

# HFP5N65F / HFS5N65F

## 650V N-Channel MOSFET

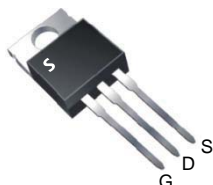
### Features

- Originative New Design
- Very Low Intrinsic Capacitances
- Excellent Switching Characteristics
- 100% Avalanche Tested
- RoHS Compliant

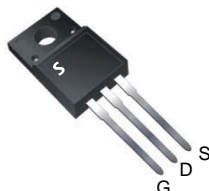
### Key Parameters

Parameter	Value	Unit
$BV_{DSS}$	650	V
$I_D$	5	A
$R_{DS(on), Typ}$	2	$\Omega$
$Qg, Typ$	12.5	nC

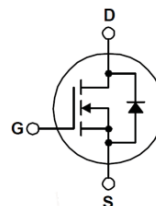
**HFP5N65F**  
**TO-220**



**HFS5N65F**  
**TO-220F**



**Symbol**



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

Symbol	Parameter	TO-220	TO-220F	Unit
$V_{DSS}$	Drain-Source Voltage	650		V
$I_D$	Drain Current – Continuous ( $T_C = 25^\circ\text{C}$ )	5.0	5.0 *	A
	Drain Current – Continuous ( $T_C = 100^\circ\text{C}$ )	3.2	3.2 *	A
$I_{DM}$	Drain Current – Pulsed (Note 1)	20	20 *	A
$V_{GS}$	Gate-Source Voltage	$\pm 30$		V
$E_{AS}$	Single Pulsed Avalanche Energy (Note 2)	110		mJ
$I_{AR}$	Avalanche Current (Note 1)	5.0		A
$E_{AR}$	Repetitive Avalanche Energy (Note 1)	12.5		mJ
dv/dt	Peak Diode Recovery dv/dt (Note 3)	4.5		V/ns
$P_D$	Power Dissipation ( $T_C = 25^\circ\text{C}$ )	125	42	W
	- Derate above $25^\circ\text{C}$	1.0	0.32	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	TO-220	TO-220F	Unit
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case, Max.	1.0	3.0	$^\circ\text{C}/\text{W}$
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink, Typ.	0.5	--	$^\circ\text{C}/\text{W}$
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient, Max.	62.5	62.5	$^\circ\text{C}/\text{W}$

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

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
<b>On Characteristics</b>						
$V_{GS}$	Gate Threshold Voltage	$V_{DS} = V_{GS}, I_D = 250 \mu\text{A}$	2.0	--	4.0	V
$R_{DS(ON)}$	Static Drain-Source On-Resistance	$V_{GS} = 10 \text{ V}, I_D = 2.5 \text{ A}$	--	2.0	2.5	$\Omega$
$g_{FS}$	Forward Transconductance	$V_{DS} = 30 \text{ V}, I_D = 2.5 \text{ A}$	--	3	--	S
<b>Off Characteristics</b>						
$BV_{DSS}$	Drain-Source Breakdown Voltage	$V_{GS} = 0 \text{ V}, I_D = 250 \mu\text{A}$	650	--	--	V
$I_{DSS}$	Zero Gate Voltage Drain Current	$V_{DS} = 650 \text{ V}, V_{GS} = 0 \text{ V}$	--	--	10	$\mu\text{A}$
		$V_{DS} = 520 \text{ V}, T_C = 125^\circ\text{C}$	--	--	100	$\mu\text{A}$
$I_{GSS}$	Gate-Body Leakage Current	$V_{GS} = \pm 30 \text{ V}, V_{DS} = 0 \text{ V}$	--	--	$\pm 100$	nA
<b>Dynamic Characteristics</b>						
$C_{iss}$	Input Capacitance	$V_{DS} = 25 \text{ V}, V_{GS} = 0 \text{ V},$ $f = 1.0 \text{ MHz}$	--	560	730	pF
$C_{oss}$	Output Capacitance		--	70	90	pF
$C_{rss}$	Reverse Transfer Capacitance		--	14	18.5	pF
<b>Switching Characteristics</b>						
$t_{d(on)}$	Turn-On Time	$V_{DS} = 325 \text{ V}, I_D = 5 \text{ A},$ $R_G = 25 \Omega$  (Note 4,5)	--	19	48	ns
$t_r$	Turn-On Rise Time		--	19	48	ns
$t_{d(off)}$	Turn-Off Delay Time		--	35	80	ns
$t_f$	Turn-Off Fall Time		--	22	54	ns
$Q_g$	Total Gate Charge	$V_{DS} = 520 \text{ V}, I_D = 5 \text{ A},$ $V_{GS} = 10 \text{ V}$  (Note 4,5)	--	12.5	16.5	nC
$Q_{gs}$	Gate-Source Charge		--	2.8	--	nC
$Q_{gd}$	Gate-Drain Charge		--	4.0	--	nC
<b>Drain-Source Diode Characteristics and Maximum Ratings</b>						
$I_S$	Maximum Continuous Drain-Source Diode Forward Current		--	--	5	A
$I_{SM}$	Maximum Pulsed Drain-Source Diode Forward Current		--	--	20	
$V_{SD}$	Drain-Source Diode Forward Voltage	$V_{GS} = 0 \text{ V}, I_S = 5 \text{ A}$	--	--	1.4	V
$t_{rr}$	Reverse Recovery Time	$V_{GS} = 0 \text{ V}, I_S = 5 \text{ A}$ $di_F/dt = 100 \text{ A}/\mu\text{s}$	--	250	--	ns
$Q_{rr}$	Reverse Recovery Charge		--	1.6	--	$\mu\text{C}$

**Notes :**

1. Repetitive Rating : Pulse width limited by maximum junction temperature
2.  $L=8\text{mH}, I_{AS}=5\text{A}, V_{DD}=50\text{V}, R_G=25\Omega,$  Starting  $T_J=25^\circ\text{C}$
3.  $I_{SD}\leq 5\text{A}, di/dt\leq 200\text{A}/\mu\text{s}, V_{DD}\leq BV_{DSS},$  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

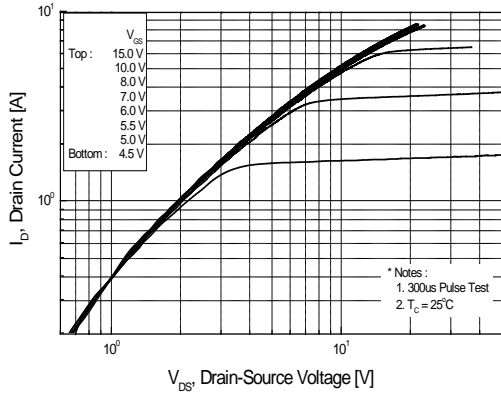


Figure 1. On Region Characteristics

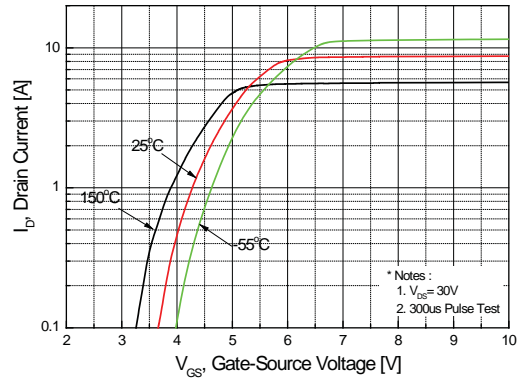


Figure 2. Transfer Characteristics

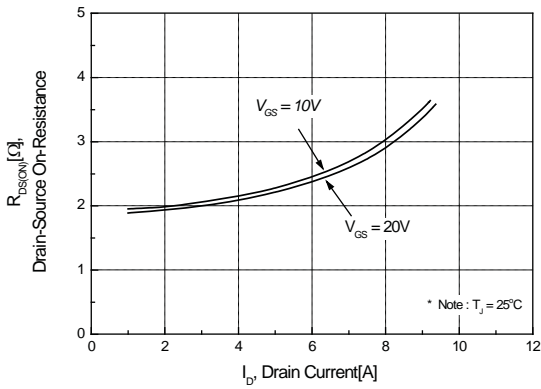


Figure 3. On Resistance Variation vs Drain Current and Gate Voltage

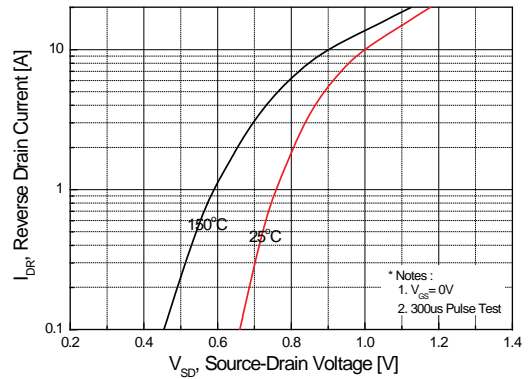


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

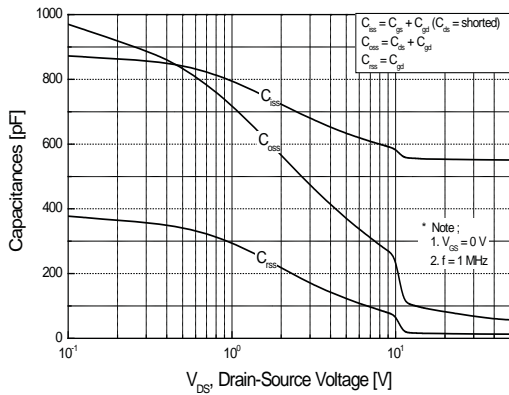


Figure 5. Capacitance Characteristics

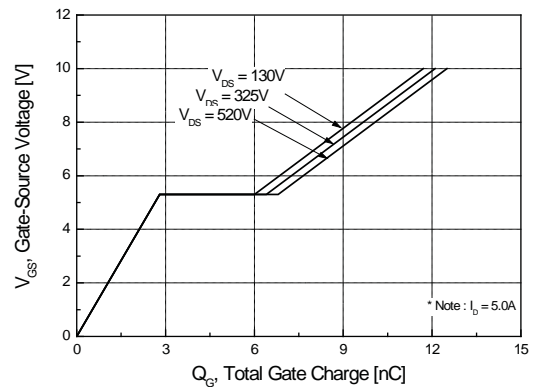


Figure 6. Gate Charge Characteristics

Typical Characteristics (continued)

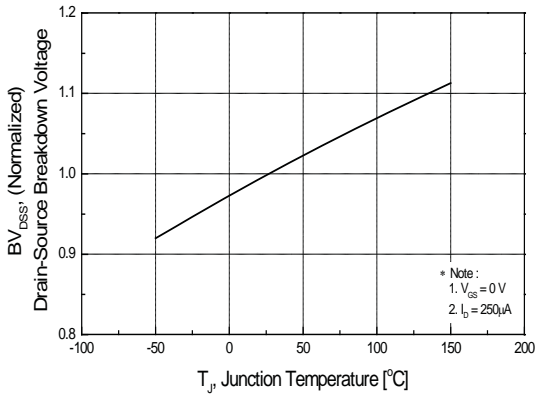


Figure 7. Breakdown Voltage Variation vs Temperature

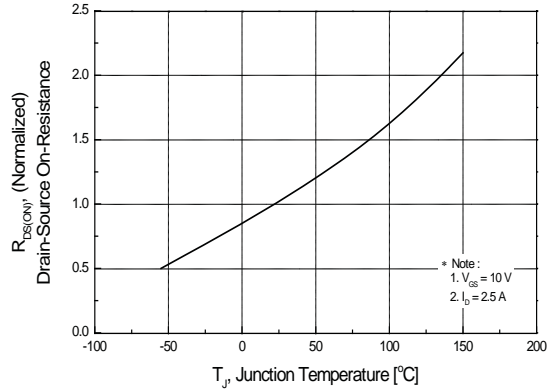


Figure 8. On-Resistance Variation vs Temperature

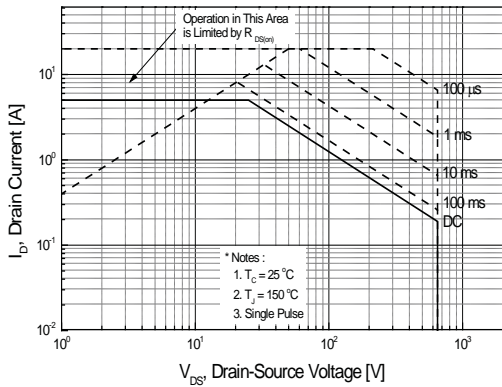


Figure 9-1. Maximum Safe Operating Area for TO-220

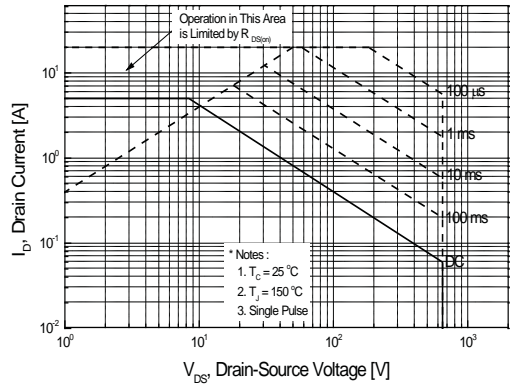


Figure 9-2. Maximum Safe Operating Area for TO-220F

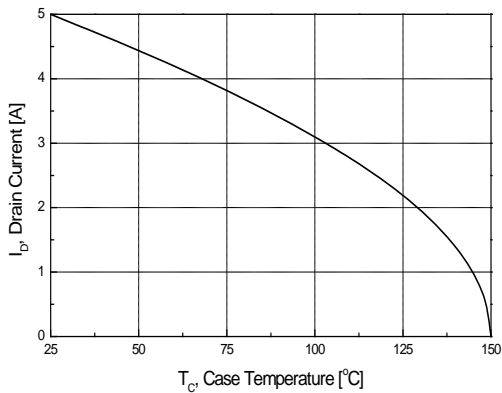


Figure 10. Maximum Drain Current vs Case Temperature

Typical Characteristics (continued)

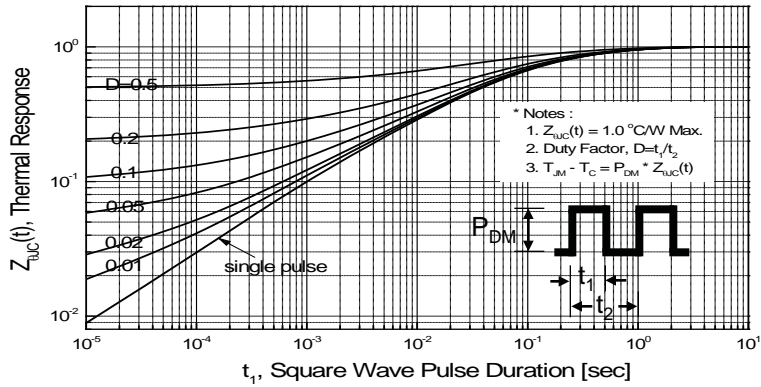


Figure 11-1. Transient Thermal Response Curve for TO-220

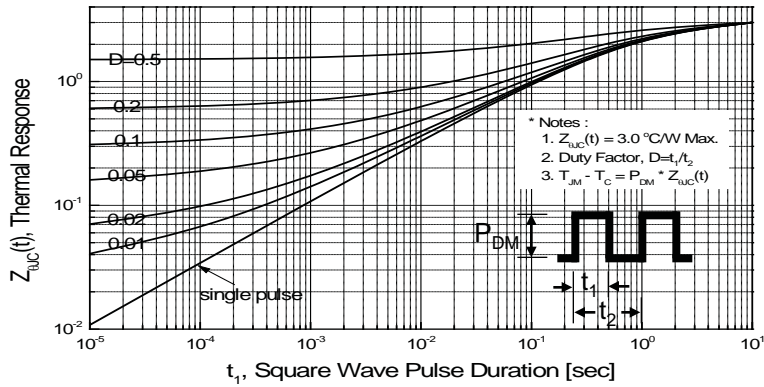


Figure 11-2. Transient Thermal Response Curve for TO-220F

Fig 12. Gate Charge Test Circuit & Waveform



Fig 13. Resistive Switching Test Circuit & Waveforms

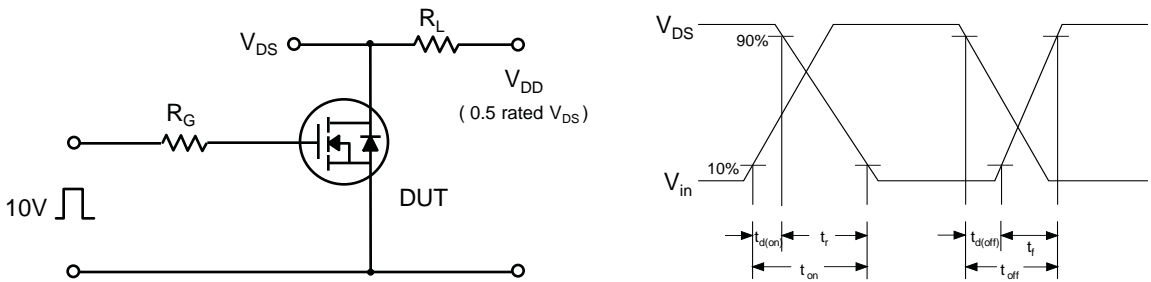


Fig 14. Unclamped Inductive Switching Test Circuit & Waveforms

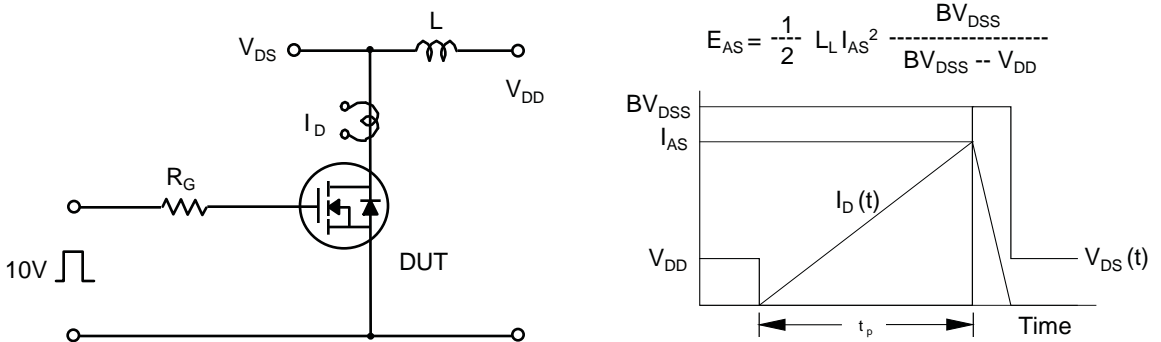
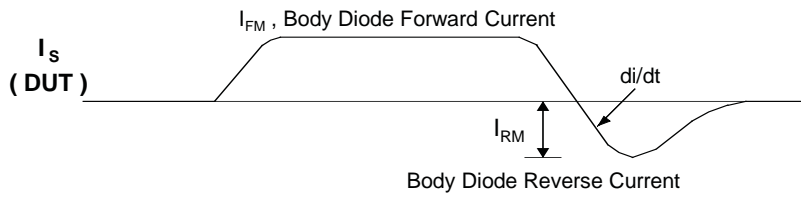
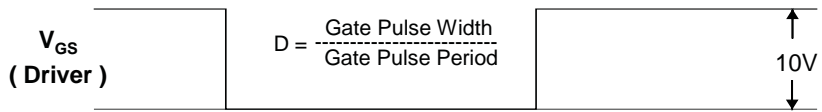
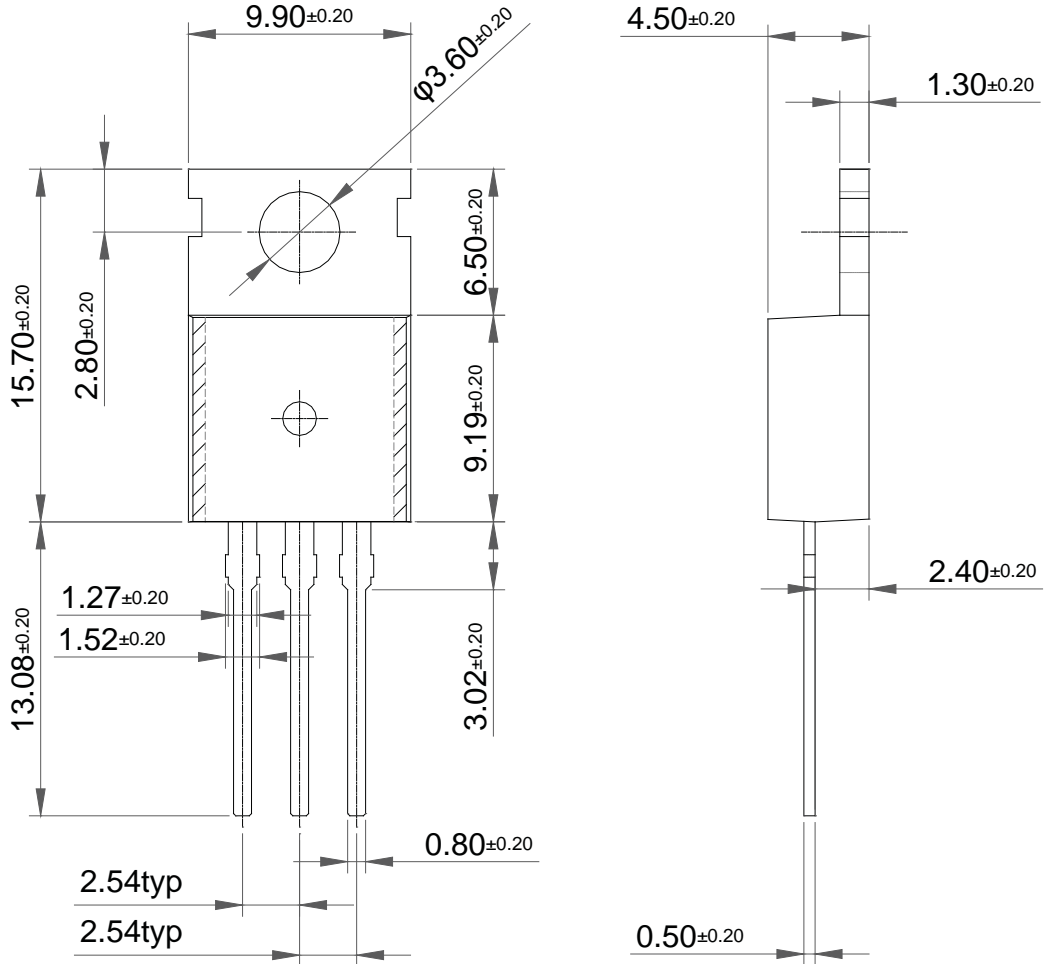


Fig 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms



Package Dimension

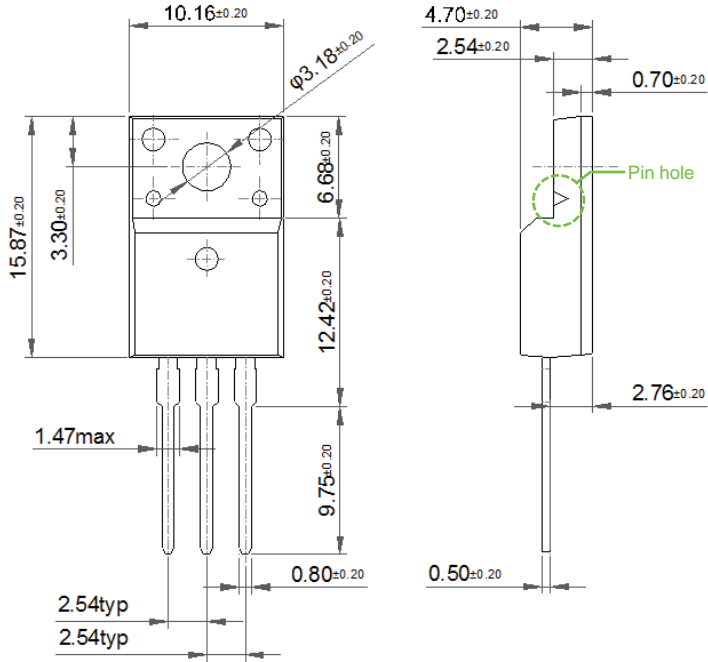
TO-220





Package Dimension

TO-220F



TO-220F-FM

