FAIRCHILD
A Schlumberger Company

2N3946/FTSO3946

T-35-11

NPN Small Signal General Purpose Amplifier & Switch

- V_{CEO} ... **40 V (Min)**

PACKAGE

2N3946	TO18
FTSO3946	TO236AA

ABSOLUTE MAXIMUM RATINGS (Note 1)

	2N	FTSO
Temperatures		
Storage Temperature	-65° C to 200° C	-55° C to 150° C
Operating Junction Temperature	175° C	150° C
Power Dissipation (Notes 2 & 3)		
Total Dissipation at	2N	FTSO
25° C Ambient Temperature	0.36 mW	0.350 W*
25° C Case Temperature	1.2 W	
Voltages & Currents		
V_{CEO} Collector to Emitter Voltage (Note 4)	40 V	40 V
V_{CBO} Collector to Base Voltage	60 V	60 V
V_{EBO} Emitter to Base Voltage	6.0 V	6.0 V
I_C Collector Current	200 mA	200 mA

Datasheet Directory

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
BV_{CEO}	Collector to Emitter Breakdown Voltage (Note 4)	40		V	I_C = 10 mA, I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage	60		V	I_C = 10 μA, I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	6.0		V	I_E = 10 μA, I_C = 0
I_{CEX}	Collector Cutoff Current		10 15	nA μA	V_{CE} = 40 V, V_{EB} = 3.0 V V_{CE} = 40 V, V_{EB} = 3.0 V, T_A = 150° C
I_{BL}	Base Cutoff Current		25	nA	V_{CE} = 40 V, V_{EB} = 3.0 V
h_{FE}	DC Current Gain (Note 5)	30 45 50 20	150		I_C = 0.1 mA, V_{CE} = 1.0 V I_C = 1.0 mA, V_{CE} = 1.0 V I_C = 10 mA, V_{CE} = 1.0 V I_C = 50 mA, V_{CE} = 1.0 V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		0.2 0.3	V V	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)	0.6	0.9 1.0	V V	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA

NOTES:

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 150° C and (TO-92) junction-to-case thermal resistance of 125° C/W (derating factor of 8.0 mW/° C); junction-to-ambient thermal resistance of 200° C/W (derating factor of 5.0 mW/° C); (TO-236) junction-to-ambient thermal resistance of 357° C/W (derating factor of 2.8 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest.
5. Pulse conditions: length = 300 μs; duty cycle = 2%.
6. For product family characteristic curves, refer to Curve Set T144.

* Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

2N3946/FTSO3946

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ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
C_{ob}	Output Capacitance		4.0	pF	V_{CB} = 10 V, I_E = 0, f = 100 kHz
C_{ib}	Input Capacitance		8.0	pF	V_{EB} = 1.0 V, I_C = 0, f = 100 kHz
h_{fe}	Current Gain Bandwidth Product	2.5			I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz
h_{ie}	Input Impedance	0.5	6.0	kΩ	I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz
h_{oe}	Output Admittance	1.0	30	μmhos	I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz
h_{re}	Voltage Feedback Ratio		10	$x10^{-4}$	I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz
t_d	Delay Time (test circuit no. 526)		35	ns	I_C = 10 mA, V_{CC} = 3.0 V, I_{B1} = 1.0 mA, $V_{BE(OFF)}$ = 0.5V
t_r	Rise Time (test circuit no. 526)		300	ns	I_C = 10 mA, V_{CC} = 3.0 V, I_{B1} = 1.0 mA, $V_{BE(OFF)}$ = 0.5V
t_s	Storage Time (test circuit no. 527)		300	ns	I_C = 10 mA, V_{CC} = 3.0 V, I_{B1} = I_{B2} = 1.0 mA
t_f	Fall Time (test circuit no. 527)		75	ns	I_C = 10 mA, V_{CC} = 3.0 V, I_{B1} = I_{B2} = 1.0 mA
$r_b'C_c$	Collector to Base Time Constant		200	ps	I_C = 10 mA, V_{CE} = 20 V, f = 31.8 MHz
NF	Noise Figure		5.0	dB	I_C = 100 μA, V_{CE} = 5.0 V, R_G = 1.0 kΩ, f = 10 Hz to 15.7 kHz

FAIRCHILD
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2N3962/PN3962 T-29-23
FTSO3962

PNP Low Level Low Noise Amplifiers

- V_{CEO} ... -60 V (Min)
- Excellent Beta Linearity from 1.0 μA to 50 mA

PACKAGE

2N3962	TO-18
PN3962	TO-92
FTSO3962	TO-236AA/AB

ABSOLUTE MAXIMUM RATINGS (Note 1)

Temperatures	**PN/FTSO**	**2N**
Storage Temperature	−55° C to 150° C	−65° C to 200° C
Operating Junction Temperature	150° C	175° C

Power Dissipation (Notes 2 & 3)

	2N	**PN**	**FTSO**
Total Dissipation at 25° C Ambient Temperature	0.36 W	0.625 W	0.350 W*
25° C Case Temperature	1.2 W	1.0 W	

Voltages & Currents

V_{CEO}	Collector to Emitter Voltage (Note 4)	−60 V
V_{CBO}	Collector to Base Voltage	−60 V
V_{EBO}	Emitter to Base Voltage	−6.0 V
I_C	Collector Current	200 mA

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
BV_{CBO}	Collector to Base Breakdown Voltage	−60		V	$I_C = 10\ \mu A$, $I_E = 0$
BV_{EBO}	Emitter to Base Breakdown Voltage	−6.0		V	$I_E = 10\ \mu A$, $I_C = 0$
BV_{CES}	Collector to Emitter Breakdown Voltage	−60		V	$I_C = 10\ \mu A$, $I_B = 0$
I_{EBO}	Emitter Cutoff Current		10	nA	$V_{EB} = -4.0$ V, $I_C = 0$
I_{CES}	Collector Reverse Current		10 10	nA μA	$V_{CE} = -50$ V, $V_{EB} = 0$ $V_{CE} = -50$ V, $V_{EB} = 0$, $T_A = 150°$ C
h_{FE}	DC Current Gain	60 100 100 100 40	 300 450 600		$I_C = 1.0\ \mu A$, $V_{CE} = -5.0$ V $I_C = 10\ \mu A$, $V_{CE} = -5.0$ V $I_C = 100\ \mu A$, $V_{CE} = -5.0$ V $I_C = 1.0$ mA, $V_{CE} = -5.0$ V $I_C = 10\ \mu A$, $V_{CE} = -5.0$ V, $T_A = -55°$ C $I_C = 1.0$ mA, $V_{CE} = -5.0$ V, $T_A = 100°$ C

NOTES:

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 150° C and (TO-92) junction-to-case thermal resistance of 125° C/W (derating factor of 8.0 mW/° C); junction-to-ambient thermal resistance of 200° C/W (derating factor of 5.0 mW/° C); (TO-236) junction-to-ambient thermal resistance of 357° C/W (derating factor of 2.8 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest.
5. Pulse conditions: length = 300 μs; duty cycle = 1%.
6. For product family characteristic curves, refer to Curve Set T219.

* Package mounted on 99.5% alumina 8 mm x 8 mm x 0.6 mm.

2N3962/PN3962/FTSO3962

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ELECTRICAL CHARACTERISTICS (25°C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	MIN	MAX	UNITS	TEST CONDITIONS
h_{FE}	DC Pulse Current Gain (Note 5)	100 90 45			I_C = 10 mA, V_{CE} = −5.0 V I_C = 50 mA, V_{CE} = −5.0 V I_C = 50 mA, V_{CE} = −5.0 V, T_A = −55°C
$V_{CE(sat)}$ $V_{CE(sat)}$	Collector to Emitter Saturation Voltage Collector to Emitter Saturation Voltage (Note 5)		−0.25 −0.4	V V	I_C = 10 mA, I_B = 0.5 mA I_C = 50 mA, I_B = 5.0 mA
$V_{BE(sat)}$ $V_{BE(sat)}$	Base to Emitter Saturation Voltage Base to Emitter Saturation Voltage (Note 5)		−0.9 −0.95	V V	I_C = 10 mA, I_B = 0.5 mA I_C = 50 mA, I_B = 5.0 mA
$V_{CEO(sus)}$	Collector to Emitter Sustaining Voltage (Notes 4 & 5)		−60	V	I_C = 5.0 mA, I_B = 0
C_{ob}	Open Circuit Output Capacitance		6.0	pF	V_{CB} = −5.0 V, I_E = 0, f = 1.0 MHz
C_{ib}	Open Circuit Input Capacitance		15	pF	V_{EB} = −5.0 V, I_C = 0, f = 1.0 MHz
h_{fe}	High Frequency Current Gain	2.0	8.0		I_C = 0.5 mA, V_{CE} = −5.0 V, f = 20 MHz
h_{fe}	Small Signal Current Gain	100	500		I_C = 1.0 mA, V_{CE} = −5.0 V, f = 1.0 kHz
h_{ie}	Input Resistance	2.5	17	kΩ	I_C = 1.0 mA, V_{CE} = 5.0 V, f = 1.0 kHz
h_{oe}	Output Conductance	5.0	40	μmhos	I_C = 1.0 mA, V_{CE} = −5.0 V, f = 1.0 kHz
h_{re}	Voltage Feedback Ratio		10	$x10^{-4}$	I_C = 1.0 mA, V_{CE} = −5.0 V, f = 1.0 kHz
NF	Wide Band Noise Figure		3.0	dB	I_C = 20 μA, V_{CE} = −5.0 V, R_S = 10 kΩ, BW = 15.7 Hz, f = 10 Hz to 10 kHz

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T-29-17

2N4030/2N4031
2N4032/2N4033

PNP Small Signal General Purpose Amplifiers

- V_{CEO} ... 60 V (Min) (2N4030/2), 80 V (Min) 2N4031/3)
- h_{FE} ... 100-300 @ 10 mA (2N4032/3), 40 (Min) 2N4032), 25 (Min) (2N4033) @ 1.0 A
- Complements ... 2N3107, 2N3108, 2N3109, 2N3020

PACKAGES

2N4030	TO-39
2N4031	TO-39
2N4032	TO-39
2N4033	TO-39

ABSOLUTE MAXIMUM RATINGS (Note 1)

Temperatures			
Storage Temperature	−65° C to 200° C		
Operating Junction Temperature	200° C		
Power Dissipation (Notes 2 & 3)			
Total Dissipation at			
25° C Ambient Temperature	0.8 W		
25° C Case Temperature	4.0 W		
Voltages & Currents	**4030/2**	**4031/3**	
V_{CEO} Collector to Emitter Voltage (Note 4)	−60 V	−80 V	
V_{CBO} Collector to Base Voltage	−60 V	−80 V	
V_{EBO} Emitter to Base Voltage	−5.0 V	−5.0 V	
I_C Collector Current	1.0 A	1.0 A	

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	4030 MIN	4030 MAX	4031 MIN	4031 MAX	UNITS	TEST CONDITIONS
BV_{CBO}	Collector to Base Breakdown Voltage	−60		−80		V	I_C = 10 μA, I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0		−5.0		V	I_E = 10 μA, I_C = 0
I_{EBO}	Emitter Cutoff Current		10		10	μA	V_{EB} = −5.0 V, I_C = 0
I_{CBO}	Collector Cutoff Current		50			nA	V_{CB} = −50 V, I_E = 0
					50	nA	V_{CB} = −60 V, I_E = 0
			50			μA	V_{CB} = −50 V, I_E = 0, T_A = 150° C
					50	μA	V_{CB} = −60 V, I_E = 0, T_A = 150° C
h_{FE}	DC Current Gain	30		30			I_C = 100 μA, V_{CE} = −5.0 V

NOTES:
1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and junction-to-case thermal resistance of 43.7° C/W (derating factor of 22.8 mW/° C); junction-to-ambient thermal resistance of 219° C/W (derating factor of 4.56 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest.
5. Pulse conditions: length = 300 μs; duty cycle = 1%.
6. For product family characteristic curves, refer to Curve Set T224.

2N4030/2N4031
2N4032/2N4033

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ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	4030 MIN	4030 MAX	4031 MIN	4031 MAX	UNITS	TEST CONDITIONS
h_{FE}	DC Pulse Current Gain (Note 5)	40 25 15 15	120	40 25 10 15	120		I_C = 100 mA, V_{CE} = −5.0 V I_C = 500 mA, V_{CE} = −5.0 V I_C = 1.0 A, V_{CE} = −5.0 V I_C = 100 mA, V_{CE} = −5.0 V, T_A = −55° C
V_{CEO}	Collector to Emitter Sustaining Voltage (Note 5)	−60		−80		V	I_C = 10 mA (pulsed), I_B = 0
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		−0.15 −0.5 −1.0		−0.15 −0.5	V V V	I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA I_C = 1.0 A, I_B = 100 mA
$V_{BE(ON)}$	Base to Emitter "On" Voltage (Note 5)		−1.1 −1.2		−1.1	V V	I_C = 500 mA, V_{CE} = −0.5 V I_C = 1.0 A, V_{CE} = −1.0 V
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)		−0.9		−0.9	V	I_C = 150 mA, I_B = 15 mA
C_{cb}	Collector to Base Capacitance		20		20	pF	V_{CB} = −10 V, I_E = 0, f = 1.0 MHz
C_{ib}	Input Capacitance		110		110	pF	V_{BE} = −0.5 V, I_C = 0, f = 1.0 MHz
$\|h_{fe}\|$	Magnitude of Common Emitter Small Signal Current Gain	1.0	4.0	1.0	4.0		I_C = 50 mA, V_{CE} = −10 V, f = 100 MHz
t_s	Storage Time (test circuit no. 341)		350		350	ns	$I_C \approx 500$ mA, $I_{B1} \approx -I_{B2} \approx 50$ mA
t_f	Fall Time (test circuit no. 341)		50		50	ns	$I_C \approx 500$ mA, $I_{B1} \approx -I_{B2} \approx 50$ mA
t_{on}	Turn On Time (test circuit no. 341)		100		100	ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA

SYMBOL	CHARACTERISTIC	4032 MIN	4032 MAX	4033 MIN	4033 MAX	UNITS	TEST CONDITIONS
BV_{CBO}	Collector to Base Breakdown Voltage	−60		−80		V	I_C = 10 μA, I_E = 0
BV_{EBO}	Emitter to Base Breakdown Voltage	−5.0		−5.0		V	I_E = 10 μA, I_C = 0
I_{EBO}	Emitter Cutoff Current		10		10	μA	V_{EB} = −5.0 V, I_C = 0
I_{CBO}	Collector Cutoff Current		50 50		 50 50	nA nA μA μA	V_{CB} = −50 V, I_E = 0 V_{CB} = −60 V, I_E = 0 V_{CB} = −50 V, I_E = 0, T_A = 150° C V_{CB} = −60 V, I_E = 0, T_A = 150° C
h_{FE}	DC Current Gain	75		75			I_C = 100 μA, V_{CE} = −5.0 V
h_{FE}	DC Pulse Current Gain (Note 5)	100 70 40 40	300	100 70 25 40	300		I_C = 100 mA, V_{CE} = −5.0 V I_C = 500 mA, V_{CE} = −5.0 V I_C = 1.0 A, V_{CE} = −5.0 V I_C = 100 mA, V_{CE} = −5.0 V, T_A = −55° C
V_{CEO}	Collector to Emitter Sustaining Voltage (Note 5)	−60		−80		V	I_C = 10 mA (pulsed), I_B = 0

2N4030/2N4031
2N4032/2N4033

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ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	4032 MIN	4032 MAX	4033 MIN	4033 MAX	UNITS	TEST CONDITIONS
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage (Note 5)		−0.15 −0.5		−0.15 −0.5 −1.0	V V V	I_C = 150 mA, I_B = 15 mA I_C = 500 mA, I_B = 50 mA I_C = 1.0 A, I_B = 100 mA
$V_{BE(ON)}$	Base to Emitter "On" Voltage (Note 5)		−1.1 |1.2		−1.1	V V	I_C = 500 mA, V_{CE} = −0.5 V I_C = 1.0 A, V_{CE} = −1.0 V
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)		−0.9		−0.9	V	I_C = 150 mA, I_B = 15 mA
C_{cb}	Collector to Base Capacitance		20		20	pF	V_{CB} = −10 V, I_E = 0, f = 1.0 MHz
C_{ib}	Input Capacitance		110		110	pF	V_{BE} = −0.5 V, I_C = 0, f = 1.0 MHz
$\|h_{fe}\|$	Magnitude of Common Emitter Small Signal Current Gain	1.5	5.0	1.5	5.0		I_C = 50 mA, V_{CE} = −10 V, f = 100 MHz
t_s	Storage Time (test circuit no. 341)		350		350	ns	$I_C \approx$ 500 mA, $I_{B1} \approx I_{B2} \approx$ 50 mA
t_f	Fall Time (test circuit no. 341)		50		50	ns	$I_C \approx$ 500 mA, $I_{B1} \approx I_{B2} \approx$ 50 mA
t_{on}	Turn On Time (see test circuit no. 341)		100		100	ns	$I_C \approx$ 500 mA, $I_{B1} \approx$ 50 mA

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2N4036/2N4037

T-27-23

PNP General Purpose Transistor

ABSOLUTE MAXIMUM RATINGS (Note 1)

PACKAGE

2N4036	TO-39
2N4037	TO-39

Temperatures

Storage Temperature	−65° C to 200° C
Operating Junction Temperature	−65° C to 200° C

Power Dissipation (Notes 2 & 3)

	4036	4037
Total Dissipation at 25° C Ambient Temperature	5.0 W	1.0 W

Voltages & Currents (Note 4)

		4036	4037
V_{CEO}	Collector to Emitter Voltage	−65 V	−40 V
V_{CBO}	Collector to Base Voltage	−90 V	−60 V
V_{EBO}	Emitter to Base Voltage	−7.0 V	−7.0 V
I_C	Collector Current (Continuous)	1.0 A	1.0 A
I_B	Base Current (Continuous)	0.5 A	0.5 A

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	2N4036 MIN	2N4036 MAX	2N4037 MIN	2N4037 MAX	UNITS	TEST CONDITIONS
BV_{CEO}	Collector to Emitter Sustaining Voltage	−65		−40		V	I_C = 100 mA, I_B = 0
BV_{CBO}	Collector to Base Breakdown Voltage			−60		V	I_C = 0.1 mA
I_{EBO}	Emitter Cutoff Current		10		1.0	μA μA	V_{EB} = −7.0 V V_{EB} = −5.0 V
I_{CBO}	Collector Cutoff Current		100		0.25	μA μA	V_{CB} = −90 V, I_E = 0 V_{CB} = −60 V, I_E = 0
I_{CEX}	Collector Cutoff Current		100 0.1			mA μA	V_{CE} = −85 V, V_{BE} = −1.5 V V_{CE} = −30 V, V_{BE} = −1.5 V T_C = 150° C
h_{FE}	DC Current Gain (Note 5)	20 20 40 20	200 140	 15 50	 250		I_C = 150 mA, V_{CE} = 2.0 V I_C = 100 μA, V_{CE} = 10 V I_C = 1.0 mA, V_{CE} = 10 V I_C = 150 mA, V_{CE} = 10 V I_C = 500 mA, V_{CE} = 10 V
$V_{CE(sat)}$	Collector to Emitter Saturation Voltage		−0.65		−1.4	V	I_C = 150 mA, I_B = 15 mA
$V_{BE(sat)}$	Base to Emitter Saturation Voltage (Note 5)		−1.4			V	I_C = 150 mA, I_B = 15 mA
$V_{BE(ON)}$	Base to Emitter On Voltage			−1.4		V	I_C = 150 mA, V_{CE} = 10 V

NOTES:

1. These ratings are limiting values above which the serviceability of any individual semiconductor device may be impaired.
2. These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3. These ratings give a maximum junction temperature of 200° C and (2N4036) junction-to-case thermal resistance of 35° C/W (derating factor of 28.6 mW/° C); (2N4037) junction-to-case thermal resistance of 175° C/W (derating factor of 5.71 mW/° C).
4. Rating refers to a high current point where collector to emitter voltage is lowest.
5. Pulse conditions: length = 300 μs, duty cycle = 1%.
6. For product family characteristic curves, refer to Curve Set T224.

ELECTRICAL CHARACTERISTICS (25° C Ambient Temperature unless otherwise noted) (Note 6)

SYMBOL	CHARACTERISTIC	2N4036 MIN	2N4036 MAX	2N4037 MIN	2N4037 MAX	UNITS	TEST CONDITIONS
$\|h_{fe}\|$	High Frequency Current Gain	3.0		3.0	10		I_C = 50 mA, V_{CE} = −10 V, f = 20 MHz
C_{cb}	Collector to Base Capacitance				30	pF	V_{CB} = 10 V, f = 1.0 MHz
t_r	Rise Time		70			ns	I_C = 150 mA, I_{B1} = 15 mA
t_s	Storage Time		600			ns	I_C = 150 mA, $I_{B1} = I_{B2}$ = 15 mA
t_f	Fall Time		100			ns	I_C = 150 mA, $I_{B1} = I_{B2}$ = 15 mA
t_{on}	Turn On Time		110			ns	I_C = 150 mA, I_{B1} = 15 mA
t_{off}	Turn Off Time		700			ns	I_C = 150 mA, $I_{B1} = I_{B2}$ = 15 mA