



August 2000

QFET™

# FQB19N10L / FQI19N10L

## 100V LOGIC N-Channel MOSFET

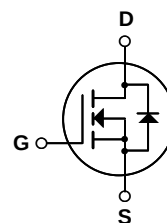
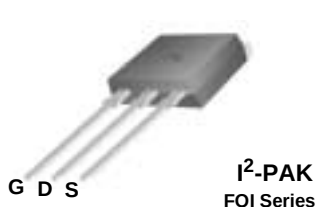
### General Description

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 low voltage applications such as high efficiency switching DC/DC converters, and DC motor control.

### Features

- 19A, 100V,  $R_{DS(on)} = 0.1\Omega$  @  $V_{GS} = 10V$
- Low gate charge ( typical 14 nC)
- Low  $C_{rss}$  ( typical 35 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability
- 175°C maximum junction temperature rating



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

| Symbol         | Parameter                                                                     | FQB19N10L / FQI19N10L | Units               |
|----------------|-------------------------------------------------------------------------------|-----------------------|---------------------|
| $V_{DSS}$      | Drain-Source Voltage                                                          | 100                   | V                   |
| $I_D$          | Drain Current - Continuous ( $T_C = 25^\circ\text{C}$ )                       | 19                    | A                   |
|                | - Continuous ( $T_C = 100^\circ\text{C}$ )                                    | 13.5                  | A                   |
| $I_{DM}$       | Drain Current - Pulsed (Note 1)                                               | 76                    | A                   |
| $V_{GSS}$      | Gate-Source Voltage                                                           | $\pm 20$              | V                   |
| $E_{AS}$       | Single Pulsed Avalanche Energy (Note 2)                                       | 220                   | mJ                  |
| $I_{AR}$       | Avalanche Current (Note 1)                                                    | 19                    | A                   |
| $E_{AR}$       | Repetitive Avalanche Energy (Note 1)                                          | 7.5                   | mJ                  |
| dv/dt          | Peak Diode Recovery dv/dt (Note 3)                                            | 6.0                   | V/ns                |
| $P_D$          | Power Dissipation ( $T_A = 25^\circ\text{C}$ ) *                              | 3.75                  | W                   |
|                | Power Dissipation ( $T_C = 25^\circ\text{C}$ )                                | 75                    | W                   |
|                | - Derate above $25^\circ\text{C}$                                             | 0.5                   | W/ $^\circ\text{C}$ |
| $T_J, T_{STG}$ | Operating and Storage Temperature Range                                       | -55 to +175           | $^\circ\text{C}$    |
| $T_L$          | 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      | --  | 2.0  | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient * | --  | 40   | $^\circ\text{C/W}$ |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient   | --  | 62.5 | $^\circ\text{C/W}$ |

\* 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            | $V_{GS} = 0\text{ V}, I_D = 250\text{ }\mu\text{A}$               | 100 | --   | --   | V                   |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250\text{ }\mu\text{A}$ , Referenced to $25^\circ\text{C}$ | --  | 0.09 | --   | V/ $^\circ\text{C}$ |
| $I_{DSS}$                      | Zero Gate Voltage Drain Current           | $V_{DS} = 100\text{ V}, V_{GS} = 0\text{ V}$                      | --  | --   | 1    | $\mu\text{A}$       |
|                                |                                           | $V_{DS} = 80\text{ V}, T_C = 150^\circ\text{C}$                   | --  | --   | 10   | $\mu\text{A}$       |
| $I_{GSSF}$                     | Gate-Body Leakage Current, Forward        | $V_{GS} = 20\text{ V}, V_{DS} = 0\text{ V}$                       | --  | --   | 100  | nA                  |
| $I_{GSSR}$                     | Gate-Body Leakage Current, Reverse        | $V_{GS} = -20\text{ V}, V_{DS} = 0\text{ V}$                      | --  | --   | -100 | nA                  |

**On Characteristics**

|              |                                   |                                                     |     |       |      |          |
|--------------|-----------------------------------|-----------------------------------------------------|-----|-------|------|----------|
| $V_{GS(th)}$ | Gate Threshold Voltage            | $V_{DS} = V_{GS}, I_D = 250\text{ }\mu\text{A}$     | 1.0 | --    | 2.0  | V        |
| $R_{DS(on)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10\text{ V}, I_D = 9.5\text{ A}$          | --  | 0.074 | 0.10 | $\Omega$ |
|              |                                   | $V_{GS} = 5\text{ V}, I_D = 9.5\text{ A}$           | --  | 0.082 | 0.11 | $\Omega$ |
| $g_{FS}$     | Forward Transconductance          | $V_{DS} = 30\text{ V}, I_D = 9.5\text{ A}$ (Note 4) | --  | 15    | --   | S        |

**Dynamic Characteristics**

|           |                              |                                                                      |    |     |     |    |
|-----------|------------------------------|----------------------------------------------------------------------|----|-----|-----|----|
| $C_{iss}$ | Input Capacitance            | $V_{DS} = 25\text{ V}, V_{GS} = 0\text{ V},$<br>$f = 1.0\text{ MHz}$ | -- | 670 | 870 | pF |
| $C_{oss}$ | Output Capacitance           |                                                                      | -- | 160 | 210 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance |                                                                      | -- | 35  | 45  | pF |

**Switching Characteristics**

|              |                     |                                                                                           |    |     |     |    |
|--------------|---------------------|-------------------------------------------------------------------------------------------|----|-----|-----|----|
| $t_{d(on)}$  | Turn-On Delay Time  | $V_{DD} = 50\text{ V}, I_D = 19\text{ A},$<br>$R_G = 25\text{ }\Omega$<br><br>(Note 4, 5) | -- | 14  | 38  | ns |
| $t_r$        | Turn-On Rise Time   |                                                                                           | -- | 410 | 830 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time |                                                                                           | -- | 20  | 50  | ns |
| $t_f$        | Turn-Off Fall Time  |                                                                                           | -- | 140 | 290 | ns |
| $Q_g$        | Total Gate Charge   | $V_{DS} = 80\text{ V}, I_D = 19\text{ A},$<br>$V_{GS} = 5\text{ V}$<br><br>(Note 4, 5)    | -- | 14  | 18  | nC |
| $Q_{gs}$     | Gate-Source Charge  |                                                                                           | -- | 2.9 | --  | nC |
| $Q_{gd}$     | Gate-Drain Charge   |                                                                                           | -- | 9.2 | --  | nC |

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

|                 |                                                       |                                                                                           |    |       |     |    |
|-----------------|-------------------------------------------------------|-------------------------------------------------------------------------------------------|----|-------|-----|----|
| I <sub>S</sub>  | Maximum Continuous Drain-Source Diode Forward Current |                                                                                           | -- | --    | 19  | A  |
| I <sub>SM</sub> | Maximum Pulsed Drain-Source Diode Forward Current     |                                                                                           | -- | --    | 76  | A  |
| V <sub>SD</sub> | Drain-Source Diode Forward Voltage                    | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 19 A                                              | -- | --    | 1.5 | V  |
| t <sub>rr</sub> | Reverse Recovery Time                                 | V <sub>GS</sub> = 0 V, I <sub>S</sub> = 19 A,<br>dI <sub>F</sub> / dt = 100 A/μs (Note 4) | -- | 80    | --  | ns |
| Q <sub>rr</sub> | Reverse Recovery Charge                               |                                                                                           | -- | 0.195 | --  | μC |

**Notes:**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L = 0.9\text{ mH}, I_{AS} = 19\text{ A}, V_{DD} = 25\text{ V}, R_G = 25\text{ }\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 19\text{ A}, di/dt \leq 300\text{ A}/\mu\text{s}, V_{DD} \leq BV_{DSS}$ , 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

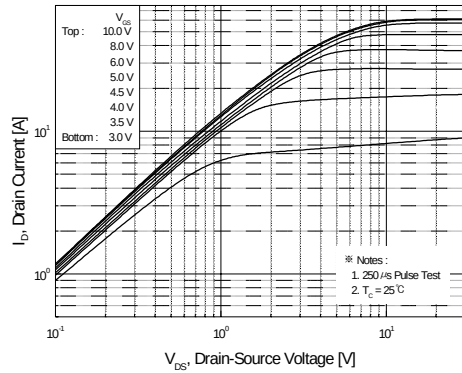


Figure 1. On-Region Characteristics

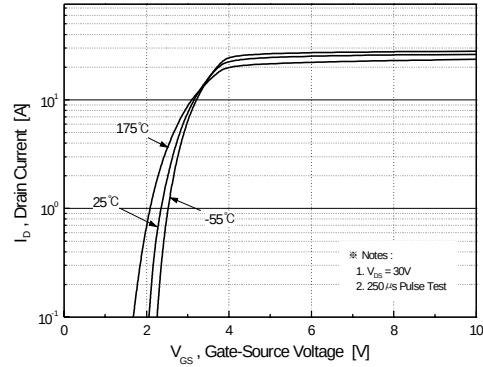


Figure 2. Transfer Characteristics

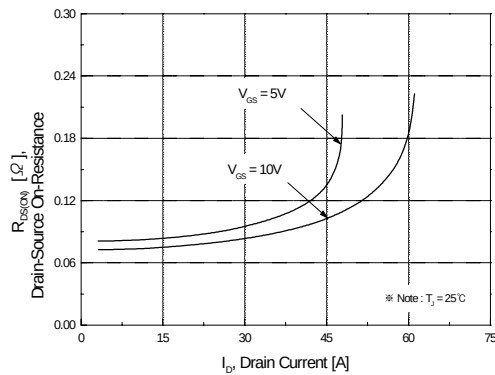


Figure 3. On-Resistance Variation vs. Drain Current and Gate Voltage

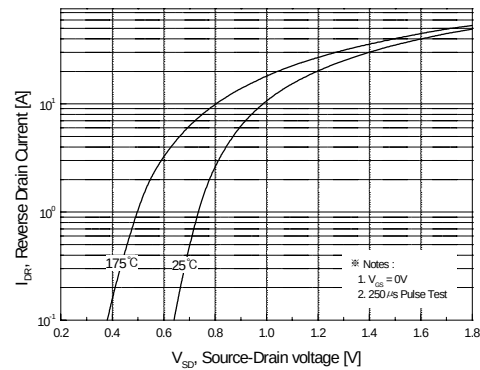


Figure 4. Body Diode Forward Voltage Variation vs. Source Current and Temperature

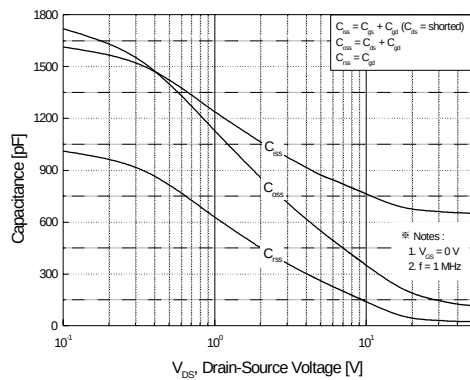


Figure 5. Capacitance Characteristics

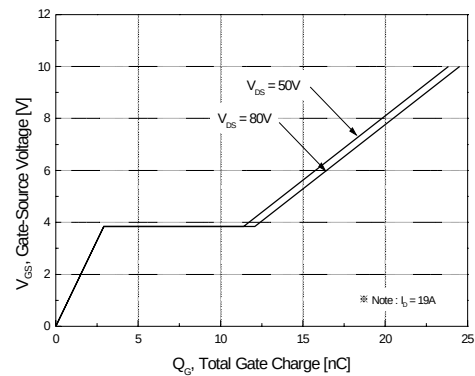


Figure 6. Gate Charge Characteristics

## Typical Characteristics (Continued)

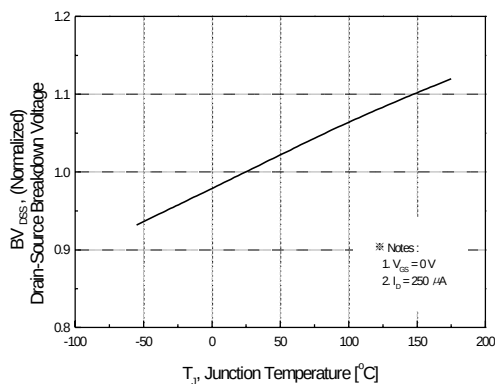


Figure 7. Breakdown Voltage Variation vs. Temperature

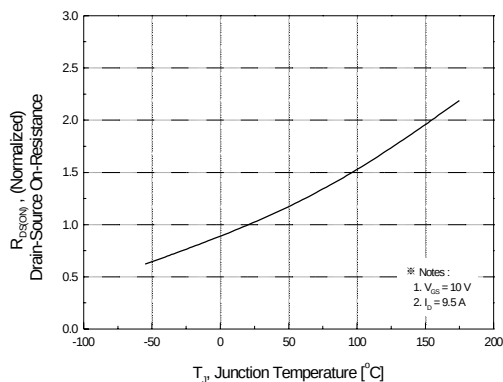


Figure 8. On-Resistance Variation vs. Temperature

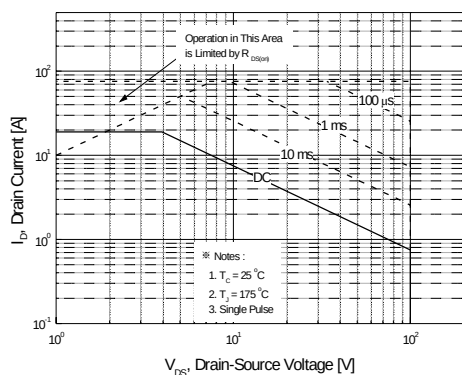


Figure 9. Maximum Safe Operating Area

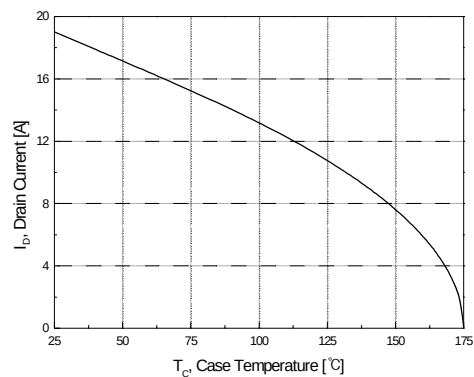


Figure 10. Maximum Drain Current vs. Case Temperature

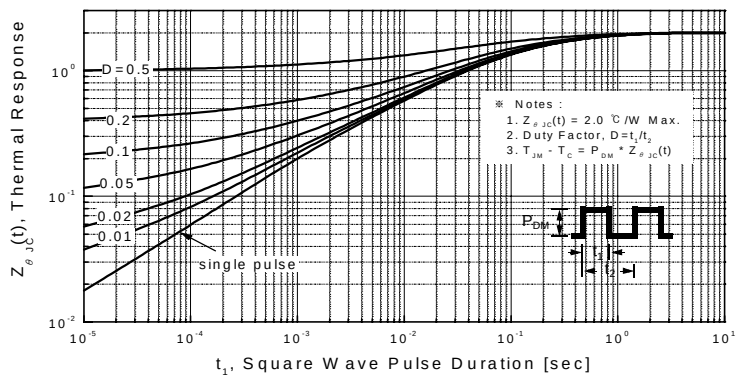
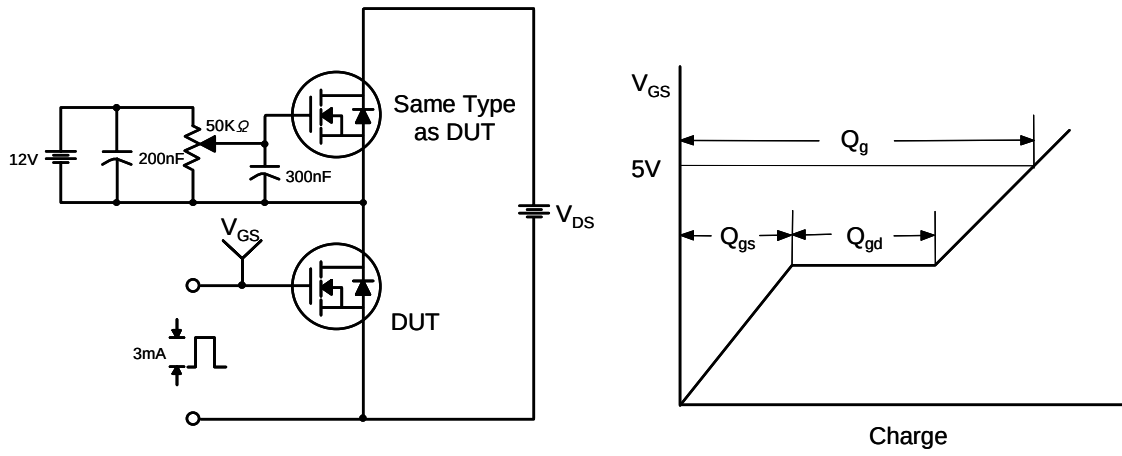
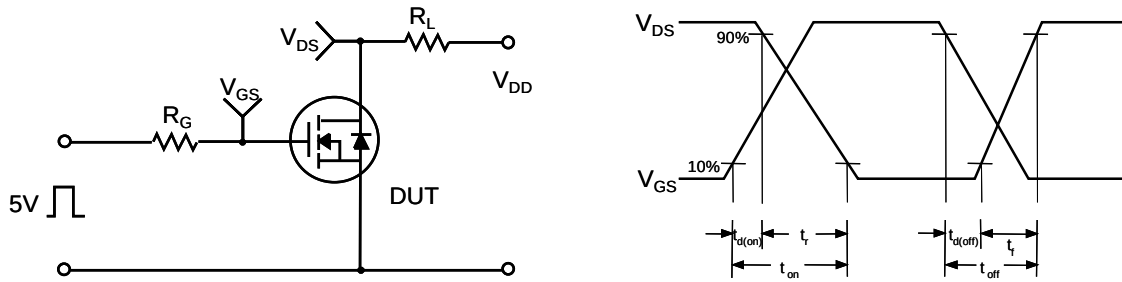


Figure 11. Transient Thermal Response Curve

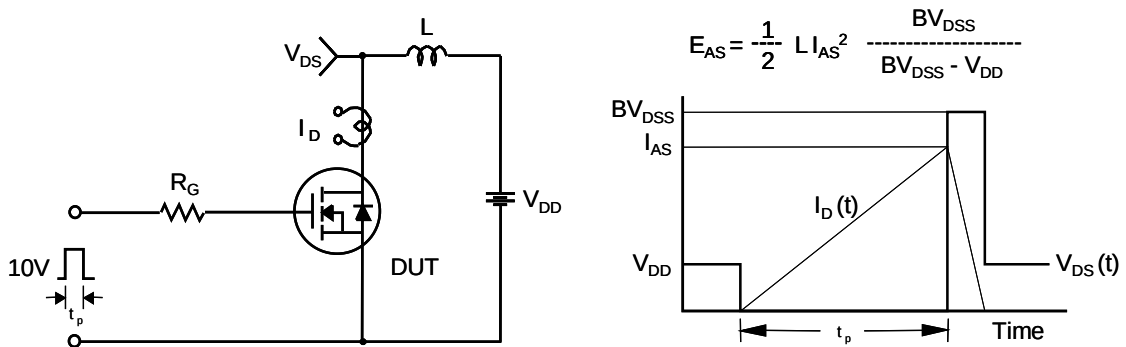
### Gate Charge Test Circuit & Waveform



### Resistive Switching Test Circuit & Waveforms



### Unclamped Inductive Switching Test Circuit & Waveforms



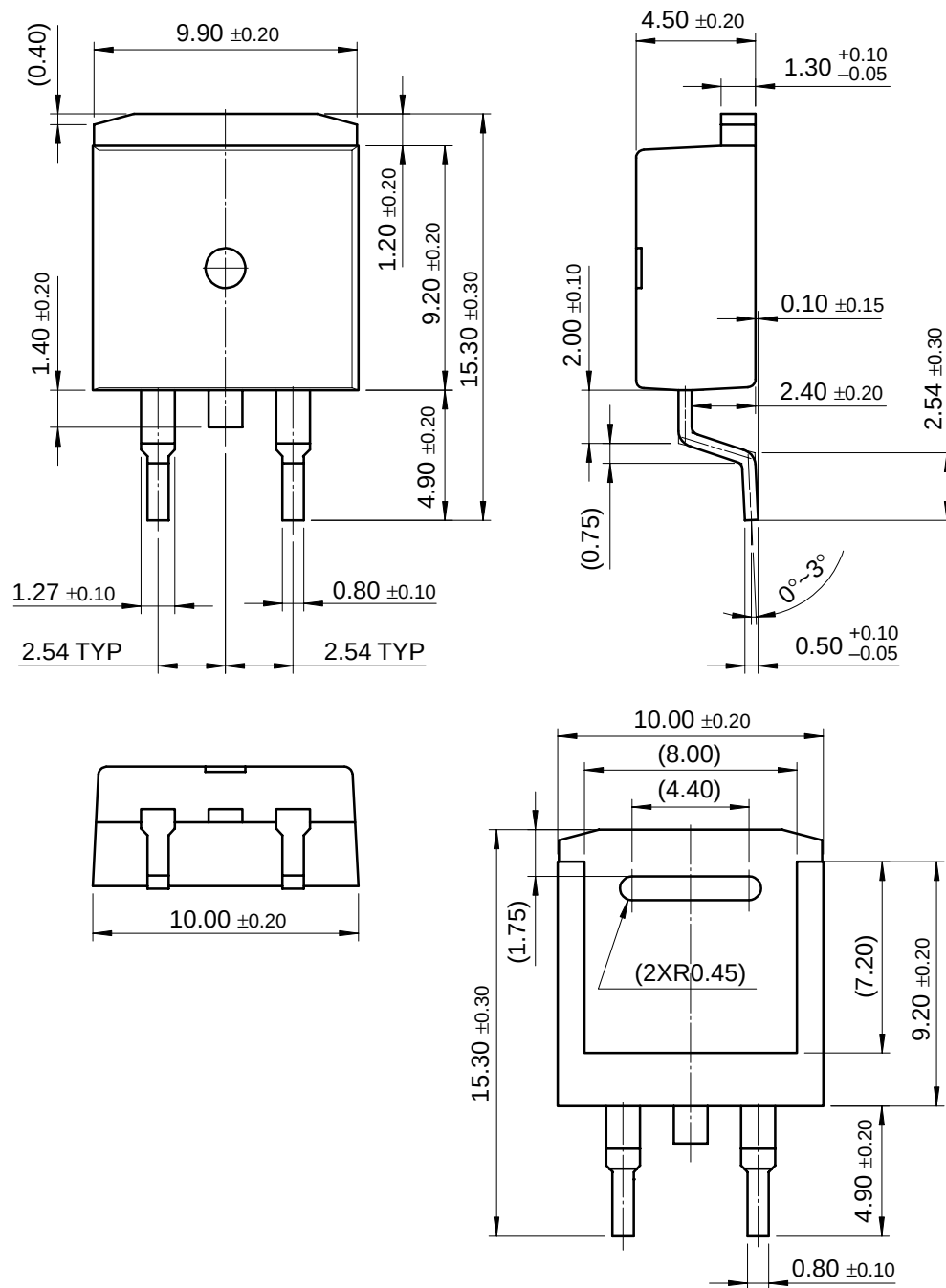
The top diagram shows a circuit for testing the body diode of a MOSFET. The DUT (Device Under Test) is a MOSFET with its gate connected to its drain. The source is connected to the source of a driver MOSFET. The driver's gate is driven by a square wave  $V_{GS}$  through a resistor  $R_G$ . The driver's drain is connected to the DUT's drain through an inductor  $L$ . The DUT's drain is also connected to a DC supply  $V_{DD}$ . The DUT's source current is  $I_{SD}$ , and the drain-source voltage is  $V_{DS}$ . The driver is of the same type as the DUT.

Below the circuit, three waveforms are shown:

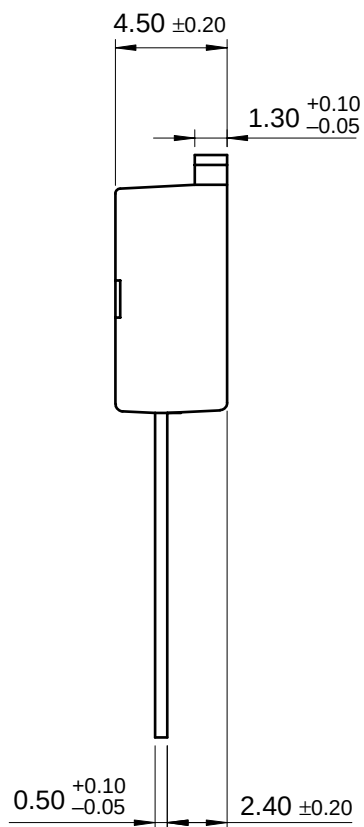
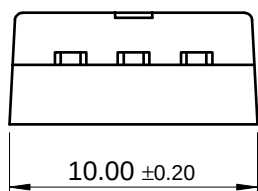
- $V_{GS}$  (Driver):** A square wave pulse. The duty cycle is defined as  $D = \frac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$ . The pulse height is  $10V$ .
- $I_{SD}$  (DUT):** The source current. It shows a forward current  $I_{FM}$  during the pulse, followed by a reverse current  $I_{RM}$  during the recovery phase. The recovery is characterized by  $di/dt$ .
- $V_{DS}$  (DUT):** The drain-source voltage. It shows a forward voltage drop  $V_{SD}$  during the pulse, followed by a recovery phase with  $dv/dt$  oscillations. The reverse voltage is  $V_{DD}$ .

Package Dimensions

D<sup>2</sup>PAK



**FQB19N10L / FQI19N10L**

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