

# **FQP2P40**

## **400V P-Channel MOSFET**

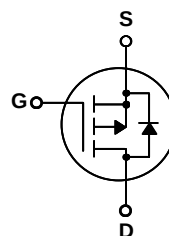
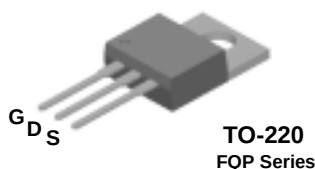
### **General Description**

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

This advanced technology is especially tailored to minimize on-state resistance, provide superior switching performance, and withstand a high energy pulse in the avalanche and commutation modes. These devices are well suited for electronic lamp ballasts based on the complementary half bridge topology.

### **Features**

- -2.0A, -400V,  $R_{DS(on)} = 6.5\Omega$  @  $V_{GS} = -10$  V
- Low gate charge ( typical 10 nC)
- Low  $C_{rss}$  ( typical 6.5 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability



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

| Symbol         | Parameter                                                                     | FQP2P40     | Units               |
|----------------|-------------------------------------------------------------------------------|-------------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                          | -400        | V                   |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )                       | -2.0        | A                   |
|                | - Continuous ( $T_C = 100^\circ\text{C}$ )                                    | -1.27       | A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                               | -8.0        | A                   |
| $V_{GSS}$      | Gate-Source Voltage                                                           | $\pm 30$    | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                       | 120         | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)                                                    | -2.0        | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 6.3         | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)                                            | -4.5        | V/ns                |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                | 63          | W                   |
|                | - Derate above $25^\circ\text{C}$                                             | 0.51        | 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, 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    | --  | 1.98 | $^\circ\text{C/W}$ |
| $R_{\theta CS}$ | Thermal Resistance, Case-to-Sink        | 0.5 | --   | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | --  | 62.5 | $^\circ\text{C/W}$ |

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

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|--------|-----------|-----------------|-----|-----|-----|-------|
|--------|-----------|-----------------|-----|-----|-----|-------|

**Off Characteristics**

|                                |                                           |                                                                    |      |    |      |                     |
|--------------------------------|-------------------------------------------|--------------------------------------------------------------------|------|----|------|---------------------|
| $BV_{DSS}$                     | Drain-Source Breakdown Voltage            | $V_{GS} = 0\text{ V}, I_D = -250\text{ }\mu\text{A}$               | -400 | -- | --   | V                   |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = -250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | --   | -  | --   | V/ $^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = -400\text{ V}, V_{GS} = 0\text{ V}$                      | --   | -- | -1   | $\mu\text{A}$       |
|                                |                                           | $V_{DS} = -320\text{ V}, T_C = 125^\circ\text{C}$                  | --   | -- | -10  | $\mu\text{A}$       |
| $I_{GSSF}$                     | 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            | $V_{DS} = V_{GS}, I_D = -250\text{ }\mu\text{A}$      | -3.0 | --   | -5.0 | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = -10\text{ V}, I_D = -1.0\text{ A}$          | --   | 5.0  | 6.5  | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = -50\text{ V}, I_D = -1.0\text{ A}$ (Note 4) | --   | 1.42 | --   | S        |

**Dynamic Characteristics**

|           |                              |                                                                       |    |     |     |    |
|-----------|------------------------------|-----------------------------------------------------------------------|----|-----|-----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = -25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 270 | 350 | pF |
| $C_{oss}$ | Output Capacitance           |                                                                       | -- | 45  | 60  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                       | -- | 6.5 | 8.5 | pF |

**Switching Characteristics**

|              |                     |                                                                                               |    |     |    |    |
|--------------|---------------------|-----------------------------------------------------------------------------------------------|----|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = -200\text{ V}, I_D = -2.0\text{ A},$<br>$R_G = 25\text{ }\Omega$<br><br>(Note 4, 5) | -- | 9   | 30 | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                               | -- | 33  | 75 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                               | -- | 22  | 55 | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                               | -- | 25  | 60 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = -320\text{ V}, I_D = -2.0\text{ A},$<br>$V_{GS} = -10\text{ V}$<br><br>(Note 4, 5)  | -- | 10  | 13 | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                               | -- | 2.1 | -- | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                               | -- | 5.5 | -- | nC |

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

|                 |                                                       |                                                                                             |    |      |      |    |
|-----------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------|----|------|------|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |                                                                                             | -- | --   | -2.0 | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                             | -- | --   | -8.0 | A  |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -2.0 A                                              | -- | --   | -5.0 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -2.0 A,<br>dI <sub>F</sub> / dt = 100 A/μs (Note 4) | -- | 250  | --   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |                                                                                             | -- | 0.85 | --   | μC |

**Notes:**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 52.5\text{ mH}$ ,  $I_{AS} = -2.0\text{ A}$ ,  $V_{DD} = -50\text{ V}$ ,  $R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq -2.0\text{ A}$ ,  $dI/dt \leq 200\text{ A}/\mu\text{s}$ ,  $V_{DD} \leq BV_{DSS}$ , 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

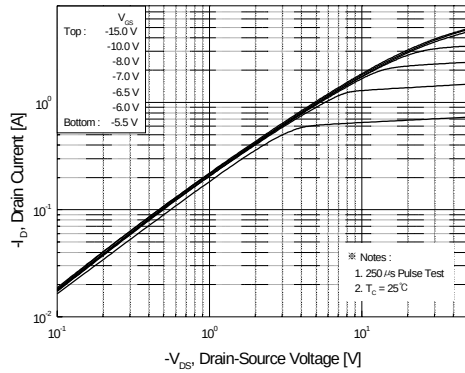


Figure 1. On-Region Characteristics

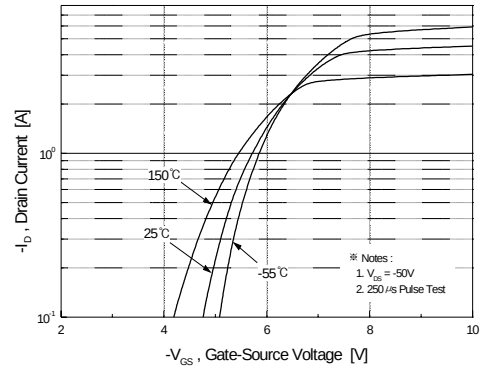


Figure 2. Transfer Characteristics

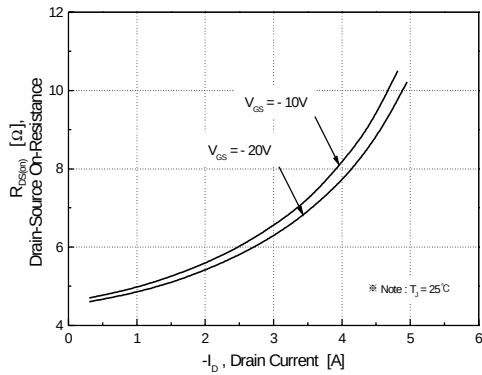


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

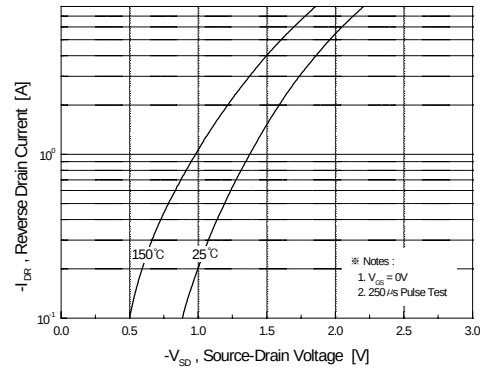


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

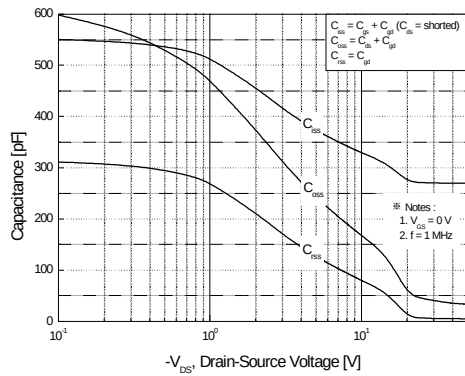


Figure 5. Capacitance Characteristics

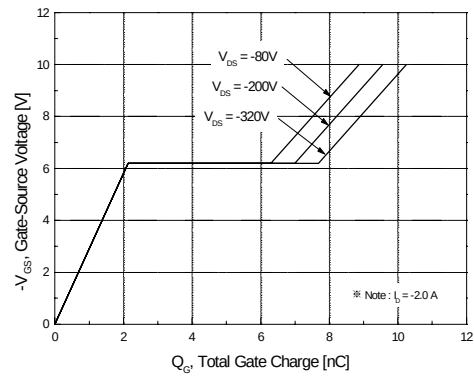
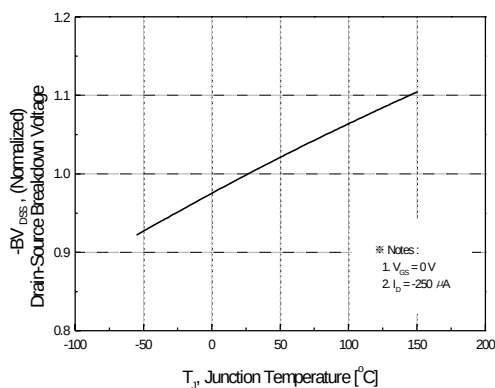
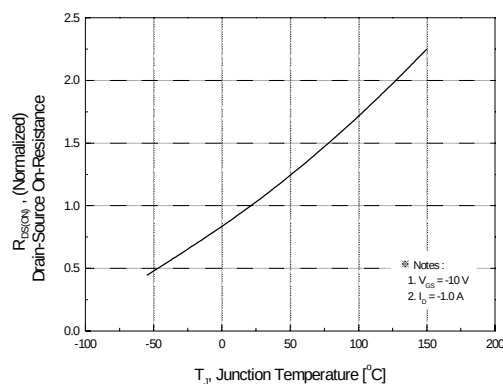


Figure 6. Gate Charge Characteristics

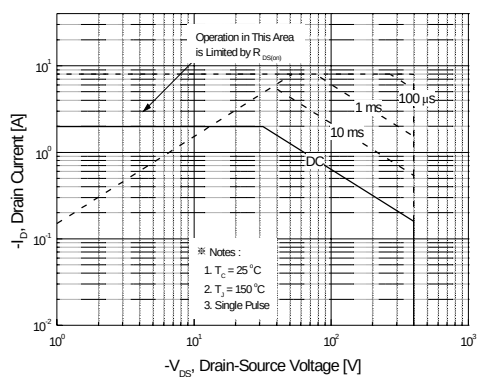
# Typical Characteristics (Continued)



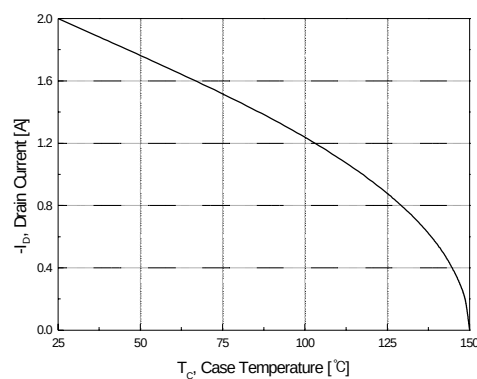
**Figure 7. Breakdown Voltage Variation vs. Temperature**



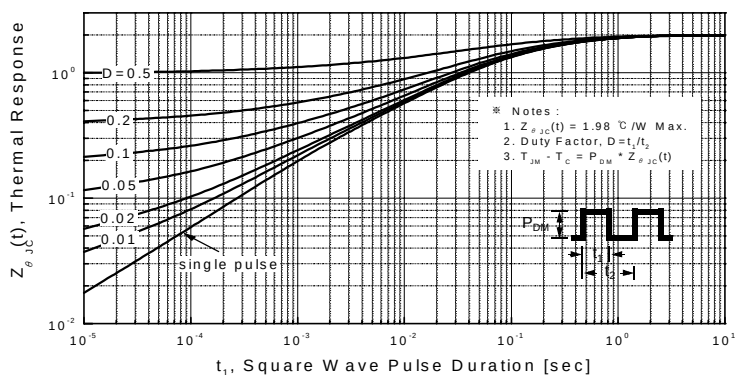
**Figure 8. On-Resistance Variation vs. Temperature**



**Figure 9. Maximum Safe Operating Area**

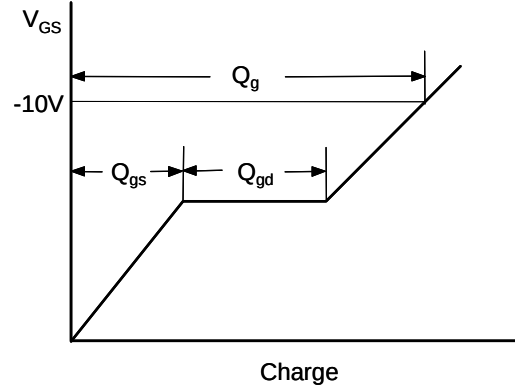
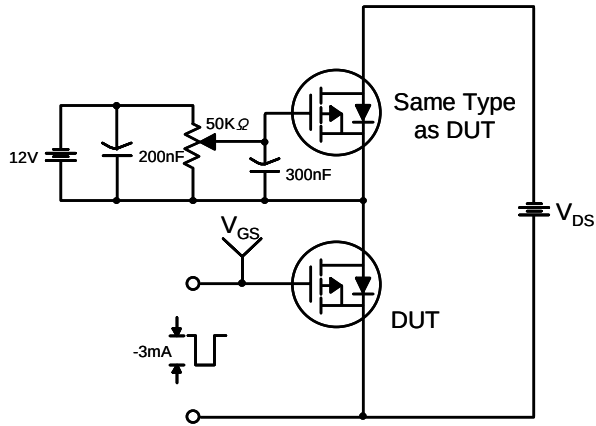


**Figure 10. Maximum Drain Current vs. Case Temperature**

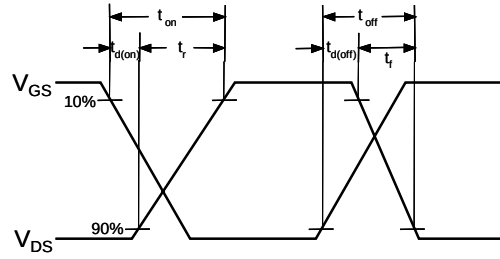
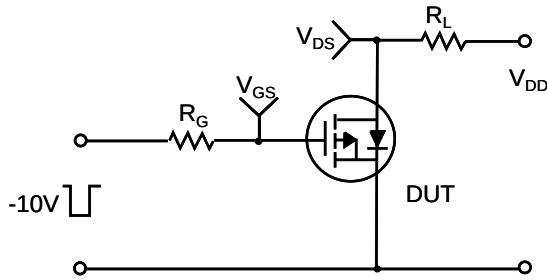


**Figure 11. Transient Thermal Response Curve**

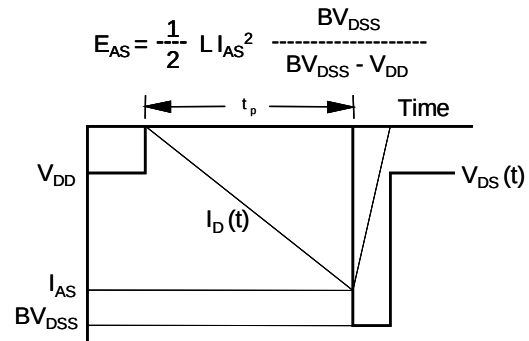
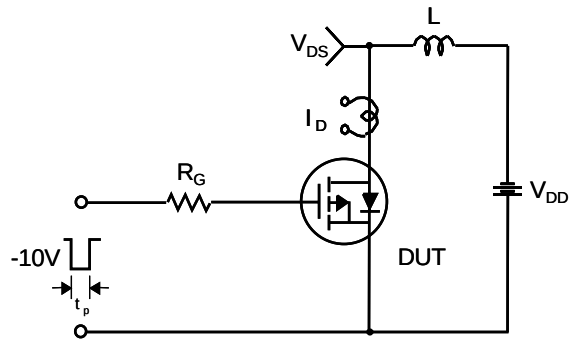
### Gate Charge Test Circuit & Waveform



### Resistive Switching Test Circuit & Waveforms



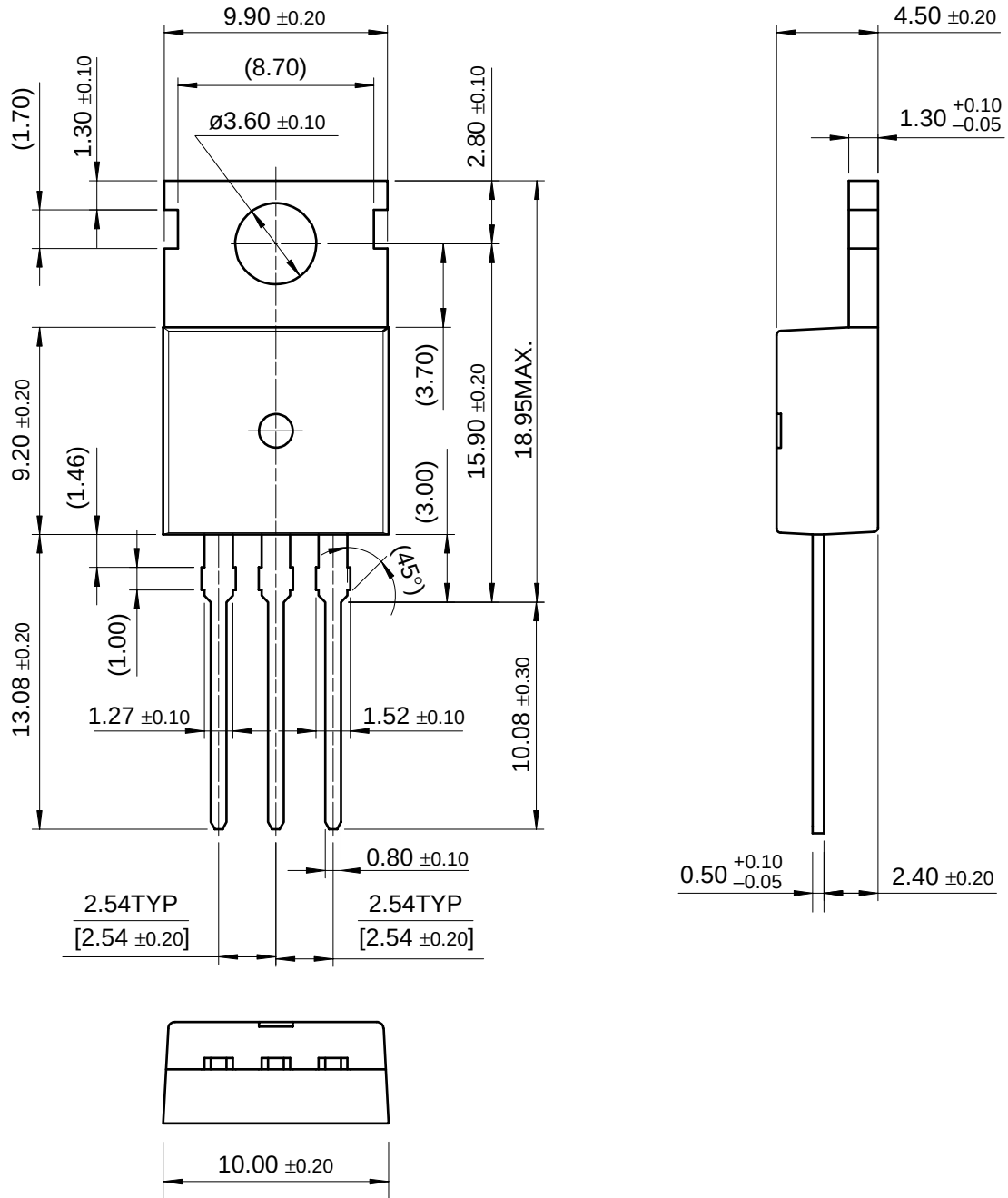
### Unclamped Inductive Switching Test Circuit & Waveforms





Package Dimensions

TO-220



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