PRICE $1.00

Assembling and Using Your...

Heathkit

ELECTRONIC CROSSOVER

MODEL XO-1

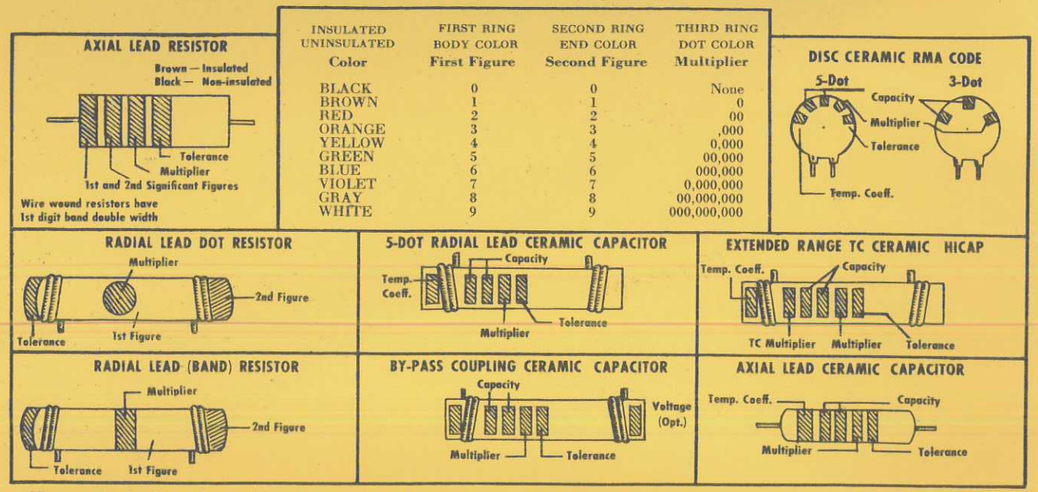
HEATH COMPANY

A Subsidiary of Daystrom Inc.

BENTON HARBOR, MICHIGAN

595-130

STANDARD COLOR CODE — RESISTORS AND CAPACITORS

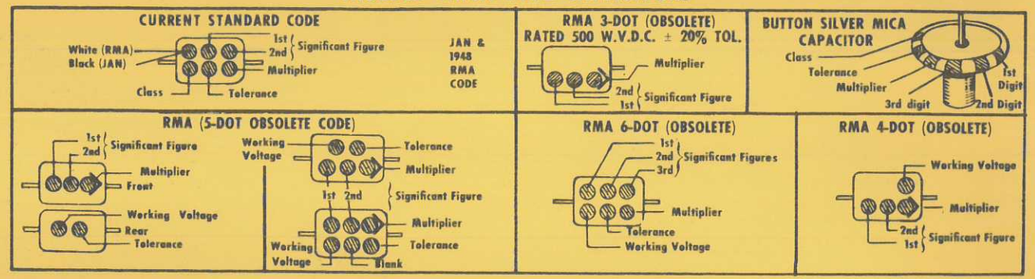


INSULATED UNINSULATED Color	FIRST RING BODY COLOR First Figure	SECOND RING END COLOR Second Figure	THIRD RING DOT COLOR Multiplier
BLACK	0	0	None
BROWN	1	1	0
RED	2	2	00
ORANGE	3	3	,000
YELLOW	4	4	0,000
GREEN	5	5	00,000
BLUE	6	6	000,000
VIOLET	7	7	0,000,000
GRAY	8	8	00,000,000
WHITE	9	9	000,000,000

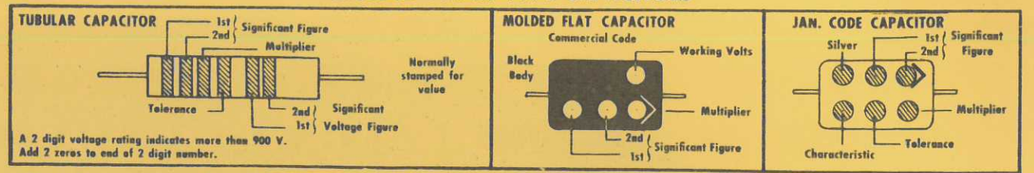
The standard color code provides all necessary information required to properly identify color coded resistors and capacitors. Refer to the color code for numerical values and the zeroes or multipliers assigned to the colors used. A fourth color band on resistors determines tolerance rating as follows: Gold = 5%, silver = 10%. Absence of the fourth band indicates a 20% tolerance rating.

The physical size of carbon resistors is determined by their wattage rating. Carbon resistors most commonly used in Heathkits are ½ watt. Higher wattage rated resistors when specified are progressively larger in physical size. Small wire wound resistors ½ watt, 1 or 2 watt may be color coded but the first band will be double width.

MOLDED MICA TYPE CAPACITORS



MOLDED PAPER TYPE CAPACITORS



The tolerance rating of capacitors is determined by the color code. For example: red = 2%, green = 5%, etc. The voltage rating of capacitors is obtained by multiplying the color value by 100. For example: orange = 3 × 100 or 300 volts. Blue = 6 × 100 or 600 volts.

In the design of Heathkits, the temperature coefficient of ceramic or mica capacitors is not generally a critical factor and therefore Heathkit manuals avoid reference to temperature coefficient specifications.

Courtesy of Centralab

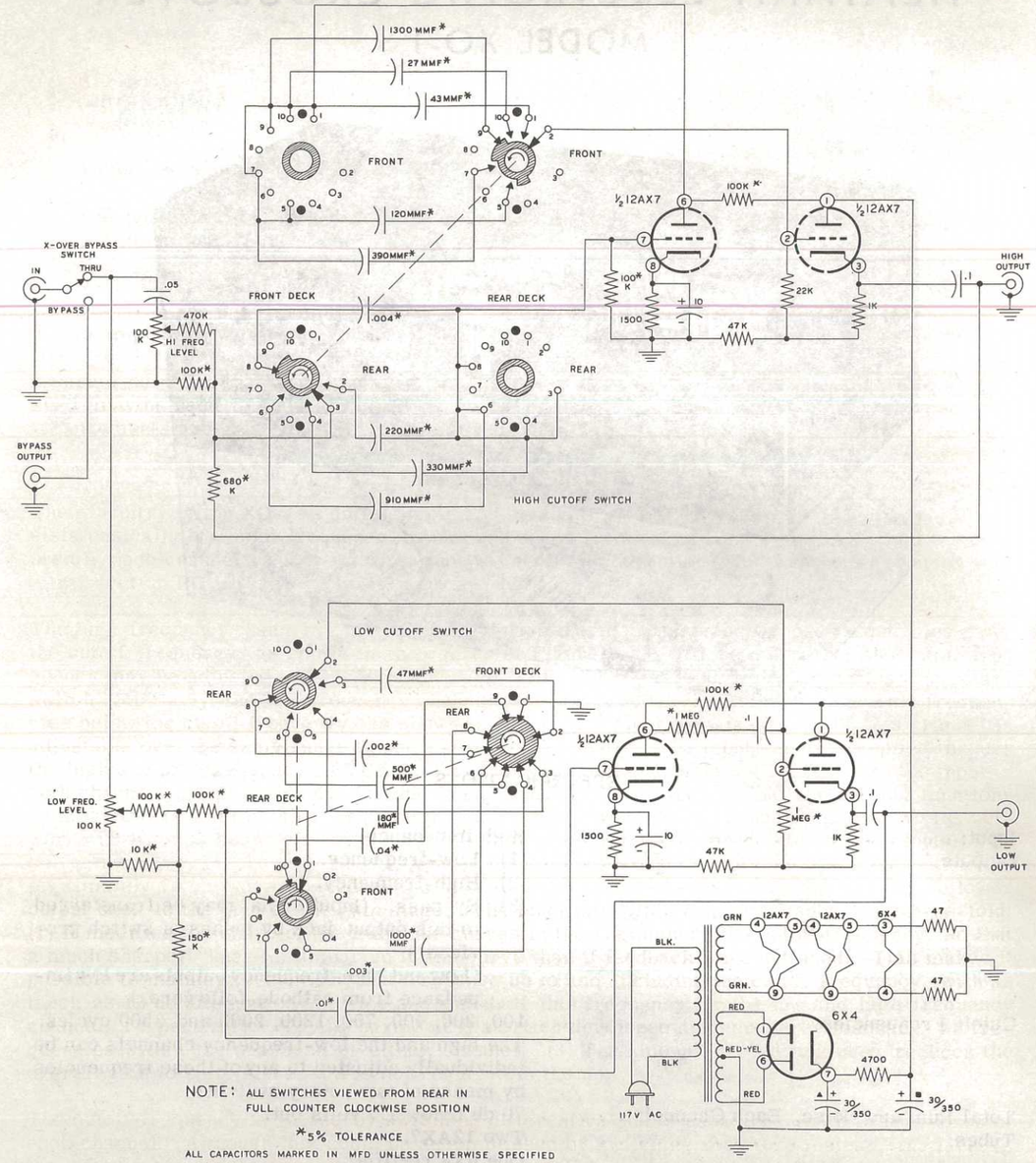
HEATHKIT ELECTRONIC CROSSOVER

MODEL XO-1

SPECIFICATIONS

Input:	High impedance.
Outputs:	(1). Low-frequency. (2). High-frequency. (3). By-pass. (Input signal may be transferred to this output jack by means of switch provided.) (Low and high-frequency outputs are low impedance from cathode-followers.)
Cutoff Frequencies:	100, 200, 400, 700, 1200, 2000 and 3500 cycles. The high and the low-frequency channels can be individually adjusted to any of these frequencies by means of two rotary switches.
Total Hum and Noise, Each Channel:	70 db below 1.5 volts out.
Tubes:	Two 12AX7. One 6X4 rectifier.
Dimensions:	9" wide, 5 3/4" high, 4 3/4" deep.
Power Requirements:	105 - 125 volts, 50-60 cycles AC. 5 watts.
Kit Shipping Weight:	6 lbs.

8/24/59



NOTE: ALL SWITCHES VIEWED FROM REAR IN FULL COUNTER CLOCKWISE POSITION

*5% TOLERANCE

ALL CAPACITORS MARKED IN MFD UNLESS OTHERWISE SPECIFIED

HEATHKIT ELECTRONIC CROSSOVER
MODEL XO-1

Maximum Gain of Each Channel: . . . . . Unity.

Normal Operating Level: . . . . . 2.0 volts rms or less.

Maximum Recommended Operating Level: . . . 5.0 volts rms.

Frequency Response:

Low-Frequency Channel: . . . . . ±1.2 db from 10 cycles to cutoff frequency.

High-Frequency Channel: . . . . . ±1.2 db from cutoff frequency to 20,000 cycles.

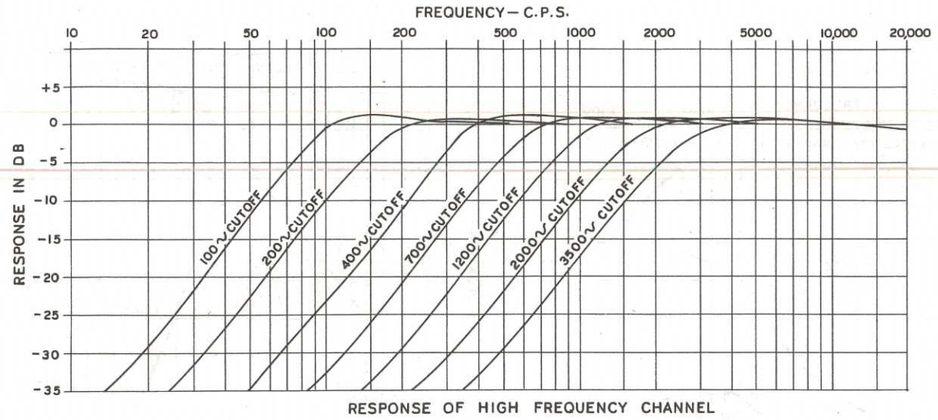


Figure 1

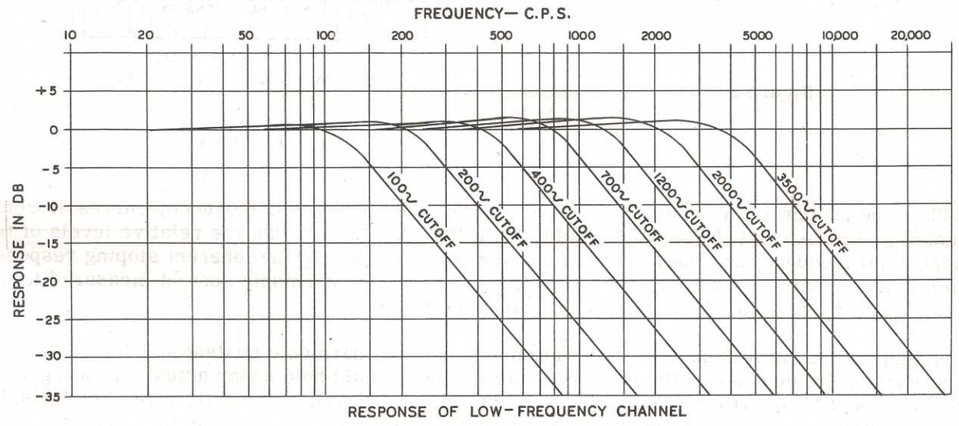


Figure 2

Distortion: Distortion introduced by the XO-1 is extremely low, and can be considered negligible. It was not possible to measure intermodulation distortion with laboratory equipment ordinarily available, owing to the frequency characteristics of the XO-1; distortion figures so obtained would not be valid. For this reason, harmonic distortion tests were relied upon to furnish information as to linearity of the XO-1 circuits.

Harmonic Distortion:

Low-Frequency Channel: . . . . . Less than .1 of 1% at 2 volts out at any frequency up to approximately one-half the cutoff frequency. See curve (Figure 3) for further data on distortion vs. frequency.

High-Frequency Channel: . . . . . Less than .25 of 1% when measured at the cutoff frequency; drops rapidly at higher frequencies, to less than .1 of 1% (see curve of Figure 4).

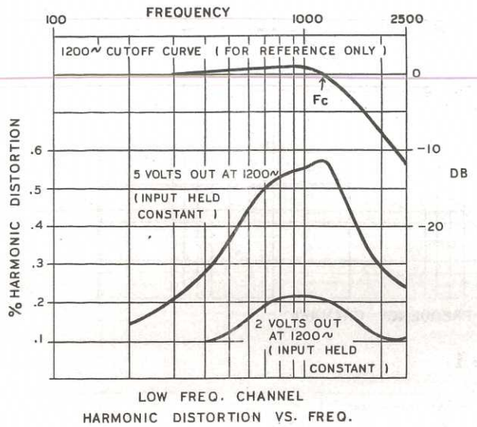


Figure 3

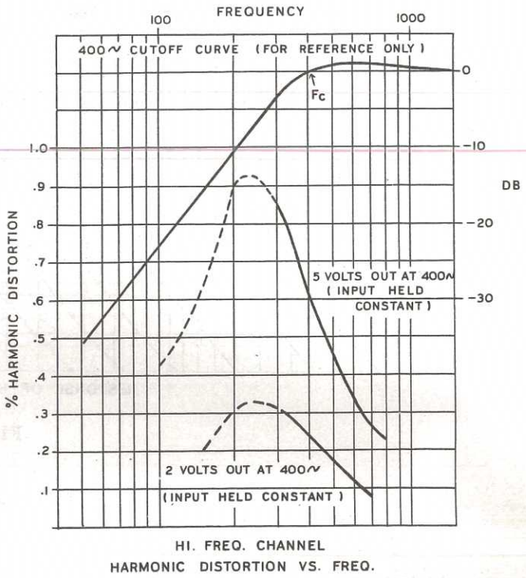


Figure 4

NOTE: The proper interpretation of these harmonic distortion vs. frequency curves is complicated by the fact that the response is far from flat. In other words, the relative levels of the fundamental frequency and the total harmonic content are upset by the inherent sloping response which is an essential characteristic of the XO-1. Thus, the harmonic content measured is not a true "percentage distortion" under the normal interpretation.

Nevertheless the curves indicate the relationship between harmonic content and the fundamental at various frequencies in the region of cutoff, which would hold under actual operating conditions; it is NOT a TRUE measure of distortion introduced by non-linearity of the XO-1 itself. Since the measurements were made by the method which shows "total harmonic content", it is difficult to accurately correct the curves in order to gain a true distortion figure for the XO-1. However, if this were done, it would be found that the distortion would not rise appreciably with decreasing frequency as appears to be the case in Figure 4. In Figure 3 the corrected distortion figure would be somewhat higher at frequencies close to Fc and would tend to level off above Fc instead of dropping. However, these corrected distortion figures are of little value anyway in the case of Figure 3 since harmonic products of frequencies approaching Fc are rapidly attenuated. From this it can be concluded that distortion introduced by the XO-1, at normal operating levels, can be considered negligible.

NOTE: The performance specifications given are based on careful measurements made on a typical unit, and kits constructed in exact accordance with the instructions can be expected to conform to these specifications to a reasonable degree. We cannot guarantee, however, that measurements made on completed kits will be in exact agreement with the specifications, owing to factors beyond our reasonable control. Such factors include placement of critical leads, normal variation of components and tube characteristics.

INTRODUCTION

It is generally appreciated that to satisfactorily reproduce the spectrum of audio frequencies from approximately 30 cycles to 15,000 cycles requires a relatively large speaker or "woofer" to reproduce the low frequencies, say from 30 to 1000 cycles and a comparitively small speaker or "tweeter" to reproduce the higher range, in this example, from 1000 to 15,000 cycles. Such a system requires an electrical dividing network or "crossover" to divide the total audio spectrum into the proper ranges, in order that only the high frequencies will be fed to the tweeter and only the low frequencies to the woofer. (Many 2-way speakers built as an integral unit with separate cones for the high and the low frequencies have a built-in or "mechanical" crossover and are not considered here. Best results and greatest flexibility are generally achieved by the use of a separate woofer and tweeter and an electrical, rather than a mechanical crossover.

Figure 5 shows, in block diagram form, the connection of a conventional electrical crossover unit of the type which has come into general use. Note that the crossover unit is connected between the output of the power amplifier and the speakers.

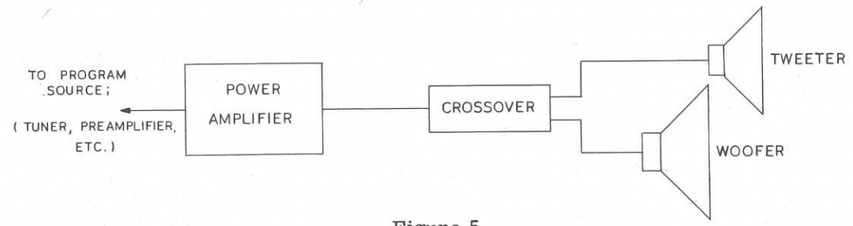


Figure 5

The Heathkit XO-1 Electronic Crossover is designed to operate in conjunction with a two-way speaker system where separate power amplifiers are used for the high and the low frequencies as shown in the block diagram of Figure 6. This has several important advantages over the conventional method of Figure 5.

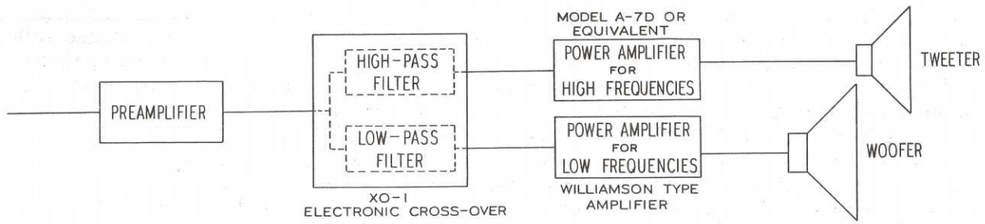


Figure 6

(1) Since the crossover unit operates at the input of the power amplifiers rather than at the output, no output power is dissipated and therefore wasted in the crossover unit itself. In contrast, it is to be noted that a conventional type crossover with an insertion loss of only 1 db would reduce the power capability of a 20 watt amplifier to 16 watts and a 50 watt amplifier to 40 watts.

(2) In an electronic crossover device, it is practical to vary the crossover frequency over a wide range to accommodate almost countless woofer-tweeter combinations and acoustic environments. Changing speakers in your hi-fi system will not obsolete the XO-1. Also, there are no complex impedance matching problems in assembling your own speaker crossover system.

(3) It is possible to achieve a near ideal crossover characteristic by means of electronic circuitry, without significant peaks or valleys in the overall response. Also, the response and crossover characteristics are unaffected by differences in speakers and enclosures.

(4) Amplifier damping factor is not altered by the crossover device.

(5) The possibility of intermodulation distortion (modulation of the high frequencies by high-amplitude low frequencies) in the amplifiers is reduced, particularly at high power levels.

(6) No reactive-load conditions, sometimes caused by conventional crossover units, are imposed on the power amplifier. Such load conditions can result in instability (oscillation) in amplifiers with heavy feedback.

It should be noted that while the above discussion is confined to two-way speaker systems, the XO-1 may be used to good advantage in three or four-way systems. A number of suggested arrangements are given in the section entitled "Installation and Operation".

CIRCUIT DESCRIPTION

The circuitry of the XO-1 is quite simple and straightforward. Refer to the Schematic. It consists basically of a high-frequency channel and a low-frequency channel. A 12AX7 dual triode is used in each channel. A 6X4 rectifier tube is used in a conventional full wave power supply with a two-section RC filter.

The high-frequency channel is actually a high-pass filter; it passes only those frequencies above the cutoff frequency, as shown in the curves of Figure 1. It will be noted that the cutoff frequency may be adjusted to 100, 200, 400, 700, 1200, 2000 or 3500 cycles by means of a rotary switch. Similarly, the low-frequency channel is a low-pass filter which will pass only frequencies below the cutoff frequency, as shown in Figure 2. The cutoff frequency of this channel is adjustable over the same range by means of another switch. The input signal is applied through the high and low-frequency LEVEL controls, through suitable isolating resistors to the input of both channels. The 12AX7 dual triode in each channel is utilized so that one section functions as a gain stage and the other as an output cathode follower. Each channel employs two RC networks in order to achieve a cutoff slope of 12 db per octave since each network contributes 6 db per octave. In each channel the 12AX7 gain stage serves to separate the two RC networks. Approximately 14 db negative feedback is applied around each channel from the cathode-follower output back to the grid of the gain stage. The function of this negative feedback is three-fold: (1) It modifies the shape of the response curves in the region near the cutoff frequency, so that a much sharper "knee" is imparted to the curve than if feedback were not used. This makes it possible to maintain essentially flat response up to and including the cutoff frequency, with as much as 12 db attenuation at twice and one-half this frequency for the low and high-frequency channel, respectively. (2) Any harmonic distortion developed is reduced by feedback, at frequencies within the passband of either channel. (3) The amount of feedback used reduces the overall gain to unity since gain is not required in the unit.

The cutoff frequency is varied by switching different values of capacity in both RC networks of each channel. Although this could be accomplished by switching resistors instead, the level in the "flat" region would vary appreciably with the cutoff frequency due to the finite values of resistance already in the circuit. A unique method of switching capacitors has been devised whereby each capacitor (with exceptions) serves for two successive cutoff frequencies. This greatly reduces the number of components required and is made possible by "staggering" the turnover frequencies of the two RC networks in each channel.

NOTES ON ASSEMBLY AND WIRING

A great deal of engineering has gone into the design of your Heathkit Electronic Crossover to ensure highest performance and the components have been carefully selected for quality and long life. We urge you to proceed with the utmost care in construction, follow the instructions exactly and perform each step in the most workmanlike manner possible. By so doing you will protect your investment in time and money and be rewarded with the fine performance of which your Electronic Crossover is capable as well as the deep feeling of satisfaction that comes from a job well done.

This manual is supplied to assist you in every way to complete the instrument with the least possible chance for error. The detailed instructions are specifically written to allow either the experienced or inexperienced constructor to construct the unit with a minimum of difficulty. Only a very small percentage of Heathkit assemblers encounter any difficulty whatsoever in completing kits of this kind. The large fold-in pictorial diagrams included in this manual are intended to be attached to the wall above your work space, for convenient reference. The diagrams are repeated in smaller form within the manual proper.

UNPACK THE KIT CAREFULLY AND CHECK EACH PART AGAINST THE PARTS LIST. DO NOT DISCARD ANY PACKING MATERIAL UNTIL THIS HAS BEEN DONE. In so doing you will become acquainted with each part. Full size sketches of the various type parts will be found on Page 28 to help you identify any questionable components. If a parts shortage is found, please notify us promptly and return the inspection slip to us with your letter. Hardware items are counted by weight and if a few are missing, we suggest that to save time, you obtain them locally if at all possible.

Resistors and controls generally have a tolerance rating of ±20% unless otherwise stated in the parts list. Thus a 100 KΩ resistor may test anywhere from 80 KΩ to 120 KΩ and still be acceptable. Tolerances on electrolytic condensers may be even wider and commonly run from +100% to -50%. The parts furnished with your Heathkit have been specified so as to meet the performance specifications given. Refer to the color code information given on the inside front cover of this manual when in doubt as to the value or tolerance of a resistor or capacitor.

In order to expedite delivery to you, we are occasionally forced to make minor substitutions of parts. Such substitutions are very carefully checked before they are approved and the parts supplied will work satisfactorily in your kit. For example, if your kit is short a 15 KΩ resistor and an 18 KΩ resistor is furnished which is not on the parts list, you will understand that such a substitution has been made. This fact is mentioned here only to prevent any confusion in checking the contents of your kit.

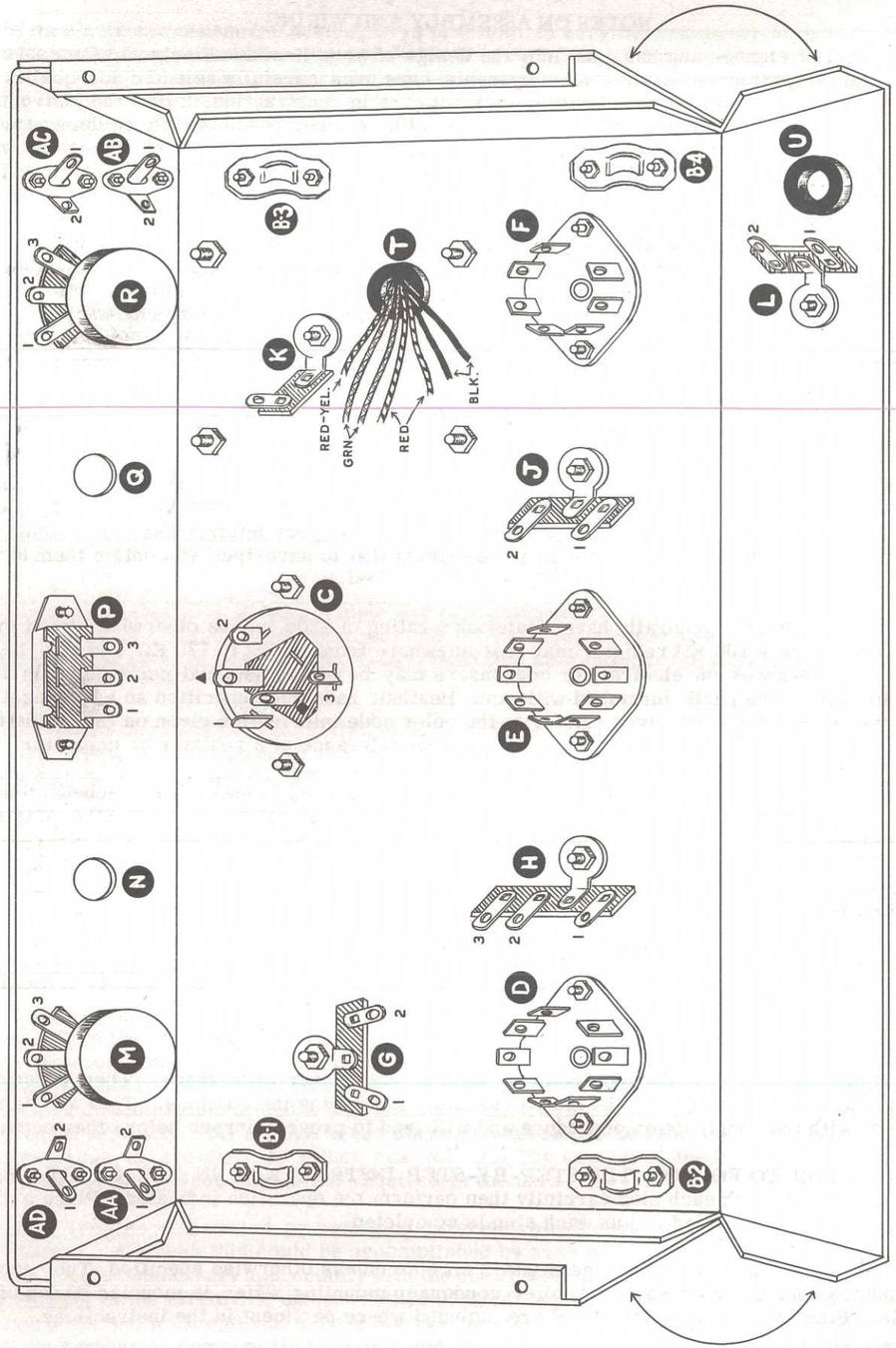
CAUTION: We strongly urge that you follow exactly the wiring and parts layout shown in this manual. The position of certain leads and components in this instrument is quite critical and changes may seriously affect the characteristics of the circuit.

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

First attach the large fold-in pictorials to the wall above your work space. Then we suggest that you carefully read through the entire assembly and wiring instructions. This will familiarize you with the construction procedure and will tend to prevent errors before they occur.

WE URGE YOU TO FOLLOW THE STEP-BY-STEP INSTRUCTIONS IN THE EXACT ORDER GIVEN. Read through each step carefully then perform the operation indicated. Place a check mark in the space provided ( ) as each step is completed.

In assembling the kit, use lockwashers under all nuts unless otherwise specified. Tube sockets are mounted inside the chassis; the filter condenser mounting wafer is mounted on top of the chassis. Other details of construction are included where pertinent in the instructions.



PICTORIAL 1

( ) Place the chassis with its open side up in front of you on your workbench. Be sure the front apron (with the lettering on the outside) is away from you. The chassis will then be in the position shown in Pictorial 1.

( ) Install a phono connector socket at location AA. Be sure lug 2 is away from the end of the chassis. Mount with two 6-32 screws through the chassis and the holes in the socket. Place a #6 lockwasher directly under each nut.

( ) In the same manner, install a phono connector socket at location AB. As before, be sure lug 2 is away from the end of the chassis.

( ) Likewise, install the two remaining phono connector sockets at AC and AD, observing lug orientation as before.

( ) Mount the four spring catch clips at B1, B2, B3 and B4. Secure each clip on the under side of the chassis, with two 4-40 pan head screws inserted from the top of the chassis. Use a #4 lockwasher under each nut.

( ) Install the fiber mounting wafer for the electrolytic filter condenser at C. IMPORTANT: Make sure this wafer is installed with the triangular hole positioned as shown in Pictorial 1. Secure with 6-32 hardware.

( ) Mount a 9-pin wafer tube socket at D. Be sure to observe lug orientation shown with the blank space (between lugs 1 and 9) to the right away from the end of the chassis. See Figure 7. Secure socket with two 3-48 screws and nuts. Lockwashers are not required with 3-48 hardware.

( ) Mount a 9-pin wafer tube socket at E observing the same lug orientation as before.

( ) Install the 7-pin wafer tube socket at F with the blank space (between lugs 1 and 7) to the right toward this end of the chassis.

( ) Mount a 2-lug terminal strip at G observing orientation shown in Pictorial 1. Use 6-32 hardware.

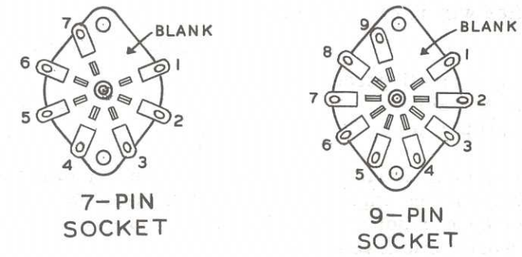


Figure 7

( ) In the same manner, mount a 3-lug terminal strip at H. Be sure terminal 1 is nearest the rear chassis apron.

( ) Install a 2-lug terminal strip at J.

( ) Mount a 1-lug terminal strip at K.

NOTE: The 2-lug terminal strip at L will be mounted later.

( ) Install a 100 KΩ control at M. Orient so that the lugs are toward the open side of the chassis. Refer to Figure 8 for control mounting details. Use a 3/8" lockwasher between the control and the chassis. Place a control washer under the 3/8"-32 nut used to secure the control.

( ) In the same manner install a 100 KΩ control at R.

( ) Using two 6-32 screws, mount the SPDT slide switch at P with the switch handle protruding through the rectangular opening in the front chassis apron. Observe orientation shown with the three lugs away from the open side of the chassis.

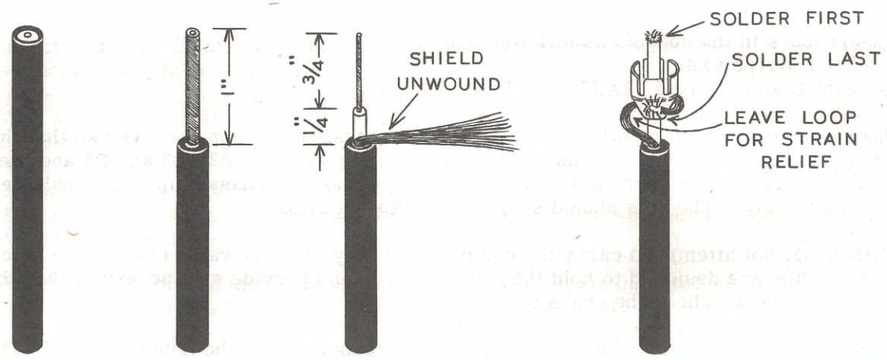


Figure 15

INSTALLATION AND OPERATION OF THE XO-1

All terminal and control designations pertinent to operation of the XO-1 are on the front chassis apron.

Connect a shielded cable from the output of your preamplifier (or tuner or other program source) to the input jack (marked IN) of the XO-1. Connect a similar cable between the jack marked HIGH-OUT and the input of the power amplifier for the tweeter. Connect another cable between the jack marked LOW-OUT and the input of the power amplifier for the woofer. Set the slide-switch to the "THRU" position. Set the HIGH and LOW frequency LEVEL controls to their maximum clockwise positions. Set the HIGH and LOW frequency CUTOFF switches to the approximate crossover frequency desired, depending upon the particular speakers used. For more detailed information see below.

NOTE: The XO-1 does not incorporate a power switch since it is intended to be plugged into a "switched" auxiliary power outlet on one of the amplifiers. Some tuners also have such AC outlets.

CAUTION: DO NOT CONNECT THIS INSTRUMENT TO A DC (DIRECT CURRENT) LINE. SERIOUS DAMAGE TO THE POWER TRANSFORMER WILL RESULT. Do not attempt to operate the amplifier on a 25 cycle source, for it will not operate and the transformer will be damaged.

When plugged in, the three tube filaments should light. If they fail to light, check the steps outlined under "IN CASE OF DIFFICULTY".

Use the volume control on the preamplifier to set volume at the preferred level. Adjust the HIGH and LOW frequency LEVEL controls for the desired balance between high and low frequencies.

THRU-BYPASS switch: If desired, a single amplifier-speaker system may be operated from the BY-PASS OUT jack by placing the switch in the "BY-PASS" position. This feeds the input directly to this jack, by-passing the XO-1 filter circuits.

Setting of CUTOFF switches: Settings of these switches depend primarily upon the particular woofer and tweeter used. The best guide is the crossover frequency recommended by the speaker manufacturer. Alternatively, the crossover frequency to use may be determined roughly by knowing the response limits of the woofer and tweeter. For example, assume a tweeter having a rated response of "700 to 16,000 cycles". Immediately, we may assume that the response of

this tweeter does not extend below approximately 700 cycles; this sets the limit on the lowest cutoff frequency that may be used for the high-frequency channel. It also implies that the response of the woofer should extend as high as 700 cycles, not a difficult requirement for most woofers.

This example should serve in a general way to illustrate the relationship between the low-frequency limit of the tweeter, the high-frequency limit of the woofer and the crossover frequency used. It implies that the high and the low-frequency cutoffs should be equal (700 cycles), but this is not necessarily true. If, in our example, the treble response of the woofer happened to extend smoothly beyond 700 cycles, say to 2000 cycles, then the cutoff of the low-frequency channel could be increased to 2000 cycles, while the cutoff of the high-frequency channel remained at 700 cycles. This would represent an "overlap" in the overall response; both speakers would reproduce the range from 700 to 2000 cycles. The cutoff of the high-frequency channel could be advanced to 2000 cycles, too, whereupon there would be no overlap and we would have a simple crossover at 2000 cycles instead of 700. These are mentioned merely as examples of the many combinations of settings possible with the XO-1. With a given woofer-tweeter combination, there is generally a considerable latitude of permissible settings, and the setting which sounds best can only be determined by experimentation under existing room acoustic conditions. The fact that different cutoff frequencies may be used for the two channels is often an advantage. An overlapping crossover, as mentioned above, tends to give a smoother transition from woofer to tweeter, in the frequency region near crossover. This is particularly true where there is appreciable physical separation between woofer and tweeter. It also tends to accentuate those frequencies in the range of overlap, an effect which may be desirable under certain conditions or as a matter of personal preference.

It is also possible to so adjust the two cutoff frequencies as to produce a "gap" or "hole" at some point in the overall response. While this is not generally recommended, it could conceivably correct for a peak in the response of one of the speakers. Figure 16 illustrates these effects.

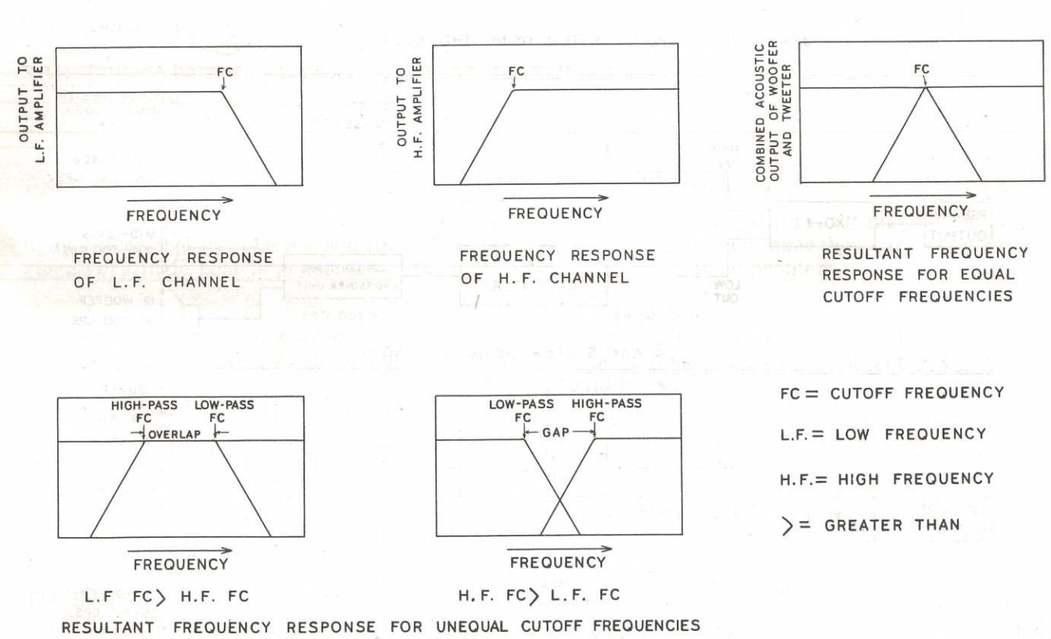
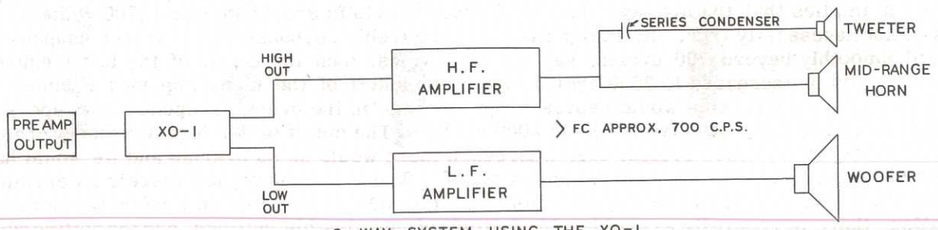
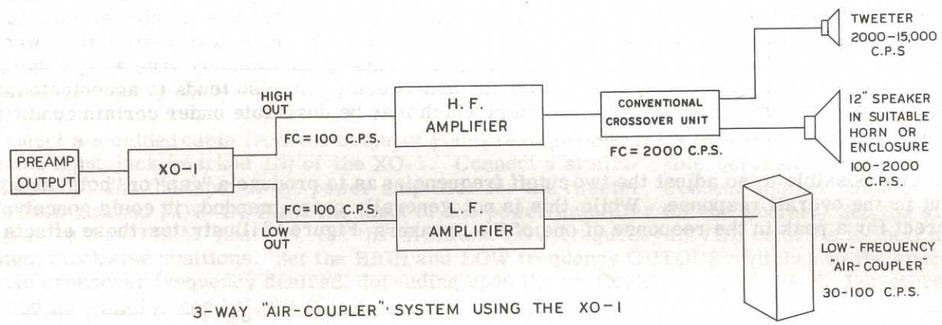


Figure 16

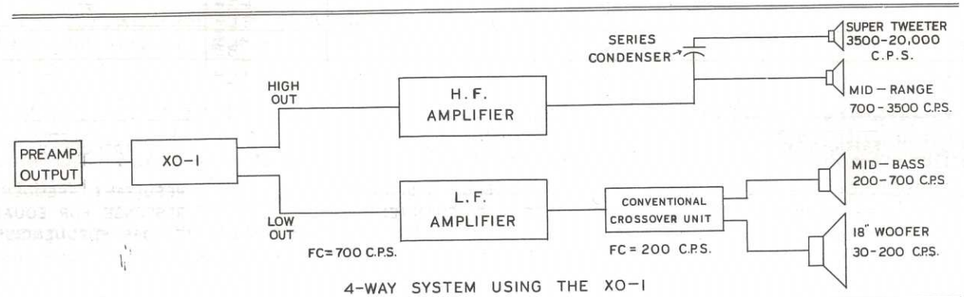
USE OF THE XO-1 IN THREE OR FOUR-WAY SYSTEMS: Figure 17 illustrates three suggested arrangements, in addition to the recommended connection in the case of the Heathkit SS-2 and SS-1B Speaker System. Note that in many cases the additional crossover device required can take the form of a simple capacitor; the XO-1 still performs the principal crossover function, thus retaining the advantages of electronic crossover.



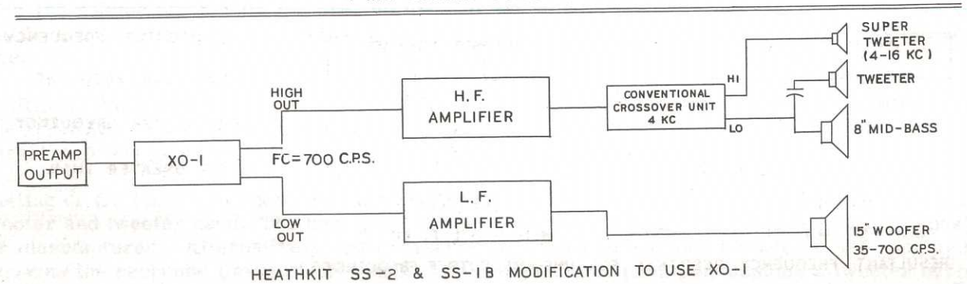
3-WAY SYSTEM USING THE XO-1



3-WAY "AIR-COUPLER" SYSTEM USING THE XO-1



4-WAY SYSTEM USING THE XO-1



HEATHKIT SS-2 & SS-1B MODIFICATION TO USE XO-1

Figure 17

IN CASE OF DIFFICULTY

Recheck the wiring. Trace each lead in colored pencil on the pictorial as it is checked in the unit. Most cases of difficulty result from wrong connections. Often having a friend check the wiring will reveal a mistake consistently overlooked.

If possible, compare the tube socket voltages with those given in the voltage chart below. Readings within 20% of those shown may be considered normal. If a discrepancy is noted, check the associated circuits carefully. Any component in those circuits should be suspected until proven satisfactory.

If only one of the channels in the XO-1 is defective, i. e., noisy or inoperative, reversing the two 12AX7 tubes in their sockets will indicate whether or not one of these tubes is at fault.

VOLTAGE CHART

SOCKET	TUBE TYPE	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8	PIN 9
D	12AX7	310	25*	67	Fil.	Fil.	220	0	1.5	Fil.
E	12AX7	310	65*	67	Fil.	Fil.	220	0	1.5	Fil.
F	6X4	260 A.C.		Fil.	Fil.		260 A.C.	335		

Filter Condenser ▲335 ■310

All voltages positive DC to chassis, measured with a Heathkit V-7 VTVM with 11 megohm input resistance.

Line Voltage: 117 volts AC.

Fil.: Voltage between points so designated, 6.3 volts AC.

*Will vary depending on impedance of voltmeter used.

PHYSICAL LOCATION OF THE XO-1

This crossover unit should preferably be located near the power amplifiers. It may be located in an out-of-the-way place since its controls do not require adjustment once they have been set. Since very little heat is generated in the unit, there is no ventilation problem.

REPLACEMENTS

Material supplied with Heathkits has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty tube or component. Should inspection reveal the necessity for replacement, write to the Heath Company and supply all of the following information:

A. Thoroughly identify the part in question by using the part number and description found in the manual parts list.
B. Identify the type and model number of kit in which it is used.
C. Mention the order number and date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

The Heath Company will promptly supply the necessary replacement. Please do not return the original component until specifically requested to do so. Do not dismantle the component in question as this will void the guarantee. If tubes are to be returned, pack them carefully to

prevent breakage in shipment as broken tubes are not eligible for replacement. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SERVICE

In event continued operational difficulties of the completed Crossover are experienced, the Heath Company is willing to offer its full cooperation to assist you in obtaining the specified performance level in your Crossover. You may contact the Technical Consultation Department by mail, or you may return your Crossover for inspection or repair by our Factory Service Department for a service fee of $4.00, plus the price of any additional material. In some areas, Local Service is available through authorized Heathkit Dealers. Although you may find charges for local service somewhat higher than those listed in Heathkit manuals (for factory service), the amount of increase is usually offset by the transportation charges you will pay if you elect to return your kit to the Heath Company. THESE SERVICE POLICIES APPLY ONLY TO COMPLETED INSTRUMENTS CONSTRUCTED IN ACCORDANCE WITH THE INSTRUCTIONS AS STATED IN THE MANUAL. Instruments that are not entirely completed or instruments that are modified in design will not be accepted for repair. Instruments showing evidence of acid core solder or paste fluxes will be returned NOT repaired.

For information regarding possible modifications of Heathkits, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although the Heath Company sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for specific purposes. Therefore, such modifications must be made at the discretion of the kit builder according to information which will be much more readily available from some local source.

SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

ATTACH A TAG TO THE INSTRUMENT GIVING NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. DO NOT SHIP IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Ship by prepaid express if possible. Return shipment will be made by express collect. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

SPECIFICATION CHANGES

All prices are subject to change without notice. The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold

WARRANTY

Heath Company warrants that for a period of three months from the date of shipment, all Heathkit parts shall be free of defects in materials and workmanship under normal use and service and that in fulfillment of any breach of such warranty, Heath Company shall replace such defective parts upon the return of the same to its factory. The foregoing warranty shall apply only to the original buyer, and is and shall be in lieu of all other warranties, whether express or implied and of all other obligations or liabilities on the part of Heath Company and in no event shall Heath Company be liable for any anticipated profits, consequential damages, loss of time or other losses incurred by the buyer in connection with the purchase, assembly or operation of Heathkits or components thereof. No replacement shall be made of parts damaged by the buyer in the course of handling or assembling Heathkit equipment.

NOTE: The foregoing warranty is completely void and we will not replace, repair or service instruments or parts thereof in which acid core solder or paste fluxes have been used.

HEATH COMPANY

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors		
1-1	2	47 Ω
1-9	2	1000 Ω
1-11	2	1500 Ω
1-16	1	4700 Ω
1-22	1	22 KΩ
1-25	2	47 KΩ
1-33	1	470 KΩ
1-101	2	1 megohm 5%
1-104	6	100 KΩ 5%
1-105	1	10 KΩ 5%
1-106	1	680 KΩ 5%
1-107	1	150 KΩ 5%
Capacitors		
20-35	1	910 μμf 5% mica
20-61	1	27 μμf 5% mica
20-62	1	45 μμf 5% mica
20-63	1	47 μμf 5% mica
20-64	1	120 μμf 5% mica
20-65	1	180 μμf 5% mica
20-66	1	220 μμf 5% mica
20-67	1	330 μμf 5% mica
20-68	1	390 μμf 5% mica
20-69	1	500 μμf 5% mica
20-70	1	1000 μμf 5% mica
20-71	1	1300 μμf 5% mica
20-72	1	2000 μμf 5% mica
20-73	1	3000 μμf 5% mica
20-74	1	4000 μμf 5% mica
23-28	3	.1 μf plastic molded paper
23-59	1	.05 μf plastic molded paper
23-73	1	.01 μf 5% plastic molded paper
23-74	1	.04 μf 5% plastic molded paper
25-4	2	10 μf tubular electrolytic
25-42	1	30-30 μf 350 volt electrolytic
Controls-Switches		
10-46	2	100 K controls
60-4	1	SPDT slide switch
63-116	1	Rotary switch HIGH CUTOFF
63-117	1	Rotary switch LOW CUTOFF
Transformer		
54-40	1	Power transformer

PART No.	PARTS Per Kit	DESCRIPTION
Connectors-Insulators-Sockets		
73-1	1	3/8" rubber grommet
73-3	1	1/2" rubber grommet
431-2	3	2-lug terminal strip
431-3	1	3-lug terminal strip
431-15	1	1-lug terminal strip
434-15	1	7-pin tube socket
434-16	2	9-pin tube socket
434-42	4	Phono connector socket
438-4	4	Phono plug
481-4	1	Electrolytic capacitor mounting wafer
Tubes		
411-26	2	Type 12AX7
411-64	1	Type 6X4
Sheet Metal Parts		
200-M102-F125	1	Chassis
205-M52	1	Bottom plate
90-47	1	Perforated cover
Wire-Sleeving		
344-1	1	Length hookup wire
340-2	1	Length bare wire
89-1	1	Line cord
346-1	1	Length insulated sleeving
343-3	1	Length shielded cable
Hardware		
250-2	6	3-48 screw
250-8	4	#6 sheet metal screw
250-9	17	6-32 screw
250-17	4	8-32 screw
250-52	8	4-40 pan head screw
252-1	6	3-48 nut
252-2	8	4-40 nut
252-3	19	6-32 nut
252-4	4	8-32 nut
252-7	4	3/8" control nut
253-10	4	Control washer
254-1	19	#6 lockwasher
254-2	4	#8 lockwasher
254-4	4	Control lockwasher
254-9	8	#4 lockwasher
260-11	4	Spring catch clip
262-4	4	Spring catch pin
Miscellaneous		
261-4	4	Rubber feet
462-19	2	Skirt knobs
462-38	2	Knobs
595-130	1	Manual