New Jersey Semi-Conductor Products, Inc.

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BUS98
BUS98A

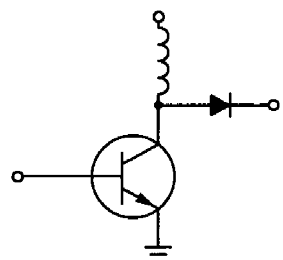
Designer's™ Data Sheet

SWITCHMODE Series
NPN Silicon Power Transistors

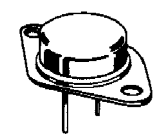
30 AMPERES
NPN SILICON
POWER TRANSISTORS
400 AND 450 VOLTS
(BVCEO)
250 WATTS
850–1000 V (BVCES)

The BUS98 and BUS98A transistors are designed for high–voltage, high–speed, power switching in inductive circuits where fall time is critical. They are particularly suited for line–operated switchmode applications such as:

- Switching Regulators
- Inverters
- Solenoid and Relay Drivers
- Motor Controls
- Deflection Circuits



Fast Turn–Off Times
  60 ns Inductive Fall Time –25°C (Typ)
  120 ns Inductive Crossover Time –25°C (Typ)
Operating Temperature Range –65 to +200°C
100°C Performance Specified for:
  Reverse–Biased SOA with Inductive Loads
  Switching Times with Inductive Loads
  Saturation Voltages
  Leakage Currents (125°C)



TO–204AA

MAXIMUM RATINGS

Rating	Symbol	BUS98	BUS98A	Unit
Collector–Emitter Voltage	$V_{CEO(sus)}$	400	450	Vdc
Collector–Emitter Voltage	V_{CEV}	850	1000	Vdc
Emitter Base Voltage	V_{EB}	7		Vdc
Collector Current — Continuous — Peak (1) — Overload	I_C I_{CM} I_{ol}	30 60 120		Adc
Base Current — Continuous — Peak (1)	I_B I_{BM}	10 30		Adc
Total Power Dissipation — T_C = 25°C — T_C = 100°C Derate above 25°C	P_D	250 142 1.42		Watts W/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W
Maximum Lead Temperature for Soldering Purposes: 1/8″ from Case for 5 Seconds	T_L	275	°C

(1) Pulse Test: Pulse Width = 5 ms, Duty Cycle ≦ 10%.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (1)					
Collector–Emitter Sustaining Voltage (Table 1) (I_C = 200 mA, I_B = 0) L = 25 mH — BUS98 BUS98A	$V_{CEO(sus)}$	 400 450	 — —	 — —	Vdc
Collector Cutoff Current (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc) (V_{CEV} = Rated Value, $V_{BE(off)}$ = 1.5 Vdc, T_C = 125°C)	I_{CEV}	 — —	 — —	 0.4 4.0	mAdc
Collector Cutoff Current (V_{CE} = Rated V_{CEV}, R_{BE} = 10 Ω) — T_C = 25 °C T_C = 125 °C	I_{CER}	 — —	 — —	 1.0 6.0	mAdc
Emitter Cutoff Current (V_{EB} = 7 Vdc, I_C = 0)	I_{EBO}	—	—	0.2	mAdc
Emitter–Base Breakdown Voltage (I_E = 100 mA – I_C = 0)	V_{EBO}	7.0	—	—	Vdc
SECOND BREAKDOWN					
Second Breakdown Collector Current with Base Forward Biased	$I_{S/b}$		See Figure 12		
Clamped Inductive SOA with Base Reverse Biased	RBSOA		See Figure 13		
ON CHARACTERISTICS (1)					
DC Current Gain (I_C = 20 Adc, V_{CE} = 5 Vdc) — BUS98 (I_C = 16 Adc, V_{CE} = 5 V) — BUS98A	h_{FE}	8	—	—	—
Collector–Emitter Saturation Voltage (I_C = 20 Adc, I_B = 4 Adc) — BUS98 (I_C = 30 Adc, I_B = 8 Adc) (I_C = 20 Adc, I_B = 4 Adc, T_C = 100°C) (I_C = 16 Adc, I_B = 3.2 Adc) — BUS98A (I_C = 24 Adc, I_B = 5 Adc) (I_C = 16 Adc, I_B = 3.2 Adc, T_C = 100°C)	$V_{CE(sat)}$	 — — — — — —	 — — — — — —	 1.5 3.5 2.0 1.5 5.0 2.0	Vdc
Base–Emitter Saturation Voltage (I_C = 20 Adc, I_B = 4 Adc) — BUS98 (I_C = 20 Adc, I_B = 4 Adc, T_C = 100°C) (I_C = 16 Adc, I_B = 3.2 Adc) — BUS98A (I_C = 16 Adc, I_B = 3.2 Adc, T_C = 100°C)	$V_{BE(sat)}$	 — — — —	 — — — —	 1.6 1.6 1.6 1.6	Vdc
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f_{test} = 100 kHz)	C_{ob}	—	—	700	pF
SWITCHING CHARACTERISTICS					
Restive Load (Table 1) (V_{CC} = 250 Vdc, I_C = 20 A, I_{B1} = 4.0 A, t_p = 30 µs, Duty Cycle ≤ 2%, $V_{BE(off)}$ = 5 V) (for BUS98A: I_C = 16 A, I_{b1} = 3.2 A)					
Delay Time	t_d	—	0.1	0.2	µs
Rise Time	t_r	—	0.4	0.7	µs
Storage Time	t_s	—	1.55	2.3	µs
Fall Time	t_f	—	0.2	0.4	µs
Inductive Load, Clamped (Table 1) ($I_{C(pk)}$ = 20 A, I_{b1} = 4 A (BUS98); $V_{BE(off)}$ = 5 V, $V_{CE(c1)}$ = 250 V) $I_{C(pk)}$ = 16 A, I_{B1} = 3.2 A) (BUS98A)					
Storage Time (T_C = 25°C)	t_{sv}	—	1.55	—	µs
Fall Time (T_C = 25°C)	t_{fi}	—	0.06	—	µs
Storage Time (T_C = 100°C)	t_{sv}	—	1.8	2.8	µs
Crossover Time (T_C = 100°C)	t_c	—	0.3	0.6	µs
Fall Time (T_C = 100°C)	t_{fi}	—	0.17	0.35	µs

(1) Pulse Test: PW = 300 µs, Duty Cycle ≤ 2%.

DC CHARACTERISTICS

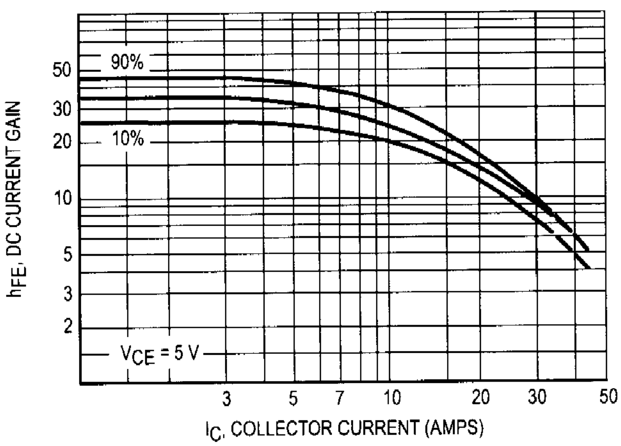


Figure 1. DC Current Gain

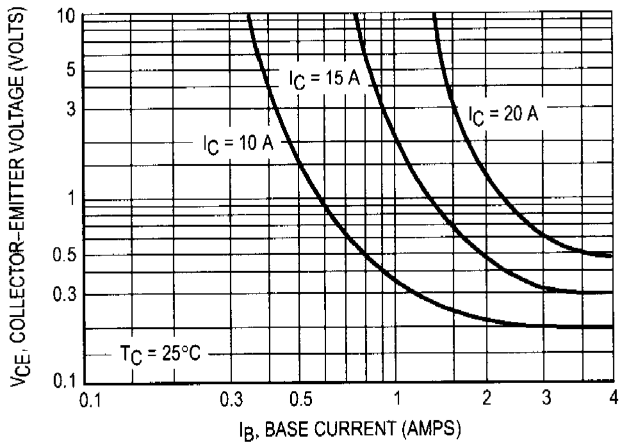


Figure 2. Collector Saturation Region

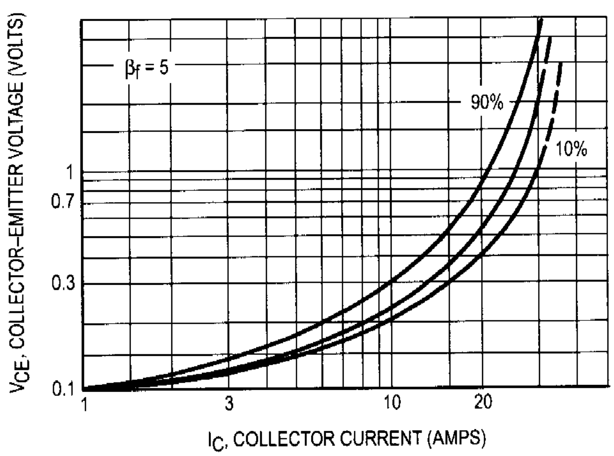


Figure 3. Collector–Emitter Saturation Voltage

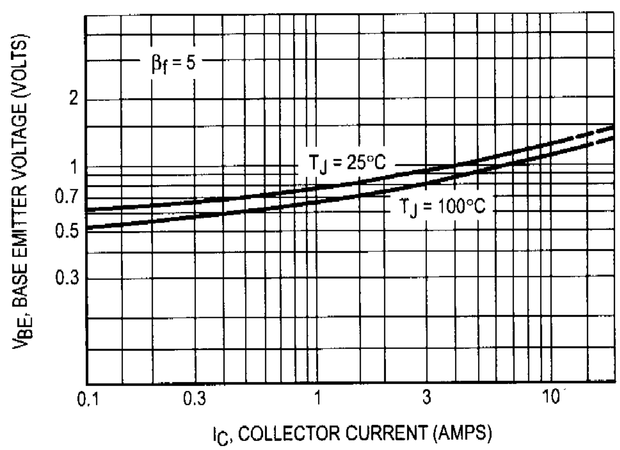


Figure 4. Base–Emitter Voltage

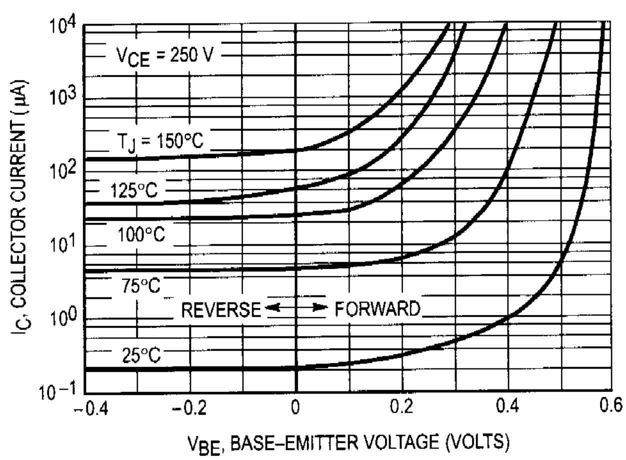


Figure 5. Collector Cutoff Region

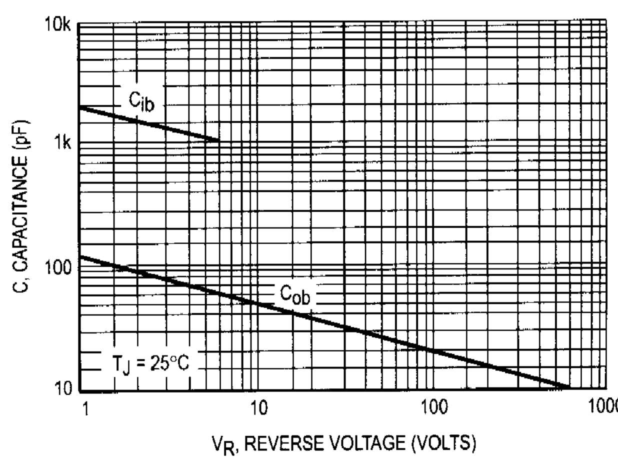
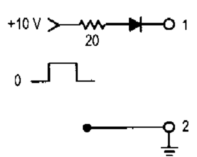
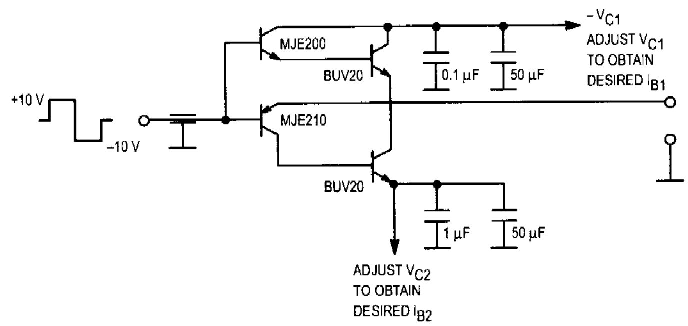
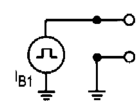
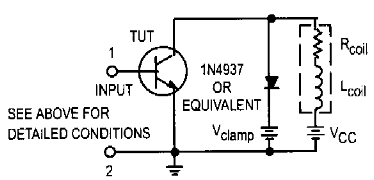


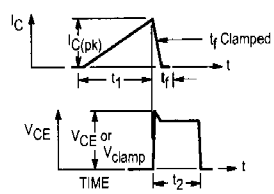
Figure 6. Capacitance

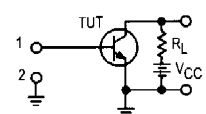
Table 1. Test Conditions for Dynamic Performance

<table>
<tr><th></th><th>$V_{CEO(sus)}$</th><th>RBSOA AND INDUCTIVE SWITCHING</th><th>RESISTIVE SWITCHING</th></tr>
<tr><td>INPUT CONDITIONS</td><td>

PW Varied to Attain I_C = 100 mA</td><td>
</td><td>TURN–ON TIME


I_{B1} adjusted to obtain the forced h_{FE} desired
TURN–OFF TIME
Use inductive switching driver as the input to the resistive test circuit.</td></tr>
<tr><td>CIRCUIT VALUES</td><td>L_{coil} = 25 mH, V_{CC} = 10 V
R_{coil} = 0.7 Ω</td><td>L_{coil} = 180 µH
R_{coil} = 0.05 Ω
V_{CC} = 20 V
V_{clamp} = 250 V</td><td>V_{CC} = 250 V
Pulse Width = 10 µs</td></tr>
<tr><td>TEST CIRCUITS</td><td colspan="2">INDUCTIVE TEST CIRCUIT


OUTPUT WAVEFORMS


t_1 Adjusted to Obtain I_C
$t_1 \approx \frac{L_{coil}\,(I_{C(pk)})}{V_{CC}}$
$t_2 \approx \frac{L_{coil}\,(I_{C(pk)})}{V_{clamp}}$
Test Equipment
Scope — Tektronix 475 or Equivalent</td><td>RESISTIVE TEST CIRCUIT

</td></tr>
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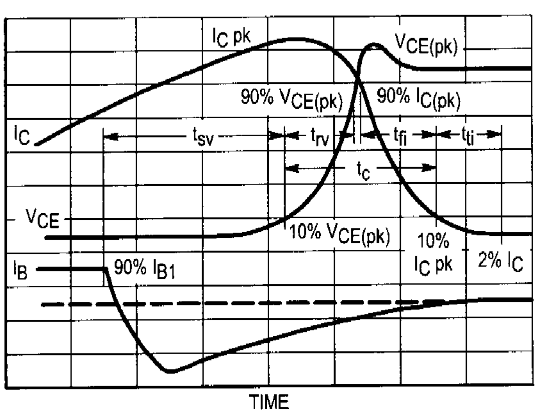

Figure 7. Inductive Switching Measurements

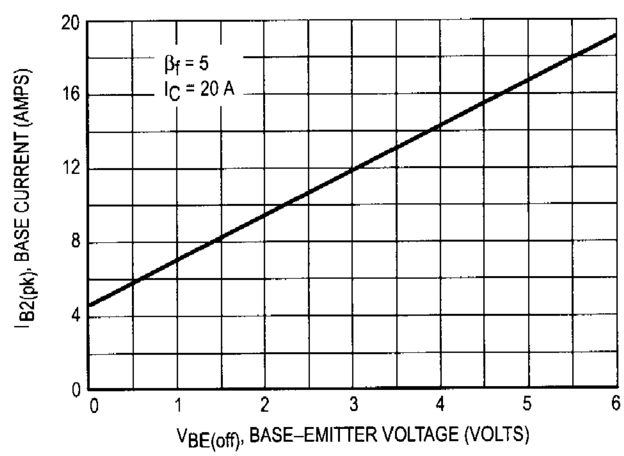

Figure 8. Peak–Reverse Current