July 2014

SemiHow
Know-How for Semiconductor

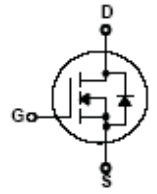
# HFS12N60U
## 600V N-Channel MOSFET

$BV_{DSS}$ = 600 V
$R_{DS(on)\ typ}$ = 0.53 Ω
$I_D$ = 12 A

**TO-220F**




**1.Gate 2. Drain 3. Source**




## FEATURES

- ❑ Originative New Design
- ❑ Superior Avalanche Rugged Technology
- ❑ Robust Gate Oxide Technology
- ❑ Very Low Intrinsic Capacitances
- ❑ Excellent Switching Characteristics
- ❑ Unrivalled Gate Charge : 42 nC (Typ.)
- ❑ Extended Safe Operating Area
- ❑ Lower $R_{DS(ON)}$ : 0.53 Ω (Typ.) @$V_{GS}$=10V
- ❑ 100% Avalanche Tested

## Absolute Maximum Ratings

$T_C$=25℃ unless otherwise specified

| Symbol | Parameter | | Value | Units |
|---|---|---|---|---|
| $V_{DSS}$ | Drain-Source Voltage | | 600 | V |
| $I_D$ | Drain Current – Continuous ($T_C$ = 25℃) | | 12* | A |
| | Drain Current – Continuous ($T_C$ = 100℃) | | 7.4* | A |
| $I_{DM}$ | Drain Current – Pulsed | (Note 1) | 48* | A |
| $V_{GS}$ | Gate-Source Voltage | | ±30 | V |
| $E_{AS}$ | Single Pulsed Avalanche Energy | (Note 2) | 840 | mJ |
| $I_{AR}$ | Avalanche Current | (Note 1) | 12 | A |
| $E_{AR}$ | Repetitive Avalanche Energy | (Note 1) | 5.2 | mJ |
| dv/dt | Peak Diode Recovery dv/dt | (Note 3) | 4.5 | V/ns |
| $P_D$ | Power Dissipation ($T_C$ = 25℃) | | 52 | W |
| | - Derate above 25℃ | | 0.42 | W/℃ |
| $T_J$, $T_{STG}$ | Operating and Storage Temperature Range | | -55 to +150 | ℃ |
| $T_L$ | Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds | | 300 | ℃ |

* Drain current limited by maximum junction temperature

## Thermal Resistance Characteristics

| Symbol | Parameter | Typ. | Max. | Units |
|---|---|---|---|---|
| $R_{\theta JC}$ | Junction-to-Case | -- | 2.4 | ℃/W |
| $R_{\theta JA}$ | Junction-to-Ambient | -- | 62.5 | |

## Package Marking and Odering Information

| Device Marking | Week Marking | Package | Packing | Quantity | RoHS Status |
|---|---|---|---|---|---|
| HFS12N60U | YWWX | TO-220F | Tube | 50 | Pb Free |
| HFS12N60U | YWWXg | TO-220F | Tube | 50 | Halogen Free |

## Electrical Characteristics $T_C$=25 °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 μA | 2.5 | -- | 4.5 | V |
| $R_{DS(ON)}$ | Static Drain-Source On-Resistance | $V_{GS}$ = 10 V, $I_D$ = 6 A | -- | 0.53 | 0.65 | Ω |
| **Off Characteristics** | | | | | | |
| $BV_{DSS}$ | Drain-Source Breakdown Voltage | $V_{GS}$ = 0 V, $I_D$ = 250 μA | 600 | -- | -- | V |
| $I_{DSS}$ | Zero Gate Voltage Drain Current | $V_{DS}$ = 600 V, $V_{GS}$ = 0 V | -- | -- | 1 | μA |
| | | $V_{DS}$ = 480 V, $T_C$ = 125℃ | -- | -- | 10 | μA |
| $I_{GSS}$ | Gate-Body Leakage Current | $V_{GS}$ = ±30 V, $V_{DS}$ = 0 V | -- | -- | ±100 | nA |
| **Dynamic Characteristics** | | | | | | |
| $C_{iss}$ | Input Capacitance | $V_{DS}$ = 25 V, $V_{GS}$ = 0 V, f = 1.0 MHz | -- | 2100 | 2750 | pF |
| $C_{oss}$ | Output Capacitance | | -- | 170 | 220 | pF |
| $C_{rss}$ | Reverse Transfer Capacitance | | -- | 11 | 14.5 | pF |
| **Switching Characteristics** | | | | | | |
| $t_{d(on)}$ | Turn-On Time | $V_{DS}$ = 300 V, $I_D$ = 12 A, $R_G$ = 25 Ω (Note 4,5) | -- | 55 | 120 | ns |
| $t_r$ | Turn-On Rise Time | | -- | 45 | 100 | ns |
| $t_{d(off)}$ | Turn-Off Delay Time | | -- | 145 | 300 | ns |
| $t_f$ | Turn-Off Fall Time | | -- | 25 | 60 | ns |
| $Q_g$ | Total Gate Charge | $V_{DS}$ = 480V, $I_D$ = 12 A, $V_{GS}$ = 10 V (Note 4,5) | -- | 42 | 55 | nC |
| $Q_{gs}$ | Gate-Source Charge | | -- | 12 | -- | nC |
| $Q_{gd}$ | Gate-Drain Charge | | -- | 12 | -- | nC |
| **Source-Drain Diode Maximum Ratings and Characteristics** | | | | | | |
| $I_S$ | Continuous Source-Drain Diode Forward Current | | -- | -- | 12 | A |
| $I_{SM}$ | Pulsed Source-Drain Diode Forward Current | | -- | -- | 48 | A |
| $V_{SD}$ | Source-Drain Diode Forward Voltage | $I_S$ = 12 A, $V_{GS}$ = 0 V | -- | -- | 1.4 | V |
| trr | Reverse Recovery Time | $I_S$ = 12 A, $V_{GS}$ = 0 V $di_F/dt$ = 100 A/μs (Note 4) | -- | 430 | -- | ns |
| Qrr | Reverse Recovery Charge | | -- | 4.0 | -- | μC |

**Notes ;**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. L=10.7mH, $I_{AS}$=12A, $V_{DD}$=50V, $R_G$=25Ω, Starting $T_J$=25°C
3. $I_{SD}$≤12A, di/dt≤200A/μs, $V_{DD}$≤$BV_{DSS}$, Starting $T_J$=25 °C
4. Pulse Test : Pulse Width ≤ 300μs, Duty Cycle ≤ 2%
5. Essentially Independent of Operating Temperature

## Typical Characteristics

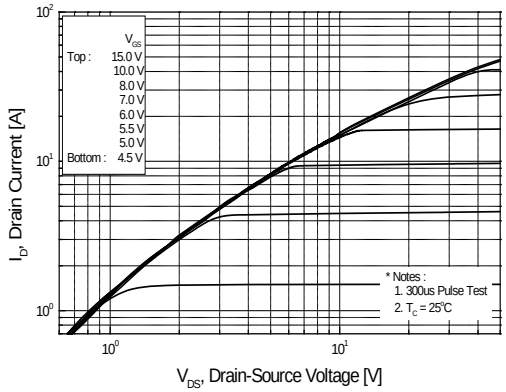



**Figure 1. On Region Characteristics**

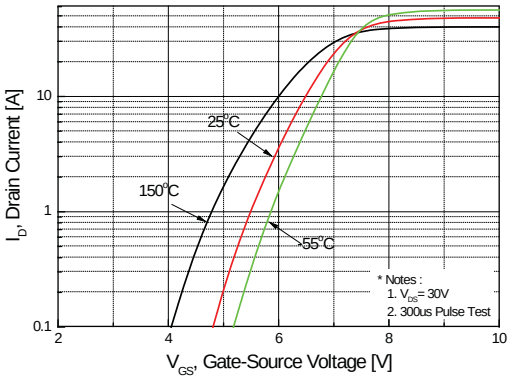



**Figure 2. Transfer Characteristics**

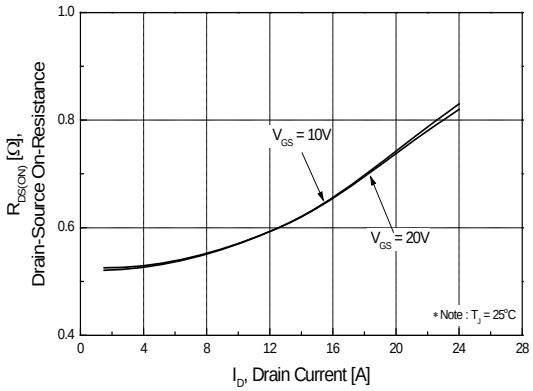



**Figure 3. On Resistance Variation vs Drain Current and Gate Voltage**

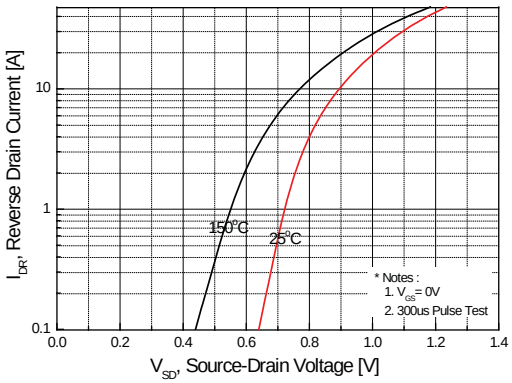



**Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature**

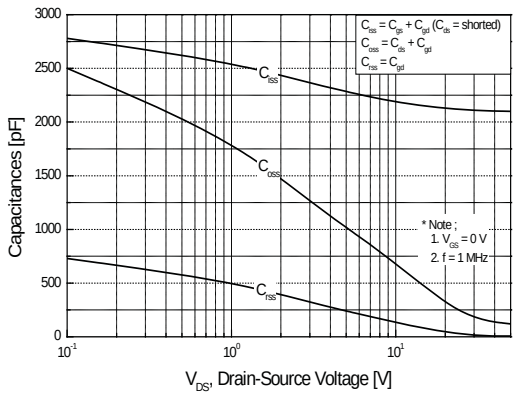



**Figure 5. Capacitance Characteristics**

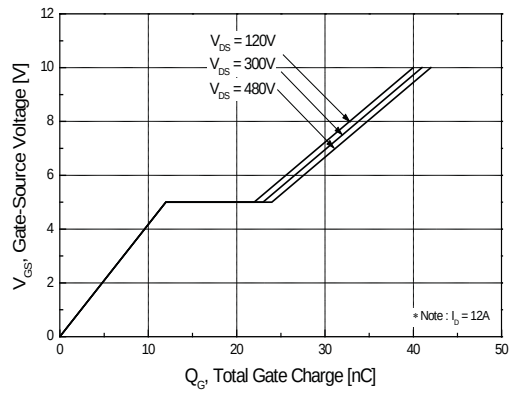



**Figure 6. Gate Charge Characteristics**

## Typical Characteristics

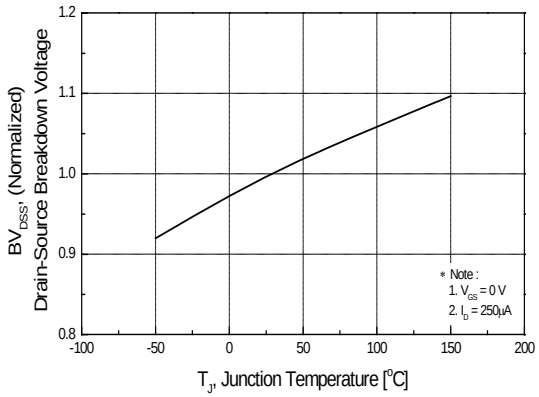



**Figure 7. Breakdown Voltage Variation vs Temperature**

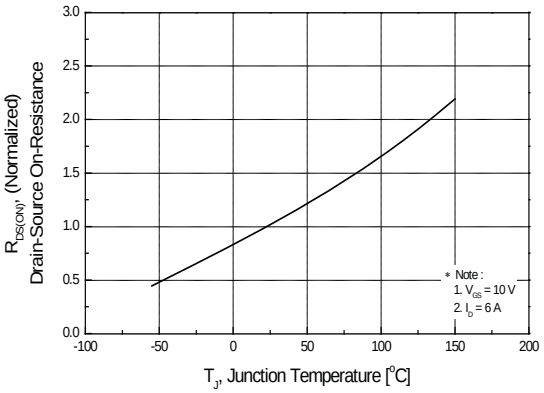



**Figure 8. On-Resistance Variation vs Temperature**

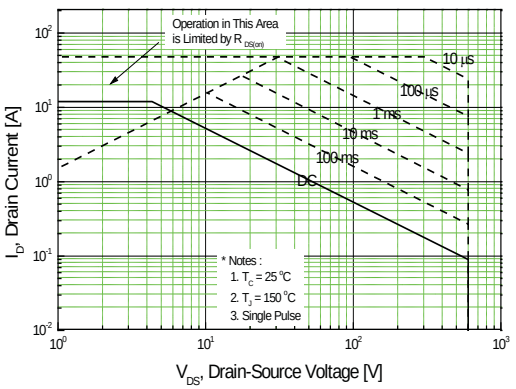



**Figure 9. Maximum Safe Operating Area**

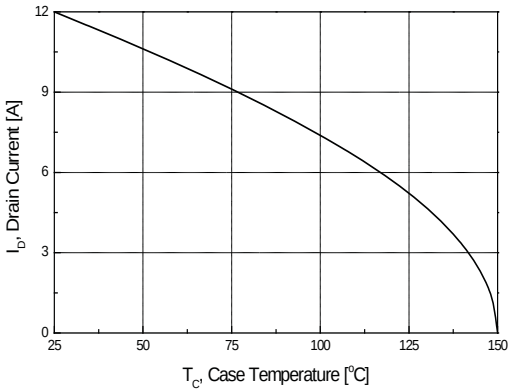



**Figure 10. Maximum Drain Current vs Case Temperature**

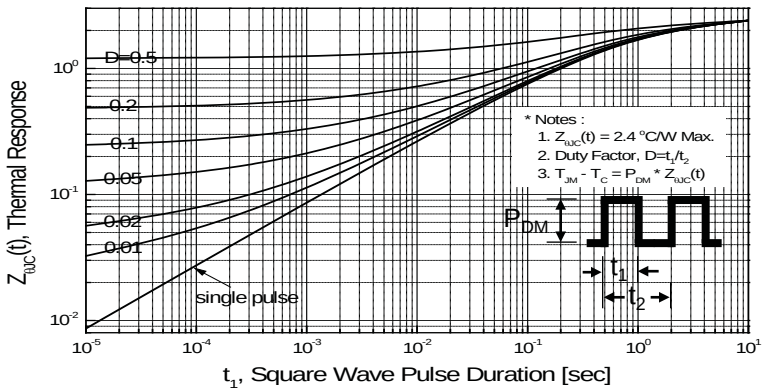
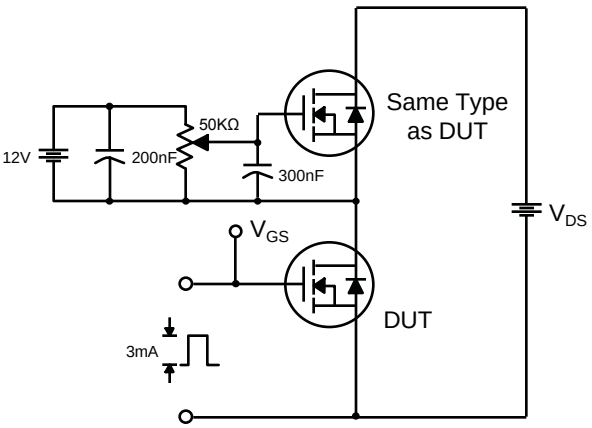



**Figure 11. Transient Thermal Response Curve**

**Fig 12. Gate Charge Test Circuit & Waveform**



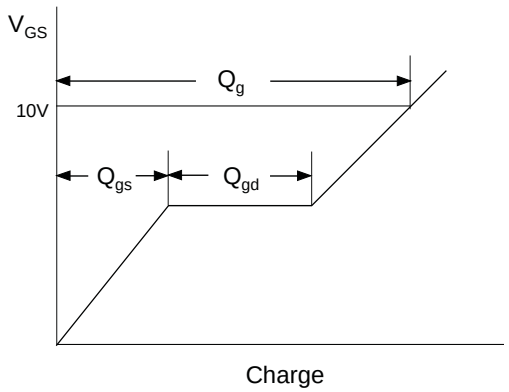
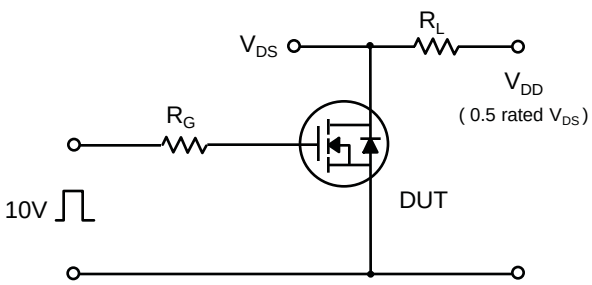




**Fig 13. Resistive Switching Test Circuit & Waveforms**



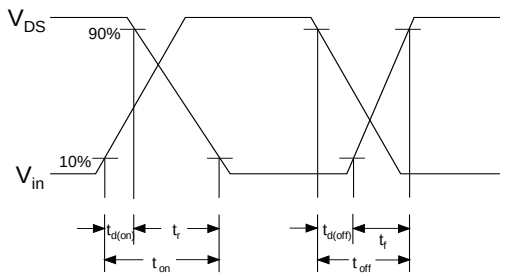
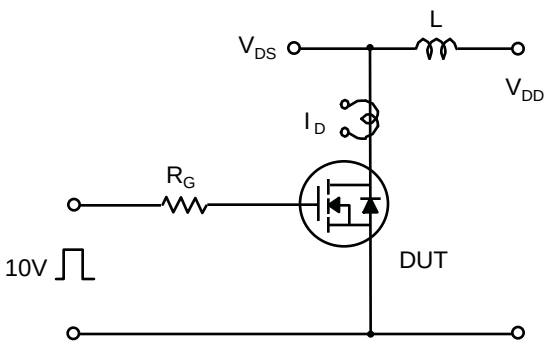




**Fig 14. Unclamped Inductive Switching Test Circuit & Waveforms**




$$E_{AS} = \frac{1}{2} L_L I_{AS}^2 \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$

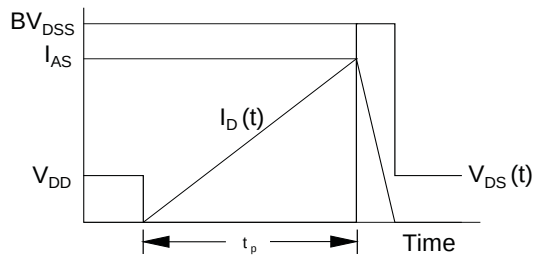
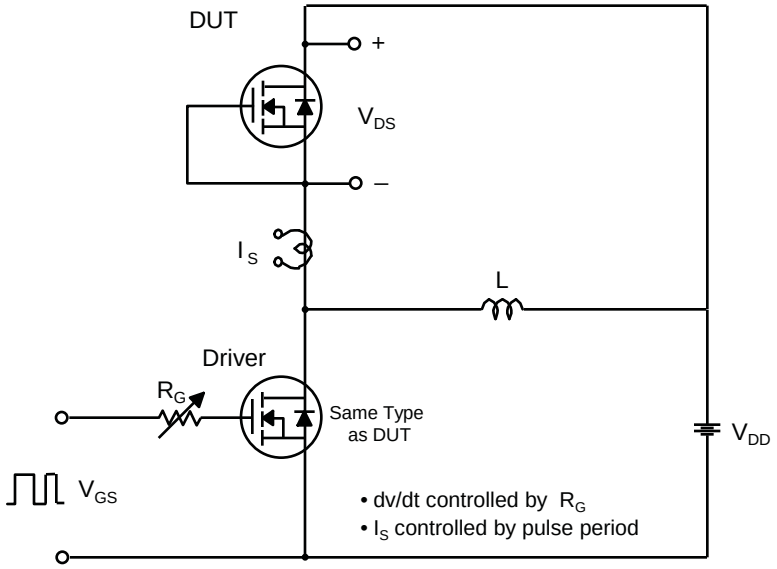
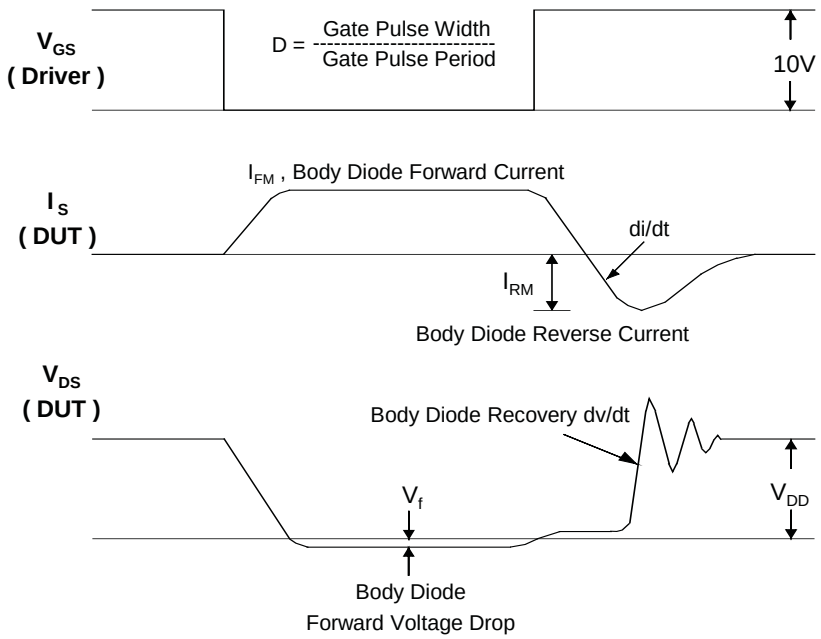


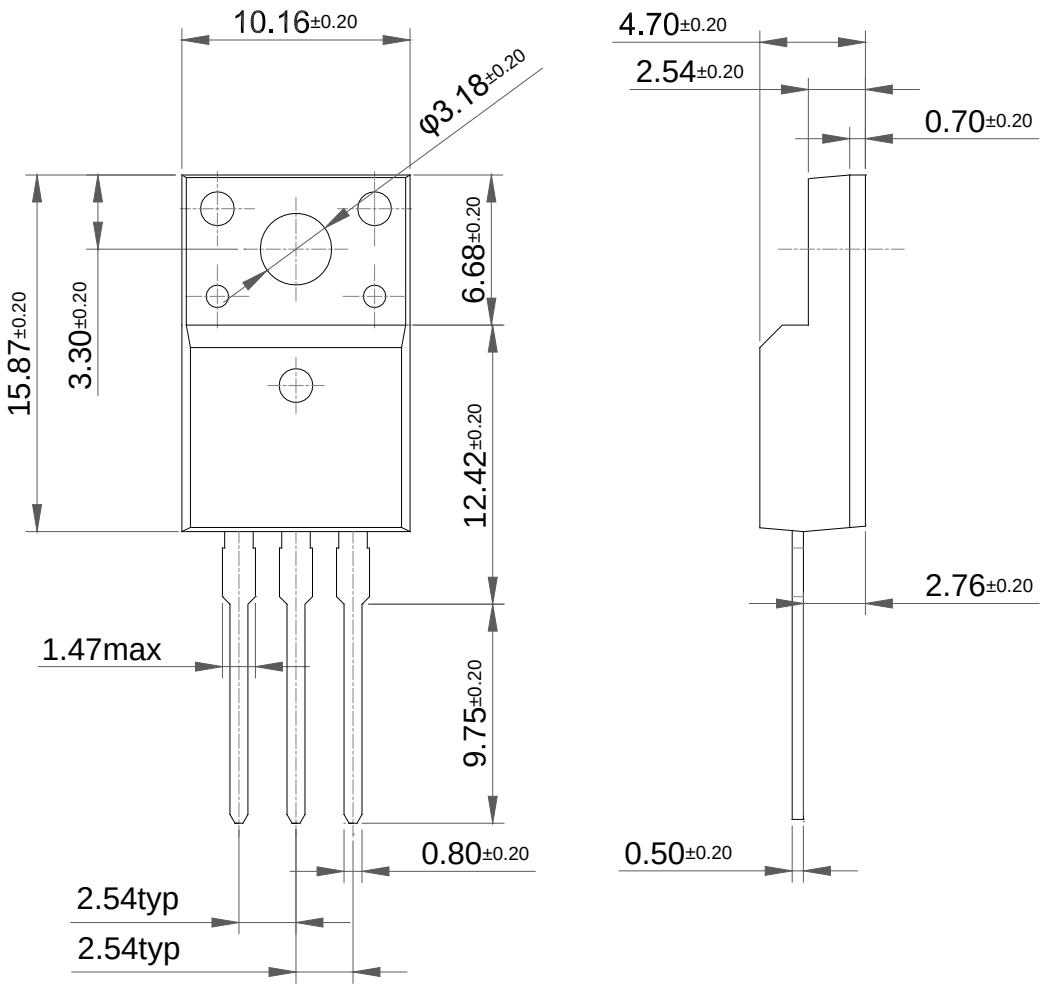
**Fig 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms**



## Package Dimension

# TO-220F




◎ SEMIHOW REV.A0,July 2014