



August 2000

QFET™

# FQPF4P40

## 400V P-Channel MOSFET

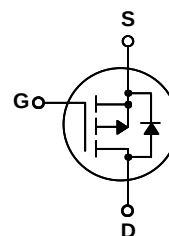
### General Description

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

This advanced technology 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 electronic lamp ballast based on complimentary half bridge.

### Features

- -2.4A, -400V,  $R_{DS(on)} = 3.1\Omega$  @  $V_{GS} = -10V$
- Low gate charge ( typical 18 nC)
- Low  $C_{rss}$  ( typical 11 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability



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

| Symbol         | Parameter                                                                     | FQPF4P40    | Units               |
|----------------|-------------------------------------------------------------------------------|-------------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                          | -400        | V                   |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )                       | -2.4        | A                   |
|                | - Continuous ( $T_C = 100^\circ\text{C}$ )                                    | -1.52       | A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                               | -9.6        | 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)                                                    | -2.4        | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 3.9         | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)                                            | -4.5        | V/ns                |
| $P_D$          | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                | 39          | W                   |
|                | - Derate above $25^\circ\text{C}$                                             | 0.31        | 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    | --  | 3.2  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | 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 $25^\circ\text{C}$ | --   | 0.36 | --   | 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 | $V_{GS} = -10\text{ V}, I_D = -1.2\text{ A}$          | --   | 2.44 | 3.1  | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = -50\text{ V}, I_D = -1.2\text{ A}$ (Note 4) | --   | 2.4  | --   | S        |

**Dynamic Characteristics**

|           |                              |                                                                       |    |     |     |    |
|-----------|------------------------------|-----------------------------------------------------------------------|----|-----|-----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = -25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 520 | 680 | pF |
| $C_{oss}$ | Output Capacitance           |                                                                       | -- | 80  | 105 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                       | -- | 11  | 15  | pF |

**Switching Characteristics**

|              |                     |                                                                                               |    |     |     |    |
|--------------|---------------------|-----------------------------------------------------------------------------------------------|----|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = -200\text{ V}, I_D = -3.5\text{ A},$<br>$R_G = 25\text{ }\Omega$<br><br>(Note 4, 5) | -- | 13  | 35  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                               | -- | 55  | 120 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                               | -- | 35  | 80  | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                               | -- | 37  | 85  | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = -320\text{ V}, I_D = -3.5\text{ A},$<br>$V_{GS} = -10\text{ V}$<br><br>(Note 4, 5)  | -- | 18  | 23  | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                               | -- | 3.8 | --  | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                               | -- | 9.4 | --  | nC |

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

|                 |                                                       |                                                                                             |    |     |      |    |
|-----------------|-------------------------------------------------------|---------------------------------------------------------------------------------------------|----|-----|------|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |                                                                                             | -- | --  | -2.4 | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                             | -- | --  | -9.6 | A  |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -2.4 A                                              | -- | --  | -5.0 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = -3.5 A,<br>dI <sub>F</sub> / dt = 100 A/μs (Note 4) | -- | 260 | --   | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |                                                                                             | -- | 1.4 | --   | μC |

**Notes:**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 79\text{ mH}, I_{AS} = -2.4\text{ A}, V_{DD} = -50\text{ V}, R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq -3.5\text{ A}, dI/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , 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

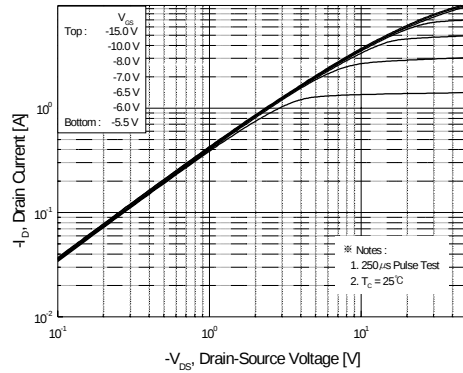


Figure 1. On-Region Characteristics

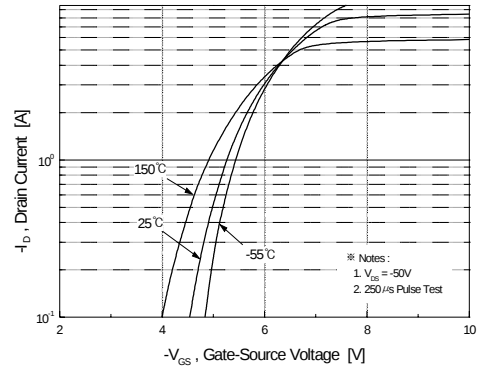


Figure 2. Transfer Characteristics

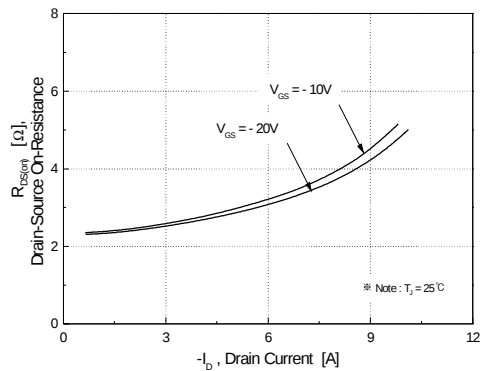


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

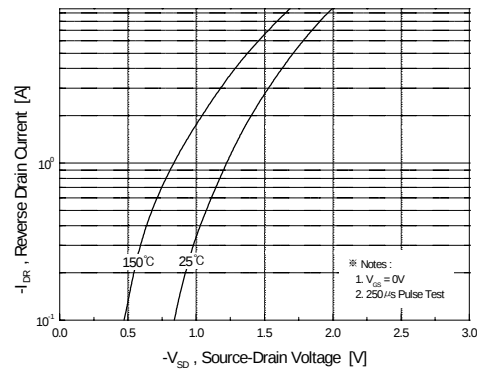


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

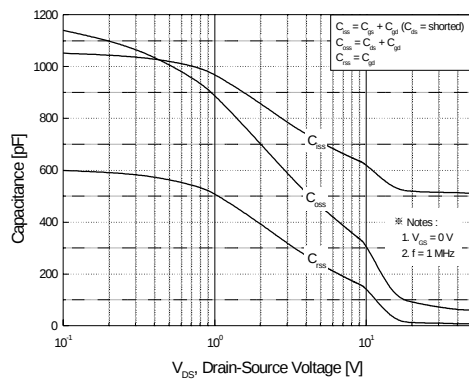


Figure 5. Capacitance Characteristics

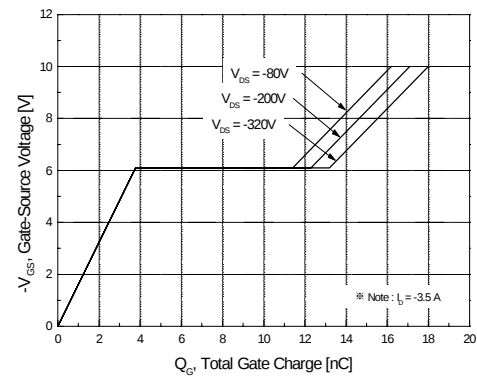


Figure 6. Gate Charge Characteristics

## Typical Characteristics (Continued)

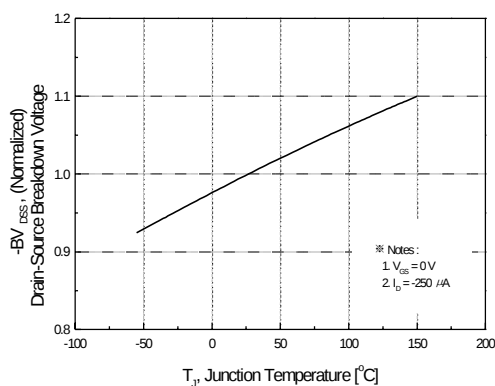


Figure 7. Breakdown Voltage Variation vs. Temperature

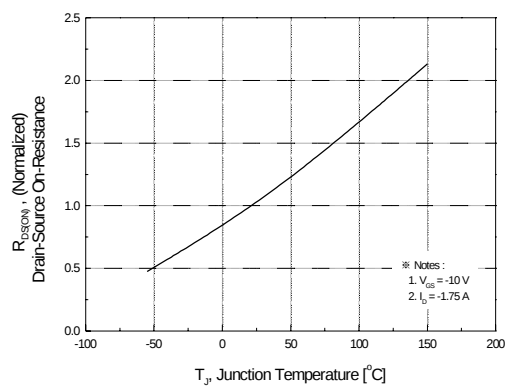


Figure 8. On-Resistance Variation vs. Temperature

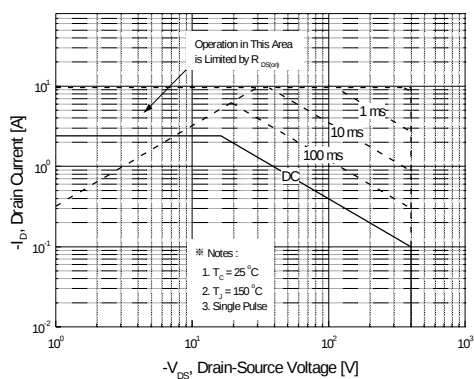


Figure 9. Maximum Safe Operating Area

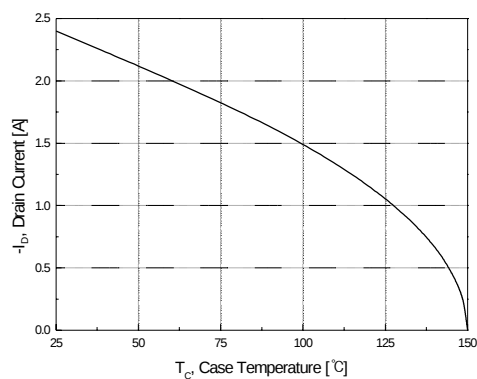


Figure 10. Maximum Drain Current vs. Case Temperature

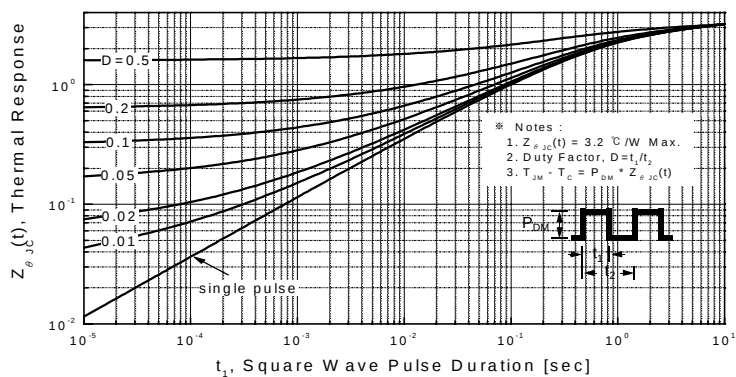
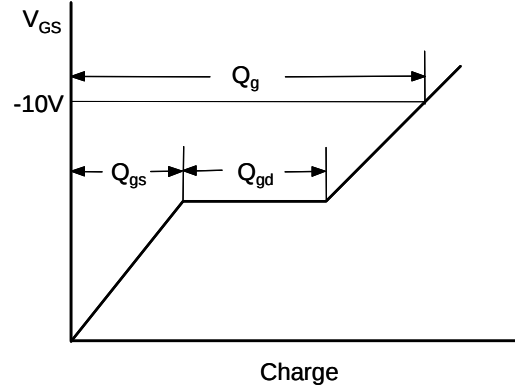
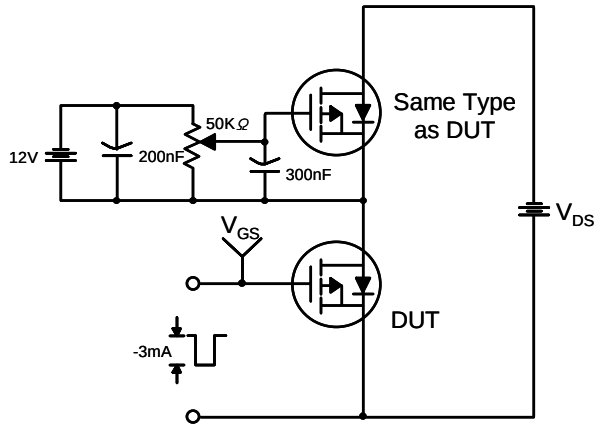
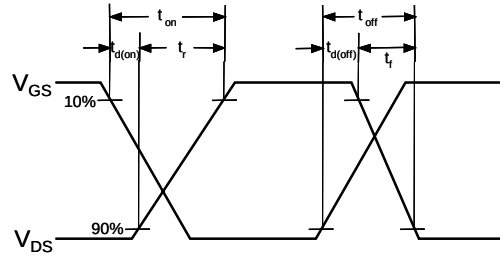
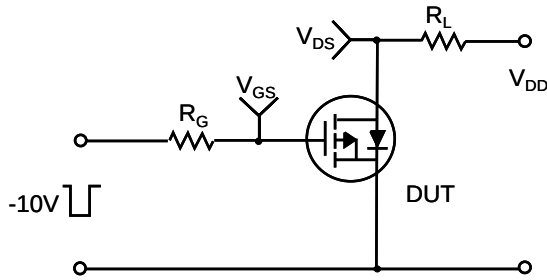


Figure 11. Transient Thermal Response Curve

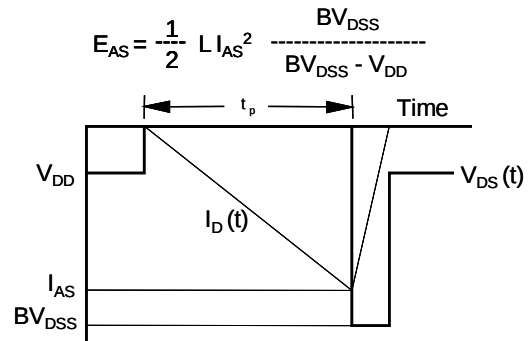
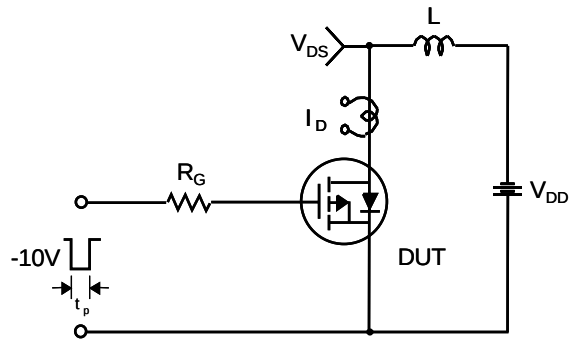
### Gate Charge Test Circuit & Waveform



### Resistive Switching Test Circuit & Waveforms



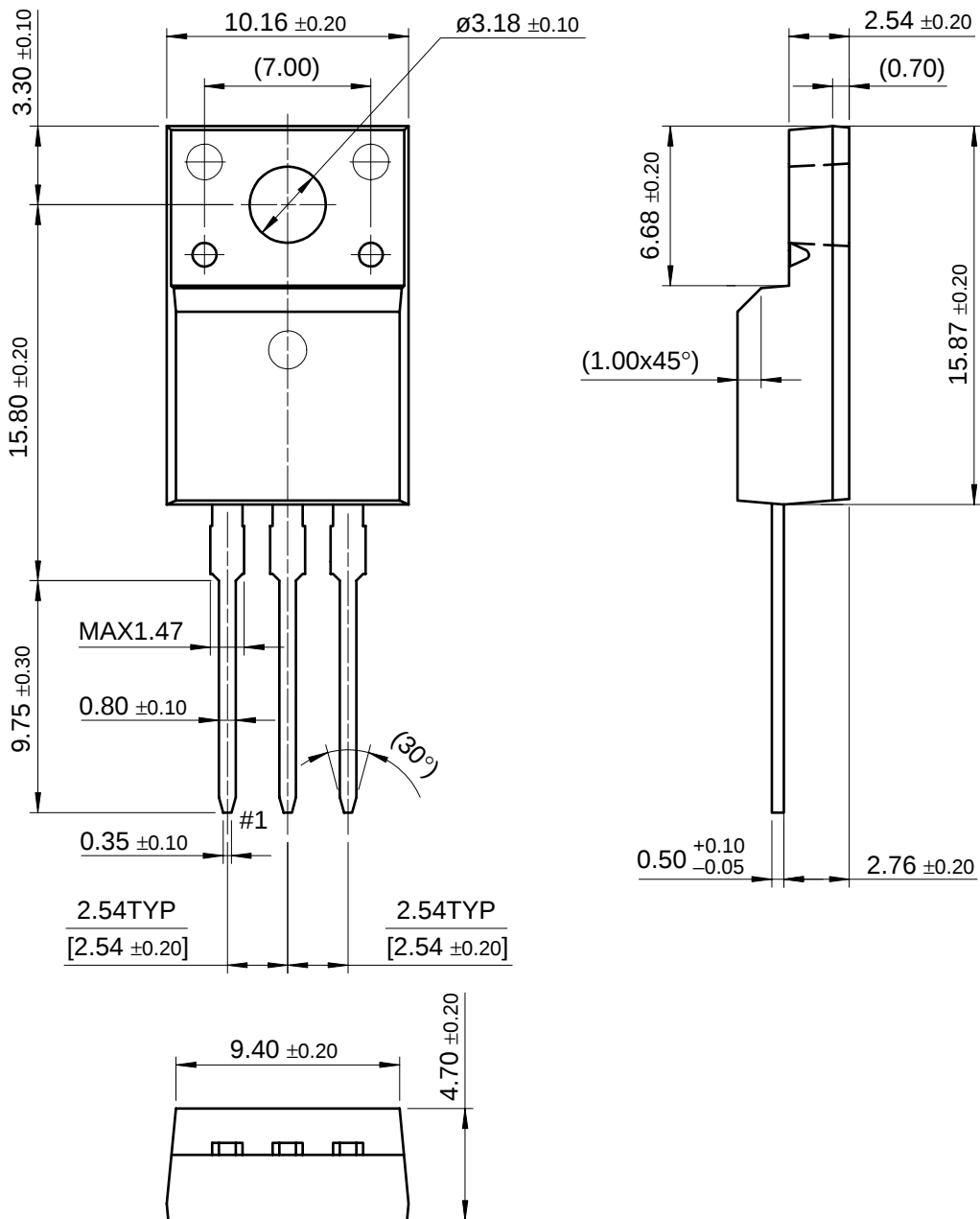
### Unclamped Inductive Switching Test Circuit & Waveforms





Package Dimensions

TO-220F



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