T-33-01

January 1990
Edition 1.1

FUJITSU

PRODUCT PROFILE

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

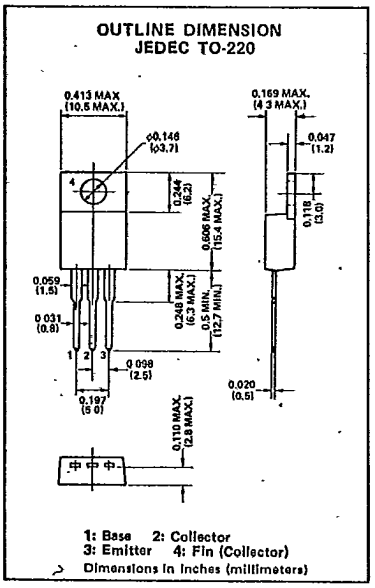
- Switching regulators
- Motor controls
- Ultrasonic oscillators
- Class C and D amplifiers
- Deflection circuits

Outline of the Series

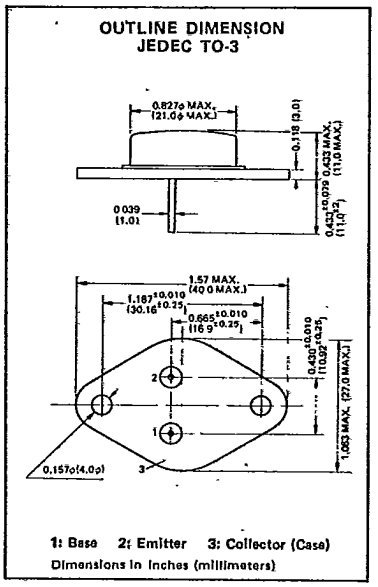
Item	Symbol	2SC3178	2SC3059	2SC3060	2SC3061	Unit
Collector to Base Breakdown Voltage	V_{CBO}	1200				V
Collector to Emitter Breakdown Voltage	V_{CEO}	850				V
Emitter to Base Breakdown Voltage	V_{EBO}	7				V
Collector Current (continuous)	I_C	2		5	10	A
Collector Current (pulsed)	I_{CP}	4		8	20	A
Collector Power Dissipation	P_C	60	100	150	200	W
Reverse Bias Safe Operating Area @ 900V	RBSOA	2.5		5	7	A
Rise Time (Typ.)	t_r	0.20				μs
Storage Time (Typ.)	t_{stg}	2.50				μs
Fall Time (Typ.)	t_f	0.07				μs
Collector to Emitter Saturation Voltage (Typ.)	$V_{CE(sat)}$	0.3				V
Base to Emitter Saturation Voltage (Typ.)	$V_{BE(sat)}$	1.0				V
Package	–	TO-220	TO-3			–

OUTLINE DIMENSION

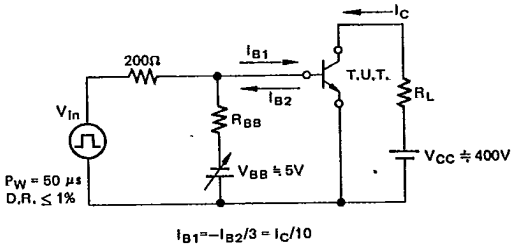
2SC3178

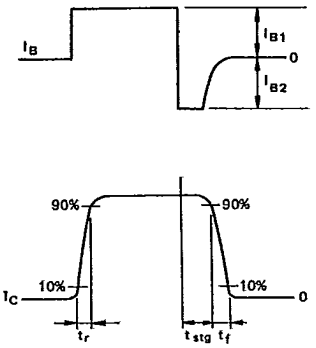


2SC3059
2SC3060
2SC3061

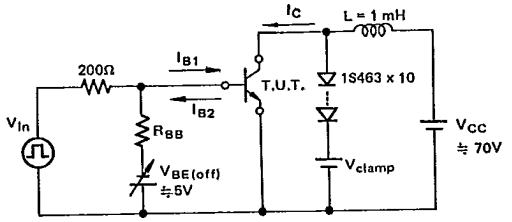


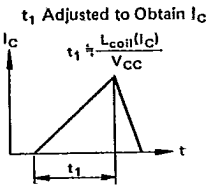
TEST CIRCUIT USED FOR MEASUREMENT OF SWITCHING TIME (RESISTIVE)





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





$V_{CEX(SUS)}$

Type No.	I_C (A)	I_{B2}(A)	R_{BB}(Ω)
2SC3178	2.5	-0.3	20
2SC3059			
2SC3060	5.0	-0.6	10
2SC3061	7.0	-1.2	5

Vclamp = 900V

REVERSE BIAS SAFE OPERATING AREA

Type No.	I_{B2}(A)	R_{BB}(Ω)
2SC3178	-0.3	20
2SC3059		
2SC3060	-0.6	10
2SC3061	-1.2	5

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PRODUCT PROFILE

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2SC3178

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	V
Emitter to Base Voltage	V_{EBO}	7	V
Collector Current-Continuous	I_C	2	A
Collector Current-Pulsed $P_W \leqq 25\ \mu s$, D.R. $\leqq 50\%$	I_{CP}	4	A
Base Current-Continuous	I_B	1	A
Collector Power Dissipation ($T_C = 25°C$)	P_C	60	W
Junction Temperature	T_j	+150	°C
Storage Temperature Range	T_{stg}	−55 ~ +150	°C

ELECTRICAL CHARACTERISTICS ($T_a = 25°C$)

Parameter	Symbol	Test Conditions	Limit			Unit
			Min.	Typ.	Max.	
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	$V_{(BR)CEO}$	$I_C = 10mA$, $R_{BE} = \infty\Omega$	850	–	–	V
Collector to Emitter Sustaining Voltage	$V_{CEX(SUS)}$	I_C=2.5A, I_{B2}=−0.3A, L=1mH(*1)	900	–	–	V
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$	–	–	100	μA
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$, $T_C = 100°C$	–	–	1	mA
Emitter Cutoff Current	I_{EBO}	$V_{EB} = 6V$, $I_C = 0$	–	–	100	μA
DC Current Gain	h_{FE}	$V_{CE} = 5V$, $I_C = 1A$ (*2)	10	15	30	–
Collector to Emitter Saturation Voltage	$V_{CE}(sat)$	$I_C = 1A$, $I_B = 0.2A$ (*2)	–	0.3	1.5	V
Base to Emitter Saturation Voltage	$V_{BE}(sat)$		–	1.0	2.0	V
Output Capacitance	C_{ob}	$V_{CB} = 10V$, $I_E = 0$, $f = 1MHz$	–	60	–	pF
Gain Bandwidth Product	f_T	$V_{CE} = 10V$, $I_C = 0.2A$	–	15	–	MHz
Rise Time	t_r	$V_{CC} = 400V$ (*1) $I_C = 1A$, $I_{B1} = -I_{B2} = 0.3A$	–	0.2	0.5	μs
Storage Time	t_{stg}		–	2.5	3.5	μs
Fall Time	t_f		–	0.07	0.3	μs

*1 Test Circuit *2 Pulse $P_W \leqq 300\ \mu s$, Duty Ratio $\leqq 6\%$

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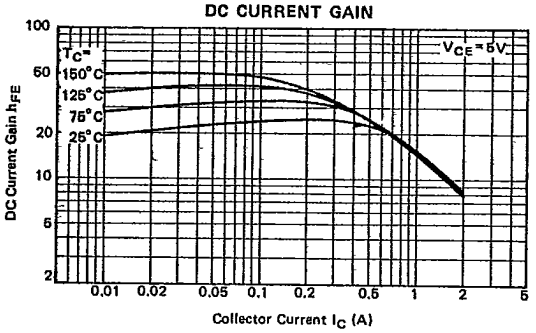
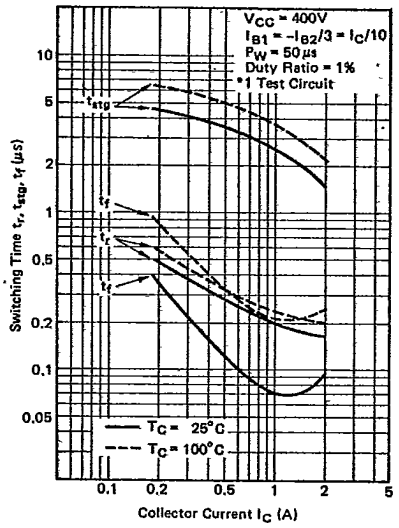
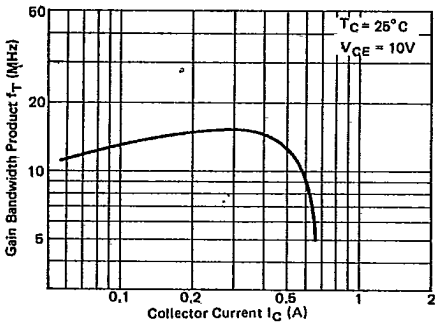
DC CURRENT GAIN



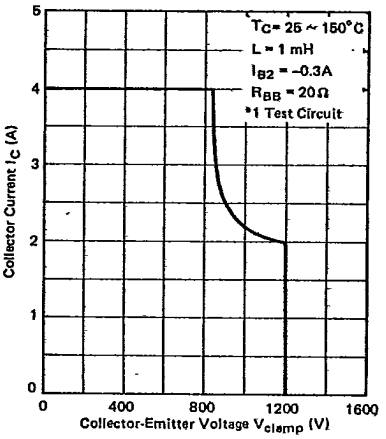
SWITCHING TIME



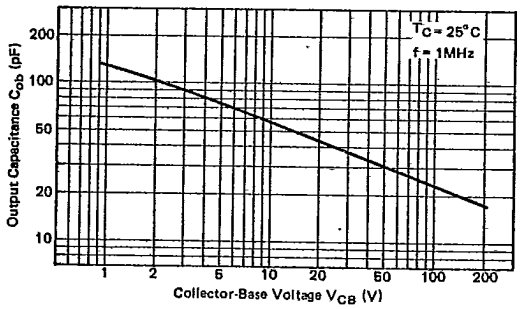
GAIN BANDWIDTH PRODUCT



REVERSE BIAS SAFE OPERATING AREA

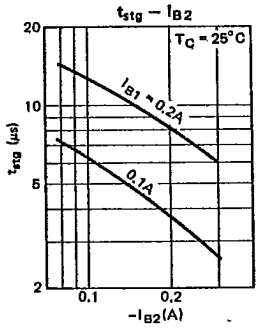


OUTPUT CAPACITANCE

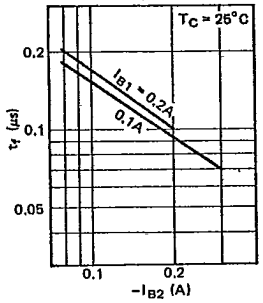


SWITCHING TIME
V_{CC} = 400V
I_C = 1A
P_W = 50 μs
Duty ratio = 1%

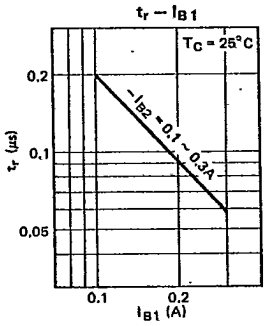
$t_{stg} - I_{B2}$



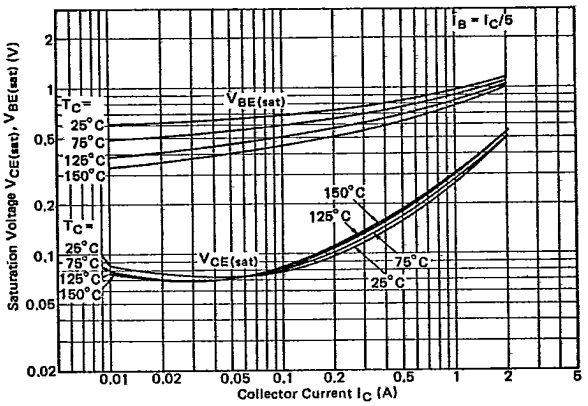
$t_f - I_{B2}$



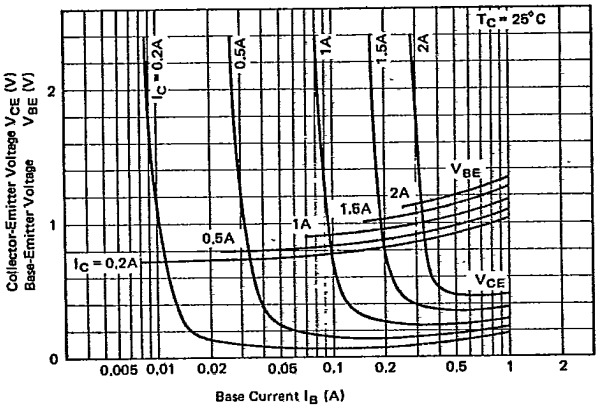
$t_r - I_{B1}$



SATURATION VOLTAGE



COLLECTOR SATURATION REGION



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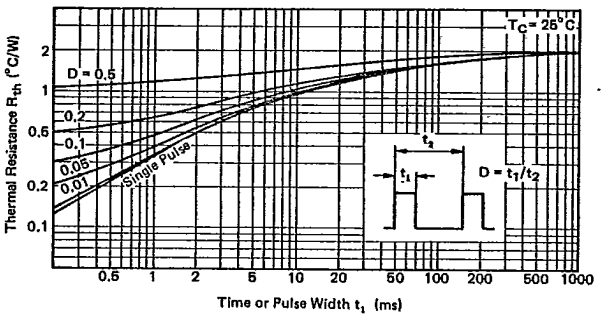
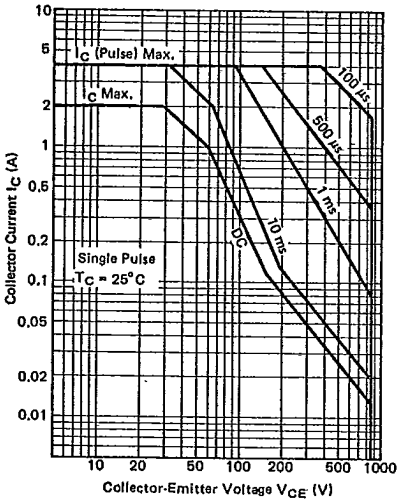
2SC3178

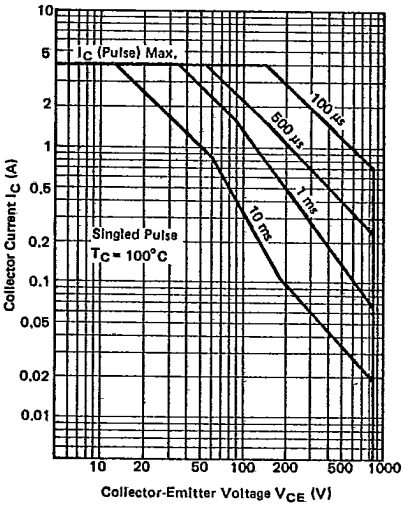
THERMAL RESPONCE



FOWARD BIAS SAFE OPERATING AREA



FOWARD BIAS SAFE OPERATING AREA



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PRODUCT PROFILE

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2SC3059

Silicon High Speed Power Transistor

1

ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector to Emitter Voltage	V_{CEO}	850	V
Collector to Base Voltage	V_{CBO}	1200	V
Emitter to Base Voltage	V_{EBO}	7	V
Collector Current-Continuous	I_C	2	A
Collector Current-Pulsed $P_W \leqq 25\,\mu s$, D.R. $\leqq 50\%$	I_{CP}	4	A
Base Current-Continuous	I_B	1	A
Collector Power Dissipation ($T_C = 25°C$)	P_C	100	W
Junction Temperature	T_j	+175	°C
Storage Temperature Range	T_{stg}	−65 ~ +175	°C

ELECTRICAL CHARACTERISTICS ($T_a = 25°C$)

Parameter	Symbol	Test Conditions	Limit			Unit
			Min.	Typ.	Max.	
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	$V_{(BR)CEO}$	$I_C = 10mA$, $R_{BE} = \infty\Omega$	850	–	–	V
Collector to Emitter Sustaining Voltage	$V_{CEX(SUS)}$	I_C=2.5A, I_{B2}=-0.3A, L=1mH(*1)	900	–	–	V
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$	–	–	100	μA
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$, $T_C = 100°C$	–	–	1	mA
Emitter Cutoff Current	I_{EBO}	$V_{EB} = 6V$, $I_C = 0$	–	–	100	μA
DC Current Gain	h_{FE}	$V_{CE} = 5V$, $I_C = 1A$ (*2)	10	15	30	–
Collector to Emitter Saturation Voltage	$V_{CE}(sat)$	$I_C = 1A$, $I_B = 0.2A$ (*2)	–	0.3	1.5	V
Base to Emitter Saturation Voltage	$V_{BE}(sat)$		–	1.0	2.0	V
Output Capacitance	C_{ob}	$V_{CB} = 10V$, I_E0, f = 1MHz	–	60	–	PF
Gain Bandwidth Product	f_T	$V_{CE} = 10V$, $I_C = 0.2A$	–	15	–	MHz
Rise Time	t_r	$V_{CC} = 400V$ (*1) $I_C = 1A$, $3I_{B1} = -I_{B2} = 0.3A$	–	0.2	0.5	μs
Storage Time	t_{stg}		–	2.5	3.5	μs
Fall Time	t_f		–	0.07	0.3	μs

*1 Test Circuit *2 Pulsed $P_W \leqq 300\,\mu s$, Duty Ratio $\leqq 6\%$

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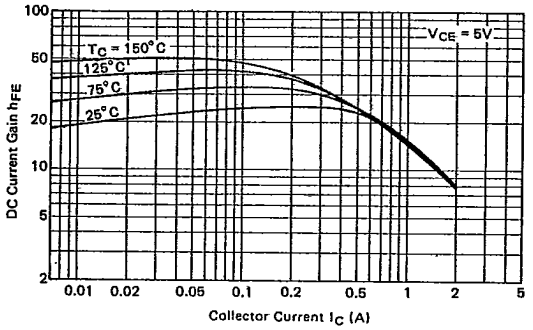
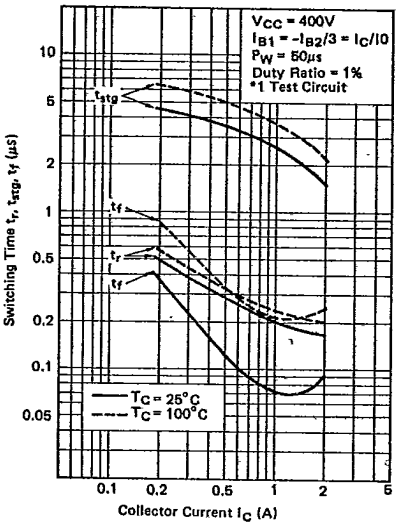
2SC3059

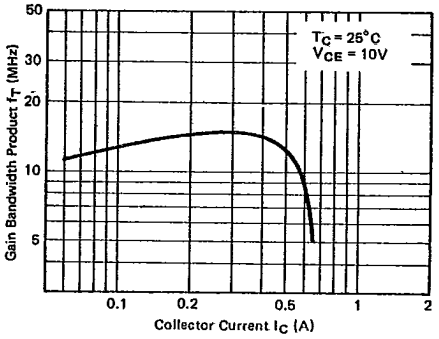
DC CURRENT GAIN



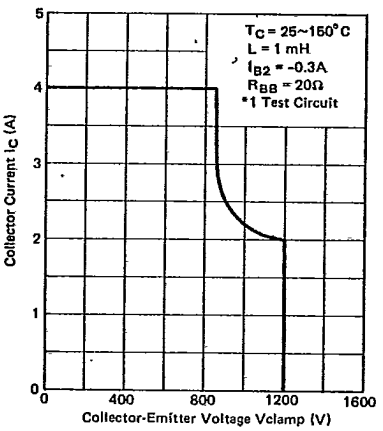
SWITCHING TIME



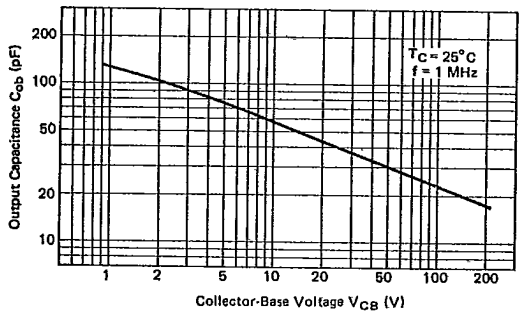
GAIN BANDWIDTH PRODUCT



REVERSE BIAS SAFE OPERATING AREA

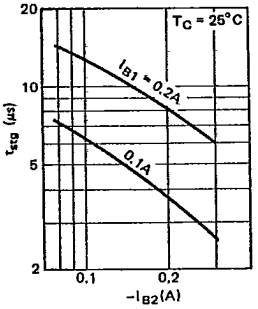


OUTPUT CAPACITANCE

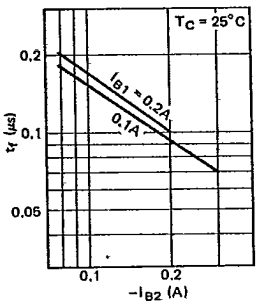


SWITCHING TIME
V_{CC} = 400V
I_C = 1A
Pw = 50μs
Duty Ratio = 1%

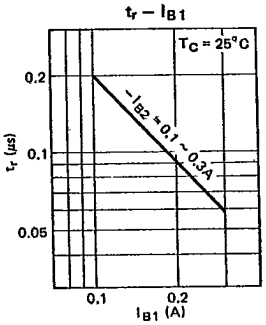
$t_{stg} - I_{B2}$



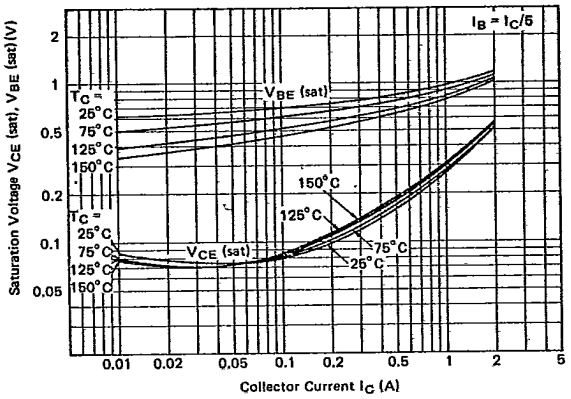
$t_f - I_{B2}$



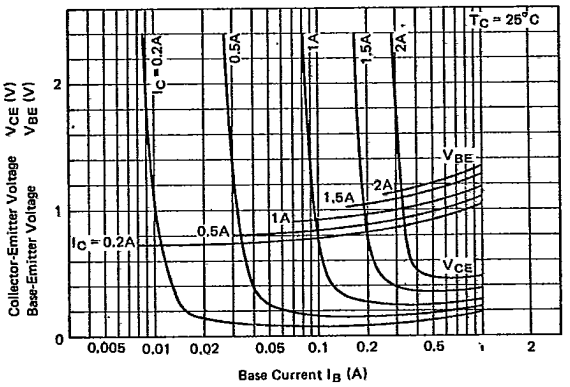
$t_r - I_{B1}$



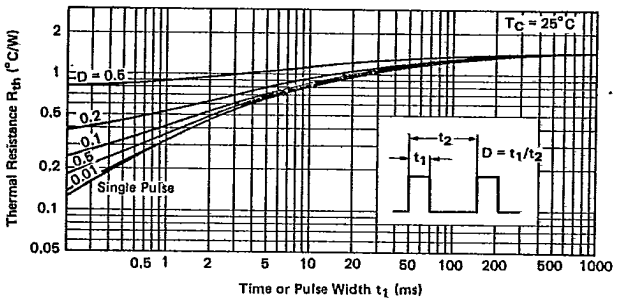
SATURATION VOLTAGE



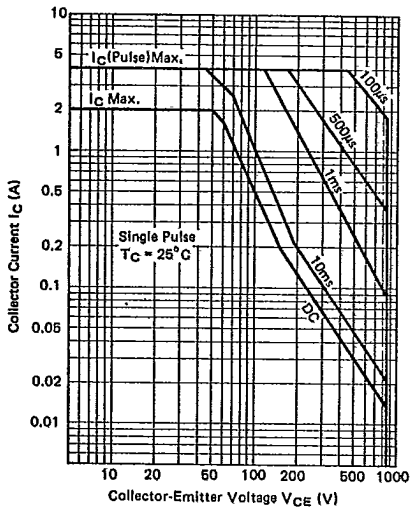
COLLECTOR SATURATION REGION



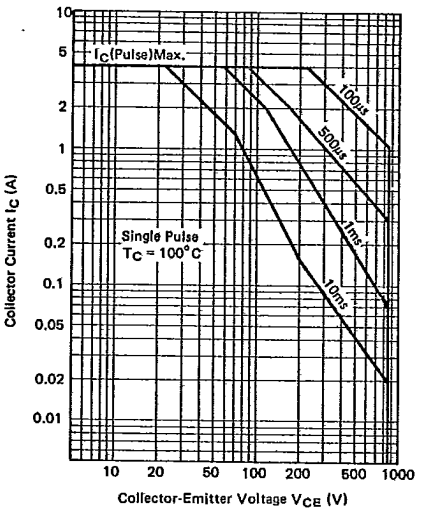
THERMAL RESPONSE



FOWARD BIAS SAFE OPERATING AREA



FOWARD BIAS SAFE OPERATING AREA



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PRODUCT PROFILE

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	V
Emitter to Base Voltage	V_{EBO}	7	V
Collector Current-Continuous	I_C	5	A
Collector Current-Pulsed $P_W \leqq 25\,\mu s$, D.R. $\leqq 50\%$	I_{CP}	8	A
Base Current-Continuous	I_B	3	A
Collector Power Dissipation ($T_C = 25°C$)	P_C	150	W
Junction Temperature	T_j	+175	°C
Storage Temperature Range	T_{stg}	−65 ~ +175	°C

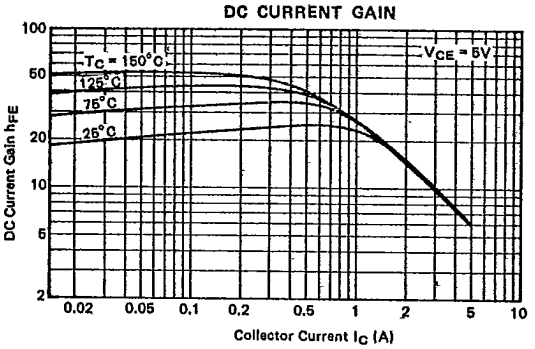
ELECTRICAL CHARACTERISTICS ($T_a = 25°C$)

Parameter	Symbol	Test Conditions	Limit			Unit
			Min.	Typ.	Max.	
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	$V_{(BR)CEO}$	$I_C = 10mA$, $R_{BE} = \infty\Omega$	850	–	–	V
Collector to Emitter Sustaining Voltage	$V_{CEX\ (SUS)}$	$I_C = 5A, I_{B2} = -0.6A, L = 1mH$(*1)	900	–	–	V
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$	–	–	100	μA
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$, $T_C = 100°C$	–	–	1	mA
Emitter Cutoff Current	I_{EBO}	$V_{EB} = 6V$, $I_C = 0$	–	–	100	μA
DC Current Gain	h_{FE}	$V_{CE} = 5V$, $I_C = 2A$ (*2)	10	15	30	–
Collector to Emitter Saturation Voltage	$V_{CE\ (sat)}$	$I_C = 2A$, $I_B = 0.4A$ (*2)	–	0.3	1.5	V
Base to Emitter Saturation Voltage	$V_{BE\ (sat)}$		–	1.0	2.0	V
Output Capacitance	C_{ob}	$V_{CB} = 10V$, $I_E = 0$, $f = 1MHz$	–	120	–	PF
Gain Bandwidth Product	f_T	$V_{CE} = 10V$, $I_C = 0.5A$	–	15	–	MHz
Rise Time	t_r	$V_{CC} = 400V$ (*1) $I_C = 2A$, $3I_{B1} = -I_{B2} = 0.6A$	–	0.2	0.5	μs
Storage Time	t_{stg}		–	2.5	3.5	μs
Fall Time	t_f		–	0.07	0.3	μs

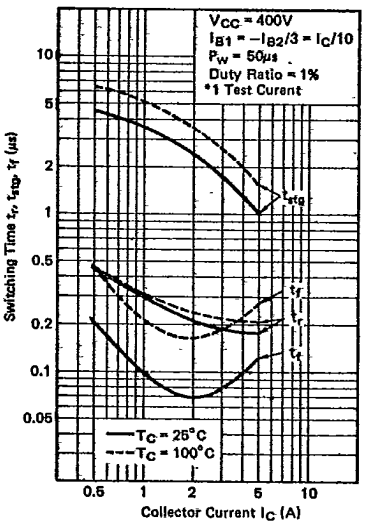
*1 Test Circuit *2 Pulsed $P_W \leqq 300\,\mu s$, Duty Ratio ≦ 6%

2SC3060

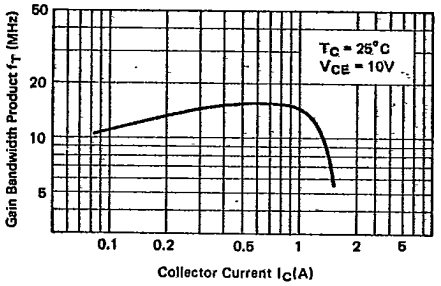
DC CURRENT GAIN



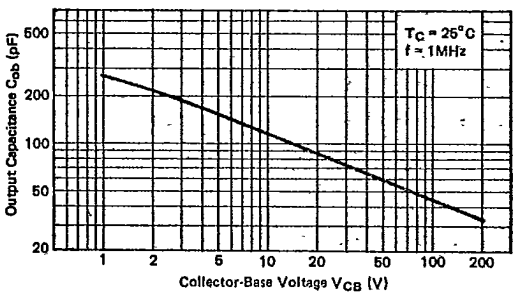
SWITCHING TIME



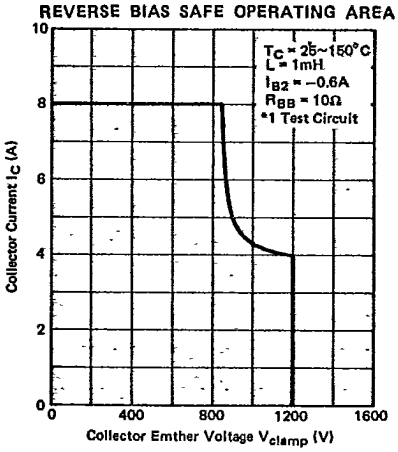
GAIN BANDWIDTH PRODUCT



OUTPUT CAPACITANCE



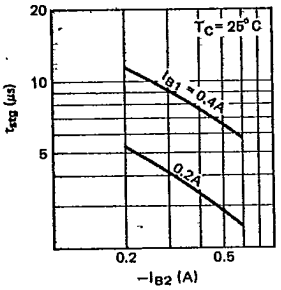
REVERSE BIAS SAFE OPERATING AREA



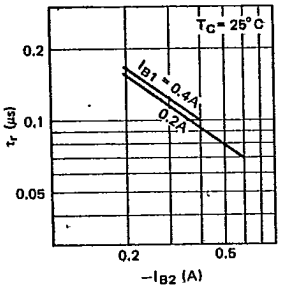
SWITCHING TIME

V_{CC} = 400V
I_C = 2A
P_W = 60μs
Duty Ratio = 1%

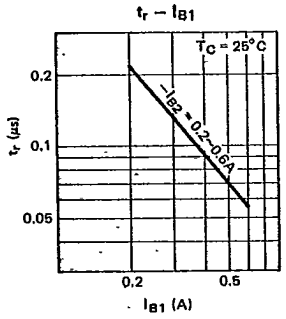
$t_{stg} - I_{B2}$



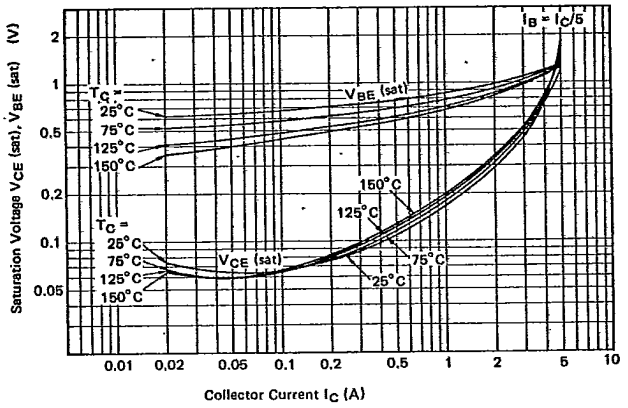
$t_f - I_{B2}$



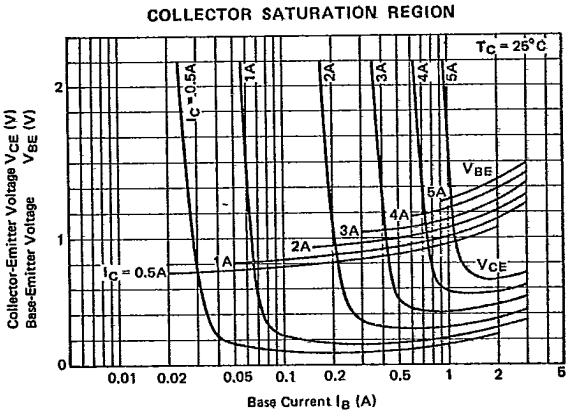
$t_r - I_{B1}$



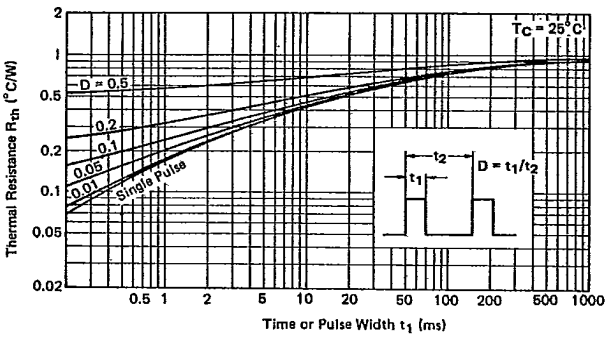
SATURATION VOLTAGE



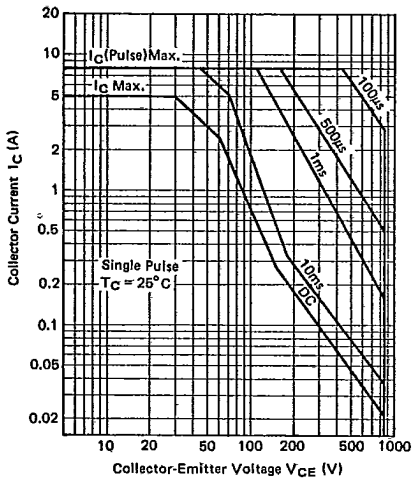
COLLECTOR SATURATION REGION



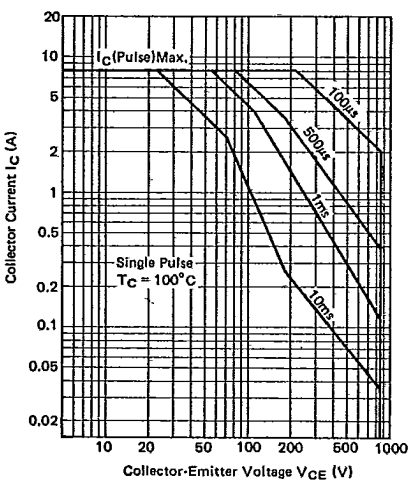
THERMAL RESPONSE



FORWARD BIAS SAFE OPERATING AREA



FORWARD BIAS SAFE OPERATING AREA



T-33-01

January 1990
Edition 1.1

FUJITSU

PRODUCT PROFILE

2SC3061

Silicon High Speed Power Transistor

ABSOLUTE MAXIMUM RATINGS

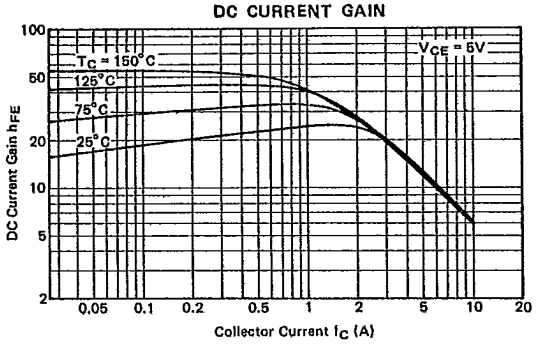
Rating	Symbol	Value	Unit
Collector to Emitter Voltage	V_{CEO}	850	V
Collector to Base Voltage	V_{CBO}	1200	V
Emitter to Base Voltage	V_{EBO}	7	V
Collector Current-Continuous	I_C	10	A
Collector Current-Pulsed $P_W \leqq 25\,\mu s$, $D.R \leqq 50\%$	I_{CP}	20	A
Base Current-Continuous	I_B	5	A
Collector Power Dissipation ($T_C = 25°C$)	P_C	200	W
Junction Temperature	T_j	+175	°C
Storage Temperature Range	T_{stg}	−65 ~ +175	°C

ELECTRICAL CHARACTERISTICS ($T_a = 25°C$)

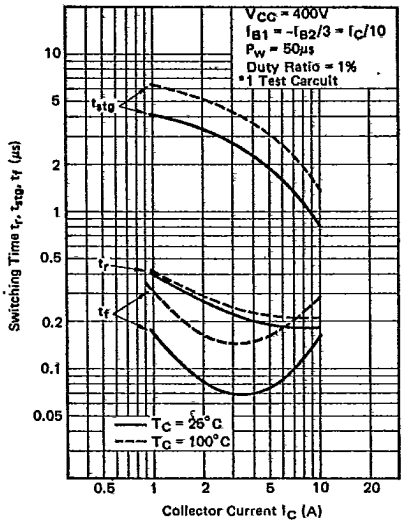
Parameter	Symbol	Test Conditions	Limit			Unit
			Min.	Typ.	Max.	
Collector to Base Breakdown Voltage	$V_{(BR)CBO}$	$I_C = 1mA$, $I_E = 0$	1200	–	–	V
Emitter to Base Breakdown Voltage	$V_{(BR)EBO}$	$I_E = 1mA$, $I_C = 0$	7	–	–	V
Collector to Emitter Sustaining Voltage	$V_{(BR)CEO}$	$I_C = 10mA$, $R_{BE} = \infty\Omega$	850	–	–	V
Collector to Emitter Sustaining Voltage	V_{CEX} (sus)	$I_C = 7A$, $I_{B2} = -1.2A$, L=1mH(*1)	900	–	–	V
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$	–	–	100	μA
Collector Cutoff Current	I_{CBO}	$V_{CB} = 1000V$, $I_E = 0$, $T_C = 100°C$	–	–	1	mA
Emitter Cutoff Current	I_{EBO}	$V_{EB} = 6V$, $I_C = 0$	–	–	100	μA
DC Current Gain	h_{FE}	$V_{CE} = 5V$, $I_C = 4A$(*2)	10	15	30	–
Collector to Emitter Saturation Voltage	V_{CE} (sat)	$I_C = 4A$, $I_B = 0.8A$(*2)	–	0.3	1.5	V
Base to Emitter Saturation Voltage	V_{BE} (sat)		–	1.0	2.0	V
Output Capacitance	C_{ob}	$V_{CB} = 10V$, $I_E = 0$, f = 1MHz	–	220	–	PF
Gain Bandwidth Product	f_T	$V_{CE} = 10V$, $I_C = 1A$	–	15	–	MHz
Rise Time	t_r	$V_{CC} = 400V$(*1) $I_C = 4A$, $3I_{B1} = -I_{B2} = 1.2A$	–	0.2	0.5	μs
Storage Time	t_{stg}		–	2.5	3.5	μs
Fall Time	t_f		–	0.07	0.3	μs

*1 Test Circuit *2 Pulsed $P_W \leqq 300\,\mu s$, Duty Ratio ≦ 6%

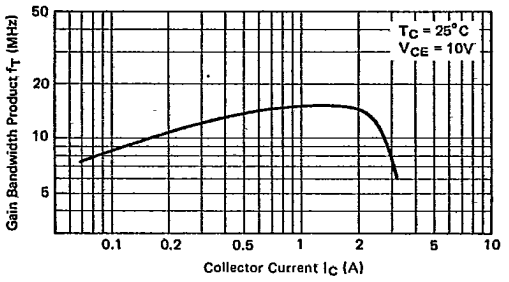
DC CURRENT GAIN



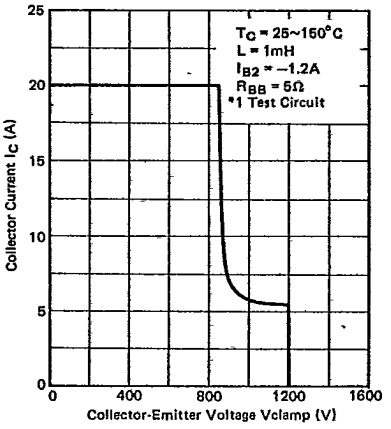
SWITCHING TIME



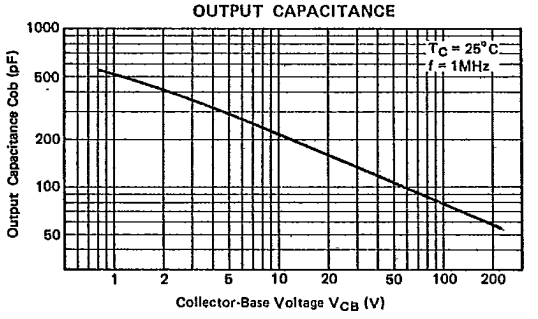
GAIN BANDWIDTH PRODUCT



REVERSE BIAS SAFE OPERATING AREA

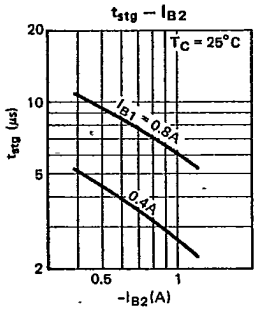


OUTPUT CAPACITANCE

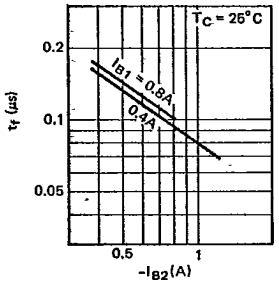


SWITCHING TIME
V_{CC} = 400V
I_C = 4A
P_W = 50μs
Duty Ratio = 1%

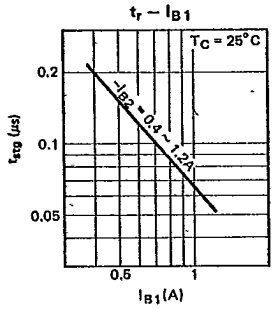
$t_{stg} - I_{B2}$



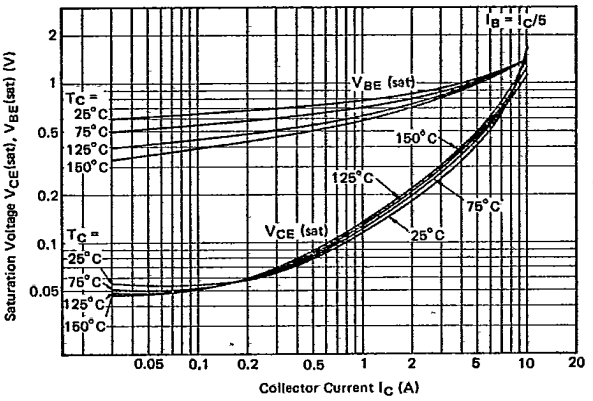
$t_f - I_{B2}$



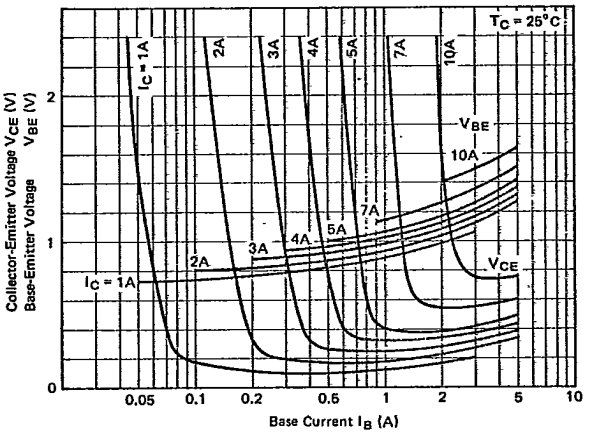
$t_r - I_{B1}$



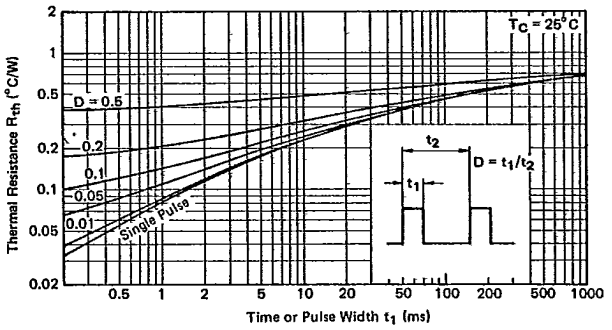
SATURATION VOLTAGE



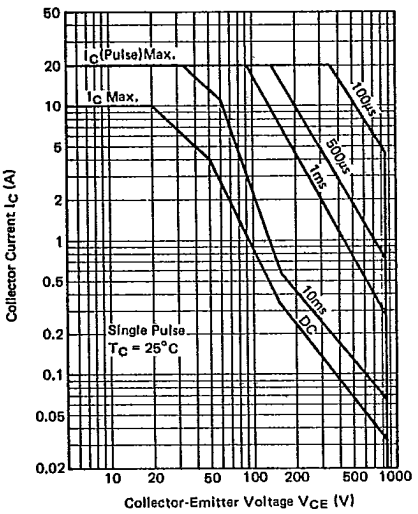
COLLECTOR SATURATION REGION



THERMAL RESPONSE



FORWARD BIAS SAFE OPERATING AREA



FOWARD BIAS SAFE OPERATING AREA