2N3510
2N3511

CASE 27, STYLE 1
TO-52 (TO-206AC)

2N3647
2N3648

CASE 26, STYLE 1
TO-46 (TO-206AB)

SWITCHING TRANSISTOR

NPN SILICON

4

MAXIMUM RATINGS

Rating	Symbol	2N3510 2N3647	2N3511 2N3648	Unit
Collector-Emitter Voltage	V_{CEO}	10	15	Vdc
Collector-Base Voltage	V_{CBO}	40	40	Vdc
Emitter-Base Voltage	V_{EBO}	6.0		Vdc
Collector Current — Continuous	I_C	500		mAdc
		TO-46 2N3647 2N3648	TO-52 2N3510 2N3511	
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.28	360 2.06	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.0 11.43	1.2 6.9	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

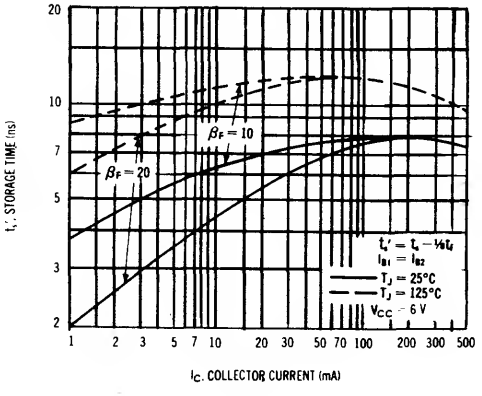
Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 10 mAdc, I_B = 0)	2N3510, 2N3647 2N3511, 2N3648	$V_{(BR)CEO}$	 10 15	 — —	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	—	Vdc
Collector Cutoff Current (V_{CE} = 10 Vdc, $V_{EB(off)}$ = 1.0 Vdc) (V_{CE} = 10 Vdc, $V_{EB(off)}$ = 1.0 Vdc, T_A = 150°C)		I_{CEX}	 — —	 .025 50	μAdc
Base Cutoff Current (V_{CE} = 10 Vdc, V_{OB} = 1.0 Vdc)		I_{BL}	—	.025	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (I_C = 150 mAdc, V_{CE} = 1.0 Vdc, TA = −55°C) (I_C = 300 mAdc, V_{CE} = 1.0 Vdc) (I_C = 500 mAdc, V_{CE} = 1.0 Vdc)	 2N3510, 2N3647 2N3511, 2N3648 2N3510, 2N3647 2N3511, 2N3648 2N3510, 2N3647 2N3511, 2N3648 2N3511, 2N3648 2N3510, 2N3647 2N3511, 2N3648	h_{FE}	 12 15 20 25 25 30 12 15 12	 — — — — 150 120 — — —	—
Collector-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 300 mAdc, I_B = 30 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	 2N3510, 2N3647 2N3511, 2N3648	$V_{CE(sat)}$	 — — — —	 0.25 0.4 0.6 0.8	Vdc
Base-Emitter Saturation Voltage(1) (I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 300 mAdc, I_B = 30 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	 2N3510, 2N3647 2N3511, 2N3648	$V_{BE(sat)}$	 — 0.8 — —	 0.8 1.0 1.15 1.5	Vdc

ELECTRICAL CHARACTERISTICS (continued) (T_A = 25°C unless otherwise noted.)

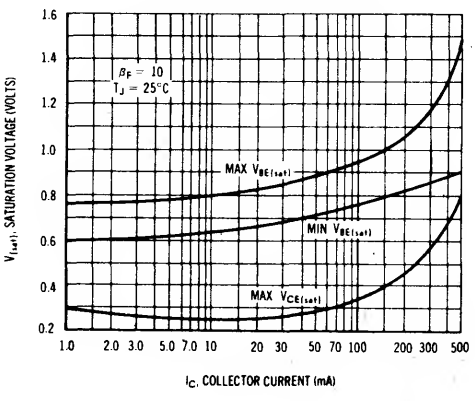
Characteristic		Symbol	Min	Max	Unit
SMALL-SIGNAL CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)		C_{obo}	—	4.0	pF
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kHz)		C_{ibo}	—	8.0	pF
Input Impedance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)		h_{ie}	0.6	4.5	kohms
Voltage Feedback Ratio (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)		h_{re}	—	25	X 10^{-4}
Small-Signal Current Gain (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	2N3510, 2N3647	h_{fe}	3.5	—	—
	2N3511, 2N3648		4.5	—	
(I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)			20	150	
Output Admittance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1.0 kHz)		h_{oe}	10	100	μmhos
SWITCHING CHARACTERISTICS					
Delay Time	(I_C = 150 mA, I_{B1} = 15 mA, V_{EB} = 0.5 V, V_{CC} = 6.0 V) 2N3510, 2N3647	t_d	—	10	ns
	2N3511, 2N3648		—	8.0	
Rise Time	2N3510, 2N3647	t_r	—	12	ns
	2N3511, 2N3648		—	10	
Storage Time	(I_C = 150 mA, I_{B1} = $-I_{B2}$ = 15 mA, V_{CC} = 6.0 V) 2N3510, 2N3647	t_s	—	16	ns
	2N3511, 2N3648		—	12	
Fall Time	2N3510, 2N3647	t_f	—	12	ns
	2N3511, 2N3648		—	8.0	
Turn-On Time	(I_C = 150 mA, I_{B1} = 15 mA, V_{EB} = 0.5 V, V_{CC} = 6.0 V) 2N3510, 2N3647	t_{on}	—	20	ns
	2N3511, 2N3648		—	16	
Turn-Off Time	(I_C = 150 mA, I_{B1} = $-I_{B2}$ = 15 mA, V_{CC} = 6.0 V) 2N3510, 2N3647	t_{off}	—	25	ns
	2N3511, 2N3648		—	18	
Total Control Charge (I_C = 150 mA, I_B = 15 mA, V_{CC} = 6.0 V)		Q_T	—	300	pC

(1) Pulse Test: PW ≤ 300 μs, Duty Cycle ≤ 2.0%.

STORAGE TIME VARIATION



LIMITS OF SATURATION VOLTAGE



MINIMUM CURRENT GAIN CHARACTERISTICS