Western Electric

NOVEMBER 1971

FILE:
MICROWAVE SECTION

DATA SHEET

416C
ELECTRON TUBE

DESCRIPTION — PLANAR TRIODE

The 416C is a planar type triode designed for use as an amplifier or frequency multiplier at frequencies in the order of 4000 megacycles. The 416C is similar to the 416B and has increased power capabilities.

ELECTRICAL CHARACTERISTICS

OPERATING CONDITIONS	Symbol	Min.	Typ.	Max.	Units
Heater Voltage (Note 1)	E_f	–	6.1	–	V
Plate Voltage	E_b	–	250	–	Vdc
OPERATING CHARACTERISTICS (Note 2)					
Heater Current	I_f	1.07	1.13	1.23	A
Amplification Factor	μ	–	250	–	–
Tranconductance	G_m	–	65,000	–	µmhos
Direct Interelectrode Capacitances (E_f = 0, E_b = 0)	C_{gp}	1.25	1.45	1.60	pF
(E_f = 0, E_b = 0, See Note 3)	C_{gsh}	7.2	9.8	11.2	pF
(E_f = 6.1 V, E_b = 0, See Note 3)	C_{gsh}	6.5	8.7	9.8	pF
(E_f = 0, E_b = 0, See Note 3)	C_{psh}	–	.019	.050	pF
(E_f = 0, E_b = 0)	C_{ksh}	30.0	42.5	57.0	pF
Plate Current (E_b = 250V)	I_b	–	45	–	mAdc
Gain (100 mW Output)		–	10	–	dB
Gain (2 W Output, E_b = 250V)		–	8	–	dB
Frequency	F	–	4,000	–	MHz
Band Width	ΔF	–	100	–	MHz

Note 1: For optimum life, heater should be supplied from a source of 10.8 ± 0.2 volts through a circuit resistance of 4.16 ohms.

Note 2: Test conditions for these characteristics are E_b = 200 Vdc, E_f = 6.1 V unless otherwise specified.

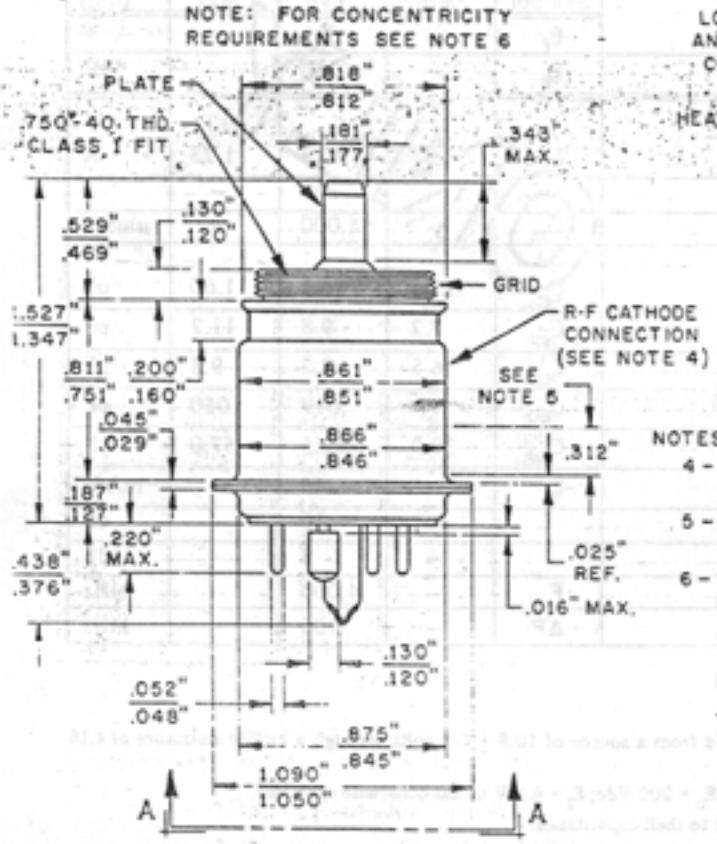
Note 3: Cathode connected to shell through cathode to shell capacitance.

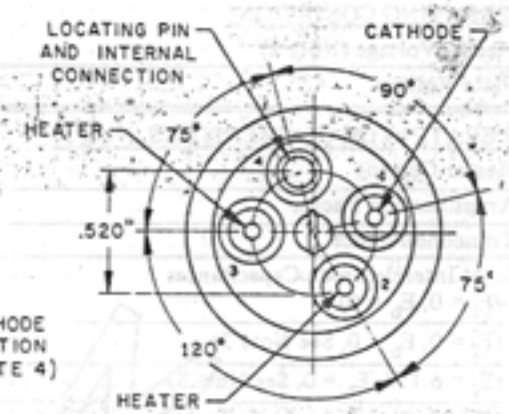
MAXIMUM RATINGS

	Symbol	Min.	Max.	Units
Plate Voltage	E_b	–	300	Vdc
Grid Voltage	E_c	-15.0	+1.5	Vdc
Plate Current	I_b	–	50	mAdc
Grid Current	I_c	–	20	mAdc
Plate Dissipation	P_p	–	15	W
Plate Seal Temperature	T_p	–	150	C
Grid Seal Temperature	T_g	–	150	C
Heater Cathode Voltage	V_{h-k}	–	45	Vdc

MECHANICAL DATA

Cathode	Unipotential
Mounting Position	Any
Weight, Approximate	1 oz.
Socket	KS14134 or Equivalent





VIEW A-A

NOTES:

4 – SURFACES OF R-F CATHODE, GRID AND ANODE CONNECTIONS ARE PLATED.

5 – .856" ± .010" DIMENSION APPLIES ONLY OVER THE .312" LENGTH.

6 – WITH THE .750"-40 THREAD SCREWED INTO A GUAGE HAVING A THREAD WITH A .750"-40 CLASS 1 FIT, THE .856", 1.070" AND .180" DIAMETERS MUST FIT IN CYLINDERS CONCENTRIC WITH THE .750"-40 THD. AND HAVING DIAMETERS OF .895" X .720" LG., 1.135" X .157" LG. AND .210" X .375" LG. ALLOWANCE FOR THESE TOLERANCES MUST BE MADE IN ANY CIRCUIT DESIGN.

A development of Bell Telephone Laboratories, the Research and Development Unit of the Bell System.
PRINTED IN U.S.A.

	WE 416-D
Filament Voltage/Current	6.3/1.18
Plate Voltage - Max/Typical	200/185
Max Plate Watts	6 watts
Grid Voltage	R(k)=260
Transconductance	65k
Plate Resistance	----
Plate Current	30 ma max
Amp. Factor	250

416B

416C
416D

416A 1948. UHF-SHF triode. The 416A was a close-spaced planar triode with 0.0005" grid spacing and a grid pitch of 1000 turns per inch using 0.0003" diameter wire. The cathode was coated on a nickel base assembled on a ceramic ring. The cathode and grid were made coplanar by a grinding and lapping operation. The cathode coating was limited to 0.0005". The assembly was supported by spring-loading the ceramic cathode ring to the grid frame with a precision spacer. The grid consisted of parallel lateral wires wound on a circular moly grid frame. The tungsten grid wire was drawn to 0.0005" and the diameter further reduced by electrochemical etching on a continuous etcher that was feedback controlled by a reading taken on the resistivity of the moving wire. The frame was given an evaporated gold-plating on one side; then mounted in a winding chuck and wound with dynamic-controlled tension. At an operating potential of 200 V and a current of 0.2 A/cm^2, three of these tubes cascaded in the TD2 transmitting amplifier produced 23 dB gain and 0.5 W output with more than 30 MHz bandwidth. The average life at low level reached 40,000 hrs. At 0.5 W, life was 15,000 hrs. Further development allowed amplifier operation at 1 W output.

The 416 series (A through D) were used as transmitter amplifiers in the TD2 and TD3D radio systems. Starting with a route capacity of 2400 telephone circuits in 1950, the 416D was capable (at 4 GHz) of 19,800 circuits per route. About 100,000 of these tubes were used in amplifier circuits, signal generators and frequency converters. By 1982, the 416-types were replaced with a GaAs solid state device. MD 1954. Similar type: L. M. Ericsson 416A.

416B 1952. Disc-seal planar triode developed from the 416A. Mounted in a KS-14134 tube socket. The anode was made from an iron-nickel-cobalt alloy and a metalized ceramic disc. The cathode was formed from centerless ground nickel rod. Insulator material was steatite. Grid-to-cathode spacing was maintained by a selected shim of oxygen-free copper. The grid frame material was molybdenum. Frequency 3.7 to 4.2 GHz. E_f 6.1 V, I_f 1.17 A, E_b 200 V, I_b 30 mA, gain 3 dB, bandwidth 100 MHz, 1.875" x 1.07" dia. MD 1984. Dual-numbered 6280.

416C 1965. Same as 416B except E_b was 250 V, I_b was 45 mA, and gain was 5 dB. Had a moly-copper grid frame with etched tungsten lateral wire, metalized ceramic rings, cathodes made from pressure-formed centerless-ground nickel rods, an aluminum-oxide coated spiral heater, and a Ba-Sr coated cathode. Production in 1977 was 117,070. MD 1984.

416D 1970. Same as 416C except test specification was changed for higher power. As glass-to-ceramic seals evolved, the seals in the 416D were eventually replaced with beryllia, which reduced RF losses and raised the RF output, thereby increasing the circuits per route to 19,800. Used in the V3 (final) socket of the TD2 transmitting amplifier. Production in 1977 was 12,740. MD 1982.