



# THE DATASHEET OF FQP4N60



## FQP4N60

### 600V N-Channel MOSFET

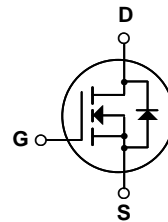
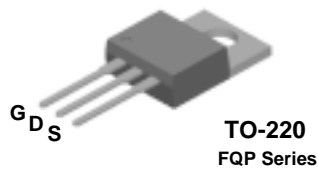
#### General Description

These N-Channel enhancement mode power field effect transistors are produced using Fairchild's proprietary, planar stripe, DMOS technology.

This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficiency switch mode power supply.

#### Features

- 4.4A, 600V,  $R_{DS(on)} = 2.2\Omega$  @  $V_{GS} = 10V$
- Low gate charge ( typical 15 nC)
- Low Crss ( typical 8.0 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability



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

| Symbol         | Parameter   | FQP4N60     | Units               |
|----------------|---|-------------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage  | 600         | V                   |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )<br>- Continuous ( $T_C = 100^\circ\text{C}$ ) | 4.4         | A                   |
|                |   | 2.8         | A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)   | 17.6        | A                   |
| $V_{GSS}$      | Gate-Source Voltage   | $\pm 30$    | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)   | 260         | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)  | 4.4         | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)  | 10.6        | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)  | 4.5         | V/ns                |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ\text{C}$ )<br>- Derate above $25^\circ\text{C}$                   | 106         | W                   |
|                |   | 0.85        | W/ $^\circ\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range   | -55 to +150 | $^\circ\text{C}$    |
| $T_L$          | Maximum lead temperature for soldering purposes,<br>1/8" from case for 5 seconds                      | 300         | $^\circ\text{C}$    |

#### Thermal Characteristics

| Symbol          | Parameter                               | Typ | Max  | Units                     |
|-----------------|---|-----|------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case    | --  | 1.18 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink        | 0.5 | --   | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | --  | 62.5 | $^\circ\text{C}/\text{W}$ |

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

| Symbol                         | Parameter                                 | Test Conditions   | Min | Typ | Max  | Units                     |
|--------------------------------|---|---|-----|-----|------|---------------------------|
| <b>Off Characteristics</b>     |   |   |     |     |      |                           |
| $BV_{DSS}$                     | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = 250\ \mu\text{A}$               | 600 | --  | --   | V                         |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\ \mu\text{A}$ , Referenced to $25^\circ\text{C}$ | --  | 0.6 | --   | $\text{V}/^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 600\text{ V}, V_{GS} = 0\text{ V}$                | --  | --  | 10   | $\mu\text{A}$             |
|                                |   | $V_{DS} = 480\text{ V}, T_C = 125^\circ\text{C}$            | --  | --  | 100  | $\mu\text{A}$             |
| $I_{GSSF}$                     | Gate-Body Leakage Current, Forward        | $V_{GS} = 30\text{ V}, V_{DS} = 0\text{ V}$                 | --  | --  | 100  | nA                        |
| $I_{GSSR}$                     | Gate-Body Leakage Current, Reverse        | $V_{GS} = -30\text{ V}, V_{DS} = 0\text{ V}$                | --  | --  | -100 | nA                        |

**On Characteristics**

|              |                                   |   |     |      |     |          |
|--------------|-----------------------------------|---|-----|------|-----|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250\ \mu\text{A}$           | 3.0 | --   | 5.0 | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 2.2\text{ A}$          | --  | 1.77 | 2.2 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = 50\text{ V}, I_D = 2.2\text{ A}$ (Note 4) | --  | 4.0  | --  | S        |

**Dynamic Characteristics**

|           |                              |  |    |     |     |    |
|-----------|------------------------------|--|----|-----|-----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 520 | 670 | pF |
| $C_{oss}$ | Output Capacitance           |  | -- | 70  | 90  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |  | -- | 8   | 11  | pF |

**Switching Characteristics**

|              |                     |   |   |     |     |    |
|--------------|---------------------|---|---|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 300\text{ V}, I_D = 4.4\text{ A},$<br>$R_G = 25\ \Omega$<br><br>(Note 4, 5) | --  | 13  | 35  | ns |
| $t_r$        | Turn-On Rise Time   |   | --  | 45  | 100 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |   | --  | 25  | 60  | ns |
| $t_f$        | Turn-Off Fall Time  |   | --  | 35  | 80  | ns |
| $Q_g$        | Total Gate Charge   |   | $V_{DS} = 480\text{ V}, I_D = 4.4\text{ A},$<br>$V_{GS} = 10\text{ V}$<br><br>(Note 4, 5) | --  | 15  | 20 |
| $Q_{gs}$     | Gate-Source Charge  |   | --  | 3.4 | --  | nC |
| $Q_{gd}$     | Gate-Drain Charge   |   | --  | 7.1 | --  | nC |

**Drain-Source Diode Characteristics and Maximum Ratings**

|          |   |   |    |      |     |               |
|----------|---|---|----|------|-----|---------------|
| $I_S$    | Maximum Continuous Drain-Source Diode Forward Current | --  | -- | 4.4  | A   |               |
| $I_{SM}$ | Maximum Pulsed Drain-Source Diode Forward Current     | --  | -- | 17.6 | A   |               |
| $V_{SD}$ | Drain-Source Diode Forward Voltage                    | $V_{GS} = 0\text{ V}, I_S = 4.4\text{ A}$   | -- | --   | 1.4 | V             |
| $t_{rr}$ | Reverse Recovery Time                                 | $V_{GS} = 0\text{ V}, I_S = 4.4\text{ A},$<br>$dI_F / dt = 100\text{ A}/\mu\text{s}$ (Note 4) | -- | 250  | --  | ns            |
| $Q_{rr}$ | Reverse Recovery Charge                               |   | -- | 1.5  | --  | $\mu\text{C}$ |

**Notes:**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 25\text{ mH}, I_{AS} = 4.4\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\ \Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 4.4\text{ A}, dI/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
4. Pulse Test : Pulse width  $\leq 300\ \mu\text{s}$ , Duty cycle  $\leq 2\%$
5. Essentially independent of operating temperature

Typical Characteristics

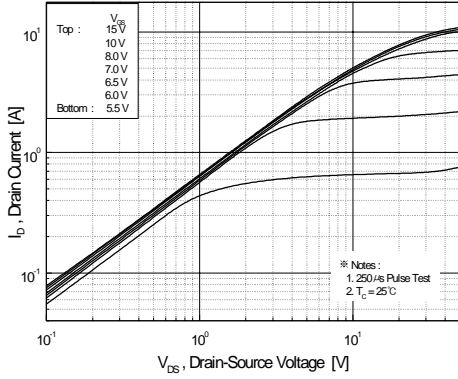


Figure 1. On-Region Characteristics

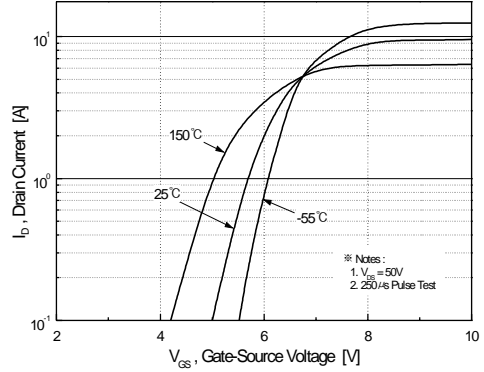


Figure 2. Transfer Characteristics

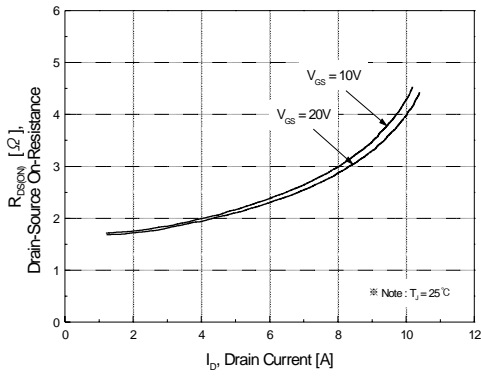


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

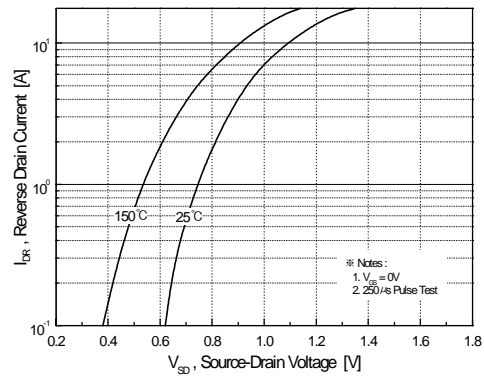


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

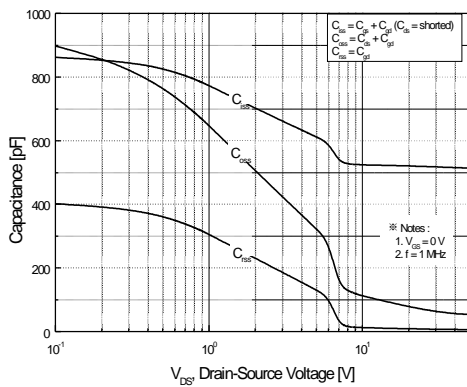


Figure 5. Capacitance Characteristics

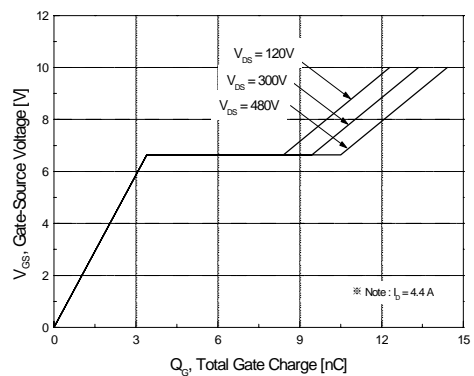
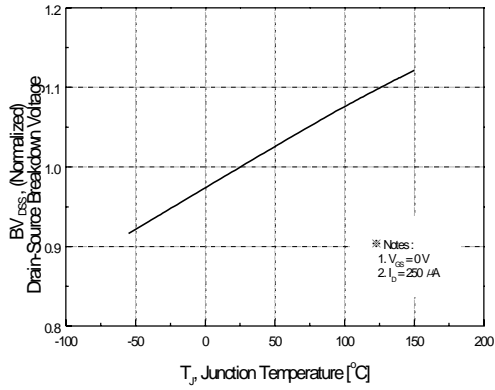
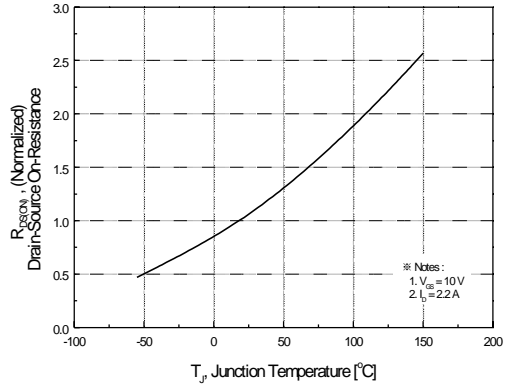


Figure 6. Gate Charge Characteristics

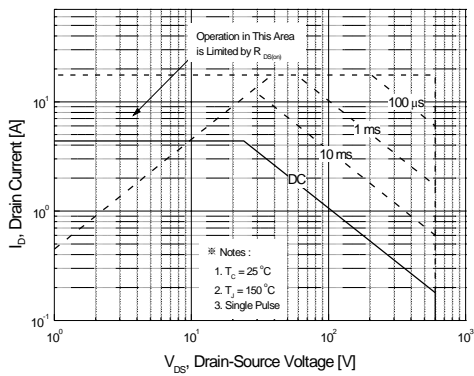
**Typical Characteristics** (Continued)



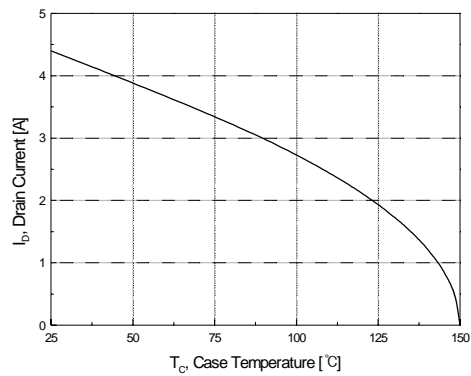
**Figure 7. Breakdown Voltage Variation vs. Temperature**



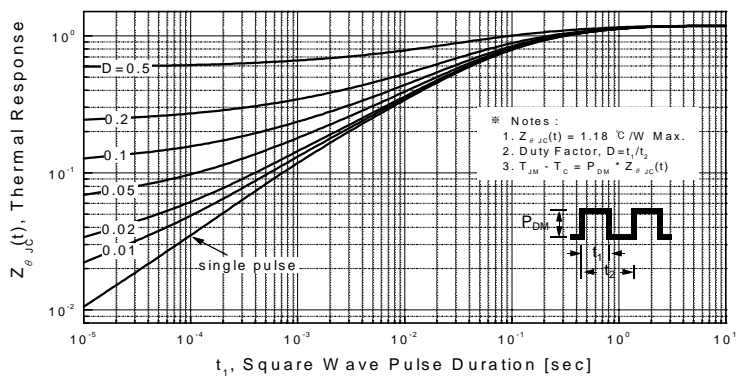
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**

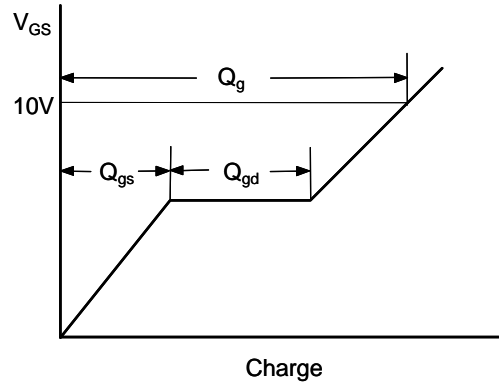
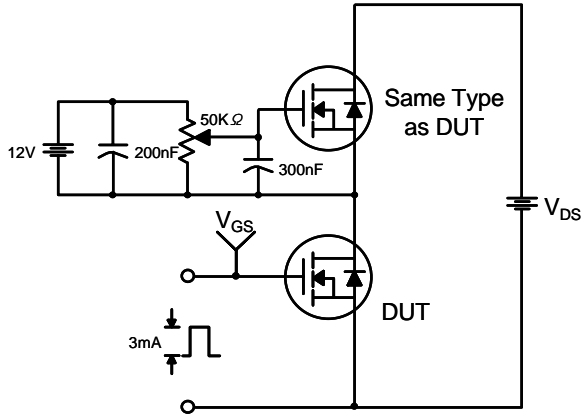


**Figure 10. Maximum Drain Current vs. Case Temperature**

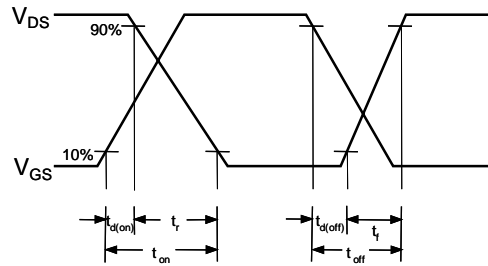
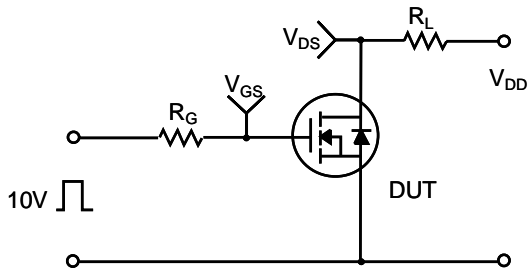


**Figure 11. Transient Thermal Response Curve**

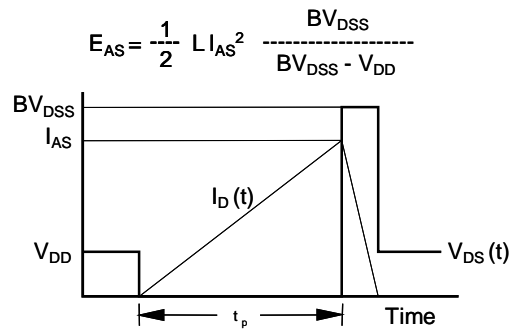
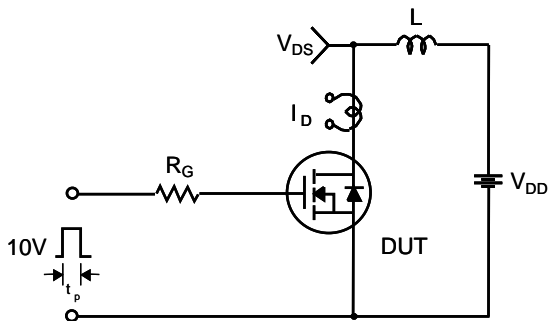
Gate Charge Test Circuit & Waveform



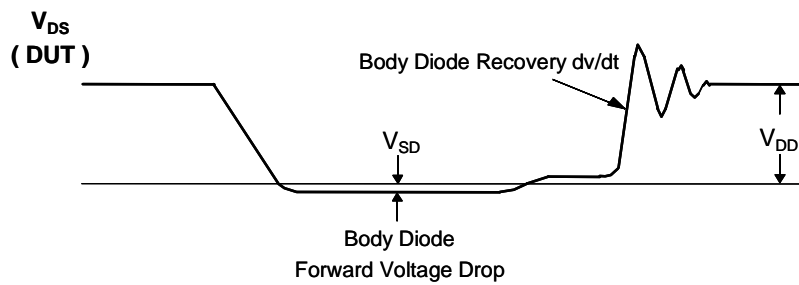
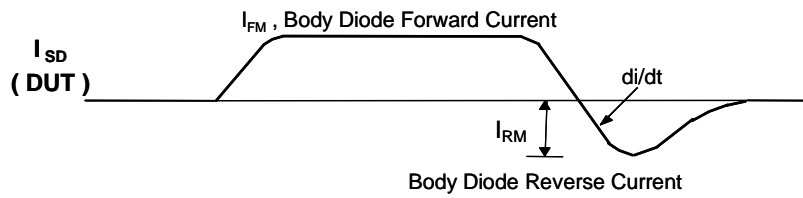
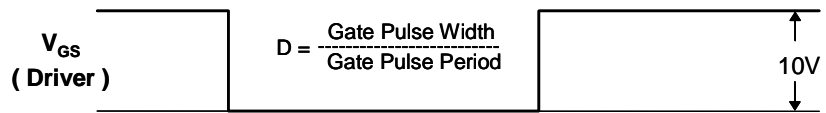
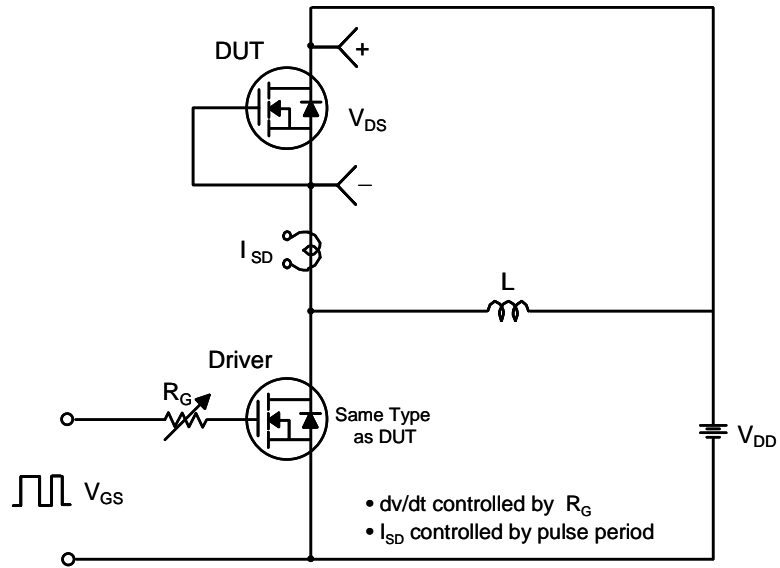
Resistive Switching Test Circuit & Waveforms



Unclamped Inductive Switching Test Circuit & Waveforms

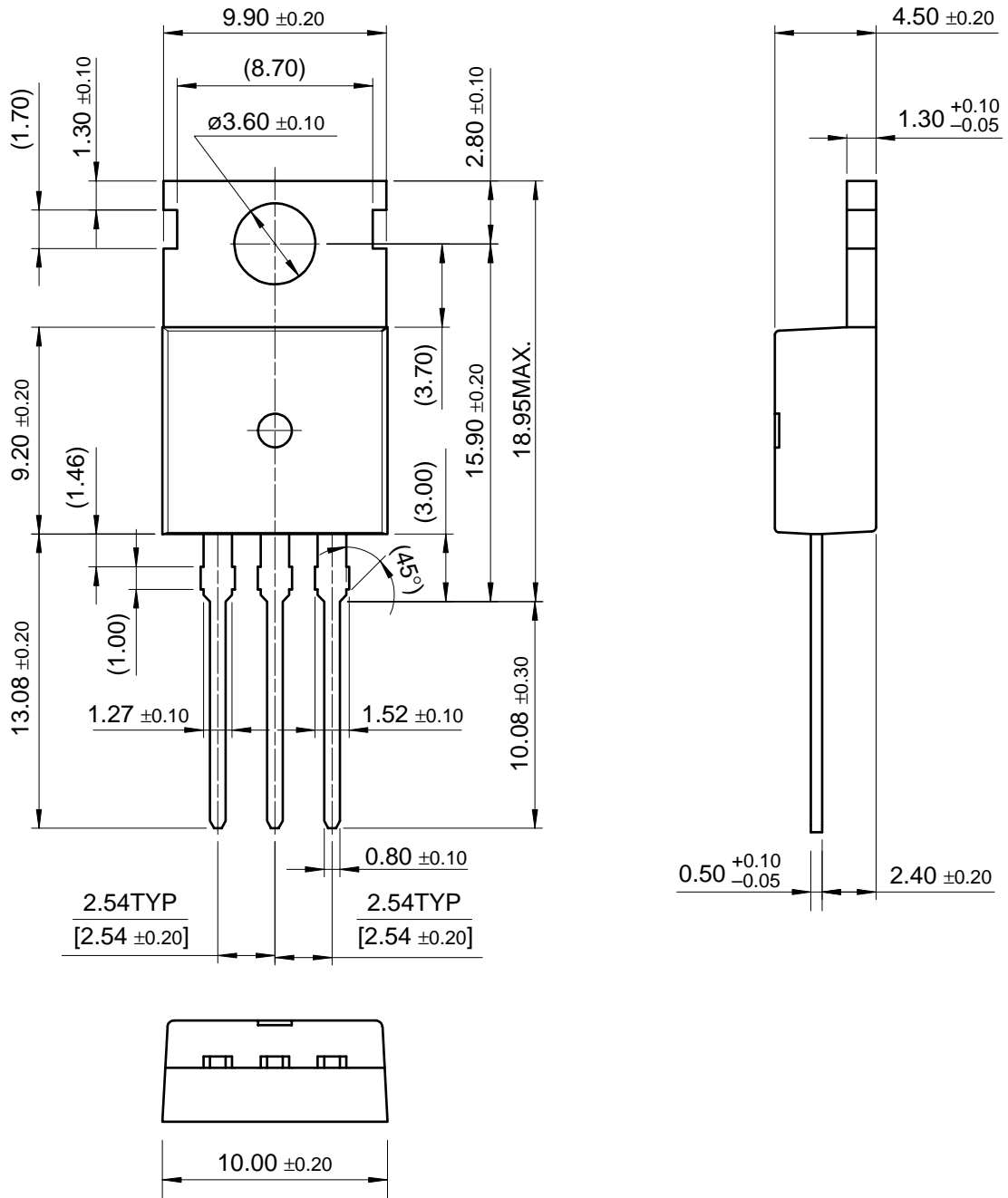


Peak Diode Recovery dv/dt Test Circuit & Waveforms



Package Dimensions

TO-220



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