MOTOROLA
Semiconductors
BOX 955 • PHOENIX, ARIZONA 85001

2N5209
2N5210

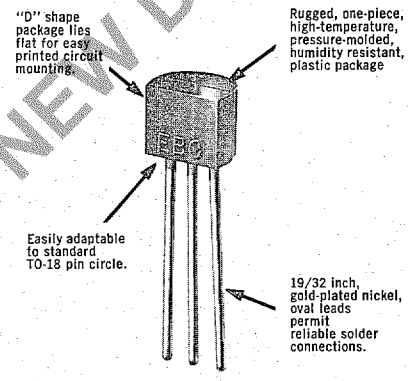
NPN SILICON AMPLIFIER TRANSISTORS

MARCH 1968 – DS 5241

NPN SILICON ANNULAR* TRANSISTORS

. . . NPN silicon annular transistors designed for low-level, low-noise amplifier applications and for complementary circuitry with PNP types 2N5086 and 2N5087.

- High Breakdown Voltage – BV_{CEO} = 50 Vdc (Min) @ I_C = 1.0 mA
- Low Noise Figure – @ f = 1.0 kHz
  2N5209 – NF = 4.0 dB (Max)
  2N5210 – NF = 3.0 dB (Max)
- High DC Current Gain at Low Current –
  2N5210 – h_{FE} = 200 @ I_C = 100 μA
- Low Current-Gain – Bandwidth Product to Facilitate Audio Frequency Design – f_T = 80 MHz (Typ)
- Low Leakage Current – I_{CBO} = 10 nA max @ V_{CB} = 10 V
- Low Collector Base Capacitance – C_{cb} = 4.0 pF (Max)

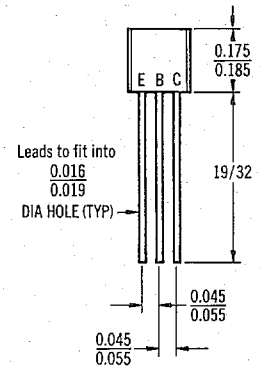


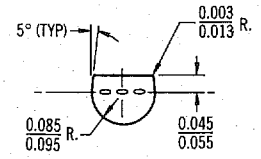
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CB}	50	Vdc
Emitter-Base Voltage	V_{EB}	4.5	Vdc
Collector Current – Continuous Peak	I_C	50 100	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	310 2.81	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +135	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Ambient	θ_{JA}	0.357	°C/mW





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CASE 29(1)

* Annular Semiconductors Patented by Motorola Inc.

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

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)		BV_{CEO}	50	-	-	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)		BV_{CBO}	50	-	-	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)		I_{CBO}	-	-	10	nAdc
(V_{CB} = 35 Vdc, I_E = 0)			-	-	50	
Emitter Cutoff Current (V_{BE} = 3.0 Vdc, I_C = 0)		I_{EBO}	-	-	50	nAdc
(V_{BE} = 4.5 Vdc, I_C = 0)			-	-	100	
ON CHARACTERISTICS						
DC Current Gain (I_C = 100 μAdc, V_{CE} = 5.0 Vdc)	2N5209	h_{FE}	100	-	300	-
	2N5210		200	-	600	
(I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)	2N5209		150	-	-	
	2N5210		250	-	-	
(I_C = 10 mAdc, V_{CE} = 5.0 Vdc)	2N5209		150	-	-	
	2N5210		250	-	-	
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)		$V_{CE(sat)}$	-	-	0.7	Vdc
Base-Emitter On Voltage (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc)		$V_{BE(on)}$	-	-	0.85	Vdc
SMALL-SIGNAL CHARACTERISTICS						
Current-Gain—Bandwidth Product (I_C = 500 μAdc, V_{CE} = 5.0 Vdc, f = 20 MHz)		f_T	30	80	-	MHz
Collector Base Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 100 kHz) (emitter guarded)		C_{cb}	-	-	4.0	pF
Small-Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)	2N5209	h_{fe}	150	-	600	-
	2N5210		250	-	900	
Noise Figure (I_C = 20 μAdc, V_{CE} = 5.0 Vdc, R_S = 22 k ohms,		NF				dB
f = 10 Hz to 15.7 kHz)	2N5209		-	-	3.0	
	2N5210		-	-	2.0	
(I_C = 20 μAdc, V_{CE} = 5.0 Vdc, R_S = 10 k ohms,						
f = 1.0 kHz)	2N5209		-	1.6	4.0	
	2N5210		-	1.4	3.0	

NOISE FIGURE
(V_{CE} = 5.0 Vdc, T_A = 25°C)

FIGURE 1 – NOISE FIGURE versus FREQUENCY

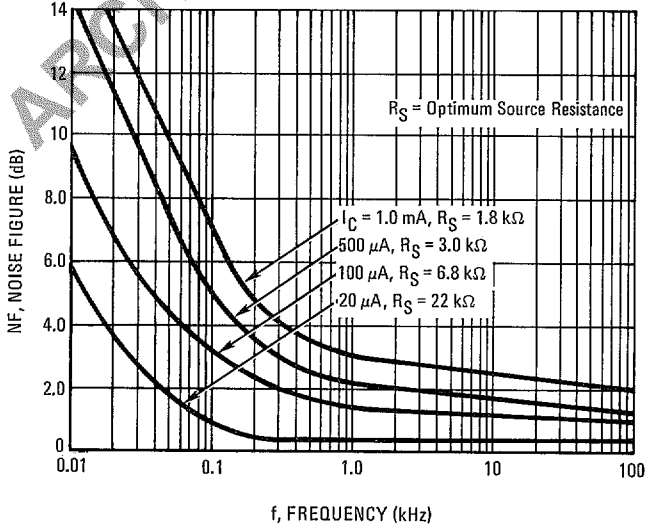
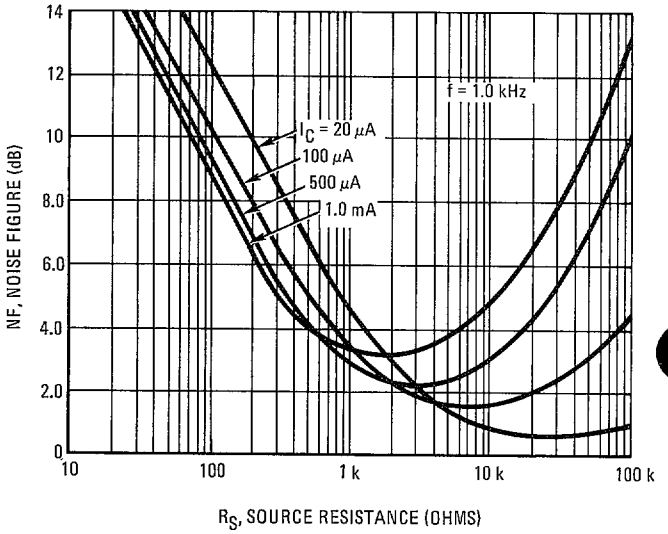


FIGURE 2 – NOISE FIGURE versus SOURCE RESISTANCE



h PARAMETERS

V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C

(For Figures 3, 4, 5, 6, 8)

This group of graphs illustrates the relationship of the "h" parameters for this series of transistors. To obtain these curves, 4 units were selected and identified by number — the same units were used to develop curves on each graph.

FIGURE 3 — INPUT IMPEDANCE versus COLLECTOR CURRENT

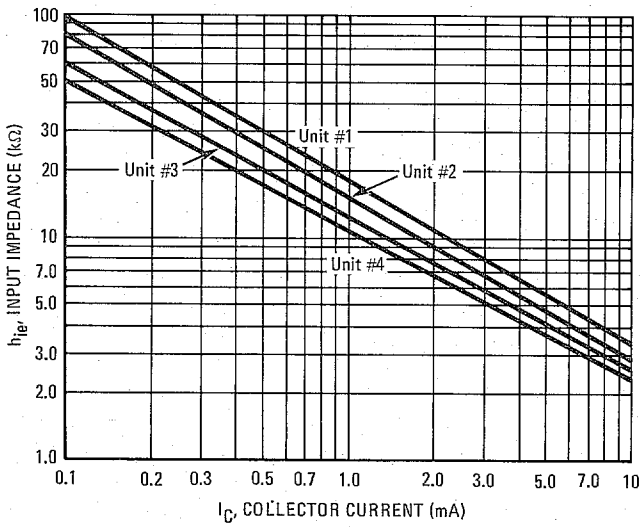


FIGURE 4 — VOLTAGE FEEDBACK RATIO versus COLLECTOR CURRENT

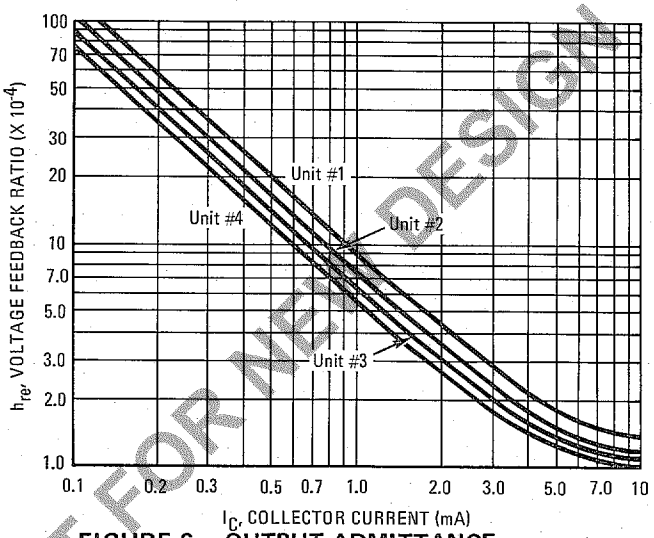


FIGURE 5 — CURRENT GAIN versus COLLECTOR CURRENT

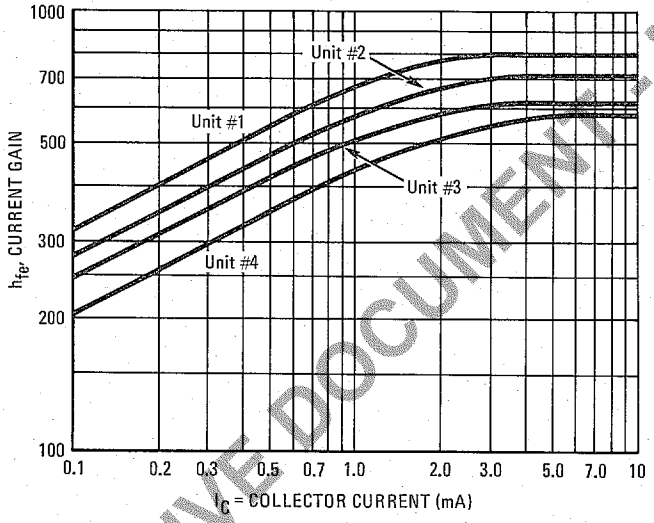


FIGURE 6 — OUTPUT ADMITTANCE versus COLLECTOR CURRENT

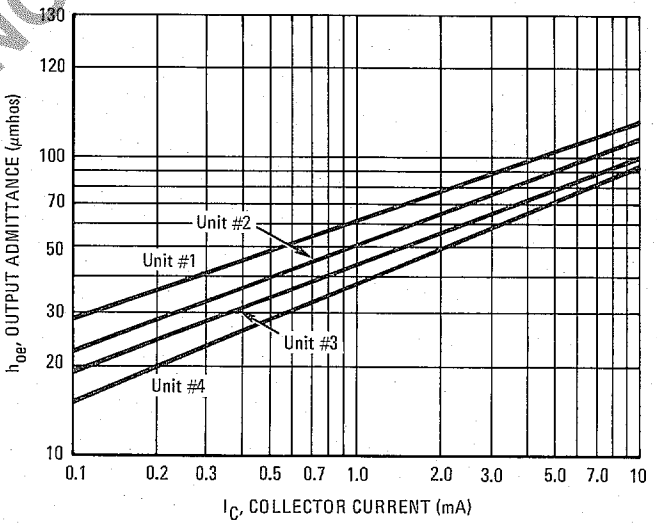


FIGURE 7 — EFFECT OF VOLTAGE

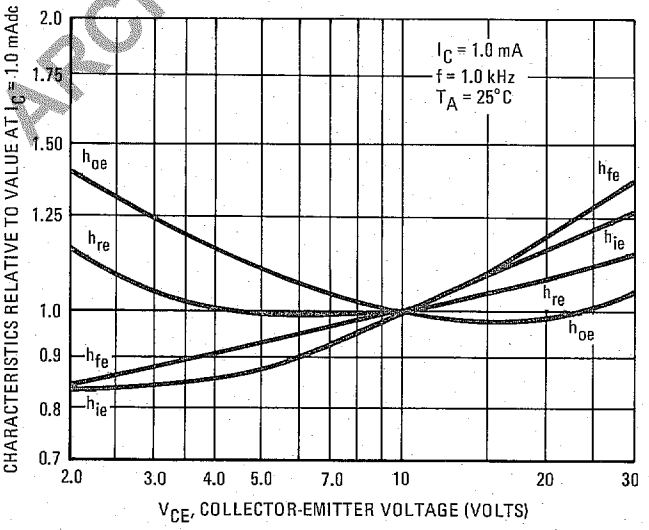


FIGURE 8 — HYBRID DETERMINANT versus COLLECTOR CURRENT

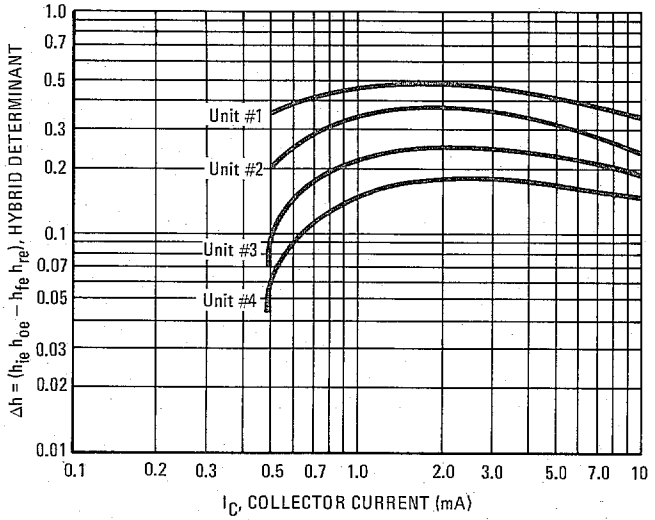


FIGURE 9 – DC CURRENT GAIN

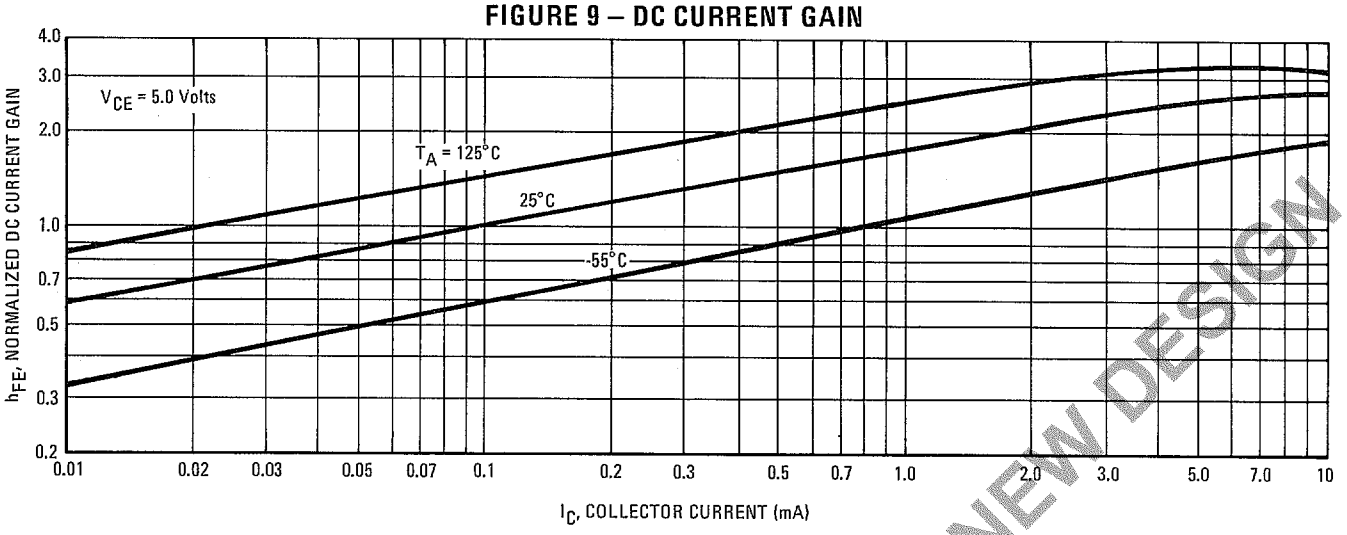


FIGURE 10 – COLLECTOR SATURATION REGION

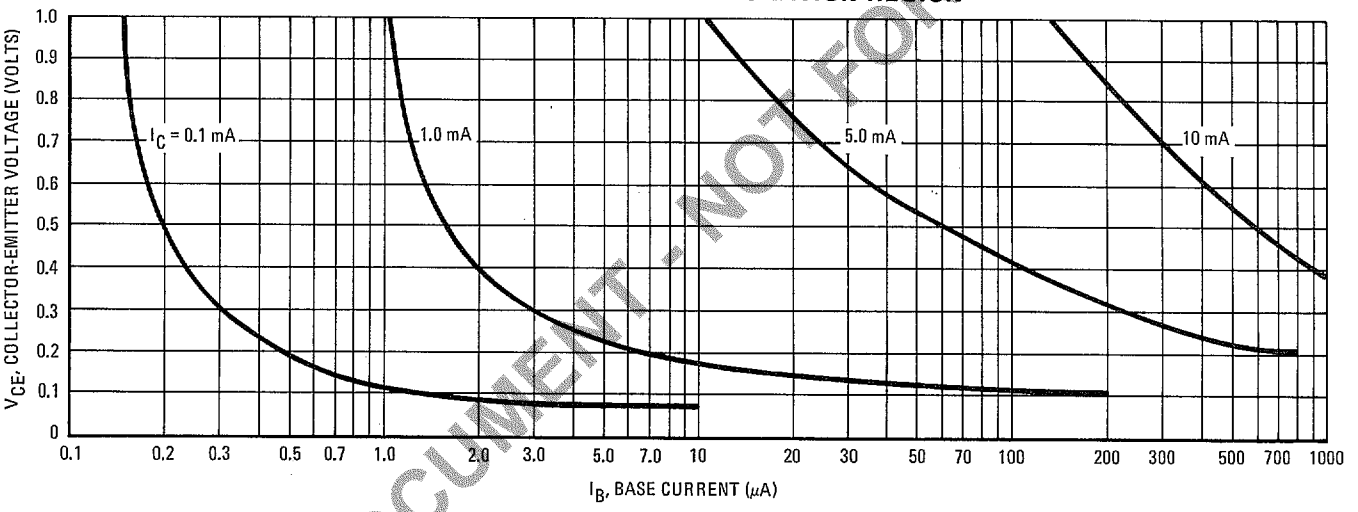


FIGURE 11 – CURRENT-GAIN – BANDWIDTH PRODUCT

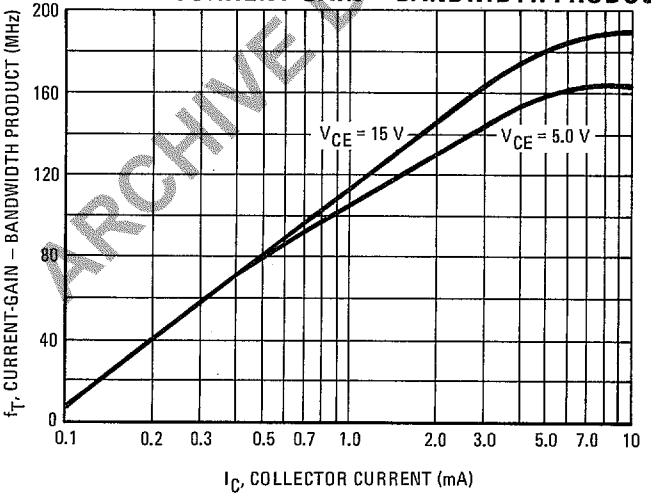
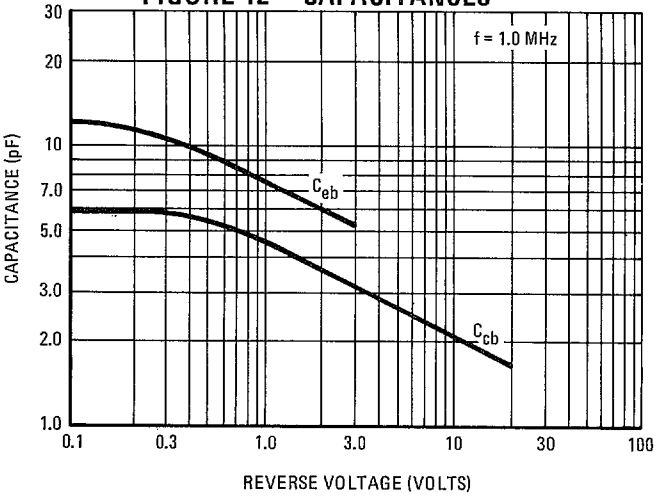


FIGURE 12 – CAPACITANCES



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