

THE VACUUM TUBE

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Some Notes on Cathode-Ray Tubes

This column presents “where-used” information on numerous small cathode-ray tubes (CRTs) of collector-restorer interest. These were used mainly in oscilloscopes, but also as indicators in a whole array of devices: radars, automatic direction finders, identification-friend-or-foe (IFF) gear, radio altimeters, LORAN navigation receivers, spectrum analyzers, panoramic adapters, modulation monitors, and specialized test sets. A few even appeared in TV sets.

Many of these tubes were made in variants with differing screen phosphors, giving varying color and persistence of image. For quick reference, the most usual phosphors were:

Screen	Usual Use	Color/Persistence
P1	most 'scopes	green/medium
P2	prof. 'scopes	blue-green/long
P4	B & W TV	blue-white/short
P7	radar displays	blue-green + yellow/long (minutes)
P11	photo recording	bluish/short

Often professional-grade 'scopes could be ordered with any of several variant CRTs. The Hewlett-Packard 150A, for example, had options for a 5AMP1, 5AMP2, 5AMP7, or 5AMP11.

The accompanying “CRTs IN EQUIPMENT” where-used table lists the CRTs in a goodly variety of 'scopes and other devices. It was developed from the two Rider books on 'scopes [1, 2], three summaries of military test gear [3, 4, 5], and some general scrounging. In some cases the tube is identified with the phosphor number left out [“()”], denoting a unit with multiple options. However, in these cases the most common phosphor remains P1.

The table may be helpful in an e-Bay or flea-market context in locating junker 'scopes, etc., that contain useful or collectable tubes. A forlorn Du Mont 168, depending on vintage, may contain a 54XH CRT, with its beautiful clear-glass bulb in the class of the prized Western Electric 224A. An orphan Du Mont 164 may provide a 34XH, a similar but smaller tube. Numerous early 3" 'scopes used the RCA 906 tube, whose initial production (into 1935) was similarly clear-bulbed.

Where a 'scope appeared with the 906 CRT, later renumbered 3AP1, the “906” is shown to emphasize those units that may have the early-vintage tubes. Other renumberings that occurred in the '40s were 1802P() to 5BP() and 1805P1 to 5AP1.

This is not to encourage wholesale scrapping of old 'scopes, particularly the '30s ones. However, there is such a glut of '40s-'60s Eicos and the like, and such a cheap supply of “real” 'scopes like Tektronix models, that it is no great crime to extract the CRT to fix a panadapter, modulation monitor, or other more interesting instrument.

A few tubes, of TV-restorer interest, came with a phosphor for oscilloscope or black-and-white TV. The 3KP4 was designed with P4 phosphor for the Pilot TV-37 3" TV set, but was more successful commercially as the 3KP1 in 'scopes. Thus several otherwise dead-end 'scopes will yield 3KP1s, useful for testing (or even operating) the TV-37 in lieu of the now-“unobtainable” 3KP4. Such source 'scopes include the GE YNA-4, Millen 90903, RCA WO-79, Simpson 480, and military OS-4/AP. The 5BP4, used in prewar TV sets (RCA TRK-5 and TT-5, GE HM-171 and HM-185) also appeared in several wartime radar indicators and was plentiful enough in surplus to be used in some Heathkit O-7 'scopes in lieu of the far more common 5BP1. The 7JP4, another tube in early postwar television, had a P1 version also — used in the Eico 470 and Precise 300B 'scopes.

Speaking of the 3KP4, there may be some insight into this tube's commercial history from the Dowd-RCA archive. “Identical with 3KP1 except that it uses the P4 phosphor,” it was introduced in mid-1948, “limited for sale to Pilot Radio Corporation only” and “pending determination of the commercial possibilities of low-priced, small-size television receivers.”

The expected sales were 25,000 tubes in 1948 and 75,000 in 1949. Pilot, of course, had priced its 3" set just below \$100 (1948 dollars), hoping for good sales volume.

In early 1949 the sales picture had changed: “After a trial of six months, Pilot has decided to discontinue this model and has cancelled their remaining tube orders. Since this company has a

good record of merchandising this type of product, we consider it unlikely that any other concern would be any more successful at this time.”

With a RCA inventory of 3000 tubes, the 3KP4 was “limited to sale for renewal purposes only,” with enough tubes on hand to take care of requirements “for a considerable period” [6]. (Of course, if sales had been good, the tube people at RCA would have been tempted to tip off their set-designer cousins at RCA Victor!)

In light of this sales failure, it is surprising how many TV-37s — now highly collectable — have survived.

In terms of equipment restoration, at one time the TV-service market featured adapters to allow an ordinary tube tester to measure emission and gas in a picture tube. These were not particularly adapted to the small-CRT field, where testing by substitution had been more usual. There were also picture-tube reactivators like the RCA WT-333B, which could restore emission to a weak cathode by discharging a capacitor (say, 20 μ F charged to 250 volts) between the grid and cathode of the tube. A limiting resistor of a few ohms restricted the current, but the often-successful process was rather violent.

Sometimes simple external checks of a suspect tube will be helpful. The screen may have a spot or line burned in it (‘scope tubes) or an ion burn (picture tubes). Old-time TV servicers knew how often an apparently open heater could be fixed by resoldering the heater pins on the base.

It may be helpful to mention the TV picture-tube “brighteners” and “rejuvenators” of the ’50s. These were small transformers that plugged in between the socket and base of the tube. Various models were available to improve brightness of a tube having low emission by boosting its heater voltage to, typically, 7.8 volts, or to remove the effects of a heater-to-cathode leak by providing an isolation transformer, or both. (The writer once saw a TV set where two voltage boosters had been used in tandem.) Dif-

ferent versions were available for series- and parallel-string TV sets.

These units are often found in old service technicians’ tube caddies and should be saved: they can still be used to stretch out the life of a weak or leaky tube. The transformer from an isolation type can also be removed and rewired as a 6.3-to-12.6-volt autoformer. This potentially allows replacement of, say, the rare 7S7 tube in an RME 84 communication receiver with a not-so-scarce 14S7. The autotransformer takes up less space under the chassis and is less messy than wiring up a voltage doubler for the same purpose.

For anyone interested in CRTs generally, Peter Keller’s 1991 book [7] remains the “Tyne” of its field. It has been nearly out-of-print in recent years, but Amazon.com still listed one copy as of late June. Other sources on the Web may still carry it.

REFERENCES

1. J. F. Rider and S. D. Usan, *Encyclopedia on Cathode-Ray Oscilloscopes and Their Uses* (New York: John F. Rider Publisher Inc., 1950), pp. 848-954.
2. As [1], 2nd. ed., 1959, pp. 23-3 to 23-232.
3. *Technical Manual TM11-1200*, “Radar Test Equipment” (Washington: War Dept., 1945), pp. 4-64 to 4-83.
4. *Technical Order T. O. 33A1-1-13*, “Electronic Test Equipment” (Washington: Dept. of the Air Force, 1957), pp. 351-407.
5. *Test Equipment Data Handbook*, Vol. 3, “Waveform Measuring” and/or “Analyzing Equipment” (Wheaton, MD: Frederick Research Corp., n. d.), Section 3.1.
6. Dowd-RCA Archive (an AWA Museum resource), product-management binders, “CRTs” binder.
7. P. A. Keller, *The Cathode-Ray Tube - Technology, History, and Applications* (New York: Palisades Press, 1991, ISBN 0-9631559-0-3).

CRTS IN EQUIPMENT

CIVILIAN GEAR		
Aeroquip 10,000	5BP1 or 5LP1	175A (I-245)5LP()
Bendix 160	3AP1	208, A, B5LP1 or 5LP5
Beta Electronics 701	3NP4	224A3GP1
Browning Model 2	2511A4	241 (TS-324/U, Navy
Browning OL-15B	5JP()	60109, Navy OCG)5JP()
CAA CA-2521 (Hycon)	5CP1 or 5CP1A	2475CP()
CENCO 71552	5CP1	250A5CP()
Clough-Bregle CRA	906	250AH5RP()
Cossor (Canada)		256D (OS-5/U)5CP()
1039 M Mk II	24D	274, A5BP1
1049 M Mk III	89J	275A5CP()
1058	91D	2795SP()
Du Mont		281A5RP()
164	34XH, 3AP1 or 3AP5	2923RP1A
164E	3AP1 or 3AP5	293K1068P()
168 (OS-1/U)	54XH or 5MP1	294A5XP()
		301A (AN/USM-32)3WP()
		303A5XP()A or 5YP()
		303AH5XP()
		3045CP()
		304A5ADP()
		3225SP()
		323A5AMP()
		3275AMP()
		329A5ATP()
		3313WP()
		336A5ATP()
		340, 3415ADP()
		350, 401A5ADP()
		4035AQP()
		4115ARP()
		EG&G 2236AKR-3B
		Eico
		400, 4255BP1
		4605UP1
		4707JP1

Electronic Meas. Corp. 600 5UP1	9788 914	BC-612 5BP4
Electronic Tube Corp. K-260 62DRP (2-gun)	W0-27A 5UP1	BC-665-T2 5BP4
Electronic Tube Corp. K-470 74DRP (4-gun)	W0-55A 3MP1	BC-704 5BP1 or 5GP1
ETC H-21 5SP1	W0-56A 7JP1 or 7VP1	BC-718A 3AP1 or 3AP4
Fed. Tel. & Radio	W0-57B 3MP1	BC-719, A 5HP1 or 5HP4
NLS-518 3 AP1	W0-58A, 60C 5UP1	BC-910 3EP1
Feller TS-4A 5BP1	W0-78A, B 5ABP1	BC-929, A 3BP1
General Electric	W0-79A, B 3KP1	BC-956 5BP1
CRO-5A 5CP1	W0-88A, 91A 5UP1	BC-957A 5HP4
ST-2A, 4ST2A1 5UP1	Simpson	BC-986A 12CP7
YNA-4 3KP1	459, 466 5UP1	BC-993B 3EP1
General Radio	480 3KP1	BC-1035A 5CP1 (two)
635A 635-P1	535 24XH	BC-1060A 3GP1, A
687A 905	545 906	BC-1084A1 5GP1
699 906	546, A 3AP1	BC-1087 3BP1
699A 3AP1	555 913	BC-1088 3DP1
1109A 3DP1A	560A, 650 3AP1	BC-1098 2AP1
Hewlett-Packard	655 (options) 3AP1 or 5CP1	BC-1111 12EP1, 12EP8, or 12HP7
120A, 122A 5AQP1	Supreme 555 906	BC-1112 5AP1
150A 5AMP1	Supreme 660 5CP1	BC-1159 5BP1
151A (AN/USM-105) 5AMP1	Sylvania	BC-1159A 5NP1
Hallcrafters SP-44 2AP1	101 5BP1	BC-1184A 5CP1
Heathkit	131 3AP1	BC-1213B 7CP1
0-4 5BP1	132 7GP1	BC-1214 7CP1
0-7 5BP1, 5BP4, or 5GP1	132-Z, 400, 404 7JP1 or 7VP1	BC-1266A 7CP1
0-10 5UP1	405 5UP1	BC-1268A 5CP1
OL-1 3GP1	Tektronix	BC-1287A 3BP1
OM-1 5BP1	310 3WP1	BC-1293A 5CP1
OP-1, OR-1 5ADP2	311 T31P2	I-102A 3CP1
Hickok	315, D 3WP2	I-134B (Du Mont 241) 3GP1
193 3AP1	316 T32P2	I-152A 3DP1-S1
195, B 5UP1	502 T60P2 (2-gun)	I-152AM 3DP1
305 3AP1	511 (late) 5ABP1	I-212 2AP1
505A, 675A, 685 5UP1	511A (early) 5CP1	I-240 913
770 5ABP1 or 5ADP1	511AD 5CP1 or 5ABP1	I-245 (Du Mont 208) 5LP1
RFO-1, 4 906	512 (OS-48/U) 5CP1 (see 5ABP)	ID-3/APQ-5 5FP7
RFO-5 3AP1	513 (early) 5XP1	ID-6/APN-4 5CP1
Hycon	514, A 5CP1	ID-6/CPN-2 3BP1
49 (OS-8/U) 3RP1A	514AD 5CP1A or 5ABP1	ID-11/APN-4 3FP7
617-T 3RP1A	515A T55P2	ID-12/TPS-1 3BP1 + 5FP7
627-R 3WP1 or 3WP11	524AD 5ABP1	ID-13/AN/CPN-3 2AP1
ITT Indust. Prod.	536 T56P2	ID-16/TPS-1A 5CP1 + 7BP7
Div. 2135D 17QP1 or 21ECP7	545 T54P1	ID-17/APN-3 3DP1
Jackson 520 906	545A T12G, HD2607, or 5BHP2	ID-19/APS-3 5FP7
Jackson CRO-1, -2 5UP1	Television Eqpt. Co.	ID-30A/APS-2D 5FP7
Knight 83YU144, 83Y144 5UP1	T-602 5RP1	ID-31/APQ-10 3FP7 + 5FP7
Knight 83Y146 5CP1	Trad Telev. PO-400	ID-33/APA-6 3BP1
LFE 401 5YP1	(AN/USM-38) 3WP1	ID-36/MPN-1 Two 7BP7
LFE 411 5ABP1	Triumph	ID-37/MPN-1 Two 7BP7
Maguire 60ACF 2AP1	800 906	ID-41/APQ-13 5FP7
Millen	840 3AP1	ID-50/APA-5 3FP7
90902 2BP1	841, 850 3BP1	ID-51/TPS-3 5CP1 + 7BP7
90903 3KP1	830 (Navy 60018) 3AP1	ID-66/AXR-1 7CP1
90905 5UP1	United Sound Eng. CR-3 906	IE-20 3GP1
90915 5AQP1	Waterman	OBL 3BP1
90923 3KP1	S-10-A, B 2AP1	OBT (Du Mont) 3GP1
P4, -2 5LP1	S-11-A, S-12-A 3MP1	OCG (Du Mont 241, TS-324/U) 5JP1
Modern Electronics 830 3GP1	S-12-C 3RP1A	OS-1/U (Du Mont 168) 5MP1
National CRU 2AP1	S-14-A, B, C 3RP1A	OS-4/AP (AN/URM-25) 3KP1, 3SP1, or 3WP1
Paco S-50 5BP1	S-15-A 3SP1 (two)	OS-5/U (Du Mont 256D) 5CP1A
Paco S-55 5UP1	S-16-A 5BTP1	OS-7C/U 3DP1A
Panoramic (panadapters)	S-17-A 3YP1	OS-8/U (Hycon 49) 3RP1, A
PCA-2 2AP1	S-5-B (AN/USM-24) 3JP1	OS-8C/U 3RP1
PR-1 3BP1A	Weston 983 Type 2 5ADP1	OS-10A/U 5UP1
SA-3 3AP1	Weston 983 Type 3 5UP1	OS-48/U (Tektronix 512) 5CP1A
T-200 902A	MILITARY GEAR	R-36/TPS-2 5CP1
Philco 7008 3MP1	AN/APA-10 3BP1	R-65/APN-9 3BP1
Polarad TSA spectrum analyzer 5ADP1	AN/APA-38 3BP1	R-70/APS-15 2AP1 + 5FP7
Precise 300B 7JP1 or 7VP1	AN/APQ-5 3BP1	TS-28/UPM 5CP1
Precise 308 8CP1	AN/CPS-5 3BP1 + two 12DP7	TS-34/AP 2AP1
Precision ES-500, A 5CP1	AN/MPG-1 2AP1 + two 7BP1 + 7BP7	TS-54/AP 2AP1
Precision ES-550 5CP1A	AN/TPL-1 Two 2AP1 + 5CP1	TS-64/MPN-1 3AP1
Radio City Products	AN/URM-25 (OS-4/AP) 3KP1, 3SP1, or 3WP1	TS-100/AP 3DP1
55 5BP1	AN/USM-24 (Waterman	TS-126/AP 2AP1
550 5BP1	S-5-B) 3JP1	TS-149/TRC-6 3BP1
TV-90 3BP1	AN/USM-24A, B, C, D 3JP1	TS-198/CPM-4 3BP1
RCA	AN/USM-25A, B 3WP1	TS-239/UP 3JP1
151, A 913	AN/USM-32 3WP1	TS-262A/TPS-10 3BP1A
151-2 902	(Du Mont 301A) 3WP1	TS-324/U (Du Mont 241, Navy OCG) 5JP1
155 906	AN/USM-38 (Trad Telev.	TS-489/U (RCA 158) 5BP1
155A, B, C 3AP1	PO-400) 3WP1	TS-678/U 3JP7
158 (TS-489/U) 5BP1	AN/USM-105 (H-P 151A) 5AMP1	60018 (Navy / Triumph 830) 3AP1
160, B 5BP1	BC-403C 5BP4	60109 (Navy / Du Mont 241) 5JP1
304A 914	BC-403D 5BP1	60ACF (Navy) 2AP1
327A 914	BC-412A 5BP1	60ACZ (Navy)
715B 5UP1	BC-412B 5BP1, 5BP4, or 5HP4	(CRP-60ACZ) 3DP1, A
9545 3AP1		