RCA
Solid State
Division

RF Power Transistors

2N5921

JEDEC TO-201AA H-1629

5-W, 2-GHz, Emitter-Ballasted Silicon N-P-N Overlay Transistor

For UHF/Microwave Power Amplifiers, Microwave Fundamental-Frequency Oscillators and Frequency Multipliers

Features:

- 5-W output with 5.5-dB gain (typ.) at 2.3 GHz
- 5-W output with 7-dB gain (min.) at 2 GHz
- 10-W output with 11-dB gain (typ.) at 1.2 GHz
- Integral emitter-ballasting resistors
- Ceramic-metal hermetic package with low inductance and low parasitic capacitances
- Beryllium oxide ceramic for low thermal-resistance path between collector stud & base flange
- Stable common-base operation
- For coaxial, microstripline, & lumped-constant circuit applications

RCA 2N5921• is an epitaxial silicon n-p-n planar transistor featuring the overlay multiple-emitter-site construction. It is intended for solid-state equipment for microwave communications, S-band telemetry, microwave relay link, phased-array radar, distance measuring equipment and collision avoidance systems. Integral emitter-ballast resistance is employed for improved ruggedness and increased overdrive capability.

The ceramic-metal coaxial package of the 2N5921 features low parasitic capacitances and inductances which provide for stable operation in the common-base amplifier configuration. This transistor can be used in large signal applications in coaxial, stripline, and lumped-constant circuits. The 2N5921 can withstand load mismatch conditions at 2 GHz up to VSWR of 10:1 (all phases) in the common-base circuit shown in Fig. 9.

• Formerly RCA Dev. Type No. TA7205.

MAXIMUM RATINGS, *Absolute-Maximum Values:*

• COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	50	V
• COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance (R_{BE}) = 10 Ω	V_{CER}	50	V
• EMITTER-TO-BASE VOLTAGE	V_{EBO}	3.5	V
• DC COLLECTOR CURRENT (CONTINUOUS)	I_C	0.7	A
TRANSISTOR DISSIPATION:	P_T		
• At case temperatures up to 25°C		14.5	W
• At case temperatures above 25°C, derate linearly		0.083	W/°C
• TEMPERATURE RANGE:			
Storage and Operating (Junction)		−65 to + 200	°C
• CASE TEMPERATURE (During soldering):			
For 10 s max.		230	°C

*In accordance with JEDEC registration data format (JS-6 RDF-3 / JS-9RDF-7)

ELECTRICAL CHARACTERISTICS, *at Case Temperature (T_C) = 25°C , unless otherwise specified.*

STATIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS					LIMITS		UNITS
			DC Collector or Base Voltage (V)		DC Current (mA)					
			V_{CE}	V_{BE}	I_E	I_B	I_C	Min.	Max.	
*	Collector-Cutoff Current	I_{CES}	45	0				–	2	mA
*		I_{CES} (T_C = 100°C)	45	0				–	5	mA
	Collector-to-Base Breakdown Voltage	$V_{(BR)CBO}$			0		5	50	–	V
*	Collector-to-Emitter Breakdown Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{(BR)CER}$					10	50	–	V
*	Emitter-to-Base Breakdown Voltage	$V_{(BR)EBO}$			0.1		0	3.5	–	V
	Collector-to-Emitter Saturation Voltage	$V_{CE(sat)}$				20	100	–	1	V
	Thermal Resistance: (Junction-to-Flange)	$R_{\theta JF}$						–	12	°C/W

DYNAMIC

	CHARACTERISTIC	SYMBOL	TEST CONDITIONS		LIMITS		UNITS
			Frequency (f) – GHz	DC Collector Supply Voltage (V_{CC}) – V	Min.	Max.	
	Output Power P_{IB} = 1 W (See Fig. 9)	P_{OB}	2	28	5	–	W
*	Power Gain P_{OB} = 5 W	G_{PB}	2	28	7	–	dB
*	Collector Efficiency P_{OB} = 5 W	η_C	2	28	40	–	%
*	Collector-to-Base Capacitance V_{CB} = 30 V	C_{obo}	1 MHz	–	–	8.5	pF

*In accordance with JEDEC registration data format (JS-6-RDF-3/JS-9-RDF-7)

TYPICAL APPLICATION INFORMATION

CIRCUIT & FREQUENCY	See Fig.	DC Collector Supply Voltage (V_{CC}) – V	Input Power (P_{IB}) – W	Output Power (P_{OB}) – W
Coaxial-Line				
2-GHz Amplifier	9	28	1	6
1.2-GHz Amplifier		28	0.75	10
Microstripline				
2-GHz Amplifier	11	28	1	5
Lumped-Constant				
1.4-GHz Amplifier	15	28	1	6.8
1-GHz Amplifier	14	28	1	10.6
Microstripline				
1.2-1.4 GHz Tunable Oscillator	16	28	–	4

PERFORMANCE DATA

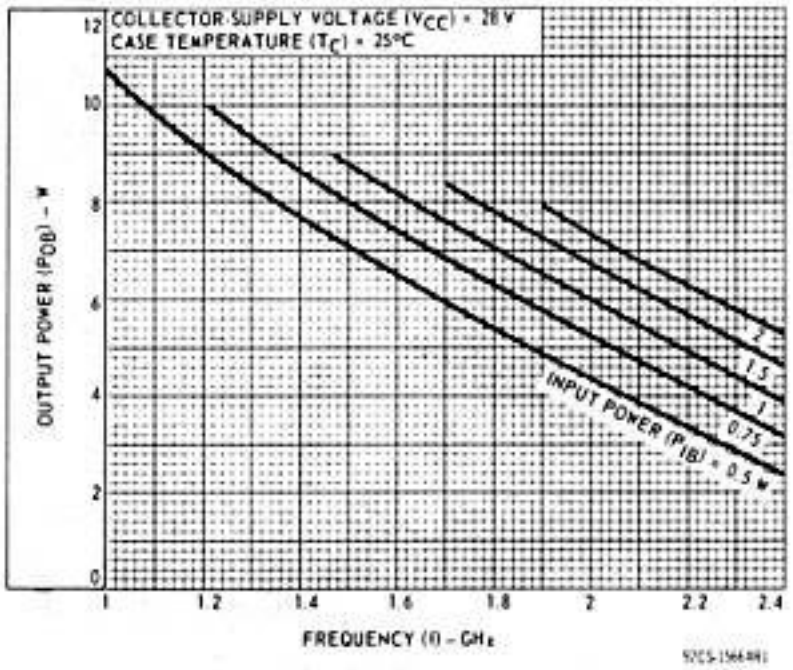


Fig. 1 - Typical output power vs. frequency.

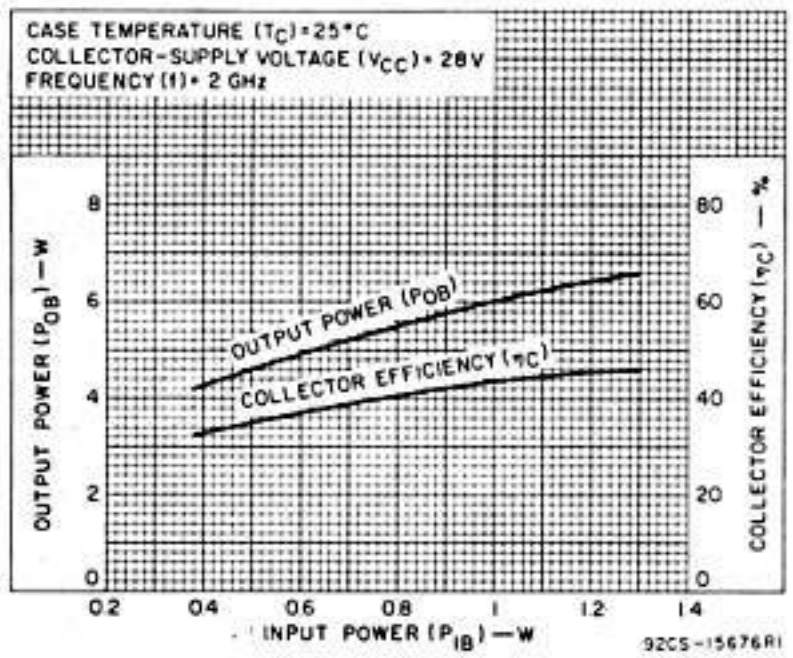


Fig. 2 - Typical power output or collector efficiency vs. power input at 2 GHz for circuit shown in Fig. 9.

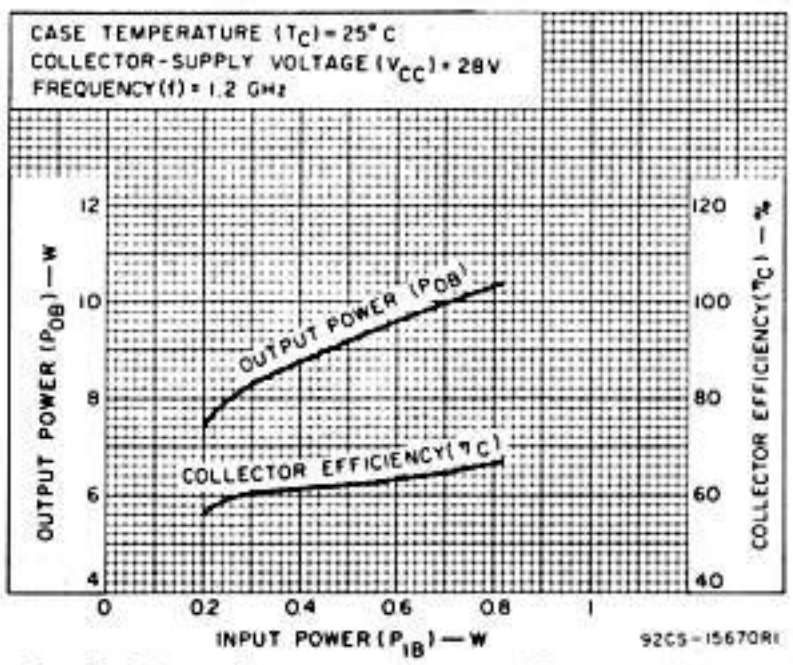


Fig. 3 - Typical power output or collector efficiency vs. power input at 1.2 GHz for circuit shown in Fig. 9.

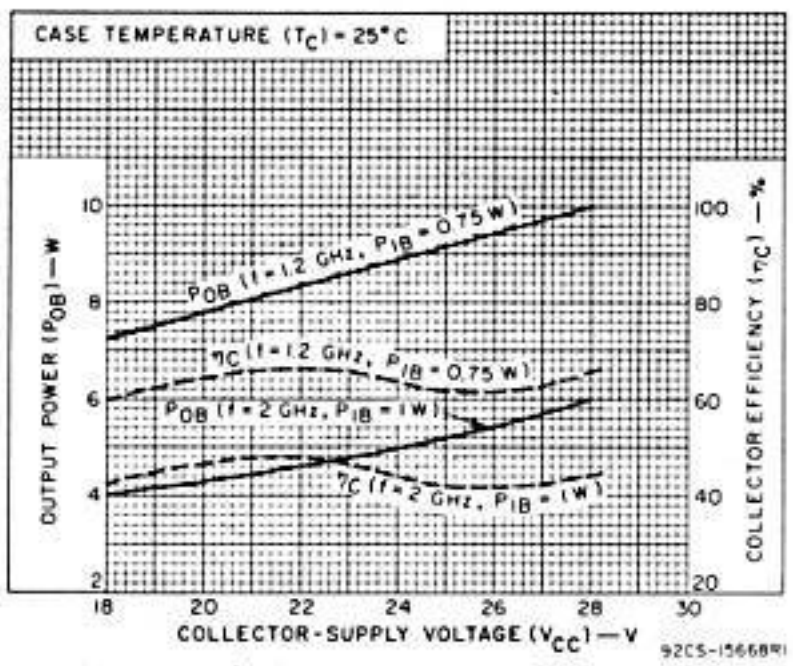


Fig. 4 - Typical power output or collector efficiency vs. collector supply voltage.

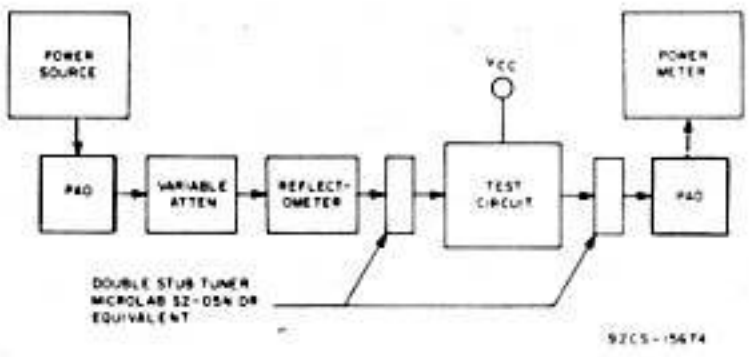


Fig. 5 - Block diagram of test set-up for measurement of output power from 1.2 - or 2-GHz common-base amplifier.

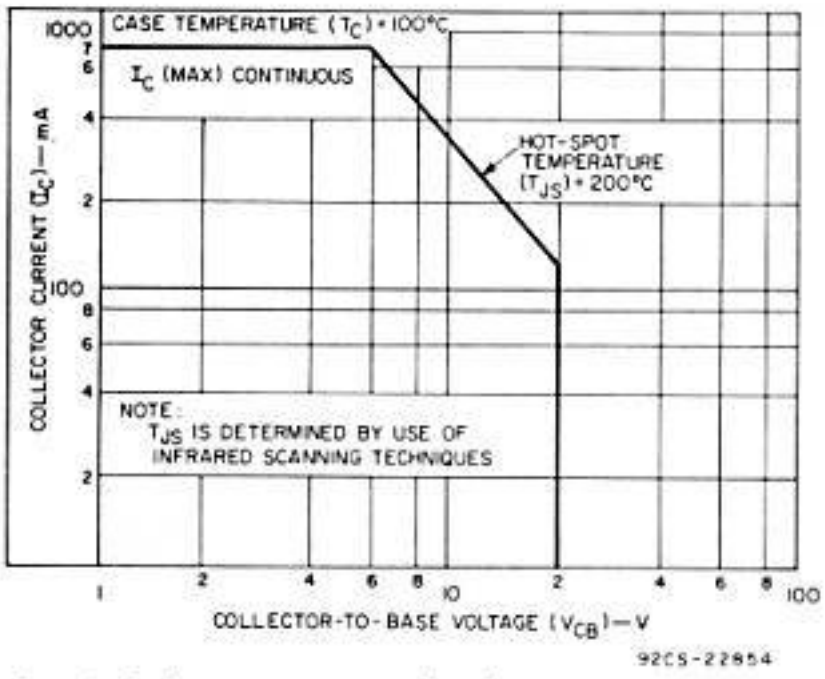


Fig. 6 - Safe operating area for dc operation.

DESIGN DATA

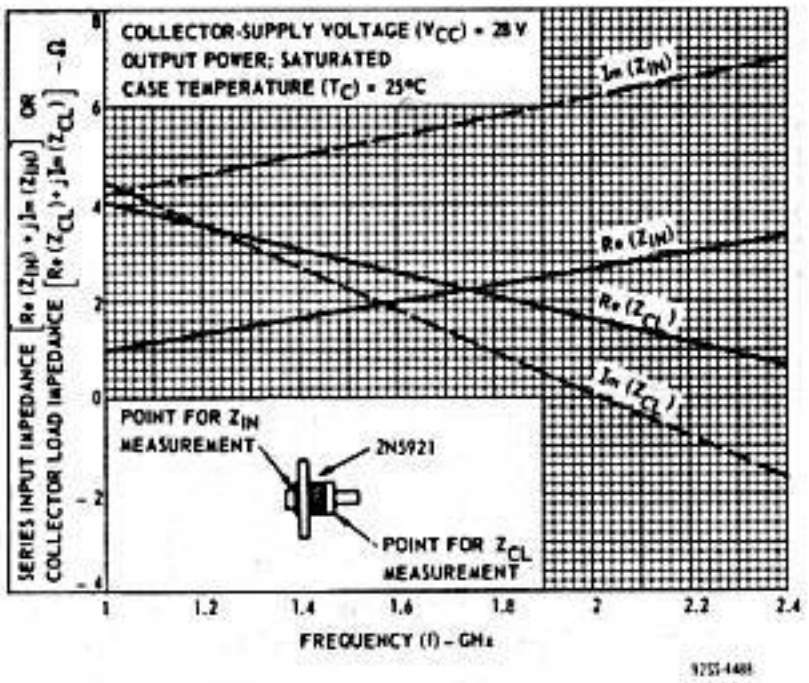


Fig. 7 - Typical large-signal series input impedance or large-signal collector load impedance vs. frequency.

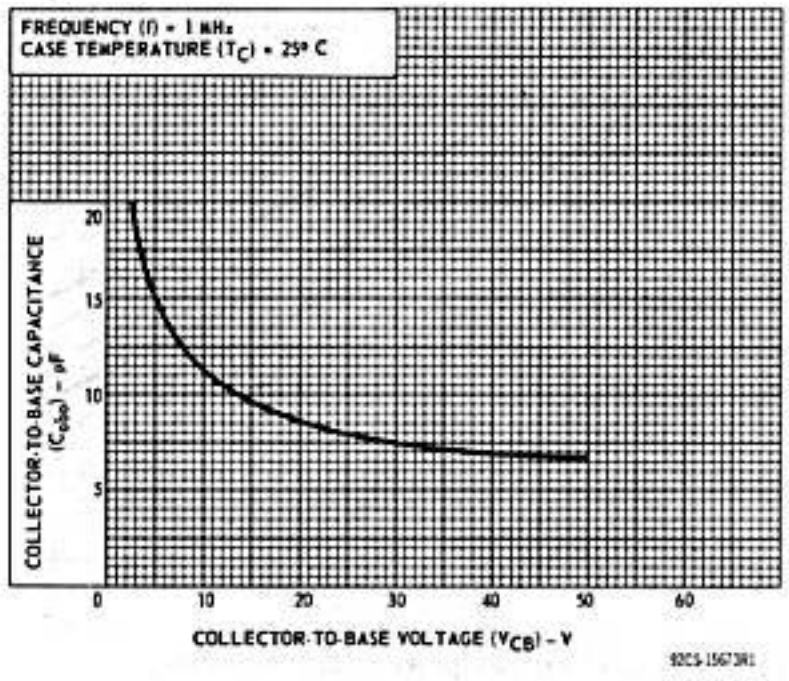
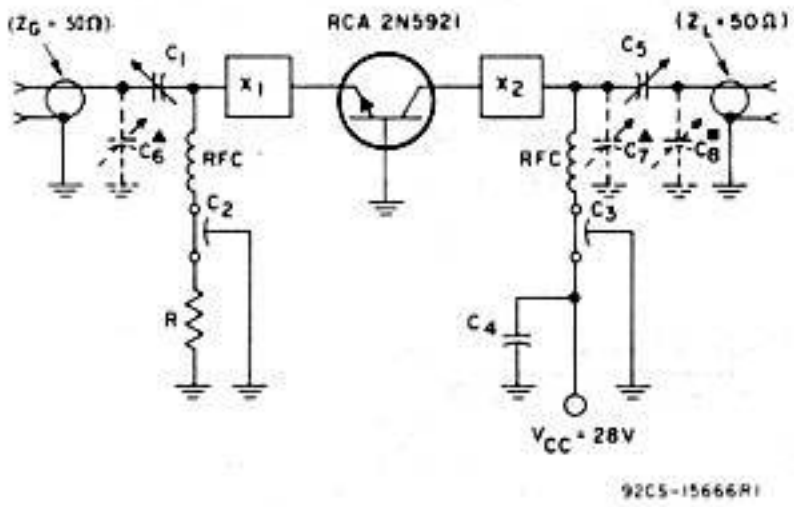


Fig. 8 - Typical collector-to-base capacitance vs. collector-to-base voltage.

APPLICATION INFORMATION



▲ Use only in the 2-GHz coaxial-line power amplifier circuit.
■ Use only in the 1.2-GHz coaxial-line test circuit.

* Johanson Mfg. Corp., Boonton, N.J. 07005

CIRCUIT	C_1 pF	C_2 pF	C_3 pF	C_4 μF	C_5 pF	C_6 pF	C_7 pF	C_8 pF	R Ω
1.2 GHz (Test Circuit)	1-10	1000	1000	0.01	1-10	-	-	0.3-3.5	0.75
2 GHz (Test Circuit)	1-10	470	470	0.01	1-10	-	-	-	0.43
2 GHz (Amplifier)	1-10	470	470	0.01	0.3-3.5	0.3-3.5	0.3-3.5	-	0.43

C_1 & C_5, 1-10pF Range: Johanson 4581, or equivalent*

C_5, C_6, C_7 & C_8, 0.3-3.5pF Range: Johanson 4700, or equivalent*

RFC: For 2-GHz Circuits: 3 turns No.32 wire 1/16 in. (1.59 mm) ID, 3/16 in. (4.76 mm) long.

For 1.2-GHz Circuit: 6 turns No.32 wire 1/16 in. (1.59 mm) ID, 3/16 in. (4.76 mm) long.

X_1, X_2: Coaxial-line circuits, see Fig. 10.

Fig. 9 - 1.2/2 GHz coaxial-line amplifier circuits.

APPLICATION INFORMATION (Cont'd)

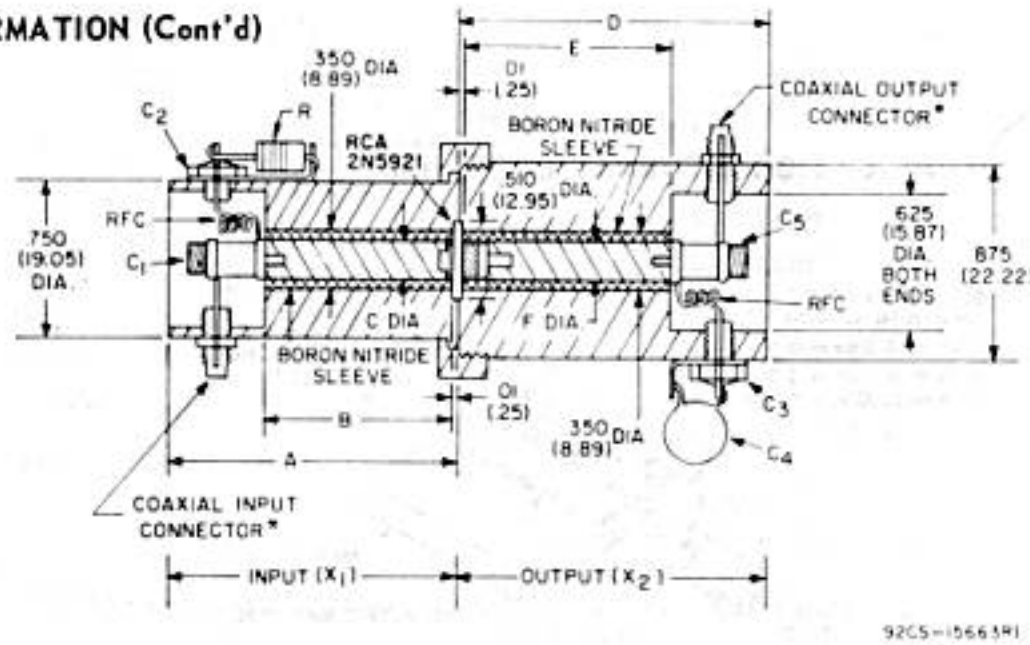


TABLE 1 - Dimensions of coaxial lines X_1 & X_2 for 2 GHz amplifier & 1.2 & 2-GHz test circuit

CIRCUIT	DIMENSIONS							
	INPUT (X_1)				OUTPUT (X_2)			
	A	B	C	Center Conductor	A	E	F	Center Conductor
1.2 GHz (Test Circuit)	1.385 (35.18)	.875 (22.22)	.282 (7.16)	.825 (20.95)	1.778 (45.16)	1.268 (32.21)	.213 (5.41)	1.05 (26.67)
2 GHz (Test Circuit)	.940 (23.88)	.430 (10.92)	.266 (6.76)	.380 (9.65)	1.04 (26.42)	.530 (13.46)	.266 (6.76)	.370 (9.39)
2 GHz (Amplifier)	.860 (21.84)	.350 (8.89)	.265 (6.73)	.300 (7.62)	1.06 (26.92)	.550 (13.97)	.270 (6.86)	.385 (9.78)

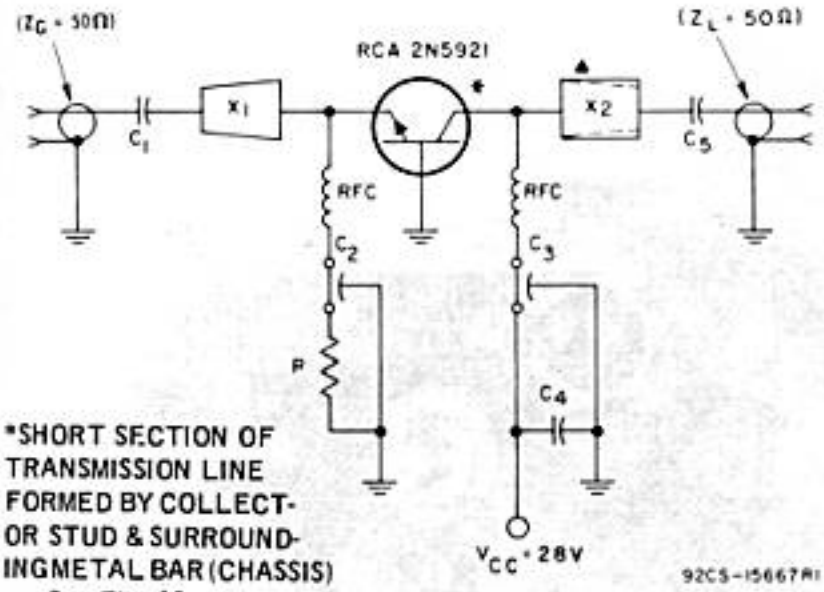
Dimensions in Inches and Millimeters

Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.

MATERIAL: Center conductor – copper
Outer conductor for input & output – brass

* Conhex 50-045-0000 Sealectro Corp., or equiv.

Fig. 10 - Constructional details of 1.2/2 GHz coaxial-line test circuits.



*SHORT SECTION OF TRANSMISSION LINE FORMED BY COLLECTOR STUD & SURROUNDING METAL BAR (CHASSIS) . . . See Fig. 12.

▲WITH SOME DEVICES, LOAD END OF X_2 MAY REQUIRE A SLIGHT TAPER TO INCREASE Z_O FOR OPTIMUM MATCH CONDITION.

C_1, C_5: 300 pF disc ceramic
C_2, C_3: 470 pF, feed through, Allen-Bradley FA5C, or equivalent
C_4: 0.01 μF, disc ceramic
R: 0.43 Ω
RFC: No.32 wire, 0.4 in. (1.02 mm) long
X_1: TAPERED MICROSTRIPLINE –
0.15 in. (3.81 mm) wide, input end
0.30 in. (7.62 mm) wide, output end
0.525 in. (13.33 mm) long
0.005 in. (0.13 mm) thick, copper
X_2: UNIFORM MICROSTRIPLINE –
0.25 in. (6.35 mm) wide
0.36 in. (9.14 mm) long
0.005 in. (0.13 mm) thick, copper
DIELECTRIC MATERIAL: 0.5 in. (12.7 mm) wide
0.75 in. (19.05 mm) long
0.005 in. (0.13 mm) thick
DuPont H-Film, or equiv.
NOTE: See Fig. 12 for suggested mounting arrangement of 2N5921.

Fig. 11 - Typical circuit for 2-GHz grounded-base microstripline power amplifier.

APPLICATION INFORMATION (Cont'd)

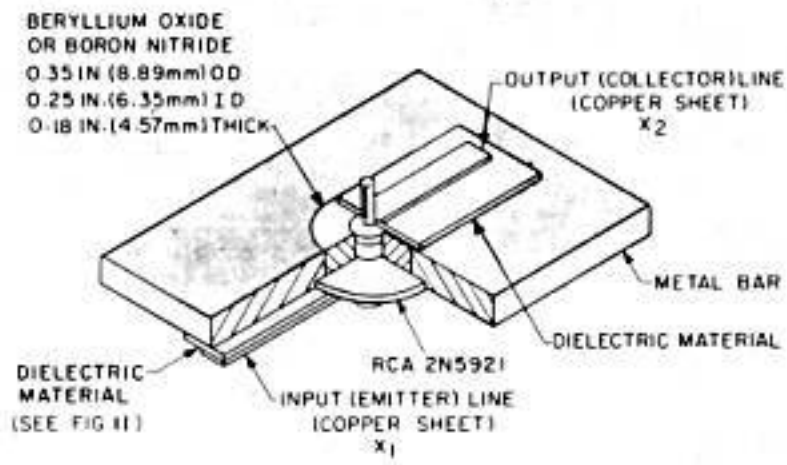


Fig. 12 - Suggested mounting arrangement of the 2N5921 in a microstripline circuit.

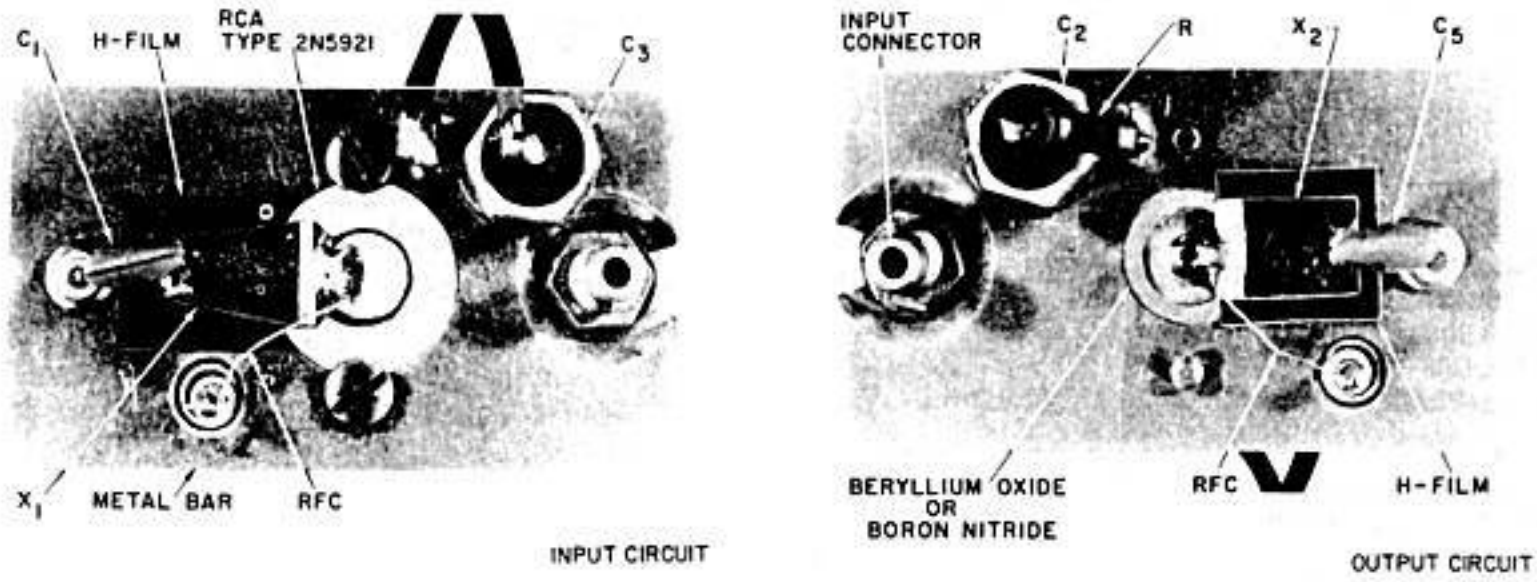
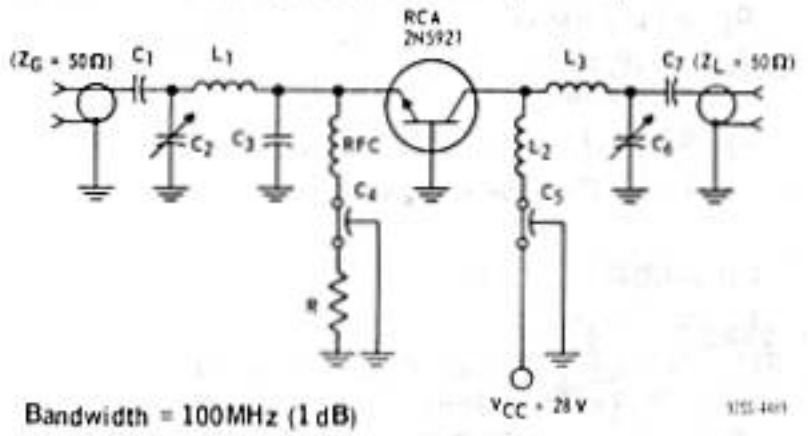


Fig. 13 - Suggested mounting arrangement of components for 2-GHz microstripline circuit shown in Fig. 11.

APPLICATION INFORMATION (Cont'd)

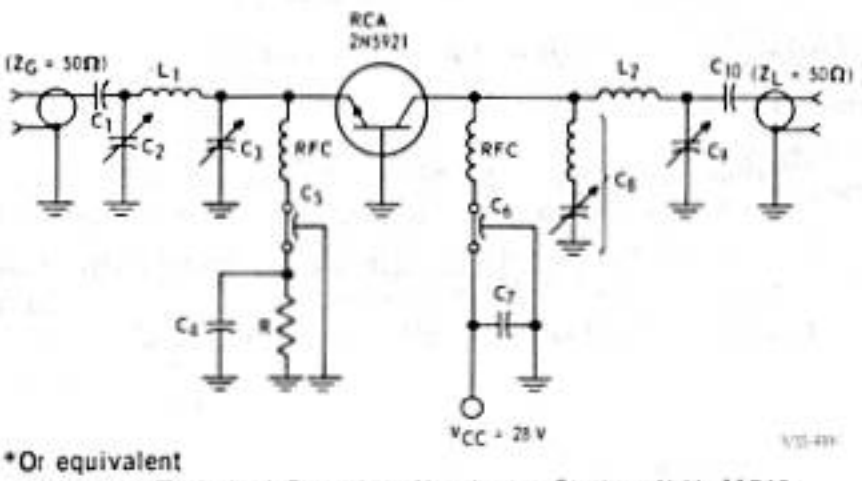


Bandwidth = 100MHz (1 dB)

C_1, C_7: 510pF, ATC-200*
C_2, C_6: 1-10pF, Johanson 2954*
C_3: 10pF, ATC-100*
C_4, C_5: 470pF, feed-through type, Allen-Bradley FA5C
L_1: 3.7nH
L_2: 0.8nH
L_3: 2.3nH
R: 0.47 Ω
RFC: 5 turns, No. 28 wire, 0.05 in. (1.27 mm) I.D., 0.4 in. (10.16 mm) long.

*Or equivalent
American Technical Ceramics, Huntington Station, N.Y. 11746
Johanson Mfg. Corp., Boonton, N.J. 07005

Fig. 14 - Typical lumped-constant circuit for 1-GHz power amplifier.



C_1, C_{10}: 510 pF, ATC-100*
C_2, C_9: 0.3-35pF, Johanson 4700*
C_3: Single, parallel-plate variable capacitor approx. 19pF
C_4, C_7: 0.01 mF, disc ceramic
C_5, C_6: 470pF, feed-through type, Allen-Bradley FA5C
C_8: 1-10pF, Johanson 2954* (series resonant in this frequency range and used as a variable inductor)
L_1: 3.4nH
L_2: 2.5nH
R: 0.47 Ω
RFC: 5 turns, No. 28 wire, 0.05 in. (1.27 mm) I.D., 0.4 in. (10.16 mm) long.

*Or equivalent
American Technical Ceramics, Huntington Station, N.Y. 11746
Johanson Mfg. Corp., Boonton, N.J. 07005

Fig. 15 - Typical lumped-constant circuit for 1.4 GHz power amplifier.

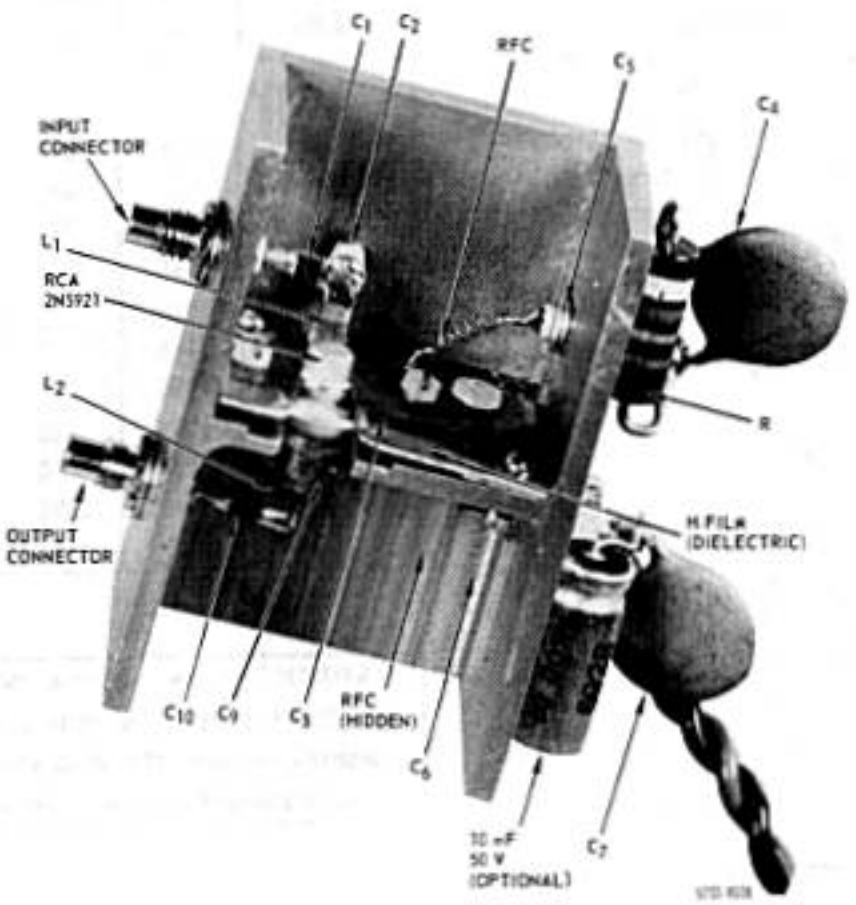
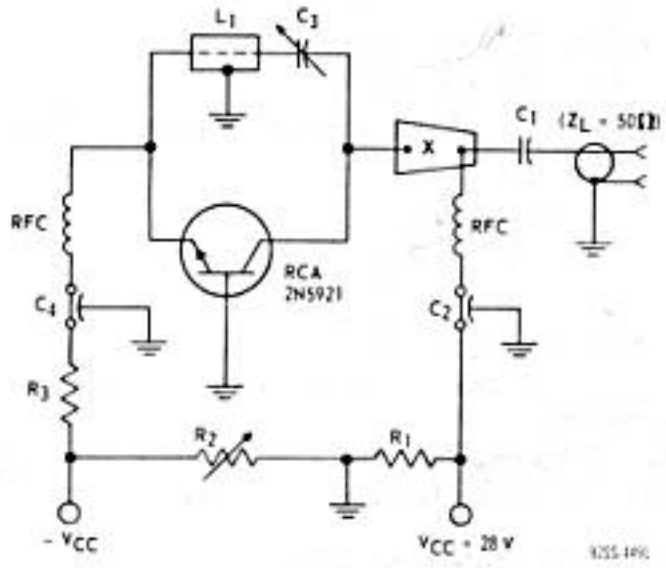


Fig. 16 - Suggested mounting arrangement of components for 1.4-GHz lumped-constant power amplifier circuit shown in Fig. 15.

APPLICATION INFORMATION (Cont'd)



*Johanson Mfg. Corp., Boonton, N.J. 07005

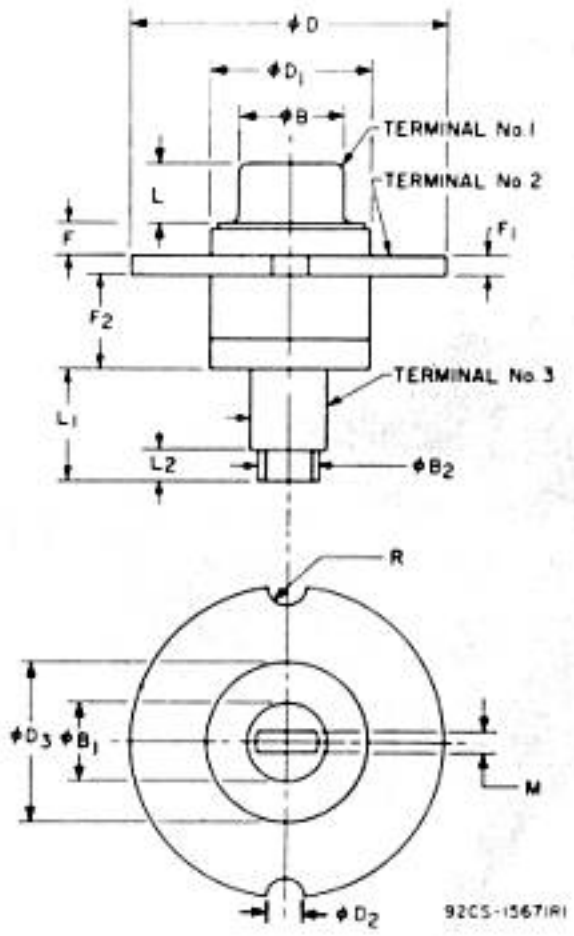
C_1: 300 pF, disc ceramic
C_2, C_4: 470 pF, feed-through type, Allen-Bradley FA5C, or equivalent
C_3: 0.3-3.5 pF, Johanson 4702, or equivalent*
L_1: 1.3 in. (33.02 mm) length of 50 Ω coaxial line
R_1: 1200 Ω
R_2: 0-250 Ω
R_3: 5 Ω
RFC: 3 turns, No. 29 wire, 0.06 in. (1.59 mm) I.D., 0.18 in. (4.77 mm) long.
X: TAPERED MICROSTRIPLINE –
0.1 in. (2.54 mm) wide, input end
0.24 in. (6.09 mm) wide, output end
0.475 in. (12.06 mm) long
0.005 in. (0.13 mm) thick, copper
DIELECTRIC MATERIAL: Same as that for Fig. 11 (See Fig. 12 for mounting of output section)

Fig. 17 - Typical circuit for tunable 1.2 - 1.4 GHz, 4-W microstripline power oscillator.

SOLDERING INSTRUCTIONS

When soldering the 2N5921 into a microstripline or lumped-constant circuit, the collector and emitter terminals of the device must be pretinned in the region where soldering is to take place. The device should be held in a high-thermal resistance support for this tinning operation. A 60/40 resin-core solder and a low-wattage (47 watts) soldering iron are suggested for the pretinning operation. The case temperature should not exceed 230°C for a maximum of 10 seconds during tinning and subsequent soldering operations.

DIMENSIONAL OUTLINE
JEDEC TO-201AA



SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
ϕB	.165	.175	4.19	4.44
ϕB_1	.115	.125	2.92	3.17
ϕB_2	.090	.110	2.29	2.79
ϕD	.495	.505	12.57	12.83
ϕD_1	.245	.255	6.22	6.48
ϕD_2	.055	.065	1.39	1.65
ϕD_3	.245	.255	6.22	6.48
F	.045	.060	1.14	1.52
F_1	.025	.035	.63	.88
F_2	.145	.175	3.68	4.44
L	.095	.115	2.41	2.92
L_1	.165	.195	4.19	4.95
L_2	.040	.060	1.02	1.52
M	.045	.055	1.14	1.39
R	.027	.033	.68	.83

WARNING: The ceramic body of this device contains beryllium oxide. Do not crush, grind, or abrade these portions because the dust resulting from such action may be hazardous if inhaled. Disposal should be by burial.

TERMINAL CONNECTIONS

Terminal No. 1 – Emitter
Terminal No. 2 – Base
Terminal No. 3 – Collector