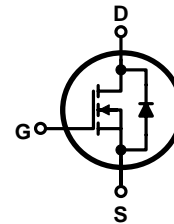
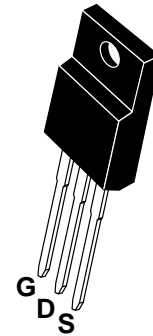


PIN Connection TO-220F

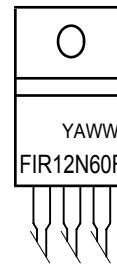
Switching Regulator Application

Features

- $BV_{DSS}=600V$ (Min.)
- Low gate charge: $Q_g=41nC$ (Typ.)
- Low drain-source On resistance: $R_{DS(on)}=0.65\Omega$ (Max.)
- 100% avalanche tested
- RoHS compliant device



Marking Diagram



- Y = Year
- A = Assembly Location
- WW = Work Week
- FIR12N60F = Specific Device Code

Absolute maximum ratings ($T_c=25^\circ C$ unless otherwise noted)

| Characteristic | Symbol | Rating | Unit | |
|--|-----------|-------------------|------------|---|
| Drain-source voltage | V_{DSS} | 600 | V | |
| Gate-source voltage | V_{GSS} | ± 30 | V | |
| Drain current (DC) * | I_D | $T_c=25^\circ C$ | 13 | A |
| | | $T_c=100^\circ C$ | 8.2 | A |
| Drain current (Pulsed) * | I_{DM} | 52 | A | |
| Single pulsed avalanche energy ^(Note 2) | E_{AS} | 544 | mJ | |
| Repetitive avalanche current ^(Note 1) | I_{AR} | 13 | A | |
| Repetitive avalanche energy ^(Note 1) | E_{AR} | 4.5 | mJ | |
| Power dissipation | P_D | 45 | W | |
| Junction temperature | T_J | 150 | $^\circ C$ | |
| Storage temperature range | T_{stg} | -55~150 | $^\circ C$ | |

* Limited only maximum junction temperature

Thermal Characteristics

| Characteristic | Symbol | Rating | Unit |
|---|---------------|-----------|------|
| Thermal resistance, junction to case | $R_{th(j-c)}$ | Max. 2.77 | °C/W |
| Thermal resistance, junction to ambient | $R_{th(j-a)}$ | Max. 62.5 | |

Electrical Characteristics ($T_C=25^\circ\text{C}$ unless otherwise noted)

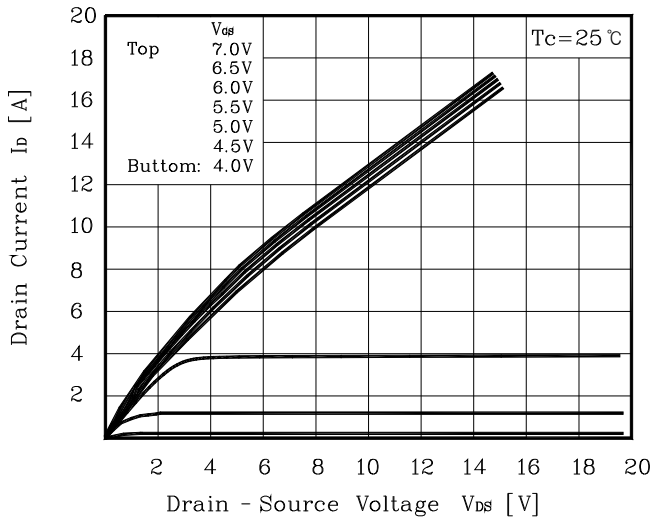
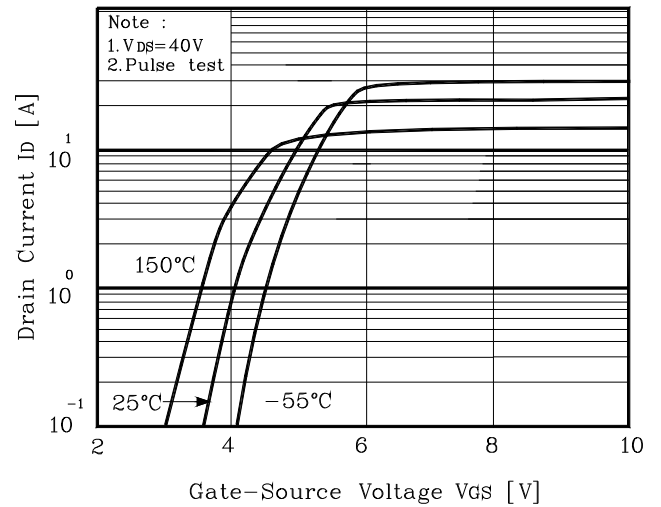
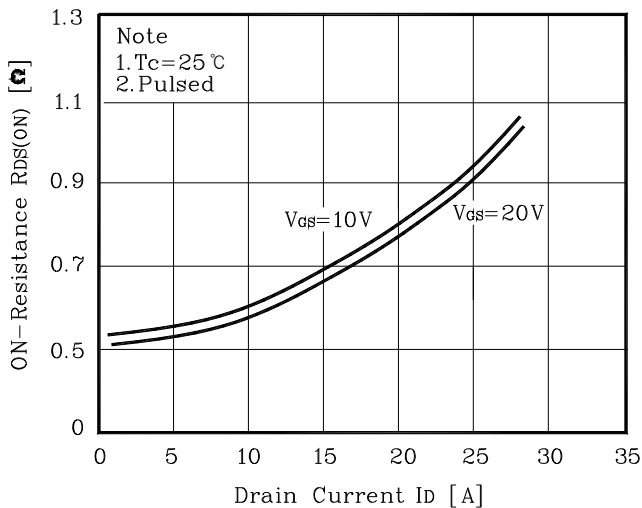
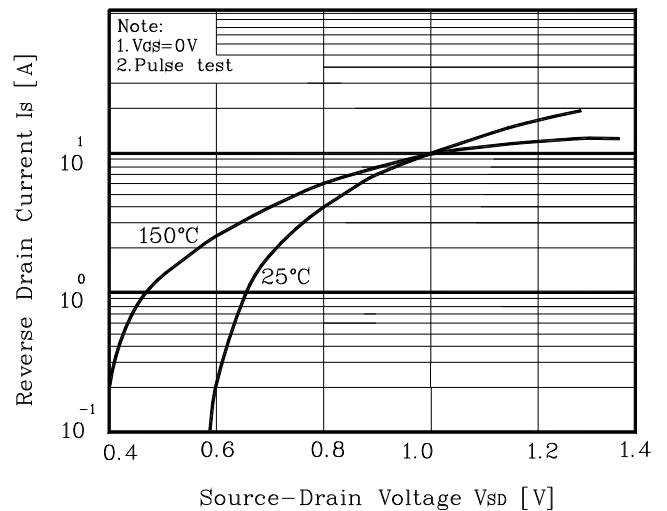
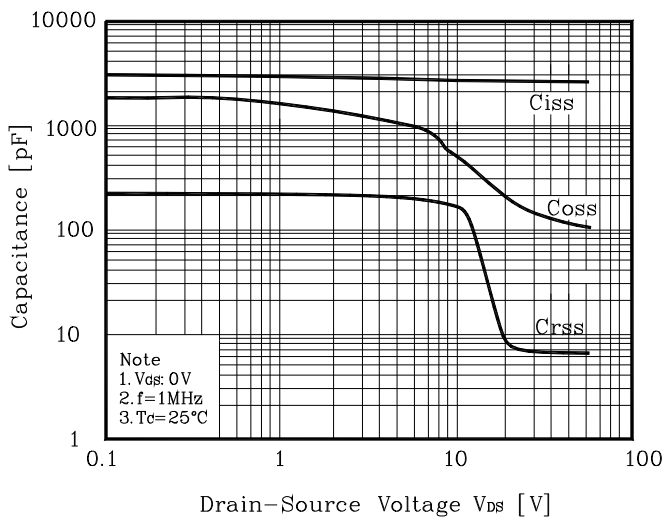
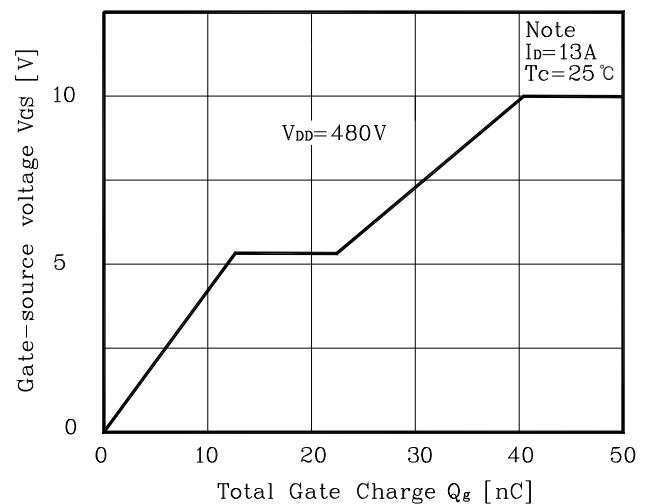
| Characteristic | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|---------------------------------------|--------------|--|------|------|-----------|---------------|
| Drain-source breakdown voltage | BV_{DSS} | $I_D=250\mu\text{A}$, $V_{GS}=0$ | 600 | - | - | V |
| Gate threshold voltage | $V_{GS(th)}$ | $I_D=250\mu\text{A}$, $V_{DS}=V_{GS}$ | 2 | - | 4 | V |
| Drain-source cut-off current | I_{DSS} | $V_{DS}=500\text{V}$, $V_{GS}=0\text{V}$ | - | - | 1 | μA |
| | | $V_{DS}=600\text{V}$, $T_C=125^\circ\text{C}$ | - | - | 100 | μA |
| Gate leakage current | I_{GSS} | $V_{DS}=0\text{V}$, $V_{GS}=\pm 30\text{V}$ | - | - | ± 100 | nA |
| Drain-source on-resistance | $R_{DS(ON)}$ | $V_{GS}=10\text{V}$, $I_D=6.5\text{A}$ | - | 0.55 | 0.65 | Ω |
| Forward transfer conductance (Note 3) | g_{fs} | $V_{DS}=10\text{V}$, $I_D=6.5\text{A}$ | - | 10 | - | S |
| Input capacitance | C_{iss} | $V_{DS}=25\text{V}$, $V_{GS}=0\text{V}$, $f=1.0\text{MHz}$ | - | 2162 | 2882 | pF |
| Output capacitance | C_{oss} | | - | 183 | 244 | |
| Reverse transfer capacitance | C_{rss} | | - | 14.6 | 19.4 | |
| Turn-on delay time (Note 3, 4) | $t_{d(on)}$ | $V_{DD}=300\text{V}$, $I_D=13\text{A}$, $R_G=25\Omega$ | - | 30 | - | ns |
| Rise time (Note 3, 4) | t_r | | - | 85 | - | |
| Turn-off delay time (Note 3, 4) | $t_{d(off)}$ | | - | 140 | - | |
| Fall time (Note 3, 4) | t_f | | - | 90 | - | |
| Total gate charge (Note 3, 4) | Q_g | $V_{DS}=480\text{V}$, $V_{GS}=10\text{V}$, $I_D=13\text{A}$ | - | 41 | 63 | nC |
| Gate-source charge (Note 3, 4) | Q_{gs} | | - | 13 | - | |
| Gate-drain charge (Note 3, 4) | Q_{gd} | | - | 10.5 | - | |

Source-Drain Diode Ratings and Characteristics ($T_C=25^\circ\text{C}$ unless otherwise noted)

| Characteristic | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|-------------------------------------|----------|---|------|------|------|---------------|
| Source current (DC) | I_S | Integral reverse diode in the MOSFET | - | - | 13 | A |
| Source current (Pulsed) | I_{SM} | | - | - | 52 | A |
| Forward voltage | V_{SD} | $V_{GS}=0\text{V}$, $I_S=13\text{A}$ | - | - | 1.4 | V |
| Reverse recovery time (Note 3, 4) | t_{rr} | $I_S=13\text{A}$, $V_{GS}=0\text{V}$ $di_S/dt=-100\text{A}/\mu\text{s}$ | - | 510 | - | ns |
| Reverse recovery charge (Note 3, 4) | Q_{rr} | | - | 4.3 | - | μC |

Note:

1. Repeated rating: Pulse width limited by safe operating area
2. $L=5.9\text{mH}$, $I_{AS}=13\text{A}$, $V_{DD}=50\text{V}$, $R_G=25\Omega$, Starting $T_J=25^\circ\text{C}$
3. Pulse test: Pulse width $\leq 300\mu\text{s}$, Duty cycle $\leq 2\%$
4. Essentially independent of operating temperature typical characteristics

Electrical Characteristics Curves
Fig. 1 $I_D - V_{DS}$

Fig. 2 $I_D - V_{GS}$

Fig. 3 $R_{DS(ON)} - I_D$

Fig. 4 $I_S - V_{SD}$

Fig. 5 Capacitance - V_{DS}

Fig. 6 $V_{GS} - Q_G$


Electrical Characteristics Curves (Continue)

Fig. 7 $V_{DSS} - T_J$

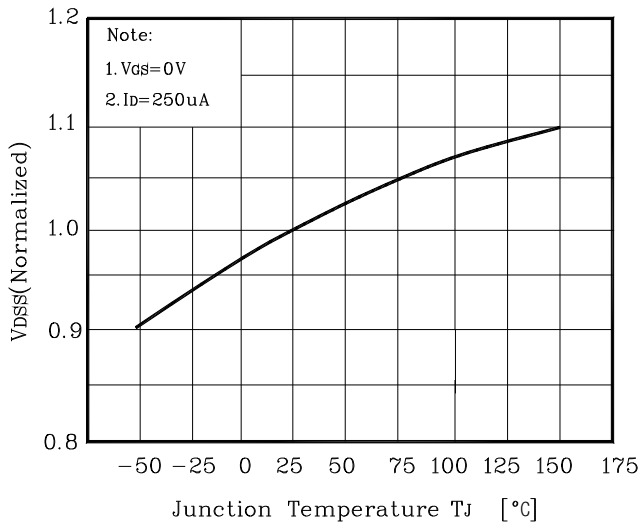


Fig. 8 $R_{DS(ON)} - T_J$

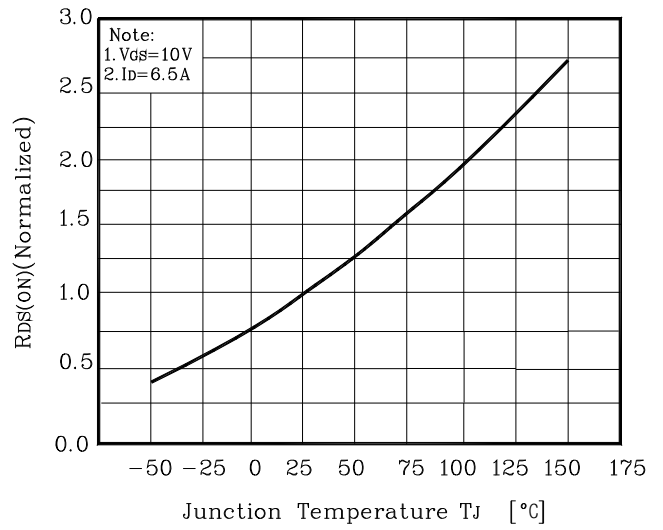


Fig. 9 $I_D - T_C$

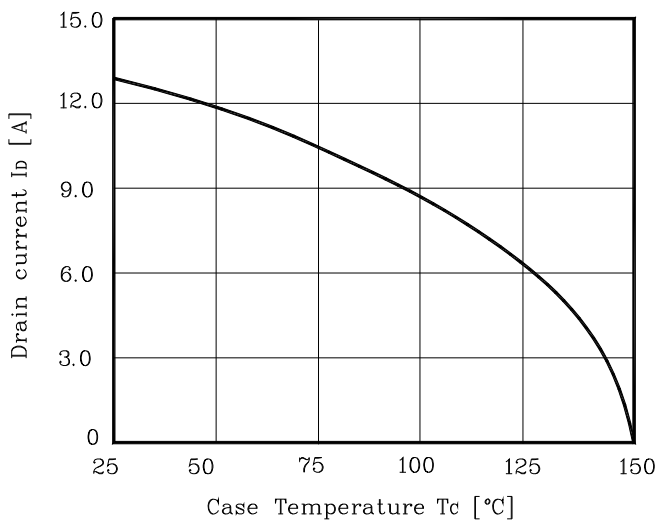


Fig. 10 Safe Operating Area

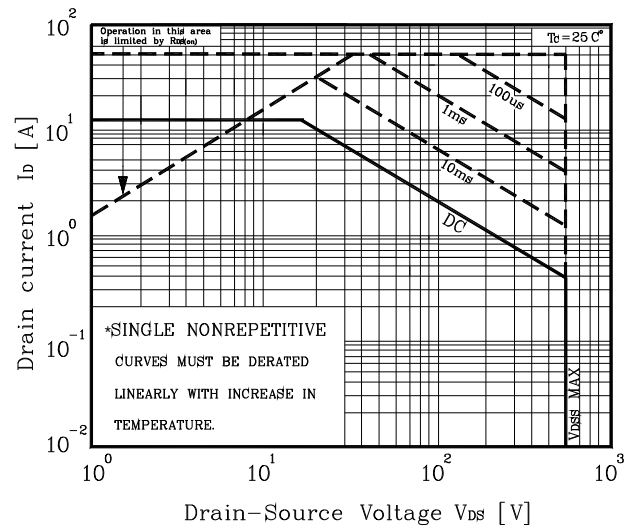


Fig. 11 Gate Charge Test Circuit & Waveform

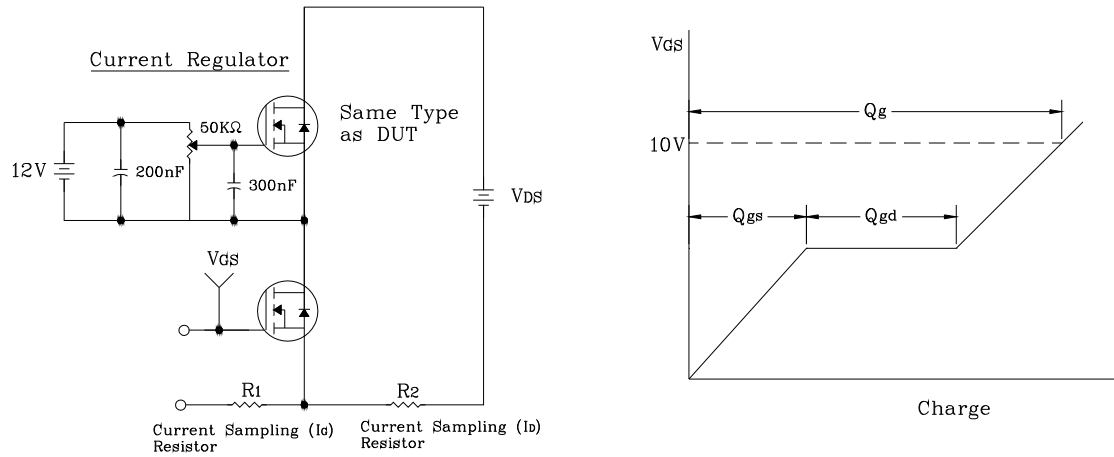


Fig. 12 Resistive Switching Test Circuit & Waveform

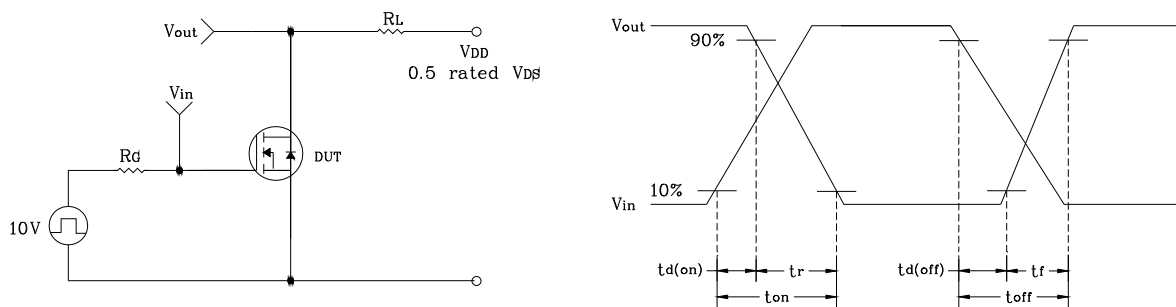


Fig. 13 E_{AS} Test Circuit & Waveform

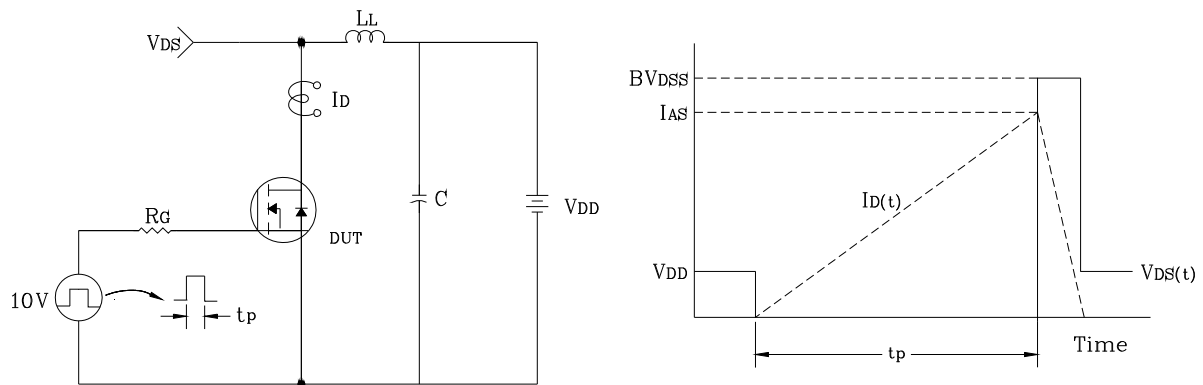
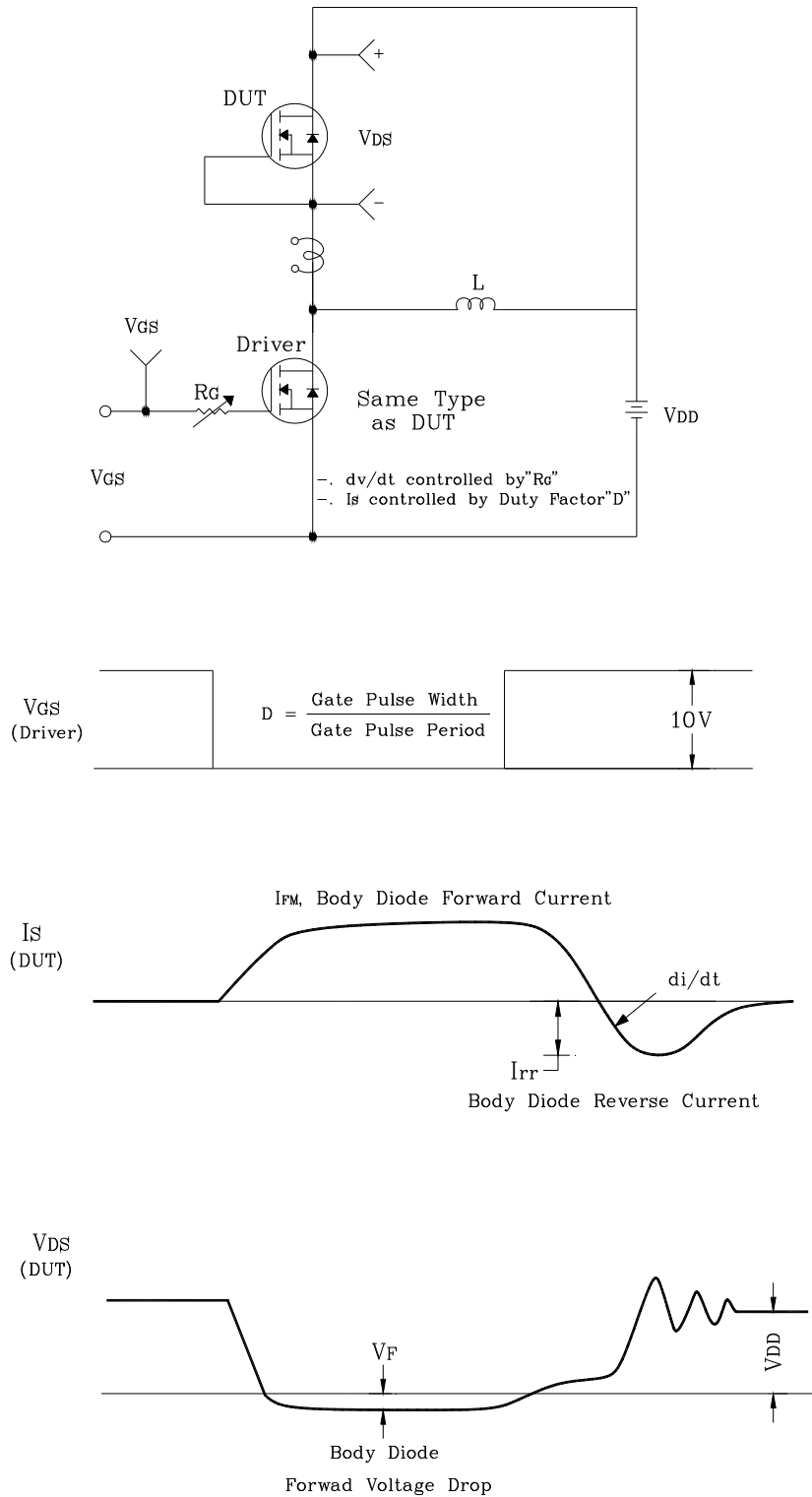
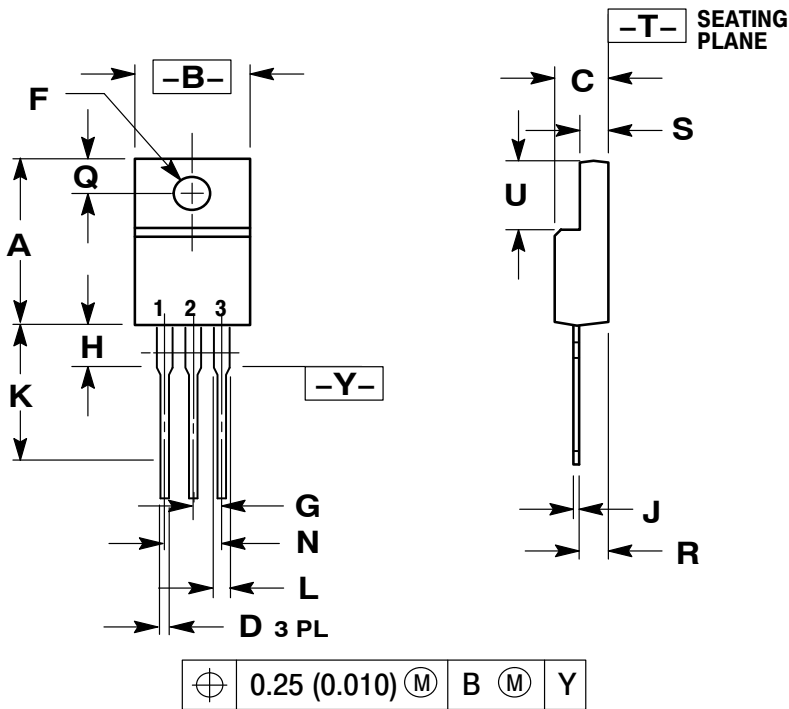


Fig. 14 Diode Reverse Recovery Time Test Circuit & Waveform


Package Dimensions

TO-220F



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. 221D-01 THRU 221D-02 OBSOLETE, NEW STANDARD 221D-03.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.617 | 0.635 | 15.67 | 16.12 |
| B | 0.392 | 0.419 | 9.96 | 10.63 |
| C | 0.177 | 0.193 | 4.50 | 4.90 |
| D | 0.024 | 0.039 | 0.60 | 1.00 |
| F | 0.116 | 0.129 | 2.95 | 3.28 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.118 | 0.135 | 3.00 | 3.43 |
| J | 0.018 | 0.025 | 0.45 | 0.63 |
| K | 0.503 | 0.541 | 12.78 | 13.73 |
| L | 0.048 | 0.058 | 1.23 | 1.47 |
| N | 0.200 BSC | | 5.08 BSC | |
| Q | 0.122 | 0.138 | 3.10 | 3.50 |
| R | 0.099 | 0.117 | 2.51 | 2.96 |
| S | 0.092 | 0.113 | 2.34 | 2.87 |
| U | 0.239 | 0.271 | 6.06 | 6.88 |