FAIRCHILD SEMICONDUCTOR®

November 2001

IRF654B/IRFS654B

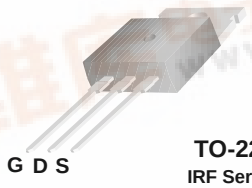
250V N-Channel MOSFET

General Description

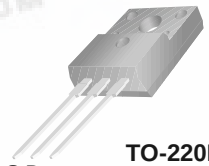
These N-Channel enhancement mode power field effect transistors are produced using Fairchild's proprietary, planar, DMOS technology.
This advanced technology has been especially tailored to minimize on-state resistance, provide superior switching performance, and withstand high energy pulse in the avalanche and commutation mode. These devices are well suited for high efficiency switching DC/DC converters and switch mode power supplies.

Features

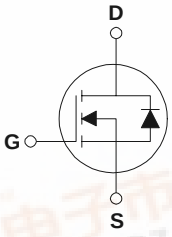
- 21A, 250V, $R_{DS(on)}$ = 0.14Ω @V_{GS} = 10 V
- Low gate charge (typical 95 nC)
- Low Crss (typical 60 pF)
- Fast switching
- 100% avalanche tested
- Improved dv/dt capability



TO-220
IRF Series



TO-220F
IRFS Series



Absolute Maximum Ratings

T_C = 25°C unless otherwise noted

Symbol	Parameter		IRF654B	IRFS654B	Units
V_{DSS}	Drain-Source Voltage		250		V
I_D	Drain Current - Continuous (T_C = 25°C)		21	21 *	A
	- Continuous (T_C = 100°C)		13.3	13.3 *	A
I_{DM}	Drain Current - Pulsed	(Note 1)	84	84 *	A
V_{GSS}	Gate-Source Voltage		± 30		V
E_{AS}	Single Pulsed Avalanche Energy	(Note 2)	700		mJ
I_{AR}	Avalanche Current	(Note 1)	21		A
E_{AR}	Repetitive Avalanche Energy	(Note 1)	15.6		mJ
dv/dt	Peak Diode Recovery dv/dt	(Note 3)	5.5		V/ns
P_D	Power Dissipation (T_C = 25°C)		156	50	W
	- Derate above 25°C		1.25	0.4	W/°C
T_J, T_{STG}	Operating and Storage Temperature Range		-55 to +150		°C
T_L	Maximum lead temperature for soldering purposes, 1/8" from case for 5 seconds		300		°C

* Drain current limited by maximum junction temperature.

Thermal Characteristics

Symbol	Parameter	IRF654B	IRFS654B	Units
$R_{\theta JC}$	Thermal Resistance, Junction-to-Case Max.	0.8	2.5	°C/W
$R_{\theta CS}$	Thermal Resistance, Case-to-Sink Typ.	0.5	--	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient Max.	62.5	62.5	°C/W

Electrical Characteristics

T_C = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Typ	Max	Units
Off Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0 V, I_D = 250 μA	250	--	--	V
ΔBV_{DSS} / ΔT_J	Breakdown Voltage Temperature Coefficient	I_D = 250 μA, Referenced to 25°C	--	0.26	--	V/°C
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS} = 250 V, V_{GS} = 0 V	--	--	10	μA
		V_{DS} = 200 V, T_C = 125°C	--	--	100	μA
I_{GSSF}	Gate-Body Leakage Current, Forward	V_{GS} = 30 V, V_{DS} = 0 V	--	--	100	nA
I_{GSSR}	Gate-Body Leakage Current, Reverse	V_{GS} = -30 V, V_{DS} = 0 V	--	--	-100	nA
On Characteristics						
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS} = V_{GS}, I_D = 250 μA	2.0	--	4.0	V
$R_{DS(on)}$	Static Drain-Source On-Resistance	V_{GS} = 10 V, I_D = 10.5 A	--	0.1	0.14	Ω
g_{FS}	Forward Transconductance	V_{DS} = 40 V, I_D = 10.5 A (Note 4)	--	23	--	S
Dynamic Characteristics						
C_{iss}	Input Capacitance	V_{DS} = 25 V, V_{GS} = 0 V, f = 1.0 MHz	--	2600	3400	pF
C_{oss}	Output Capacitance		--	290	380	pF
C_{rss}	Reverse Transfer Capacitance		--	60	80	pF
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	V_{DD} = 125 V, I_D = 25 A, R_G = 25 Ω (Note 4, 5)	--	35	80	ns
t_r	Turn-On Rise Time		--	195	400	ns
$t_{d(off)}$	Turn-Off Delay Time		--	300	610	ns
t_f	Turn-Off Fall Time		--	180	370	ns
Q_g	Total Gate Charge	V_{DS} = 200 V, I_D = 25 A, V_{GS} = 10 V (Note 4, 5)	--	95	123	nC
Q_{gs}	Gate-Source Charge		--	12	--	nC
Q_{gd}	Gate-Drain Charge		--	43	--	nC
Drain-Source Diode Characteristics and Maximum Ratings						
I_S	Maximum Continuous Drain-Source Diode Forward Current		--	--	21	A
I_{SM}	Maximum Pulsed Drain-Source Diode Forward Current		--	--	84	A
V_{SD}	Drain-Source Diode Forward Voltage	V_{GS} = 0 V, I_S = 21 A	--	--	1.5	V
t_{rr}	Reverse Recovery Time	V_{GS} = 0 V, I_S = 25 A, dI_F / dt = 100 A/μs (Note 4)	--	300	--	ns
Q_{rr}	Reverse Recovery Charge		--	3.23	--	μC

Notes:
1. Repetitive Rating : Pulse width limited by maximum junction temperature
2. L = 2.54mH, I_{AS} = 21A, V_{DD} = 50V, R_G = 25 Ω, Starting T_J = 25°C
3. $I_{SD} \leq$ 25A, di/dt $\leq$ 300A/μs, $V_{DD} \leq$ BV_{DSS}, Starting T_J = 25°C
4. Pulse Test : Pulse width $\leq$ 300μs, Duty cycle $\leq$ 2%
5. Essentially independent of operating temperature

Typical Characteristics

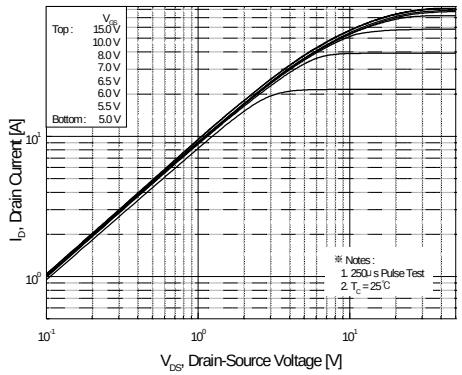


Figure 1. On-Region Characteristics

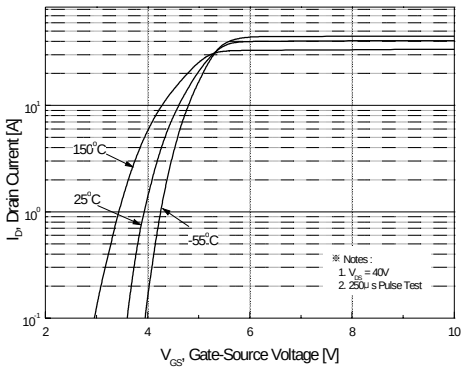


Figure 2. Transfer Characteristics

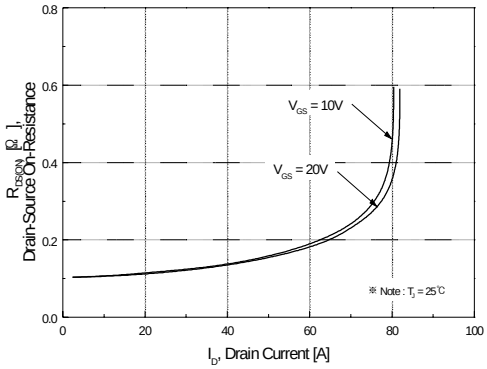


Figure 3. On-Resistance Variation vs Drain Current and Gate Voltage

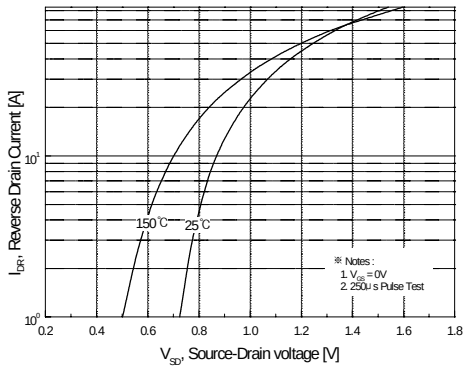


Figure 4. Body Diode Forward Voltage Variation with Source Current and Temperature

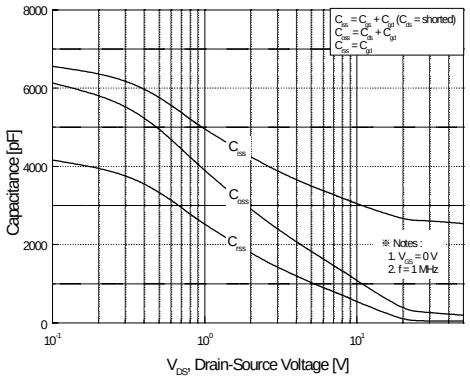


Figure 5. Capacitance Characteristics

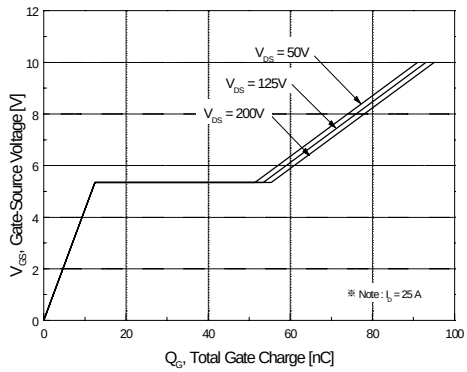


Figure 6. Gate Charge Characteristics

Typical Characteristics (Continued)

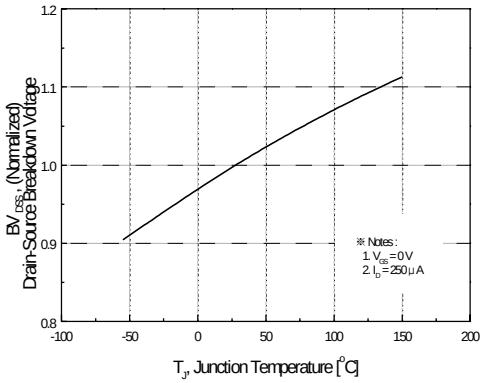


Figure 7. Breakdown Voltage Variation vs Temperature

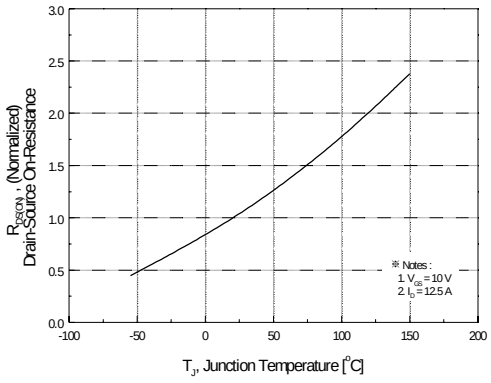


Figure 8. On-Resistance Variation vs Temperature

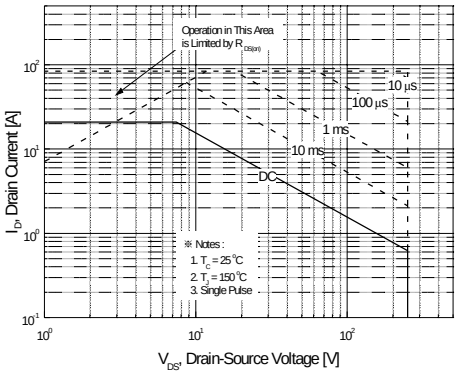


Figure 9-1. Maximum Safe Operating Area for IRF654B

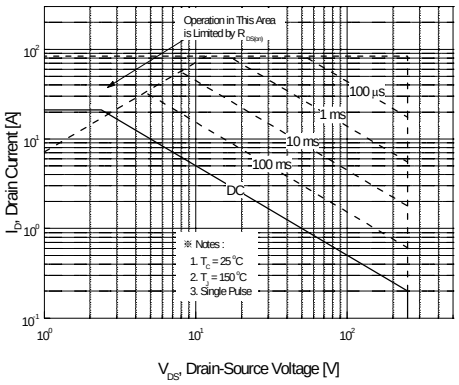


Figure 9-2. Maximum Safe Operating Area for IRFS654B

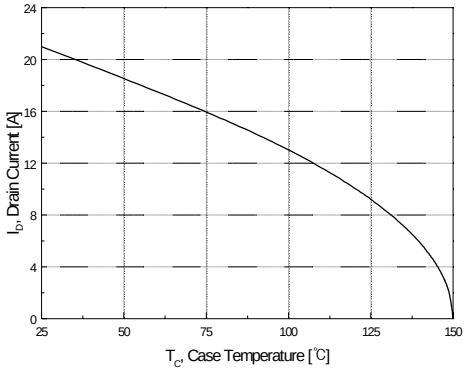


Figure 10. Maximum Drain Current vs Case Temperature

Typical Characteristics (Continued)

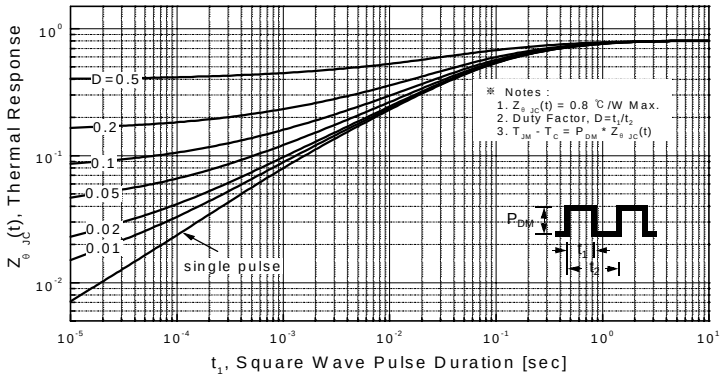


Figure 11-1. Transient Thermal Response Curve for IFR654B

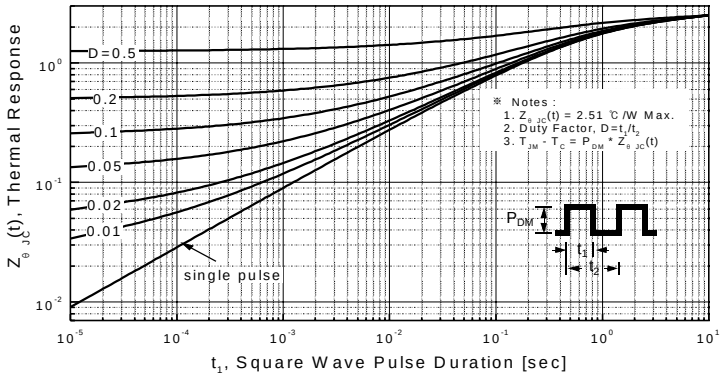
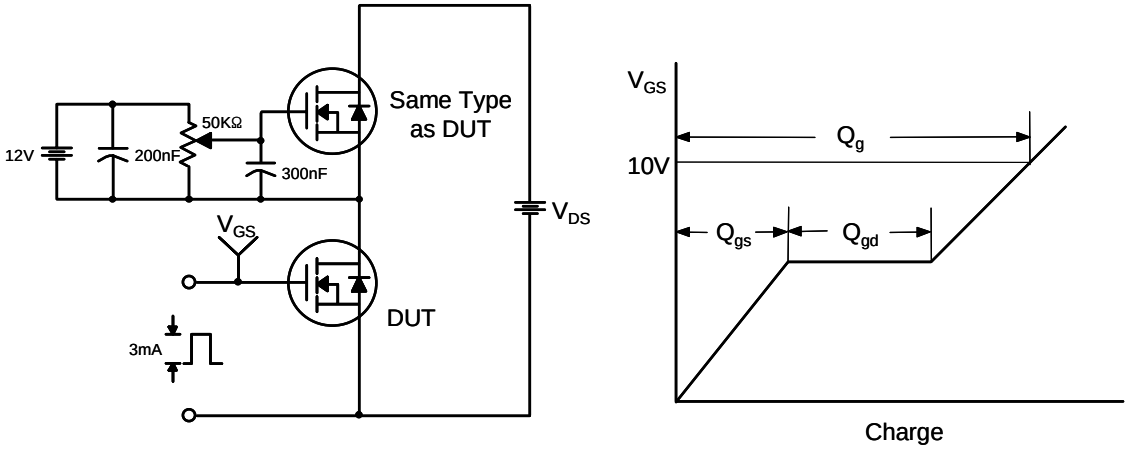
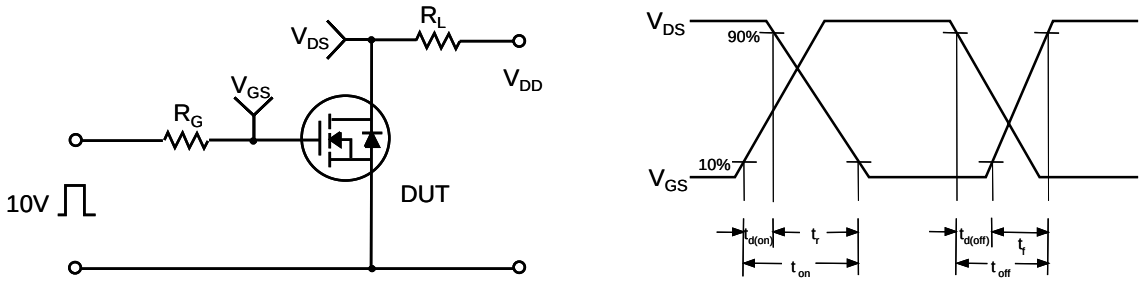


Figure 11-2. Transient Thermal Response Curve for IRFS654B

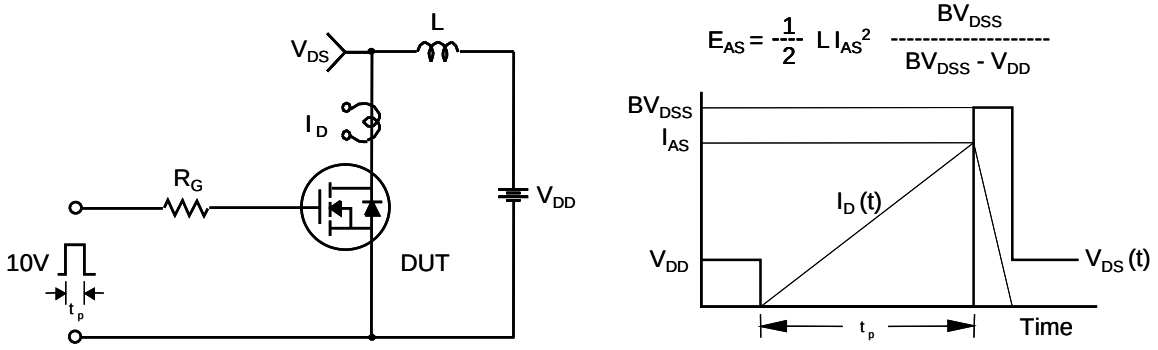
Gate Charge Test Circuit & Waveform



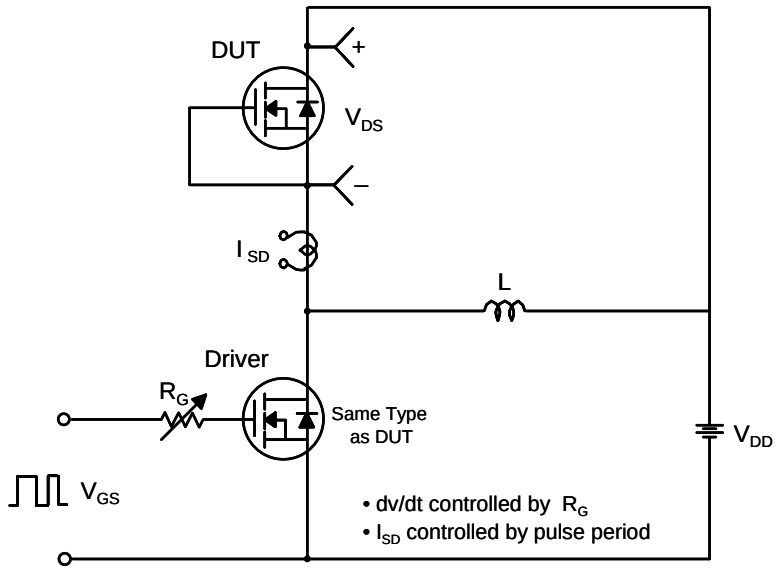
Resistive Switching Test Circuit & Waveforms

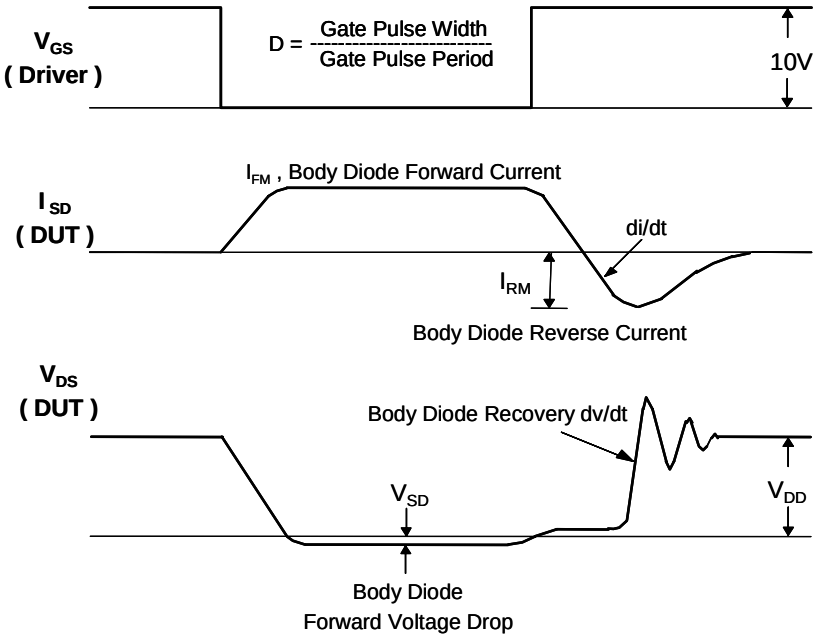


Unclamped Inductive Switching Test Circuit & Waveforms



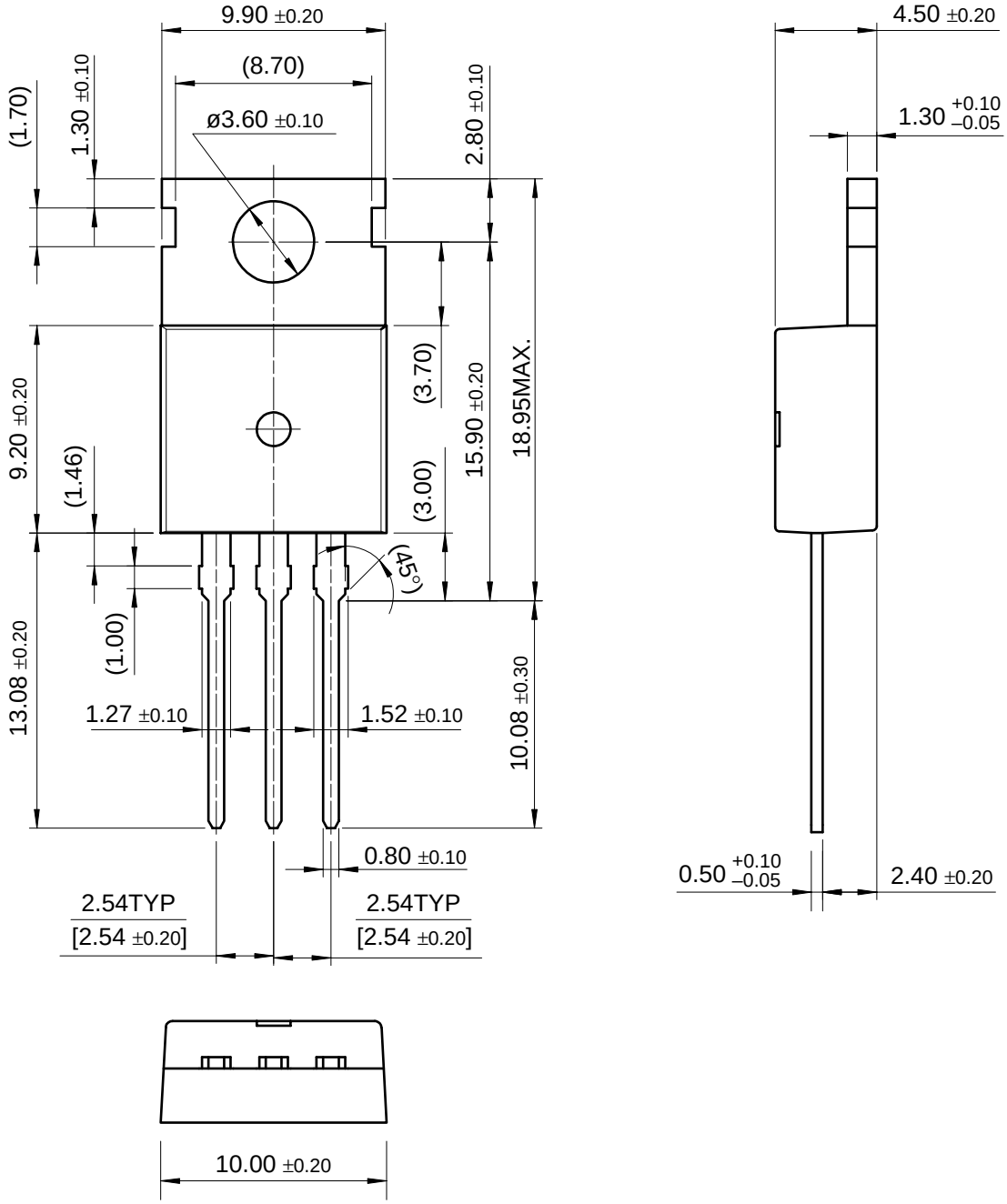
Peak Diode Recovery dv/dt Test Circuit & Waveforms





Package Dimensions

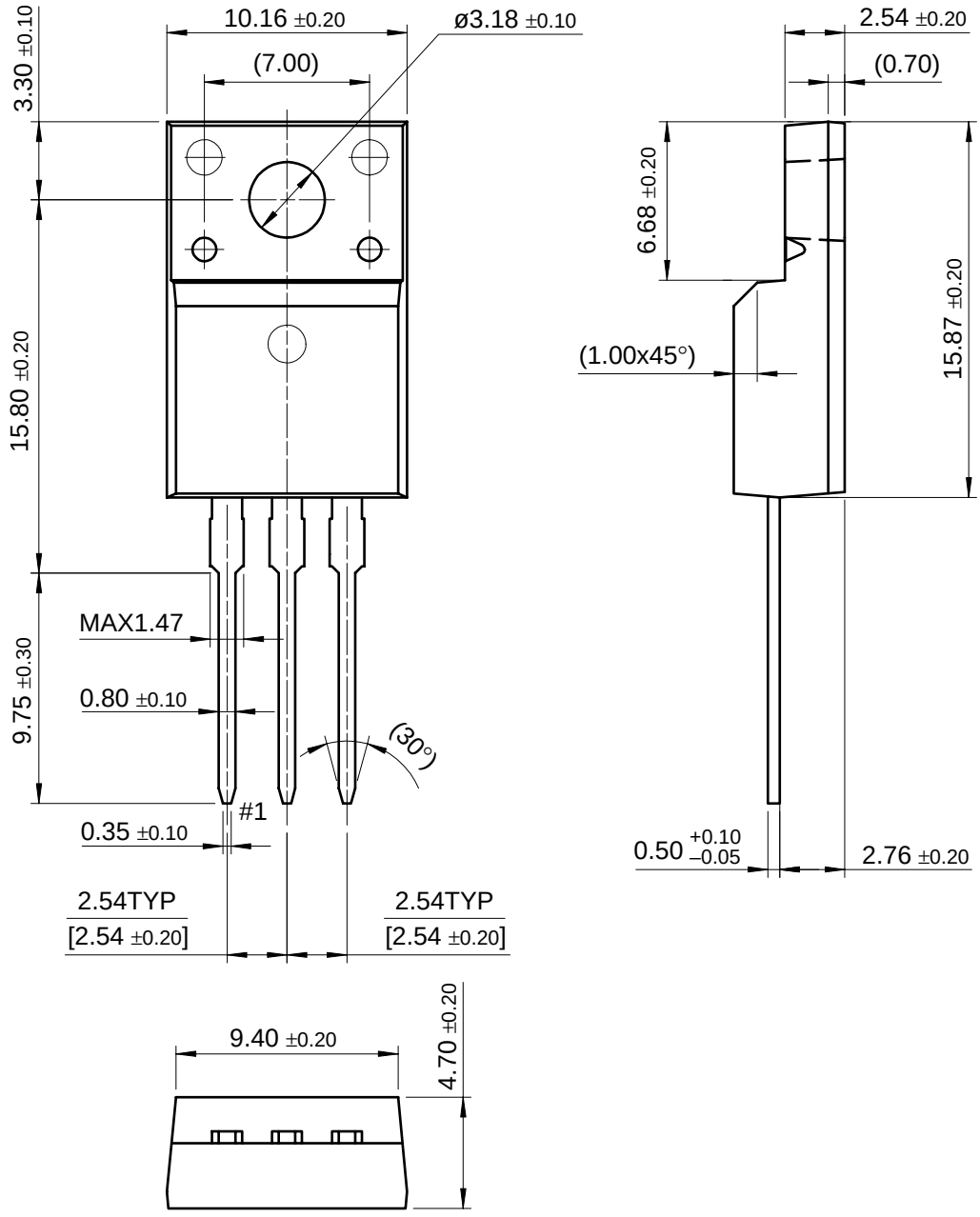
TO-220



Dimensions in Millimeters

Package Dimensions (Continued)

TO-220F



Dimensions in Millimeters

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