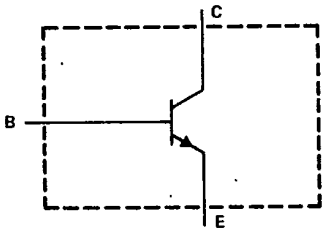
2N3713, 2N3714, 2N3715, 2N3716
N-P-N SILICON POWER TRANSISTORS

T-33-13

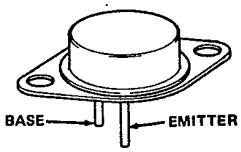
FEBRUARY 1968 – REVISED OCTOBER 1984

- 150 W at 25°C Case Temperature
- 10 A Continuous Collector Current
- 15 A Peak Collector Current
- Min f_{hfe} of 30 kHz
- Min f_T of 4 MHz
- Designed for Use in Power Amplifier and Switching Applications

device schematic



TO-3 PACKAGE



THE COLLECTOR IS IN ELECTRICAL CONTACT WITH THE CASE

2 2N Devices

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

	2N3713	2N3714	2N3715	2N3716
*Collector-base voltage	80 V	100 V	80 V	100 V
*Collector-emitter voltage (I_B = 0)	60 V	80 V	60 V	80 V
*Emitter-base voltage	7 V			
*Continuous collector current	10 A			
Peak collector current (see Note 1)	15 A			
*Continuous base current	4 A			
*Continuous device dissipation at (or below) 25°C case temperature (see Note 2)	150 W			
Continuous device dissipation at (or below) 25°C free-air temperature (see Note 3)	4 W			
Lead temperature 1,6 mm (0.0625 inch) from case for 10 seconds	235°C			
*Safe operating areas at (or below) 25°C case temperature	See Figures 8 and 9			
*Operating junction and storage temperature range	−65°C to 200°C			

NOTES: 1. This value applies for t_w = 0.3 ms, duty cycle ≤ 10%.
2. Derate linearly to 200°C case temperature at the rate of 0.855 W/°C.
3. Derate linearly to 200°C free-air temperature at the rate of 22.9 mW/°C.

*JEDEC registered data.

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2N3713, 2N3714, 2N3715, 2N3716
N-P-N SILICON POWER TRANSISTORS

electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS			2N3713			2N3714			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$V_{(BR)CEO}$	I_C = 0.2 A,	I_B = 0,	See Note 4	60			80			V
I_{CEO}	V_{CE} = 30 V,	I_B = 0				0.7				mA
	V_{CE} = 40 V,	I_B = 0							0.7	
I_{CEV}	V_{CE} = 80 V,	V_{BE} = −1.5 V				1				mA
	V_{CE} = 60 V,	V_{BE} = −1.5 V,	T_C = 150°C			10				
	V_{CE} = 100 V,	V_{BE} = −1.5 V							1	
	V_{CE} = 80 V,	V_{BE} = −1.5 V,	T_C = 150°C						10	
I_{EBO}	V_{EB} = 7 V,	I_C = 0				1			1	mA
h_{FE}	V_{CE} = 2 V,	I_C = 1 A,	See Notes 4 and 5	25		75	25		75	
	V_{CE} = 2 V,	I_C = 3 A,	See Notes 4 and 5	15			15			
	V_{CE} = 2 V,	I_C = 10 A,	See Notes 4 and 5	5			5			
V_{BE}	V_{CE} = 2 V,	I_C = 5 A,	See Notes 4 and 5			2			2	V
	V_{CE} = 4 V,	I_C = 10 A,	See Notes 4 and 5			4			4	
$V_{CE(sat)}$	I_B = 0.5 A,	I_C = 5 A,	See Notes 4 and 5			1			1	V
	I_B = 2 A,	I_C = 10 A,	See Notes 4 and 5			4			4	
h_{fe}	V_{CE} = 10 V,	I_C = 0.5 A,	f = 1 kHz	25		250	25		250	
$\lvert h_{fe} \rvert$	V_{CE} = 10 V,	I_C = 0.5 A,	f = 1 MHz	4			4			
f_{hfe}	V_{CE} = 10 V,	I_C = 0.5 A,	See Note 6	30			30			kHz
C_{obo}	V_{CB} = 10 V,	I_E = 0,	f = 100 kHz			250			250	pF

electrical characteristics at 25°C case temperature (unless otherwise noted)

PARAMETER	TEST CONDITIONS			2N3715			2N3716			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$V_{(BR)CEO}$	I_C = 0.2 A,	I_B = 0,	See Note 4	60			80			V
I_{CEO}	V_{CE} = 30 V,	I_B = 0				0.7				mA
	V_{CE} = 40 V,	I_B = 0							0.7	
I_{CEV}	V_{CE} = 0 V,	V_{BE} = −1.5 V				1				mA
	V_{CE} = 60 V,	V_{BE} = −1.5 V,	T_C = 150°C			10				
	V_{CE} = 100 V,	V_{BE} = −1.5 V							1	
	V_{CE} = 80 V,	V_{BE} = −1.5 V,	T_C = 150°C						10	
I_{EBO}	V_{EB} = 7 V,	I_C = 0				1			1	mA
h_{FE}	V_{CE} = 2 V,	I_C = 1 A,	See Notes 4 and 5	50		150	50		150	
	V_{CE} = 2 V,	I_C = 3 A,	See Notes 4 and 5	30			30			
	V_{CE} = 2 V,	I_C = 10 A,	See Notes 4 and 5	5			5			
V_{BE}	V_{CE} = 2 V,	I_C = 5 A,	See Notes 4 and 5			1.8			1.8	V
	V_{CE} = 4 V,	I_C = 10 A,	See Notes 4 and 5			4			4	
$V_{CE(sat)}$	I_B = 0.5 A,	I_C = 5 A,	See Notes 4 and 5			1			1	V
	I_B = 2 A,	I_C = 10 A,	See Notes 4 and 5			4			4	
h_{fe}	V_{CE} = 10 V,	I_C = 0.5 A,	f = 1 kHz	25		250	25		250	
$\lvert h_{fe} \rvert$	V_{CE} = 10 V,	I_C = 0.5 A,	f = 1 MHz	4			4			
f_{hfe}	V_{CE} = 10 V,	I_C = 0.5 A,	See Note 6	30			30			kHz
C_{obo}	V_{CB} = 10 V,	I_E = 0,	f = 100 kHz			250			250	pF

NOTES: 4. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.

5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts and located within 1,6 mm (0.0625 inch) from the device body.

6. f_{hfe} is the frequency at which the magnitude of the small-signal forward current transfer is 0.707 of its low-frequency value. For these devices, the reference measurement is made at 1 kHz.

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thermal characteristics

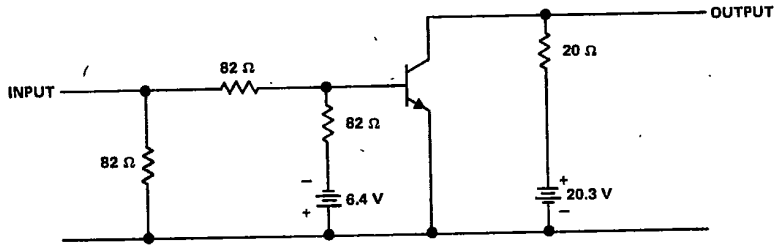
PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JC}$			1.17	°C/W
$R_{\theta JA}$			43.7	°C/W

resistive-load switching characteristics at 25°C case temperature

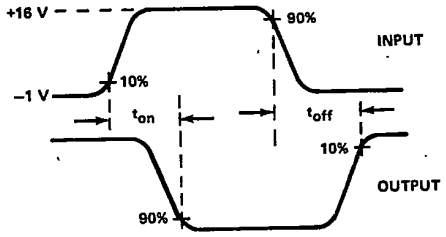
PARAMETER	TEST CONDITIONS†	MIN	TYP	MAX	UNIT
t_{on}	I_C = 1 A, I_{B1} = 0.1 A, I_{B2} = −0.1 A,		450		ns
t_{off}	$V_{BE(off)}$ = −3.7 V, R_L = 20 Ω, See Figure 1		350		ns

†Voltage and current values shown are nominal; exact values vary slightly with transistor parameters.

PARAMETER MEASUREMENT INFORMATION



TEST CIRCUIT



VOLTAGE WAVEFORMS

NOTES: A. The input waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50\ \Omega$, $t_w = 10\ \mu s$, duty cycle ≤ 2%.
B. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 15$ ns, $R_{in} \geq 10\ M\Omega$, $C_{in} \leq 11.5$ pF.
C. Resistors must be noninductive types.
D. The d-c power supplies may require additional bypassing in order to minimize ringing.

FIGURE 1. RESISTIVE-LOAD SWITCHING

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N-P-N SILICON POWER TRANSISTORS

TYPICAL CHARACTERISTICS

2N3713, 2N3714
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

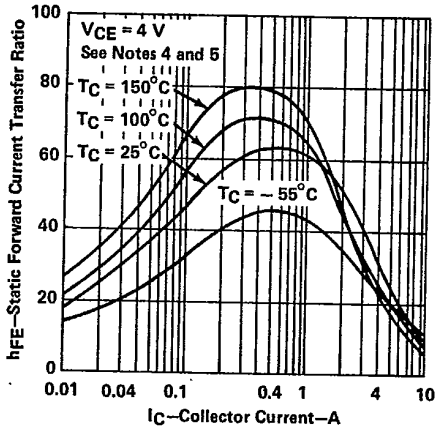

FIGURE 2

2N3715, 2N3716
STATIC FORWARD CURRENT TRANSFER RATIO
vs
COLLECTOR CURRENT

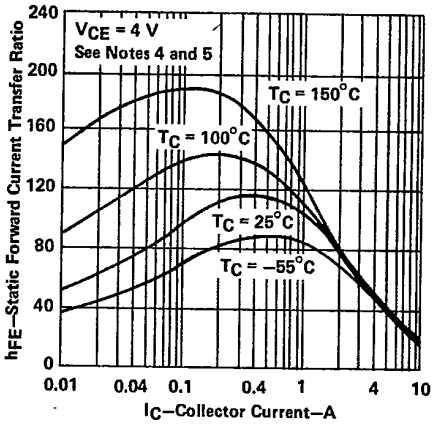

FIGURE 3

BASE-EMITTER VOLTAGE
vs
CASE TEMPERATURE

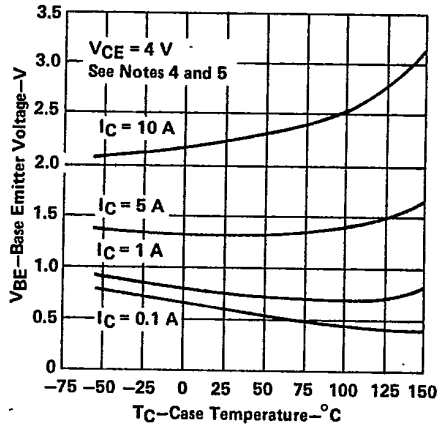

FIGURE 4

COLLECTOR-EMITTER SATURATION VOLTAGE
vs
CASE TEMPERATURE

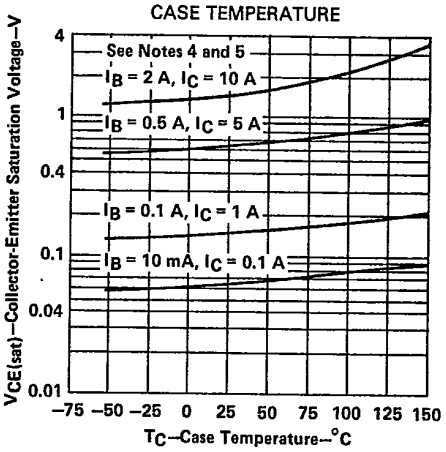

FIGURE 5

NOTES: 4. These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.
5. These parameters are measured with voltage-sensing contacts separate from the current-carrying contacts and located within 1,6 mm (0.0625 inch) from the device body.

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TYPICAL CHARACTERISTICS

NORMALIZED COLLECTOR-EMITTER BREAKDOWN VOLTAGE vs BASE-EMITTER RESISTANCE

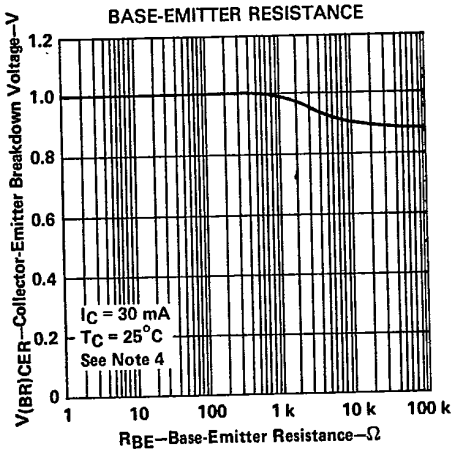

FIGURE 6

COMMON-BASE OPEN-CIRCUIT OUTPUT CAPACITANCE vs COLLECTOR-BASE VOLTAGE

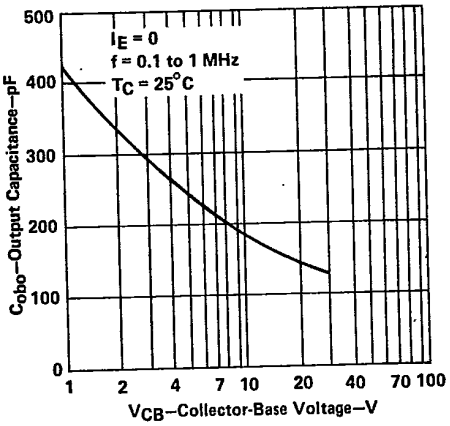

FIGURE 7

NOTE 4: These parameters must be measured using pulse techniques, t_w = 300 μs, duty cycle ≤ 2%.

MAXIMUM SAFE OPERATING AREA

2N3713, 2N3715
FORWARD-BIAS SAFE OPERATING AREA

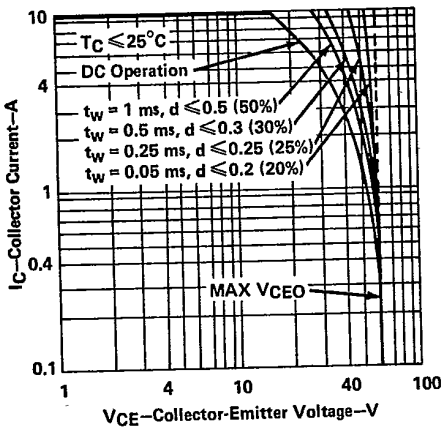

FIGURE 8

2N3714, 2N3716
FORWARD-BIAS SAFE OPERATING AREA

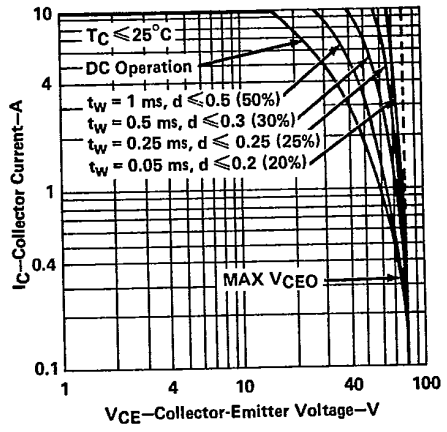

FIGURE 9

2N3713, 2N3714, 2N3715, 2N3716
N-P-N SILICON POWER TRANSISTORS

THERMAL INFORMATION

DISSIPATION DERATING CURVE

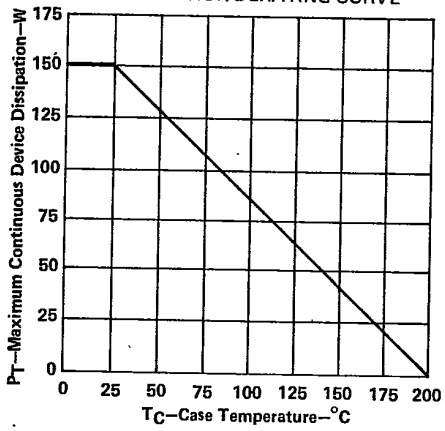

FIGURE 10

PEAK POWER COEFFICIENT CURVE

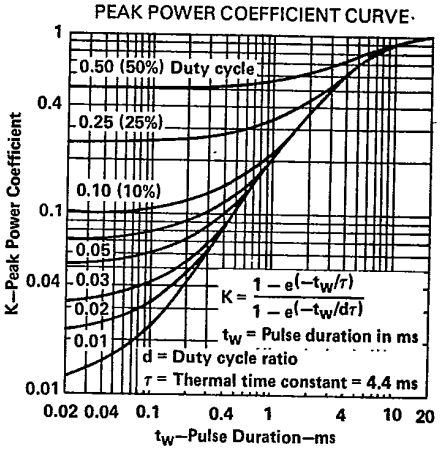

FIGURE 11

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This file is the datasheet for the following electronic components:

2N3713 - http://www.ti.com/product/2n3713?HQS=TI-null-null-dscatalog-df-pf-null-wwe

2N3714 - http://www.ti.com/product/2n3714?HQS=TI-null-null-dscatalog-df-pf-null-wwe

2N3715 - http://www.ti.com/product/2n3715?HQS=TI-null-null-dscatalog-df-pf-null-wwe

2N3716 - http://www.ti.com/product/2n3716?HQS=TI-null-null-dscatalog-df-pf-null-wwe