

FEATURES

- Originative New Design
- 100% EAS Test
- Rugged Gate Oxide Technology
- Extremely Low Intrinsic Capacitances
- Remarkable Switching Characteristics
- Unequalled Gate Charge : 12.4 nC (Typ.)
- Extended Safe Operating Area
- Lower $R_{DS(ON)}$: 2.2 Ω (Typ.) @ $V_{GS}=10V$

APPLICATION

- Low power battery chargers
- Switch mode power supply (SMPS)
- DC-AC converters.

PFP4N65F / PFF4N65F

650V N-Channel MOSFET

| | |
|---------------------------------------------------------------------------------|-------------------------------------------------|
| $BV_{DSS} = 650\text{ V}$ $R_{DS(on)} = 2.2\ \Omega$ $I_D = 4.0\text{ A}$ | |
| TO-220 1.Gate 2. Drain 3. Source | TO-220F 1.Gate 2. Drain 3. Source |

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

| Symbol | Parameter | PFP4N65F | PFF4N65F | Units |
|----------------|-------------------------------------------------------------------------------------|-------------|----------|---------------------|
| V_{DSS} | Drain-Source Voltage | 650 | | V |
| I_D | Drain Current – Continuous ($T_C = 25^\circ\text{C}$) | 4.0 | 4.0* | A |
| | Drain Current – Continuous ($T_C = 100^\circ\text{C}$) | 2.6 | 2.6* | A |
| I_{DM} | Drain Current – Pulsed (Note 1) | 16.0 | 16.0* | A |
| V_{GS} | Gate-Source Voltage | ± 30 | | V |
| E_{AS} | Single Pulsed Avalanche Energy (Note 2) | 240 | | mJ |
| I_{AR} | Avalanche Current (Note 1) | 4.0 | | A |
| E_{AR} | Repetitive Avalanche Energy (Note 1) | 10.0 | | mJ |
| dv/dt | Peak Diode Recovery dv/dt (Note 3) | 4.5 | | V/ns |
| P_D | Power Dissipation ($T_C = 25^\circ\text{C}$) - Derate above 25°C | 100 | 33 | W |
| | | 0.80 | 0.26 | 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 | | $^\circ\text{C}$ |

* Drain current limited by maximum junction temperature.

Thermal Resistance Characteristics

| Symbol | Parameter | PFP4N65F | PFF4N65F | Units |
|-----------------|-----------------------------------------|----------|----------|---------------------------|
| $R_{\theta JC}$ | Thermal Resistance, Junction-to-Case | 1.25 | 3.79 | $^\circ\text{C}/\text{W}$ |
| $R_{\theta JS}$ | Thermal Resistance, Junction-to-Sink | 0.5 | -- | |
| $R_{\theta JA}$ | Thermal Resistance, Junction-to-Ambient | 62.5 | 62.5 | |

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

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---------------------------|-----------------------------------|----------------------------------------------|-----|-----|------|----------|
| On Characteristics | | | | | | |
| V_{GS} | Gate Threshold Voltage | $V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$ | 2.5 | -- | 4.5 | V |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS} = 10 \text{ V}, I_D = 2.0 \text{ A}$ | -- | 2.2 | 2.75 | Ω |

Off Characteristics

| | | | | | | |
|--------------------------------|-------------------------------------------|------------------------------------------------------------|-----|------|------|---------------------------|
| BV_{DSS} | Drain-Source Breakdown Voltage | $V_{GS} = 0 \text{ V}, I_D = 250 \mu\text{A}$ | 650 | -- | -- | V |
| $\Delta BV_{DSS} / \Delta T_J$ | Breakdown Voltage Temperature Coefficient | $I_D = 250 \mu\text{A}$, Referenced to 25°C | -- | 0.56 | -- | $\text{V}/^\circ\text{C}$ |
| I_{DSS} | Zero Gate Voltage Drain Current | $V_{DS} = 650 \text{ V}, V_{GS} = 0 \text{ V}$ | -- | -- | 1 | μA |
| | | $V_{DS} = 520 \text{ V}, T_C = 125^\circ\text{C}$ | -- | -- | 10 | μA |
| 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 |

Dynamic Characteristics

| | | | | | | |
|-----------|------------------------------|-------------------------------------------------------------------------|----|-----|-----|----|
| C_{iss} | Input Capacitance | $V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V},$ $f = 1.0 \text{ MHz}$ | -- | 630 | 820 | pF |
| C_{oss} | Output Capacitance | | -- | 60 | 80 | pF |
| C_{rss} | Reverse Transfer Capacitance | | -- | 5 | 6.5 | pF |

Switching Characteristics

| | | | | | | |
|--------------|---------------------|-------------------------------------------------------------------------------------------------------|----|------|----|----|
| $t_{d(on)}$ | Turn-On Time | $V_{DS} = 325 \text{ V}, I_D = 4.0 \text{ A}$ $R_G = 25 \Omega, R_L = 80 \Omega$ (Note 4,5) | -- | 11 | 22 | ns |
| t_r | Turn-On Rise Time | | -- | 7 | 14 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | -- | 23 | 46 | ns |
| t_f | Turn-Off Fall Time | | -- | 13 | 26 | ns |
| Q_g | Total Gate Charge | $V_{DS} = 520 \text{ V}, I_D = 4.0 \text{ A}$ $V_{GS} = 10 \text{ V}$ (Note 4,5) | -- | 12.4 | 18 | nC |
| Q_{gs} | Gate-Source Charge | | -- | 3 | -- | nC |
| Q_{gd} | Gate-Drain Charge | | -- | 4.4 | -- | nC |

Source-Drain Diode Maximum Ratings and Characteristics

| | | | | | | |
|----------|-----------------------------------------------|-----------------------------------------------------------------------------------------------|----|-----|-----|---------------|
| I_S | Continuous Source-Drain Diode Forward Current | -- | -- | 4.0 | A | |
| I_{SM} | Pulsed Source-Drain Diode Forward Current | -- | -- | 16 | | |
| V_{SD} | Source-Drain Diode Forward Voltage | $I_S = 4.0 \text{ A}, V_{GS} = 0 \text{ V}$ | -- | -- | 1.4 | V |
| t_{rr} | Reverse Recovery Time | $I_S = 4.0 \text{ A}, V_{GS} = 0 \text{ V}$ $di_f/dt = 100 \text{ A}/\mu\text{s}$ (Note 4) | -- | 255 | -- | ns |
| Q_{rr} | Reverse Recovery Charge | | -- | 1.5 | -- | μC |

Notes ;

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. $L=26\text{mH}, I_{AS}=4.0\text{A}, V_{OD}=50\text{V}, R_G=25\Omega$, Starting $T_J=25^\circ\text{C}$
3. $I_{SD}\leq 4.0\text{A}, di/dt\leq 300\text{A}/\mu\text{s}, V_{DD}\leq BV_{DSS}$, 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

Fig.1 On Region Characteristics

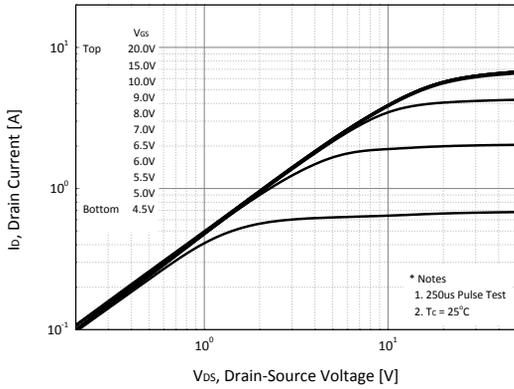


Fig.2 Transfer Characteristics

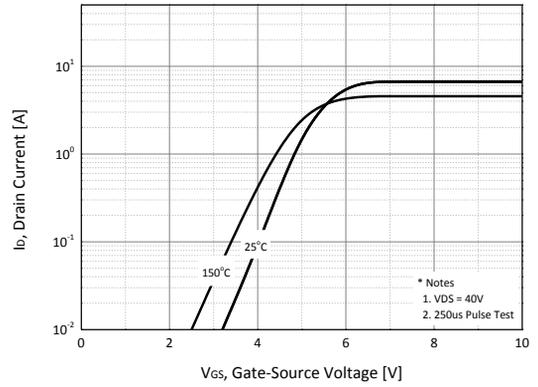


Fig.3 Static Drain-Source On Resistance

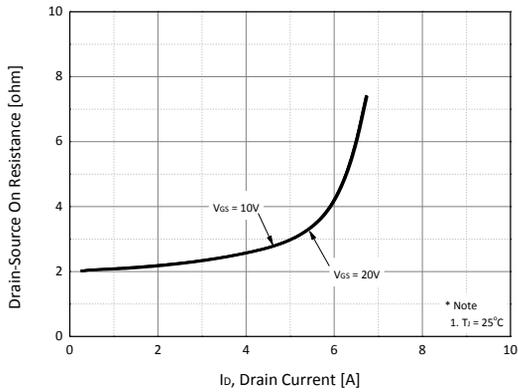


Fig.4 Body Diode Forward Voltage

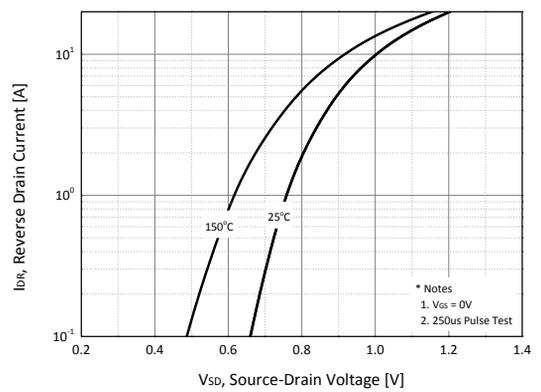


Fig.5 Capacitance Characteristics

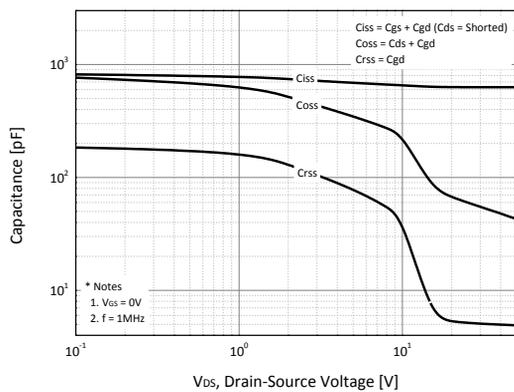
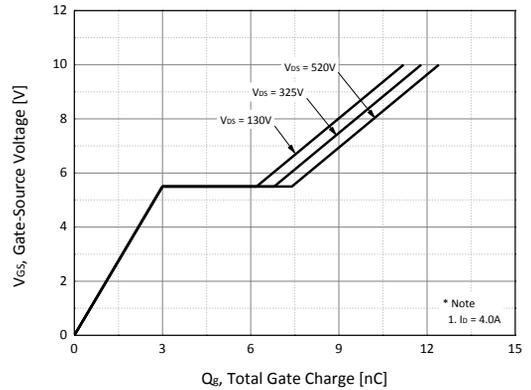


Fig.6 Gate Charge Characteristics



Typical Characteristics

Fig.7 BV_{DSS} Variation vs. Temperature

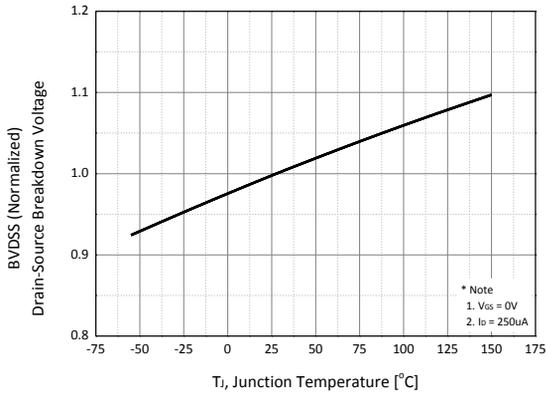


Fig.8 On-Resistance Variation vs. Temperature

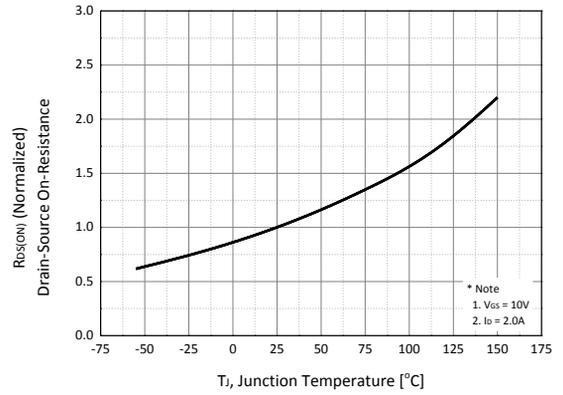


Fig.9-1 Safe Operation Area for TO-220

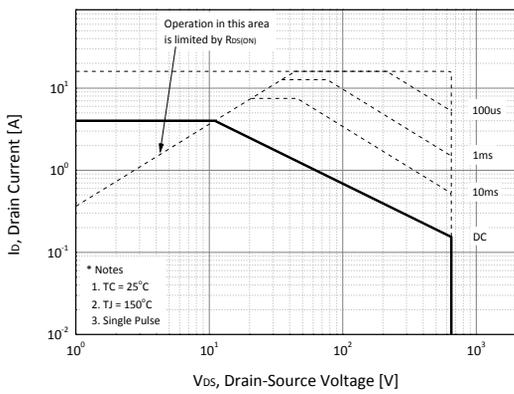


Fig.9-2 Safe Operation Area for TO-220F

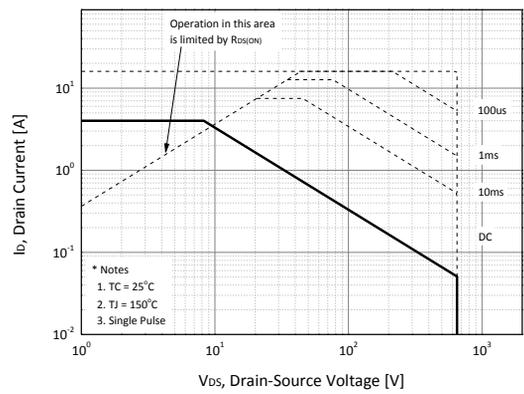
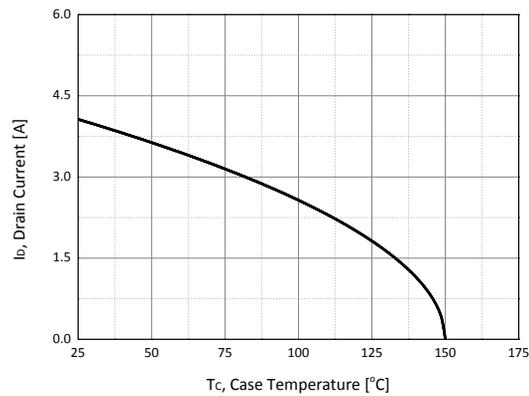


Fig.10 Maximum I_B vs. Case Temperature



Typical Characteristics

Fig.11-1 Transient Thermal Response Curve_TO-220

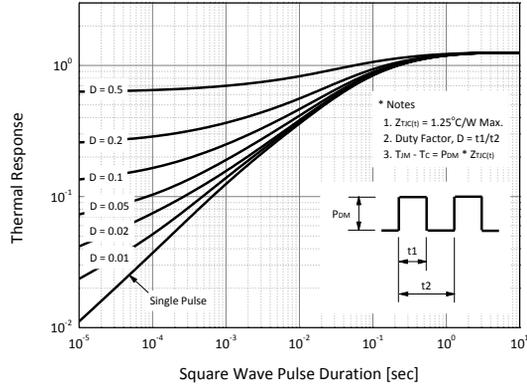
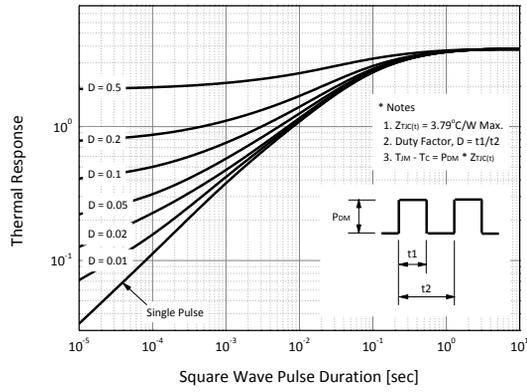
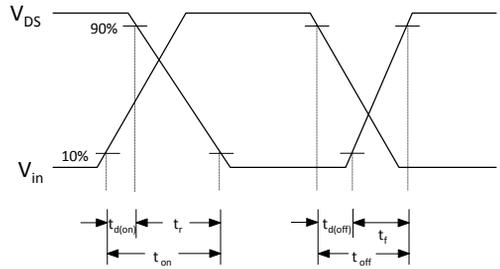
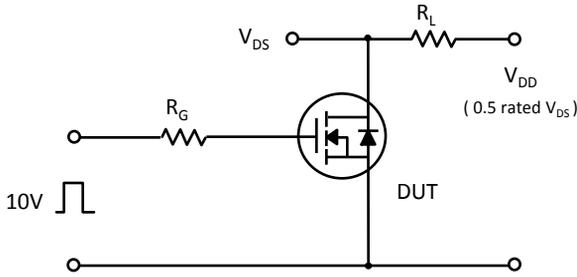


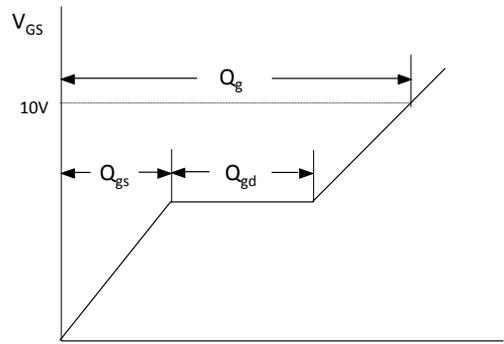
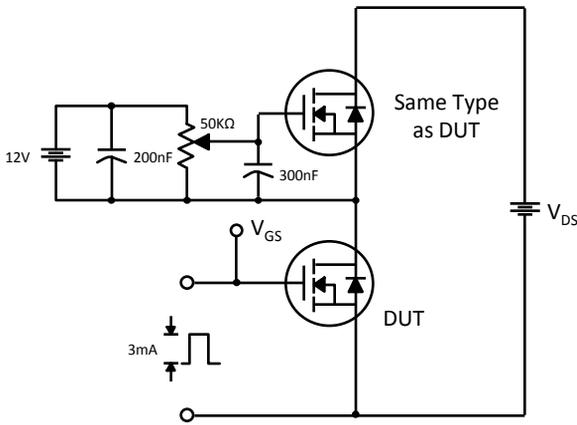
Fig.11-2 Transient Thermal Response Curve_TO-220F



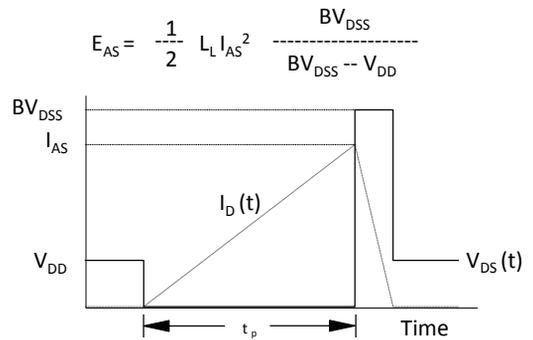
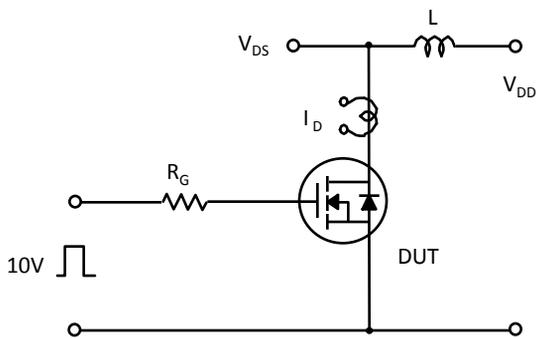
Characteristics Test Circuit & Waveform



Resistive Switching Test Circuit & Waveforms

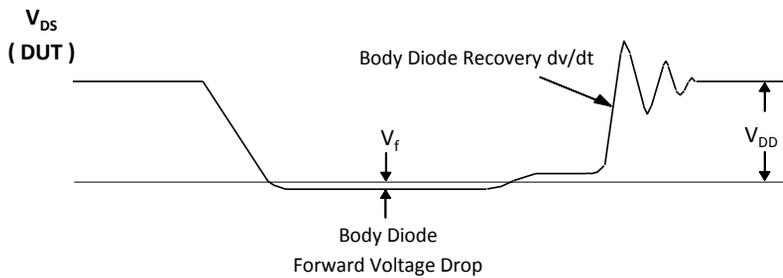
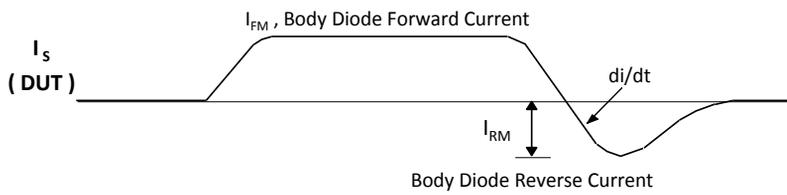
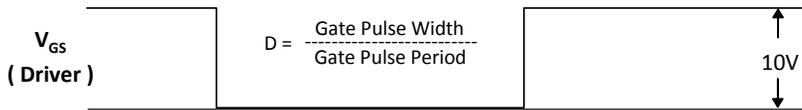
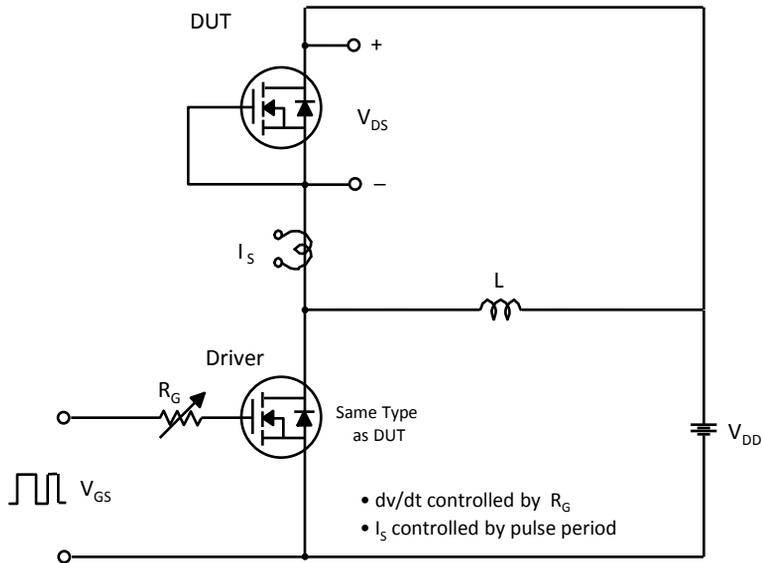


Gate Charge Test Circuit & Waveform



Unclamped Inductive Switching Test Circuit & Waveforms

Characteristics Test Circuit & Waveform (continued)



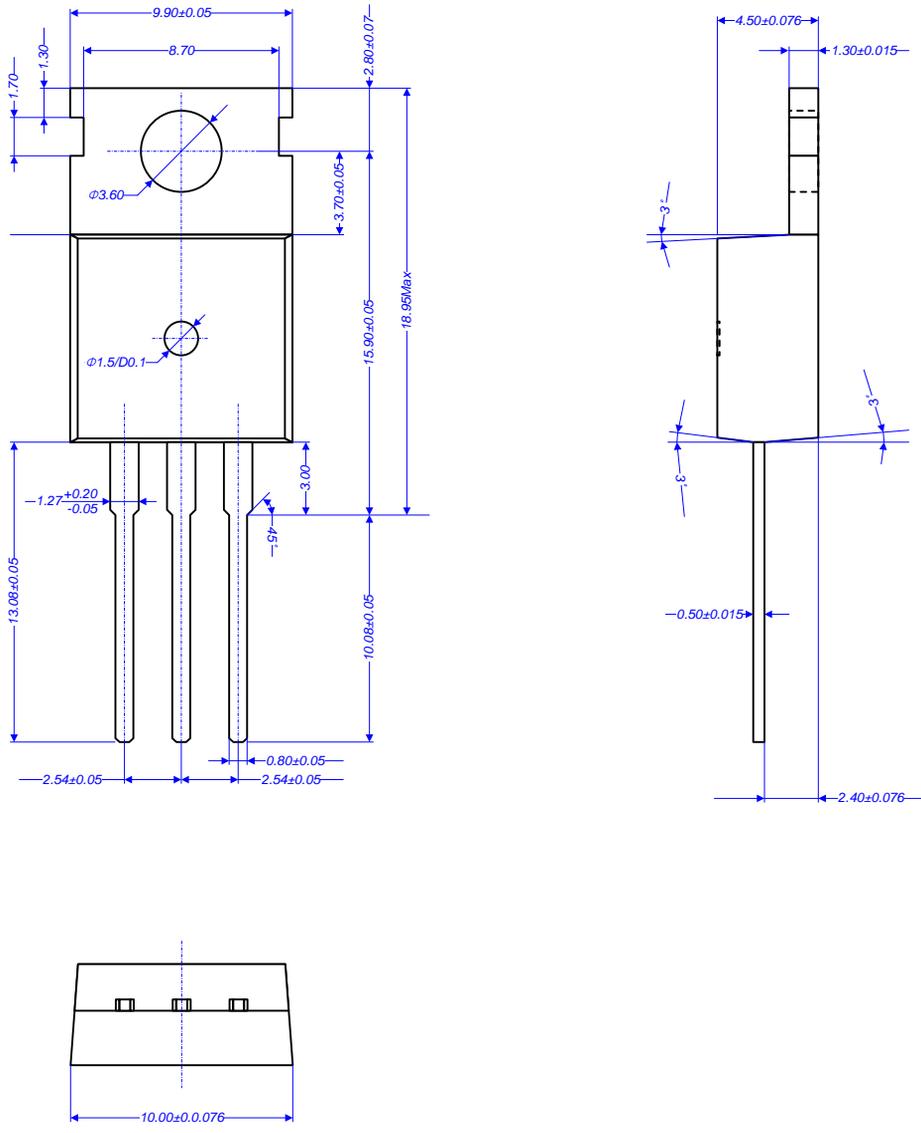
Peak Diode Recovery dv/dt Test Circuit & Waveforms

Package Dimension

Z

TO-220

PFP4N65F / PFF4N65F



Package Dimension

TO-220F

