FAIRCHILD
SEMICONDUCTOR ™

April 2001

SGS13N60UFD

IGBT

SGS13N60UFD

## Ultra-Fast IGBT

General Description

Fairchild's UFD series of Insulated Gate Bipolar Transistors (IGBTs) provides low conduction and switching losses. The UFD series is designed for applications such as motor control and general inverters where high speed switching is a required feature.

Features

- High speed switching
- Low saturation voltage : $V_{CE(sat)}$ = 2.1 V @ I_C = 6.5A
- High input impedance
- CO-PAK, IGBT with FRD : t_{rr} = 37ns (typ.)

Application

AC & DC Motor controls, general purpose inverters, robotics, servo controls

TO-220F

G C E

C

G

E
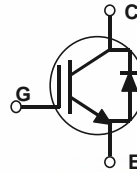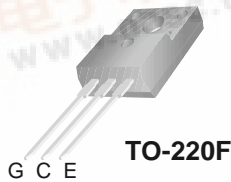
Absolute Maximum Ratings $T_C = 25°C$ unless otherwise noted

Symbol	Description		SGS13N60UFD	Units
V_{CES}	Collector-Emitter Voltage		600	V
V_{GES}	Gate-Emitter Voltage		± 20	V
I_C	Collector Current	@ T_C = 25°C	13	A
	Collector Current	@ T_C = 100°C	6.5	A
$I_{CM\ (1)}$	Pulsed Collector Current		52	A
I_F	Diode Continuous Forward Current	@ T_C = 100°C	8	A
I_{FM}	Diode Maximum Forward Current		56	A
P_D	Maximum Power Dissipation	@ T_C = 25°C	45	W
	Maximum Power Dissipation	@ T_C = 100°C	18	W
T_J	Operating Junction Temperature		-55 to +150	°C
T_{stg}	Storage Temperature Range		-55 to +150	°C
T_L	Maximum Lead Temp. for Soldering Purposes, 1/8" from Case for 5 Seconds		300	°C

Notes :
(1) Repetitive rating : Pulse width limited by max. junction temperature

Thermal Characteristics

Symbol	Parameter	Typ.	Max.	Units
$R_{\theta JC}$(IGBT)	Thermal Resistance, Junction-to-Case	--	2.7	°C/W
$R_{\theta JC}$(DIODE)	Thermal Resistance, Junction-to-Case	--	1.7	°C/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	--	62.5	°C/W

Electrical Characteristics of IGBT $T_C = 25°C$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
Off Characteristics						
BV_{CES}	Collector-Emitter Breakdown Voltage	$V_{GE} = 0V$, $I_C = 250uA$	600	--	--	V
$\Delta B_{VCES}/\Delta T_J$	Temperature Coeff. of Breakdown Voltage	$V_{GE} = 0V$, $I_C = 1mA$	--	0.6	--	V/°C
I_{CES}	Collector Cut-off Current	$V_{CE} = V_{CES}$, $V_{GE} = 0V$	--	--	250	µA
I_{GES}	G-E Leakage Current	$V_{GE} = V_{GES}$, $V_{CE} = 0V$	--	--	± 100	nA
On Characteristics						
$V_{GE(th)}$	G-E Threshold Voltage	$I_C = 6.5mA$, $V_{CE} = V_{GE}$	3.5	4.5	6.5	V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage	$I_C = 6.5A$, $V_{GE} = 15V$	--	2.1	2.6	V
		$I_C = 13A$, $V_{GE} = 15V$	--	2.6	--	V
Dynamic Characteristics						
C_{ies}	Input Capacitance	$V_{CE} = 30V$, $V_{GE} = 0V$, f = 1MHz	--	375	--	pF
C_{oes}	Output Capacitance		--	63	--	pF
C_{res}	Reverse Transfer Capacitance		--	13	--	pF
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 300$ V, $I_C = 6.5A$, $R_G = 50\Omega$, $V_{GE} = 15V$, Inductive Load, $T_C = 25°C$	--	20	--	ns
t_r	Rise Time		--	27	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	70	130	ns
t_f	Fall Time		--	97	150	ns
E_{on}	Turn-On Switching Loss		--	85	--	µJ
E_{off}	Turn-Off Switching Loss		--	95	--	µJ
E_{ts}	Total Switching Loss		--	180	270	µJ
$t_{d(on)}$	Turn-On Delay Time	$V_{CC} = 300$ V, $I_C = 6.5A$, $R_G = 50\Omega$, $V_{GE} = 15V$, Inductive Load, $T_C = 125°C$	--	30	--	ns
t_r	Rise Time		--	32	--	ns
$t_{d(off)}$	Turn-Off Delay Time		--	85	200	ns
t_f	Fall Time		--	168	250	ns
E_{on}	Turn- On Switching Loss		--	180	--	µJ
E_{off}	Turn- Off Switching Loss		--	165	--	µJ
E_{ts}	Total Switching Loss		--	345	500	µJ
Q_g	Total Gate Charge	$V_{CE} = 300$ V, $I_C = 6.5A$, $V_{GE} = 15V$	--	25	35	nC
Q_{ge}	Gate-Emitter Charge		--	7	12	nC
Q_{gc}	Gate-Collector Charge		--	8	14	nC
Le	Internal Emitter Inductance	Measured 5mm from PKG	--	7.5	--	nH

Electrical Characteristics of DIODE $T_C = 25°C$ unless otherwise noted

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Units
V_{FM}	Diode Forward Voltage	$I_F = 8A$	$T_C = 25°C$	--	1.4	1.7	V
			$T_C = 100°C$	--	1.3	--	
t_{rr}	Diode Reverse Recovery Time	$I_F = 8A$, di/dt = 200A/µs	$T_C = 25°C$	--	37	55	ns
			$T_C = 100°C$	--	55	--	
I_{rr}	Diode Peak Reverse Recovery Current		$T_C = 25°C$	--	3.5	5.0	A
			$T_C = 100°C$	--	4.5	--	
Q_{rr}	Diode Reverse Recovery Charge		$T_C = 25°C$	--	65	138	nC
			$T_C = 100°C$	--	124	--	

Fig 1. Typical Output Chacracteristics

Common Emitter
$T_C = 25℃$

Collector Current, I_C [A]

Collector - Emitter Voltage, V_{CE} [V]

20V
15V
12V
$V_{GE} = 10V$
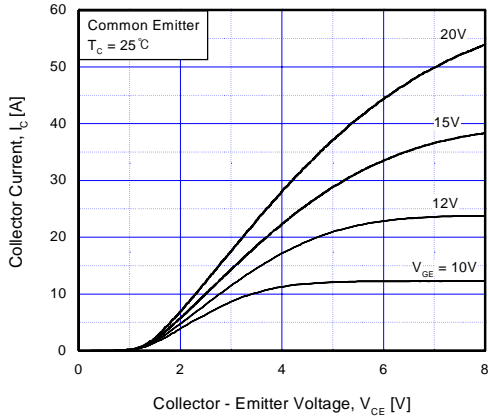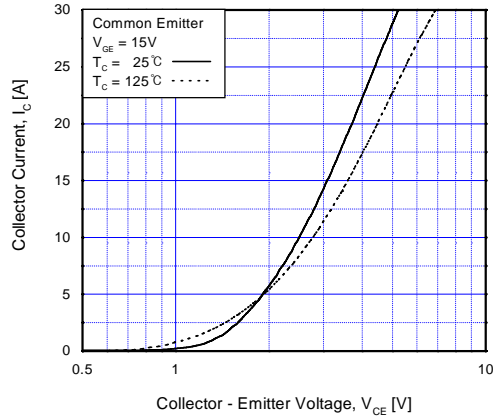
**Fig 2. Typical Saturation Voltage
Characteristics**

Common Emitter
$V_{GE} = 15V$
$T_C = 25℃$ ———
$T_C = 125℃$ ------

Collector Current, I_C [A]

Collector - Emitter Voltage, V_{CE} [V]
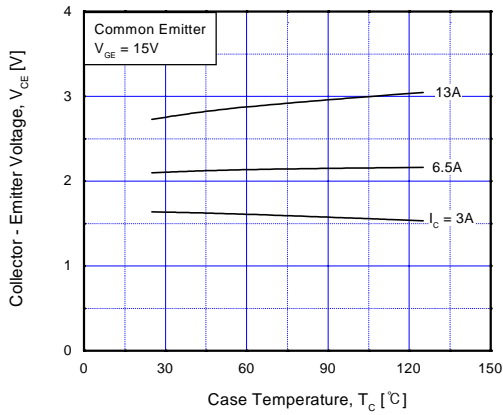
**Fig 3. Saturation Voltage vs. Case
Temperature at Variant Current Level**

Common Emitter
$V_{GE} = 15V$

Collector - Emitter Voltage, V_{CE} [V]

Case Temperature, T_C [℃]

13A
6.5A
$I_C = 3A$
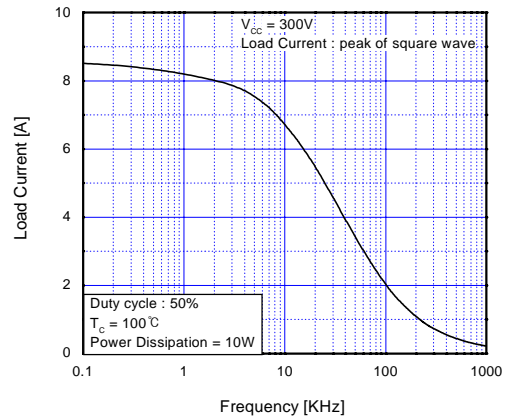
Fig 4. Load Current vs. Frequency

$V_{CC} = 300V$
Load Current : peak of square wave

Load Current [A]

Frequency [KHz]

Duty cycle : 50%
$T_C = 100℃$
Power Dissipation = 10W

Fig 5. Saturation Voltage vs. V_{GE}

Common Emitter
$T_C = 25℃$

Collector - Emitter Voltage, V_{CE} [V]

Gate - Emitter Voltage, V_{GE} [V]

13A
6.5A
$I_C = 3A$

Fig 6. Saturation Voltage vs. V_{GE}

Common Emitter
$T_C = 125℃$

Collector - Emitter Voltage, V_{CE} [V]

Gate - Emitter Voltage, V_{GE} [V]

13A
6.5A
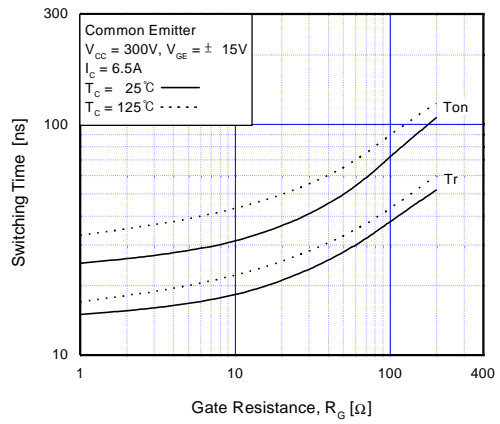$I_C = 3A$
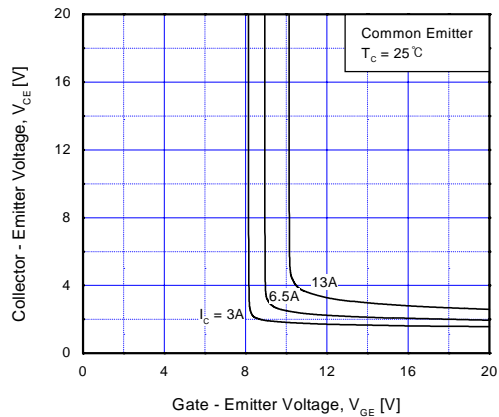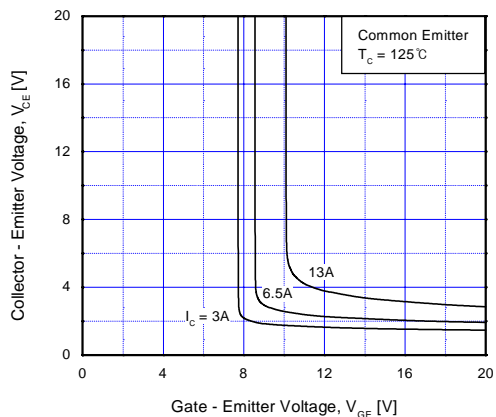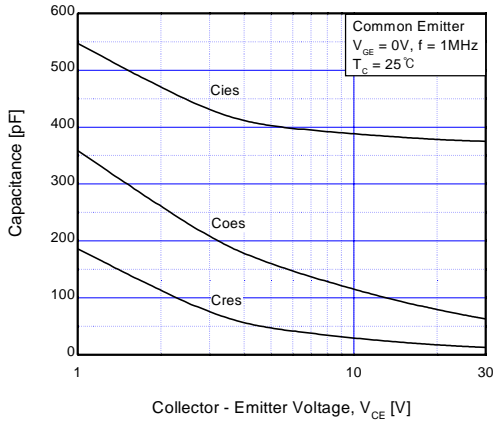
Fig 7. Capacitance Characteristics

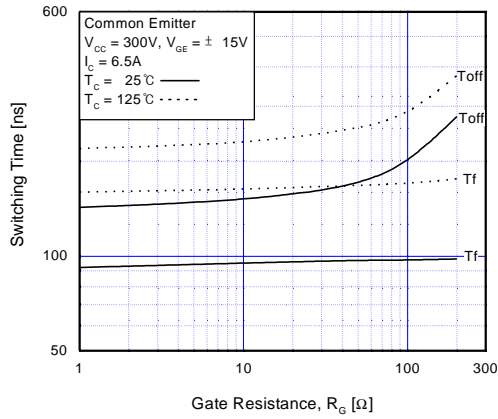**Fig 8. Turn-On Characteristics vs.
Gate Resistance**

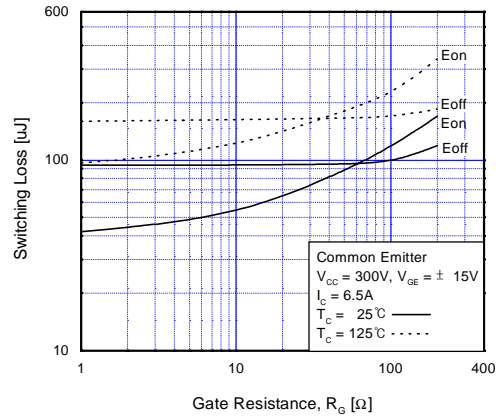**Fig 9. Turn-Off Characteristics vs.
Gate Resistance**

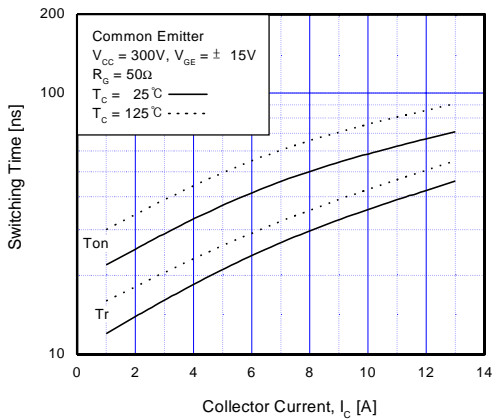**Fig 10. Switching Loss vs. Gate Resistance**

**Fig 11. Turn-On Characteristics vs.
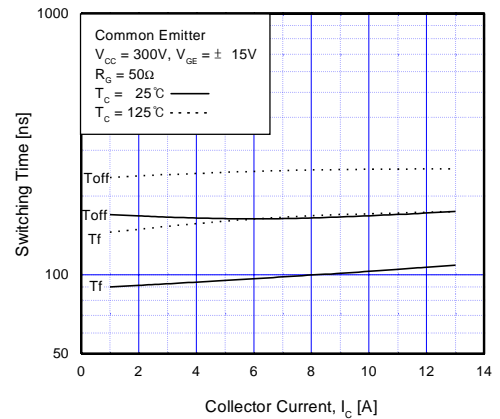Collector Current**

**Fig 12. Turn-Off Characteristics vs.
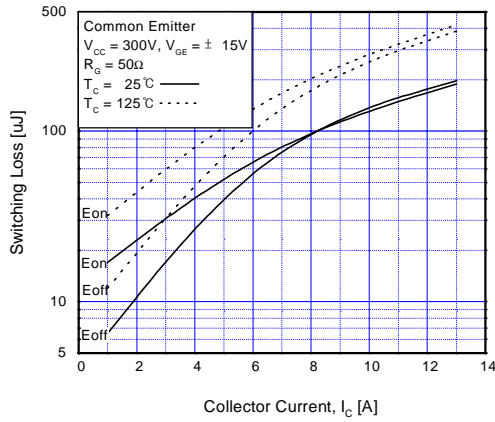Collector Current**

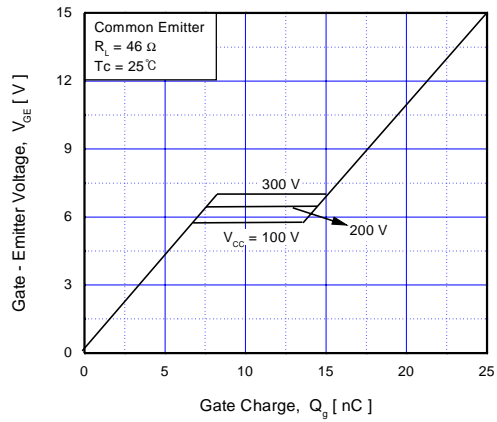Fig 13. Switching Loss vs. Collector Current

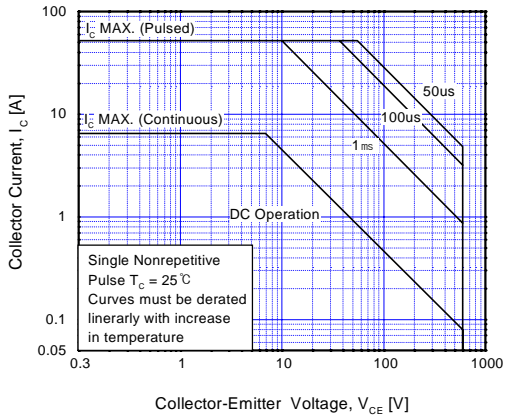Fig 14. Gate Charge Characteristics
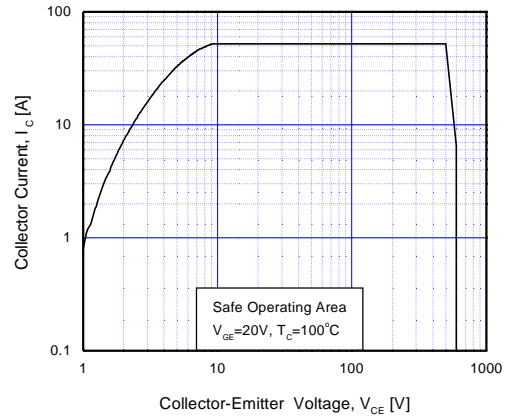

Fig 15. SOA Characteristics
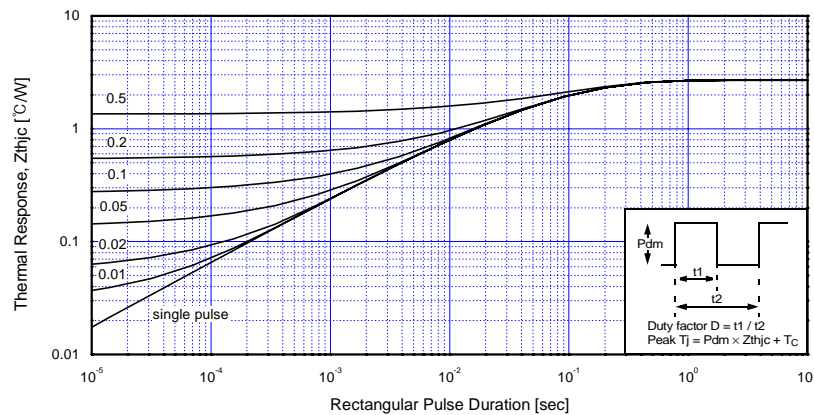

Fig 16. Turn-Off SOA Characteristics

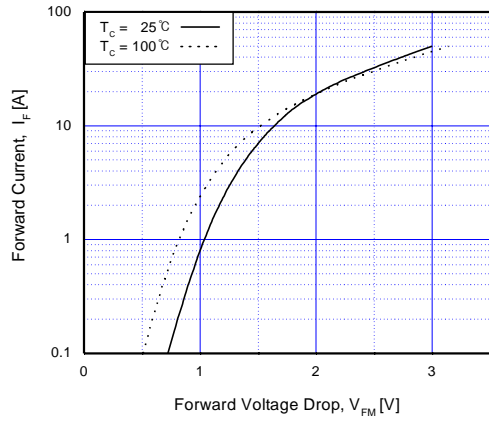
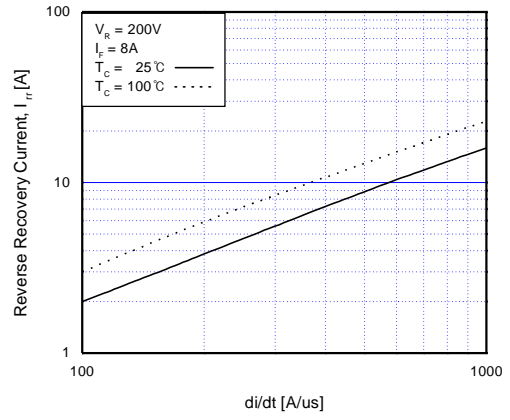Fig 17. Transient Thermal Impedance of IGBT

Fig 18. Forward Characteristics

Fig 19. Reverse Recovery Current
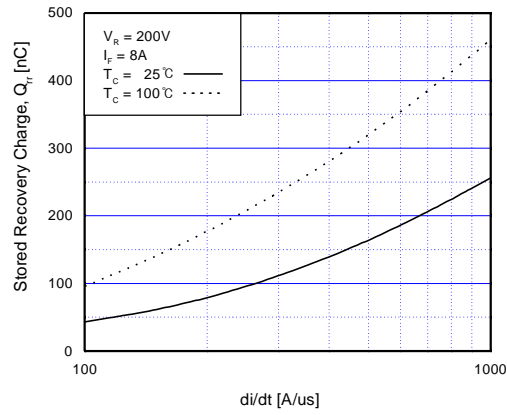
Fig 20. Stored Charge
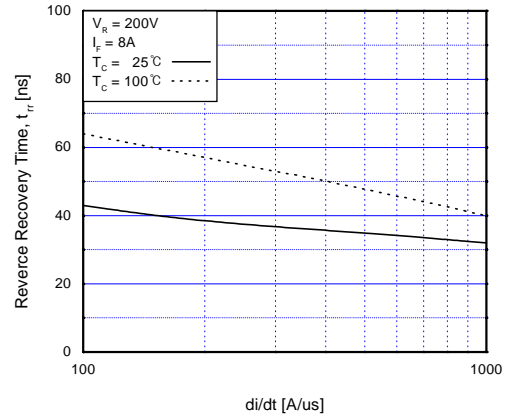
Fig 21. Reverse Recovery Time

Package Dimension

TO-220F (FS PKG CODE AQ)

10.16 ±0.20

(7.00)

ø3.18 ±0.10

3.30 ±0.10

2.54 ±0.20

(0.70)

6.68 ±0.20

15.80 ±0.20

15.87 ±0.20

(1.00x45°)

MAX1.47

0.80 ±0.10

(30°)

9.75 ±0.30

0.35 ±0.10

#1

0.50 $^{+0.10}_{-0.05}$

2.76 ±0.20

2.54TYP
[2.54 ±0.20]

2.54TYP
[2.54 ±0.20]

9.40 ±0.20

4.70 ±0.20
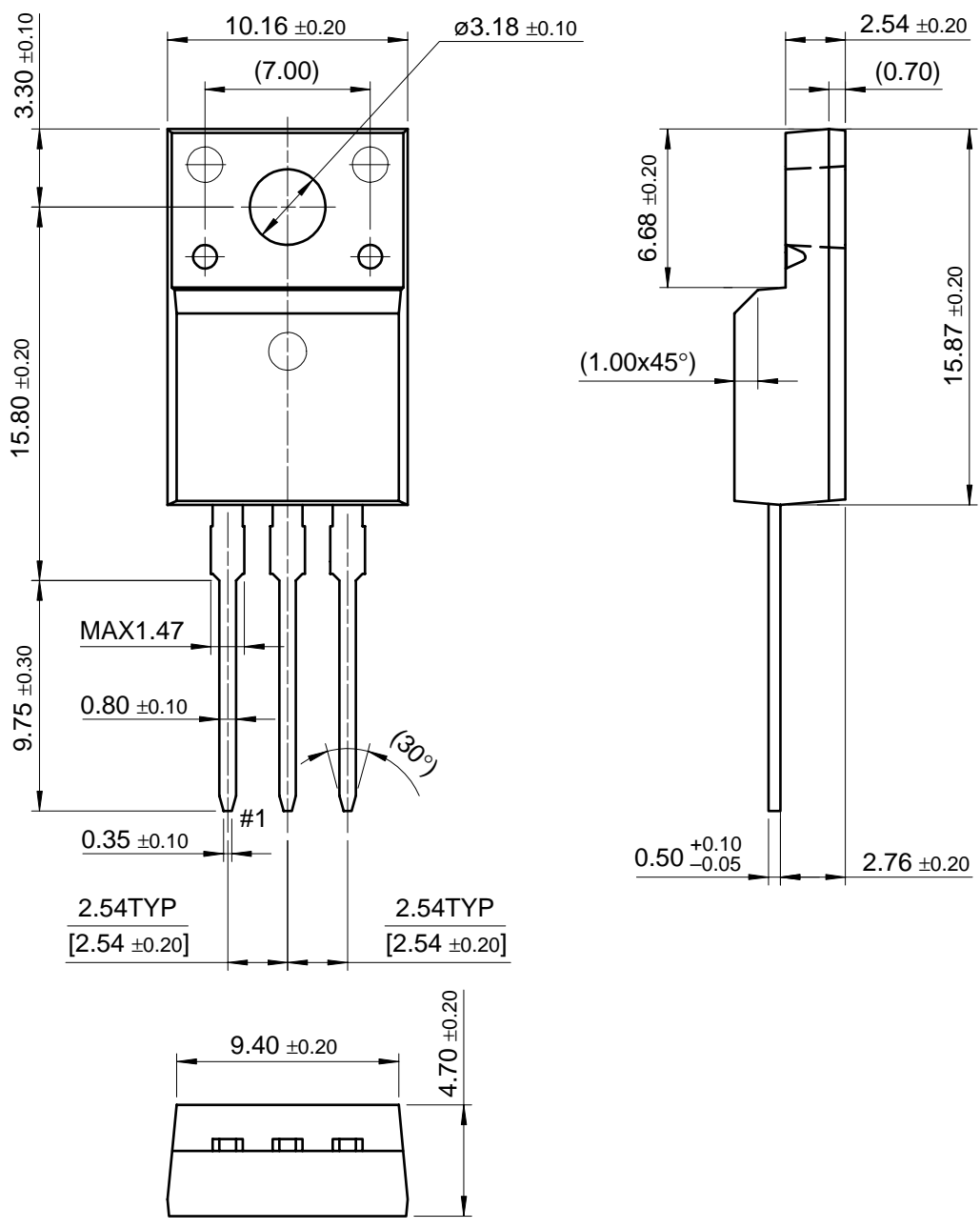
Dimensions in Millimeters

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