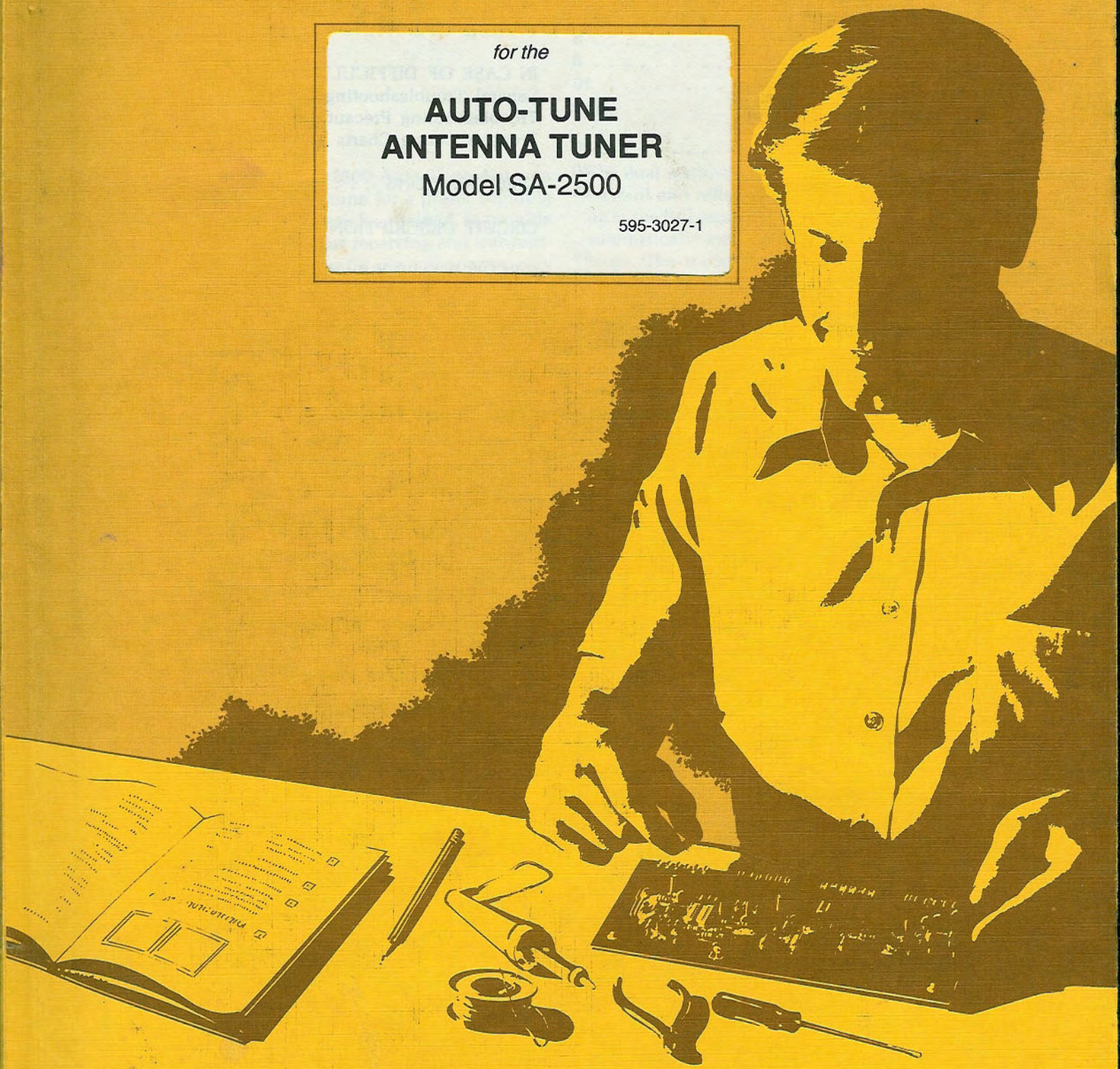
HEATHKIT® MANUAL

for the

AUTO-TUNE ANTENNA TUNER

Model SA-2500

595-3027-1



HEATH COMPANY • BENTON HARBOR, MICHIGAN

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INTRODUCTION

Your Heathkit Model SA-2500 Auto-Tune Antenna Tuner will automatically tune for a preset standing wave ratio (SWR), if that can be attained, to provide a good match between your receiving and transmitting equipment and practically any antenna you may wish to use for your HF operation. If you prefer, you can use the three front panel mounted lever switches to manually adjust your Antenna Tuner for the lowest possible SWR that can be obtained.

The Tuner is designed to operate on the 160- through 10-meter amateur bands, and will effectively tune and match balanced or unbalanced feed lines, and single-wire and ladder lines at the full legal power limit. With its continuously-variable inductor, you are assured precise antenna-matching all the way from 1.8 to 30 MHz, including the MARS frequencies, and all the newly-allocated bands.

Main circuit board mounted controls allow you to preset the roller inductor for up to 18 different positions in the AUTO mode (a low and a high for each of the nine bands, as indicated on the front panel, for example). The display on the front panel conveniently shows the number of active turns in use for each operating frequency.

The silver-plated straps and roller contact assembly minimizes RF losses at high frequencies. The large feed-through insulators withstand high-voltage RF when you use a single wire or a balanced feed line.

The dual wattmeter feature enables you to read both forward and reflected average power, in two ranges, up to the full legal power limit. An auto-range circuit automatically switches to the appropriate wattmeter range. The transition point, which is adjustable, is approximately at the 200-watt level.

The wattmeter section of your Auto-Tune Antenna Tuner installs directly into the transmission line to measure the power on all frequencies between 1.8 and 30 MHz. It measures 200/2000 watts in the forward direction and up to 50/500 watts reflected. Dual meters indicate the forward and reflected power separately for precise measurements. A factory aligned and calibrated sensor head insures high accuracy. SWR indications on the reflected meter provide direct readings from 1:1 to 3:1.

With a single switch, you can select a dummy load, or any of three permanently-connected antennas, including a long-wire antenna. You no longer need to connect and disconnect feed lines to load your transmitter into the dummy load.

With its factory-calibrated RF sensor, easy-to-read dual wattmeters, and with all its front panel controls, your new Auto-Tune Antenna Tuner will soon become an integral, indispensable component of your system.

DISPLAY CIRCUIT BOARD

PARTS LIST

Refer to the Pack Index Sheet and locate Pack #1. Then unpack these parts and check each part against the following list. Do not remove components that are supplied on a tape from the tape until you use them in a step. Return any part that is packed in an individual envelope, with the part number on it, back to the envelope after you identify it until that part is called for in a step. Do not throw away any packing material until you account for all of the parts.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Part Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

TAPED COMPONENTS

NOTE: These parts are taped on a strip which was checked before shipment. Since these parts are taped in the order of assembly, you may not wish to check these parts against the following list.

RESISTORS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise listed. A 5% tolerance is indicated by a fourth color band of gold. 1% is indicated by a brown fifth color band.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-101-12	1	100 Ω (brn-blk-brn)	R201
6-151-12	1	150 Ω (brn-grn-brn)	R238
6-471-12	1	470 Ω (yel-viol-brn)	R202
6-152-12	1	1500 Ω (brn-grn-red)	R237
6-472-12	21	4700 Ω (yel-viol-red)	R207, R208, R209, R211, R212, R213, R214, R216, R217, R218, R219, R221, R222, R223, R225, R226, R227, R228, R229, R231, R232
6-103-12	4	10 kΩ (brn-blk-org)	R205, R215, R224, R235
6-473-12	1	47 kΩ (yel-viol-org)	R236
6-104-12	1	100 kΩ (brn-blk-yel)	R234
6-1133-12	1	113 kΩ, 1% (brn-brn-org-org)	R239

NON-TAPED PARTS

The following parts are not taped on strips. The key numbers correspond to the numbers on the "Display Circuit Board Parts Pictorial" (Illustration Booklet, Page 1).

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS				
A1	3-20-5	1	5 Ω, 5-watt, 10% wire-wound	R203
A1	3-16-5	1	175 Ω, 5-watt, 10% wire-wound	R206
CAPACITORS				
B1	21-75	1	100 pF ceramic (100K)	C206
B1	21-176	1	.01 µF ceramic	C202
B2	25-255	1	.22 µF tantalum	C203
B3	25-859	2	.47 µF electrolytic	C204, C205
B3	25-917	1	10 µF electrolytic	C201
TRANSISTORS-INTEGRATED CIRCUITS (ICs)				

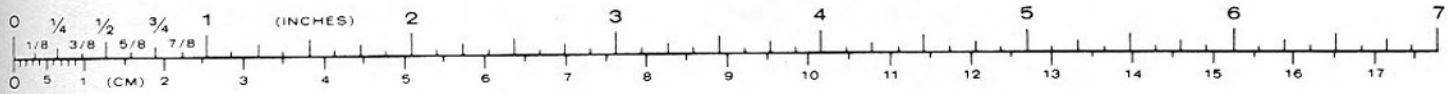
NOTES:

1. Integrated circuits may be marked for identification in any of the following four ways:
   a. Part number.
   b. Type number. (On integrated circuits, this refers only to the numbers shown in **bold** print; the letters may be different or missing. Also, your ICs may have other numbers in addition to the ones shown in bold.)
   c. Part number and type number.
   d. Part number with a type number other than the one listed.
2. Some of the ICs may be packed in conductive foam. Do not remove these ICs from the foam until a step directs you to do so.

C1	417-864	3	MPSA05 transistor	Q201, Q202, Q203
C2	442-54	1	**7805** IC	U205
C3	442-724	1	**7107** IC	U204
C3	443-967	3	**7406** IC	U201, U202, U203

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
MISCELLANEOUS				
D1	10-311	1	5000 Ω (5 k) control	R233
D1	10-312	1	10 kΩ control	R204
	85-2975-1	1	Display circuit board	
D2	411-836	1	Display tube	V201
D3	412-601	6	#2174 lamp	PL201, PL202, PL203, PL204, PL205, PL206
D4	434-298	3	14-pin IC socket	
D4	434-253	1	40-pin IC socket	
D5	475-10	1	Ferrite bead	FB201
PARTS FROM THE FINAL PACK				
	340-8	2′4″	Bare wire	
	343-2	1′	Shielded cable	
	344-2	3′6″	Large black wire	
	344-3	2′4″	Large red wire	
	344-160	6′	White-blue wire	
	344-215	4′6″	Large blue wire	
	344-219	3′	Large white wire	
	346-46	4″	Heat-shrinkable sleeving	
	347-55	2′3″	8-wire flat cable	
E1	74-34	1	Double-stick tape (1/2″ × 4″)*	
E2	390-147	1	"Danger" label*	
E3	390-2457	1	Reference preset label*	
E4	390-2491	1	Decorative label*	
	489-1		Sandpaper	
E5		1	Blue and white label*	
	597-260	1	Parts Order Form*	
		2	Taped Component Chart	
		1	Assembly Manual (See Page 1 for the part number.)	
			Solder	

* These items may be packed inside the front cover of the Manual. Set these parts aside until they are called for during the assembly of the chassis.



MAIN CIRCUIT BOARD

PARTS LIST

Refer to the Pack Index Sheet and locate Pack #2. Then unpack these parts and check them against the following list. Do not remove components that are supplied on a tape from the tape until you use them in a step. Return any part that is packed in an individual envelope, with the part number printed on it, back to the envelope after you identify it. Keep that part in the envelope until it is called for in a step. Do not throw away any packing material until you account for all the parts.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

TAPED COMPONENTS

NOTE: These parts are taped on a strip which was checked before shipment. Since these parts are taped in the order of assembly, you may not wish to check these parts against the following list.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS			
1/4-Watt, 1%			
NOTE: The following resistors have five color bands. The last band, which is brown, is set apart from the other bands and will not be called out. These resistors have a temperature coefficient (TC) of 100 parts per million per °C (100 PPM/°C) unless otherwise stated.			
6-4320-12	1	432 Ω (yel-org-red-blk)	R453
6-9090-12	1	909 Ω (wht-blk-wht-blk)	R415
Resistors (Cont'd.)			
6-1652-12	1	16.5 kΩ (brn-blu-grn-red)	R312
6-4022-12	1	40.2 kΩ (yel-blk-red-red)	R311
6-1005-12	3	10 MΩ (brn-blk-blk-grn)	R303, R395, R408
1/4-Watt, 5%			
NOTE: The following resistors have four color bands. The last band, which is gold, will not be called out.			
6-279-12	1	2.7 Ω (red-viol-gld)	R454
6-100-12	3	10 Ω (brn-blk-blk)	R407, R438, R508

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HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (Cont'd.)			
6-220-12	2	22 Ω (red-red-blk)	R434, R507
6-560-12	1	56 Ω (grn-blu-blk)	R383
6-151-12	4	150 Ω (brn-grn-brn)	R377, R425, R427, R502
6-221-12	1	220 Ω (red-red-brn)	R452
6-471-12	2	470 Ω (yel-viol-brn)	R468, R473
6-511-12	1	510 Ω (grn-brn-brn)	R322
6-561-12	22	560 Ω (grn-blu-brn)	R313, R338 R387, R388, R401, R406, R421, R432, R439, R441, R444, R445, R457, R463, R464, R467, R489, R491, R492, R494, R495, R506
6-681-12	2	680 Ω (blu-gry-brn)	R334, R382
6-751-12	1	750 Ω (viol-grn-brn)	R328
6-102-12	10	1000 Ω (brn-blk-red)	R333, R347, R351, R352, R402, R409, R431, R448, R505, R512
6-152-12	10	1500 Ω (brn-grn-red)	R337, R354, R386, R393, R404, R416, R419, R455, R458, R488
6-222-12	3	2200 Ω (red-red-red)	R422, R449, R497
6-272-12	3	2700 Ω (red-viol-red)	R321, R403, R462
6-432-12	1	4300 Ω (yel-org-red)	R451
6-472-12	11	4700 Ω (yel-viol-red)	R426, R442, R446, R465, R472, R476, R484, R485, R493, R501, R509
6-682-12	1	6800 Ω (blu-gry-red)	R376
6-752-12	3	7500 Ω (viol-grn-red)	R319, R327, R331
6-153-12	7	15 kΩ (brn-grn-org)	R314, R317, R353, R355, R399, R405, R412

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Resistors (Cont'd.)			
6-223-12	8	22 kΩ (red-red-org)	R304, R305, R307, R308, R324, R329, R339, R342
6-473-12	5	47 kΩ (yel-viol-org)	R301, R396, R423, R471, R498
6-563-12	1	56 kΩ (grn-blu-org)	R350
6-104-12	16	100 kΩ (brn-blk-yel)	R306, R336, R356, R357, R378, R394, R397, R398, R413, R414, R443, R447, R475, R477, R496, R511
6-124-12	1	120 kΩ (brn-red-yel)	R332
6-224-12	4	220 kΩ (red-red-yel)	R323, R346, R435, R346
6-334-12	1	330 kΩ (org-org-yel)	R343
6-684-12	3	680 kΩ (blu-gry-yel)	R345, R479, R481
6-105-12	1	1 MΩ (brn-blk-grn)	R325
6-125-12	2	1.2 MΩ (brn-red-grn)	R315, R316
6-225-12	3	2.2 MΩ (red-red-grn)	R348, R436, R514
CAPACITORS			
21-761	2	.01 µF (103) glass ceramic	C336, C341
CHOKES			
45-604	2	100 µH (brn-blk-brn-silv)	L301, L302
DIODES			
56-89	2	GD510	D334, D335
56-94	1	12.8-volt zener	D333
56-97	1	1N3017B	D304
57-27	4	1N2071	D329, D331, D332, D346

NON-TAPED PARTS

The following parts are not taped on strips. The key numbers correspond to the numbers on the "Main Circuit Board Parts Pictorial" (Illustration Booklet, Page 5).

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS				
1/4-Watt, 5%				
NOTE: The following resistors have four color bands. The last band, which is gold, will not be called out.				
A1	6-103-12	31	10 kΩ (brn-blk-org)	R309, R310, R341, R344, R349, R384, R385, R389, R391, R392, R411, R417, R418, R424, R428, R429, R433, R437, R459, R461, R469, R474, R478, R482, R483, R486, R487, R499, R503, R504, R515
CAPACITORS				
Ceramic				
B1	21-13	1	500 pF	C307
B1	21-140	4	.001 µF	C306, C346, C352, C353
Capacitors (Cont'd.)				
B1	21-176	34	.01 µF	C301, C302, C303, C304, C305, C308, C309, C311, C312, C314, C315, C316, C317, C318, C321, C322, C324, C326, C327, C328, C329, C335, C344, C351, C355, C356, C357, C362, C363, C364, C365, C366, C367, C368
B2	21-192	13	.1 µF (104)	C323, C338, C339, C343, C348, C349, C354, C358, C359, C361, C369, C371, C372
Electrolytic				
C1	25-922	1	.68 µF	C325
C1	25-924	1	2.2 µF	C347
C1	25-879	1	4.7 µF	C360
C1	25-917	1	10 µF vertical	C319
C2	25-864	3	10 µF horizontal	C313, C370, C373
C1	25-915	5	47 µF	C333, C334, C337, C342, C345
C1	25-887	1	220 µF	C332
C3	25-910	1	3300 µF	C331

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
DIODES				
D1	56-56	52	1N4149	D301, D302, D303, D305, D306, D307, D308, D309, D311, D312, D313, D314, D315, D316, D317, D318, D319, D321, D322, D323, D324, D325, D326, D327, D328, D336, D337, D338, D339, D342, D343, D344, D347, D348, D349, D352, D353, D354, D355, D356, D357, D358, D361, D362, D363, D364, D365, D366, D367, D369, D371, D372
SCRs - TRANSISTORS - INTEGRATED CIRCUITS (ICs)				

NOTE: SCRs, transistors, and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Type number. (On integrated circuits, use only those number and letters in **BOLD** print. Disregard any other number or letters.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

E1	57-624	4	2N5061 SCR	D341, D345, D351, D368

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
SCRs - Transistors - Integrated Circuits (ICs) (Cont'd.)				
E2	417-222	1	2N5308 transistor	Q309
E2	417-801	1	MPSA20 transistor	Q305
E3	417-818	7	MJE181 transistor	Q312, Q321, Q322, Q331, Q332, Q338, Q339
E3	417-819	1	MJE171 transistor	Q304
E2	417-864	26	MPSA05 transistor	Q301, Q302, Q303, Q306, Q307, Q311, Q313, Q314, Q315, Q316, Q317, Q318, Q319, Q325, Q326, Q327, Q328, Q329, Q335, Q336, Q337, Q342, Q343, Q344, Q345, Q347
E2	417-865	1	MPSA55 transistor	Q308
E4	417-918	6	2N6387 transistor	Q323, Q324, Q333, Q334, Q341, Q346
E5	442-53	3	555 IC	U306, U312, U313
E5	442-602	3	LM**324** IC	U302, U314, U317
E2	442-627	1	78L05 IC	U311
E2	442-665	2	79L05 IC	U308, U309
E2	442-687	1	78L10 IC	U316
E5	442-707	1	LF353 IC	U303

NOTE: The following ICs are packed in a special foam material to protect them from possible damage due to static electricity. Do not remove these ICs from their protective foam material until you are instructed to do so.

E5	443-1164	1	RC**4200** IC	U304
E5	442-99	2	CD**4016** IC	U301, U305
E5	443-607	2	MC**14013** IC	U307, U315

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
CONTROLS				
F1	10-936	16	1000 Ω (1k)	R360, R361, R362, R363, R364, R365, R366, R367, R368, R369, R370, R371, R372, R373, R374, R375
F1	10-311	5	5000 Ω (5k)	R335, R358, R359, R379, R381
F1	10-312	1	10 kΩ	R326
F1	10-390	1	20 kΩ	R318
F1	10-222	1	50 kΩ	R302

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
MISCELLANEOUS				
G1	54-992	1	Power transformer	T301
	85-2976-1	1	Main circuit board	
	134-1373	1	Wiring harness	
G2	412-640	1	LST5053 LED (light emitting diode)	D359
G3	432-866	3	Spring connector	
G4	432-1080	1	Small 3-hole socket shell	
G5	434-230	5	8-pin IC socket	
G5	434-298	7	14-pin IC socket	
G6	475-10	17	Ferrite bead	FB301, FB302, FB303, FB304, FB305, FB306, FB307, FB308, FB309, FB311, FB312, FB313, FB314, FB315, FB316, FB317, FB318

CHASSIS

PARTS LIST

Unpack all remaining parts from the large shipping carton. Check all parts against the following list and the "Chassis Parts Pictorial" (Illustration Booklet, Pages 16 through 19). Make a check (√) after each part as you identify it. If any part is packaged in an individual envelope with a part number on it, place it back in the envelope after you identify it until it is called for in a step.

ELECTRONIC PARTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A1	6-750-12	1	75 Ω (viol-grn-blk) 1/4-watt, 5% resistor	R2
A1	6-561-12	2	560 Ω (grn-blu-brn) 1/4-watt, 5% resistor	R4, R5
A2	10-1203	1	100 Ω control	R3
A2	10-14	1	250 kΩ control	R1
A3	12-68	1	1500 Ω/200 kΩ control	R6/R7
A4	21-140	2	.001 µF ceramic capacitor	C3, C4
A5	21-145	5	.001 µF feedthrough capacitor	C5, C6, C7, C8, C9
A4	21-72	3	.005 µF ceramic capacitor	C11, C12, C13
A4	21-176	3	.01 µF ceramic capacitor	C14, C15, C16
A6	40-1952	1	1 µH coil	L2
A7	40-2030	1	Roller inductor	L1
A8	54-1015	1	Power transformer	T1
A9	56-67	1	1N4740A zener diode	D1

Electronic Parts (Cont'd.)

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
A10	61-52	3	3-lug toggle switch	SW8, SW9, SW11
A11	61-53	1	6-lug toggle switch	SW6
A12	63-1402	1	Rotary switch	SW7
A13	64-927	1	Pushbutton switch assembly	SW1, SW2, SW3, SW4
A14	69-103	1	Relay	K1
A15	100-1836	1	Sensor Assembly*	
A16	150-74	2	Optical coupler	U2, U3
A17	401-163	1	Speaker	SP1
A18	407-757	1	FWD meter	M1
A19	407-758	1	REF meter	M2
A20	420-636	3	Motor	A1, A2, A3
A21	421-33	1	1/4-ampere slow-blow fuse	F1
A22	423-2	1	Fuseholder	
A23	442-674	1	7812 IC	U1
A24	475-10	5	Ferrite bead	FB1, FB2, FB3, FB4, FB5

* See separate "Sensor Assembly (#100-1836)"

HARDWARE

NOTE: Hardware packets are marked to show the size of the hardware they contain (HDW #4 or HDW #6, etc.). You may have to open more than one packet to locate all of the hardware of one size (#6, for example).

#2 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
B1	250-1172	10	2-56 × 1/4" screw
B2	252-51	10	2-56 nut
B3	254-26	10	#2 lockwasher

#4 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
C1	250-156	4	4-40 × 1/8" setscrew
C2	250-213	4	4-40 × 5/16" screw
C3	250-1448	2	4-40 × 3/8" flat head screw
C4	250-478	4	4-40 × 1-3/4" flat head screw
C5	252-15	4	Small 4-40 nut
C6	252-2	8	Large 4-40 nut
C7	254-9	10	#4 lockwasher
C8	259-9	2	#4 solder lug

#6 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
D1	250-1282	1	6-32 × 1/8" setscrew
D2	250-230	6	6-32 × 3/16" setscrew
D3	250-1325	38	6-32 × 1/4" screw
D4	250-1307	4	#6 × 1/4" sheet metal screw
D5	250-1264	2	6-32 × 3/8" hex head screw
D6	250-1280	22	6-32 × 3/8" pan head screw
D7	250-1423	4	6-32 × 3/8" flat head screw
D8	250-475	4	#6 × 3/8" hex head sheet metal screw
D9	250-1331	4	6-32 × 5/8" pan head screw
D10	250-1305	1	#6 × 5/8" self-tapping screw
D11	250-134	1	6-32 × 3/4" brass screw
D12	250-168	2	6-32 × 1-3/8" screw
D13	252-3	29	6-32 nut
D14	253-127	2	#6 steel flat washer
D15	253-714	30	#6 brass flat washer
D16	254-1	31	#6 lockwasher
D17	259-1	3	#6 solder lug

#8 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
E1	250-585	16	8-32 × 1/2" screw
E2	250-329	17	8-32 × 5/8" screw
E3	252-4	1	8-32 nut
E4	252-180	1	8-32 wing nut
E5	253-9	10	#8 steel flat washer
E6	253-715	48	#8 fiber flat washer
E7	254-2	12 ~~8~~	#8 lockwasher
E8	259-2	2	#8 solder lug

#10 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
F1	252-163	1	10-32 wing nut
F2	252-199	26	10-32 brass nut
F3	253-19	2	#10 steel flat washer
F4	253-716	16	#10 fiber flat washer
F5	259-26	3	#10 solder lug

Other Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
G1	250-1235	2	1/4-32 × 1/4" setscrew
G2	252-39	2	1/4-32 nut
G3	252-701	12	Brass control nut
G4	253-10	5	Control flat washer
G5	253-36	1	Brass spring washer
G6	254-5	3	Control lockwasher
G7	258-704	2	Dished spring
G8	258-705	2	Forked spring
G9	258-734	2 ~~3~~	Contactor spring
G10	259-10	3	Control solder lug
G11	455-11	1	Split bushing
G12	455-26	2	Shaft bushing
G13	455-642	1	Shaft collar
G14	455-667	3	Decoder disk collar

SPACERS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
H1	255-59	2	Tapered spacer
H2	255-719	50	Large 17/64" spacer
H3	255-720	4	Large 3/16" spacer
H4	255-721	100	Small 17/64" spacer
H5	255-722	4	Small 3/16" spacer
H6	255-728	8	8-32 × 8-5/16" spacer
H7	255-812	1	1/2" hex spacer
H8	255-813	1	9/16" hex spacer
H9	255-814	2	11/16" hex spacer

SHAFTS - COUPLERS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
J1	266-896	4	10-32 × 9-7/8" threaded brass rod
J2	266-1047	1	Tension rod
J3	453-278	2	9-7/8" hex shaft
J4	453-343	1	16" shaft
J5	456-1	3	Flexible shaft coupler
J6	456-7	1	Shaft coupler

METAL PARTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
K1	90-1305-1	1	Cabinet top
K2	200-1436-1	1	Main chassis
K3	203-2154-1	1	Front panel
K4	203-2155-2	1	Rear panel
K5	204-1856	1	Speaker mounting bracket
K6	204-2207	6	Capacitor mounting bracket
K7	204-2355	2	Angle bracket

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

Metal Parts (Cont'd.)

K8	204-2509	4	Meter bracket
K9	204-2688	1	Control mounting bracket
K10	204-2691	1	Switch mounting bracket
K11	205-1679	2	Capacitor front plate
K12	205-1680	2	Capacitor rear plate
K13	205-1681	50	Stator plate
K14	205-1682	52	Rotor plate
K15	205-1915	1	Top shield
K16	206-1453	1	Center shield
K17	206-1454	1	Input shield
K18	212-56	1	5-1/2" strap
K19	212-57	1	4-1/4" strap
K20	212-59	2	4-19/32" strap
K21	212-60	1	6" strap
K22	258-742	2	Grounding spring

CONNECTORS

L1	432-66	4	Push-on connector
L2	432-70	1	9-hole plug shell
L3	432-71	1	9-hole socket shell
L4	432-72	14	Male connector pin
L5	432-73	14	Female connector pin
L6	432-196	1	2-hole socket shell
L7	432-720	1	3-hole plug shell
L8	432-723	1	Large 3-hole socket shell
L9	432-907	1	2-hole plug shell

INSULATORS

N1	71-2	3	Small ceramic feedthrough insulator (disassembled)
N2	71-11	1	Large ceramic feedthrough insulator (disassembled)
N3	73-43	1	3/8" grommet
N4	73-147	1	3" foam tape
N5	75-109	2	Small insulator paper (3-3/8" × 5-3/8")
N6	75-754	1	Strain relief
	75-836	1	Large insulator paper (5" × 13")
N7	266-894	9	Ceramic insulator plate (1 extra included)

KEY No.	HEATH Part No.	QTY.	DESCRIPTION

MISCELLANEOUS

	89-54	1	Line cord
P1	205-1741	2	Inductor end plate
P2	261-9	4	Round foot
P3	266-898	2	Steel ball
P4	266-1048	1	Roller contact
P5	266-1213	1	Switch detent
P6	266-1216	2	Decoder disk
P7	351-9	1	Glue
P8	352-14	1	Grease
P9	354-5	8	Cable tie
P10	431-41	1	2-lug terminal strip
P11	431-42	1	5-lug terminal strip
P12	446-735	1	Window
P13	451-615	1	Worm gear
P14	451-618	1	Spur gear
P15	462-1130	1	Small round knob
P16	462-1178	3	Large round knob
P17	462-1170	5	Pushbutton knob
P18	462-1171	1	Lever knob
P19	485-29	2	Button plug
P20	490-5	1	Nut starter
P21	490-14	1	Large allen wrench
P22	490-23	1	Small allen wrench
P23	490-168	1	Open-end wrench

Heathkit®

Sensor Assembly (#100-1836)

INPORTANT: The Sensor Assembly contains the following parts. This Assembly has been factory tested and aligned. **Do NOT attempt to adjust any components in the Sensor Assembly;** to do so may void the Warranty. Replacing components inside the Assembly may also cause it to require realignment at the factory.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
RESISTORS, 1/4-WATT, 5%			
6-470-12	2	47 Ω (yel-viol-blk)	R101, R102
6-332-12	1	3300 Ω (org-org-red)	R103
6-223-12	1	22 kΩ (red-red-org)	X102
6-104-12	1	100 kΩ (brn-blk-yel)	X103
6-222-12	1	2200 Ω (red-red-red)	X101
6-472-12	1	4700 Ω (yel-viol-red)	X104
CONTROLS			
10-312	1	10 kΩ	R104
10-390	1	20 kΩ	R107
10-941	2	100 kΩ	R105, R106
CAPACITORS — COIL			
20-103	2	150 pF mica capacitor	C101, C102
20-172	2	.001 μF mica capacitor	C103, C104
31-8	1	1-8 pF trimmer capacitor	C105
40-1970	1	29.5 μH toroid coil	L101
HARDWARE			
250-480	2	4-40 × 15/16" screw	
252-15	2	4-40 nut	

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Hardware (Cont'd.)			
254-9	2	#4 lockwasher	
253-43	2	#5 flat washer	
250-1325	2	6-32 × 1/4" pan phillips head screw	
253-14	1	#8 fiber flat washer	
254-1	6	#6 lockwasher	
255-828	2	Spacer	
257-12	1	Eyelet	
259-6	2	#6 solder lug	
MISCELLANEOUS			
56-20	2	1N295A or 1N295S or 1N60H diode	D101, D102
63-1400	1	Rotary switch	SW101
85-2038-1	1	Printed circuit board	
204-9	2	Angle bracket	
212-61	3	Switch bus	
214-230-1	1	Sensor housing	
340-3	4-1/2"	16-gauge bare wire	
340-8	4"	22-gauge bare wire	
346-21	1"	Sleeving	
347-39	3'	5-conductor cable	
436-55	4	Coaxial jack	J1, J2, J6, J7

INITIAL TESTS

In this section of the Manual, you will perform certain tests to verify that your Antenna Tuner operates properly. If you do not obtain the correct results in any of the following tests, refer to the "Possible Cause of Trouble" column, or the "In Case of Difficulty" section on Page 126, and correct the problem before you continue.

CAUTION: Do NOT connect the line cord plug of your Antenna Tuner to an AC outlet until you are instructed to do so.

TEST PREPARATION

( ) Set the front panel controls and switches as follows:

POWER	Off (down)
SENSITIVITY	12 o'clock position
SWR/REFLD	REFLD (out)
SET/FWD	FWD (out)
AUTO On/Off	Off (out)
AUDIO ALARM On/Off	On (in)
LINEAR On/Off	Off (out)
TRANSMITTER	Neutral (center) position
INDUCTOR	Neutral (center) position
ANTENNA	Neutral (center) position
TUNE SWR	2
BAND	80
LOW/HIGH	LOW
COAX	BYPASS

Refer to Pictorial 12-1 (Illustration Booklet, Page 42) for the locations of the controls called out in the following steps.

( ) Set the following controls on the display circuit board to the 12 o'clock (center) position:

R204 (ZERO)
R233 (TURNS)

( ) Set the following controls on the main circuit board to the 12 o'clock (center) position:

R302 (WATTMETER AUTO RANGE)
R335 (TUNE SWR ADJUST)
R318 (SWR CAL)
R326 (SWR NULL)
R379 (NEG ADJ)
R381 (POS ADJ)
R358 through R375 (ROLLER INDUCTOR PRESETS)

PRIMARY WIRING TESTS

IMPORTANT: A wiring error in the primary wiring circuit (line cord, power switch, etc.) of your kit could cause you to receive a severe electrical shock. These "Primary Wiring Tests" will help you eliminate any such wiring errors that may exist.

( ) Be sure the line cord plug is not connected to an AC outlet.

( ) Be sure the POWER switch is off.

NOTE: If you do not have an ohmmeter, carefully check the line cord, switch SW6, and the transformer wiring against the wiring shown in Pictorials 11-3 and 11-5. Make sure there are no fine strands of wire or solder globs touching adjacent terminals or the chassis. Then proceed to "Power On Tests."

If you have an ohmmeter, perform the following resistance measurements. NOTE: You will be instructed to connect one of the ohmmeter leads to ground. You may use the GROUND post on the rear panel for this.

( ) Turn on your ohmmeter and allow it to warm up, if necessary.

( ) Set the ohmmeter to the R × 10 range.

NOTES:

1. The resistance readings in the following steps were taken with a Heathkit Model IM-5218 VTVM. Readings taken with other ohmmeters (because of different measuring voltages and currents) may be considerably different.

2. The internal wiring of most ohmmeters is such that the negative terminal of the meter battery is connected to the negative (black) or common test lead. In some ohmmeters this wiring is interchanged, and erroneous readings may result. Interchange the ohmmeter leads if the measurements do not check out correctly the first time.

METER CONNECTIONS		METER READING	POSSIBLE CAUSE OF TROUBLE
POSITIVE LEAD	COMMON LEAD		
( ) Either flat prong of the line cord plug.	Ground.	INFINITE with the POWER switch on or off.	A. Wiring of switch SW6. B. Wiring of transformer T1.
( ) Other flat prong of the line cord plug.	Ground.	INFINITE with the POWER switch on or off.	A. Wiring of switch SW6. B. Wiring of transformer T1.
( ) Round prong of the line cord plug.	Ground.	0 Ω with the POWER switch on or off.	A. Green wire not properly connected from line cord to solder lug L. See Pictorial 3-1 (Illustration Booklet, Page 20).
( ) Either flat prong of the line cord plug.	Other flat prong.	INFINITE with the POWER switch off.	A. Wiring of switch SW6. B. Wiring of transformer T1.
( ) Either flat prong of the line cord plug.	Other flat prong.	Approximately 20 Ω to 40 Ω with the POWER switch on.	A. Wiring of switch SW6. B. Wiring of transformer T1.

This completes the "Primary Wiring Tests." Proceed to "Power Off Tests."

POWER OFF TESTS

These ohmmeter tests provide you with a very important means to check the circuits in your Antenna Tuner so they will not become damaged when you apply power. Therefore, if you do not have an ohmmeter, you may wish to borrow one.

If you do not obtain the indicated results in any test, refer to the "Possible Cause of Trouble" column. If you do get the correct results, proceed with the next step.

(X) Turn on your ohmmeter and allow it to warm up, if necessary.

(X) Set the ohmmeter to the R × 10 range.

(X) Be sure the Antenna Tuner line cord plug is not connected to an AC outlet.

(X) Be sure the POWER switch is in the off (down) position.

Make a check (√) next to each item listed as you verify the readings in the following chart.

METER CONNECTIONS		METER READING	POSSIBLE CAUSE OF TROUBLE
POSITIVE LEAD	COMMON LEAD		
(√) Brown wire at feedthrough capacitor C8.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C8 or C303. B. Check sensor assembly. C. Check U301.
(√) Red wire at feedthrough capacitor C9.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C9 or C304. B. Check sensor assembly. C. Check U301.
(√) Black wire at feedthrough capacitor C7.	Ground.	0 Ω.	A. Check capacitor C7. B. Check sensor assembly.
(√) Green wire at feedthrough capacitor C5.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C5 or C301. B. Check sensor assembly. C. Check U301.
(√) White wire at feedthrough capacitor C6.	Ground.	200 Ω - 1000 Ω.	A. Check capacitors C6 or C302. B. Check sensor assembly. C. Check U301.

METER CONNECTIONS		METER READING	POSSIBLE CAUSE OF TROUBLE
POSITIVE LEAD	COMMON LEAD		
( ) Pin 1 of socket S2.	Ground.	0 Ω.	A. Large black wire not connected from pin 1 of socket S2 to solder lug GA. See Pictorial 11-1 (Illustration Booklet, Page 32).
( ) Pin 2 of socket S2.	Ground.	INFINITY with the POWER switch off. Minimum 10 kΩ with the POWER switch on.	A. Check wiring of switch SW6. B. Check D331 and D332. C. Check U1.
( ) Pin 1 of socket S1.	Ground.	INFINITY.	A. Check wiring of relay K1.
( ) Pin 3 of socket S1.	Ground.	INFINITY.	A. Check wiring of relay K1.
( ) Center pin on sensor assembly's INPUT jack.	Ground.	INFINITY.	A. Check sensor assembly.
( ) Center pin on sensor assembly's COAX 1 jack.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) Center pin on sensor assembly's COAX 2 jack.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) Center pin on sensor assembly's BYPASS jack.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) SINGLE WIRE post on rear panel.	Ground.	INFINITY.	A. Check wiring of rotary switch SW7.
( ) Lead of ferrite bead FB304.	Ground.	Minimum 50 Ω.	
( ) Plus (+) lead of capacitor C331.	Ground.	Minimum 10 kΩ.	A. Check D331 and D332. B. Check U1. C. Check C331.

( ) Place the COAX switch in the BYPASS position.

( ) Center pin on sensor assembly's INPUT jack.	Center pin on sensor assembly's BYPASS jack.	0 Ω.	See * on page 109.

( ) Repeat the last step for each of the three remaining COAX switch position. Each time, the meter should read "INFINITY."

( ) Place the COAX switch in the COAX 1 position.

( ) Center pin on sensor assembly's COAX 1 jack.	Feedthrough insulator C. Set inset drawing #2 on Pictorial 12-1.	0 Ω.	See * on page 109.

( ) Place the COAX switch in the COAX 2 position.

( ) Center pin on sensor assembly's COAX 2 jack.	Feedthrough insulator C.	0 Ω.	See * below.

( ) Place the COAX switch in the LONG WIRE position.

( ) SINGLE WIRE post on rear panel.	Feedthrough insulator C.	0 Ω.	See * below.

NOTE: For each position (except REMOTE) of the BAND switch, only one particular pin on plug P1 should be connected to ground (displayed as 0 Ω on your ohmmeter) as indicated in the following chart. The ohmmeter should indicate INFINITY for the remaining eight plug pins for each BAND switch setting.

Make a check (√) next to each band listed as you verify the readings in the following chart.

BAND	PLUG P1 PIN NO.								
	1	2	3	4	5	6	7	8	9
( ) 160	0 Ω								
( ) 80		0 Ω							
( ) 40			0 Ω						
( ) 30				0 Ω					
( ) 20					0 Ω				
( ) 17						0 Ω			
( ) 15							0 Ω		
( ) 12								0 Ω	
( ) 10									0 Ω
( ) Remote									

( ) Disconnect the ohmmeter leads from the Antenna Tuner.

This completes the "Power Off-Tests." Proceed to the "Power On Tests."

* If your meter does not read 0 Ω for any of the COAX switch positions, refer to Pictorial 11-12 on Page 103 and loosen the rear setscrew in the shaft coupler installed on the 16" shaft. Slowly turn that shaft in either direction until the meter reads 0 Ω. Then retighten the setscrew.

POWER ON TESTS

CAUTION: When the line cord plug is connected to an AC outlet, the AC voltage will be present at several places on the Antenna Tuner chassis, as shown in Pictorial 12-1 (Illustration Booklet, Page 42). Be careful that you do not contact this voltage because an electrical shock will result.

A DC voltmeter is required for the following tests. This voltmeter should have a 10 MΩ (or higher) input impedance.

Refer to Pictorial 12-1 for the following steps.

NOTES:

1. If you fail to obtain the desired readings in each of the following tests, push the POWER switch to off and refer to the "In Case of Difficulty" section of this Manual.

2. Set your voltmeter to the proper DC voltage range to obtain meaningful readings in the following steps. Be sure to switch your voltmeter leads or voltmeter polarity switch to check for negative (−) voltages.

3. Be sure to touch only the indicated circuit point. To do otherwise might short a connection and damage an integrated circuit (IC) or transistor, for example.

4. All voltages were taken with a vacuum-tube voltmeter (VTVM). The readings that you get should be within ± 5% of those indicated in the steps.

(✓) Turn on your voltmeter and allow it to warm up, if necessary.

(✓) Position the chassis as shown in the Pictorial.

( ) Connect the line cord plug to a 120 VAC outlet.

( ) Connect the common (negative) lead of your DC voltmeter to the GROUND post on the rear panel of your Antenna Tuner.

(✓) Place the POWER switch in the on (up) position. The digital turns counter should light. The audio alarm may sound and the visual alarm may light. Also, both capacitor motors may turn until the slot in each decoder disk is located between the posts of the respective optical couplers (U1 and U2).

(✓) Touch the test probe of your DC voltmeter to FB304 (on the main circuit board). The meter should indicate +12.0 volts.

( ) Touch the test probe of your DC voltmeter to TP303. The meter should indicate between +5.0 and +12.0 volts.

( ) Touch the test probe of your DC voltmeter to the O (output) pin of U205 (on the display circuit board). The meter should indicate +5.0 volts.

( ) Touch the test probe of your DC voltmeter to pin 4 of U317 (on the main circuit board). The meter should indicate +10.0 volts.

( ) Touch the test probe of your DC voltmeter to TP304. The meter should indicate between −5.0 and −12.0 volts. NOTE: Exchange your voltmeter leads or switch polarity as required.

( ) Touch the test probe of your DC voltmeter to the indicated lead of resistor R382 (680 Ω, blu-gry-brn). The meter should indicate between −3.0 and −3.5 volts.

( ) Touch the test probe of your DC voltmeter to the indicated lead of resistor R383 (56 Ω, grn-blu-blk). The meter should indicate between −.05 and −.2 volt.

( ) Disconnect the voltmeter leads from the Antenna Tuner.

( ) Place the POWER switch in the off (down) position.

This completes the "Power On Tests." Proceed to "Adjustments."

ADJUSTMENTS

You will need the following equipment as you make the necessary adjustments in your Antenna Tuner:

- A DC voltmeter.
- An RF source (transmitter, transceiver, etc.) covering the desired amateur bands and capable of delivering a minimum of 200 watts of RF power.
- A 50 Ω nonreactive load capable of dissipating at least the power produced by your RF source.

( ) Set the Antenna Tuner front panel controls and switches as follows:

POWER	Off
SENSITIVITY	12 o'clock position
SWR/REFLD	REFLD (out)
SET/FWD	FWD (out)
AUTO On/Off	Off (out)
AUDIO ALARM On/Off	Off (out)
LINEAR On/Off	Off (out)
TRANSMITTER, INDUCTOR, ANTENNA	Neutral (center position)
TUNE SWR	2 (12 o'clock position)
BAND	80
LOW/HIGH	LOW
COAX	COAX 1

NOTE: If you do not obtain the proper results in the following steps, place the POWER switch of your Antenna Tuner in the off position, refer to the "In Case of Difficulty" section of this Manual, and correct any difficulties before you proceed.

Refer to Pictorial 13-1 (Illustration Booklet, Page 43) for the following steps.

(✓) Check transmitter matching capacitor C1 to see that the rotor is half meshed (half closed). If it is not, turn the POWER on and push the TRANSMITTER lever switch up or down until the rotor reaches the half-mesh position. Then release the lever switch (to its neutral position).

(✓) In the same manner, if necessary, use the ANTENNA lever switch to place the rotor for antenna matching capacitor C2 in the half-mesh position.

(✓) Place the POWER switch in the off position.

(✓) Check and see if the slot on the disk decoder, which is installed on the small shaft of motor A1, is positioned between the two posts of optical coupler U2. If it is not, temporarily loosen the 4-40 × 1/8" setscrew installed in the collar of the decoder disk and rotate the decoder disk to position it properly; then tighten the setscrew.

(✓) In the same manner, if necessary, position the slot in the other decoder disk between the two posts of optical coupler U1.

Refer to Pictorial 13-2 (Illustration Booklet, Page 44) for the following steps.

( ) Turn on your DC voltmeter and allow it to warm up, if necessary.

( ) Connect the common (negative) lead of your DC voltmeter to the GROUND post on the rear panel of your Antenna Tuner.

( ) Make sure control R6 is turned fully clockwise.

( ) Place the POWER switch in the on position.

( ) Touch the test probe of your DC voltmeter to the indicated lug of ZERO control R204 (on the display circuit board). Then adjust control R204 for a voltmeter reading of +3.0 volts.

NOTE: When you operate the lever switch for the roller inductor, be careful that the roller contact does not turn past its end stops. This could cause the roller contact to jump off the wire turns on the inductor.

( ) While viewing the roller contact through the left side of the chassis and the plates of matching capacitor C1, check and see if it is positioned at the end of its travel near the rear panel. If it is not, push and hold the front panel near the rear panel INDUCTOR switch down until the roller contact just reaches this position. Then release the switch.

1. ( ) Rotate the shaft of inductor position control R6 until the front panel digital turns counter reads 00:0.

2. ( ) Carefully reinstall the spur gear on the shaft of control R6. Be sure the digital turns counter still reads 00:0. If it does not, rotate the shaft of control R6, as necessary, until it does. Then tighten the setscrew in the bushing of the spur gear.

( ) Push and hold the INDUCTOR lever switch up until the roller contact just reaches the end of its travel, near the front panel. Then release the switch.

( ) Adjust TURNS control R233, on the display circuit board, for a reading of 40:0 on the turns counter.

( ) Push and hold the INDUCTOR lever switch down until the roller contact just reaches the end of its travel, near the rear panel. Then release the switch.

( ) Be sure the turns counter still reads 00:0. If it does not, again loosen the setscrew in the bushing of the spur gear, and temporarily remove the gear. Then repeat steps 1 and 2.

( ) Push and hold the INDUCTOR lever switch up until the roller contact just reaches the end of its travel, near the front panel. Then release the switch.

( ) Be sure the turns counter still reads 40:0. If it does not, adjust TURNS control R233 until it does.

( ) Place the Antenna Tuner COAX switch in the COAX 1 position if this has not already been done.

( ) Connect a length of 50 Ω coaxial cable from the antenna output connector on your transmitter (or transceiver) to the Antenna Tuner INPUT jack.

( ) Connect a 50 Ω nonreactive load to the Antenna Tuner COAX 1 jack.

( ) Touch the test probe of your DC voltmeter to TP301 on the main circuit board. Then adjust POS ADJ control R381 for a voltmeter reading of 1.0 volt.

( ) Touch the test probe of your DC voltmeter to TP303 and record the voltmeter reading: + ~~2.85~~ 8.025 volts.

( ) Touch the test probe of your DC voltmeter to TP304 and adjust NEG ADJ control R379 for the same reading you obtained in the last step, except for having negative polarity: − 8.027 volts.

( ) Repeat the previous three steps.

NOTE: In the following step, as you slowly turn the control clockwise from its preset center position, the voltage you measure will vary quite rapidly from about −1.0 volt, through 0 volt to +1.0 volt. As soon as your voltmeter reading does not increase any more (approximately +1.0 volt), immediately stop turning the control.

( ) Touch the test probe of your DC voltmeter to pin 4 of U304. Then adjust SWR NULL control R326 for a voltmeter reading as noted above.

( ) First touch the test probe of your DC voltmeter to TP301 and then to pin 4 of U304. The two meter readings should be within ±.05 volt.

( ) Touch the test probe of your DC voltmeter to TP302 and adjust TUNE SWR ADJ control R335 for a voltmeter reading of +.7 volt.

NOTE: In the following step, you will be transmitting an RF signal. Be sure you have a suitable load connected to the COAX 1 jack of your Antenna Tuner. Also, transmit just long enough to obtain the desired result.

( ) Turn the transmitter power on and allow the transmitter time to warm up, if necessary.

( ) Connect a CW key to the transmitter key jack.

( ) Select the **low** 80-meter operating frequency that you wish to preset your roller inductor for. Then set the transmitter to that frequency.

( ) Tune up the transmitter, if necessary.

( ) Key your transmitter and adjust its output power to 10-20 watts, as indicated by the Forward (FWD) meter on your Antenna Tuner.

( ) Adjust roller inductor L1 by holding the INDUCTOR lever switch up or down, as necessary, until you obtain the lowest reading (null) on the Reflected (REF) meter on your Antenna Tuner.

( ) Release the key.

SETTING PRESET CONTROLS

NOTES:

A. In the following steps, you will adjust the reference preset controls for the roller inductor for each of the bands you intend to operate on. The reference preset label has been provided to help you locate the proper controls on the main circuit board. You may find it convenient to select two presets (one for the low end and one for the high end) for each BAND switch position, as indicated on the preset label. CAUTION: Make sure you do not adjust any of the reference preset controls so the roller inductor runs against the stops and stalls the motor.

B. The setting of the reference preset controls may vary between different antennas you are using.

1. Set the LOW/HIGH switch on your Antenna Tuner to LOW, if this has not already been done. Also, be sure the BAND switch is set to 80.

2. Locate control 80L on the preset label; then locate the corresponding preset control (R361) on the main circuit board.

3. Slowly adjust control R361 until LED (light-emitting diode) D359 lights.

4. Select the **high** 80-meter operating frequency that you wish to preset your roller inductor for. Then set the transmitter to that frequency.

5. Tune up the transmitter, if necessary.

6. Set your Antenna Tuner's LOW/HIGH switch to HIGH.

7. Locate control 80H on the preset label; then locate the corresponding control (R360) on the main circuit board.

8. Key the transmitter and adjust its output power to 25-50 watts, as indicated on the Forward meter of your Antenna Tuner.

9. Adjust roller inductor L1 by holding the INDUCTOR lever switch up or down, as necessary, until you obtain the lowest reading (null) on the Reflected (REF) meter on your Antenna Tuner.

10. Release the key.

11. Slowly adjust control R360 until LED D359 lights.

12. Repeat the last eleven steps for each position of the BAND switch that you intend to operate on. NOTE: You may not be able to obtain a null reading on 160 meters. Instead, adjust roller inductor L1 until you obtain a minimum reading on the REF meter.

NOTE: In the following steps, you will set up the automatic SWR circuit for a 2:1 standing wave ratio. Read the next four steps through before you complete these steps.

( ) Key the transmittter and adjust its output power to 50 watts, as indicated by the Forward meter on your Antenna Tuner.

( ) Use the TRANSMITTER and ANTENNA lever switches, as necessary, to tune the two variable capacitors until you obtain a 5-watt reading on the Reflected meter on your Antenna Tuner.

( ) Readjust the transmitter's ouput power, as necessary, until you obtain readings of 50 watts and 5 watts on the Forward and Reflected meters, respectively, on your Antenna Tuner.

( ) Touch the test probe of your DC voltmeter to pin 5 of U302.

( ) Key the transmitter and, with 50 watts on the Forward meter and 5 watts on the Reflected meter, adjust SWR CAL control R318 for a +.5-volt reading.

SETTING AUTO-RANGE CONTROL

NOTES:

1. In the following steps, you will set the transition point where the auto-range wattmeter circuitry switches from one power scale to the other (by adjusting control R302 on the main circuit board). This control would normally be set to the 200-watt level. However, you may wish to set it to a different level, provided it does not exceed 200 watts.

2. Turning control R302 clockwise (as viewed from the front or "knob" side of the control) increases the power level you wish to establish for the transition point.

( ) Place an amplifier in line with your RF source, if the RF source does not deliver sufficient RF power for the auto-range wattmeter circuitry to operate properly. NOTE: Make sure you connect your transmitting equipment as shown in Pictorial 15-1 (Illustration Booklet, Page 46).

( ) Turn the amplifier on (if you placed it in line with your RF source) and allow it to warm up, if necessary.

( ) Key the transmitter and adjust the power output to the level you wish to use for the power scale transition point, as indicated on the Forward meter on your Antenna Tuner.

( ) Continue to key the transmitter while you, at the same time, watch the Forward meter. Slowly turn control R302 first in one direction, then the other direction (if necessary), until the auto-range wattmeter circuitry switches to the other scale on the Forward meter. Immediately stop turning the control.

This completes the "Adjustments." Proceed to "Final Assembly."

FINAL ASSEMBLY

Refer to Pictorial 14-1 (Illustration Booklet, Page 45) for the following steps.

( ) Position the chassis assembly as shown in the Pictorial.

( ) Look at the cabinet top. Notice that the mounting holes are closer to one edge than they are to the other. When you install the cabinet top, in the next step, be sure to position the top so the wider space is toward the front of the chassis.

( ) Position the cabinet top down onto the chassis. Then use eight 6-32 × 1/4" screws to secure the top to the chassis. NOTE: If necessary, first loosen the two outside screws on each side of the main chassis until the cabinet top is secured to the chassis. Then retighten these four screws.

( ) Carefully peel the backing paper from the blue and white label. Then press the label onto the rear panel in the lower right-hand corner (just below the model number). Be sure to refer to these numbers in any communications you may have with the Heath Company about your kit.

This completes the assembly, Initial Tests, and Final Assembly of your Antenna Tuner. Proceed to "Applications and Installation."

APPLICATIONS AND INSTALLATION

APPLICATIONS

This Antenna Tuner will match a reactive and/or resistive load to a nonreactive, 50-ohm load. You can adjust it to tune out load reactance and, when necessary, transform the load impedance to the required 50-ohm transmitter (or amplifier) output impedance. The Tuner uses a roller inductor along with two variable capacitors to provide an almost unlimited matching range, and features 160-meter through 10-meter coverage.

An optional 4-to-1 (**bal**anced-to-**un**balanced) balun coil, on the output side of the Antenna Tuner, permits the use of balanced feed lines. You can use the Tuner to match into coaxial lines, random-length end-fed wires, or balanced feeders.

INSTALLATION

Pictorial 15-1 (Illustration Booklet, Page 46) shows a typical fixed-station installation. This Pictorial shows an installation where its internal coaxial switch (SW101) may be used to feed the RF source through your Antenna Tuner to any one of several 50-ohm antennas or RF loads. When the Coax switch is in the BYPASS position, your Antenna Tuner is switched out of the line; therefore, a straight-through connection is made. If an amplifier is not used, connect the cable from the transmitter's antenna connector directly to the RF input jack on the rear panel of the Antenna Tuner sensor.

Use coaxial cable, like RG-58/U or RG-8/U, to interconnect the various pieces of equipment. NOTE: Cables should be no longer than necessary.

A ground post is located on the rear panel of the Antenna Tuner. Connect this ground post to a good earth ground or a metal water pipe. **Use the shortest and heaviest connection possible.**

Before you use a water pipe ground, inspect the connection around your water meter. Make sure that no plastic or rubber hose connections are used which interrupt electrical continuity to the water supply line. Install a jumper around any insulating water connectors you find. Use heavy copper wire and pipe clamps. It is best to ground all equipment to one point at the operating position; then ground this point as discussed above.

Refer to various publications, such as the ARRL Radio Amateur Handbook, for more information concerning grounds.

CONNECTIONS

Use the following information to connect various types of antennas to your Antenna Tuner.

Coaxial-Fed Antennas

An antenna fed with coaxial line, such as a beam antenna or a center-fed dipole, can easily be matched with your Antenna Tuner to provide a good match to the transmitter across the entire band. This is particularly beneficial when, for example, you use an 80-meter dipole that has been cut for a particular portion of the band.

For coax-to-coax feeder matching, connect the antenna feed line to COAX 1 connector J1 (or to BYPASS jack J7 for a 50-ohm nonreactive dummy load) on the rear panel of your Antenna Tuner. NOTE: When you use BYPASS jack J7, the meters will still indicate forward and reflected power. However, the matching circuits will not have any effect.

Single-Wire Antennas

If possible, use a quarter-wavelength antenna or an odd multiple of a quarter wavelength. Such an antenna has low impedance and reduces the chances of high RF voltages appearing on the Antenna Tuner or associated equipment.

For end-fed antennas, random length antennas, or Windom-type antennas, connect the antenna to SINGLE WIRE connector J3 on the Antenna Tuner rear panel. Be sure the shorting bar is not connected to connector J3.

Balanced Feed Line Antennas

For antennas that use balanced feeders, connect the shorting bar between connectors J3 and J4 on the rear panel of your Antenna Tuner. Connect the antenna feed line between BALANCED FEED LINE connectors J4 and J5.

OPERATION

FRONT PANEL CONTROLS

Refer to Pictorial 16-1 (Illustration Booklet, Page 47) to identify the front panel meters, switches, controls, and the counter readout. A description of each is included.

REFLECTED (REF) METER (M2)
This meter indicates reflected power in watts on 2 scales (0-50 or 0-500). It also indicates standing wave ratio (SWR).

FORWARD (FWD) METER (M1)
This meter indicates forward power in watts on 2 scales (0-200 or 0-2000).

HI-LOW INDICATORS
Whichever indicator is lit corresponds to the power range (0-200 or 0-2000 watts) that is being selected by the Tuner's auto-range wattmeter circuitry.

This indicator lights whenever the transmitter capacitor is being turned.

This indicator lights whenever the roller inductor is being turned.

This indicator flashes on and off whenever the SWR, as "seen" by the Antenna Tuner, exceeds the setting of the front panel TUNE SWR control.

This indicator lights whenever the antenna capacitor is being turned.

TURNS COUNTER
This display indicates the number of active turns (00:0 to 40:0) used for a certain setting of the roller inductor.

COAX SWITCH
This switch is used to route the RF output power to any of three coaxial output jacks (one of which is a bypass), or to a long wire antenna.

POWER SWITCH
This switch turns the 120 VAC line power or the external 12 VDC power to the Antenna Tuner on or off. NOTE: 12 VDC and 120 VAC power cannot be connected to the Antenna Tuner at the same time.

SENSITIVITY CONTROL
Use this control to set the pointer of the reflected (REF) meter to the SET line with both the SWR-REFLD and SET-FWD switches pushed in.

SWR-REFLD SWITCH*
With this switch in the SWR (in) position, meter M2 indicates standing wave ratio. In the REFLD (out) position, meter M2 indicates reflected power.

SET-FWD SWITCH*
With this switch in the SET (in) position and the SWR switch pushed in, adjust the SENSITIVITY control for a full-scale reading (SET) on reflected meter M2. In the FWD (out) position, read forward power on meter M1.

AUTO SWITCH
In the AUTO (in) position, the Antenna Tuner automatically tunes the two variable capacitors until the SWR, as "seen" by the Antenna Tuner, corresponds to a value no higher than the setting of the TUNE SWR control (if that SWR value can be obtained in the manual mode for the same load).

In the manual (out) position, three lever switches (labeled TRANSMITTER, INDUCTOR, and ANTENNA) are used to activate the motors that turn the two variable capacitors and the roller inductor.

AUDIO ALARM SWITCH
With this switch pushed in, an audible alarm lasting for 1-2 seconds will sound whenever (1) the SWR, as "seen" by the Antenna Tuner, exceeds the setting of the TUNE SWR control and (2) if the auto control cannot match the load within about 20 seconds.

LINEAR SWITCH
Use this switch when you place an amplifier in the line with the transmitter. After the Antenna Tuner has been set up so the transmitter "looks into" a load that corresponds to an SWR that is equal to or less than the preset SWR, and you are ready to load up the amplifier, first place the AUTO switch in the manual (out) position. Then push the LINEAR switch to ON (in), apply RF power from the transmitter, and load up the amplifier as you normally would. At this time, you may push the AUTO switch to ON (in). Now, if the SWR exceeds the setting of the SWR TUNE control, the visual alarm will light and, if the AUDIO ALARM switch is ON (in), the audible alarm will sound. The amplifier is automatically bypassed while the Tuner is being retuned to the preset SWR. After the tuning has been completed, release the LINEAR switch to OFF (out). Then wait three seconds and push the LINEAR switch to ON (in); the amplifier is now back on line. NOTE: This applies only when you are in the AUTO mode.

TRANSMITTER SWITCH**
This lever switch activates the motor that turns the transmitter capacitor.

INDUCTOR SWITCH**
This lever switch activates the motor that turns the roller inductor.

ANTENNA SWITCH**
This lever switch activates the motor that turns the antenna capacitor.

TUNE SWR
Use this control to preset a maximum SWR that you consider as being acceptable for the antenna that you are using.

BAND SWITCH
This switch, along with the LOW-HIGH lever switch, selects as many as 18 different preset positions for the roller inductor. For your operating convenience, the BAND switch has nine band positions (10 through 160 meters and REMOTE), which are marked on the Antenna Tuner front panel. However, you may use all the preset positions on any band, if you wish. That is, you may use all the presets for frequencies withing the 80-meter band. By using the presets in this manner, you may operate on any desired frequency with a limited amount of time required for tune-up.

You may select nine of the 18 presets with the BAND switch in the REMOTE position. The setting of the HIGH-LOW lever switch determines which nine presets are selected. A switch contact grounds the proper remote line when you select the desired preset position. NOTE: Be sure one of the pins of REMOTE BANDSWITCH plug P1 (on the rear panel) is connected to ground before you place the BAND switch in the REMOTE position.

* Your Antenna Tuner will not work in the AUTO mode when either of these switches is in the "in" position.

** With this switch down, the motor rotates in a clockwise direction; it rotates in a counterclockwise direction with the switch up.

IMPORTANT: If you plan to use your Antenna Tuner in a remote location, be sure it is operating within its limitations (high or low temperatures, high humidity, etc.).

LOW-HIGH SWITCH
Selects one of the two roller inductor preset position for each of the nine BAND switch settings.

REAR PANEL CONTROLS AND CONNECTIONS

Refer to Pictorial 16-2 (Illustration Booklet, Page 48) to identify the rear panel controls and connections. A description of each is included.

COAX 1 JACK
Provides a connection for a 50-ohm system, such as a beam antenna, center-fed dipole antenna, or vertical antenna.

COAX 2 JACK
Provides a connection for a second 50-ohm system, such as a beam antenna, center-fed dipole antenna, or vertical antenna.

BYPASS JACK
This jack bypasses the Tuner and provides a connection for a 50-ohm RF dummy load or resonant antenna.

INPUT JACK
Provides a connection for the output jack of your transmitter, transceiver, or amplifier.

SINGLE WIRE POST
Provides a connection for an end-fed wire, random length wire, or Windom antenna.

BALANCED FEED LINE POSTS
(optional)
Provides a connection for a balanced feed line antenna.

GROUND POST
Provides a station ground connection for the Antenna Tuner.

REMOTE BAND-SWITCH SOCKET
Provides a remote band-switch port that can be used to externally control the Antenna Tuner's inductor preset controls. This is accomplished by grounding the appropriate socket pin when the BAND switch is in the REMOTE position.

12 VDC SOCKET
This is an interconnect socket so the Tuner can be powered by an external 12 VDC source.

FUSE
This fuse provides AC overcurrent protection for the electronic circuitry of the Antenna Tuner. NOTE: If you are using an external DC source to power your Antenna Tuner, be sure that source is fused.

ANT RELAY SOCKET
Provides a switch which is placed in the antenna relay line connected between the transmitter and the linear amplifier (contacts 3 and 5 of relay K1 are connected to the socket terminals). With LINEAR switch SW4 to ON (in), and the Antenna Tuner tuned to the preset value of the TUNE SWR control, this switch closes and allows the linear amplifier to operate. NOTE: Be sure to use this socket when you operate with a linear amplifier.

INITIAL ACTIONS

EQUIPMENT HOOK-UP

Before you proceed, make sure you connect your transmitting equipment as shown in Pictorial 15-1 (Illustration Booklet, Page 46). NOTE: If you are not using an amplifier, connect the coaxial cable from the transmitter's RF output connector directly to input connector J6 on the rear panel of the Antenna Tuner.

EXCITER TUNE-UP

The final stage of some transmitters must be tuned up before they can be placed on the air. It is important that you tune up a transmitter on a "dummy load" before you use it with your Antenna Tuner. You can use any load that presents a constant, resistive impedance of 50 ohms to the transmitter and can dissipate the required power for a reasonable length of time. As an example, the Heathkit "Cantenna" is a satisfactory load. NOTE: Do NOT use light bulbs as a "dummy load" since their resistance varies with current and their reactance varies with frequency.

COUPLER TUNING

This part of the "Operation" section includes the procedure for using your Antenna Tuner with various antenna systems.

NOTES:

1. When the roller inductor is turning, be careful that you do not allow it to turn past its end stops (00.0 or 40.0). This could cause the roller contact to jump off the wire turns on the inductor.

2. The "ARRL Antenna Book" is readily available and includes comprehensive information on transmission lines and antennas. You can purchase other similar radio amateur handbooks and some are available in public libraries.

IMPORTANT:

1. During the tuning procedure, apply a minimum of 10 watts of RF power from the transmitter to get a meaningful reading on REF meter M2. When the Antenna Tuner is at or near resonance, as indicated by minimum reflected power, you may increase the power from the transmitter. At this time, you can make final adjustments (in the manual mode) to the Antenna Tuner.

2. When you tune your transmitter, be sure to observe the duty cycle limitations, if any.

3. Many solid-state transmitters have automatic VSWR shut-down circuitry. During the following tuning procedure, a decrease in VSWR should correspond to an increase in forward power.

TUNING PROCEDURE

Use the following procedure to match your antenna to your transmitter:

1. Be sure your antenna is connected to the rear panel of the Antenna Tuner as described in the "Applications and Installation" section of this Manual.

2. Set COAX switch SW101 to the position that corresponds to the antenna you intend to use.

3. Set SENSITIVITY control R1 to the most sensitive (fully clockwise) position.

4. Set TUNE SWR control R2 to the desired position.

5. Set SWR/REFLD switch SW2 to the REFLD (out) position.

6. Set SET/FWD switch SW1 to the FWD (out) position to measure the forward power on FWD meter M1.

7. Set AUTO/Manual switch SW5 to the AUTO (in) position.

8. Set AUDIO ALARM switch SW3 to the ON (in) position, if you desire an audible warning when the lowest SWR your Antenna Tuner can be tuned to exceeds your setting of TUNE SWR control R2 (for a particular antenna and a specific operating frequency). Otherwise, set this switch to the OFF (out) position.

9. Set LINEAR switch SW4 to the OFF (out) position.

10. Set BAND switch SW7B to the band you intend to operate on.

11. Set LOW/HIGH switch SW7A to the position that corresponds to the portion of the band you intend to operate on.

12. Turn the transmitter's power on.

13. With the transmitter in either the tune or CW mode, advance the transmitter's carrier level (or power output) control for a reading of 20 to 100 watts on FWD meter M1.

14. Allow the Antenna Tuner enough time to tune itself to the preset SWR. Then advance the transmitter's carrier level (power output) control for full output power.

15. If you intend to use an amplifier, set LINEAR switch SW4 to the ON (in) position (Refer to "Linear Switch" on Page 119). NOTE: You do not have to retune your Antenna Tuner after you place the amplifier in the line.

SWR MEASUREMENTS

The ratio of maximum rms voltage (or current) to minimum rms voltage (or current) along a transmission line defines the standing wave ratio. To obtain an SWR indication on your REF meter:

1. Set your transmitter to the desired frequency.
2. Perform the tuning procedure that corresponds to the antenna you are using and which is described under "Coupler Tuning."
3. Set SET/FWD switch SW1 to the FWD (out) position.
4. Turn the transmitter on and advance its RF output level for the desired forward indication on FWD meter M1.
5. Set SET/FWD switch SW1 to the SET (in) position.
6. Set SWR/REFLD switch SW2 to the SWR (in) position.
7. Adjust SENSITIVITY control R1 to position the pointer of REF meter M2 over the "Set" marking on the meter.
8. Set SET/FWD switch SW1 to the FWD (out) position and read the SWR on the SWR scale of REF meter M2. At this time, FWD meter M1 will indicate the forward power. NOTE: If the SWR is greater than 3:1, read the forward and reflected power levels. Then use these power levels and the SWR Chart on Page 124 to determine the SWR.

FORWARD POWER MEASUREMENTS

Use the following procedure to determine the level of power that is being coupled to the antenna:

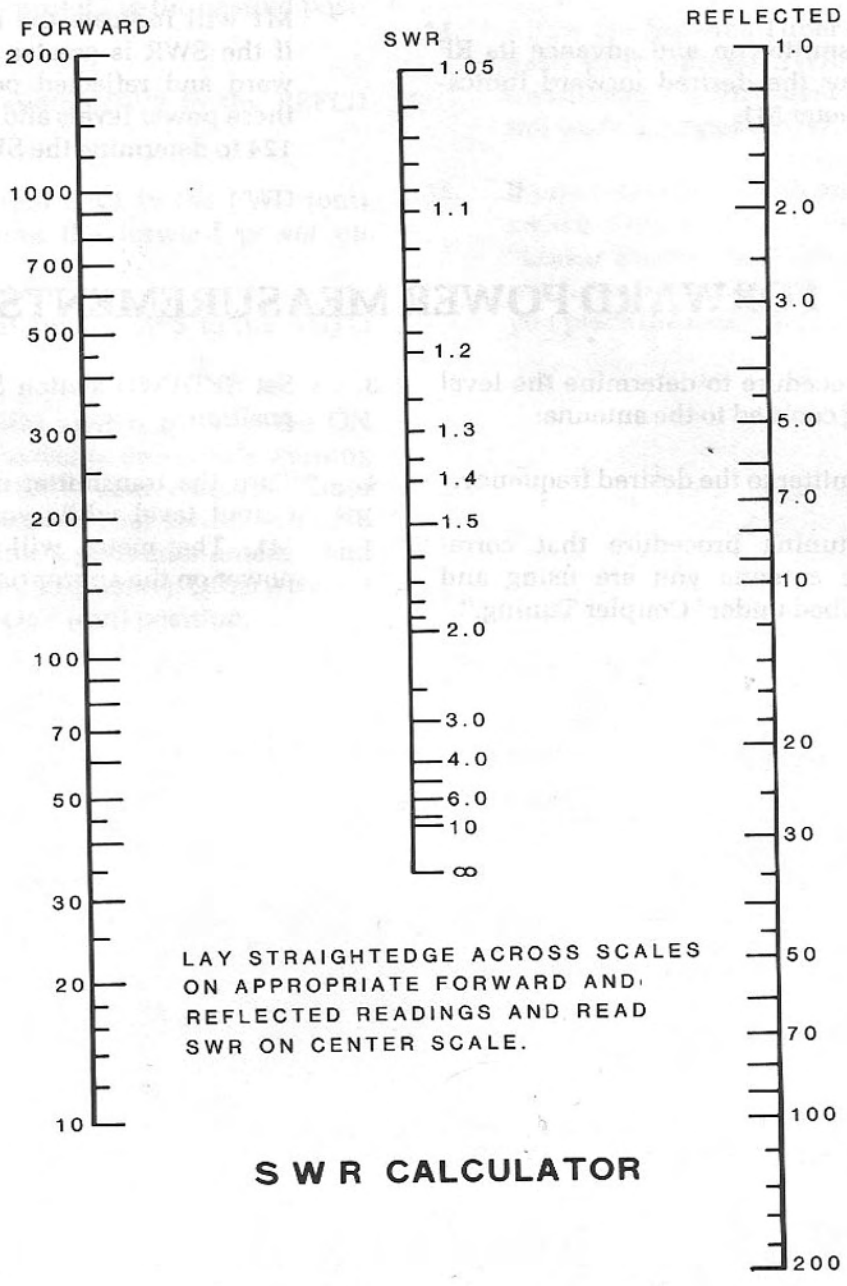
1. Set your transmitter to the desired frequency.
2. Perform the tuning procedure that corresponds to the antenna you are using and which is described under "Coupler Tuning."
3. Set SET/FWD switch SW1 to the FWD (out) position.
4. Turn the transmitter on and advance its RF output level while you observe FWD meter M1. The meter will indicate the forward power on the appropriate power scale.

REFLECTED POWER MEASUREMENT

Use the following procedure to determine the level of power that is being reflected back towards the transmitter (due to a mismatch in the antenna system).

1. Set your transmitter to the desired frequency.
2. Perform the tuning procedure that corresponds to the antenna you are using and which is described under "Coupler Tuning".
3. Set SWR/REFLD switch SW2 to the REF (out) position.
4. Turn the transmitter on and advance its RF output level while you observe REF meter M2. The REF meter will indicate the reflected power on the appropriate power scale.

SWR CHART



TYPICAL OPERATING CHARACTERISTICS

- A severe mismatch may cause a transmitter to become unstable until the SWR is reduced to a low value (1.5:1 or less). This is especially true of broadband solid-state transmitters. However, this can also occur with tube-type transmitters.
- In the AUTO mode, the roller inductor will return to the selected preset position whenever you change the BAND switch setting or the setting of the LOW/HIGH switch.
- On initial turn-on, the two matching capacitors rotate to the half-mesh position and, if in the AUTO mode, the roller inductor returns to the preset condition.
- In the AUTO mode, the two variable capacitors rotate to the half-mesh position whenever the roller inductor starts turning.
- In some cases, when your Antenna Tuner is used in the AUTO mode, it will not be able to find a match. This may happen if the antenna's impedance is outside the range of the Antenna Tuner or the setting of the tuning components is very critical.
- If you want a better match than you can obtain in the AUTO mode, place the AUTO/Manual switch in the Manual (out) position. Then use the lever switches to turn one or both matching capacitors, as necessary.
- Your Antenna Tuner will, if possible, tune for a match with an SWR below the setting of the TUNE SWR control. If a match with the preset SWR cannot be found in approximately 20 seconds, the alarm indicator will flash and, if the Audio Alarm switch is on (in), the audible alarm will sound.
- The alarm circuits may be activated under the following conditions:

  1. Upon initial power turn-on.
  2. When the standing wave ratio (SWR) as "seen" by the Antenna Tuner, exceeds the setting of the TUNE SWR control.
  3. The tune time in the AUTO mode exceeds 15-20 seconds.
  4. When you are making measurements to determine the standing-wave ratio.

- You may use any or all roller inductor presets for any of the 10 BAND positions.
- Your Antenna Tuner will not operate in the AUTO mode if either the SWR or SET switches are placed in the IN position.
- When the SWR of an antenna exceeds the setting of the TUNE SWR control for any reason (change of operating frequency, antenna problem, etc.), the alarm indicator will flash and, if the AUDIO ALARM switch is ON (in), the audible alarm will sound. Also, the Antenna Tuner will attempt to retune to this new condition (if in the AUTO mode).
- In the AUTO mode, it is normal for the Antenna Tuner to retune if the SWR of the antenna or dummy load you are using increases over the preset level as you start to apply more RF power to the antenna. NOTE: In cold weather, for example, an iced-up antenna may have an SWR that is considerably higher than it is in warm weather.

IN CASE OF DIFFICULTY

NOTE: It is important that you read the entire "General Troubleshooting Information" sections which follow, before you attempt to service your Antenna Tuner.

This section of the Manual is divided into three parts. The first part, titled "General Troubleshooting Information," describes what to do about the difficulties that may occur right after your Antenna Tuner is assembled.

The second section, titled "Troubleshooting Precautions," points out the care that is required when you service the Antenna Tuner to prevent damage to the components.

The third part, titled "Troubleshooting Charts," is provided to assist you in servicing the Antenna Tuner if the "General Troubleshooting Information" fails to clear up the problem, or if difficulties occur after your Antenna Tuner has been in use for some time. The "Troubleshooting Charts" list a number of possible difficulties that could arise along with several possible solutions to those difficulties. Refer to the "Circuit Board X-Ray Views" (Illustration Booklet, Pages 50 and 51) for the physical location of parts on the circuit boards.

GENERAL TROUBLESHOOTING INFORMATION

1. Recheck the wiring. Trace each lead with a colored pencil on the Pictorial as you check it. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the kit builder.

2. About 90% of the kits that are returned to the Heath Company for service do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by checking all connections to make sure that they are soldered correctly. Reheat the connections, if necessary, but be careful so you do not create any solder bridges.

3. Check the values of all the parts. Be sure that the proper part has been installed at each location on the circuit boards. Refer to the "Circuit Board X-Ray Views" for the physical location of parts on the circuit boards.

4. Be sure that all the wires and leads have been trimmed as close as possible to their connecting points.

5. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring or in the components on the circuit boards.

6. Check very carefully to be sure there are no solder bridges between different circuit board foils. If you are not sure a solder bridge exists, compare the circuit board foil with the "Circuit Board X-Ray Views". Remove any solder bridges by holding a clean, hot soldering iron tip between the two points that are bridged until the excess solder flows down onto the tip.

7. The antenna you use should be insulated along its entire length from any contact with any parts of building, trees, etc. Keep the antenna as far as possible from all objects for maximum operation efficiency.

If you still cannot locate and correct the trouble after you have completed the checks listed above, and if a voltmeter is available, check the voltages in the Antenna Tuner against the Schematic. A review of the "Circuit Description" and Schematic may also help you to locate any difficulties in the kit.

In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of this Manual. Your Warranty is located inside the front cover.

TROUBLESHOOTING PRECAUTIONS

- Integrated circuits U301, U305, U307, and U315 are CMOS (complimentary metal-oxide semiconductor) devices and they can be damaged by static electricity. Therefore, make sure you remove these ICs in the same manner that you installed them. Refer to Page 18 for the correct technique.
- Be sure you do not short any adjacent terminals or foils when you make tests or voltage measurements. If a probe or test lead slips for example, and shorts together two adjacent connections, it is very likely to cause damage to one or more ICs, transistors, or diodes.
- Be especially careful when you test any circuit that contains an IC or a transistor. Although these components have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than many other parts.
- In several areas of the circuit boards, the foil patterns are quite narrow. When you unsolder a part to check or replace it, avoid using excessive heat while you remove the part. A suction-type desoldering tool will make removal considerably easier. You may also use desoldering braid to remove the solder.

TROUBLESHOOTING CHARTS

These charts list the condition and possible causes of several malfunctions. If a particular part is mentioned (U302, for example) as a possible cause, check that part to see if it was installed correctly. Also, check it and the parts connected to it for poor connections. It is also possible, on rare occasions, for a part to be faulty and require replacement.

GENERAL

CONDITION	POSSIBLE CAUSE OR TEST
Tuner is completely inoperative.	A. Line cord plug not connected to an AC outlet. B. Check external DC supply, if used. C. Check fuse F1. D. Check U1 and its socket.
The meters fail to register.	A. Shorting wires across meter lugs. B. Sensitivity control R1 incorrectly wired. C. No RF input to the sensor assembly or no output from it.

DISPLAY CIRCUIT BOARD

CONDITION	POSSIBLE CAUSE OR TEST
Turns counter does not light.	A. Check for 12 volts at H. B. Check for 3.2 volts at F. C. Check for 5 volts at pin 1 of U204.
One or more display segments of the turns counter not lit.	A. Check U204. B. Check U201 through U203. C. Check Q201 through Q203. D. Check display tube V201.

MAIN CIRCUIT BOARD

CONDITION	POSSIBLE CAUSE OR TEST
The motors cannot be operated by the lever switches.	A. Auto switch SW5 is on (in). B. Check for DC voltage on lug 2 of each manual switch.
Inductor presets do not function properly.	A. Auto switch SW5 in manual (out) position. B. Check Band switch SW7 or its wiring. C. Check U316 and/or U317. D. Check wiring of control R6.
Transmitter (C1) and/or antenna (C2) capacitor(s) do not return to half-mesh position while roller inductor L1 is turning.	A. Auto/Manual switch SW5 is in th Manual (out) position. B. Decoder disk has not been adjusted properly. C. Check U2 and/or U3. D. Check Q316 through Q319. E. Check D351. F. Check Q342 through Q345. G. Check D368. H. Check U315.
Auto-range wattmeter circuitry does not operate properly.	A. Check setting of control R302. B. The RF input power is too low to switch to the high range. C. Check U302.
Auto SWR circuit cannot be adjusted.	A. Check to verify that the +8 and −8 volt supplies are adjusted correctly. B. Check U303. C. Check U304.
Nothing happens when the Tuner "looks into" an SWR that is higher than the preset SWR.	A. Auto/Manual switch SW5 is in the Manual (out) position. B. Check setting of control R335. C. Check U302. D. Check U307.

CONDITION	POSSIBLE CAUSE OR TEST
Only the alarm light and/or audible alarm sounds when the Tuner "looks into" an SWR that is higher than the preset SWR.	A. Auto/Manual switch SW5 is in the Manual (out) position. B. Check U305 and/or U306. C. Check Q303.
Alarm light functions properly, but the audio alarm is inoperative.	A. Audio alarm switch SW3 is in the off (out) position. B. Check U313. C. Check SP1.
Linear enable circuit does not function properly.	A. Linear enable switch SW4 is in the off (out) position. B. Check relay K1. C. Check D345. D. Check Q312. E. Capacitor motors are turning.

SPECIFICATIONS

Frequency Range (continuous tuning)	1.8 to 30 MHz.
Input Power Capability	
SSB	2000 watts (peak).
CW	1000 watts.
Input Impedance	50 ohms.
Output Impedance	Wide range.
Impedance Transformation	Optional 4:1 balun (balanced to unbalanced).
Meter Functions	Forward and reflected average power, and SWR.
Meter Ranges	
Forward (2 ranges)	Low — 0-200 watts. High — 0-2000 watts.
Reflected (3 ranges)	Low — 0-50 watts. High — 0-500 watts. SWR — 1:1 to 3:1
Wattmeter Accuracy (full scale)	
200 watts and 2000 watts (FWD), 500 watts (REFLD)	±5% (average).
50 watts (REFLD)	±7.5% (average).
Auto-range Wattmeter	User selected.

Insertion SWR	Less than 1.1:1
Automatic Tune Requirements	
Cycle Time	Approximately 15 seconds.
Input Power Level	10 watts min. (35 watts min. to obtain SWR SET)
VSWR	User selected.
Power Requirements	120 VAC, 50/60 Hz at .250 ampere maximum (internally); 12VDC, at 1 ampere maximum (externally).
Operating Temperature Range	32°F to 104°F (0°C to 40°C)
Dimensions Overall	14-1/2"(W) × 20"(D) × 6-3/4"(H) (36.8 × 50.8 × 17.1 cm)
Net Weight	19 lbs (8.6 kg). (including the optional balun)
Optional Accessory	4:1 balun.

The Heath Company reserves the right to discontinue products and to change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram (Illustration Booklet, Page 49) and the Schematic Diagram (fold-in) as you read the following "Circuit Description." The component numbers are arranged in the following groups to help you locate specific components on the Schematic, circuit boards, and chassis.

1-99	Parts on the chassis.
101-199	Parts on the sensor circuit board.
201-299	Parts on the display circuit board.
301-599	Parts on the main circuit board.

Tuner Circuit

The Antenna Tuner is an adjustable RF transformer that will match an unknown load presented by an antenna and its feedline to the required 50-ohm transmitter impedance.

Antenna capacitor C2 modifies the load impedance fed back to the tuned circuit formed by capacitor C1 and inductors L1 and L2 in series. The total resonant impedance across the tuned circuit depends on the L/C ratio of C1 and L1 + L2, and the load impedance as transformed by C2. Capacitor C1 performs capacitive tapping which results in a 50-ohm impedance at RF input connector J6.

The reactive loads at switched output connectors J1, J2, and J3 are compensated for as you adjust C1 and C2 to resonance.

An optional 4:1 balun (**bal**anced-to-**un**balanced) coil, T1, is used for balanced line operation.

Meter Operation

From input jack J6 on the sensor, the RF is routed through toroid coil L101, through the contacts of coaxial switch SW101, and to either the bypass output at J7, or through the Tuner circuits to outputs J1, J2, or to the feedthrough single- or double-wire outputs at J3, J4, and J5.

L101 is a current pickup element for both the forward and reflected power which passes through the sensor. A transmitted signal passing through the sensor induces a voltage in the toroid coil. This voltage is directly proportional to the amount of RF current. A voltage sampled directly from the transmission line is summed with the voltage at L101. The sum of the voltages is then rectified by diode D102 and filtered by capacitor C104. The sensor is factory calibrated to within 5% accuracy by control R106 for the 0 – 2000-watt circuit and by control R107 for the 0 – 200-watt circuit.

The out-of-phase (reflected) current-induced voltage that was summed with the sampled voltage is rectified by diode D101 and filtered by capacitor C103. With a very good load, one with less than 1.05:1 VSWR, the two voltages will be about equal and out of phase, and no reflected voltage will register in the reflected circuit. Reflected power is factory calibrated by control R104 for the 0 – 50-watt scale and by R105 for the 0 – 500-watt scale.

The calibrated voltages from the sensor are routed through a 5-wire cable, via switch-shield mounted

feedthrough capacitors C5-C9 to bilateral switch U301. Capacitors C5-C9, C301-C304, and ferrite beads FB1-FB5 provide RF line filtering.

IMPORTANT: The sensor is factory aligned and calibrated; tampering with its components may void the Warranty of your Antenna Tuner.

Switching Circuits

NOTE: The forward and reflected circuits are virtually identical. In the following discussion, we will explain the operation of the forward circuits. Where differences exist between the basic operation of the two circuits, further detail will be supplied.

The forward signal from the sensor is coupled through bilateral switch U301 and routed directly to SET-FWD switch SW1. When SW1 is in the SET (in) position, the forward (FWD) meter is temporarily disconnected from the circuit. The low-current input from the sensor is coupled directly through SW1, through Sensitivity control R1, to the contact of SWR-REF switch SW2. The SET position of SW1 is used only in conjunction with SW2 when SW2 is in the SWR position. At that time, the REF (reflected) meter Set index is used to calibrate the meter for SWR readings.

When switch SW1 is in the FWD (out) position, the FWD meter is again enabled to indicate forward power, while switch SW2, in the SWR position, indicates the amount of standing wave present at the point where the sensor is inserted in the transmission line. When SW2 is in the REF (out) position, the power reflected through the transmission line from the antenna, dummy load, etc., is indicated on the REF meter in watts.

When switch SW1 is in the FWD position, the signals coupled from U301 are direct-coupled to the FWD and REF meters.

Coaxial Switch (SW101)

The coaxial switch will select any one of four output positions. When this switch is in the Bypass position, signals are routed through the sensor and directly out of the Tuner, bypassing the tuner load-matching function.

The other coaxial jacks are used for feedlines to tribanders, center-fed doublet antennas, etc. In addition, the output signal is fed internally to connector J3, on the rear panel, when antenna switch SW101 is in the Long-wire position. This allows the signal to be fed to single-wire antennas.

With the optional SA-2500-1 balun installed, the shorting bar is connected between connectors J3 and J4; connectors J4 and J5 are usable for balanced feed line antennas.

All input signals, other than those routed to Bypass jack J7, are routed through the meter and the tuner circuits. Those signals routed to J7 will affect only the meter circuits.

Auto-Range Wattmeter Circuits

To explain how this circuit functions, we will follow the low forward (LOW FWD) signal.

When an RF signal is applied to the sensor input (J6), a forward signal is applied to pin 1 of quad bilateral switch U301. This signal is also coupled to pin 13 of operational amplifier U302D. Because this stage has a high input impedance, there is no loading of the signal applied to it. Control R302 is used to set a reference level for pin 12 of U302D. Feedback resistor R303, along with R302, provide a hysteresis path for U302D. The output (pin 14) of U302D, which is usually high, is applied to pin 9 of U302C, to pins 12 and 13 of U301, and to voltage divider R309 and R310. The high at the junction of resistors R309 and R310 is applied to the base of transistor Q301. This causes Q301 to turn on and its collector to go low. A low applied to the base of Q302 prevents it from turning on; therefore, its collector remains high. The low on the collector of Q301 is also applied to one side of low range indicator PL202, which will turn on.

Voltage divider R304 and R305 provides a reference level for pin 10 of U302C by the path provided by R306. The output (pin 8) of U302C is normally low, and this low is applied to pins 5 and 6 of U301.

U301 requires that a high be applied to a control port to close the switch and pass the signal through it. As previously noted, a high is applied to pins 12 and 13 (control ports) of U301. The two corres-

ponding sections of the quad bilateral switch are closed, while a low is applied to the other two control ports (pins 5 and 6) of U301. Thus, the two remaining switch sections are open. Under this condition, the LOW FWD and LOW REF (low reflected) signals are applied to the meter circuit.

When the LOW FWD signal on pin 13 of U302D exceeds the reference signal applied to pin 12, U302D changes state. This results in the output (pin 14) of U302D going from a high to a low. The low on pin 14 is applied to pin 9 of U302C, pins 12 and 13 of U301, and the base of Q301. The low on the base of Q301 turns this transistor off, which allows the collector to go high. The high on the collector of Q301 causes Q302 to turn on and its collector goes low. The result of this causes PL202 to turn off and high level indicator PL201 to turn on. With a high on pins 5 and 6 of U301 and a low on pins 12 and 13, the HI FWD (high forward) and HI REF (high reflected) signals are applied to the meter circuit.

This state will remain in effect until the LOW FWD signal drops below the reference level on pin 12 of U302D. The level at which this state changes from low to high is adjustable by control R302. However, it would normally be adjusted close to the 200-watt level.

As stated before, R303 provides hysteresis. This means that the circuit changes state at 200 watts (low to high), but the RF level needs to drop to the 180-190 watts level before the circuit changes back from high to low.

Automatic SWR Circuit

This circuit consists of dual buffer circuit U303 and U304 which is an analog mulitplier. L301 provides a path for the LOW FWD signal to voltage divider R315 and R316 and to pin 5 of U303B. R314 and R317 make up a feedback network to establish a gain of "1" for the buffer. The output from pin 7 is applied to pin 5 of U304 by R319, with C308 acting as a bypass. L302 provides a path for the LOW REF signal to pin 3 of U303. R322 with R327 paralleled by the series combination of R328 and D303 will provide a variable gain, depending on the level of the input signal. The output (pin 1) of U303A is applied to pin 1 of U304 via R331, with C311 providing a bypass.

U304 will "log" each input (pins 1 and 5) and then gives the difference between the logged signals. Pin 4 of U304 is the output port, which can be calibrated by R318 (SWR CAL) using a known input. Zener diode D304 with voltage divider R334, R333, and R332 provides a constant load for the output of U304.

R326 (SWR NULL), which is part of a voltage divider with R324 and R329, is used to compensate for the gain difference between the two buffers. R325 connects the wiper of R326 to pin 3 of U303A.

TUNE SWR Control/Trip Circuit

R335 is used to calibrate the voltage going to control R3 (TUNE SWR). This adjustment sets the 1.5 SWR point of the control. The wiper of R3 is connected to pin 6 of U302B and to pin 8 of SW1 (SET-FWD). The output from U304 is connected to pin 5 of U302B, and also to pin 5 of U314B and pin 12 of U314D.

With no input signal, or 1:1 match, the signal level at pin 5 of U302B will be 1.0 VDC. If a mismatch occurs, however, the signal level drops and, with a 2:1 SWR, the calibrated output will be .5 VDC. The output (pin 7) of U302B remains high until the voltage on pin 5 drops below the reference voltage on pin 6. C313 prevents spikes from tripping the circuit. U302A, with associated components, acts as a buffer and pulse-shaper; U302A's output (pin 1) is normally low.

U305 is a quad bilateral switch; two of the switch sections are used to keep the master control line open, and two sections are used to control which of the variable capacitor motors should be turned on. R344, C321, C322, and R345 shape the pulse going to dual flip-flop U307. Pin 12 of U307 is normally high and pin 13 is low unless a pulse is received.

When a change of state takes place, pin 12 goes low and shuts off the switches controlled by pins 8 and 9 of U305. Pin 13 goes high and this high is applied across D308 and voltage divider R409/R411 to the base of Q313. A high on the base of Q313 causes the collector to go low. This causes visual alarm PL206 to light and, if switch SW3 is on, the audio alarm (which is made up of U313 and SP1) will sound. This change of state of U307, which lasts 1-2

seconds, is controlled by a timing circuit which is made up of R348 and C325.

U306 is a 555 timer circuit which is set for approximately 3-second cycles. The base of Q303 is conected to the output (pin 3) of U306. The control ports (pins 12 and 13) of U305 are constantly switching (from low to high - or from high to low). The outputs of U305 either go to pin 3 of U314A and pin 6 of U314B or to pin 10 of U314C and pin 13 of U314D.

U314 is a quad operational amplifier package. However, in this application, it is used to provide two window comparators. In the following paragraphs, we will describe only one of these comparators, since they both operate in the same manner.

Pin 5 of U314B receives its reference voltage from U304. When the level at pin 3 of U314A and pin 6 of U314B is higher than the level at pin 5 of U314B, a low is applied to the base of Q314. A low on the base allows the collector of Q314 to go high; this high is connected to the base of pass transistor Q315. The voltage at the emitter of Q315 will increase to the same level (minus a .6-volt drop). When switch SW5 is in the Auto position, the high (9 VDC) at the emitter of Q315 is applied to the motor drive circuit.

Motor Drive Circuit

All three motor drives function in the same manner. Therefore, we will describe only the transmitter capacitor's motor drive circuit.

The motor drive circuit allows for both clockwise and counterclockwise travel. When a high level (6-9 VDC) is applied to AX on the main circuit board, it is applied to the base of Q321 by voltage divider R439/R441. It is also applied to the base of Darlington transistor Q324 by voltage divider R446/R447. Q321 is a pass transistor; therefore, the 6-9 VDC on its base will be present on its emitter (minus a .6-volt drop).

The voltage from Q321 is applied to motor A1, and also to the collector of Q324 through the motor windings. With the base of Q324 being high, Q324 turns on and its collector voltage is .6 VDC with respect to ground. With 6-9 VDC present on one side of the motor, and .6 VDC on the other side, the motor turns in one direction.

When a high is applied to AY, transistor Q322 and Darlington transistor Q323 operate as previously described; therefore, the motor turns in the opposite direction. D353 and D354 make up a sensing device that passes a high on the base of Q325. This transistor will turn on and indicator PL203 lights, indicating that this motor is turning.

50% Capacitor Circuit

Both the transmitter and antenna capacitors use the same type of circuit to allow them to be placed in a preset position in the Auto mode. When inductor motor A2 turns, D363 or D364 passes a high across pins 13 and 14 of switch SW5D and to the pulse-shaping network consisting of C366, R484, R483, C364, and R479. From this network, the pulse is applied to pins 3 and 5 of U315A. Pin 1 of U315A goes high, and this pulse is applied to the gate of SCR D351.

The slot in the decoder disk, which is mounted on the shaft of motor A1, fits into optical coupler U2. When the slot is lined up between the two posts of U2, its pin 2 goes high. If the slot is not positioned between the posts, however, pin 2 remains low.

Assume that a low is present on pin 2 of U2. A low from U2 is applied to the base of Q316, which remains turned off. The collector of Q316 goes high, which turns transistor Q317 on. The collector of Q317 goes low and this causes Q318 to turn off. The collector of Q318 goes high, which causes pass transistor Q319 to apply a high to the anode of SCR D351 via diode D349.

When the anode of SCR D351 is high, and a high pulse is being sensed on the SCR's gate, the SCR fires and a high is passed to the motor drive circuit by D352/R438. This allows the motor to turn and rotate the decoder disk until the slot appears between the posts of U2. Pin 2 of U2 goes high which turns Q316 on; this turns Q317 off. When Q317 is turned off, the collector of Q317 goes high. This turns Q318 on and its collector goes low. Pass transistor Q319 turns off SCR D351, which in turn shuts the motor off.

Alarm Circuit

Q308 and Q309 make up a long-tune alarm circuit. When the capacitor motor is turning, a high is applied to Q308, Q306, and the base of Q311. The voltage on the base of Q309 drops as C345 discharges through R394 and R395. After approximately 20 seconds, this voltage drops below .6 VDC. At that time, Q309 shuts off causing its collector to go high. This high is applied to pin 8 of U312, which is a 555 timer. U312, which has a 1-2 second cycle, turns Q313 on and off at this rate. Q313 control U313, which is the audio speaker alarm, and visual alarm PL206.

Linear Circuit

With linear switch SW4 closed, 12 VDC is applied to relay K1. Also, a positive pulse fires SCR D345. D345 will cause Q312 to turn on, which causes its collector to go low. This condition causes relay K1 to pull in and contacts 3 and 5 to close.

When the capacitor motors turn, Q311 turns on. This causes its collector to go low and shuts D345 off. This causes the collecter of Q312 to go high; relay K1 drops out, and contacts 3 and 5 of K1 open.

Inductor Presets

U317 is a window comparator and, as its name implies, is a specialized form of comparator designed to detect the presence of a voltage between two prescribed voltage limits — that is, within a voltage window. This is accomplished by logically combining the outputs of two single-ended comparators, one indicating greater than a lower limit, and the other indicating less than an upper limit. If both comparators indicate a true condition, the output is true. If either is not true, the output is not true.

The window we desire exists when both pins 8 and 14 of U317 or low. The window reference voltage is set up by the voltage divider made up by R452, R454 and one of the preset controls R358 through R375. The voltage that corresponds to the desired window is applied to pins 3, 6, 10, and 13 of U317 from inductor position control R6. R6 is controlled by the worm gear that is connected to the shaft of inductor motor A2.

When the voltage coming from R6 is above the window, output pins 1 and 7 of U317 go low, which causes Q326 to shut off. The collector of Q326 goes high, which applies a high to the motor drive circuit. The motor turns, which causes R6 to turn, resulting in the change of the voltage going back to U317 until the voltage is in the window.

When the voltage from R6 is below the window, the output (pin 14) of U317 goes high. This turn Q328 on, forcing its collector low and shuts Q329 off. The collector of Q329 goes high and this high is applied to the opposite side of the motor drive circuit, causing the inductor motor to turn in the opposite direction. This forces R6 to turn the other way until the voltage on pin 2 falls into the window again.

When the R6 control voltage is in the window, Q327 shuts off and light-emitting diode D359 lights. By adjusting the preset control, the window can be moved up or down. This will cause the roller contact to move to a different position. The BAND switch selects which pair of the preset controls that will be used, and the LOW-HIGH switch (SW7A) selects which one of the two controls will be part of the voltage divider circuit.

Turns Counter

U204 is an A/D converter that takes an analog voltage and converts it to digital information. R7 provides the analog voltage to the input (CK on the display circuit board) via TURNS control R233.

U201, U202, and U203 are open-ended drivers that supply the proper level to the V201 display tube. Q201, Q202, and Q203 are used to drive the 7th segment of each digit. U205 is a 5-volt regulator that supplies the proper voltage to U204 and V201.

As the inductor turns, the voltage from R7 changes. In other words, the turns counter is similar to a simple digital voltmeter. Controls R204 and R233 are used to calibrate the voltmeter to correspond with the position of the roller contact as it travels over the approximately 40 turns of inductor L1.

Power Supply Circuits

The operating power required by the various circuits of the Antenna Tuner is provided by four regulated power supplies, which are derived from a single input. This input, which is nominally 12 VDC and present at filter capacitor C331, is provided either from a line-voltage-derived source or from an external voltage source. Each of these circuit areas are covered in the following paragraphs.

During line operation, AC power is applied through slow-blow fuse F1 and power switch SW6 and then across the primary winding of power transformer T1. The input at capacitor C331 is produced from the secondary winding of transformer T1, in conjunction with the full-wave rectifier circuit of diodes D331 and D332. Capacitors C11 – C13 provide filtering of line-conducted noise signals. Capacitors C326 – C329 suppress noise generated by the three tuner motors to prevent the noise from getting onto the AC power line.

When an external voltage source is used to power the Antenna Tuner, a nominal 12 VDC source is connected to plug P2 on the rear panel of the Tuner. Diode D329 provides reverse polarity protection for the Tuner.

DC-DC Converter

This circuit is made up of transistors Q304 and Q305, transformer T301, and associated circuitry. Q304 and Q305 act as a switch, cycling the input voltage source to the primary winding of T301. This switching action results in a square wave primary voltage, inducing secondary voltages which are rectified and filtered to provide +12- and −12 VDC outputs.

Regulators

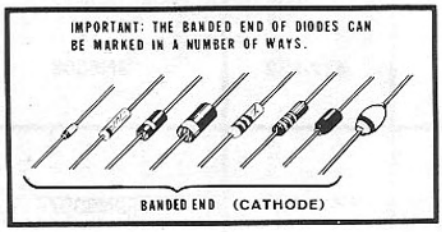
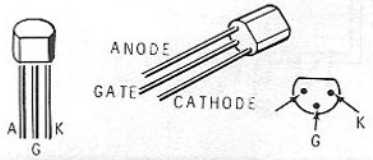
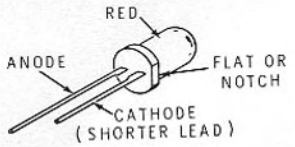
The 12 VDC output voltage from the DC-DC converter is applied to the input of voltage regulator U311 to provide an 8 VDC source that may be adjusted by control R381.

The −12 VDC output voltage from the DC-DC converter is applied to the input of voltage regulators U308 and U309. Regulator U308 provides a −8 VDC source that may be adjusted by control R379. Regulator U309 produces a −3.2 VDC source. Resistors R382 and R383 form a voltage divider to establish a −.1 VDC source.

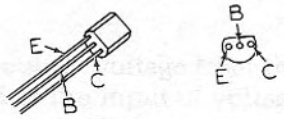
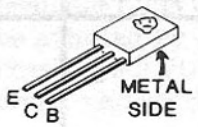
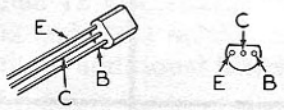
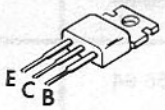
The voltage at C331 is fed to U1 which produces a well-regulated 12 VDC supply. This voltage is filtered by C332 and C333 on the main circuit board. It is used without additional filtering on the display circuit board.

SEMICONDUCTOR IDENTIFICATION CHARTS

DIODES

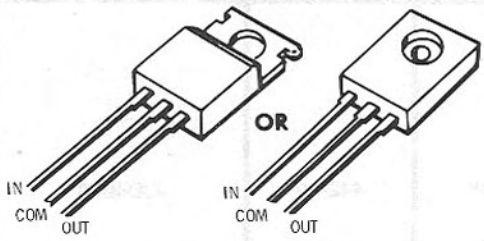
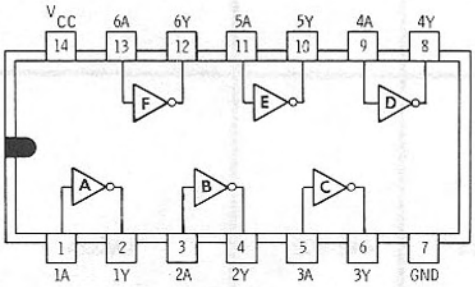
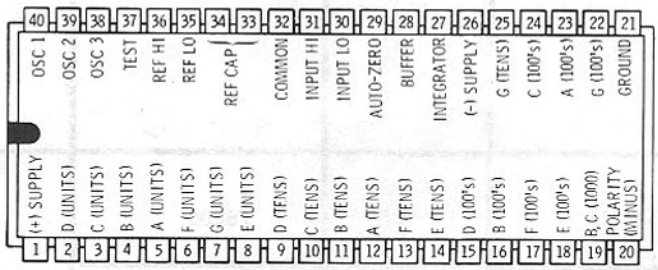
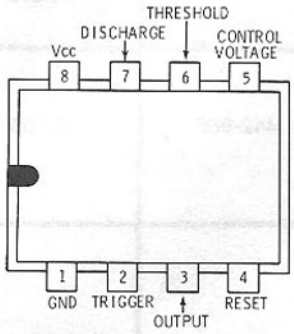
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
D301, D302, D305 through D328, D336, D337, D338, D339, D342, D343, D344, D347, D348, D349, D352, D353, D354, D355, D356, D357, D358, D361 through D372. (10's not used)	56-56	1N4149	
D334, D335	56-89	GD510	
D333	56-94	12.8V Zener	
D304	56-97	1N3017B	
D329, D331 D332, D346	57-27	1N2071	
D341, D345, D351, D368	57-624	2N5061 SCR	
D359	412-640	LST5053 LED	

TRANSISTORS

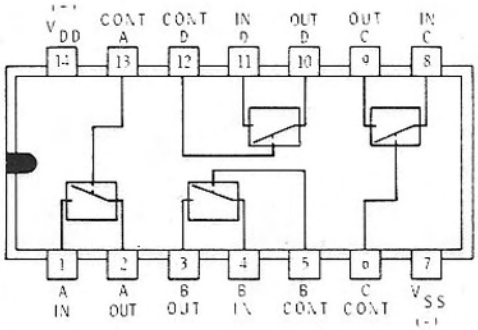
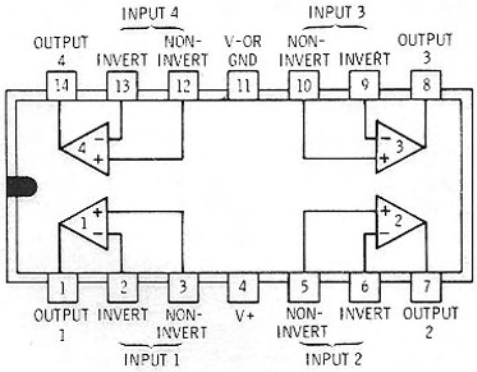
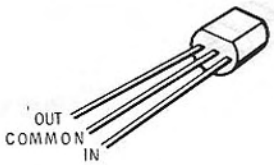
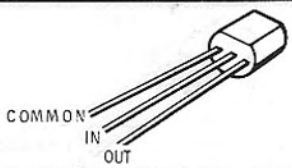
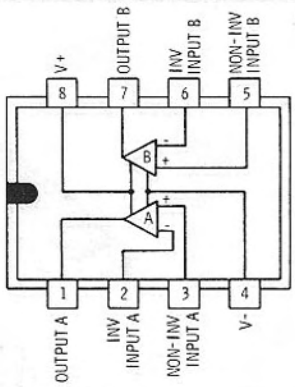
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION
Q305	417-801	MPSA20	
Q201-Q203, Q301-Q303 Q306, Q307 Q311, Q313-Q319, Q325-Q329, Q335-Q337, Q342-Q345, Q347 (10's not used)	417-864	MPSA05	
Q308	417-865	MPSA55	
Q304	417-819	MJE171	
Q312, Q321, Q322, Q331, Q332, Q338, Q339	417-818	MJE181	
Q309	417-222	2N5308	
Q323, Q324, Q333, Q334, Q341, Q346	417-918	2N6387	

Heathkit®

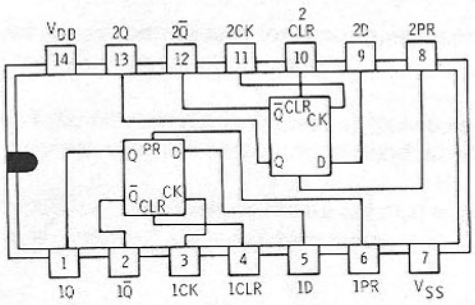
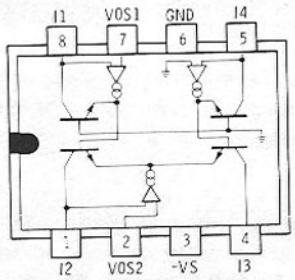
INTEGRATED CIRCUITS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U1	442-674	7812	
U205	442-54	7805	
U201, U202 U203	443-967	7406	
U204	442-724	7107	
U306, U312, U313	442-53	555	

Integrated Circuits (cont'd)

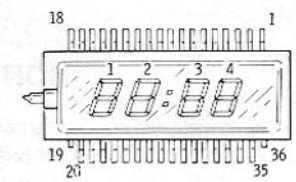
CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U301, U305	442-99	CD4016	
U302, U314 U317	442-602	LM324	
U311	442-627	78L05	
U316	442-687	78L10	
U308, U309	442-665	79L05	
U303	442-707	LF353	

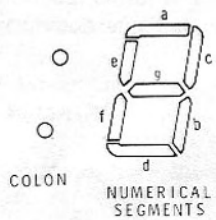
Integrated Circuits (cont'd)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U307, U315	443-607	MC14013	
U304	443-1164	RC4200	

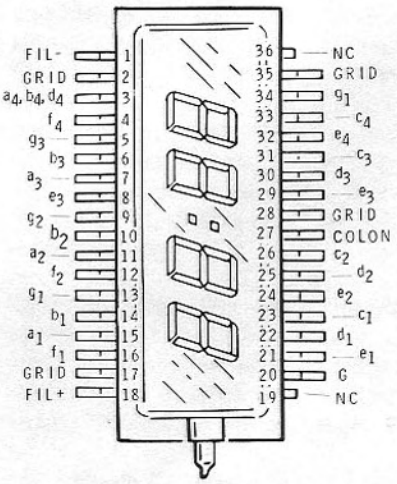
READOUT TUBE V201

Heath #411-836,
Manufacturer's Number FUTABA 4BT-04





PIN CONNECTIONS 411-836

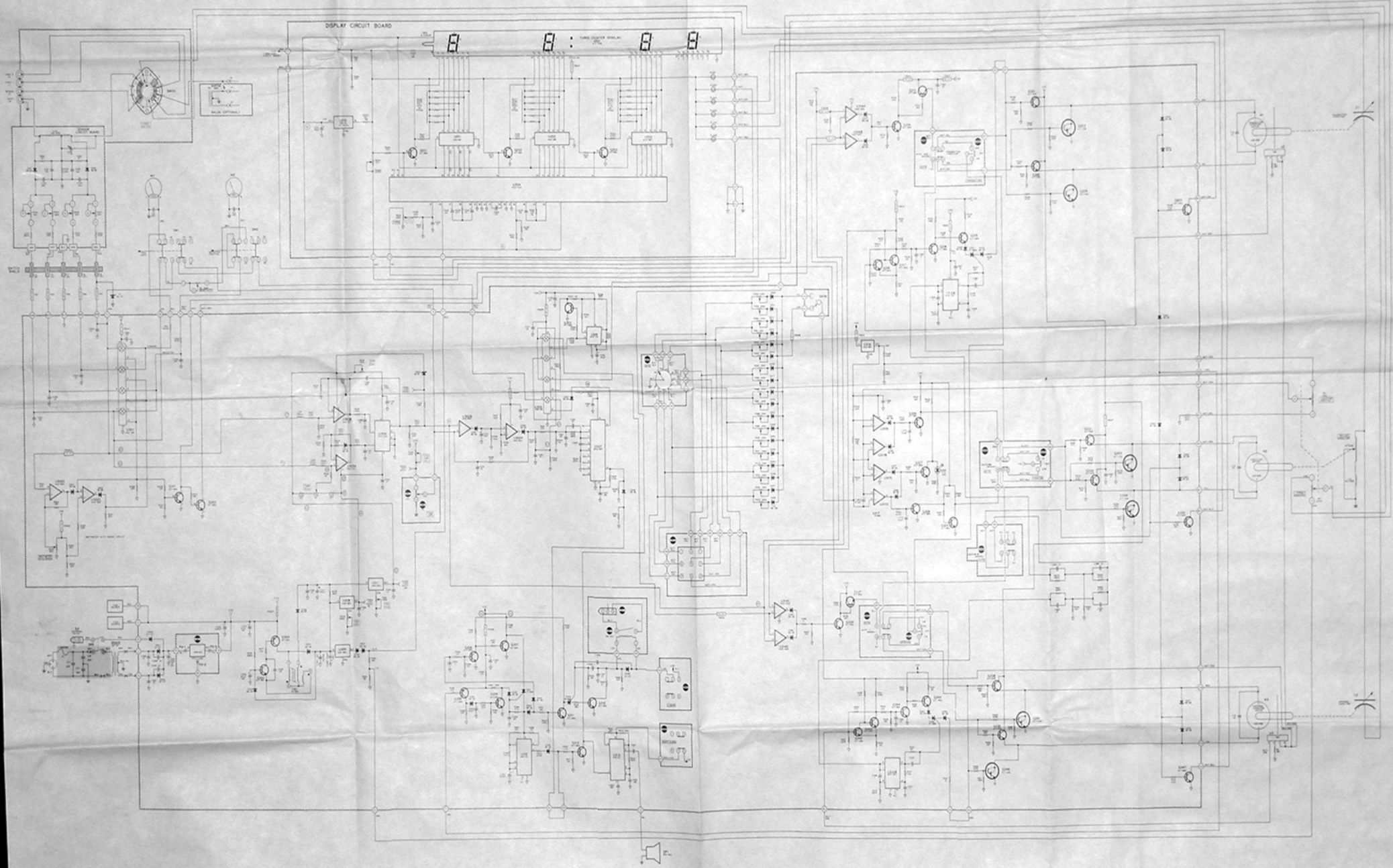


SCHEMATIC OF THE HEATHKIT® AUTO-TUNE ANTENNA TUNER MODEL SA-2500

Part of 595-3027-1

NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:
   1–99 COMPONENTS MOUNTED ON THE CHASSIS.
   101–199 COMPONENTS MOUNTED ON THE SENSOR CIRCUIT BOARD.
   201–299 COMPONENTS MOUNTED ON THE DISPLAY CIRCUIT BOARD.
   301–599 PARTS MOUNTED ON THE MAIN CIRCUIT BOARD.
2. ALL RESISTORS ARE 1/4-WATT, 5% TOLERANCE UNLESS OTHERWISE NOTED. RESISTOR VALUES ARE IN OHMS: K=1000, M=1,000,000.
3. CAPACITORS LESS THAN 1 ARE IN µF (MICROFARADS). ALL OTHER CAPACITORS ARE IN pF (PICOFARADS) UNLESS OTHERWISE NOTED.
4. COAX SWITCH SW101 IS SHOWN IN THE FULLY COUNTERCLOCKWISE (BYPASS) POSITION.
5. ARROWS AT CONTROLS INDICATE A CLOCKWISE ROTATION AS VIEWED FROM THE SHAFT END OF THE CONTROL.
6. THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASURED WITH A HIGH IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CHASSIS GROUND.
7. THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
8. THIS SYMBOL INDICATES A CHASSIS GROUND.
9. THIS SYMBOL INDICATES A WIRED CONNECTION TO A CIRCUIT BOARD.
10. REFER TO THE "CIRCUIT BOARD X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF PARTS.
11. PARTS IN THE SHADED AREAS ARE CRITICAL TO CONTINUED SAFETY. REPLACE ONLY WITH THE SAME RATED PART, OR WITH THE CORRECT HEATH COMPANY PART.



SCHEMATIC OF THE HEATHKIT® AUTO-TUNE ANTENNA TUNER MODEL SA-2500

Part of 595-3027-1

NOTES:

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   - 101-199 COMPONENTS MOUNTED ON THE SENSOR CIRCUIT BOARD.
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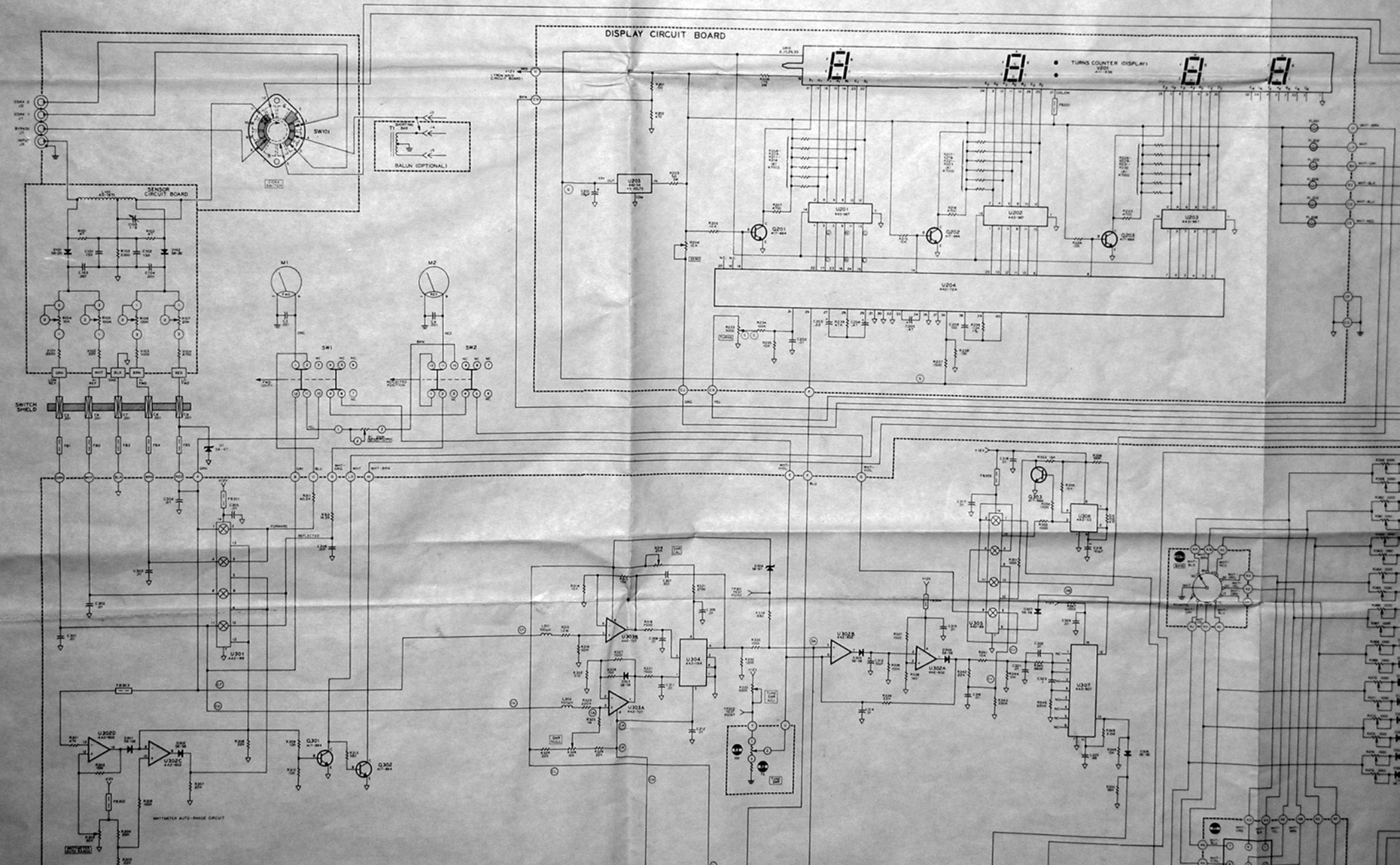
3. CAPACITORS LESS THAN 1 ARE IN µF (MICROFARADS). ALL OTHER CAPACITORS ARE IN pF (PICOFARADS) UNLESS OTHERWISE NOTED.
4. COAX SWITCH SW101 IS SHOWN IN THE FULLY COUNTERCLOCKWISE (BYPASS) POSITION.
5. ARROWS AT CONTROLS INDICATE A CLOCKWISE ROTATION AS VIEWED FROM THE SHAFT END OF THE CONTROL.
6. ⬭ THIS SYMBOL INDICATES A POSITIVE DC V… HIGH IMPEDANCE VOLTMETER FROM THE P… GROUND.
7. ▽ THIS SYMBOL INDICATES A CIRCUIT BOARD…
8. ⏚ THIS SYMBOL INDICATES A CHASSIS GROUN…
9. □ THIS SYMBOL INDICATES A WIRED CONNEC…
10. REFER TO THE "CIRCUIT BOARD X-RAY VIEWS" F… PARTS.
11. PARTS IN THE SHADED AREAS ARE CRITICA… REPLACE ONLY WITH THE SAME RATED PAR… HEATH COMPANY PART.



6. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASURED WITH A HIGH IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CHASSIS GROUND.

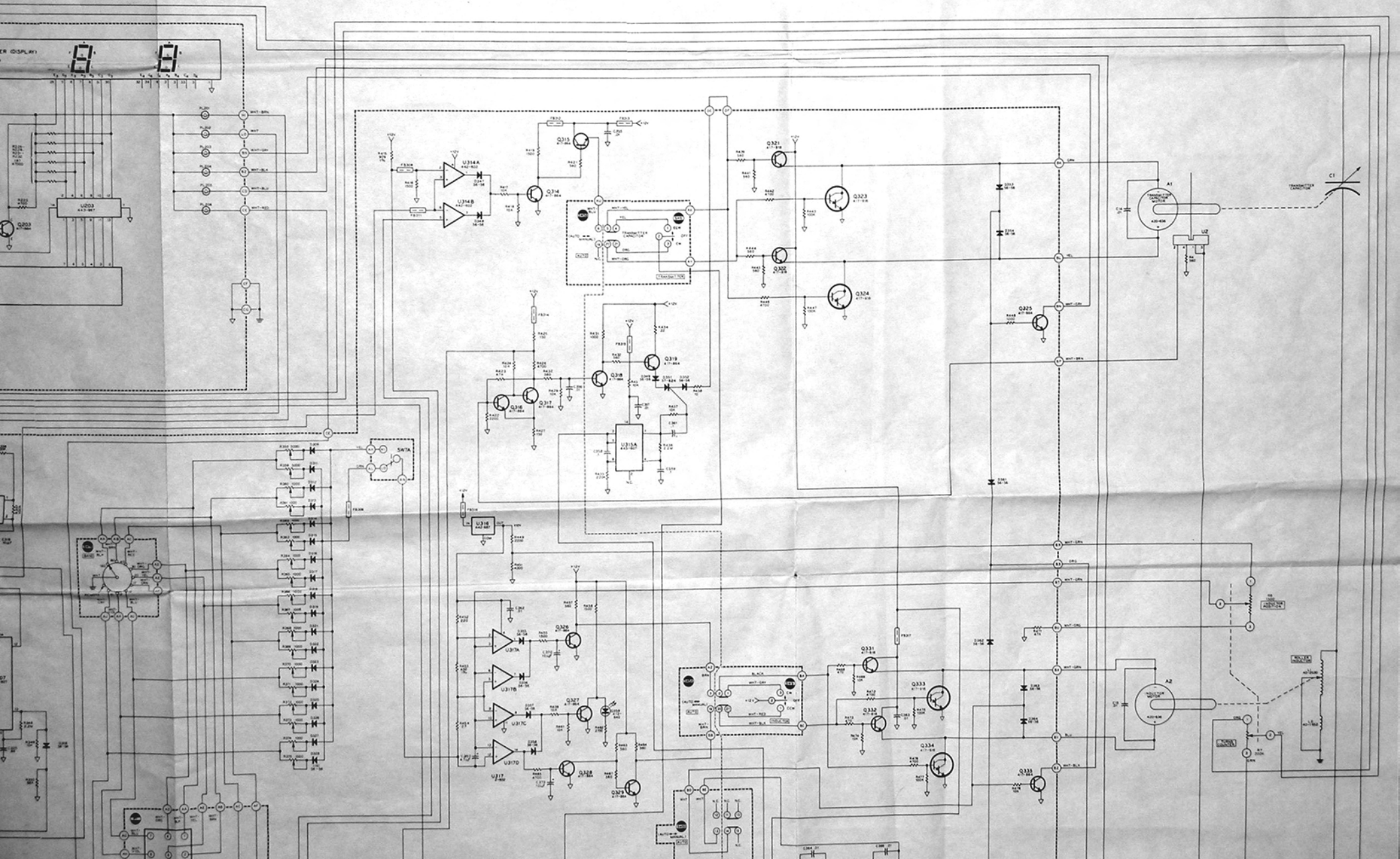
7. ⏚ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.

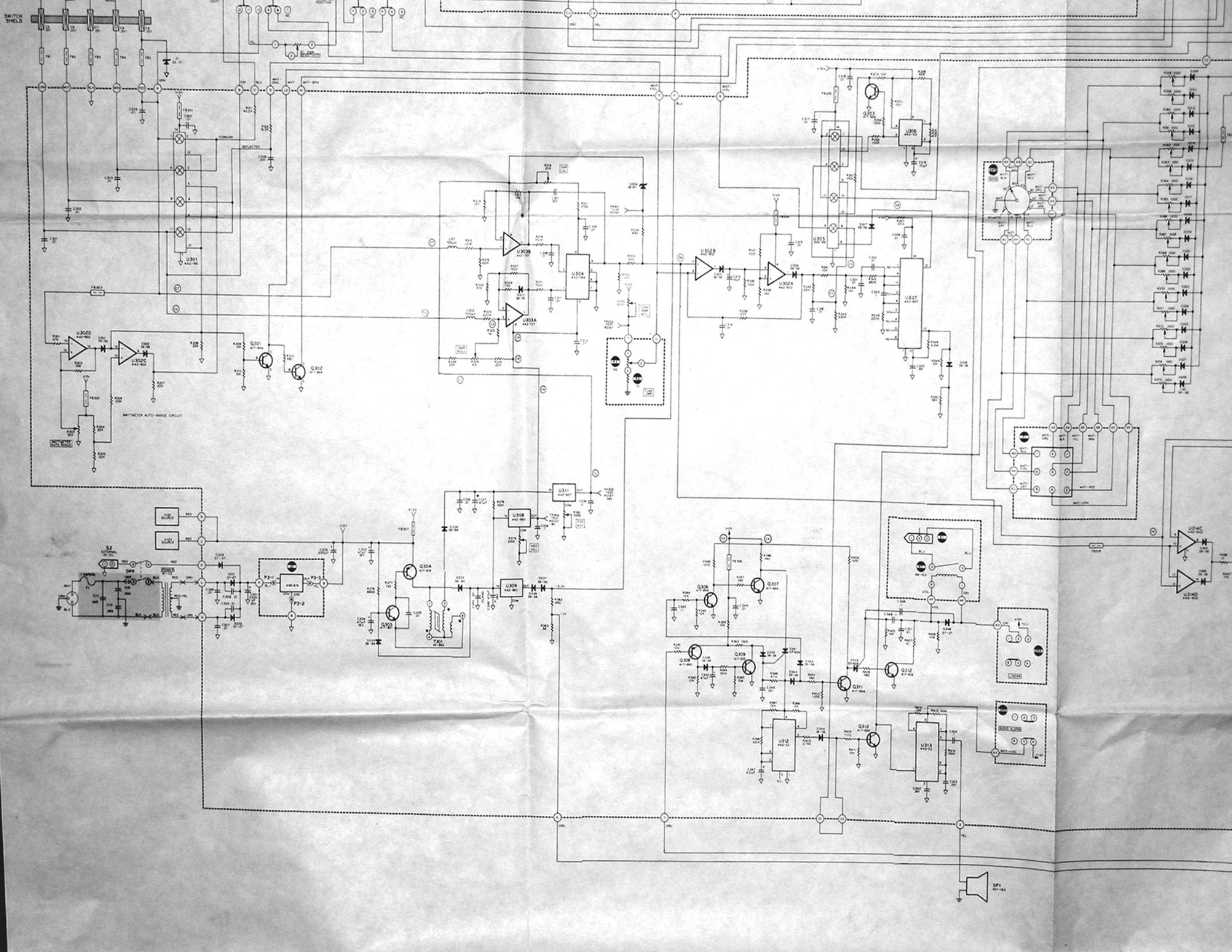
8. ⏚ THIS SYMBOL INDICATES A CHASSIS GROUND.

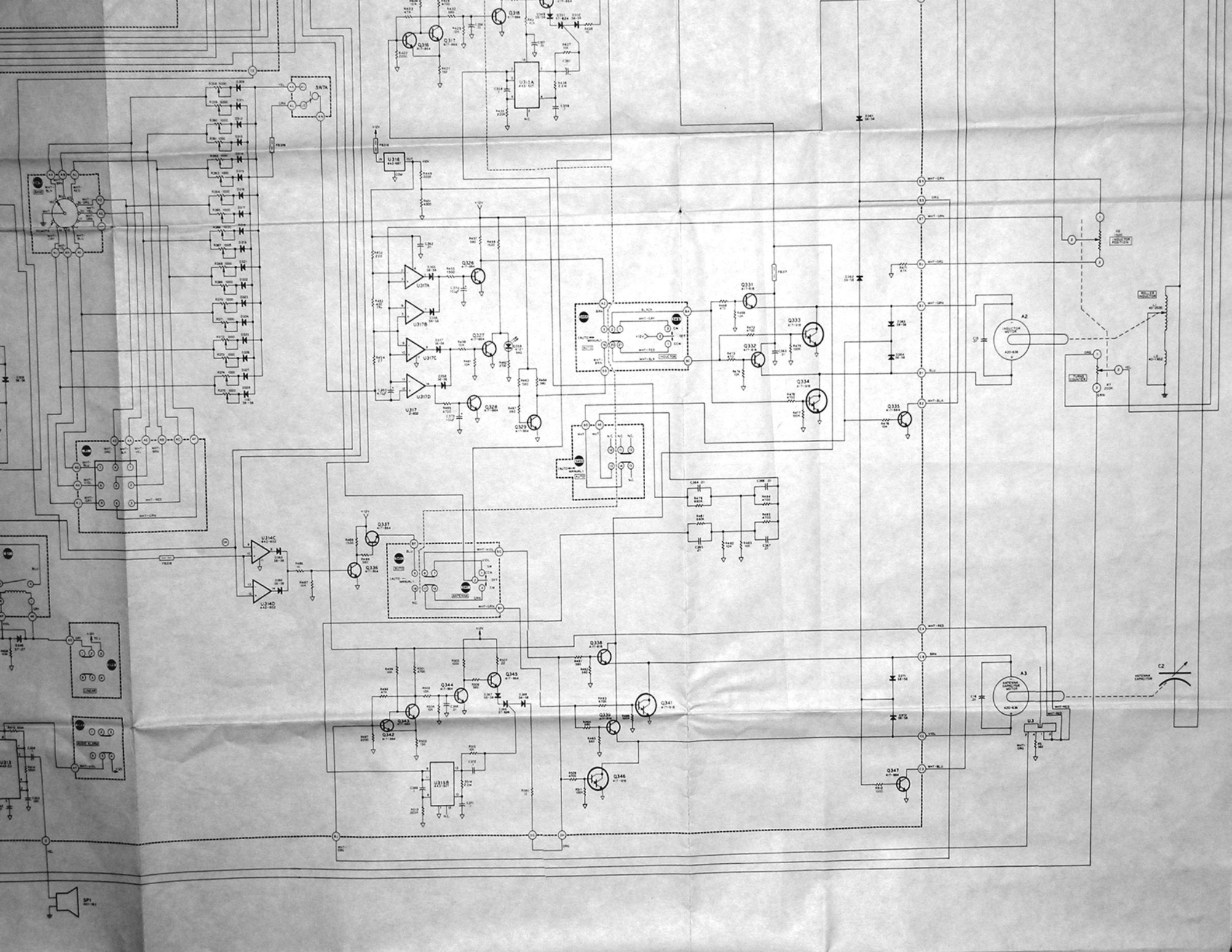
9. ☐ THIS SYMBOL INDICATES A WIRED CONNECTION TO A CIRCUIT BOARD.

10. REFER TO THE "CIRCUIT BOARD X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF PARTS.

11. PARTS IN THE SHADED AREAS ARE CRITICAL TO CONTINUED SAFETY. REPLACE ONLY WITH THE SAME RATED PART, OR WITH THE CORRECT HEATH COMPANY PART.

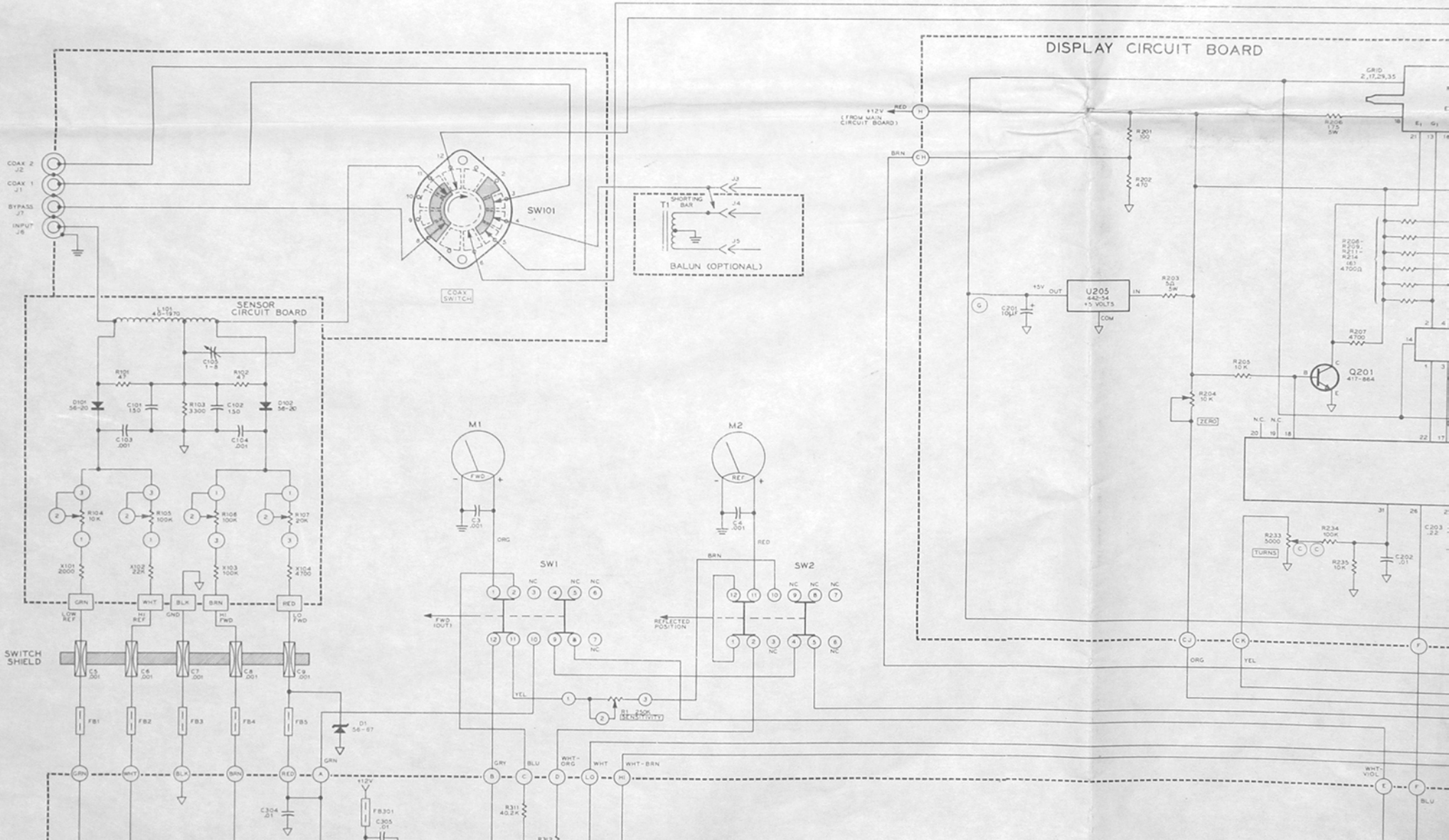






SCHEMATIC OF THE HEATHKIT® AUTO-TUNE ANTENNA TUNER MODEL SA-2500

Part of 595-3027-1



CHEMATIC OF THE HEATHKIT® TUNE ANTENNA TUNER MODEL SA-2500

7-1

NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:
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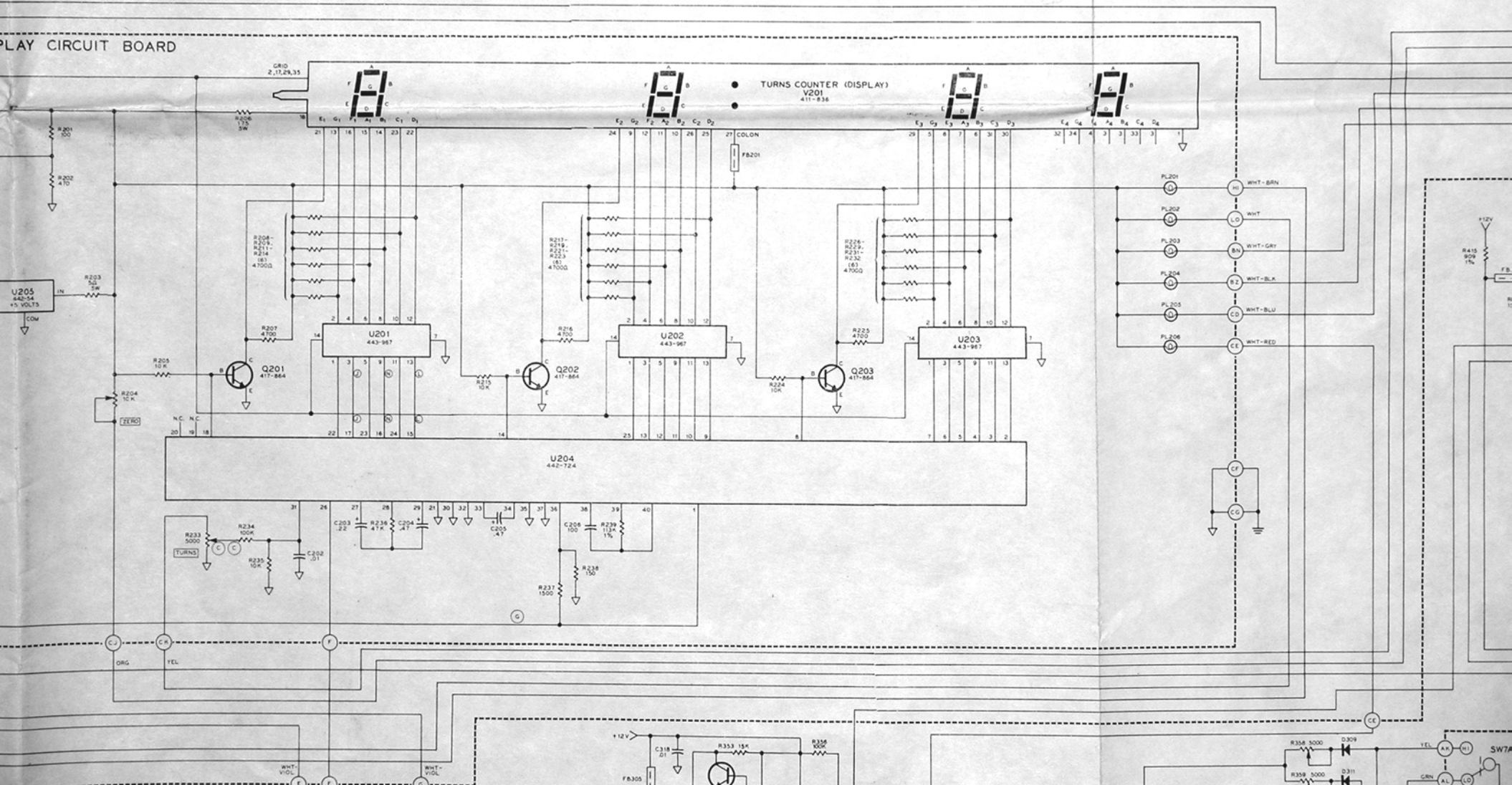
8. THIS SYMBOL INDICATES A CHASSIS GROUND.
9. THIS SYMBOL INDICATES A WIRED CONNECTION TO A CIRCUIT BOARD.
10. REFER TO THE "CIRCUIT BOARD X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF PARTS.
11. PARTS IN THE SHADED AREAS ARE CRITICAL TO CONTINUED SAFETY. REPLACE ONLY WITH THE SAME RATED PART, OR WITH THE CORRECT HEATH COMPANY PART.

PLAY CIRCUIT BOARD



IS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASURED WITH A GH IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CHASSIS ROUND.

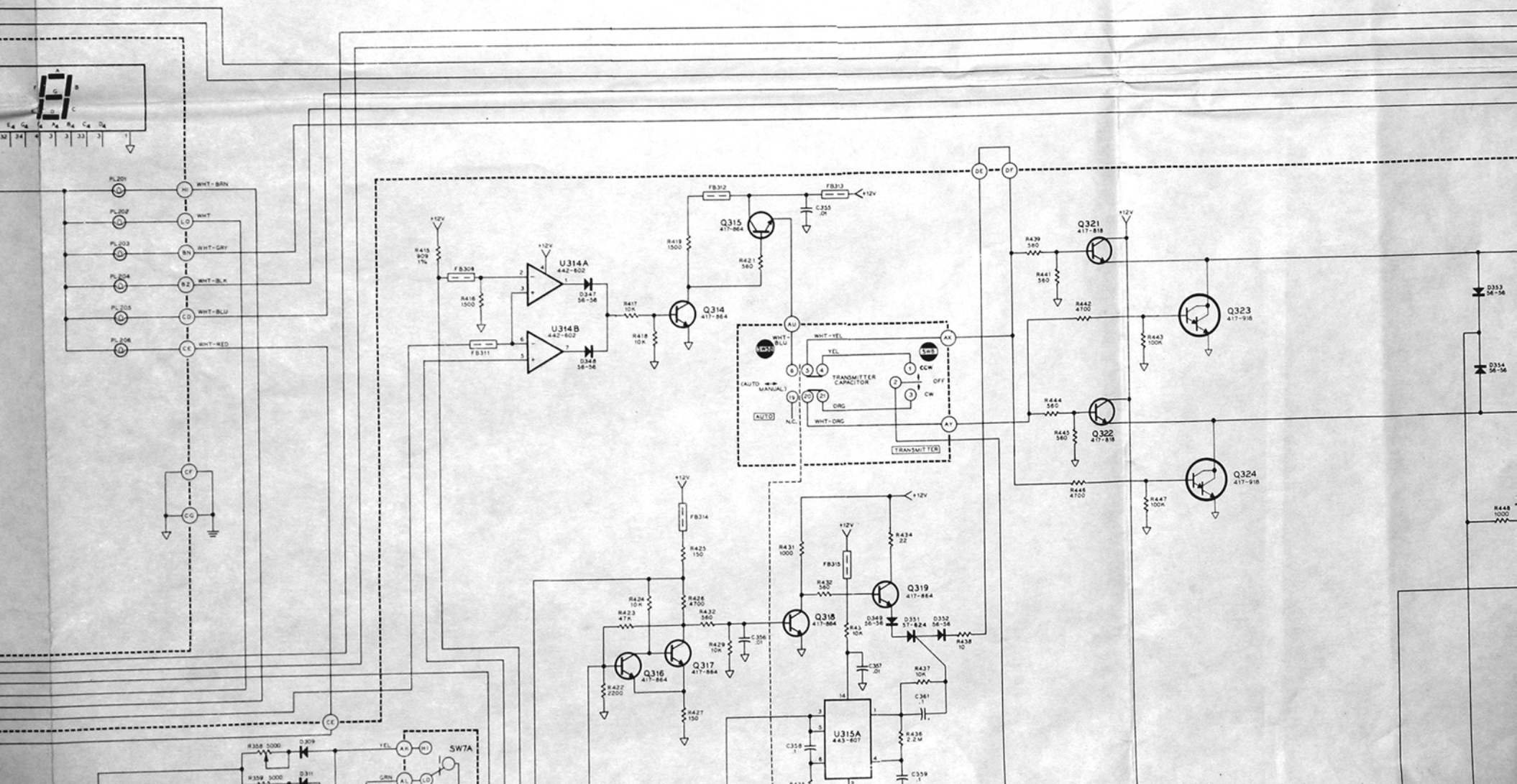
IS SYMBOL INDICATES A CIRCUIT BOARD GROUND.

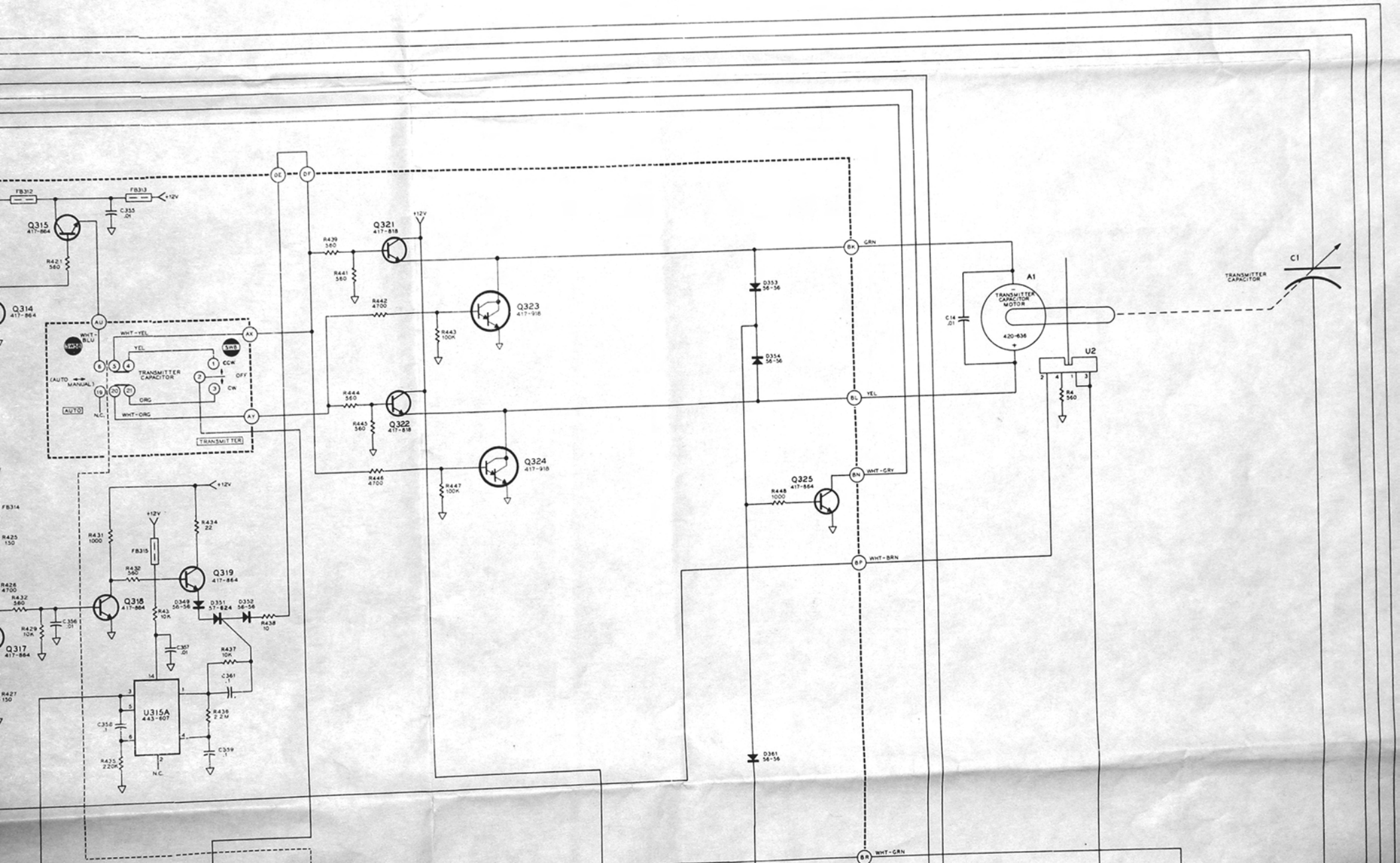
IS SYMBOL INDICATES A CHASSIS GROUND.

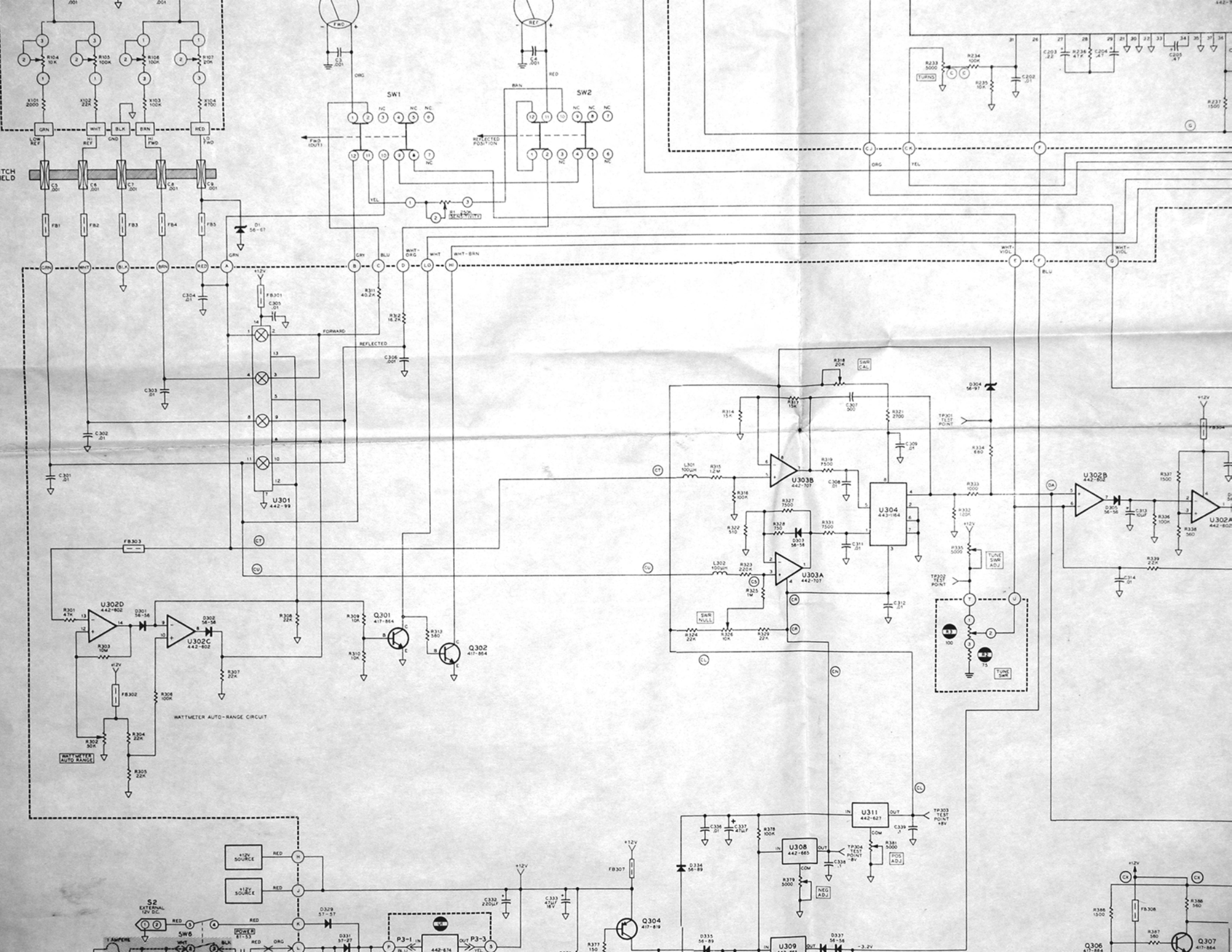
IS SYMBOL INDICATES A WIRED CONNECTION TO A CIRCUIT BOARD.

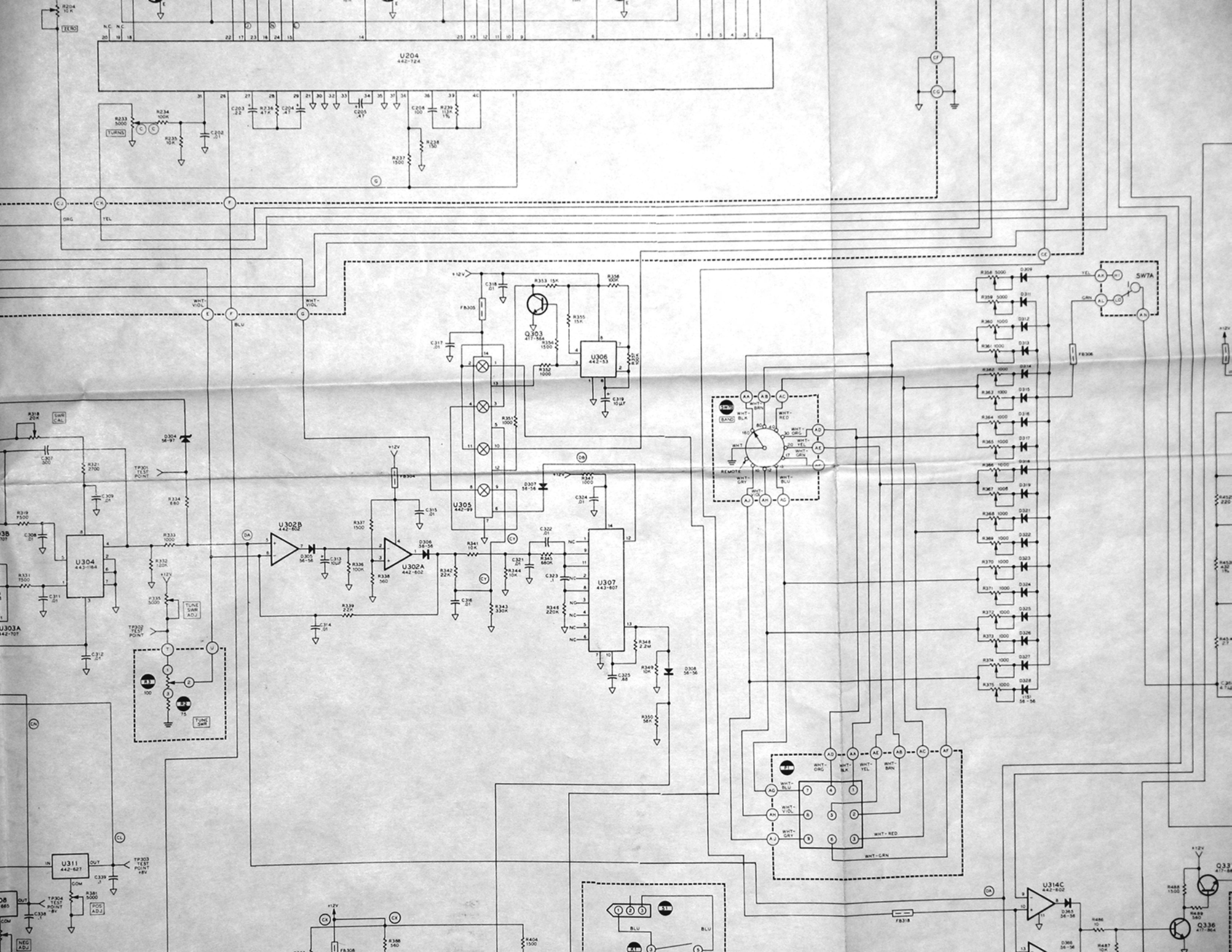
O THE "CIRCUIT BOARD X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF

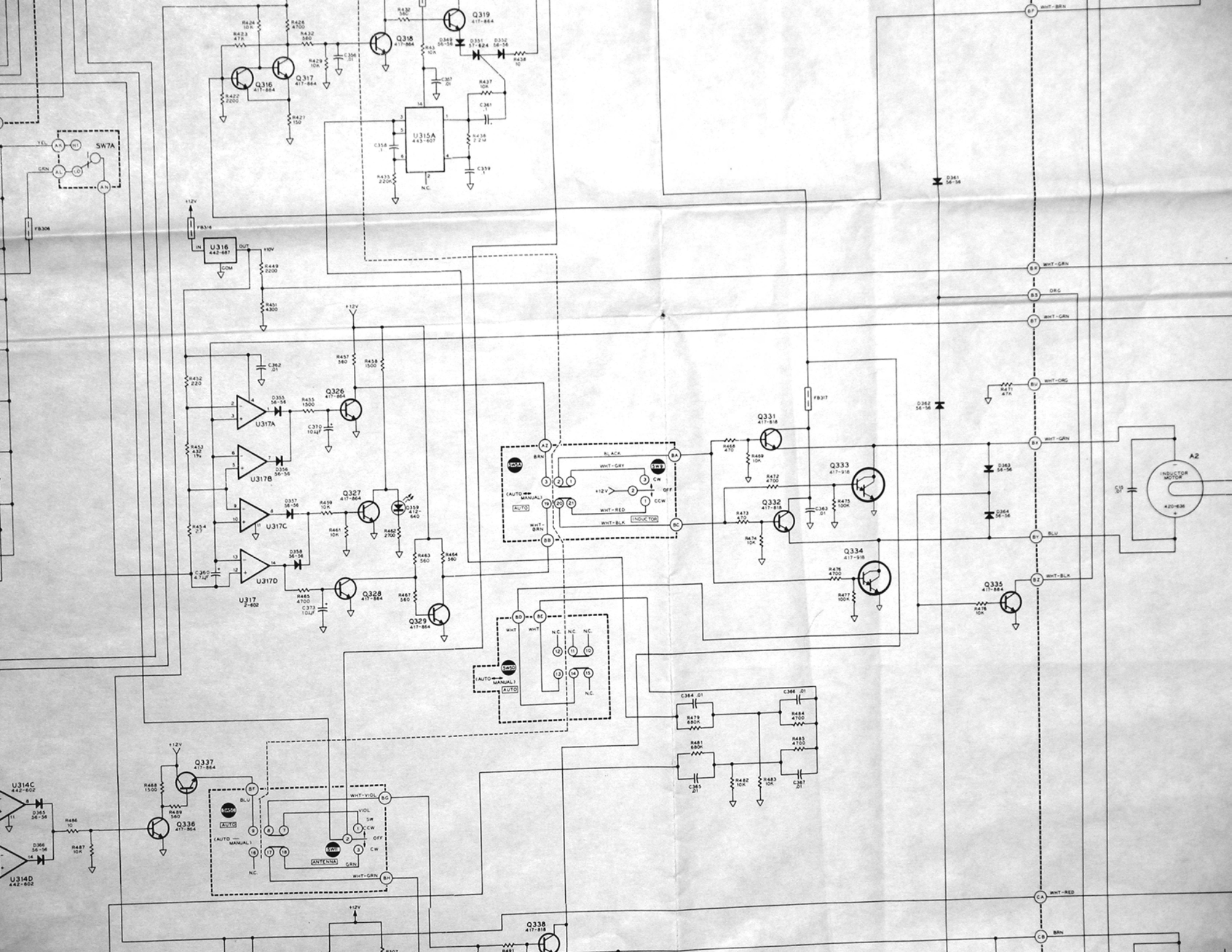
N THE SHADED AREAS ARE CRITICAL TO CONTINUED SAFETY.
E ONLY WITH THE SAME RATED PART, OR WITH THE CORRECT COMPANY PART.




FB312
FB313
+12V
C355 .01
Q315 417-864
R421 560
Q314 417-864
AU
AX
AY
WHT-BLU
WHT-YEL
YEL
SW1
SW2
CCW
OFF
CW
TRANSMITTER CAPACITOR
(AUTO MANUAL)
ORG
AUTO
N.C.
WHT-ORG
TRANSMITTER
DE
DF
Q321 417-818
R439 560
R441 560
R442 4700
R443 100K
Q323 417-918
R444 560
R445 560
Q322 417-818
R446 4700
R447 100K
Q324 417-918
D353 56-56
D354 56-56
D361 56-56
BK
GRN
BL
YEL
BN
WHT-GRY
BP
WHT-BRN
BR
WHT-GRN
Q325 417-864
R448 1000
A1
TRANSMITTER CAPACITOR MOTOR
420-636
C14 .01
U2
R4 560
C1
TRANSMITTER CAPACITOR
FB314
R425 150
R426 4700
R427 150
R431 1000
FB315
R434 22
Q319 417-864
R432 560
Q318 417-864
R433 10K
D349 56-56
D351 57-824
D352 56-56
R438 10
R429 10K
C356 .01
Q317 417-864
C357 .01
R437 10K
C361 .1
U315A 443-607
C358 .1
R436 2.2M
C359 .1
R435 220K
N.C.


WATTMETER AUTO-RANGE CIRCUIT
SW1
SW2
U301
442-99
U302B
442-602
U302C
442-602
U302D
442-602
U303A
442-707
U303B
442-707
U304
443-1164
U308
442-665
U309
442-665
U311
442-627
Q301
417-864
Q302
417-864
Q304
417-819
Q306
417-864
Q307
417-864
S2
EXTERNAL 12V DC
SW6
POWER
TUNE SWR ADJ
TUNE SWR
POS ADJ
NEG ADJ
SWR CAL
SWR NULL
WATTMETER AUTO RANGE
FORWARD
REFLECTED
+12V SOURCE
TP301 TEST POINT
TP302 TEST POINT
TP303 TEST POINT +8V
TP304 TEST POINT -8V


U204
442-724
TURNS
U306
442-53
Q303
417-564
U305
442-99
U302B
442-602
U302A
442-602
U304
443-1184
U307
443-807
U311
442-627
U314C
442-602
SW7A
BAND
REMOTE
TUNE SWR ADJ
TUNE SWR
POS ADJ
NEG ADJ
SWR CAL
TP301 TEST POINT
TP302 TEST POINT
TP303 TEST POINT +8V
TP304 TEST POINT -8V
FB305
FB306
FB318
WHT-VIOL
WHT-BLK
WHT-BRN
WHT-RED
WHT-ORG
WHT-YEL
WHT-GRN
WHT-BLU
WHT-GRY
ORG
YEL
BLU
GRN


Q319
417-864
Q318
417-864
Q316
417-864
Q317
417-864
U315A
443-607
N.C.
SW7A
FB306
+12V
FB316
U316
442-687
IN
OUT
COM
+10V
U317
2-602
U317A
U317B
U317C
U317D
Q326
417-864
Q327
417-864
Q328
417-864
Q329
417-864
Q331
417-818
Q332
417-818
Q333
417-918
Q334
417-918
Q335
417-864
Q336
417-864
Q337
417-864
Q338
417-818
U314C
442-602
U314D
442-602
SW6A
SW6B
SW6C
SW6D
SW7B
AUTO
MANUAL
ANTENNA
INDUCTOR
BLACK
WHT-GRY
WHT-RED
WHT-BLK
WHT-GRN
BRN
BLU
VIOL
WHT-VIOL
ORG
WHT
CW
CCW
OFF
SW
N.C.
A2
INDUCTOR MOTOR
420-636
D361
56-56
D362
56-56
D363
56-56
D364
56-56
D365
56-56
D366
56-56
D351
57-824
D352
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D355
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D356
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D357
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D358
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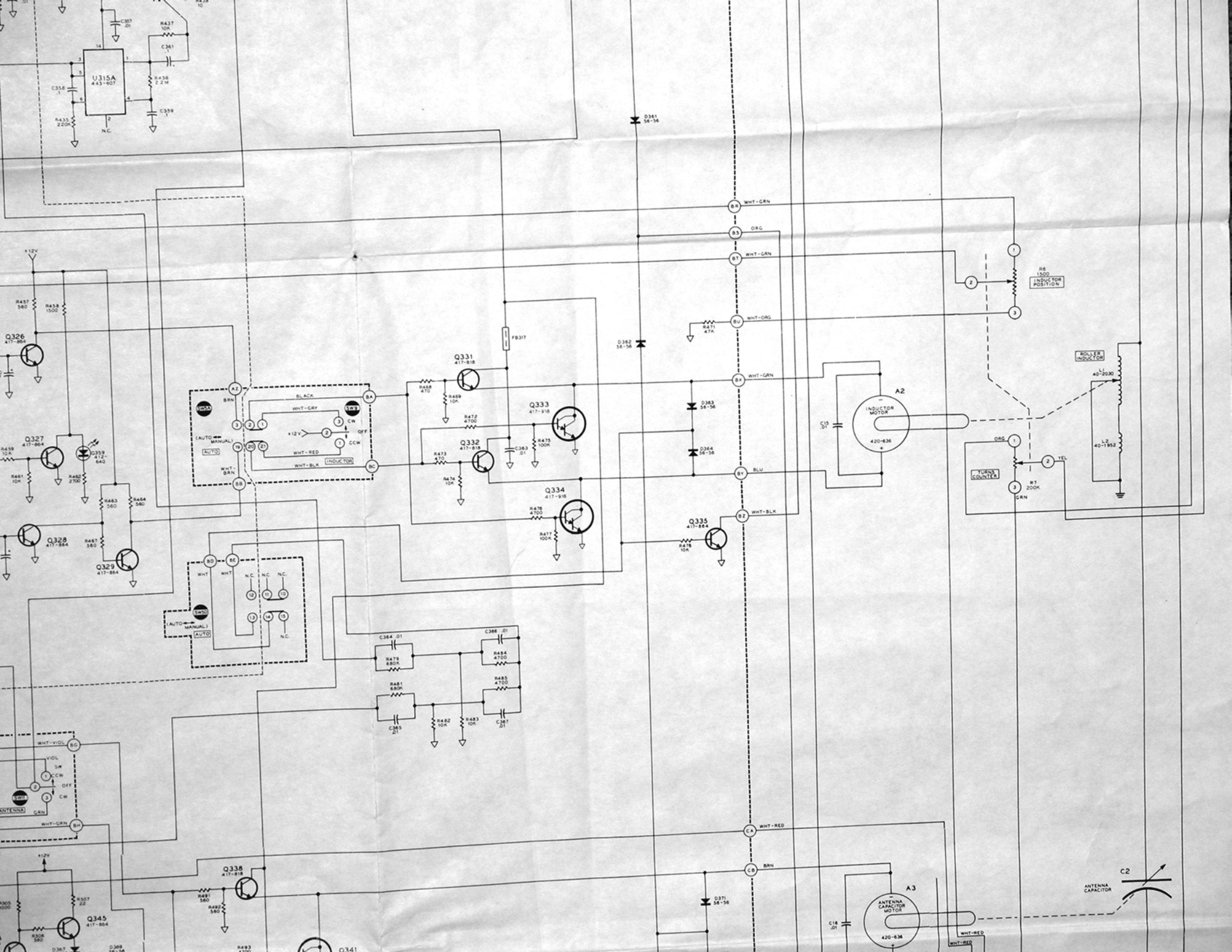
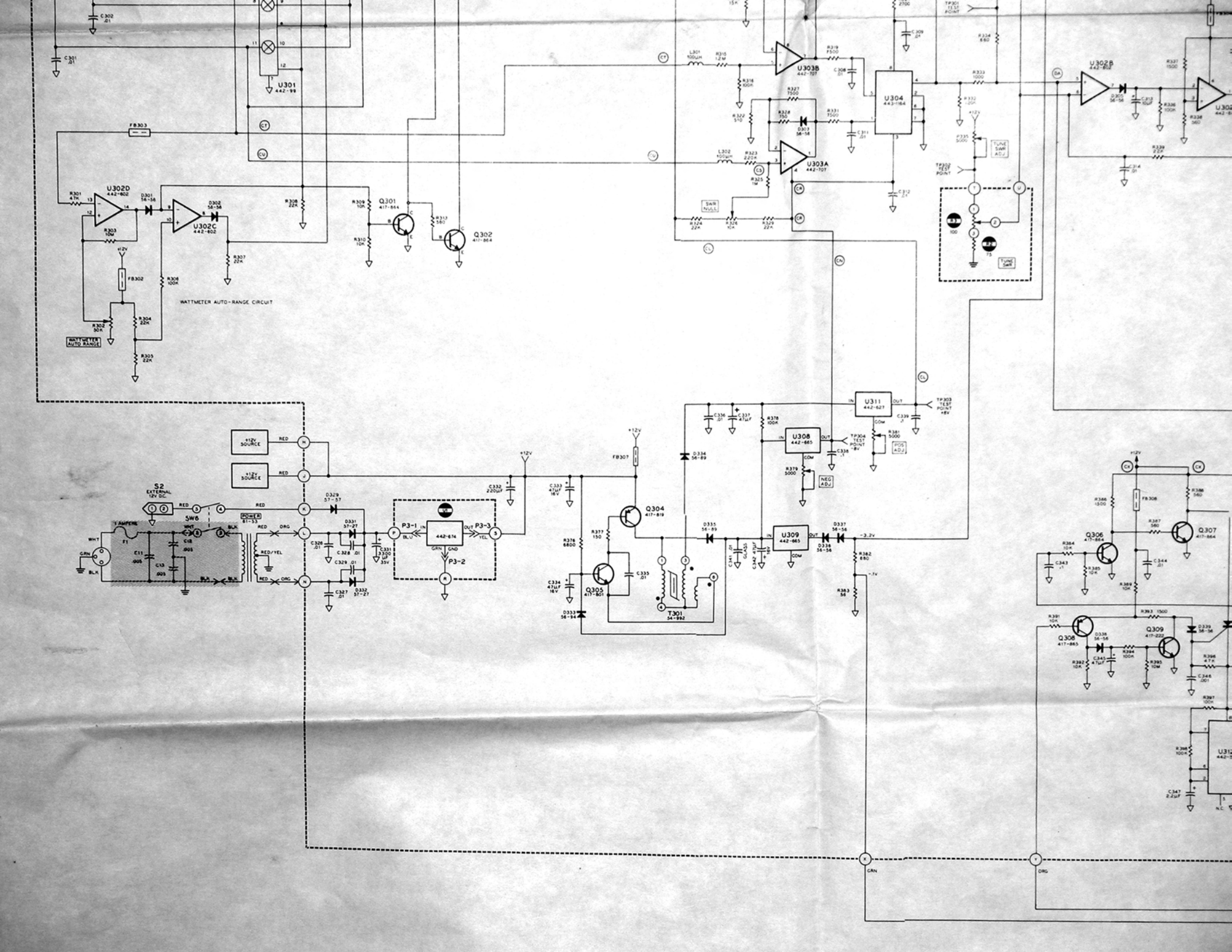
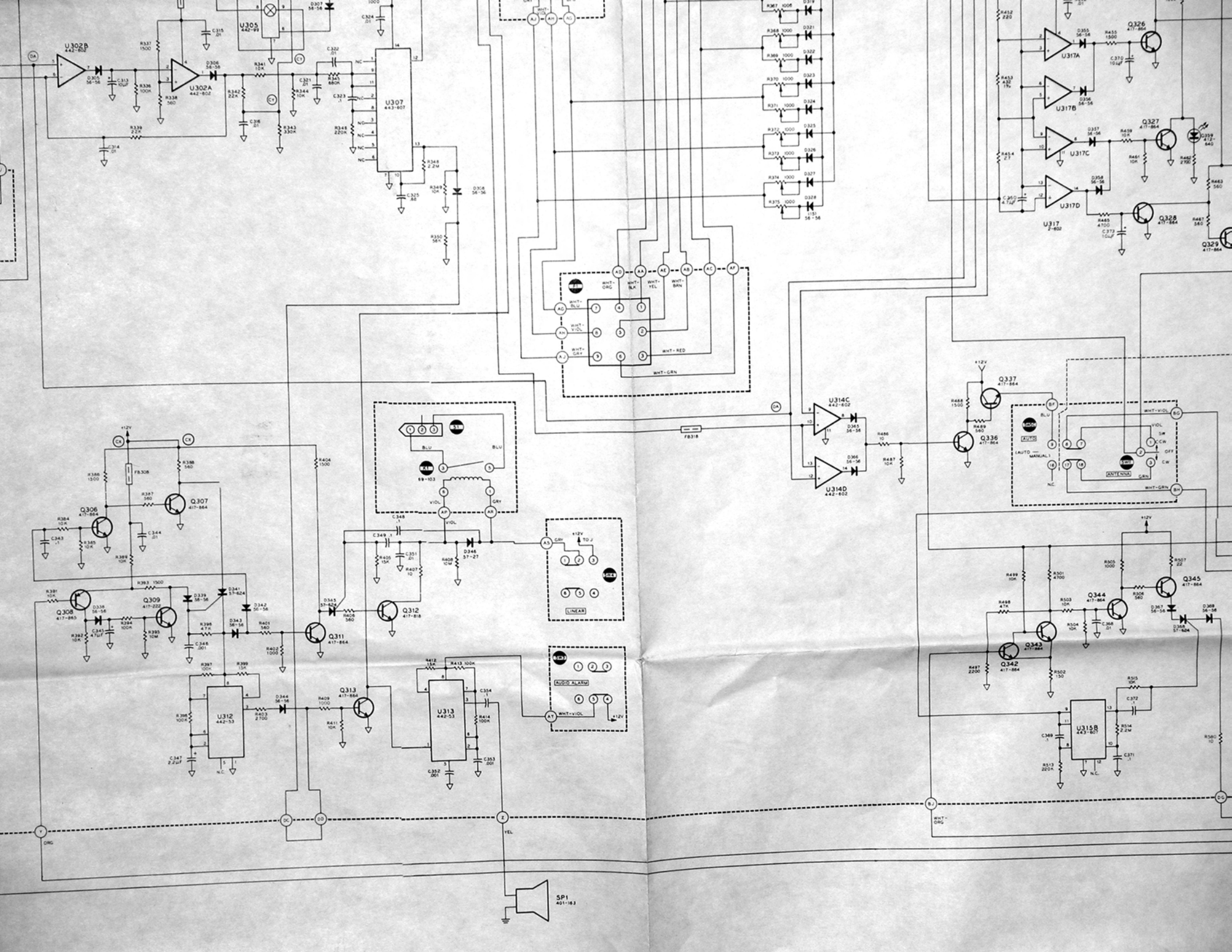
D359
412-640


U315A
443-607
N.C.
R437 10K
C361 .1
R436 2.2M
C359 .1
C358 .1
R433 220K
C357 .01
R428 10
D361 56-56
WHT-GRN
ORG
WHT-GRN
WHT-ORG
R6 1500 INDUCTOR POSITION
R471 47K
D362 56-56
FB317
+12V
R457 560
R458 1500
Q326 417-864
Q327 417-864
Q359 412-640
R459 10K
R461 10K
R462 2700
R463 560
R464 560
Q328 417-864
R467 560
Q329 417-864
SW302
(AUTO MANUAL)
AUTO
BRN
WHT-GRY
WHT-RED
WHT-BLK
WHT-BRN
BLACK
SW303
CW
OFF
CCW
INDUCTOR
Q331 417-818
R468 470
R469 10K
Q332 417-818
R472 4700
R473 470
R474 10K
C363 .01
Q333 417-916
R475 100K
Q334 417-916
R476 4700
R477 100K
WHT-GRN
D363 56-56
D364 56-56
BLU
WHT-BLK
Q335 417-864
R478 10K
A2
INDUCTOR MOTOR
420-636
C15 .01
ROLLER INDUCTOR
L1 40-2030
L2 40-1952
ORG
YEL
GRN
TURNS COUNTER
R7 200K
WHT
N.C.
C364 .01
R479 680K
C366 .01
R484 4700
R481 680K
R485 4700
C365 .01
R482 10K
R483 10K
C367 .01
WHT-VIOL
VIOL
SW
CCW
OFF
CW
ANTENNA
GRN
WHT-GRN
WHT-RED
BRN
Q338 417-818
R491 560
R492 560
Q345 417-864
R505 1000
R507 22
R506 560
D367 56-56
D369 56-56
R493
Q341
D371 56-56
A3
ANTENNA CAPACITOR MOTOR
420-636
C16 .01
C2
ANTENNA CAPACITOR


U301
442-99
U302D
442-802
U302C
442-802
U303B
442-107
U303A
442-107
U304
442-1164
U302B
442-802
WATTMETER AUTO-RANGE CIRCUIT
WATTMETER AUTO RANGE
TUNE SWR ADJ
TUNE SWR
SWR NULL
Q301
417-864
Q302
417-864
Q304
417-819
Q305
417-801
Q306
417-864
Q307
417-864
Q308
417-865
Q309
417-220
U308
442-865
U309
442-865
U311
442-627
T301
54-982
S2
EXTERNAL 12V DC
SW6
POWER 81-33
+12V SOURCE
+12V SOURCE
P3-1
P3-2
P3-3
442-674
NEG ADJ
POS ADJ
TP303 TEST POINT +8V
TP304 TEST POINT +8V
GRN
ORG


U302B
442-602
U302A
442-602
U305
442-99
U307
443-607
U314C
442-602
U314D
442-602
U317
2-602
U317A
U317B
U317C
U317D
U312
442-53
U313
442-53
U315B
443-607
Q306
417-864
Q307
417-864
Q308
417-865
Q309
417-202
Q311
417-864
Q312
417-818
Q313
417-864
Q326
417-864
Q327
417-864
Q328
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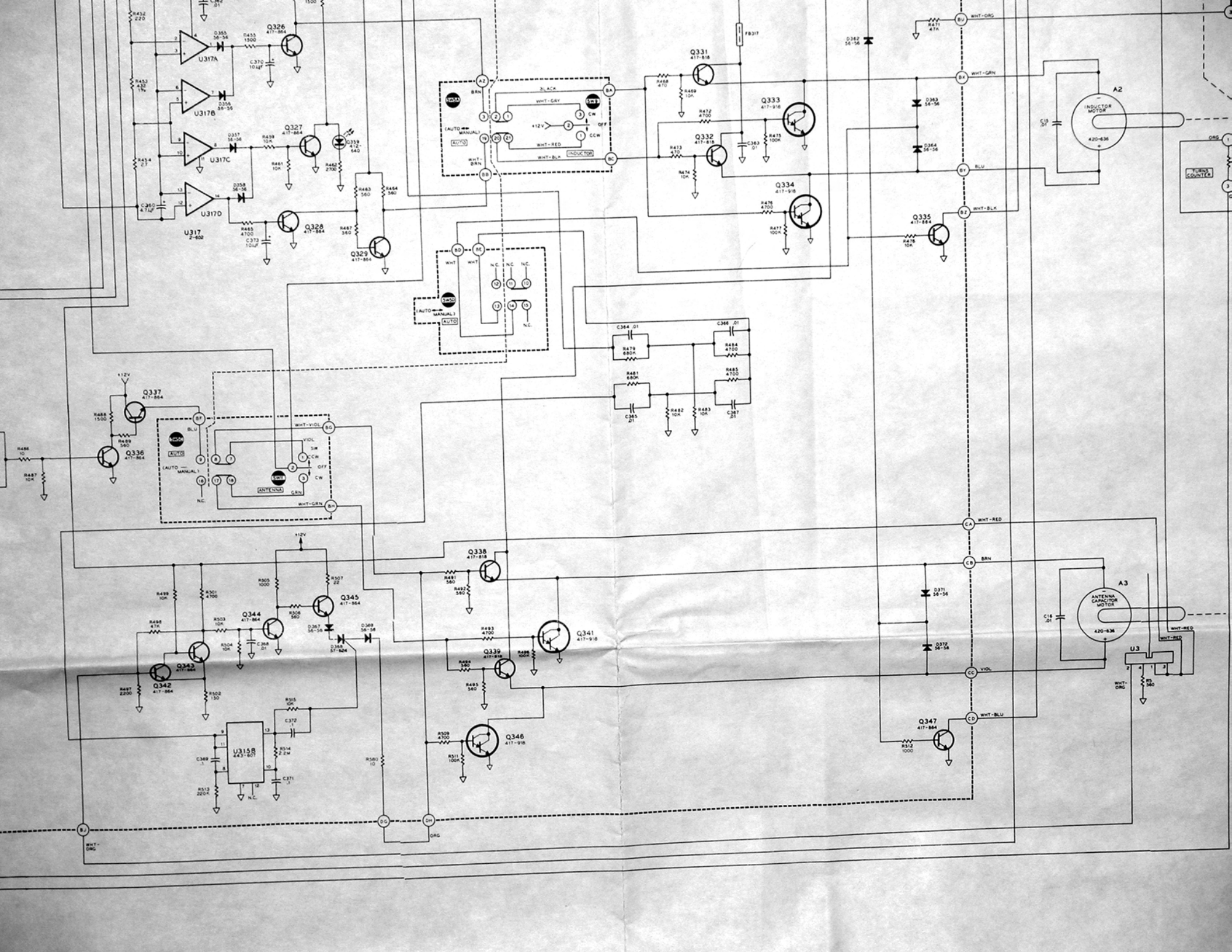
Q329
417-864
Q336
417-864
Q337
417-864
Q342
417-864
Q343
417-864
Q344
417-864
Q345
417-864
FB308
FB318
S1A
69-103
S1B
S1C
S1D
S1E
S1F
S1G
S1H
S1J
S1K
S1L
S1M
S1N
S1P
S1R
S1S
S1T
S1U
S1V
S1W
S1X
S1Y
S1Z
SP1
401-163
LINEAR
AUDIO ALARM
ANTENNA
+12V
WHT-ORG
WHT-BLK
WHT-YEL
WHT-BRN
WHT-BLU
WHT-VIOL
WHT-RED
WHT-GRN
BLU
VIOL
GRY
ORG
YEL


U317A
U317B
U317C
U317D
U317
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U3158
443-607
A2
INDUCTOR MOTOR
420-636
A3
ANTENNA CAPACITOR MOTOR
420-636
U3
TURNS COUNTER
INDUCTOR
ANTENNA
AUTO
MANUAL
CW
CCW
OFF
+12V
BLACK
WHT-GRY
WHT-RED
WHT-BLK
WHT-BRN
WHT-ORG
WHT-GRN
BLU
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N.C.
BRN
VIOL
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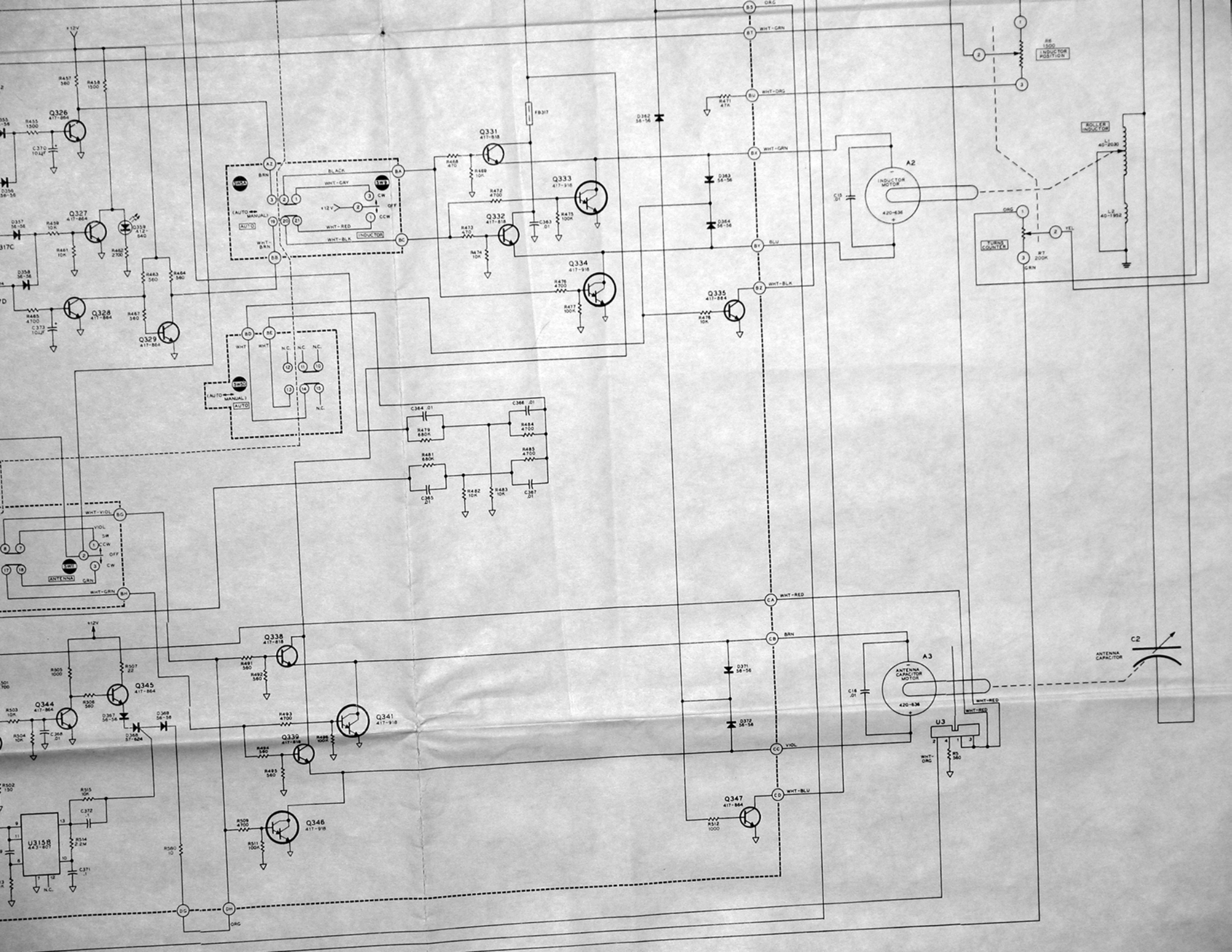
GRN
ORG
WHT-RED
WHT-BLU


+12V
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U3158 443-801
U3
A2
INDUCTOR MOTOR
420-636
A3
ANTENNA CAPACITOR MOTOR
420-636
ROLLER INDUCTOR
INDUCTOR POSITION
TURNS COUNTER
ANTENNA CAPACITOR
C2
WHT-GRN
WHT-ORG
WHT-BLK
WHT-RED
WHT-VIOL
WHT-BLU
BLACK
WHT-GRY
WHT-BRN
ORG
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GRN
BRN
VIOL
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INDUCTOR
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MANUAL
CW
CCW
OFF
SW1A
SW1B
SW1C
SW1D
SW1E
SW1F
FB317
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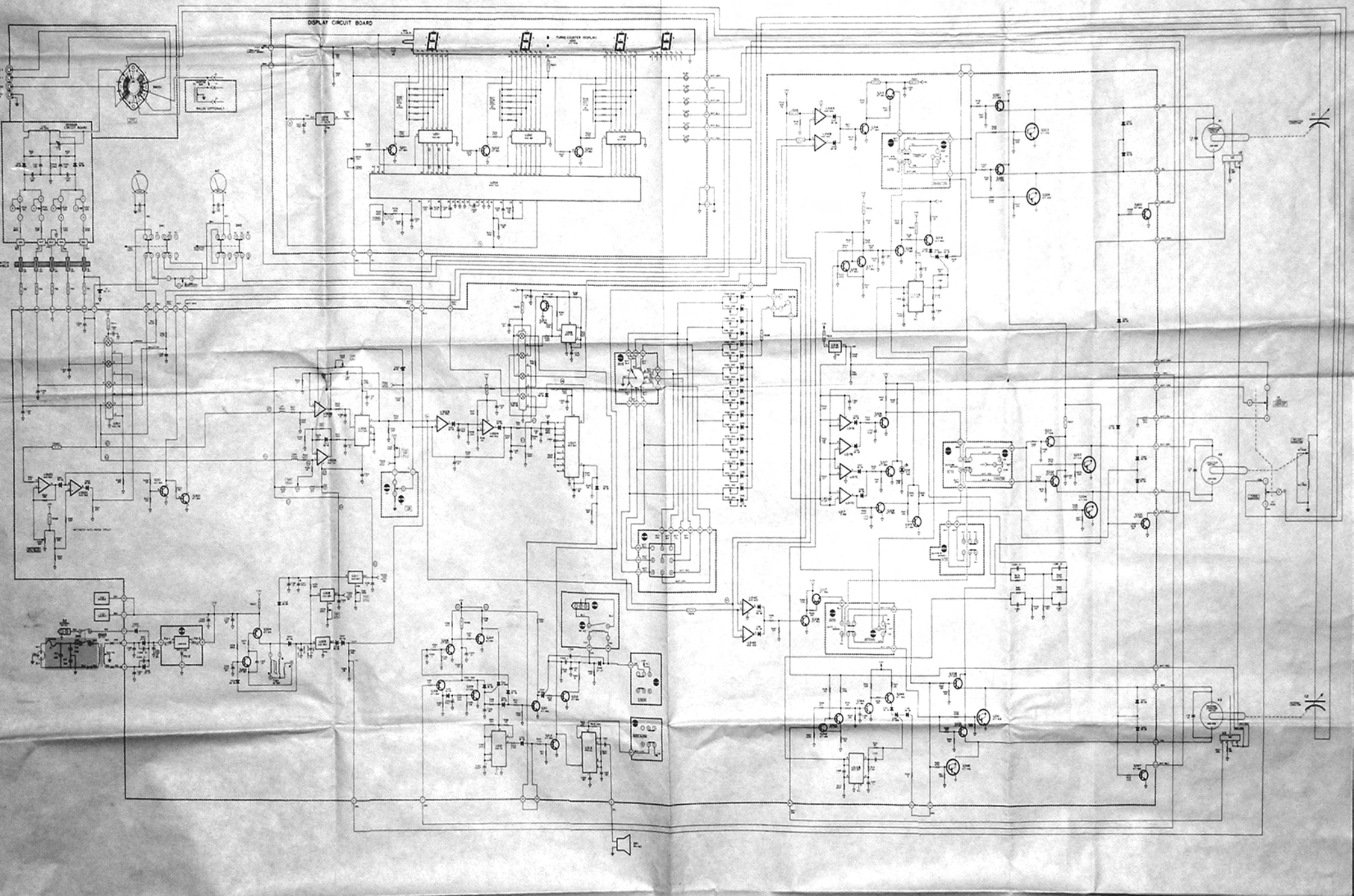
D363 56-56
D364 56-56
D371 56-56
D372 56-56
D367 56-56
D368 57-624
D369 56-56
D358 56-56
D357 56-56
D359 412-640
N.C.

SCHEMATIC OF THE HEATHKIT® AUTO-TUNE ANTENNA TUNER MODEL SA-2500

Part of 595-3027-1

NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:
   1-99 COMPONENTS MOUNTED ON THE CHASSIS.
   101-199 COMPONENTS MOUNTED ON THE SENSOR CIRCUIT BOARD.
   201-299 COMPONENTS MOUNTED ON THE DISPLAY CIRCUIT BOARD.
   301-599 PARTS MOUNTED ON THE MAIN CIRCUIT BOARD.
2. ALL RESISTORS ARE 1/4-WATT, 5% TOLERANCE UNLESS OTHERWISE NOTED. RESISTOR VALUES ARE IN OHMS: K=1000, M=1,000,000.
3. CAPACITORS LESS THAN 1 ARE IN µF (MICROFARADS). ALL OTHER CAPACITORS ARE IN pF (PICOFARADS) UNLESS OTHERWISE NOTED.
4. COAX SWITCH SW101 IS SHOWN IN THE FULLY COUNTERCLOCKWISE (BYPASS) POSITION.
5. ARROWS AT CONTROLS INDICATE A CLOCKWISE ROTATION AS VIEWED FROM THE SHAFT END OF THE CONTROL.
6. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASURED WITH A HIGH IMPEDANCE VOLTMETER FROM THE POINT INDICATED TO CHASSIS GROUND.
7. ⏚ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
8. ⏚ THIS SYMBOL INDICATES A CHASSIS GROUND.
9. □ THIS SYMBOL INDICATES A WIRED CONNECTION TO A CIRCUIT BOARD.
10. REFER TO THE "CIRCUIT BOARD X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF PARTS.
11. PARTS IN THE SHADED AREAS ARE CRITICAL TO CONTINUED SAFETY. REPLACE ONLY WITH THE SAME RATED PART, OR WITH THE CORRECT HEATH COMPANY PART.



SCHEMATIC OF THE HEATHKIT® AUTO-TUNE ANTENNA TUNER MODEL SA-2500

Part of 595-3027-1

NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:
   - 1–99 COMPONENTS MOUNTED ON THE CHASSIS.
   - 101–199 COMPONENTS MOUNTED ON THE SENSOR CIRCUIT BOARD.
   - 201–299 COMPONENTS MOUNTED ON THE DISPLAY CIRCUIT BOARD.
   - 301–599 PARTS MOUNTED ON THE MAIN CIRCUIT BOARD.
2. ALL RESISTORS ARE 1/4-WATT, 5% TOLERANCE UNLESS OTHERWISE NOTED. RESISTOR VALUES ARE IN OHMS: K=1000, M=1,000,000.
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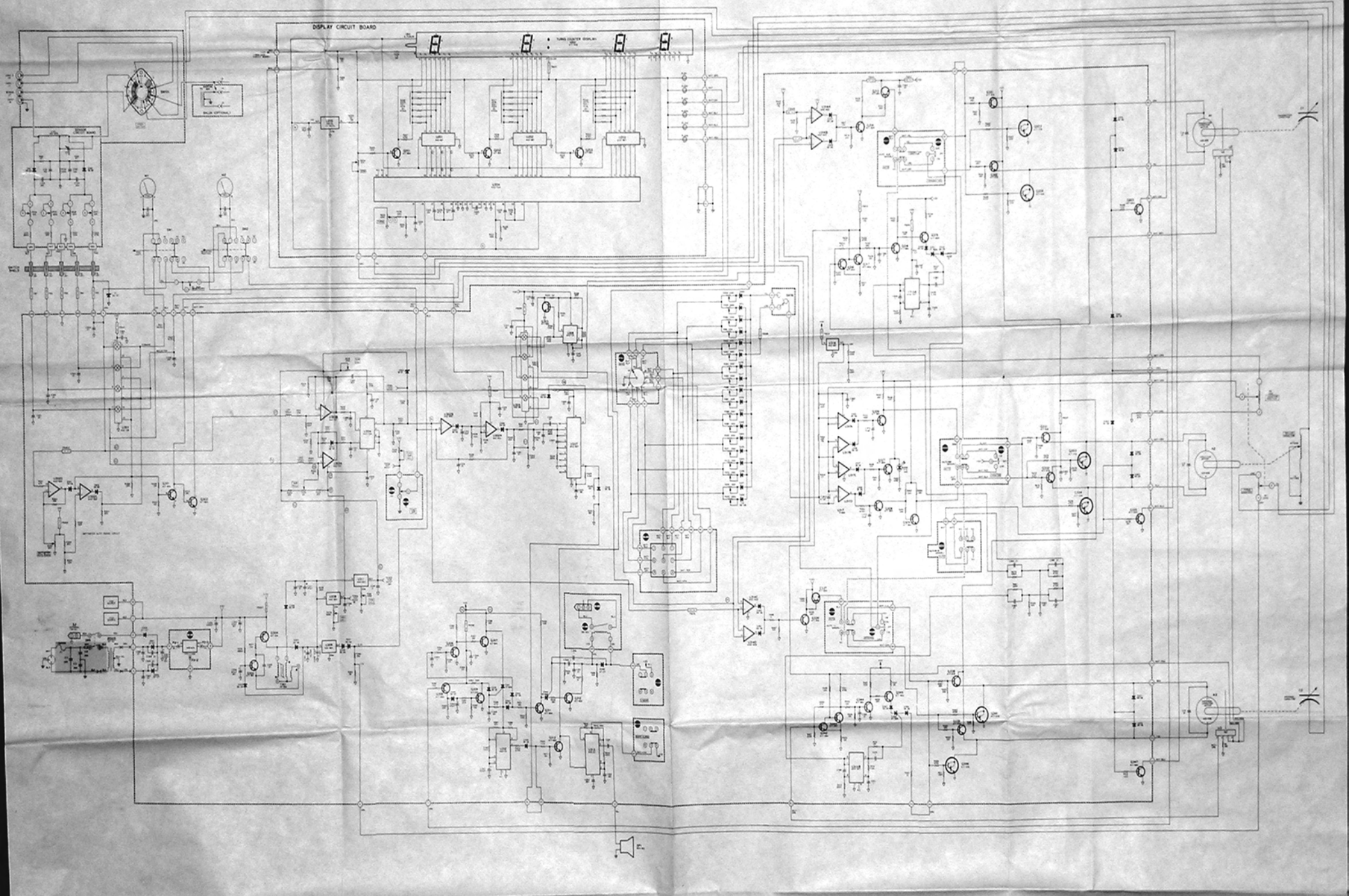
7. ⏚ THIS SYMBOL INDICATES A CIRCUIT BOARD GROUND.
8. ⏚ THIS SYMBOL INDICATES A CHASSIS GROUND.
9. ▭ THIS SYMBOL INDICATES A WIRED CONNECTION TO A CIRCUIT BOARD.
10. REFER TO THE "CIRCUIT BOARD X-RAY VIEWS" FOR THE PHYSICAL LOCATION OF PARTS.
11. PARTS IN THE SHADED AREAS ARE CRITICAL TO CONTINUED SAFETY. REPLACE ONLY WITH THE SAME RATED PART, OR WITH THE CORRECT HEATH COMPANY PART.



CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH

ZENITH

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.