |
| ◆ $I_{D, pulse}$                  | 33 A    |
| ◆ $R_{DS(ON), max @ V_{GS}=10 V}$ | 380 mΩ  |
| ◆ $Q_g$                           | 12.5 nC |

## Schematic and Package Information

| Schematic Diagram  | Pin Assignment Top View   |   |   |  |   |   |
|--|---|---|---|--|---|---|
|  |  |  |  |  |  |  |
|  | TO251   | TO252   | TO220F  | TO220  | TO263   | TO262   |
|  | OSG65R380AF   | OSG65R380DF   | OSG65R380FF   | OSG65R380PF  | OSG65R380KF   | OSG65R380IF   |

## Absolute Maximum Ratings at $T_j=25^{\circ}\text{C}$ unless otherwise noted

| Parameter  | Symbol         | Value      | Unit               |
|--|----------------|------------|--------------------|
| Drain source voltage   | $V_{DS}$       | 650        | V                  |
| Gate source voltage  | $V_{GS}$       | $\pm 30$   | V                  |
| Continuous drain current <sup>1)</sup> , $T_C=25^{\circ}\text{C}$                        | $I_D$          | 11         | A                  |
| Continuous drain current <sup>1)</sup> , $T_C=100^{\circ}\text{C}$                       |                | 7          |                    |
| Pulsed drain current <sup>2)</sup> , $T_C=25^{\circ}\text{C}$                            | $I_{D, pulse}$ | 33         | A                  |
| Power dissipation <sup>3)</sup> for TO251, TO252, TO220, TO263, $T_C=25^{\circ}\text{C}$ | $P_D$          | 83         | W                  |
| Power dissipation <sup>3)</sup> for TO220F, $T_C=25^{\circ}\text{C}$                     |                | 31         |                    |
| Single pulsed avalanche energy <sup>5)</sup>   | $E_{AS}$       | 200        | mJ                 |
| MOSFET dv/dt ruggedness, $V_{DS}=0\text{...}480\text{ V}$                                | dv/dt          | 50         | V/ns               |
| Reverse diode dv/dt, $V_{DS}=0\text{...}480\text{ V}$ , $I_{SD}\leq I_D$                 | dv/dt          | 15         | V/ns               |
| Operation and storage temperature  | $T_{stg}, T_j$ | -55 to 150 | $^{\circ}\text{C}$ |

## ■ Thermal Characteristics

| Parameter  | Symbol          | Value                             |        | Unit |
|--|-----------------|-----------------------------------|--------|------|
|  |                 | TO251/TO252/TO220/<br>TO263/TO262 | TO220F |      |
| Thermal resistance, junction-case                  | $R_{\theta JC}$ | 1.5                               | 4      | °C/W |
| Thermal resistance, junction-ambient <sup>4)</sup> | $R_{\theta JA}$ | 62                                | 62.5   | °C/W |

## ■ Electrical Characteristics at $T_j=25\text{ }^\circ\text{C}$ unless otherwise specified

| Parameter                        | Symbol       | Min. | Typ. | Max. | Unit          | Test condition  |
|----------------------------------|--------------|------|------|------|---------------|---|
| Drain-source breakdown voltage   | $BV_{DSS}$   | 650  |      |      | V             | $V_{GS}=0\text{ V}$ , $I_D=250\text{ }\mu\text{A}$                                      |
|                                  |              | 700  | 770  |      |               | $V_{GS}=0\text{ V}$ , $I_D=250\text{ }\mu\text{A}$ ,<br>$T_j=150\text{ }^\circ\text{C}$ |
| Gate threshold voltage           | $V_{GS(th)}$ | 2.9  |      | 3.9  | V             | $V_{DS}=V_{GS}$ , $I_D=250\text{ }\mu\text{A}$  |
| Drain-source on-state resistance | $R_{DS(on)}$ |      | 0.35 | 0.38 | $\Omega$      | $V_{GS}=10\text{ V}$ , $I_D=5.5\text{ A}$   |
|                                  |              |      | 0.89 |      |               | $V_{GS}=10\text{ V}$ , $I_D=5.5\text{ A}$ ,<br>$T_j=150\text{ }^\circ\text{C}$          |
| Gate-source leakage current      | $I_{GSS}$    |      |      | 100  | nA            | $V_{GS}=30\text{ V}$  |
|                                  |              |      |      | -100 |               | $V_{GS}=-30\text{ V}$   |
| Drain-source leakage current     | $I_{DSS}$    |      |      | 1    | $\mu\text{A}$ | $V_{DS}=650\text{ V}$ , $V_{GS}=0\text{ V}$   |

## ■ Dynamic Characteristics

| Parameter                    | Symbol       | Min. | Typ.  | Max. | Unit | Test condition   |
|------------------------------|--------------|------|-------|------|------|--|
| Input capacitance            | $C_{iss}$    |      | 743.4 |      | pF   | $V_{GS}=0\text{ V}$ ,<br>$V_{DS}=50\text{ V}$ ,<br>$f=100\text{ kHz}$                            |
| Output capacitance           | $C_{oss}$    |      | 63.3  |      | pF   |  |
| Reverse transfer capacitance | $C_{rss}$    |      | 6.0   |      | pF   |  |
| Turn-on delay time           | $t_{d(on)}$  |      | 20.3  |      | ns   | $V_{GS}=10\text{ V}$ ,<br>$V_{DS}=400\text{ V}$ ,<br>$R_G=2\text{ }\Omega$ ,<br>$I_D=6\text{ A}$ |
| Rise time                    | $t_r$        |      | 5.4   |      | ns   |  |
| Turn-off delay time          | $t_{d(off)}$ |      | 29.5  |      | ns   |  |
| Fall time                    | $t_f$        |      | 4.4   |      | ns   |  |

## ■ Gate Charge Characteristics

| Parameter            | Symbol               | Min. | Typ. | Max. | Unit | Test condition  |
|----------------------|----------------------|------|------|------|------|---|
| Total gate charge    | $Q_g$                |      | 12.5 |      | nC   | $I_D=6\text{ A}$ ,<br>$V_{DS}=400\text{ V}$ ,<br>$V_{GS}=10\text{ V}$ |
| Gate-source charge   | $Q_{gs}$             |      | 3.2  |      | nC   |   |
| Gate-drain charge    | $Q_{gd}$             |      | 4.8  |      | nC   |   |
| Gate plateau voltage | $V_{\text{plateau}}$ |      | 5.7  |      | V    |   |

## ■ Body Diode Characteristics

| Parameter                     | Symbol    | Min. | Typ.  | Max. | Unit          | Test condition  |
|-------------------------------|-----------|------|-------|------|---------------|---|
| Diode forward current         | $I_S$     |      |       | 11   | A             | $V_{GS} < V_{th}$   |
| Pulsed source current         | $I_{SP}$  |      |       | 33   |               |   |
| Diode forward voltage         | $V_{SD}$  |      |       | 1.3  | V             | $I_S=11\text{ A}$ , $V_{GS}=0\text{ V}$                                     |
| Reverse recovery time         | $t_{rr}$  |      | 228.6 |      | ns            | $V_R=400\text{ V}$ , $I_S=6\text{ A}$ ,<br>$di/dt=100\text{ A}/\mu\text{s}$ |
| Reverse recovery charge       | $Q_{rr}$  |      | 2.3   |      | $\mu\text{C}$ |   |
| Peak reverse recovery current | $I_{rrm}$ |      | 20.4  |      | A             |   |

## ■ Note

- 1) Calculated continuous current based on maximum allowable junction temperature.
- 2) Repetitive rating; pulse width limited by max. junction temperature.
- 3)  $P_d$  is based on max. junction temperature, using junction-case thermal resistance.
- 4) The value of  $R_{\theta JA}$  is measured with the device mounted on 1 in 2 FR-4 board with 2oz. Copper, in a still air environment with  $T_a=25\text{ }^\circ\text{C}$ .
- 5)  $V_{DD}=100\text{ V}$ ,  $R_G=25\text{ }\Omega$ ,  $L=80\text{ mH}$ , starting  $T_j=25\text{ }^\circ\text{C}$ .

■ **Electrical Characteristics Diagrams**

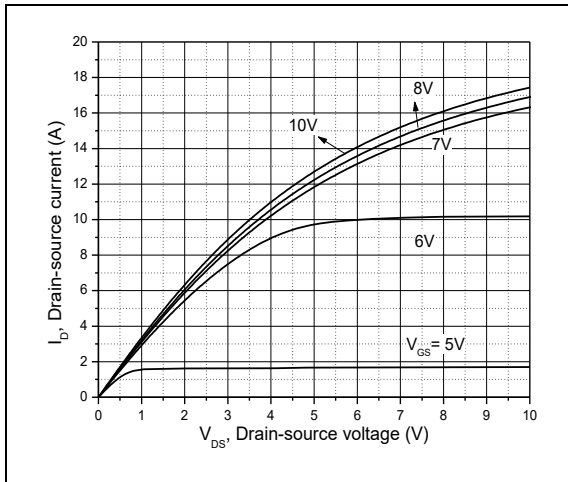


Figure 1, Typ. output characteristics

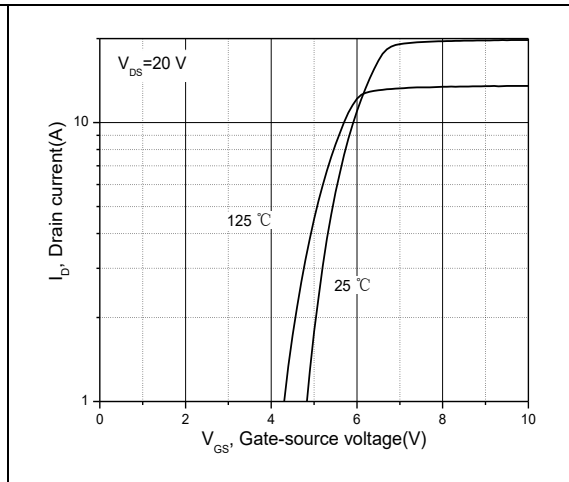


Figure 2, Typ. transfer characteristics

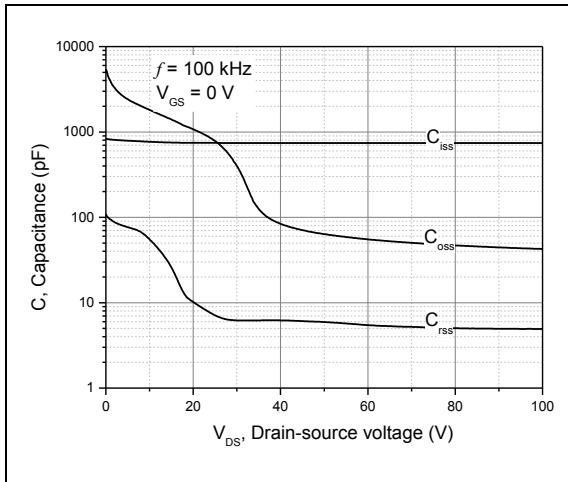


Figure 3, Typ. capacitances

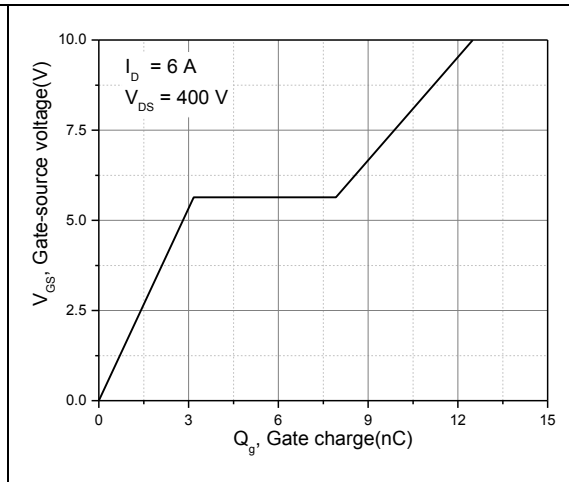


Figure 4, Typ. gate charge

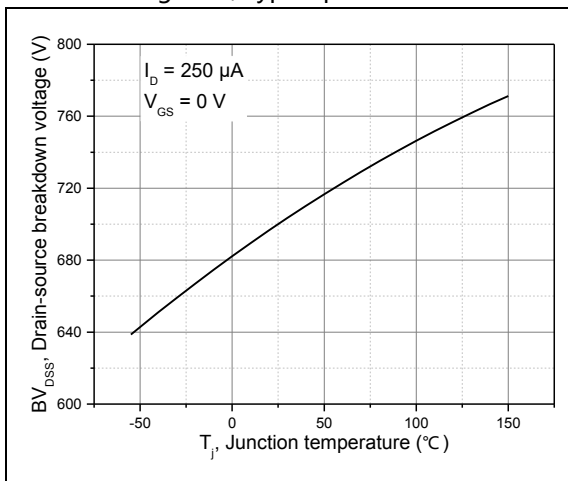


Figure 5, Drain-source breakdown voltage

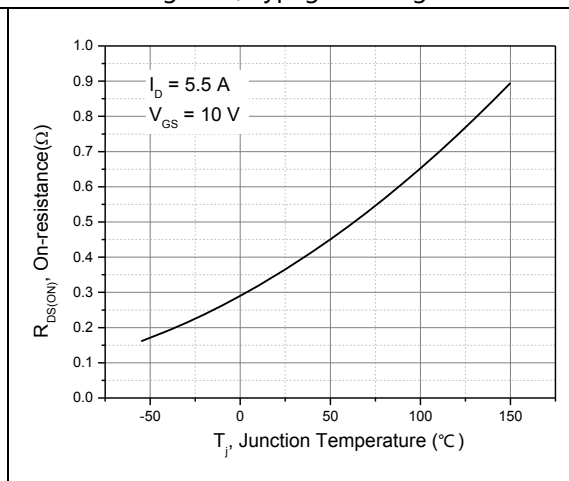


Figure 6, Drain-source on-state resistance

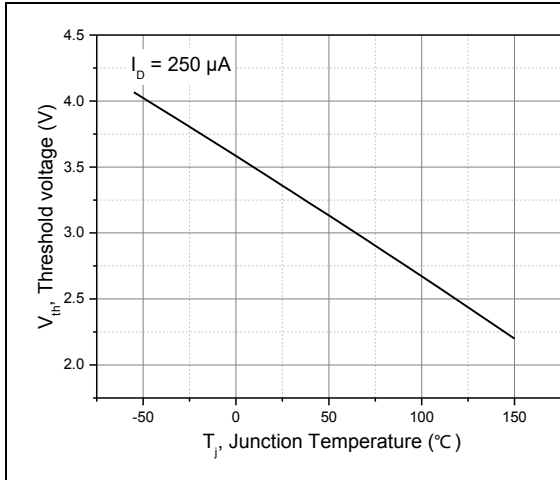


Figure 7, Threshold voltage

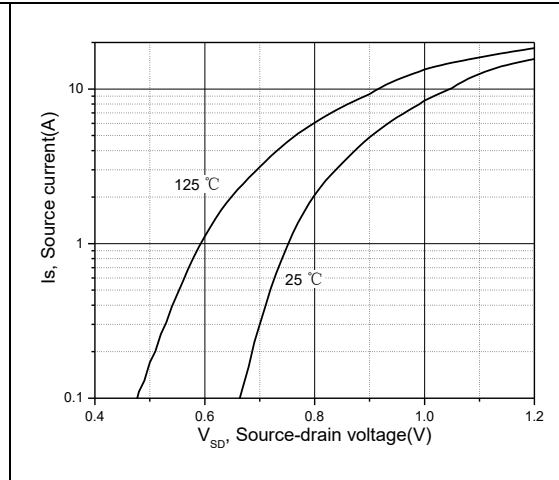


Figure 8, Forward characteristic of body diode

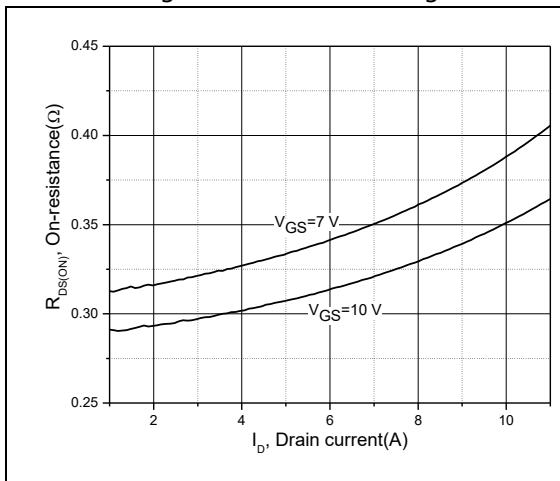


Figure 9, Drain-source on-state resistance

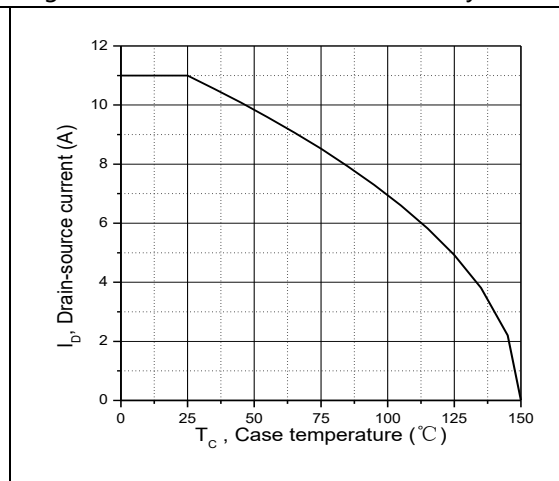


Figure 10, Drain current

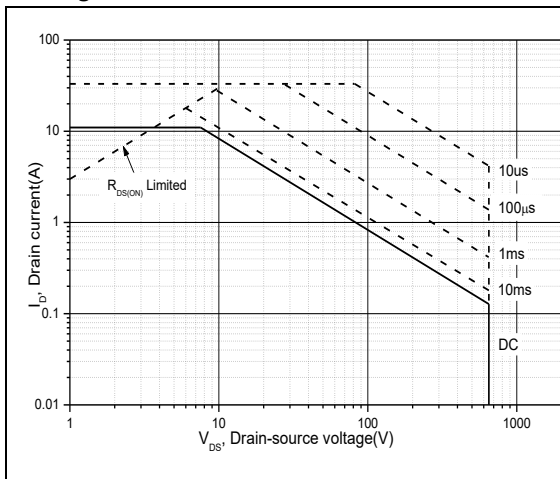


Figure 11, Safe operation area for TO251/TO252/TO220/TO263/TO262  $T_C=25\text{ }^\circ\text{C}$

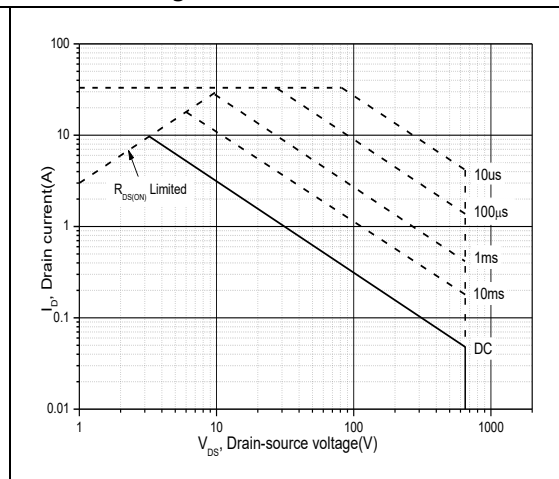


Figure 12, Safe operation area for TO220F  $T_C=25\text{ }^\circ\text{C}$

■ Test circuits and waveforms

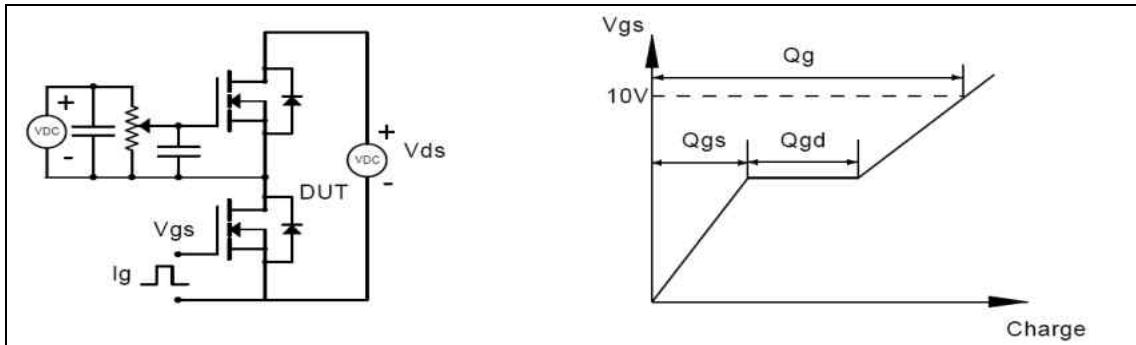


Figure 1, Gate charge test circuit & waveform

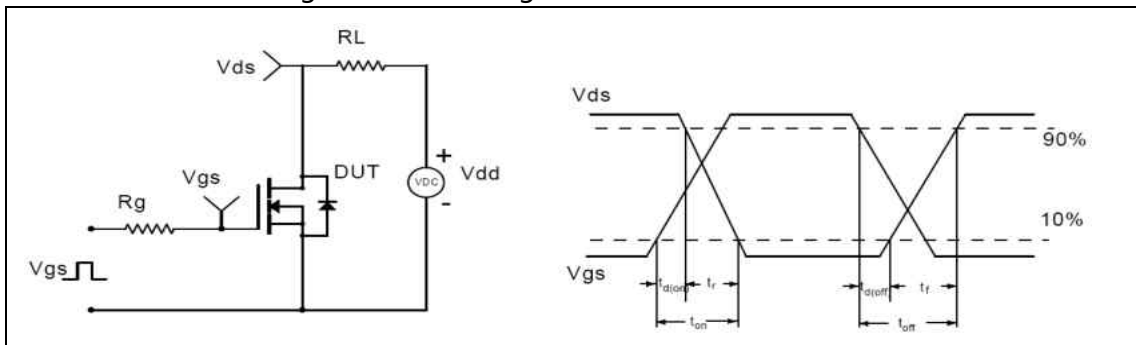


Figure 2, Switching time test circuit & waveforms

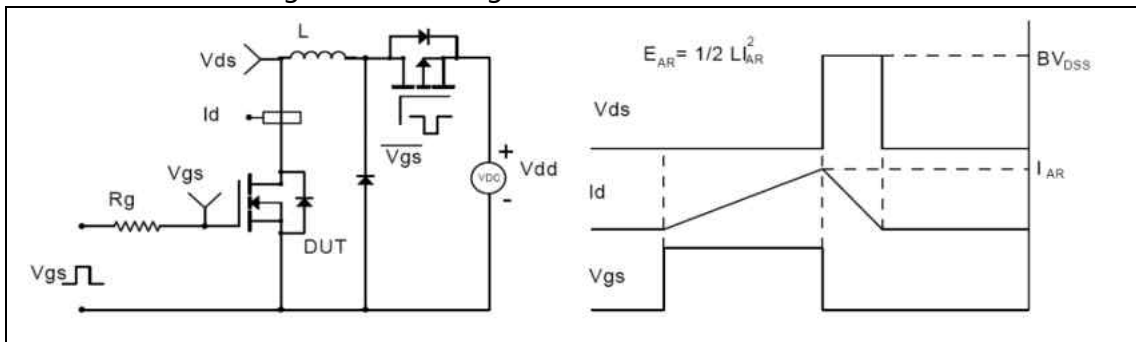


Figure 3, Unclamped inductive switching (UIS) test circuit & waveforms

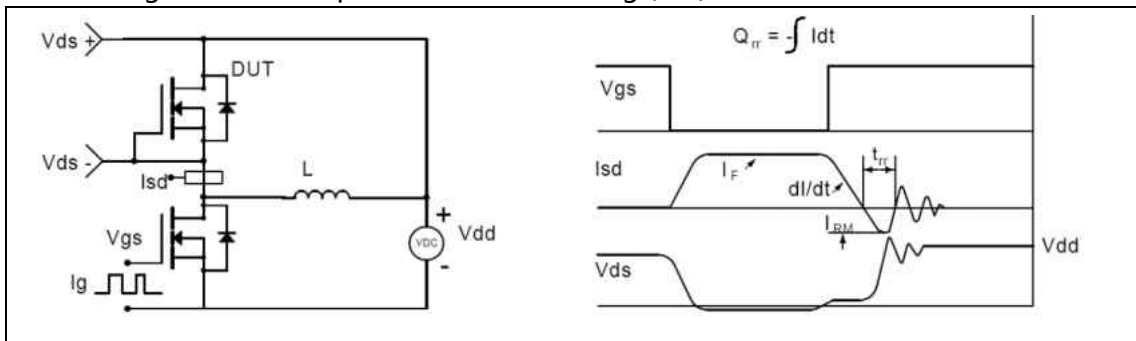
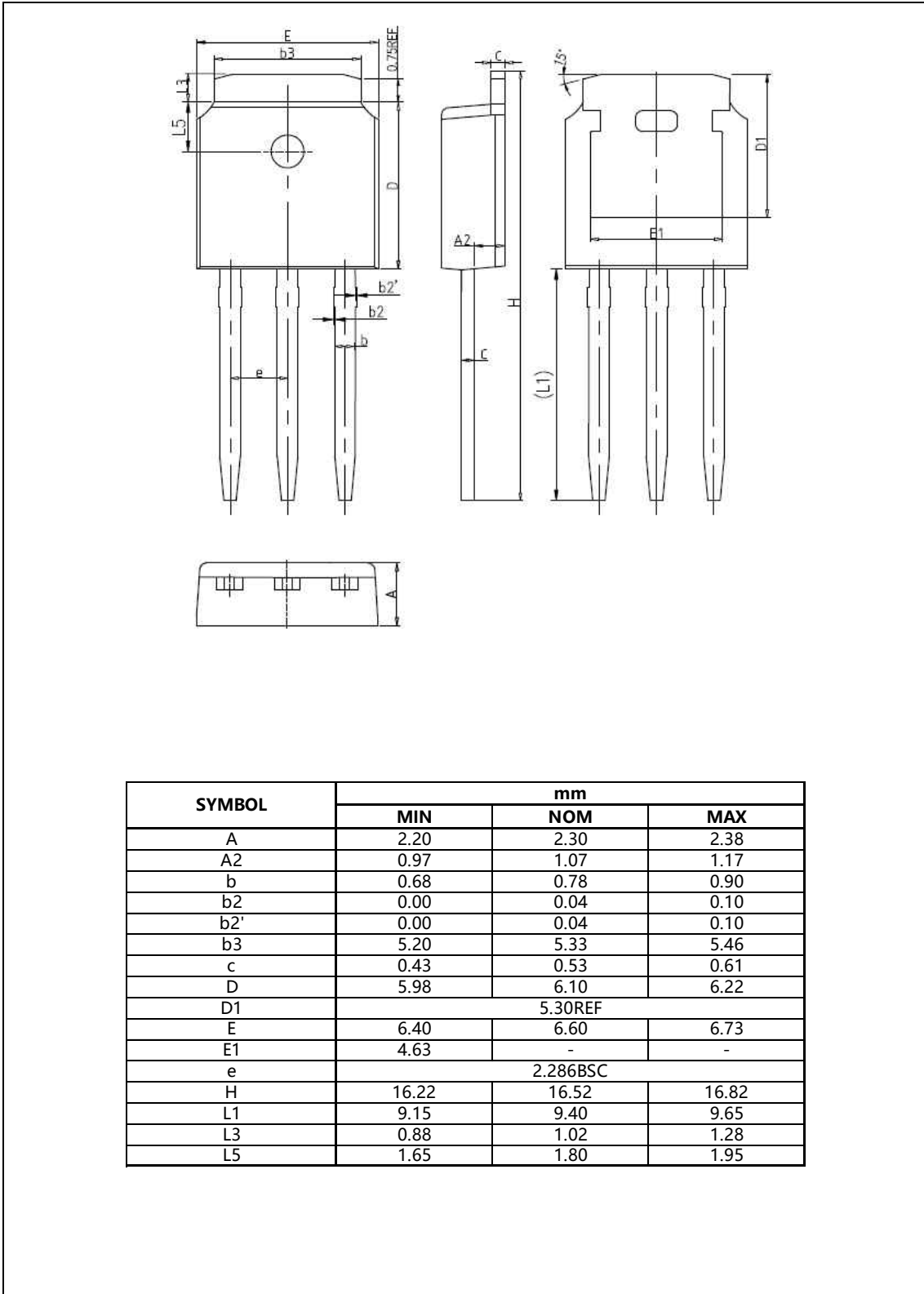


Figure 4, Diode reverse recovery test circuit & waveforms

**■ Package Information**

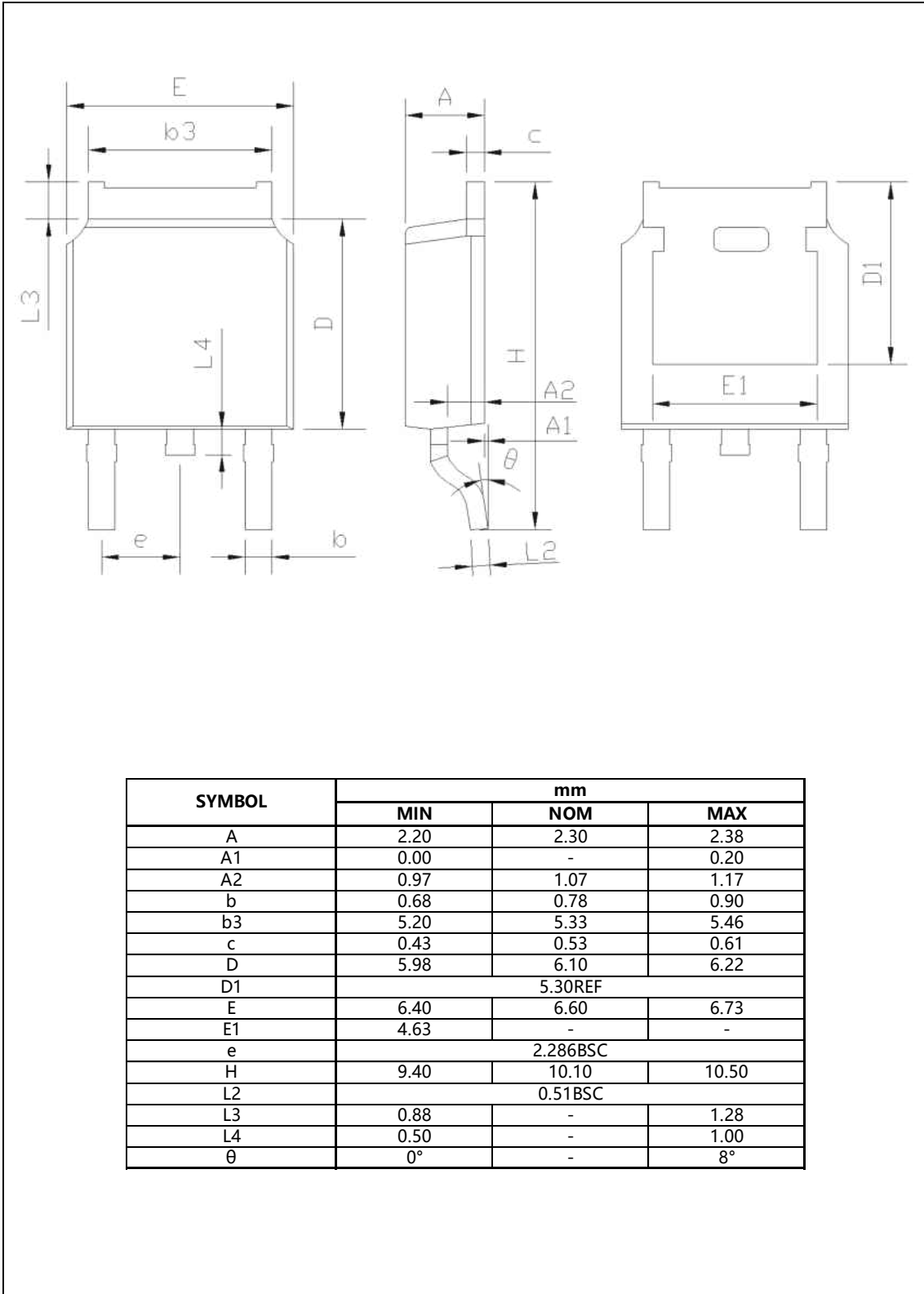
Figure1, TO251 package outline dimension





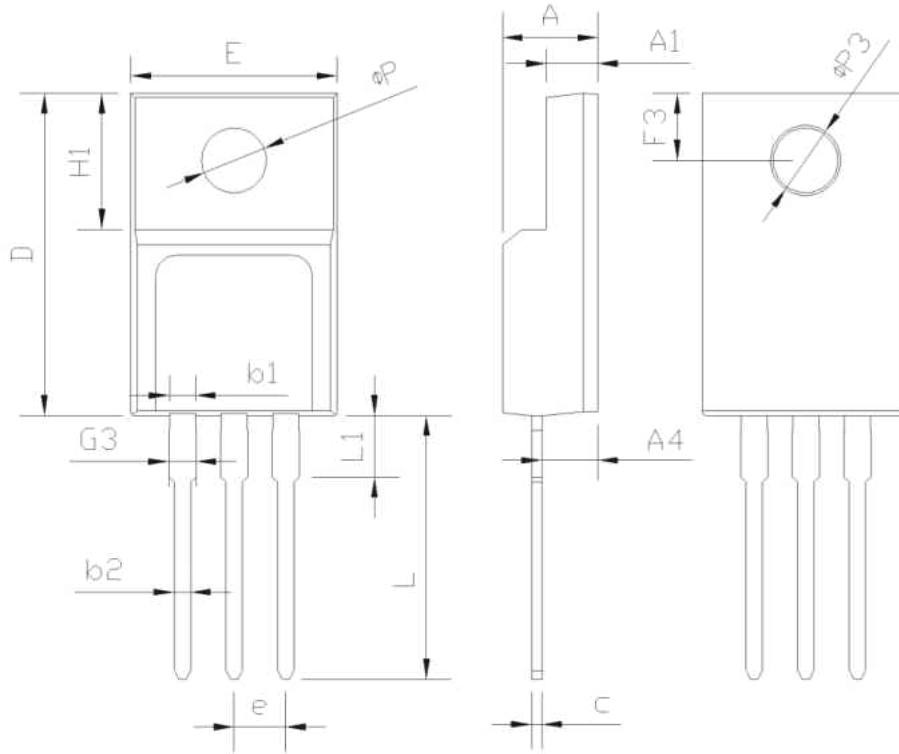
**■ Package Information**

Figure2, TO252 package outline dimension



**■ Package Information**

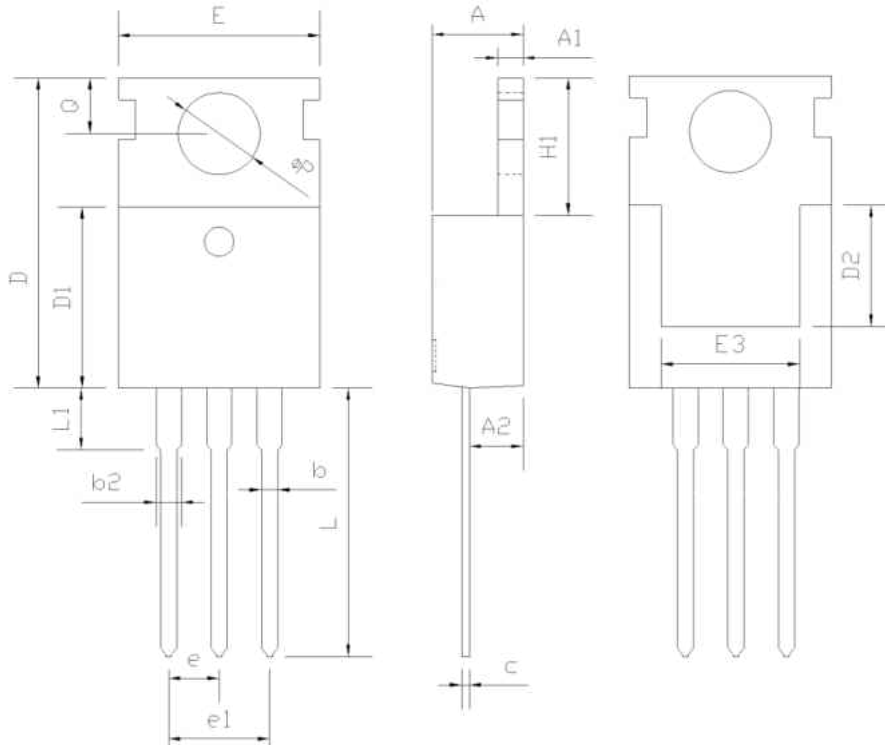
Figure3, TO220F package outline dimension



| SYMBOL | mm      |       |       |
|--------|---------|-------|-------|
|        | MIN     | NOM   | MAX   |
| E      | 9.96    | 10.16 | 10.36 |
| A      | 4.50    | 4.70  | 4.90  |
| A1     | 2.34    | 2.54  | 2.74  |
| A4     | 2.56    | 2.76  | 2.96  |
| c      | 0.40    | 0.50  | 0.65  |
| D      | 15.57   | 15.87 | 16.17 |
| H1     | 6.70REF |       |       |
| e      | 2.54BSC |       |       |
| L      | 12.68   | 12.98 | 13.28 |
| L1     | 2.88    | 3.03  | 3.18  |
| ΦP     | 3.03    | 3.18  | 3.38  |
| ΦP3    | 3.15    | 3.45  | 3.65  |
| F3     | 3.15    | 3.30  | 3.45  |
| G3     | 1.25    | 1.35  | 1.55  |
| b1     | 1.18    | 1.28  | 1.43  |
| b2     | 0.70    | 0.80  | 0.95  |

**■ Package Information**

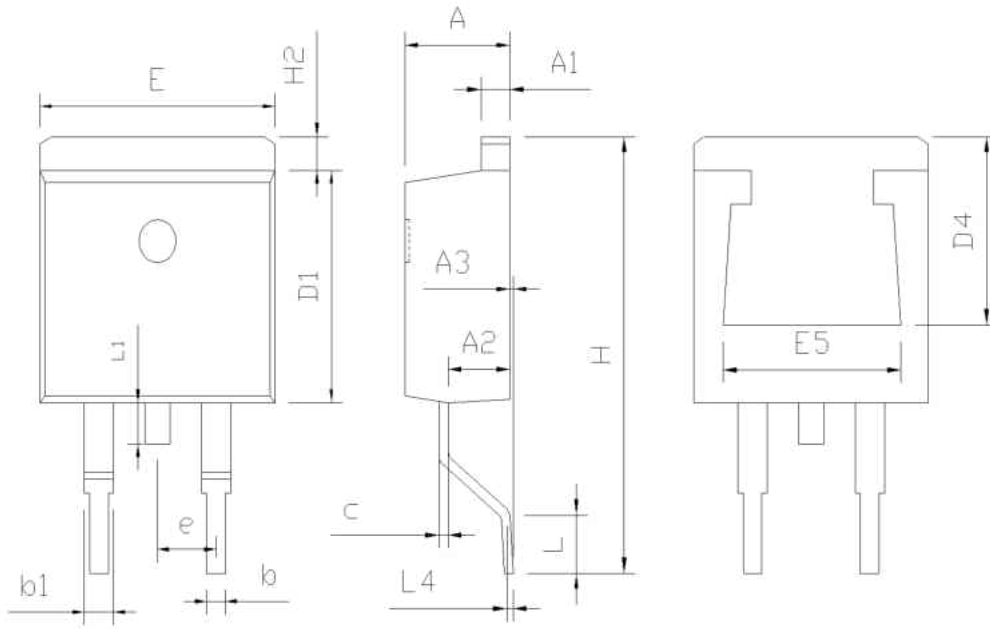
Figure4, TO220 package outline dimension



| SYMBOL | mm       |       |       |
|--------|----------|-------|-------|
|        | MIN      | NOM   | MAX   |
| A      | 4.37     | 4.57  | 4.70  |
| A1     | 1.25     | 1.30  | 1.40  |
| A2     | 2.20     | 2.40  | 2.60  |
| b      | 0.70     | 0.80  | 0.95  |
| b2     | 1.17     | 1.27  | 1.47  |
| c      | 0.45     | 0.50  | 0.60  |
| D      | 15.10    | 15.60 | 16.10 |
| D1     | 8.80     | 9.10  | 9.40  |
| D2     | 5.50     | -     | -     |
| E      | 9.70     | 10.00 | 10.30 |
| E3     | 7.00     | -     | -     |
| e      | 2.54 BSC |       |       |
| e1     | 5.08 BSC |       |       |
| H1     | 6.25     | 6.50  | 6.85  |
| L      | 12.75    | 13.50 | 13.80 |
| L1     | -        | 3.10  | 3.40  |
| ΦP     | 3.40     | 3.60  | 3.80  |
| Q      | 2.60     | 2.80  | 3.00  |

**■ Package Information**

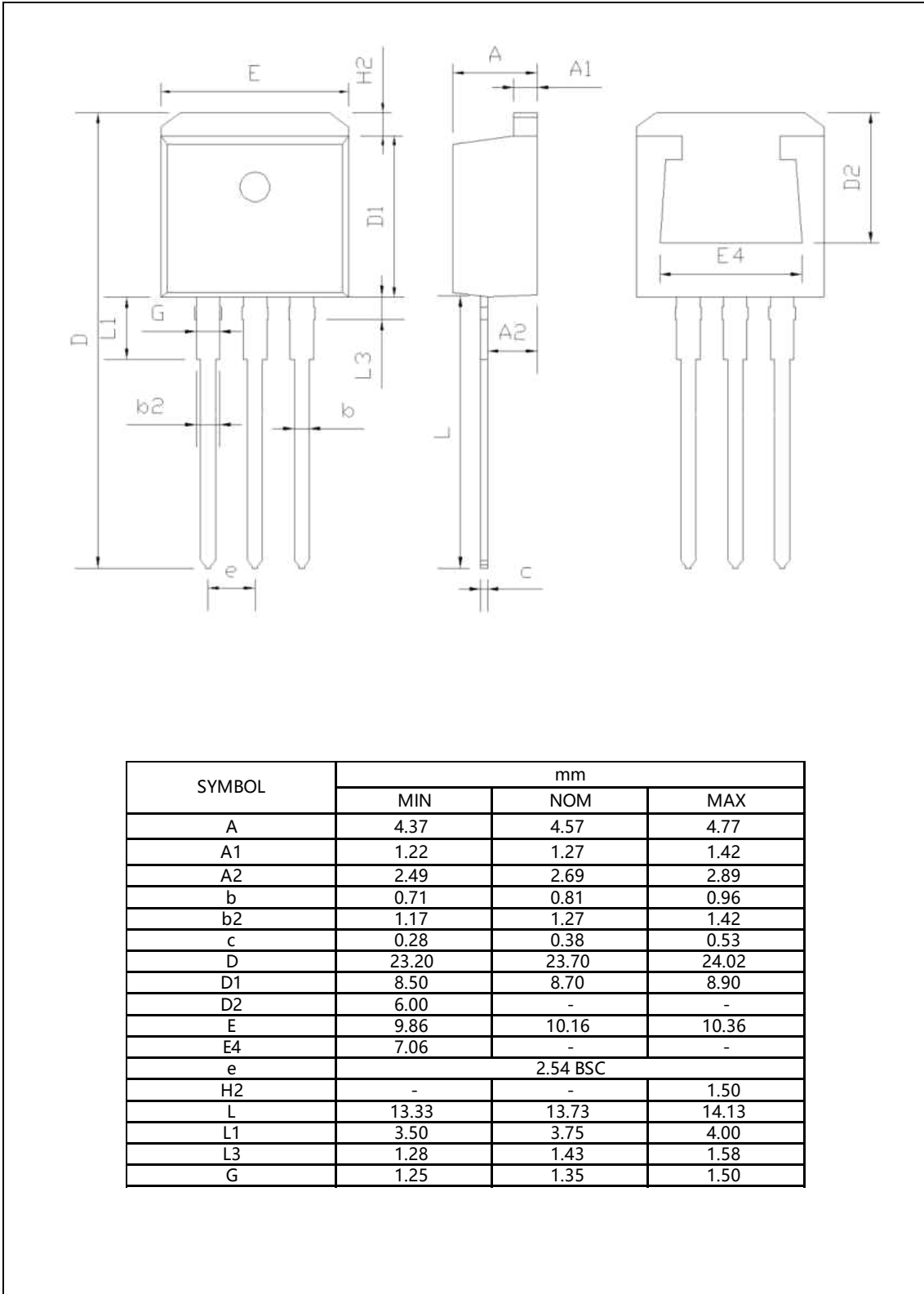
Figure5, TO263 package outline dimension



| SYMBOL | mm       |       |       |
|--------|----------|-------|-------|
|        | MIN      | NOM   | MAX   |
| A      | 4.37     | 4.57  | 4.77  |
| A1     | 1.22     | 1.27  | 1.42  |
| A2     | 2.49     | 2.69  | 2.89  |
| A3     | 0.00     | 0.13  | 0.25  |
| b      | 0.70     | 0.81  | 0.96  |
| b1     | 1.17     | 1.27  | 1.47  |
| c      | 0.30     | 0.38  | 0.53  |
| D1     | 8.50     | 8.70  | 8.90  |
| D4     | 6.60     | -     | -     |
| E      | 9.86     | 10.16 | 10.36 |
| E5     | 7.06     | -     | -     |
| e      | 2.54 BSC |       |       |
| H      | 14.70    | 15.10 | 15.50 |
| H2     | 1.07     | 1.27  | 1.47  |
| L      | 2.00     | 2.30  | 2.60  |
| L1     | 1.40     | 1.55  | 1.70  |
| L4     | 0.25 BSC |       |       |

■ Package Information

Figure6, TO262 package outline dimension



## ■ Ordering Information

| Package | Units/Tube | Tubes/Inner Box | Units/Inner Box | Inner Box/Carton Box | Units/Carton Box |
|---------|------------|-----------------|-----------------|----------------------|------------------|
| TO251   | 75         | 66              | 4950            | 6                    | 29700            |
| TO220F  | 50         | 20              | 1000            | 6                    | 6000             |
| TO220   | 50         | 20              | 1000            | 6                    | 6000             |
| TO263   | 50         | 20              | 1000            | 6                    | 6000             |
| TO262   | 50         | 20              | 1000            | 6                    | 6000             |

| Package | Units/Tape | Tapes/Inner Box | Units/Inner Box | Inner Box/Carton Box | Units/Carton Box |
|---------|------------|-----------------|-----------------|----------------------|------------------|
| TO252   | 2500       | 2               | 5000            | 5                    | 25000            |

## ■ Product Information

| Product     | Package | Pb Free | RoHS | Halogen Free |
|-------------|---------|---------|------|--------------|
| OSG65R380AF | TO251   | yes     | yes  | yes          |
| OSG65R380DF | TO252   | yes     | yes  | yes          |
| OSG65R380FF | TO220F  | yes     | yes  | yes          |
| OSG65R380PF | TO220   | yes     | yes  | yes          |
| OSG65R380KF | TO263   | yes     | yes  | yes          |
| OSG65R380IF | TO262   | yes     | yes  | yes          |