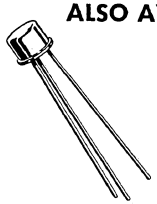
2N2218 (SILICON)
2N2219
2N2221
2N2222
2N2904 thru 2N2907

$V_{CEO} = 30$ V
$f_T = 400$ Mc Typ

ALSO AVAILABLE AS JAN AND HI-REL UNITS

CASE 22
(TO-18)

2N2221
2N2222
2N2906
2N2907



CASE 31
(TO-5)

2N2218, 2N2219,
2N2904, 2N2905

Silicon annular star transistors for high-speed switching and DC to UHF amplifier applications. NPN types 2N2218 thru 2N2222 are complementary to PNP types 2N2904 thru 2N2907.

Collector connected to case

MAXIMUM RATINGS

Characteristic	Symbol	NPN	PNP	Unit
Collector - Base Voltage	V_{CBO}	60	60	Vdc
Collector - Emitter Voltage	V_{CEO}	30	40	Vdc
Emitter - Base Voltage	V_{EBO}	5	5	Vdc
Collector Current	I_C	800	600	mAdc
Total Device Dissipation @ 25°C Case Temperature	P_D			
To - 5: 2N2218, 2N2219		3		W
Derate Above 25°C		20		mW/°C
2N2904, 2N2905			3	W
Derate Above 25°C			17.2	mW/°C
To - 18: 2N2221, 2N2222		1.8		W
Derate Above 25°C		12		mW/°C
2N2906, 2N2907			1.8	W
Derate Above 25°C			10.3	mW/°C
Total Device Dissipation @ 25°C Ambient Temperature	P_D			
To - 5: 2N2218, 2N2219		0.8		W
Derate Above 25°C		5.33		mW/°C
2N2904, 2N2905			0.6	W
Derate Above 25°C			3.43	mW/°C
To - 18: 2N2221, 2N2222		0.5		W
Derate Above 25°C		3.33		mW/°C
2N2906, 2N2907			0.4	W
Derate Above 25°C			2.28	mW/°C
Operating Junction Temperature	T_J	-65 to +175	-65 to+200	°C
Storage Temperature	T_{stg}	-65 to + 200	-65 to +200	°C

2N2218 SERIES, 2N2904 SERIES (continued)

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

Static Characteristic		Fig. No.	Symbol	Min	Max	Unit
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	All Types	---	BV_{CBO}	60	---	Vdc
Collector-Emitter Breakdown Voltage* (I_C = 10 mAdc, I_B = 0)	2N2218-19, 2N2221-22 2N2904 thru 2N2907	9	BV_{CEO}*	30 40	--- ---	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	All Types	---	BV_{EBO}	5	---	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	2N2218-19, 2N2221-22 2N2904 thru 2N2907	---	I_{CBO}	--- ---	.01 .02	μAdc
(V_{CB} = 50 Vdc, I_E = 0, T_A = 150°C)	2N2218-19, 2N2221-22 2N2904 thru 2N2907			--- ---	10 20	
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0.5 Vdc)	2N2904 thru 2N2907	---	I_{CEX}	---	50	nAdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0.5 Vdc)	2N2904 thru 2N2907	---	I_{BL}	---	50	nAdc
Collector-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	All Types All Types	12, 15	$V_{CE(sat)}$*	--- ---	0.4 1.6	Vdc
Base-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	All Types All Types	13, 16	$V_{BE(sat)}$*	--- ---	1.3 2.6	Vdc
DC Forward Current Transfer Ratio (I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	2N2218, 2N2221, 2N2904, 2N2906 2N2219, 2N2222, 2N2905, 2N2907	10 11	h_{FE}	20 35	--- ---	---
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N2218, 2N2221, 2N2904, 2N2906 2N2219, 2N2222, 2N2905, 2N2907			25 50	--- ---	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N2218, 2N2221, 2N2904, 2N2906 2N2219, 2N2222, 2N2905, 2N2907			35 75	--- ---	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)*	2N2218, 2N2221, 2N2904, 2N2906 2N2219, 2N2222, 2N2905, 2N2907			40 100	120 300	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)*	2N2218, 2N2221, 2N2904, 2N2906 2N2219, 2N2222, 2N2905, 2N2907			20 30	--- ---	

Dynamic Characteristic		Fig. No.	Symbol	Min	Typ	Max	Unit
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kc)	All Types	4	C_{ob}	---	---	8	pf
Input Capacitance (V_{BE} = 0.5 Vdc, I_C = 0, f = 100 kc) (V_{BE} = 2 Vdc, I_C = 0, f = 100 kc)	2N2218-19, 2N2221-22 2N2904 thru 2N2907	4	C_{ib}	--- ---	--- ---	30 30	pf
Current Gain - Bandwidth Product (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 mc) (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 100 mc)	2N2218-19, 2N2221-22 2N2904 thru 2N2907	8	f_T	250 200	--- ---	--- ---	mc
Delay Time	2N2904 thru 2N2907	1	t_d	---	6	10	nsec
Rise Time	2N2904 thru 2N2907	1	t_r	---	20	40	nsec
Turn-On Time	2N2218-19, 2N2221-22 2N2904 thru 2N2907	1	t_{on}	--- ---	26 26	--- 45	nsec
Storage Time	2N2904 thru 2N2907	2	t_s	---	50	80	nsec
Fall Time	2N2904 thru 2N2907	2	t_f	---	20	30	nsec
Turn-Off Time	2N2218-19, 2N2221-22 2N2904 thru 2N2907	2	t_{off}	--- ---	70 70	--- 100	nsec
Total Switching Time	All Types	3	t_{total}	---	12	---	nsec

*Pulse Test, Pulse Width ≤ 300 μsec, Duty Cycle ≤ 2%

PNP SWITCHING-TIME CIRCUITS

For NPN Switching Tests, reverse diodes, polarities, and input pulses.

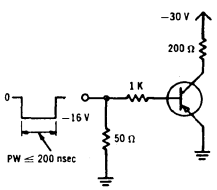


FIGURE 1 — SATURATED TURN-ON SWITCHING-TIME TEST CIRCUIT

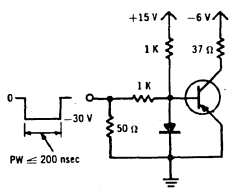


FIGURE 2 — SATURATED TURN-OFF SWITCHING-TIME TEST CIRCUIT

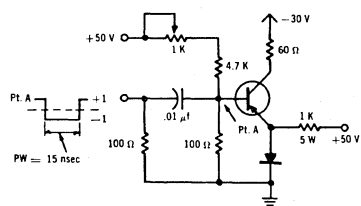


FIGURE 3 — NON-SATURATED SWITCHING-TIME TEST CIRCUIT

2N2218 SERIES, 2N2904 SERIES (continued)

FIGURE 4 — CAPACITANCE VARIATIONS versus VOLTAGE

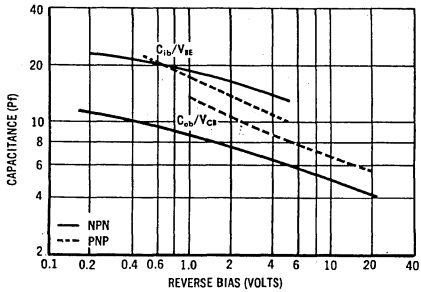


FIGURE 5 — ACTIVE REGION TIME CONSTANT versus COLLECTOR CURRENT

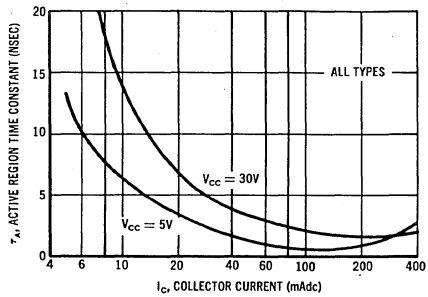


FIGURE 6 — TOTAL CONTROL CHARGE versus BASE CURRENT

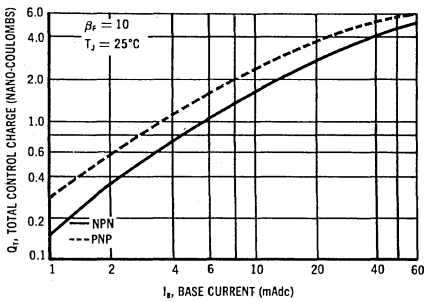
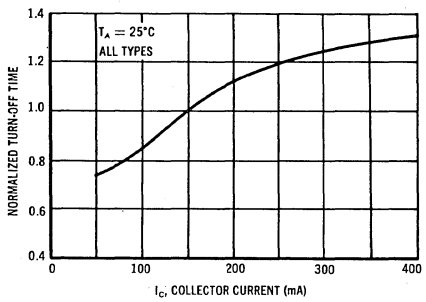
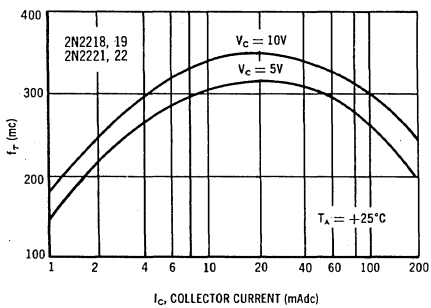


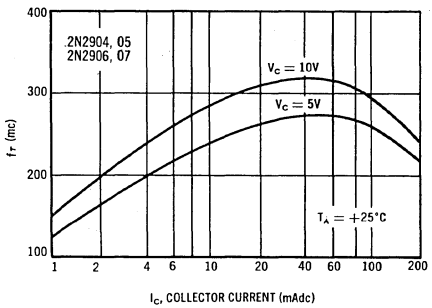
FIGURE 7 — NORMALIZED TURN-OFF TIME versus COLLECTOR CURRENT



NPN PNP

FIGURE 8 — CURRENT-GAIN — BANDWIDTH PRODUCT versus COLLECTOR CURRENT





2N2218 SERIES, 2N2904 SERIES (continued)

NPN PNP

FIGURE 9 — COLLECTOR CURRENT versus MINIMUM COLLECTOR-EMITTER BREAKDOWN VOLTAGE

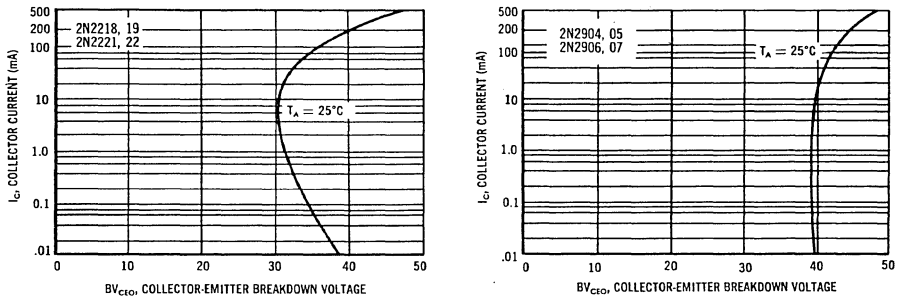


FIGURE 10 — LOW CURRENT GAIN

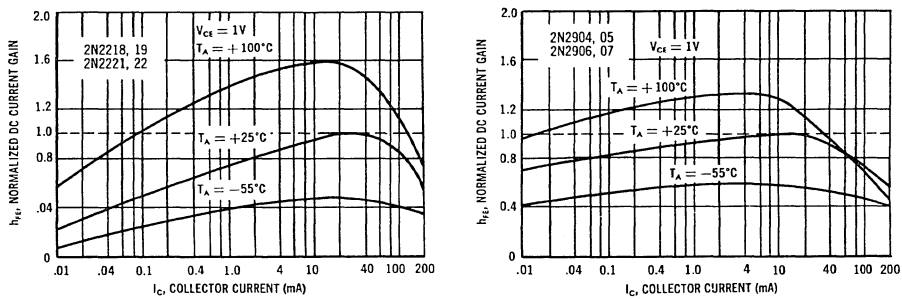
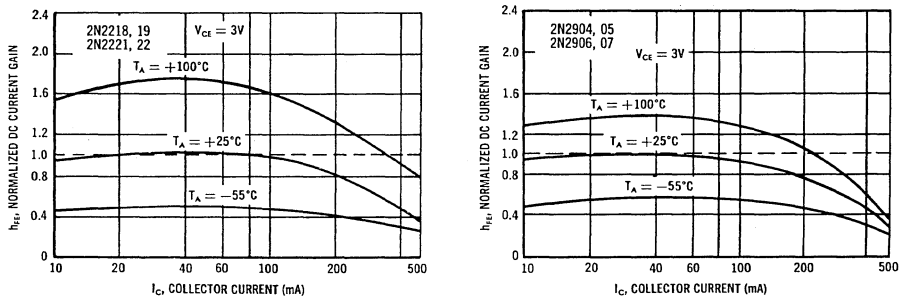


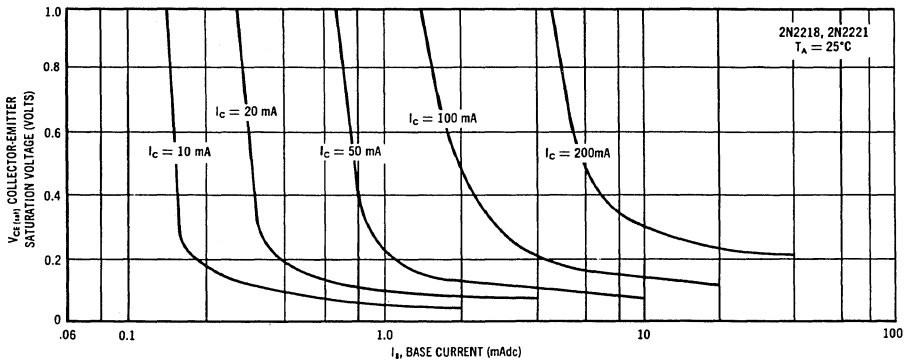
FIGURE 11 — HIGH CURRENT GAIN



2N2218 SERIES, 2N2904 SERIES (continued)

NPN

FIGURE 12 — COLLECTOR SATURATION VOLTAGE versus BASE CURRENT



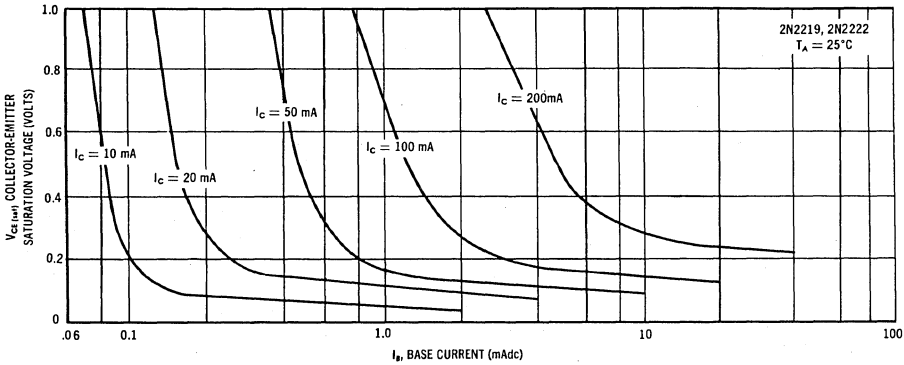


FIGURE 13 — BASE SATURATION VOLTAGE versus BASE CURRENT

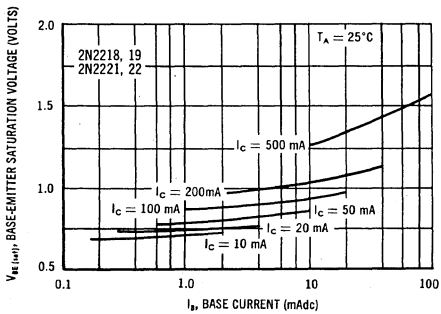
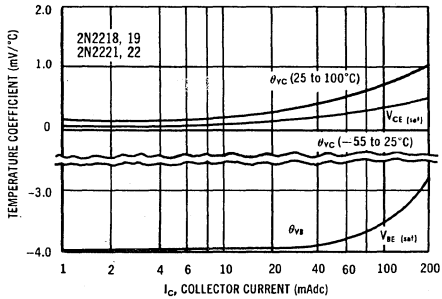


FIGURE 14 — TEMPERATURE COEFFICIENTS



2N2218 SERIES, 2N2904 SERIES (continued)

PNP

FIGURE 15 — COLLECTOR SATURATION VOLTAGE versus BASE CURRENT

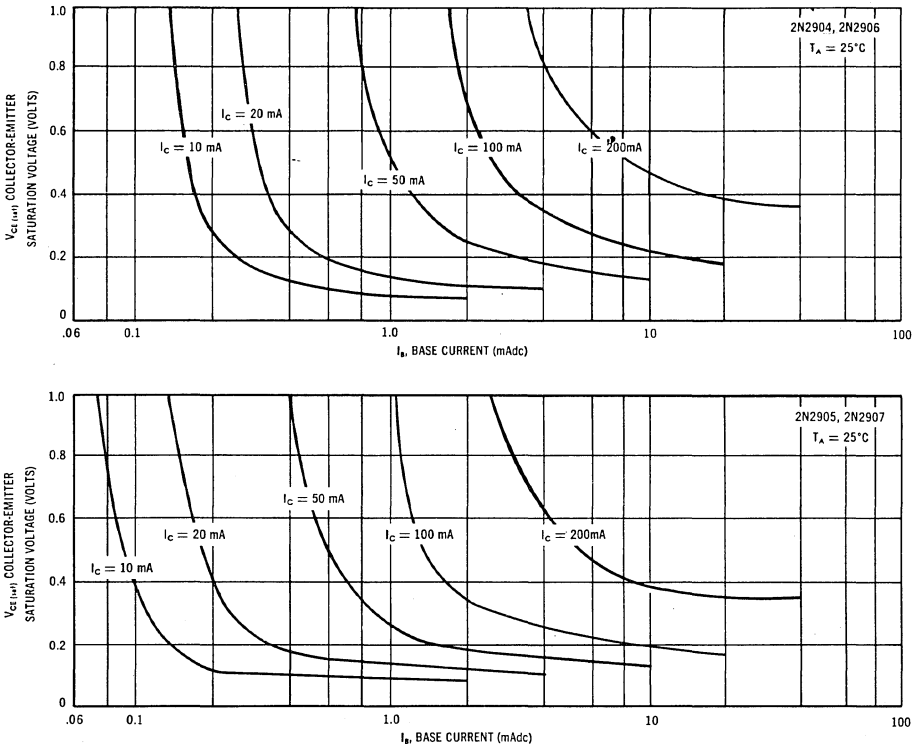


FIGURE 16 — BASE SATURATION versus BASE CURRENT

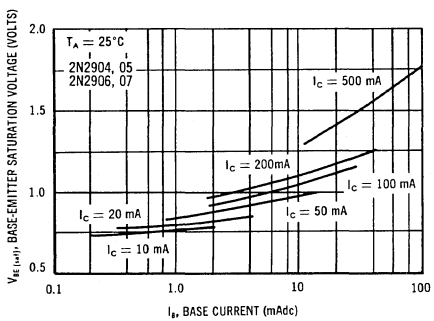
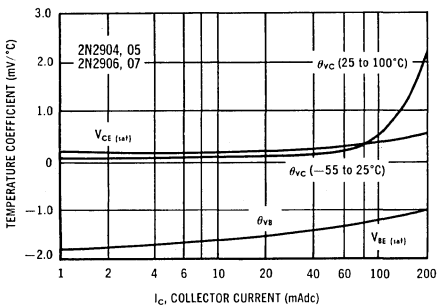


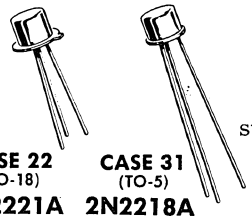
FIGURE 17 — TEMPERATURE COEFFICIENTS



2N2218A (SILICON)
2N2219A
2N2221A
2N2222A

ALSO AVAILABLE AS JAN AND HI-REL UNITS

$V_{CEO} = 40$ V
$f_T = 400$ Mc Typ



CASE 22 (TO-18) **2N2221A 2N2222A**

CASE 31 (TO-5) **2N2218A 2N2219A**

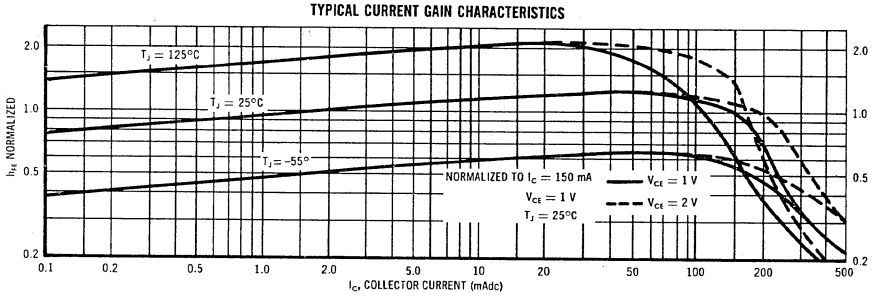
NPN silicon annular Star transistors for high-speed switching and DC to VHF amplifier applications.

Collector connected to case

MAXIMUM RATINGS

Characteristic	Symbol	2N2218A 2N2219A (TO-5)	2N2221A 2N2222A (TO-18)	Unit
Collector-Base Voltage	V_{CBO}	75	75	Vdc
Collector-Emitter Voltage	V_{CEO}	40	40	Vdc
Emitter-Base Voltage	V_{EBO}	6	6	Vdc
Total Device Dissipation at 25°C Case Temperature Derating Factor Above 25°C	P_D	3 20	1.8 12	Watts mW/°C
Total Device Dissipation at 25°C Ambient Temperature Derating Factor Above 25°C	P_D	0.8 5.33	0.5 3.33	Watts mW/°C
Junction Temperature Range	T_J	-65 to +175		°C
Storage Temperature Range	T_{stg}	-65 to +200		°C

TYPICAL CURRENT GAIN CHARACTERISTICS



2N2218A, 2N2219A, 2N2221A , 2N2222A (continued)

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

Static Characteristics		Symbol	Min	Max	Unit
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	All Types	BV_{CBO}	75	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	All Types	BV_{CEO}	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	All Types	BV_{EBO}	6	—	Vdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0)	All Types	I_{CBO}	—	0.01	μAdc
(V_{CB} = 60 Vdc, I_E = 0, T_A = 150°C)	All Types		—	10	
Collector Cutoff Current (V_{CE} = 60 Vdc, V_{OB} = 3Vdc)	All Types	I_{CEX}	—	10	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, V_{OB} = 3 Vdc)	All Types	I_{BL}	—	20	nAdc
Emitter Cutoff Current (V_{OB} = 3 Vdc, I_C = 0)	All Types	I_{EBO}	—	10	nAdc
Collector-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc)	All Types	$V_{CE(sat)}$*	—	0.3	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)	All Types		—	1.0	
Base-Emitter Saturation Voltage* (I_C = 150 mAdc, I_B = 15 mAdc)	All Types	$V_{BE(sat)}$*	0.6	1.2	Vdc
(I_C = 500 mAdc, I_B = 50 mAdc)	All Types		—	2.0	
DC Forward Current Transfer Ratio* (I_C = 0.1 mAdc, V_{CE} = 10 Vdc)	2N2218A, 2N2221A	h_{FE}*	20	—	—
	2N2219A, 2N2222A		35	—	
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc)	2N2218A, 2N2221A		25	—	
	2N2219A, 2N2222A		50	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc)	2N2218A, 2N2221A		35	—	
	2N2219A, 2N2222A		75	—	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = -55°C)	2N2218A, 2N2221A		15	—	
	2N2219A, 2N2222A		35	—	
(I_C = 150 mAdc, V_{CE} = 10 Vdc)	2N2218A, 2N2221A		40	120	
	2N2219A, 2N2222A		100	300	
(I_C = 150 mAdc, V_{CE} = 1.0 Vdc)	2N2218A, 2N2221A		20	—	
	2N2219A, 2N2222A		50	—	
(I_C = 500 mAdc, V_{CE} = 10 Vdc)	2N2218A, 2N2221A		25	—	
	2N2219A, 2N2222A		40	—	

* Pulse Test ≤300 μsec, duty cycle ≤2%

V_{OB} - Base-Emitter Reverse Bias

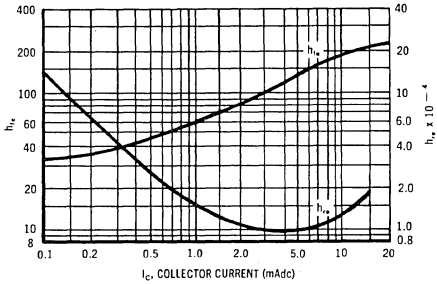
SMALL SIGNAL CHARACTERISTICS		Symbol	Min	Max	Unit
Small Signal Current Gain (I_C = 1.0 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A	h_{fe}	30	150	—
	2N2219A, 2N2222A		50	300	
(I_C = 10 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A		50	300	
	2N2219A, 2N2222A		75	375	
Voltage Feedback Ratio (I_C = 1.0 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A	h_{re}	-	5	$X10^{-4}$
	2N2219A, 2N2222A		-	8	
(I_C = 10 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A		-	2.5	
	2N2219A, 2N2222A		-	4	
Input Impedance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A	h_{ie}	1	3.5	k ohms
	2N2219A, 2N2222A		2.0	8	
(I_C = 10 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A		0.2	1.0	
	2N2219A, 2N2222A		0.25	1.25	
Output Admittance (I_C = 1.0 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A	h_{oe}	3	15	μmhos
	2N2219A, 2N2222A		5	35	
(I_C = 10 mA, V_{CE} = 10 V, f = 1 kc)	2N2218A, 2N2221A		10	100	
	2N2219A, 2N2222A		25	200	
Collector-Base Time Constant (I_C = 20 mA, V_{CE} = 20 V, f = 31.8 mc)		r'_bC_c	-	150	psec
Noise Figure (I_C = 100 μA, V_{CE} = 10 V, Rg = 1 kΩ, f = 1 kc)	2N2219A, 2N2222A	NF	-	4	db

2N2218A, 2N2219A, 2N2221A , 2N2222 A (continued)

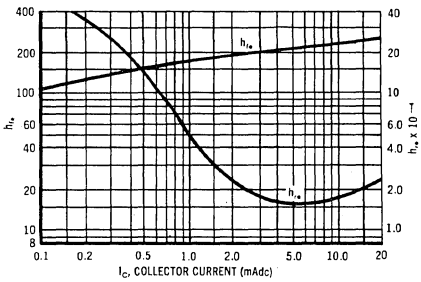
SMALL SIGNAL FORWARD CURRENT GAIN AND VOLTAGE FEEDBACK RATIO versus COLLECTOR CURRENT

V_{CE} = 10 V @ 1 Kc

2N2218A, 2N2221A



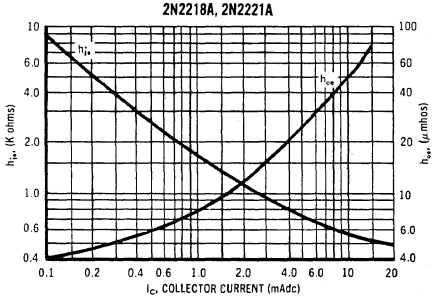
2N2219A, 2N2222A



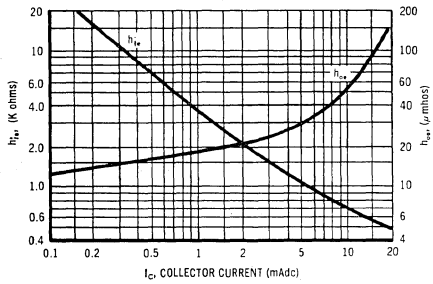
SMALL SIGNAL INPUT IMPEDANCE AND OUTPUT CONDUCTANCE versus COLLECTOR CURRENT

V_{CE} = 10 V @ 1 Kc

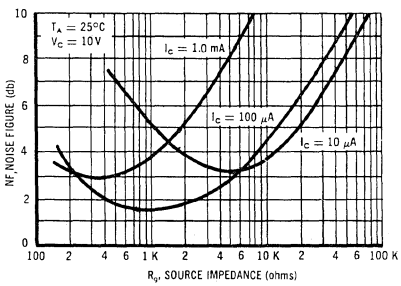
2N2218A, 2N2221A



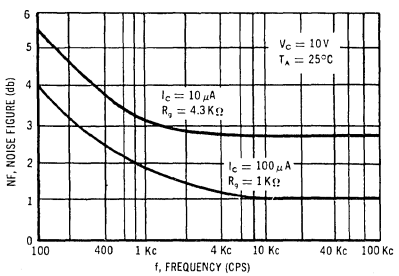
2N2219A, 2N2222A



1 KC NOISE FIGURE versus SOURCE IMPEDANCE

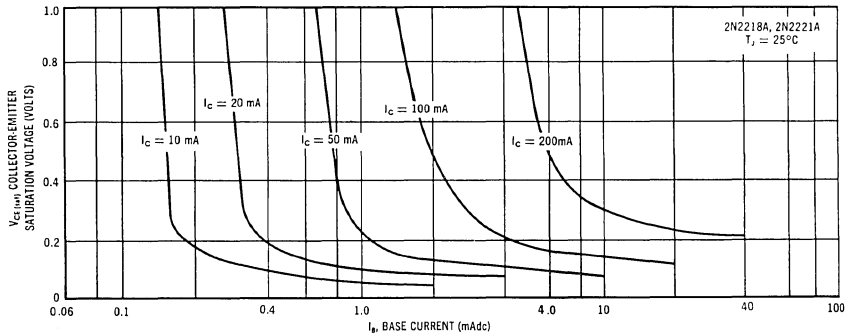


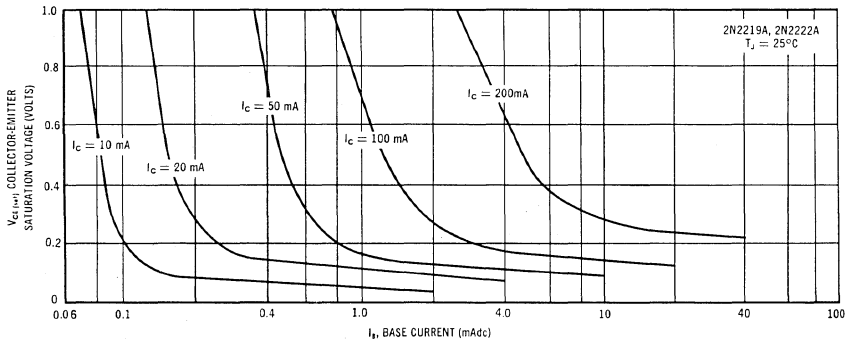
NOISE FIGURE versus FREQUENCY



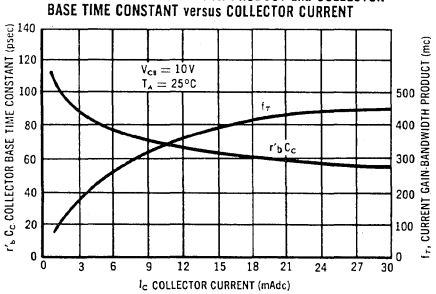
2N2218A, 2N2219A, 2N2221A, 2N2222A (continued)

COLLECTOR SATURATION VOLTAGE versus BASE CURRENT





CURRENT GAIN – BANDWIDTH PRODUCT and COLLECTOR BASE TIME CONSTANT versus COLLECTOR CURRENT



STORAGE AND FALL TIME versus COLLECTOR CURRENT