2N6686, 2N6687, 2N6688

File Number **1171**

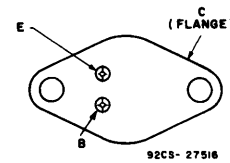
25-A SwitchMax Power Transistors

N-P-N Types for
Power Supplies and Other High-Voltage
Switching Applications

Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *Low V_{CE} (sat)*
- *Steel hermetic TO-204AA Package*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

The RCA-2N6686, 2N6687, and 2N6688• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits. These high-current, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C as well as at 25°C, to provide information necessary for worst-case design.

The 2N6686, 2N6687, and 2N6688 transistors are supplied in steel JEDEC TO-204AA hermetic packages.

•Formerly RCA Dev. Type Nos. TA9119A, TA9119B, TA9119C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6686	2N6687	2N6688	
* V_{CEV}				
V_{BE} = −1.5 V	260	280	300	V
* V_{CEX}(Clamped)				
V_{BE} = −1.5 V	210	230	250	V
* V_{CEO}	160	180	200	V
* V_{EBO}		8		V
I_{C}(sat)	25	25	20	A
* I_C	25	25	20	A
I_{CM}		50		A
* I_B		8		A
* P_T				
T_C up to 25 °C		200		W
T_C above 25 °C, derate linearly		1.14		W/°C
* T_{stg}, T_J		−65 to 200		°C
* T_L				
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.		235		°C

* In accordance with JEDEC registration data.

2N6686, 2N6687, 2N6688

ELECTRICAL CHARACTERISTICS T_C = 25°C

	CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N6686		2N6687		2N6688		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{CEV}	260	-1.5	—	—	—	50	—	—	—	—	
		280	-1.5	—	—	—	—	—	50	—	—	
		300	-1.5	—	—	—	—	—	—	—	50	μA
*	I_{EBO}	—	-8	0	—	—	100	—	100	—	100	
*	$V_{CEO(sus)}$[b]	—	—	0.2[a]	0	160	—	180	—	200	—	V
*	h_{FE}	2	—	1[a]	—	30	—	30	—	25	—	
		2	—	10[a]	—	25	100	25	100	20	80	
		2	—	20[a]	—	—	—	—	—	15	—	—
		2	—	25[a]	—	15	—	15	—	—	—	
*	V_{BE}(sat)	—	—	20[a]	2	—	—	—	—	—	1.8	
		—	—	25[a]	2.5	—	1.8	—	1.8	—	—	
*	V_{CE}(sat)	—	—	20[a]	2	—	—	—	—	—	1.5	
		—	—	25[a]	2.5	—	1.5	—	1.5	—	—	V
*	V_{CEX}[b] (Clamped $E_{S/b}$) L = 25 μH, R_{BB} = 10 Ω	—	-4	25	3	210	—	230	—	250	—	
	$I_{S/b}$	18	—	11.1	—	1	—	1	—	1	—	s
*	$\|h_{fe}\|$ f = 5 MHz	10	—	1	—	4	20	4	20	4	20	—
	f_T	10	—	1	—	20	100	20	100	20	100	MHz
*	C_{obo} f = 0.1 MHz	10[c]	—	—	—	300	650	300	650	300	650	pF
*	t_d[d]	—	-4	20	2	—	—	—	—	—	0.1	
		—	-4	25	2.5	—	0.1	—	0.1	—	—	
*	t_r[d]	—	-4	20	2	—	—	—	—	—	0.60	
		—	-4	25	2.5	—	0.60	—	0.60	—	—	
*	t_s[d]	—	-4	20	2[e]	—	—	—	—	—	1.50	
		—	-4	25	2.5[e]	—	1.50	—	1.50	—	—	
*	t_f[d]	—	-4	20	2[e]	—	—	—	—	—	0.25	
		—	-4	25	2.5[e]	—	0.25	—	0.25	—	—	μs
*	t_c V_{CC} = 80 V, L = 25 μH, $R_C \leq 4$ Ω, Collector clamped to V_{CEX}	—	-4	20	3[e]	—	—	—	—	—	0.5	
		—	-4	25	3[e]	—	0.5	—	0.5	—	—	

2N6686, 2N6687, 2N6688

ELECTRICAL CHARACTERISTICS (cont'd)

	CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N6686		2N6687		2N6688		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
	T_C = 125°C											
*	I_{CEV}	260	−1.5			−	0.5	−	−	−	−	mA
		280	−1.5			−	−	−	0.5	−	−	
		300	−1.5			−	−	−	−	−	0.5	
*	V_{CE}(sat)			20[a]	2	−	−	−	−	−	1.5	V
				25[a]	2.5	−	1.5	−	1.5	−	−	
*	t_rd		−4	20	2	−	−	−	−	−	0.8	μs
				25	2.5	−	0.8	−	0.8	−	−	
*	t_sd		−4	20	2	−	−	−	−	−	2.5	
				25	2.5[e]	−	2.5	−	2.5	−	−	
*	t_fd		−4	20	2	−	−	−	−	−	0.8	
				25	2.5[e]	−	0.8	−	0.8	−	−	
*	t_c V_{CC}=80 V, L=25 μH, $R_C \leqslant 4\ \Omega$, Collector Clamped to V_{CEX}		−4	20	3[e]	−	−	−	−	−	0.8	
			−4	25	3[e]	−	0.8	−	0.8	−	−	
*	$R_{\theta JC}$	10		5		−	0.875	−	0.875	−	0.875	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 μs, duty factor ⩽2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) and V_{CEX} **MUST NOT** be measured on a curve tracer.

[c] V_{CB} value.

[d] V_{CC} = 80 V, t_p = 20 μs

[e] $I_{B_1} = -I_{B_2}$

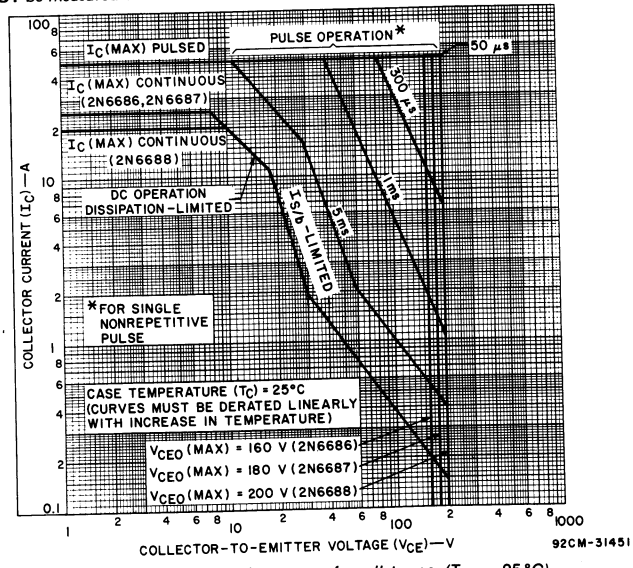


Fig. 1-Maximum operating areas for all types (T_C = 25°C).

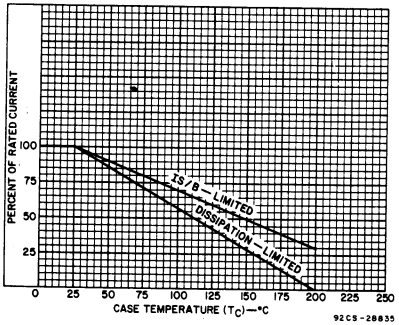


Fig. 2 — Dissipation and $I_{S/b}$ derating curves for all types.

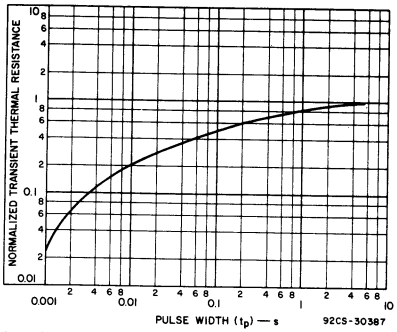


Fig. 3 — Typical thermal-response characteristic for all types.

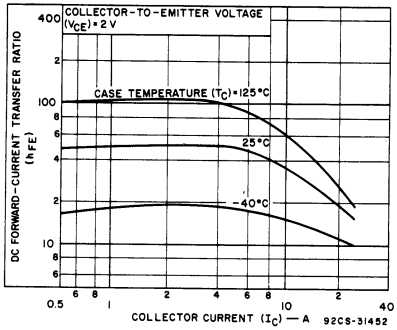


Fig. 4 — Typical dc beta characteristics for all types.

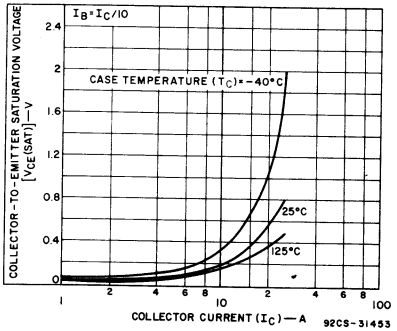


Fig. 5 — Typical collector-to-emitter saturation voltage characteristics for all types.

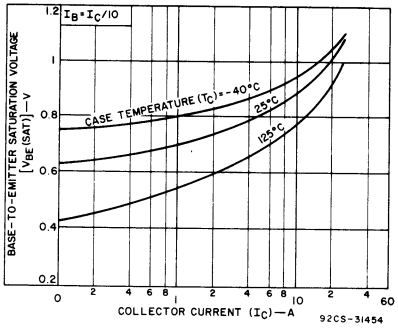


Fig. 6 — Typical base-to-emitter saturation voltage characteristic for all types.

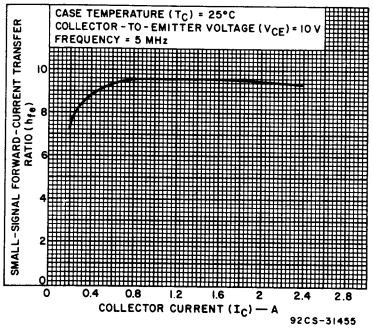


Fig. 7 — Typical small-signal forward-current transfer ratio characteristic for all ypes (f = 5 MHz).

2N6686, 2N6687, 2N6688

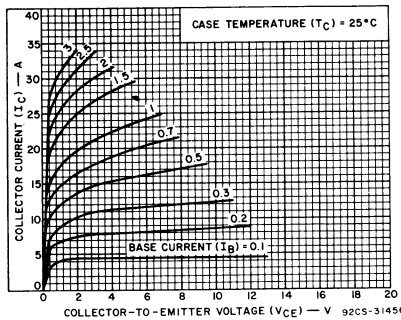


Fig. 8 — Typical output characteristics for all types.

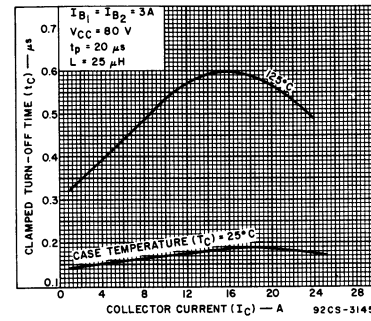


Fig. 9 — Typical clamped turn-off time characteristics for all types.

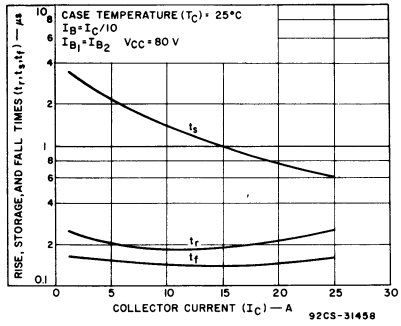


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

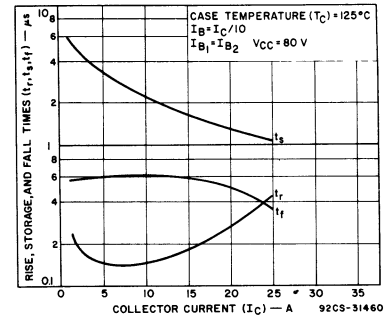


Fig. 11 — Typical saturated-switching-time characteristics at T_C = 125° C as a function of collector current for all types.

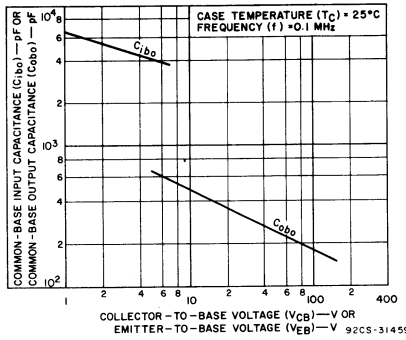


Fig. 12 — Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

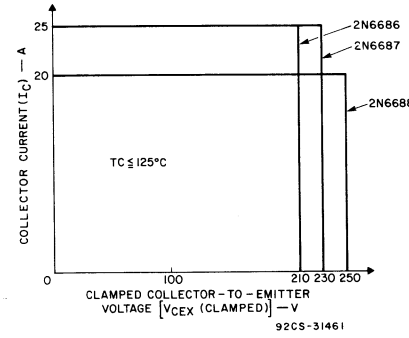


Fig. 13 — Maximum operating conditions for switching between saturation and cutoff for all types.

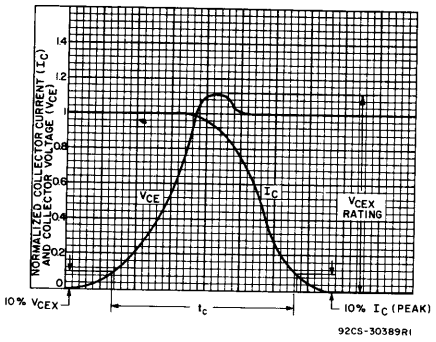


Fig. 14 — Oscilloscope display for normalized measurement of clamped inductive switching time (t_c).

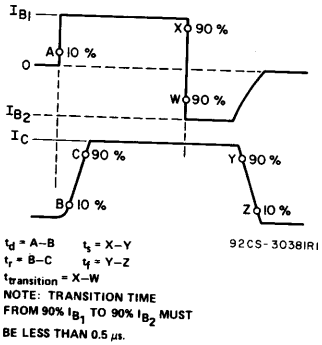


Fig. 15 — Phase relationship between input and output currents showing reference points for specification of switching times.

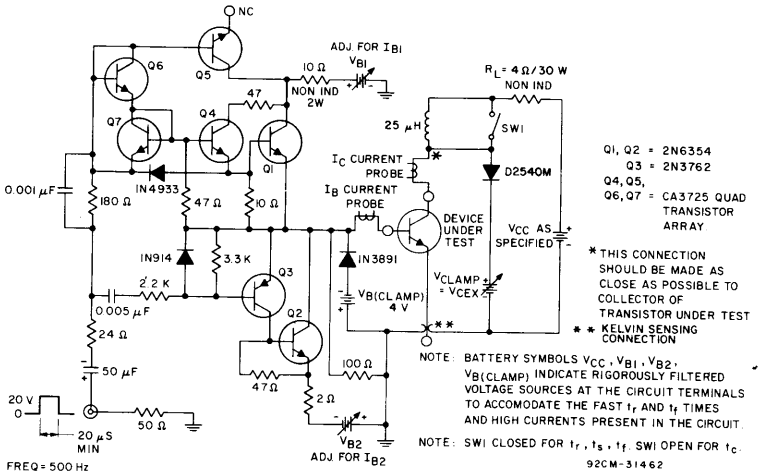


Fig. 16 — Circuit for measuring switching times.

2N6702, 2N6703, 2N6704

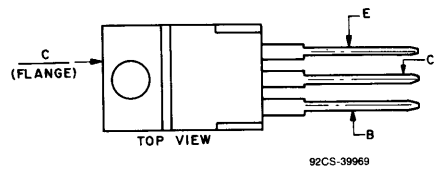
File Number **1187**

High-Current, Silicon N-P-N VERSAWATT Transistors

Switching Applications

Features:
- *Fast switching speed at temperatures up to 125° C*
- *Low $V_{CE}(sat)$*
- *VERSAWATT plastic package*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

RCA-2N6702, 2N6703, and 2N6704* epitaxial-base silicon n-p-n power transistors which feature fast switching speeds, low saturation voltages, and high safe-operating-area (SOA) ratings. They are specially designed for converters, inverters, pulse-width-modulated regulators and a variety of power switching circuits.

The 2N6702, 2N6703, and 2N6704 transistors are supplied in the JEDEC TO-220AB (RCA VERSAWATT) plastic packages.

*Formerly RCA Dev. Type Nos. TA9164A, TA9164B, TA9164C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6702	2N6703	2N6704	
* V_{CEV}				
V_{BE} = -1.5 V	140	160	180	V
* V_{CEO}	90	110	130	V
* V_{EBO}		7		V
$I_C(sat)$	5	5	4	A
* I_C		7		A
I_{CM}		10		A
* I_B		5		A
* P_T				
T_C up to 25° C		50		W
T_C above 25° C ... Derate Linearly		0.4		W/° C
* T_{stg}, T_J		-65 to 150		°C
* T_L				
At distance ≥ 1/8 in. (3.16 mm) from seating plane for 10 s max.		235		°C

*In accordance with JEDEC registration data.

2N6702, 2N6703, 2N6704

ELECTRICAL CHARACTERISTICS, at Case Temperature $T_C = 25°C$ Unless Otherwise Specified

	CHARACTERISTIC	TEST CONDITIONS				LIMITS						UNITS
		VOLTAGE V dc		CURRENT A dc		2N6702		2N6703		2N6704		
		V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	Min.	Max.	
*	I_{CEV}	140	−1.5			–	100	–	–	–	–	μA
		160	−1.5			–	–	–	100	–	–	
		180	−1.5			–	–	–	–	–	100	
	$T_C = 125°C$	140	−1.5			–	1	–	–	–	–	mA
		160	−1.5			–	–	–	1	–	–	
		180	−1.5			–	–	–	–	–	1	
*	I_{EBO}		−7	0		–	100	–	100	–	100	μA
*	$V_{CEO(sus)}$**b**			0.01[a]	0	90	–	110	–	130	–	V
*	h_{FE}	2		0.2[a]		30	–	30	–	30	–	
		2		4[a]		–	–	–	–	20	–	
		2		5[a]		20	–	20	–	–	–	
*	$V_{BE(sat)}$			4[a]	0.4	–	–	–	–	–	1.4	V
				5[a]	0.5	–	1.5	–	1.5	–	–	
*	$V_{CE(sat)}$			4[a]	0.4	–	–	–	–	–	0.7	
				5[a]	0.5	–	0.8	–	0.8	–	–	
				7[a]	0.7	–	1.5	–	1.5	–	1.5	
	$I_{S/b}$	20		2.5		1	–	1	–	1	–	s
*	$\lvert h_{fe} \rvert$ f = 5 MHz	10		0.5		10	40	10	40	10	40	
	f_T	10		0.5		50	200	50	200	50	200	MHz
*	C_{obo} f = 0.1 MHz	10[c]				50	150	50	150	50	150	pF
*	t_d**d**		−4	4	0.4	–	–	–	–	–	0.1	μs
				5	0.5	–	0.1	–	0.1	–	–	
*	t_r**d**		−4	4	0.4	–	–	–	–	–	0.25	
				5	0.5	–	0.25	–	0.25	–	–	
*	t_s**d**		−4	4	0.4[e]	–	–	–	–	–	1	
				5	0.5[e]	–	1	–	1	–	–	
*	t_f**d**		−4	4	0.4[e]	–	–	–	–	–	0.5	
				5	0.5[e]	–	0.5	–	0.5	–	–	
*	$R_{\theta JC}$	4		5		–	2.5	–	2.5	–	2.5	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO(sus)}$ *MUST NOT* be measured on a curve tracer.

[c] V_{CB} value.

[d] $V_{CC} = 70$ V, $t_p = 20$ μs

[e] $I_{B_1} = -I_{B_2}$.

2N6702, 2N6703, 2N6704

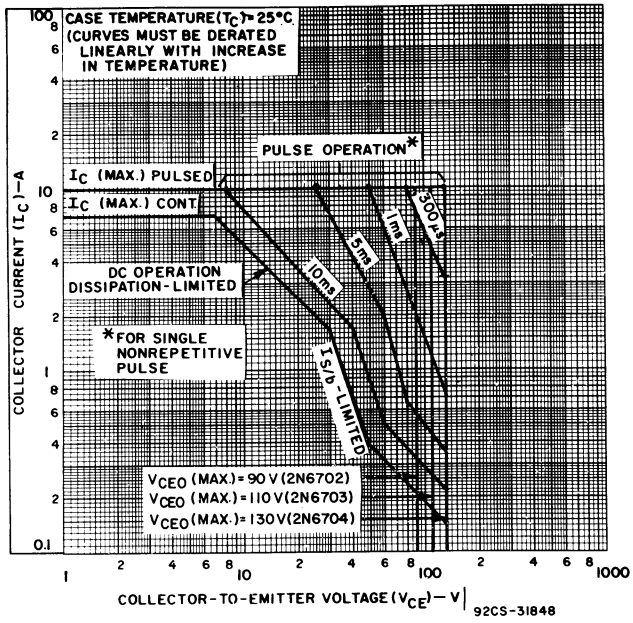


Fig. 1 — Maximum operating areas for all types (T_C = 25°C).

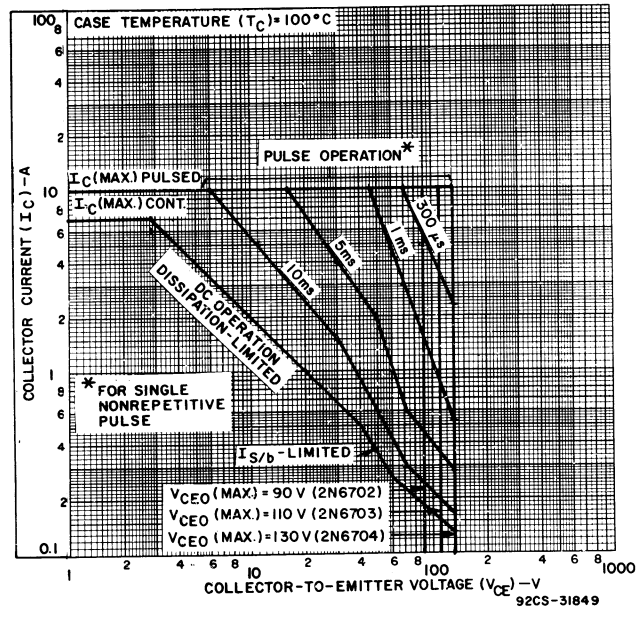


Fig. 2 — Maximum operating areas for all types (T_C = 100°C).

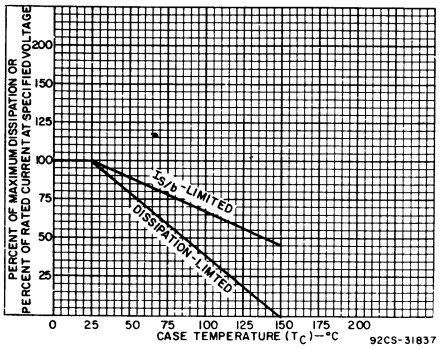


Fig. 3 — Dissipation and $I_{S/b}$ derating curves for all types.

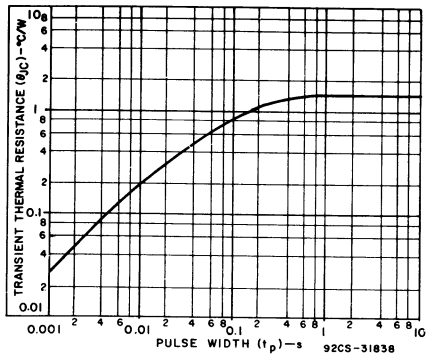


Fig. 4 — Typical thermal-response characteristic for all types.

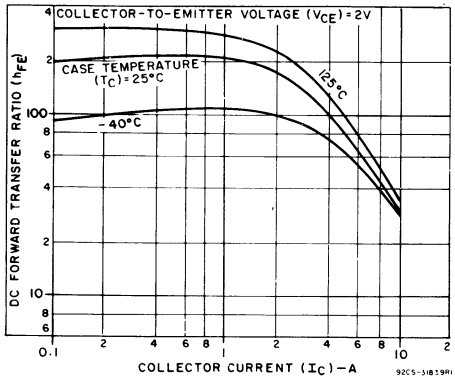


Fig. 5 — Typical dc beta characteristics for all types.

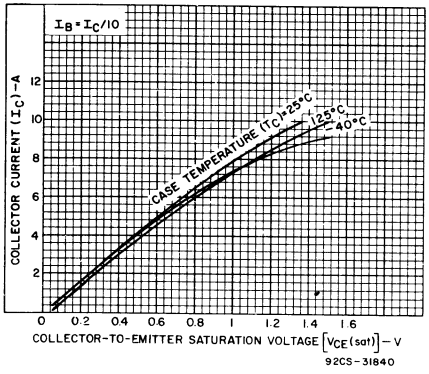


Fig. 6 — Typical collector-to-emitter saturation voltage characteristics for all types.

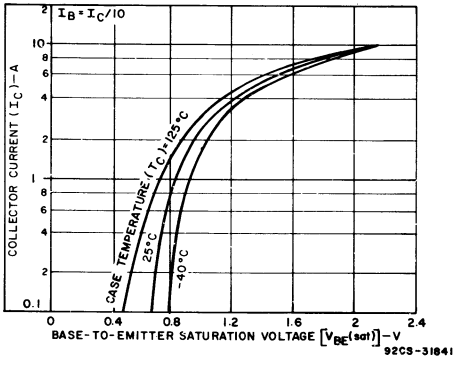


Fig. 7 — Typical base-to-emitter saturation voltage characteristic for all types.

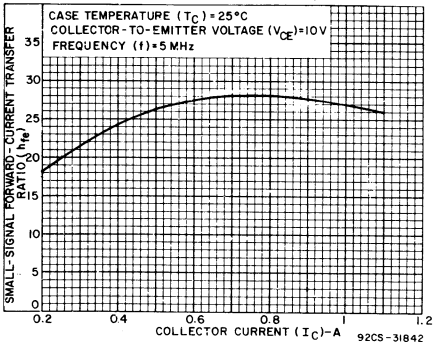


Fig. 8 — Typical small-signal forward-current transfer ratio characteristic for all types (f = 5 MHz).

2N6702, 2N6703, 2N6704

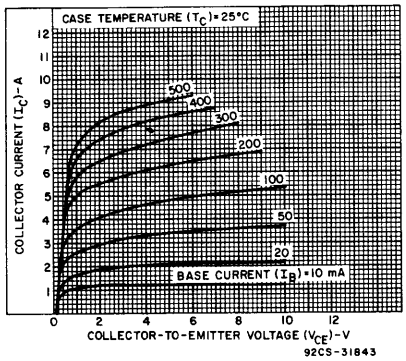


Fig. 9 – Typical output characteristics for all types.

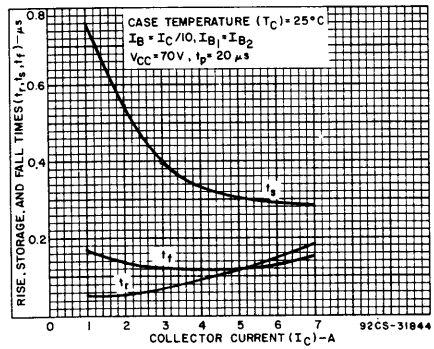


Fig. 10 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 25°C).

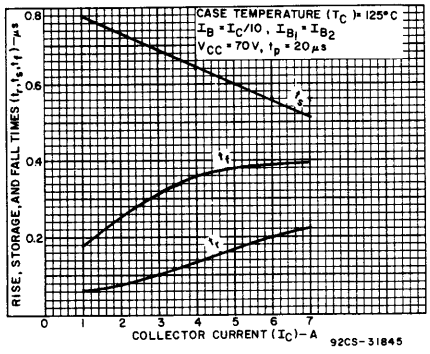


Fig. 11 – Typical saturated-switching-time characteristics as a function of collector current for all types (T_C = 125°C).

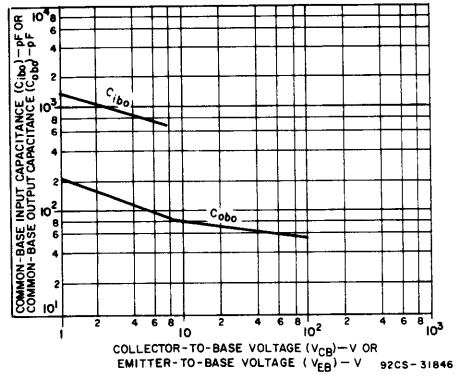


Fig. 12 – Typical common-base input (C_{ibo}) or output (C_{obo}) capacitance characteristic for all types.

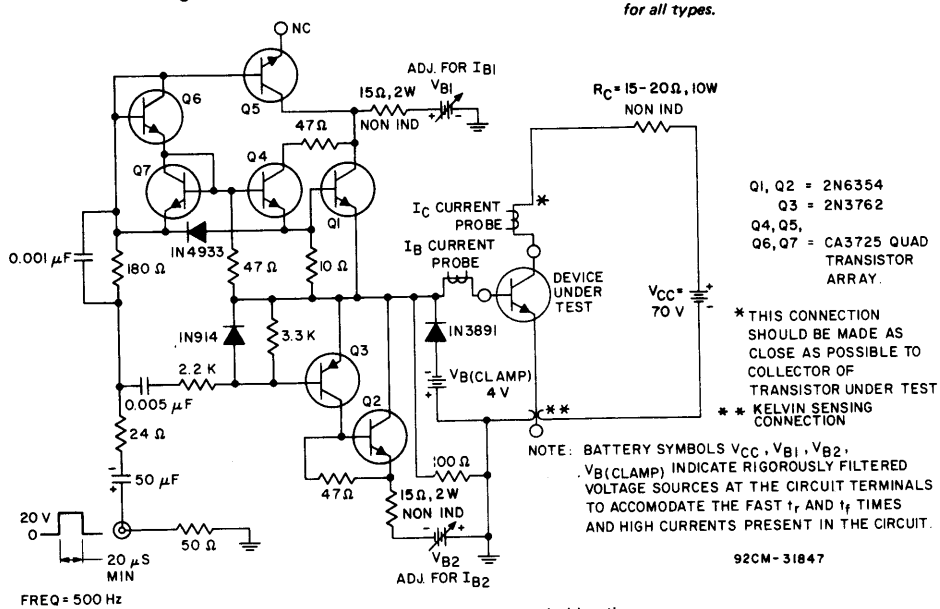


Fig. 13 – Circuit for measuring switching times.

2N6738, 2N6739, 2N6740 File Number **1291**

5-A SwitchMax Power Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

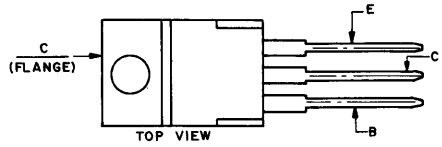
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* V_{CEX} *= 350 V to 450 V*
- *Low* V_{CE} *(sat) at* I_C *= 5 A*
- *VERSAWATT package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA 2N6738 and 2N6739 and 2N6740* SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of industrial high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The RCA-2N6738, 2N6739, and 2N6740 series transistors are supplied in the JEDEC TO-220AB package.

*Formerly RCA Dev. Type Nos. TA9141A, TA9141B, and TA9141C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6738	2N6739	2N6740	
* V_{CEV} V_{BE}=−1.5 V	450	550	650	V
* V_{CEX}(Clamped) V_{BE}=−1.5 V	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}		8		V
I_C(sat)		5		A
* I_C		8		A
I_{CM}		10		A
* I_B		4		A
* P_T				
T_C up to 25°C		100		W
T_C above 25°C, derate linearly		0.8		W/°C
* T_{stg}, T_J		−65 to 150		°C
* T_L At distance ≥ 1/8" in. (3.17 mm) from seating plane for 10 s max.		235		°C

*In accordance with JEDEC registration data.

ELECTRICAL CHARACTERISTICS

2N6738, 2N6739, 2N6740

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	2N6738 Min.	2N6738 Max.	2N6739 Min.	2N6739 Max.	2N6740 Min.	2N6740 Max.	UNITS
T_C=25°C											
* I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
	550	−1.5			—	—	—	0.1	—	—	
	650	−1.5			—	—	—	—	—	0.1	
* I_{EBO}		−8	0		—	2	—	2	—	2	
* $V_{CEO(sus)}$[b]			0.2[a]	0	300	—	350	—	400	—	V
* h_{FE}	3		5[a]		10	40	10	40	10	40	
* $V_{BE(sat)}$			5[a]	1	—	1.6	—	1.6	—	1.6	
* $V_{CE(sat)}$			5[a]	1	—	1	—	1	—	1	
			8[a]	4	—	2	—	2	—	2	
* V_{CEX}[b] (Clamped $E_{S/b}$) L=170 μH, R_{BB}=5 Ω		−5	5	1[e]	350	—	400	—	450	—	V
		−5	8	3[e]	200	—	250	—	300	—	
* $I_{S/b}$	25		4		0.5	—	0.5	—	0.5	—	s
* $\|h_{fe}\|$ f=5 MHz	10		0.2		3	12	3	12	3	12	
f_T	10		0.2		15	60	15	60	15	60	MHz
* C_{obo} f=0.1 MHz	10[c]				50	300	50	300	50	300	pF
* t_d[d]			5	1	—	0.1	—	0.1	—	0.1	μs
* t_r[d]			5	1	—	0.5	—	0.5	—	0.5	
* t_s[d]			5	1[e]	—	2.5	—	2.5	—	2.5	
* t_f[d]			5	1[e]	—	0.4	—	0.4	—	0.4	
* t_c V_{CC}=125 V, L=170 μH, R_C=25 Ω Collector clamped to V_{CEX}			5	1[e]	—	0.4	—	0.4	—	0.4	
T_C=125°C											
* I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
	550	−1.5			—	—	—	1	—	—	
	650	−1.5			—	—	—	—	—	1	
* $V_{CE(sat)}$			5[a]	1	—	2	—	2	—	2	V
* t_r[d]			5	1	—	0.8	—	0.8	—	0.8	μs
* t_s[d]			5	1[e]	—	4	—	4	—	4	
* t_f[d]			5	1[e]	—	0.8	—	0.8	—	0.8	
* t_c V_{CC}=125 V, L=170 μH; R_C=25 Ω Collector clamped to V_{CEX}			5	1[e]	—	0.8	—	0.8	—	0.8	
* $R_{\theta JC}$	10		5		—	1.25	—	1.25	—	1.25	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

*In accordance with JEDEC registration data.

[a]Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[b]CAUTION: The sustaining voltage $V_{CEO(sus)}$ and V_{CEX} MUST NOT be measured on a curve tracer.

[c]V_{CB} value.

[d]V_{CC} = 125 V, t_p = 20 μs.

[e]$I_{B1} = -I_{B2}$.

2N6738, 2N6739, 2N6740

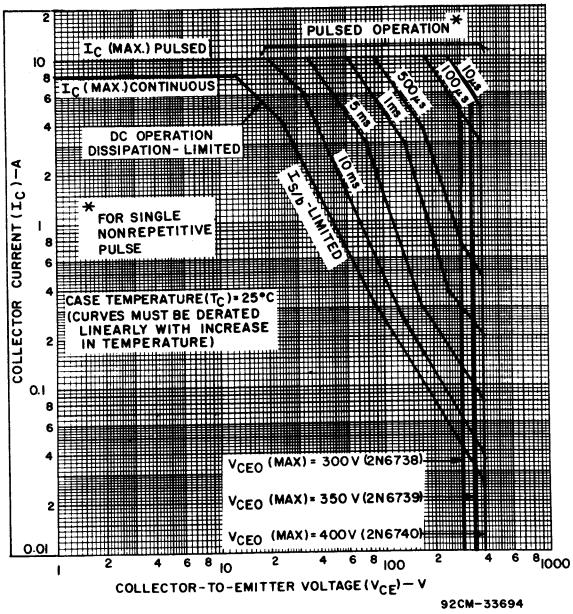


Fig. 1 — Maximum operating areas for all types (T_C = 25° C).

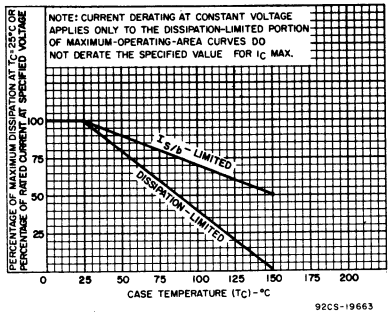


Fig. 2 — Dissipation and derating curve for all types.

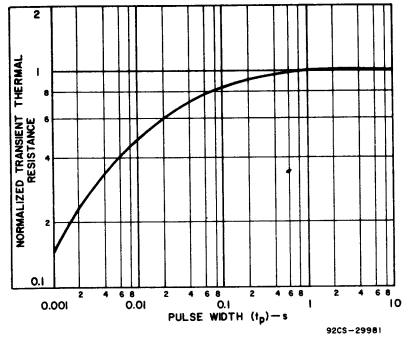


Fig. 3 — Typical thermal-response characteristic for all types.

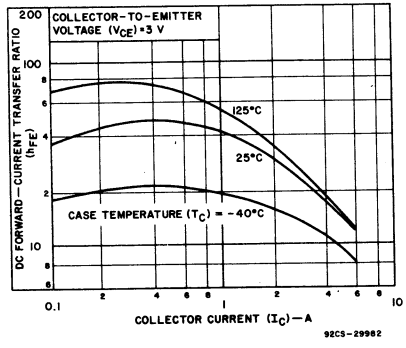


Fig. 4 — Typical dc beta characteristics for all types.

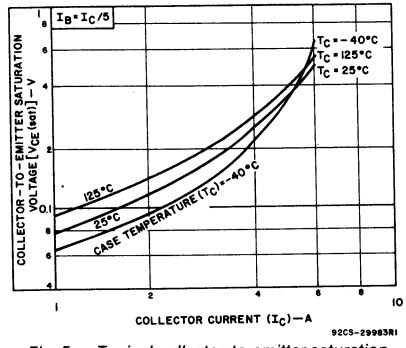


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

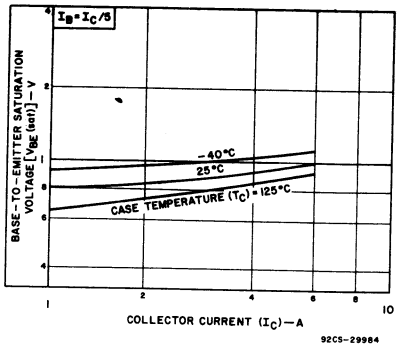


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

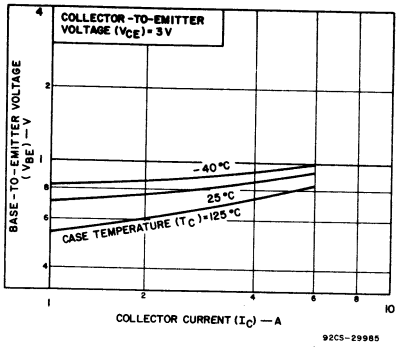


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

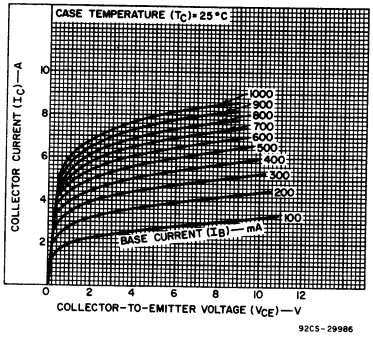


Fig. 8 — Typical output characteristics for all types.

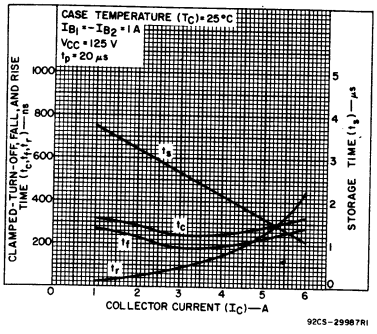


Fig. 9 — Typical saturated switching time characteristics for all types.

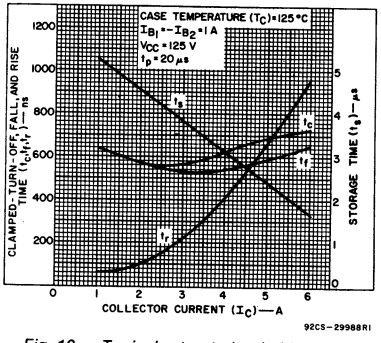


Fig. 10 — Typical saturated switching time characteristics for all types.

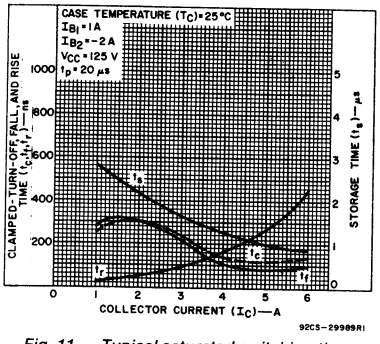


Fig. 11 — Typical saturated switching time characteristics for all types.

2N6738, 2N6739, 2N6740

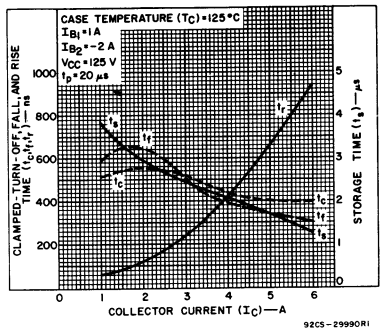


Fig. 12 — Typical saturated switching time characteristics for all types.

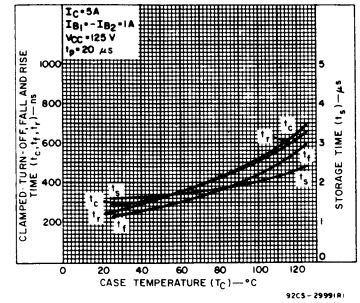


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

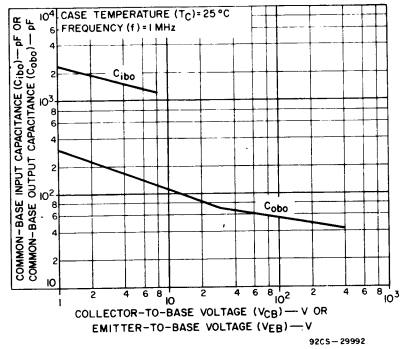


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

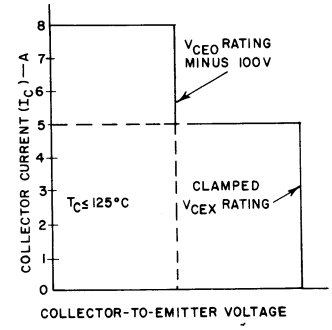


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

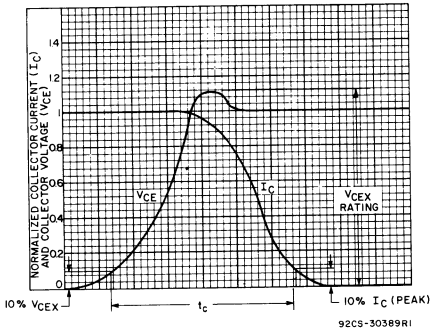


Fig. 16 — Oscilloscope display for measurement of clamped induction switching-time (t_c).

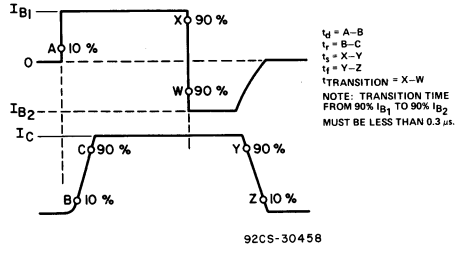
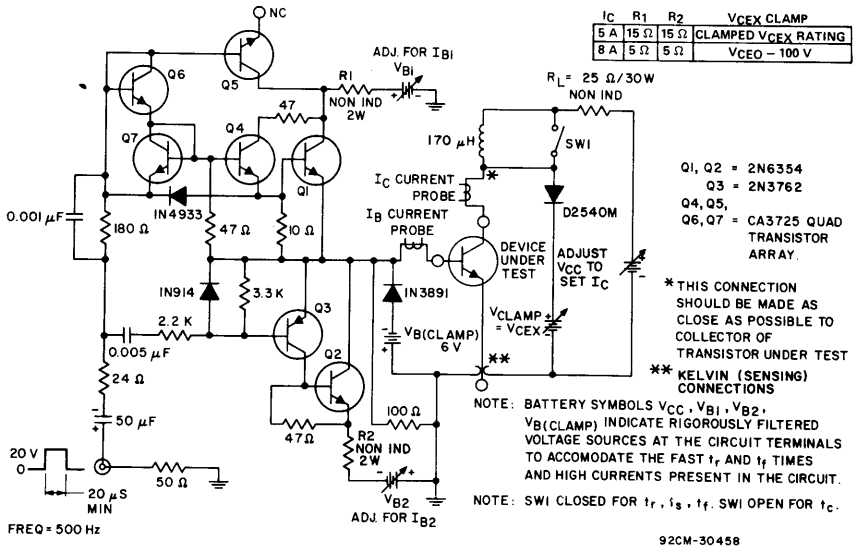


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.



I_C	R_1	R_2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING
8 A	5 Ω	5 Ω	V_{CEO} – 100 V

Q1, Q2 = 2N6354
Q3 = 2N3762
Q4, Q5, Q6, Q7 = CA3725 QUAD TRANSISTOR ARRAY.

* THIS CONNECTION SHOULD BE MADE AS CLOSE AS POSSIBLE TO COLLECTOR OF TRANSISTOR UNDER TEST

** KELVIN (SENSING) CONNECTIONS

NOTE: BATTERY SYMBOLS V_{CC}, V_{B1}, V_{B2}, $V_{B(CLAMP)}$ INDICATE RIGOROUSLY FILTERED VOLTAGE SOURCES AT THE CIRCUIT TERMINALS TO ACCOMODATE THE FAST t_r AND t_f TIMES AND HIGH CURRENTS PRESENT IN THE CIRCUIT.

NOTE: SW1 CLOSED FOR t_r, t_s, t_f. SW1 OPEN FOR t_c.

Fig. 18 — Circuit for measuring switching times.

2N6751, 2N6752, 2N6753, 2N6754

File Number **1244**

5-A SwitchMax Power Transistors

High-Voltage N-P-N Types for 240 V Off-Line Power Supplies and Other High-Voltage Switching Applications

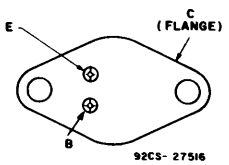
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* V_{CEX} = *450 V — 550 V*
- *Low* V_{CE} *(sat) at* I_C = *5 A*
- *Steel hermetic TO-204AA package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-204AA

(200 mil diameter pin isolation)

The RCA-2N6751, 2N6752, 2N6753 and 2N6754 SwitchMax series• of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits. Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 100°C to provide information necessary for worst-case design.

The 2N6751, 2N6752, 2N6753, and 2N6754 series transistors are supplied in steel JEDEC TO-204AA hermetic packages.

•Formerly TA9153, TA9153A, TA9153B,

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6751	2N6752	2N6753	2N6754	
* V_{CEV}					
V_{BE} = −1.5 V	800	850	900	1000	V
* $V_{CEX(Clamped)}$					
V_{BE} = −1.5 V	450	500	550	550	V
* V_{CEO}	400	450	500	500	V
V_{EBO}	8				V
* $I_{C(sat)}$	5				A
I_C	10				A
* I_{CM}	10				A
* I_B	5				A
P_T					
$T_C \leq 25°C$	150				W
* $T_C \geq 25°C$, derate linearly	1				W/°C
* T_J	−65 to 175				°C
* T_{stg}	−65 to 200				°C
T_L					
At distance ≥ 1/16 in. (1.58 mm) from seating plane for 10 s max.	235				°C

* In accordance with JEDEC registration data.

2N6751, 2N6752, 2N6753, 2N6754

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6751		2N6752		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
T_C = 25°C									
* I_{CEV}	800	−1.5			—	0.1	—	—	mA
	850	−1.5			—	—	—	0.1	
* I_{EBO}		−8	0		—	2	—	2	mA
* $V_{CEO(sus)}$[b]			0.2[a]	0	400	—	450	—	V
* h_{FE}	3		5[a]		8	40	8	40	
* $V_{BE(sat)}$			5[a]	1	—	1.3	—	1.3	V
* $V_{CE(sat)}$			5[a]	1	—	1	—	1	V
			10[a]	3	—	3	—	3	
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 μH		−6	5	1[c]	450	—	500	—	V
$I_{S/b}$	30		5		1	—	1	—	s
* $\|h_{fe}\|$ f = 5 MHz	10		0.2		3	12	3	12	
f_T	10		0.2		15	60	15	60	MHz
* C_{obo} f = 0.1 MHz	10[d]				50	250	50	250	pF
* t_d[e]		−6	5	1	—	0.1	—	0.1	μs
* t_r[e]		−6	5	1	—	0.4	—	0.4	μs
* t_s[e]		−6	5	1[c]	—	3	—	3	μs
* t_f[e]		−6	5	1[c]	—	0.4	—	0.4	μs
* t_c V_{CC} = 250 V, L = 170 μH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1[c]	—	0.4	—	0.4	μs
T_C = 100°C									
* I_{CEV}	800	−1.5			—	1	—	—	mA
	850	−1.5			—	—	—	1	
* $V_{CE(sat)}$			5[a]	1	—	1.5	—	1.5	V
* t_r[e]		−6	5	1	—	0.6	—	0.6	μs
* t_s[e]		−6	5	1[c]	—	5	—	5	μs
* t_f[e]		−6	5	1[c]	—	0.7	—	0.7	μs
* t_c V_{CC} = 250 V, L = 170 μH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1[c]	—	0.7	—	0.7	μs
* $R_{\theta JC}$	10		5		—	1	—	1	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed duration = 300 μs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltage V_{CEO}(sus) and V_{CEX} *MUST NOT* be measured on a curve tracer.

[c] $I_{B_1} = -I_{B_2}$ [d] V_{CB} value [e] V_{CC} = 250 V, tp = 20 μs

2N6751, 2N6752, 2N6753, 2N6754

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS				LIMITS				UNITS
	VOLTAGE V dc		CURRENT A dc		2N6753		2N6754		
	V_{CE}	V_{BE}	I_C	I_B	Min.	Max.	Min.	Max.	
T_C = 25°C									
* I_{CEV}	900	−1.5			—	0.1	—	—	mA
	1000	−1.5			—	—	—	0.1	
* I_{EBO}		−8	0		—	2	—	2	mA
* $V_{CEO(sus)}$[b]			0.2[a]	0	500	—	500	—	V
* h_{FE}	3		5[a]		8	40	8	40	
* $V_{BE(sat)}$			5[a]	1	—	1.3	—	1.3	V
* $V_{CE(sat)}$			5[a]	1	—	1	—	1	V
			10[a]	3	—	3	—	3	
V_{CEX}[b] (Clamped $E_{S/b}$) L = 170 μH		−6	5	1[c]	550	—	550	—	V
$I_{S/b}$	30		5		1	—	1	—	s
* $\|h_{fe}\|$ f = 5 MHz	10		0.2		3	12	3	12	
f_T	10		0.2		15	60	15	60	MHz
* C_{obo} f = 0.1 MHz	10[d]				50	250	50	250	pF
* t_d[e]		−6	5	1	—	0.1	—	0.1	μs
* t_r[e]		−6	5	1	—	0.4	—	0.4	μs
* t_s[e]		−6	5	1[c]	—	3	—	3	μs
* t_f[e]		−6	5	1[c]	—	0.4	—	0.4	μs
* t_c V_{CC} = 250 V, L = 170 μH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1[c]	—	0.4	—	0.4	μs
T_C = 100°C									
* I_{CEV}	900	−1.5			—	1	—	—	mA
	1000	−1.5			—	—	—	1	
* $V_{CE(sat)}$			5[a]	1	—	1.5	—	1.5	V
* t_r[e]		−6	5	1	—	0.6	—	0.6	μs
* t_s[e]		−6	5	1[c]	—	5	—	5	μs
* t_f[e]		−6	5	1[c]	—	0.7	—	0.7	μs
* t_c V_{CC} = 250 V, L = 170 μH, R_C = 50 Ω, Collector clamped to V_{CEX}		−6	5	1[c]	—	0.7	—	0.7	μs
* $R_{\theta JC}$	10		5		—	1	—	1	°C/W

* In accordance with JEDEC registration data.

[a] Pulsed duration = 300 μs, duty factor ≤ 2%.

[b] **CAUTION:** The sustaining voltage $V_{CEO(sus)}$ and V_{CEX} *MUST NOT* be measured on a curve tracer.

[c] $I_{B_1} = -I_{B_2}$ [d] V_{CB} value [e] V_{CC} = 250 V, t_p = 20 μs

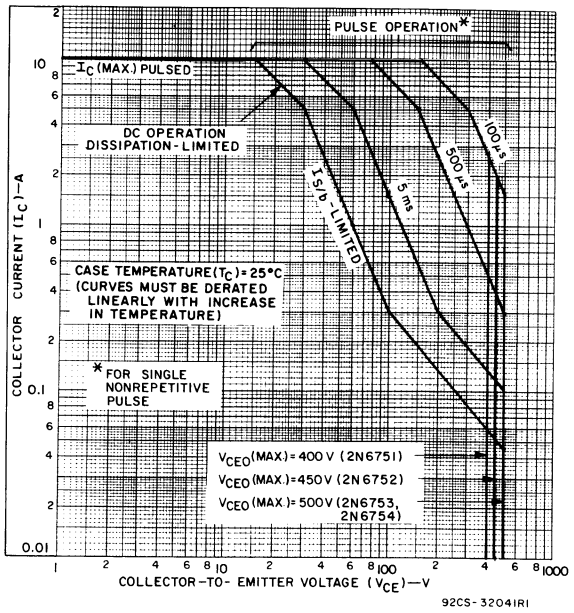


Fig. 1 — Maximum operating areas for all type (T_CC).

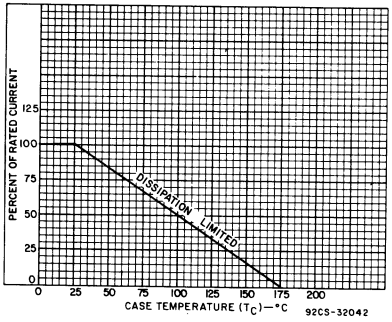


Fig. 2 — Dissipation derating curves for all types.

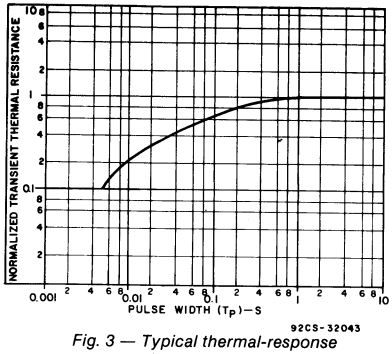


Fig. 3 — Typical thermal-response characteristic for all types.

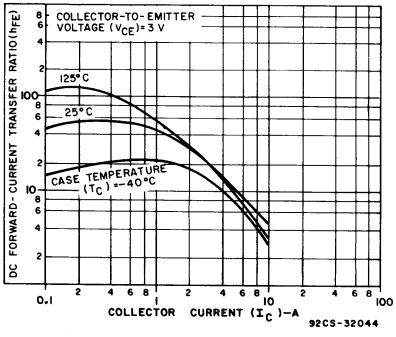


Fig. 4 — Typical dc beta characteristics for all types.

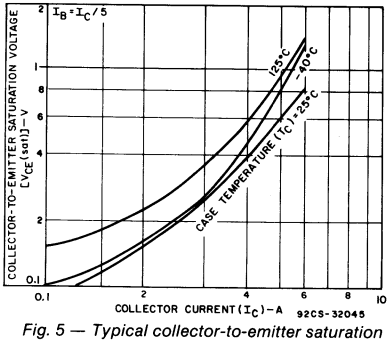


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6751, 2N6752, 2N6753, 2N6754

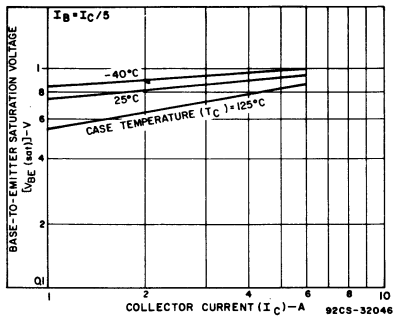


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

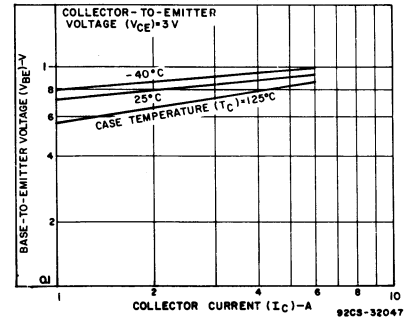


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

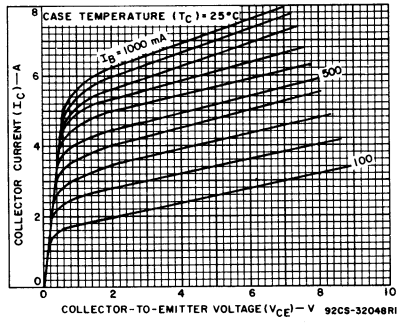


Fig. 8 — Typical output characteristics for all types.

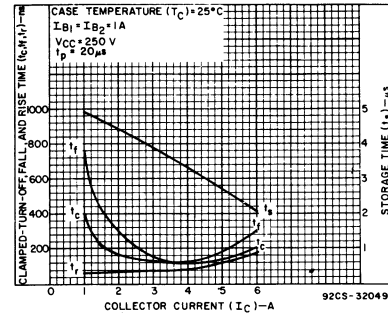


Fig. 9 — Typical saturated switching time characteristics for all types.

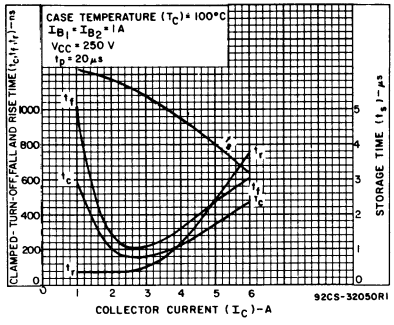


Fig. 10 — Typical saturated switching time characteristics for all types.

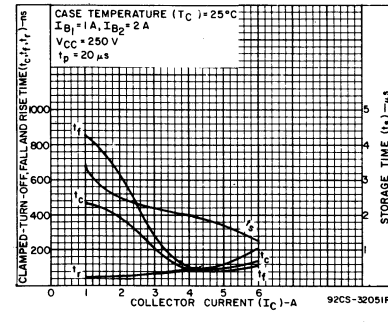


Fig. 11 — Typical saturated switching time characteristics for all types.

2N6751, 2N6752, 2N6753, 2N6754

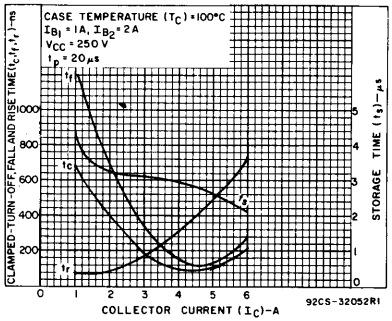


Fig. 12 — Typical saturated switching time characteristics for all types.

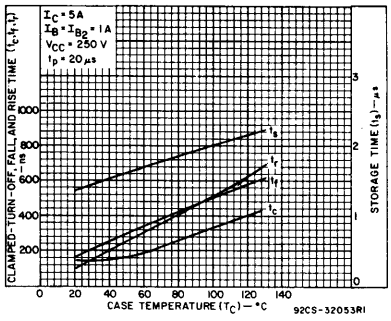


Fig. 13 — Typical saturated switching time characteristics as a function of case temperature for all types.

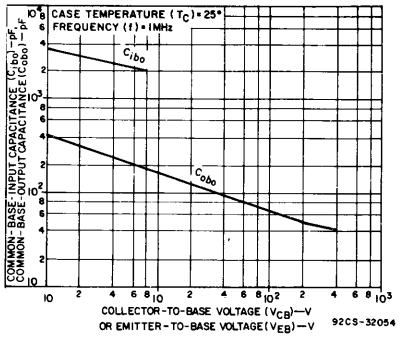


Fig. 14 — Typical common-base input or output capacitance characteristics as a function of collector-to-base voltage or emitter-to-base voltage for all types.

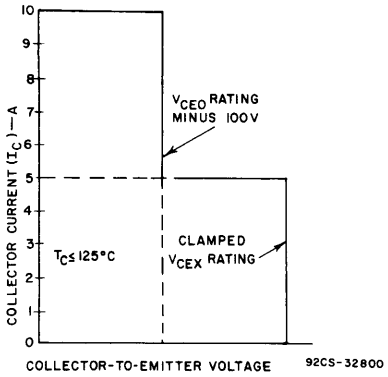


Fig. 15 — Maximum operating conditions for switching between saturation and cutoff.

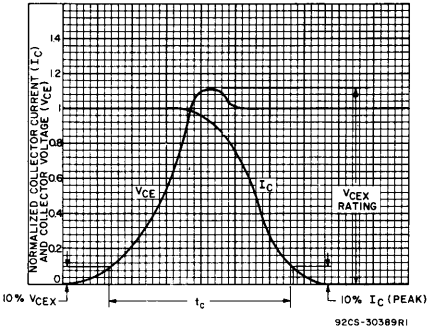


Fig. 16 — Oscilloscope display for measurement of clamped induction switching time (t_c).

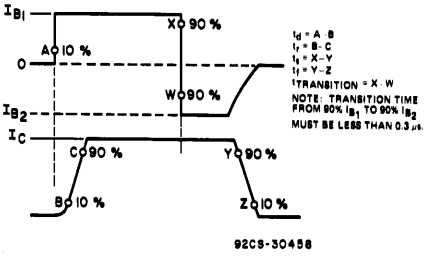
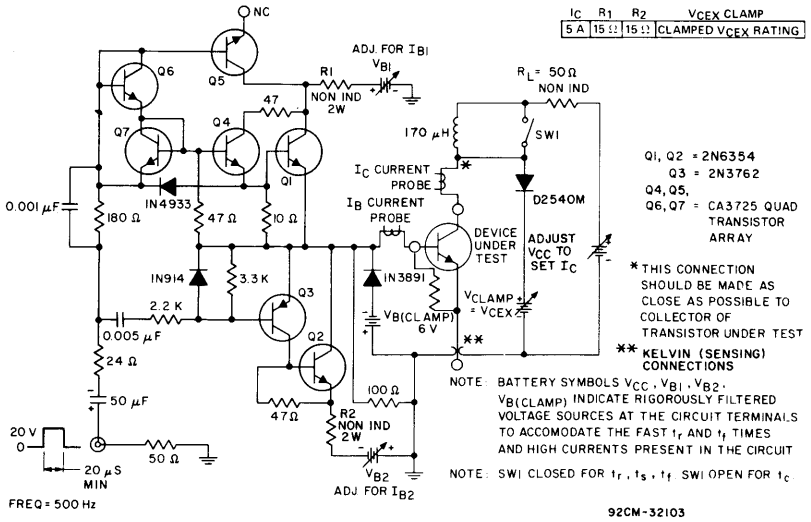


Fig. 17 — Phase relationship between input and output currents showing reference points for specification of switching times.

2N6751, 2N6752, 2N6753, 2N6754



I_C	R_1	R_2	V_{CEX} CLAMP
5 A	15 Ω	15 Ω	CLAMPED V_{CEX} RATING

Fig. 18 — Circuit for measuring switching times.

File Number **1292**

2N6771, 2N6772, 2N6773

1-A SwitchMax VERSAWATT Transistors

High-Voltage N-P-N Types for Off-Line Power Supplies and Other High-Voltage Switching Applications

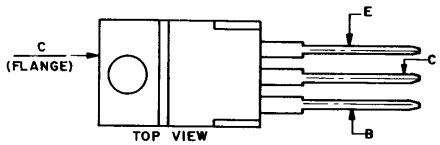
Features:

- *High-temperature parameters guaranteed*
- *Fast switching speed*
- *High voltage ratings:* V_{CEX} *= 350 V to 450 V*
- *Low* V_{CE} *(sat) at* I_C *= 1 A*
- *VERSAWATT package*

Applications:

- *Off-line power supplies*
- *High-voltage inverters*
- *Switching regulators*

TERMINAL DESIGNATIONS



JEDEC TO-220AB

The RCA-2N6771, 2N6772, and 2N6773• SwitchMax series of silicon n-p-n power transistors feature high-voltage capability, fast switching speeds, and low saturation voltages, together with high safe-operating-area (SOA) ratings. They are specially designed for off-line power supplies and are also well suited for use in a wide range of inverter or converter circuits and pulse-width-modulated regulators. These high-voltage, high-speed transistors are 100-per-cent tested for parameters that are essential to the design of high-power switching circuits.

Switching times, including inductive turn-off time, and saturation voltages are guaranteed at 125°C to provide information necessary for worst-case design.

The RCA-2N6771, 2N6772, and 2N6773 series transistors are supplied in the JEDEC TO-220AB VERSAWATT plastic packages.

•Formerly RCA8863A, RCA8863B, and RCA8863C, respectively.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

	2N6771	2N6772	2N6773	
* V_{CEV}				
V_{BE} = -1.5 V	450	550	650	V
* V_{CEX} (Clamped)				
V_{BE} = -1.5 V	350	400	450	V
* V_{CEO}	300	350	400	V
* V_{EBO}	8			V
I_C(sat)	1			A
* I_C	1			A
I_{CM}	2			A
* I_B	0.6			A
* P_T				
T_C up to 25°C	40			W
T_C above 25°C, derate linearly	0.32			W/°C
* T_{stg}, T_J	-65 to 150			°C
* T_L				
At distance ≥ 1/8 in. (3.17 mm) from seating plane for 10 s max.	235			°C

*In accordance with JEDEC registration data.

2N6771, 2N6772, 2N6773

ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	TEST CONDITIONS VOLTAGE V dc V_{CE}	V_{BE}	CURRENT A dc I_C	I_B	2N6771 Min.	2N6771 Max.	2N6772 Min.	2N6772 Max.	2N6773 Min.	2N6773 Max.	UNITS
T_C=25° C											
* I_{CEV}	450	−1.5			—	0.1	—	—	—	—	mA
	550	−1.5			—	—	—	0.1	—	—	
	650	−1.5			—	—	—	—	—	0.1	
* I_{EBO}		−8	0		—	2	—	2	—	2	
* $V_{CEO(sus)}$[b]			0.2[a]	0	300	—	350	—	400	—	V
* $V_{CE(sat)}$			1[a]	0.2	—	1.0	—	1.0	—	1.0	
* $V_{BE(sat)}$			1[a]	0.2	—	1.2	—	1.2	—	1.2	
* h_{FE}	3		0.3[a]		20	100	20	100	20	100	
	3		1[a]		10	50	10	50	10	50	
* V_{CEX}[b] (Clamped $E_{S/b}$) L=450 μH, R_{BB}=50 Ω		−5	1	0.1[e]	350	—	400	—	450	—	V
* $I_{S/b}$	100		0.4		0.5	—	0.5	—	0.5	—	s
* $\|h_{fe}\|$ f=1 MHz	10		0.2		10	50	10	50	10	50	
f_T	10		0.2		10	50	10	50	10	50	MHz
* C_{obo} f=0.1 MHz	10[c]				20	60	20	60	20	60	pF
* t_d[d]			1	0.2	—	0.05	—	0.05	—	0.05	μs
* t_r[d]			1	0.2	—	0.4	—	0.4	—	0.4	
* t_s[d]			1	0.2[e]	—	2.5	—	2.5	—	2.5	
* t_f[d]			1	0.2[e]	—	0.6	—	0.6	—	0.6	
* t_c V_{CC}=200 V, L=450 μH, R_C=200 Ω Collector clamped to V_{CEX}			1	0.2[e]	—	0.6	—	0.6	—	0.6	
T_C=125° C											
* I_{CEV}	450	−1.5			—	1	—	—	—	—	mA
	550	−1.5			—	—	—	1	—	—	
	650	−1.5			—	—	—	—	—	1	
* $V_{CE(sat)}$			1[a]	0.2	—	2	—	2	—	2	V
* t_r[d]			1	0.2	—	0.8	—	0.8	—	0.8	μs
* t_s[d]			1	0.2[e]	—	4.5	—	4.5	—	4.5	
* t_f[d]			1	0.2[e]	—	1.5	—	1.5	—	1.5	
* t_c V_{CC}=200 V, L=450 μH, R_C=200 Ω Collector clamped to V_{CEX}			1	0.2[e]	—	1.5	—	1.5	—	1.5	
* $R_{\theta JC}$	20		1		—	3.12	—	3.12	—	3.12	°C/W
$R_{\theta JA}$					—	70	—	70	—	70	°C/W

*In accordance with JEDEC registration data.

[a]Pulsed: pulse duration = 300 μs, duty factor ≤ 2%.

[b]CAUTION: The sustaining voltage $V_{CEO(sus)}$ and V_{CEX} MUST NOT be measured on a curve tracer.

[c]V_{CB} value.

[d]V_{CC} = 200 V, t_p = 20 μs.

[e]$I_{B_1} = -I_{B_2}$.

2N6771, 2N6772, 2N6773

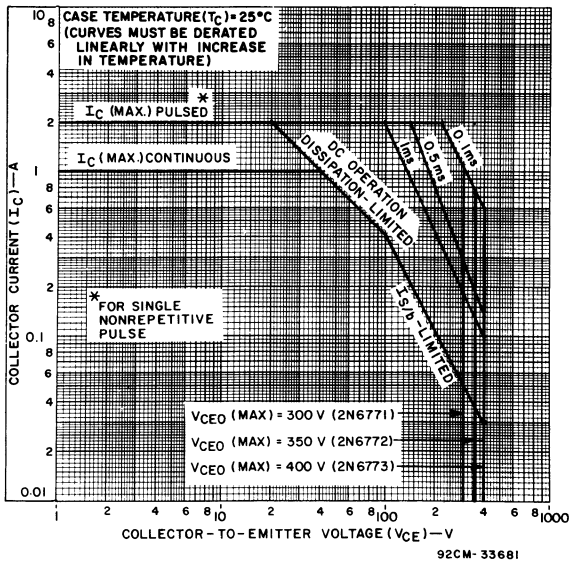


Fig. 1 — Maximum operating areas for all types.

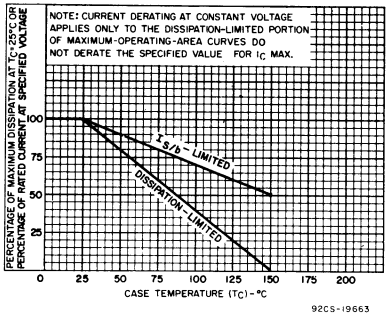


Fig. 2 — Derating curve for all types.

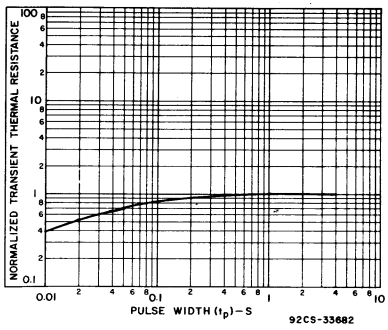


Fig. 3 — Typical thermal-response characteristics for all types.

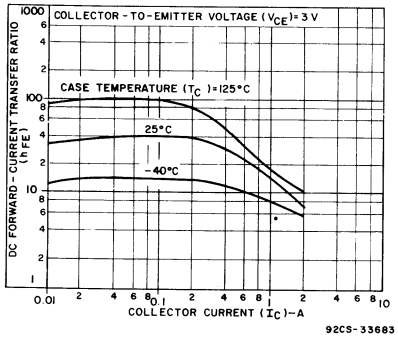


Fig. 4 — Typical dc beta characteristics for all types.

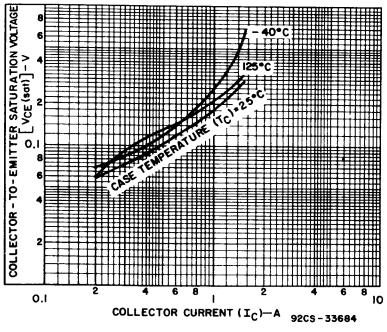


Fig. 5 — Typical collector-to-emitter saturation voltage as a function of collector current for all types.

2N6771, 2N6772, 2N6773

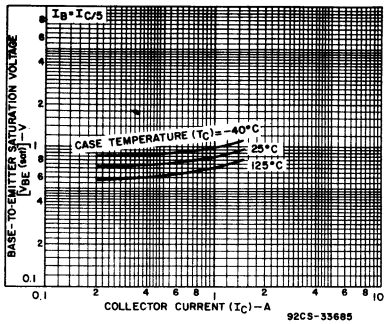


Fig. 6 — Typical base-to-emitter saturation voltage as a function of collector current for all types.

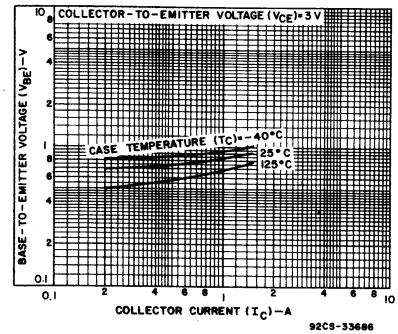


Fig. 7 — Typical base-to-emitter voltage as a function of collector current for all types.

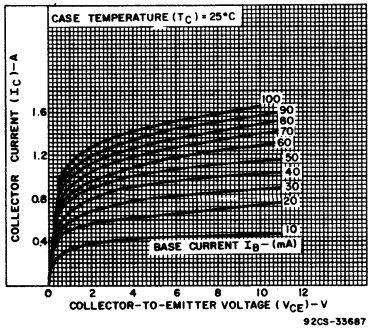


Fig. 8 — Typical output characteristics for all types.

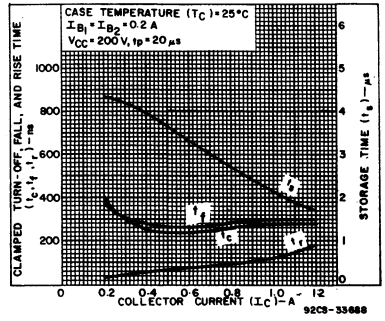


Fig. 9 — Typical saturated-switching-time characteristics for all types.

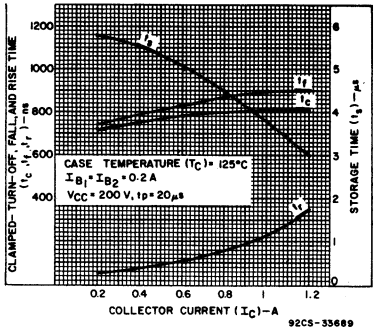


Fig. 10 — Typical saturated-switching-time characteristics as a function of collector current for all types.

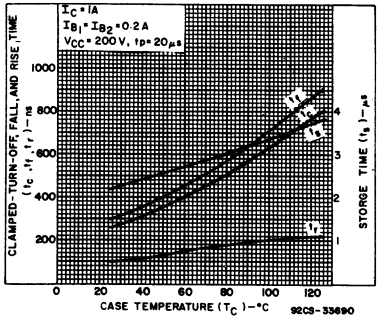


Fig. 11 — Typical saturated-switching-time characteristics as a function of case temperature for all types.

2N6975, 2N6976, 2N6977, 2N6978

File Number **2297**

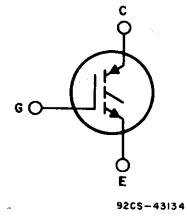
N-Channel Enhancement-Mode Conductivity-Modulated Power Field-Effect Transistors

5 A, 400 V and 500 V
$V_{CE(on)}$: 2 V
T_{fi}: 1 μs, 0.5 μs

Features:
- *Low on-state voltage*
- *Fast switching speeds*
- *High input impedance*

Applications:
- *Power supplies*
- *Motor drives*
- *Protection circuits*

N-CHANNEL ENHANCEMENT MODE

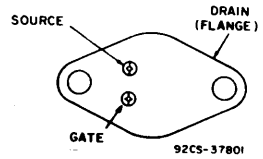


TERMINAL DIAGRAM

The 2N6975, 2N6976, 2N6977 and the 2N6978 are n-channel enhancement-mode conductivity-modulated power field-effect transistors designed for high-voltage, low on-dissipation applications such as switching regulators and motor drivers. These types can be operated directly from low-power integrated circuits.

These types are supplied in the JEDEC TO-204AA steel package.

TERMINAL DESIGNATION



JEDEC TO-204AA

MAXIMUM RATINGS, *Absolute-Maximum Values (T_C = 25° C):*

	2N6975 2N6977		2N6976 2N6978	
COLLECTOR-EMITTER VOLTAGE, V_{CES}	400*		500*	V
COLLECTOR-GATE VOLTAGE (R_{GE} = 1 MΩ), V_{CGR}	400*		500*	V
REVERSE COLLECTOR-EMITTER VOLTAGE, $V_{CES(rev.)}$		5*		V
GATE-EMITTER VOLTAGE, V_{GE}		±20*		V
COLLECTOR CURRENT, RMS Continuous, I_C		5*		A
Pulsed, I_{CM}		10*		A
POWER DISSIPATION @ T_C = 25°C, P_T		100*		W
Derate above T_C = 25°C		0.8*		W/°C
OPERATING AND STORAGE TEMPERATURE, T_J, T_{stg}		-55 to +150*		°C

*JEDEC registered value.

Harris Semiconductor IGBT product is covered by one or more of the following U.S. patents:

4,364,073	4,417,385	4,430,792	4,443,931	4,466,176	4,532,534	4,567,641
4,587,713	4,618,872	4,620,211	4,631,564	4,639,754	4,639,762	4,641,162
4,644,637	4,682,195	4,684,413	4,717,679	4,794,432	4,801,986	4,803,533
4,809,045	4,810,665					

2N6975, 2N6976, 2N6977, 2N6978

ELECTRICAL CHARACTERISTICS *At Case Temperature (T_C) = 25°C Unless Otherwise Specified*

CHARACTERISTICS	SYMBOL	TEST CONDITIONS	LIMITS				UNITS
			2N6975 2N6977		2N6976 2N6978		
			Min.	Max.	Min.	Max.	
Collector-Emitter Breakdown Voltage	BV_{CES}	I_C = 1 mA V_{GE} = 0	400*	—	500*	—	V
Gate Threshold Voltage	$V_{GE(th)}$	V_{GE} = V_{CE} I_C = 1 mA	2*	4.5*	2*	4.5*	V
Zero-Gate Voltage Collector Current	I_{CES}	V_{CE} = 400 V V_{CE} = 500 V	— —	250* —	— —	— 250*	μA
		T_C = 125°C V_{CE} = 400 V V_{CE} = 500 V	— — —	— 1000* —	— — —	— — 1000*	
Gate-Emitter Leakage Current	I_{GES}	V_{GE} = ±20 V V_{CE} = 0	—	100*	—	100*	nA
Reverse Collector-Emitter Leakage Current	I_{ECS}	R_{GE} = 0 Ω V_{EC} = 5 V	—	5*	—	5*	mA
Collector-Emitter On Voltage	$V_{CE(on)}$	I_C = 5 A V_{GE} = 10 V	—	2*	—	2*	V
		I_C = 10 A V_{GE} = 20V	—	2.5	—	2.5	
Gate-Emitter Plateau Voltage	V_{GEP}	I_C = 5 A V_{CE} = 10 V	3.4*	6.8*	3.4*	6.8*	V
On-State Gate Charge	$Q_{g(on)}$	I_C = 5 A V_{CE} = 10 V	12*	25*	12*	25*	nC
Turn-On Delay Time	$t_{d(on)}$	I_C = 5 A	50 max				ns
Rise Time	t_r	$V_{CE(CLP)}$ = 300 V	50 max				
Turn-Off Delay Time	$t_{d(off)}$	L = 50 μH	400 max *				
Fall Time	t_{fi}	T_J = 125°C V_{GE} = 10 V R_G = 50 Ω	2N6975 2N6976	1000 max*			
			2N6977 2N6978	500 max *			
Turn-Off Energy Loss per Cycle (off switching dissipation = E_{off} x frequency)	E_{off}	I_C = 5 A $V_{CE(CLP)}$ = 300 V L = 50 μH T_J = 125°C V_{GE} = 10 V R_G = 50 Ω	2N6975 2N6977	1000 max*			μJ
			2N6976 2N6978	500 max*			
Thermal Resistance Junction-to-Case	$R_{\theta JC}$		1.25*				°C/W

*JEDEC registered value.

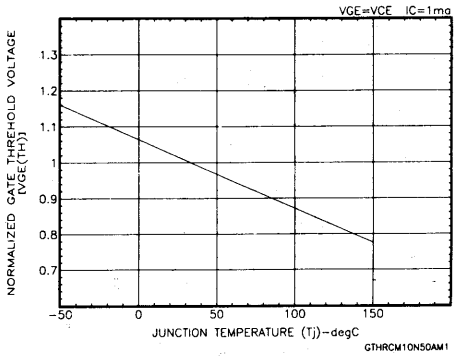


Fig. 1 - Typical normalized gate threshold voltage as a function of junction temperature for all types.

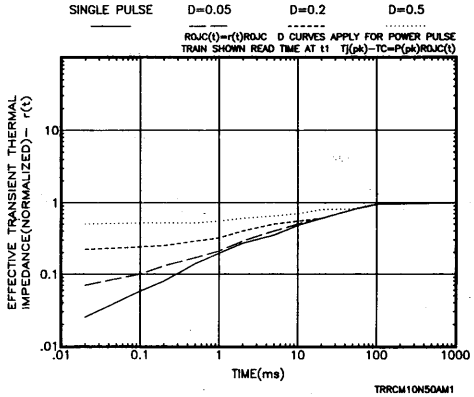


Fig. 2 - Normalized thermal response characteristics for all types.

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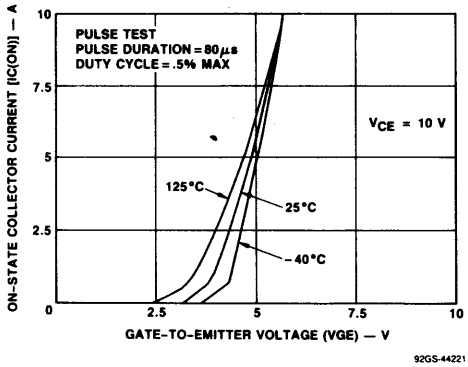

Fig. 3 - Typical transfer characteristics for all types.

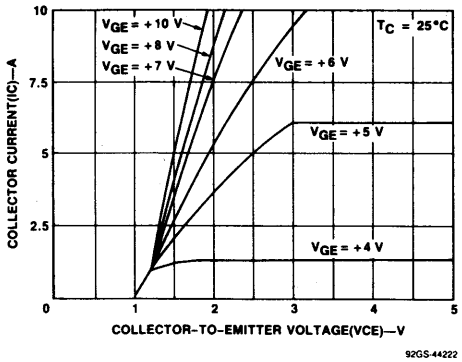

Fig. 4 - Typical saturation characteristics for all types.

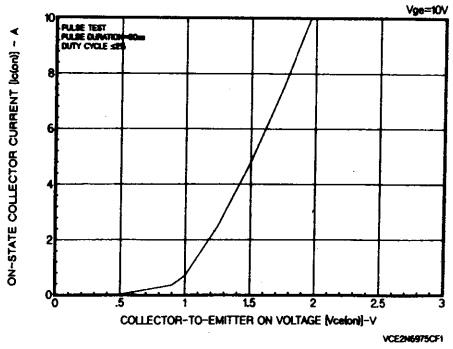

Fig. 5 - Typical collector-to-emitter on-voltage as a function of collector current for all types.

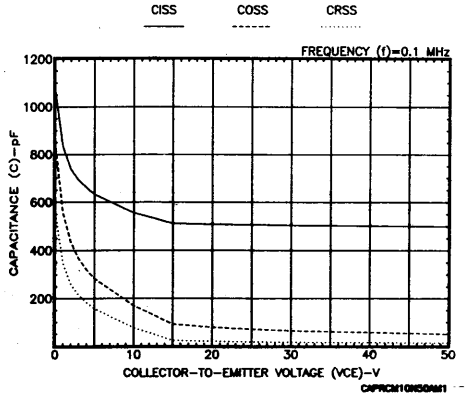

Fig. 6 - Capacitance as a function of collector-to-emitter voltage for all types.

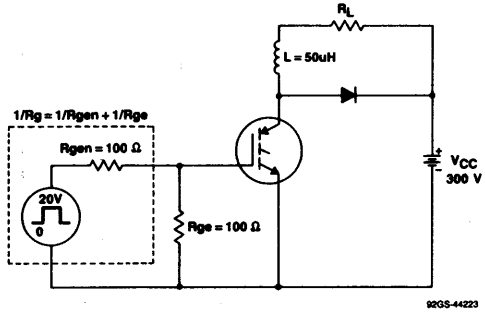

Fig. 7 - Inductive switching test circuit.

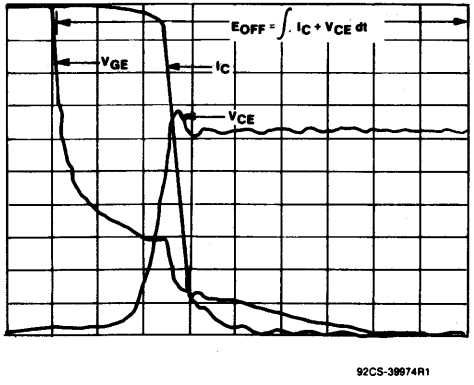

Fig. 8 - Typical inductive switching waveforms.

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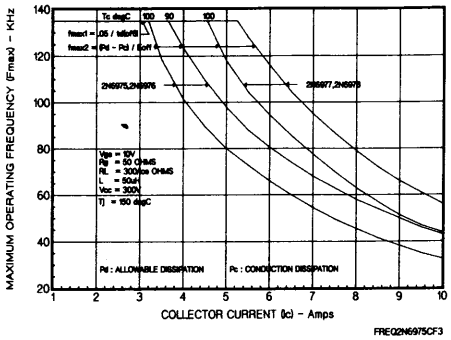

Fig. 9 - Maximum operating frequency vs collector current (typical).

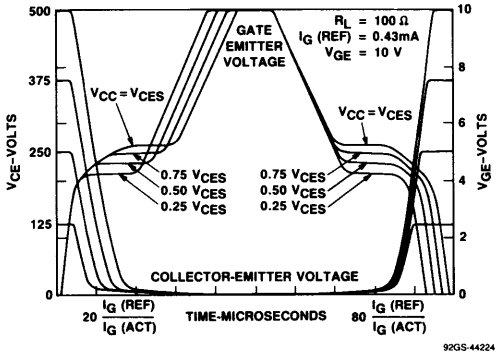

Fig. 10 - Normalized switching waveforms at constant gate current. (Refer to RCA application notes AN-7254 and AN7260.)