January 1990 Edition 1.1 **FUJITSU**

2SC3178, 2SC3059, 2SC3060, 2SC3061

Silicon High Speed Power Transistor

DESCRIPTION

This series are silicon NPN planer general purpose, high power switching transistors fabricated with Fujitsu's unique Ring Emitter Transistor (RET) technology. RET devices are constructed with multiple emitters connected through ballast resistors which provide uniform current density. This structure permits the design of high power transistors with superior switching characteristics and frequency response in high current applications.

This series are especially well-suited for high speed/high voltage switching systems or other applications where large SOA is required.

Features

- High voltage
- Ultra-fast switching
- Large safe operating area

Applications

- Switching regulators
- Motor controls
- Ultrasonic oscillators
- · Class C and D amplifiers
- Deflection circuits

Outline of the Series

Item	Symbol	2SC3178	2SC3059	2SC3060	2SC3061	Unit	
Collector to Base Breakdown Voltage	V _{CBO}		12	00	-	٧	
Collector to Emitter Breakdown Voltage	V _{CEO}		85	0		٧	
Emitter to Base Breakdown Voltage	V _{EBO}		7	-			
Collector Current (continuous)	1 _c	2	2	5	10	Α	
Collector Current (pulsed)	1 _{CP}	4		8	20	Α	
Collector Power Dissipation	Pc	60	100	150	200	w	
Reverse Bias Safe Operating Area @ 900V	RBSOA	2.	.5	5	7	Α	
Rise Time (Typ.)	t _r		0.:	20		μs	
Storage Time (Typ.)	t _{stg}		2.	50		μs	
Fall Time (Typ.)	t _f		0.0	07		μs	
Collector to Emitter Saturation Voltage (Typ.)	V _{CE(sat)}		0.	3		٧	
Base to Emitter Saturation Voltage (Typ.)	V _{BE(sat)}		1.0	0		٧	
Package	_	TO-220		TO-3		_	

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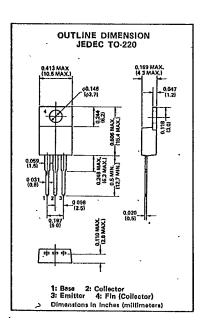
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2SC3178, 2SC3059, 2SC3060, 2SC3061

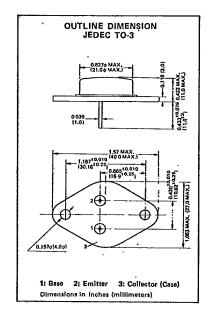
OUTLINE DIMENSION



2SC3178



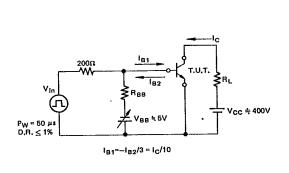
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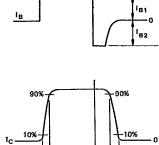


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2SC3178, 2SC3059, 2SC3060, 2SC3061

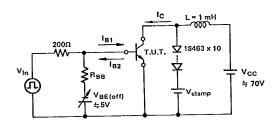
TEST CIRCUIT USED FOR MEASUREMENT OF SWITCHING TIME (RESISTIVE)

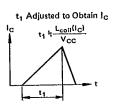






TEST CIRCUIT USED FOR MEASUREMENT OF $V_{\text{CEX}\{\text{SUS}\}}$ AND REVERSE BIAS SAFE OPERATING AREA





V_{CEX} (SUS)

Туре No.	I _C (A)	I _{B2} (A)	R _{BB} (Ω)
2SC3178	2.5		20
2SC3059	2.5	-0.3	20
2SC3060	5,0	-0.6	10
2SC3061	7.0	-1.2	5

V clamp = 900V

REVERSE BIAS SAFE OPERATING AREA

Type No.	I _{B2} (A)	R ₈₈ (Ω)
2SC3178		20
25C3059	-0.3	20
2\$C3060	-0.6	10
2SC3061	-1.2	5



January	1990
Edition	

FUJITSU

= PRODUCT PROFILE

2SC3178

T-33-01

Silicon High Speed Power Transistor

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector to Emitter Voltage	V _{CEO}	850	٧
Collector to Base Voltage	V _{C80}	1200	٧
Emitter to Base Voltage	V _{EBO}	7	٧
Collector Current-Continuous	Ic	2	Α
Collector Current-Pulsed P _W ≤ 25 µs, D.R.≤ 50%	I _{CP}	4	Α
Base Current-Continuous	I _B	1	Α
Collector Power Dissipation (T _C = 25°C)	P _C	60	w
Junction Temperature	T ₁	+150	°C
Storage Temperature Range	T _{stg}	-55 ~ +150	°c



FI FCTRICAL CHARACTERISTICS (Ta = 25°C)

				Limit		Unit
Illector to Base Breakdown Voltage $V_{(BR)}CBO$ $I_C = 1mA, I_E$ whiter to Base Breakdown Voltage $V_{(BR)}CBO$ $I_C = 1mA, I_C$ whiter to Emitter Sustaining Voltage $V_{(BR)}CEO$ $I_C = 10mA, F$ whilector to Emitter Sustaining Voltage $V_{CEX}(SUS)$ $I_C = 2.5A, I_{B2}$ whilector Cutoff Current I_{CBO} $V_{CB} = 1000V$ whilector Cutoff Current I_{CBO} $V_{CB} = 1000V$ whilector Cutoff Current I_{CBO} $V_{CB} = 6V, I_C$ $V_{CE} = 5V, I_C$ $V_{CE} = 5V, I_C$ where $V_{CE} = 5V, I_C$ as to Emitter Saturation Voltage $V_{CE}(Sat)$ $V_{CE}(Sat)$ as to Emitter Saturation Voltage $V_{CE}(Sat)$	Test Conditions	Min.	Тур.	Max.	Onit	
Collector to Base Breakdown Voltage	V _(вп) сво	I _C = 1mA, I _E = 0	1200			٧
Emitter to Base Breakdown Voltage	V(BR)EBO	l _E = 1mA, I _C = 0	7			٧
Collector to Emitter Sustaining Voltage	V _(BR) CEO	I _C = 10mA, R _{BE} =∞Ω	850		-	٧
Collector to Emitter Sustaining Voltage	V _{CEX} (SUS)	I _C =2.5A, I _{B2} =-0.3A, L=1mH(*1)	900	_	_	٧
Collector Cutoff Current	I _{CBO}	V _{CB} = 1000V, I _E = 0	1	-	100	μΑ
Collector Cutoff Current	I _{CBO}	$V_{CB} = 1000V, I_E = 0, T_C = 100^{\circ}C$		-	1	mA
Emitter Cutoff Current	I _{EBO}	V _{EB} = 6V, I _C = 0		-	100	μА
DC Current Gain	h _{FE}	V _{CE} = 5V, I _C = 1A (*2)	10	15	30	
Collector to Emitter Saturation Voltage	V _{CE} (sat)	-10 -0 20 (*2)	L	0.3	1.5	٧
Base to Emitter Saturation Voltage	V _{BE} (sat)	IC = IA, IB = 0.2A (2)		1.0	2.0	٧
Output Capacitance	Cob	V _{CB} = 10V, I _E = 0, f = 1MHz	_	60		pF
Gain Bandwidth Product	f _T	V _{CE} = 10V, I _C = 0.2A	_	15		MH:
Rise Time	tr		_	0.2	0.5	μs
Storage Time	t _{stg}	(sat) $I_C = 1A$, $I_B = 0.2A$ (*2) $V_{CB} = 10V$, $I_E = 0$, $f = 1MHz$	_	2.5	3,5	μs
Fall Time	tf		-	0.07	0.3	μs

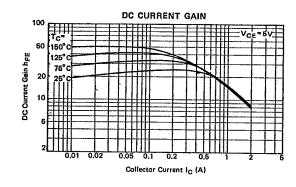
^{*1} Test Circuit

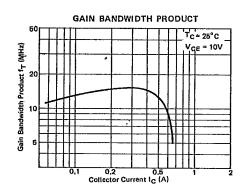
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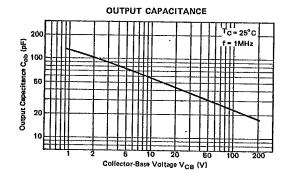
^{*2} Pulse $P_w \le 300 \,\mu s$, Duty Ratio $\le 6\%$

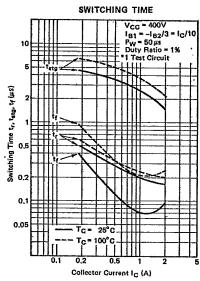
2SC3178

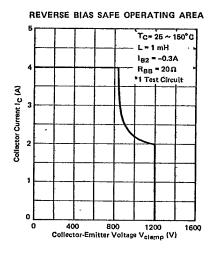




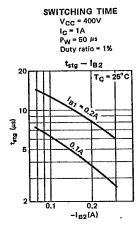


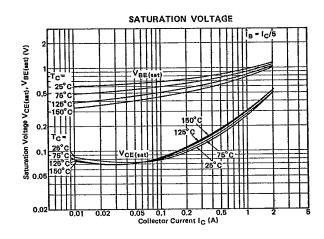




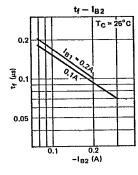


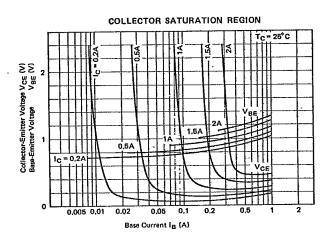
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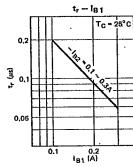








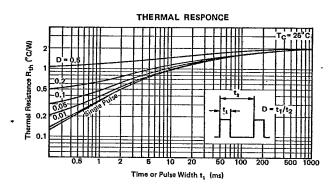




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2SC3178

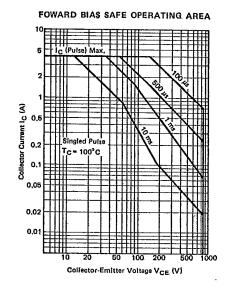




FOWARD BIAS SAFE OPERATING AREA

10
5 C (Pulse) Max.
2
1 C Max.
2
3 O .2
3 Single Pulse
7 C = 25°C
0.02
0.02
0.01

Collector-Emitter Voltage VCE (V)



January 1990 Edition 1.1

PRODUCT PROFILE:

FUJITSU

2SC3059

Silicon High Speed Power Transistor

T-33-01

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector to Emitter Voltage	V _{CEO}	850	V
Collector to Base Voltage	V _{C80}	1200	٧
Emitter to Base Voltage	V _{EBO}	7	٧
Collector Current-Continuous	Ic	2	Α
Collector Current-Pulsed P _W ≤ 25 µs, D.R. ≤ 50%	I _{CP}	4	Α
Base Current-Continuous	l _B	1	Α
Collector Power Dissipation (T _C = 25°C)	Pc	100	w
Junction Temperature	Tj	+175	°c
Storage Temperature Range	T _{stg}	65 ~ +175	°c



ELECTRICAL CHARACTERISTICS (Ta = 25°C)

	Complete	Total Conditions	Limit			Unit
Parameter	Symbol	Test Conditions	Min.	Тур.	Max.	Onit
Collector to Base Breakdown Voltage	V _(BR) CBO	I _C = 1mA, I _E = 0	1200	1	_	٧
Emitter to Base Breakdown Voltage	V _(BR) EBO	I _E = 1mA _r I _C = 0	7	-	_	v
Collector to Emitter Sustaining Voltage	V _(BR) CEO	Ic = 10mA, R _{BE} = ∞Ω	850	-		٧
Collector to Emitter Sustaining Voltage	V _{CEX} (sus)	I _C =2.5A, I _{B2} =-0.3A, L=1mH(*1)	900	_		٧
Collector Cutoff Current	I _{CBO}	V _{CB} = 1000V, I _E = 0		-	100	μΑ
Collector Cutoff Current	Ісво	$V_{CB} = 1000V, I_E = 0, T_C = 100^{\circ}C$	-	ſ	1	mA.
Emitter Cutoff Current	l _{EBO}	V _{EB} = 6V, I _C = 0	-	-	100	μΑ
DC Current Gain -	hFE	V _{CE} = 5V, I _C = 1A (*2)	10	15	30	
Collector to Emitter Saturation Voltage	V _{CE} (sat)		-	0.3	1.5	V
Base to Emitter Saturation Voltage	VBE (sat)	1c = 1A, IB = 0.2A ("2)	_	1.0	2,0	٧
Output Capacitance	Cop	V _{CB} = 10V, I _E 0, f = 1MHz	-	60	-	PF
Gain Bandwidth Product	f _T	V _{CE} = 10V, I _C = 0.2A	_	15	-	MHz
Rise Time	tr		_	0.2	0.5	μς
Storage Time	t _{stg}	SUS) $I_C = 2.5A, I_{B2} = -0.3A, L = 1 mH(*1)$ $V_{CB} = 1000V, I_E = 0$ $V_{CB} = 1000V, I_E = 0, T_C = 100^{\circ}C$ $V_{EB} = 6V, I_C = 0$ $V_{CE} = 5V, I_C = 1A (*2)$ $I_C = 1A, I_B = 0.2A (*2)$ $V_{CB} = 10V, I_E 0, f = 1 MHz$	_	2.5	3.5	μs
Fall Time	tf	- 1C - 1C, 0181 - 9182 - 0.0A	_	0.07	0.3	μs

^{*1} Test Circuit

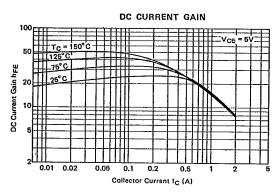
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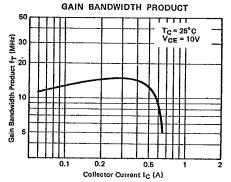
^{*2} Pulsed $P_W \le 300 \,\mu s$, Duty Ratio $\le 6\%$

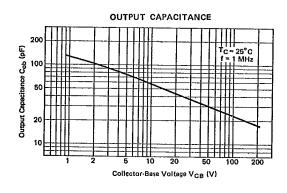
FUJITSU MICROELECTRONICS

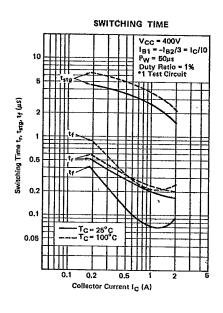
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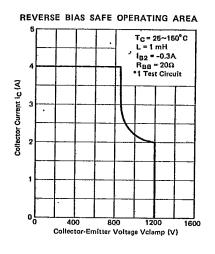
2SC3059



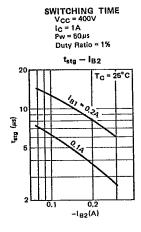


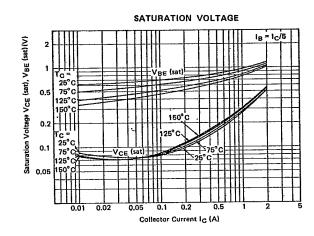




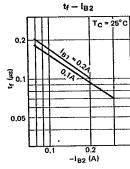


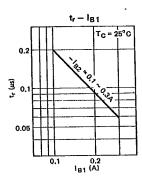
2SC3059

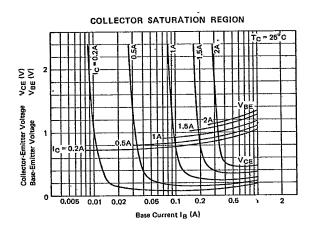






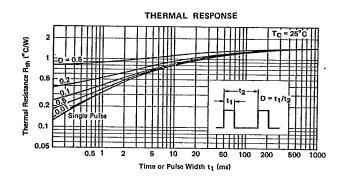


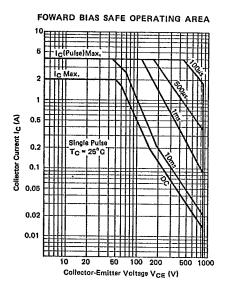


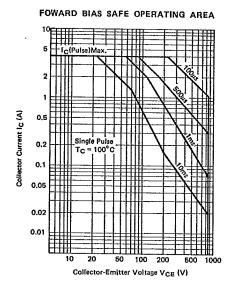


2SC3059









January 1990 Edition 1.1

2SC3060

Silicon High Speed Power Transistor

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector to Emitter Voltage	V _{CEO}	850	V
Collector to Base Voltage	V _{CBO}	1200	٧
Emitter to Base Voltage	V _{EBO}	7	٧
Collector Current-Continuous	1 _c	5	Α
Collector Current-Pulsed P _W ≤ 25 µs, D.R. ≤ 50%	I _{CP}	8	Α
Base Current-Continuous	I _B	3	A
Collector Power Dissipation (T _C = 25°C)	Pc	150	W
Junction Temperature	T _i	+175	°c
Storage Temperature Range	T _{stg}	-65 ~ +175	°c



ELECTRICAL CHARACTERISTICS (Ta = 25°C)

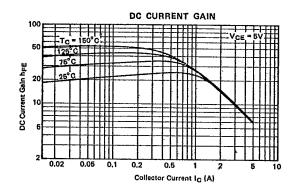
Parameter	Symbol	o . m	Limit			Unit
Parameter	Symbol	Test Conditions	Min.	Тур.	Max.	Ont
Collector to Base Breakdown Voltage	V _(BR) CBO	I _C = 1mA, I _E = 0	1200			V
Emitter to Base Breakdown Voltage	V _(BR) EBO	I _E = 1mA, I _C = 0	7		_	V
Collector to Emitter Sustaining Voltage	V _(BR) CEO	I _C = 10mA, R _{BE} = ∞Ω	850			V
Collector to Emitter Sustaining Voltage	V _{CEX} (SUS)	I _C = 5A, I _{B 2} = -0.6A, L = 1mH(*1)	900	_		٧
Collector Cutoff Current	Ісво	V _{CB} = 1000V, I _E = 0			100	μА
Collector Cutoff Current	Ісво	V _{CB} = 1000V, I _E = 0, T _C = 100°C	1		1	mA
Emitter Cutoff Current	I _{EBO}	V _{EB} = 6V, I _C = 0	1		100	μΑ
DC Current Gain	h _{FE}	V _{CE} = 5V, I _C = 2A (*2)	10	15	30	_
Collector to Emitter Saturation Voltage	V _{CE} (sat)		-	0.3	1.5	V
Base to Emitter Saturation Voltage	V _{BE} (sat)	$l_C = 2A$, $l_B = 0.4A (*2)$		1.0	2.0	V
Output Capacitance	Cob	V _{CB} = 10V, I _E = 0, f = 1MHz		120	_	PF
Gain Bandwidth Product	f _T	V _{CE} = 10V, I _C = 0.5A	-	15		MHz
Rīse Time	tr		_	0.2	0.5	μs
Storage Time	t _{stg}	V _{CC} = 400V (*1) I _C = 2A, 3I _{B1} = - I _{B2} = 0.6A	_	2.5	3.5	μs
Fall Time	tf	10 - 20, 0181 182 0.00	_	0.07	0.3	μs

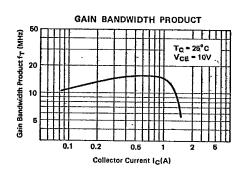
^{*2} Pulsed $P_W \le 300 \,\mu s$, Duty Ratio $\le 6\%$ *1 Test Circuit

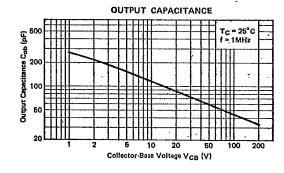
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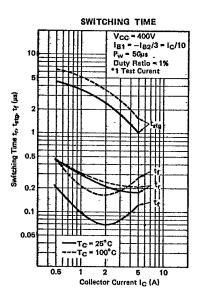
2SC3060

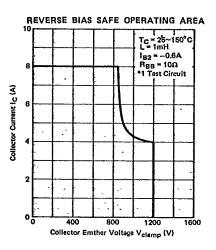


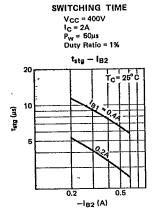


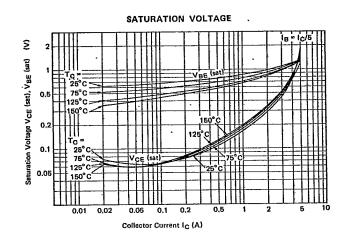




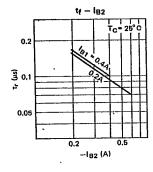


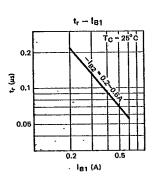


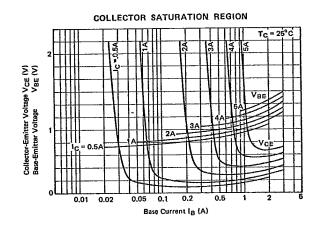




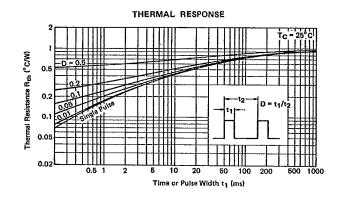




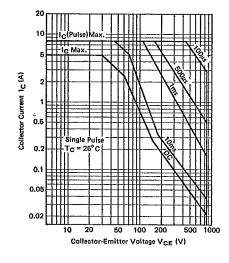




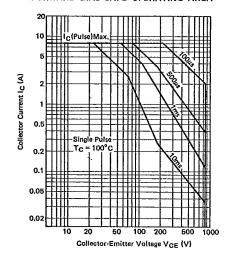






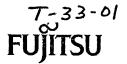


FORWARD BIAS SAFE OPERATING AREA



January 1990 Edition 1.1

PRODUCT PROFILE:



2SC3061

Silicon High Speed Power Transistor

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector to Emitter Voltage	V _{CEO}	850	٧
Collector to Base Voltage	V _{СВО}	1200	٧
Emitter to Base Voltage	V _{EBO}	7	٧
Collector Current-Continuous	l _C	10	Α
Collector Current-Pulsed P _W ≤ 25 μs, D _R ≤ 50%	· I _{CP}	20	A
Base Current-Continuous	1 _B	5	Α
Collector Power Dissipation (T _C = 25°C)	Pc	200	w
Junction Temperature	Tj	+175	°c
Storage Temperature Range	T _{stg}	-65 ~ +175	°c



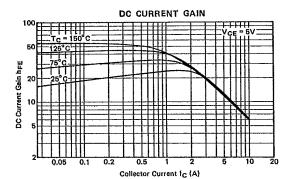
ELECTRICAL CHARACTERISTICS (Ta = 25°C)

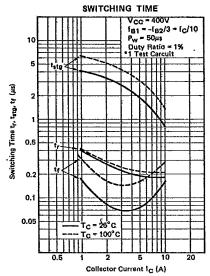
Parameter	Compleal	Test Conditions	Limit			Unit
Parameter	Symbol	Jest Conditions	Min.	Тур.	Max.	Oint
Collector to Base Breakdown Voltage	V _(BR) CBO	i _C = 1mA, i _E = 0	1200	-		٧
Emitter to Base Breakdown Voltage	V _(BR) EBO	I _E = 1mA, I _C = 0	7	_	-	٧
Collector to Emitter Sustaining Voltage	V _(BR) CEO	I _C = 10mA, R _{BE} = ∞Ω	850	1	_	٧
Collector to Emitter Sustaining Voltage	V _{CEX} (sus)	I _C = 7A, I _{B2} = -1.2A, L=1mH(*1)	900	ī	-	٧
Collector Cutoff Current	I _{CBO}	V _{CB} = 1000V, I _E = 0		_	100	μΑ
Collector Cutoff Current	I _{CBO}	V _{CB} = 1000V, I _E = 0, T _C = 100°C		-	1	mΑ
Emitter Cutoff Current	I _{EBO}	$V_{EB} = 6V, I_{C} = 0$	_	-	100	μА
DC Current Gain	h _{FE}	V _{CE} = 5V, I _C = 4A(*2)	10	15	30	_
Collector to Emitter Saturation Voltage	V _{CE} (sat)	Ic = 4A. Is = 0.8A(*2)		0.3	1.5	V
Base to Emitter Saturation Voltage	V _{BE} (sat)	1 IC = 4A, 1B = 0.8A(2)		1.0	2.0	V
Output Capacitance	Сов	V _{CB} = 10V, I _E = 0, f = 1MHz	_	220		PF
Gain Bandwidth Product	f _T	V _{CE} = 10V, I _C = 1A	_	15		MHz
Rise Time	t _r		_	0.2	0.5	μs
Storage Time	t _{stg}	V _{CC} = 400V (*1)	_	2.5	3.5	μs
Fall Time	tf	15	1	0.07	0.3	μs

^{*1} Test Circuit

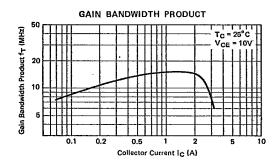
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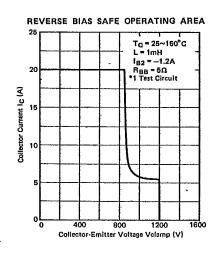
^{*2} Pulsed $P_W \le 300 \,\mu\text{s}$, Duty Ratio $\le 6\%$

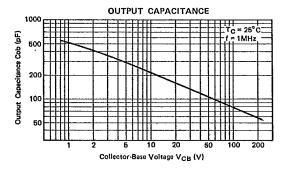


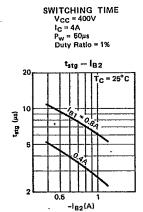


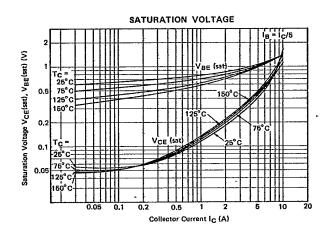
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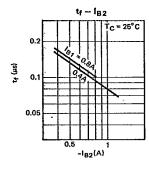


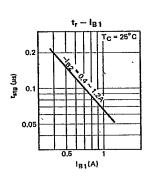


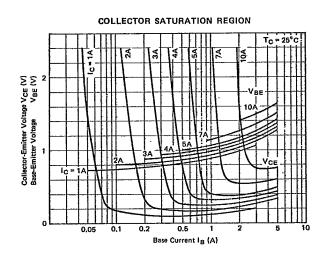












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