



April 2000

QFET™

## FQD3N60 / FQU3N60

### 600V N-Channel MOSFET

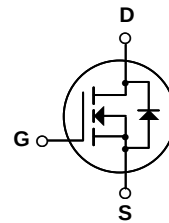
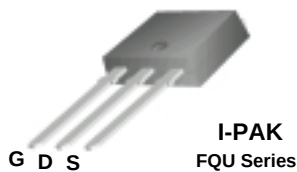
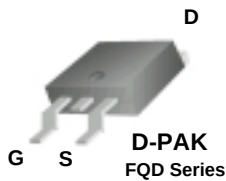
#### General Description

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

- 2.4A, 600V,  $R_{DS(on)} = 3.6\Omega$  @  $V_{GS} = 10V$
- Low gate charge ( typical 10 nC)
- Low  $C_{rss}$  ( typical 5.5 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability



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

| Symbol         | Parameter                                                                     | FQD3N60 / FQU3N60 | Units               |
|----------------|-------------------------------------------------------------------------------|-------------------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                          | 600               | V                   |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )                       | 2.4               | A                   |
|                | - Continuous ( $T_C = 100^\circ\text{C}$ )                                    | 1.5               | 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)                                       | 200               | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)                                                    | 2.4               | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 5.0               | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)                                            | 4.5               | V/ns                |
| $P_D$          | Power Dissipation ( $T_A = 25^\circ\text{C}$ ) *                              | 2.5               | W                   |
|                | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                | 50                | W                   |
|                | - Derate above $25^\circ\text{C}$                                             | 0.4               | 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      | --  | 2.5 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient * | --  | 50  | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient   | --  | 110 | $^\circ\text{C}/\text{W}$ |

\* When mounted on the minimum pad size recommended (PCB Mount)

**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            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$               | 600 | --  | --   | V                  |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | --  | 0.6 | --   | $V/^\circ\text{C}$ |
| $I_{DSS}$                      | 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            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$     | 3.0 | --  | 5.0 | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 1.2\text{ A}$          | --  | 2.8 | 3.6 | $\Omega$ |
| $g_{FS}$     | 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>$f = 1.0\text{ MHz}$ | -- | 350 | 450 | pF |
| $C_{oss}$ | Output Capacitance           |                                                                      | -- | 50  | 65  | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                      | -- | 5.5 | 7.5 | pF |

**Switching Characteristics**

|              |                     |                                                                                             |    |     |    |    |
|--------------|---------------------|---------------------------------------------------------------------------------------------|----|-----|----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 300\text{ V}, I_D = 3.0\text{ A},$<br>$R_G = 25\text{ }\Omega$<br><br>(Note 4, 5) | -- | 10  | 30 | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                             | -- | 30  | 70 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                             | -- | 20  | 50 | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                             | -- | 30  | 70 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 480\text{ V}, I_D = 3.0\text{ A},$<br>$V_{GS} = 10\text{ V}$<br><br>(Note 4, 5)   | -- | 10  | 13 | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                             | -- | 2.7 | -- | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                             | -- | 4.9 | -- | 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                                              | -- | --  | 1.4 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 3.0 A,<br>dI <sub>F</sub> / dt = 100 A/μs (Note 4) | -- | 210 | --  | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |                                                                                            | -- | 1.2 | --  | μC |

**Notes:**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 64\text{ mH}, I_{AS} = 2.4\text{ A}, V_{DD} = 50\text{ V}, R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 3.0\text{ A}, dI/dt \leq 200\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , 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

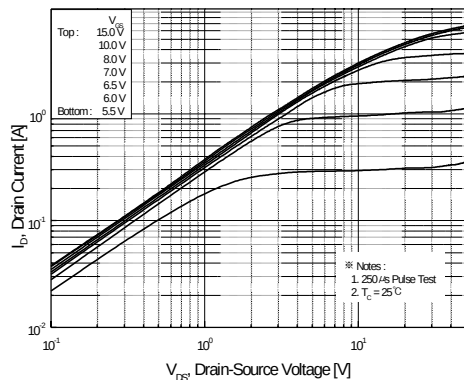


Figure 1. On-Region Characteristics

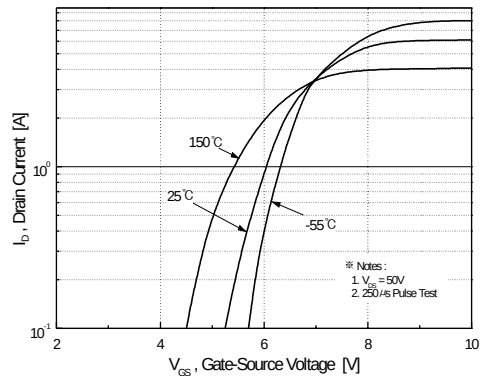


Figure 2. Transfer Characteristics

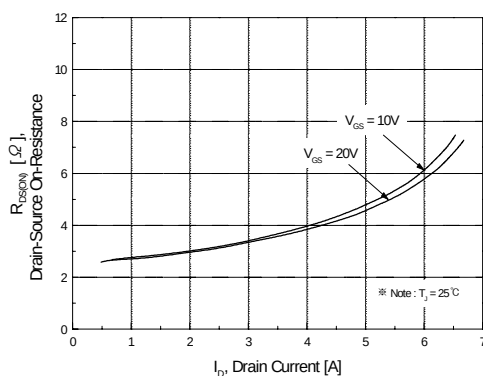


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

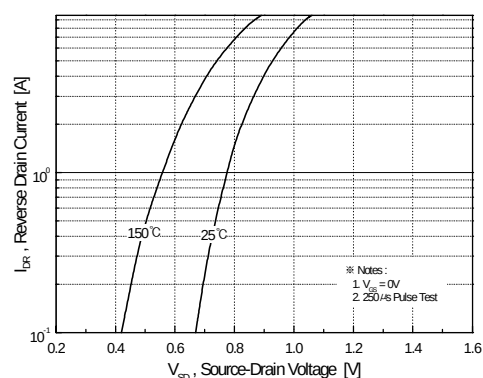


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

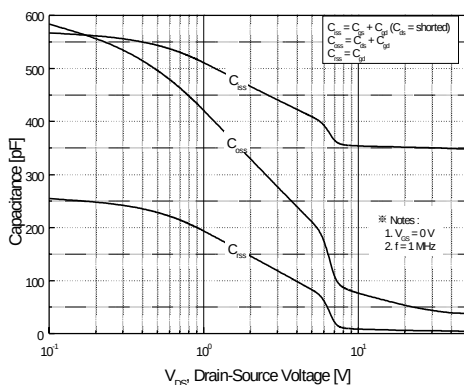


Figure 5. Capacitance Characteristics

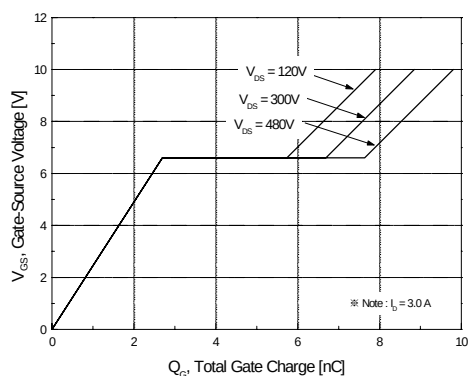


Figure 6. Gate Charge Characteristics

## Typical Characteristics (Continued)

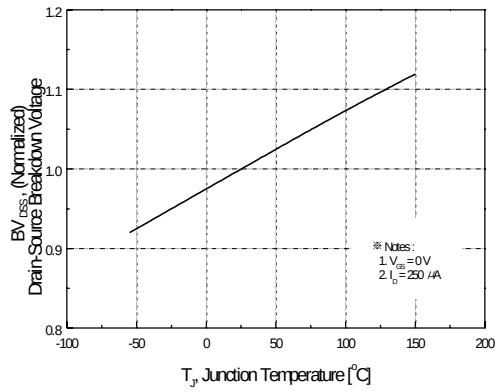


Figure 7. Breakdown Voltage Variation vs. Temperature

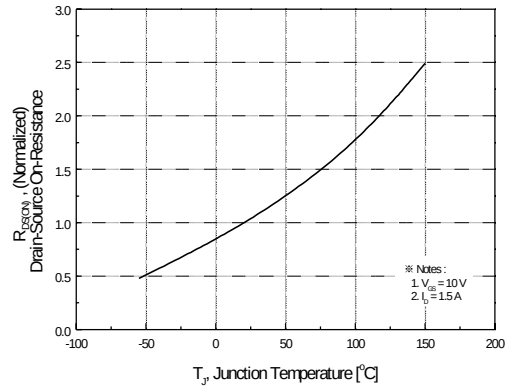


Figure 8. On-Resistance Variation vs. Temperature

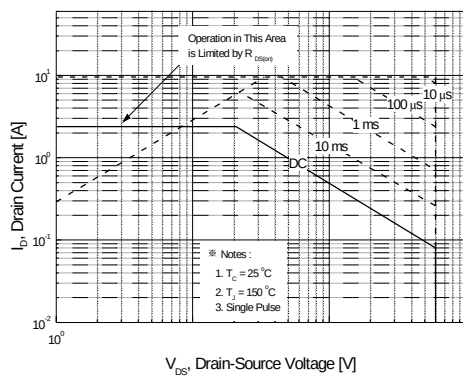


Figure 9. Maximum Safe Operating Area

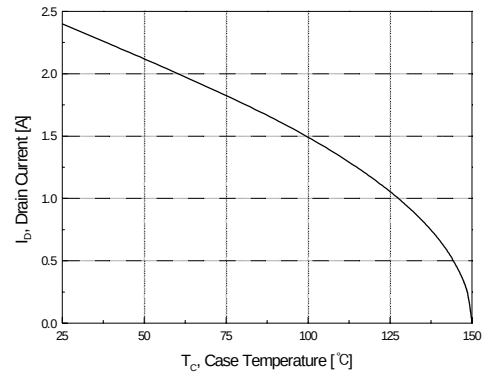


Figure 10. Maximum Drain Current vs. Case Temperature

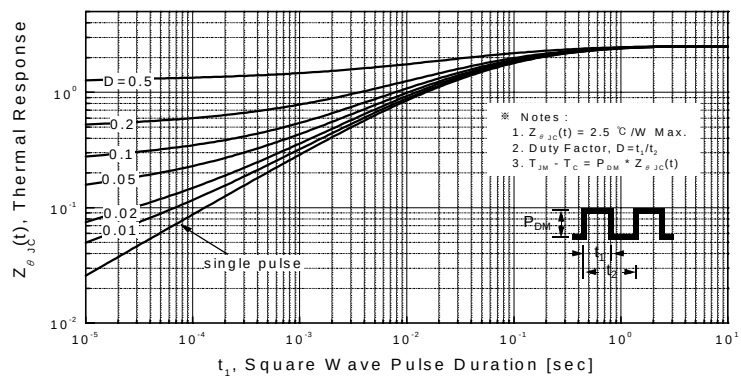
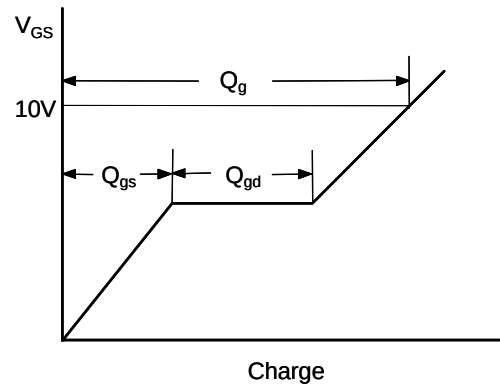
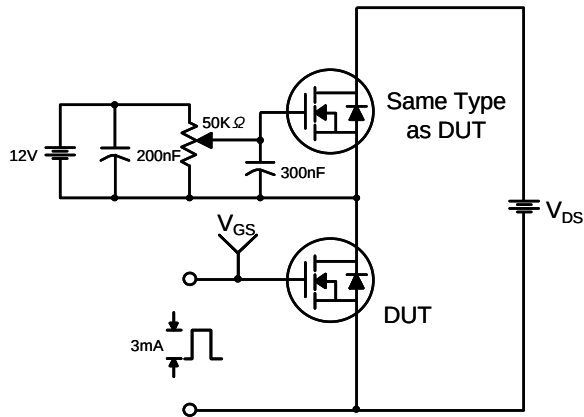
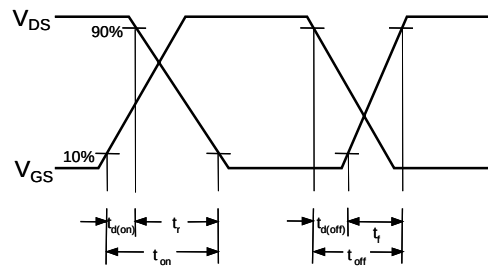
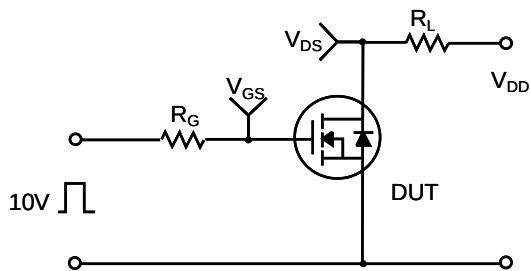


Figure 11. Transient Thermal Response Curve

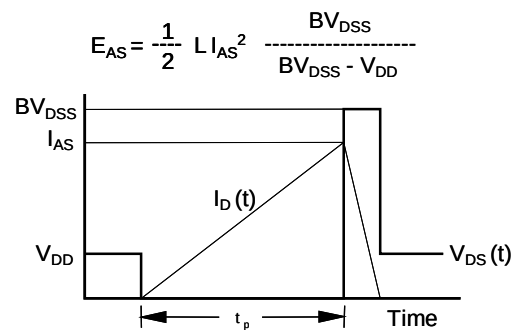
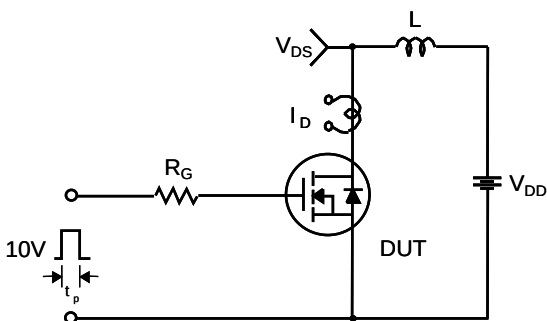
### Gate Charge Test Circuit & Waveform



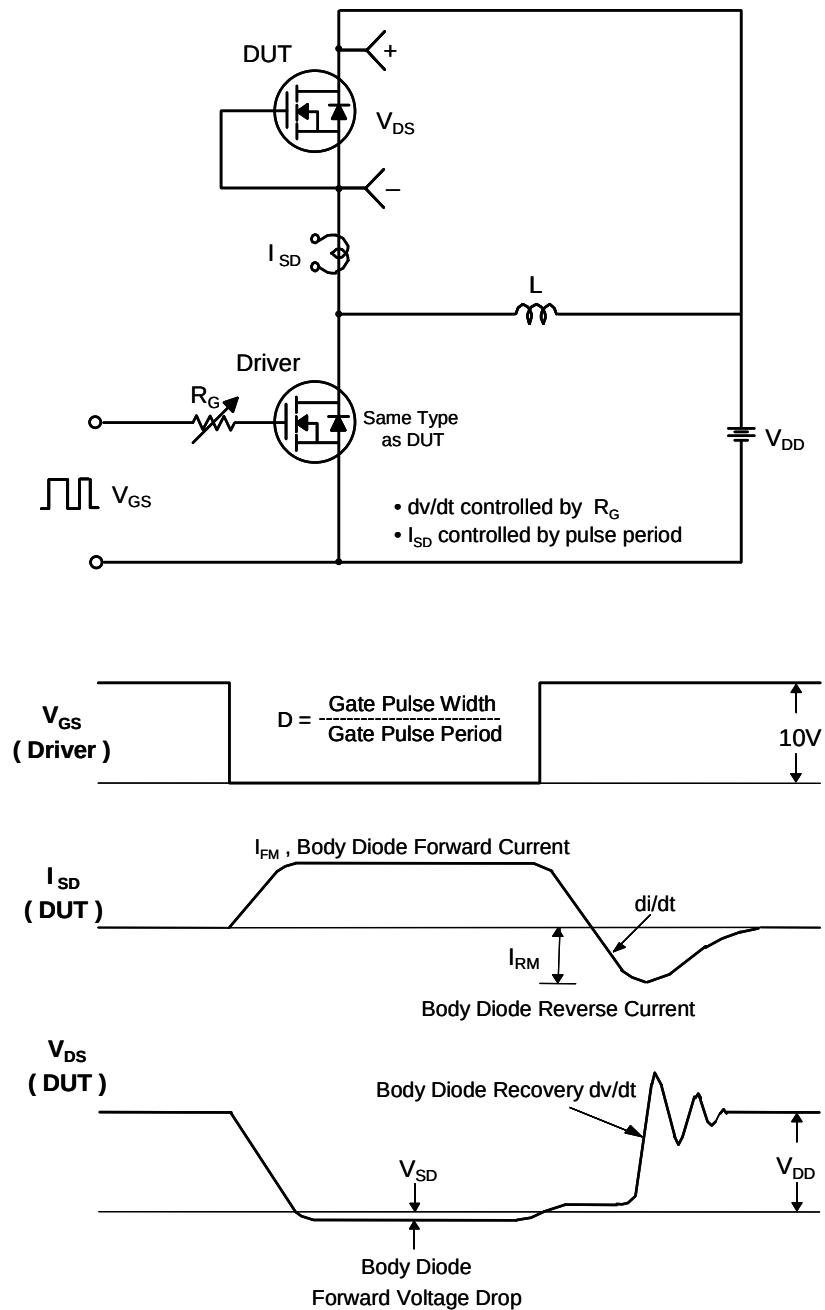
### Resistive Switching Test Circuit & Waveforms



### Unclamped Inductive Switching Test Circuit & Waveforms

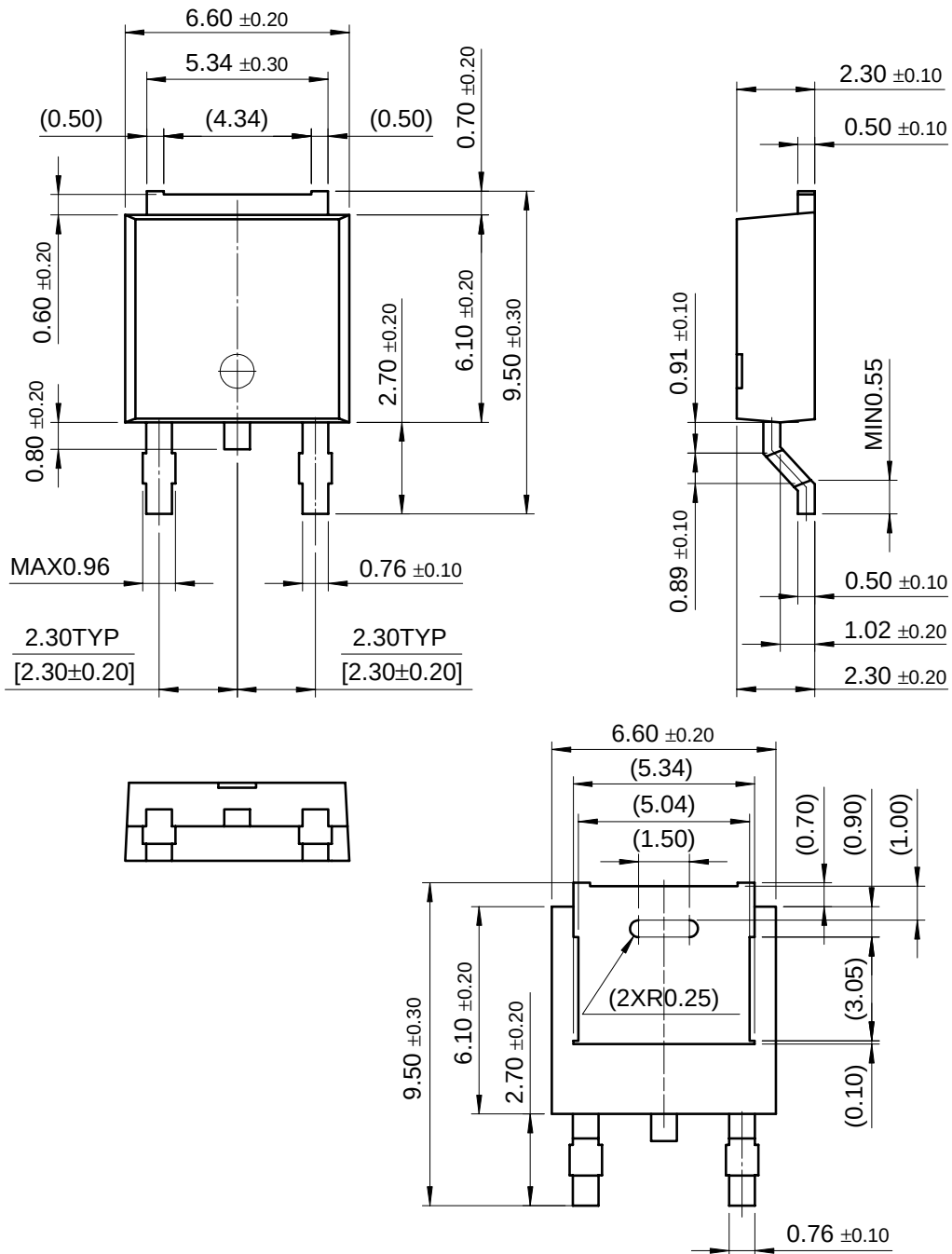


# Peak Diode Recovery dv/dt Test Circuit & Waveforms



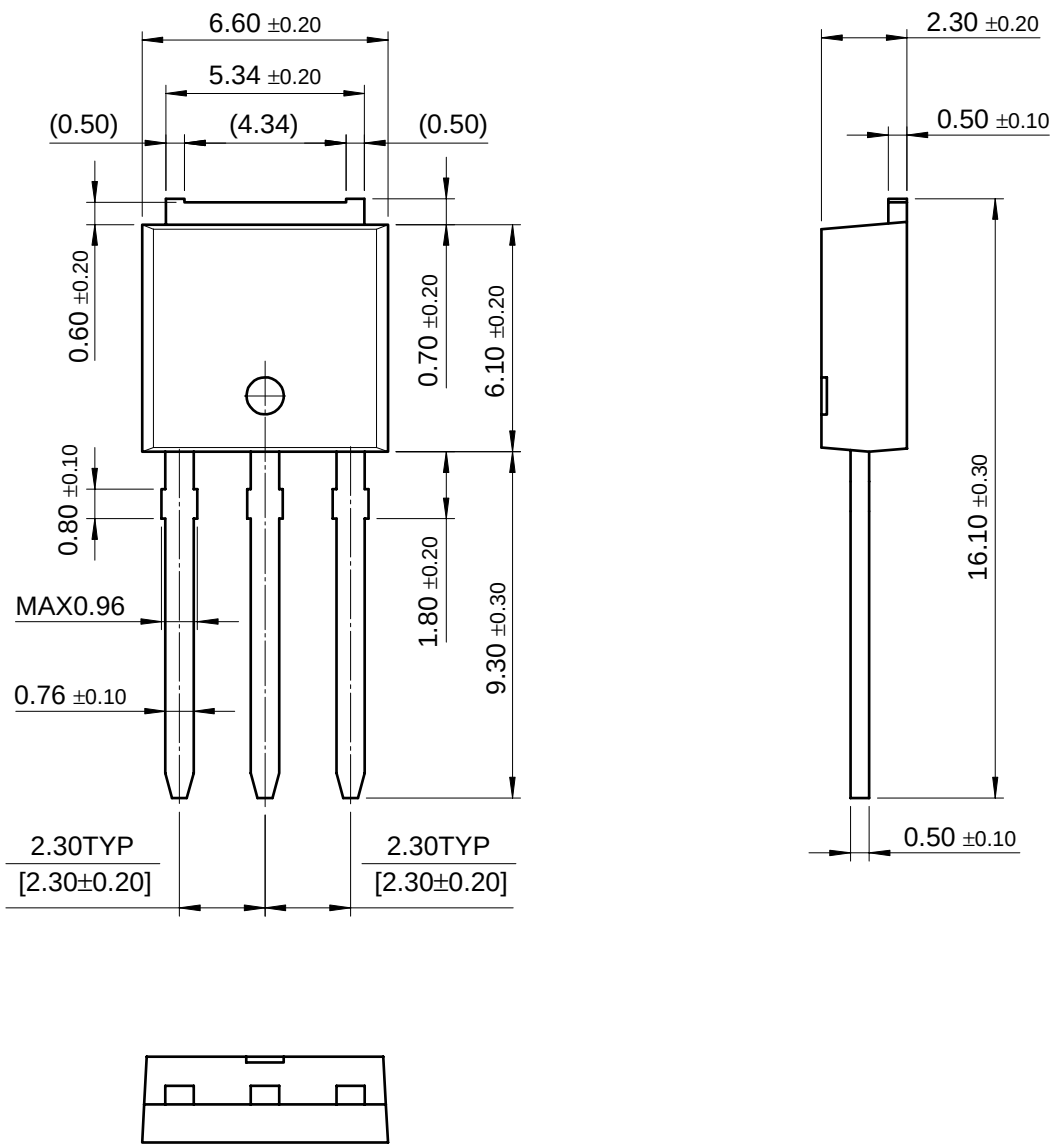
Package Dimensions

DPAK



Package Dimensions (Continued)

IPAK





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