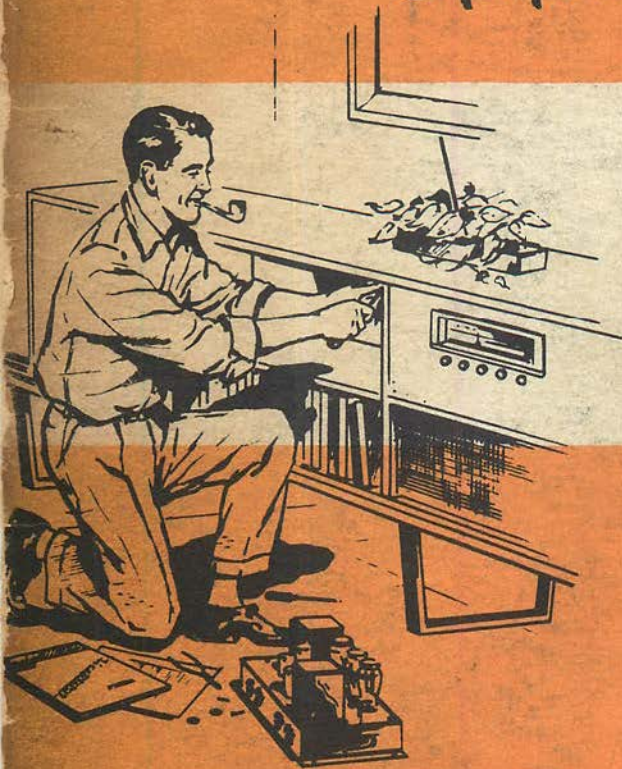


Klett

Heathkit

HIGH FIDELITY

Equipment



specifications
and schematics

HEATH COMPANY • BENTON HARBOR, MICHIGAN

A Subsidiary of Daystrom, Inc.

Heathkit

HIGH FIDELITY

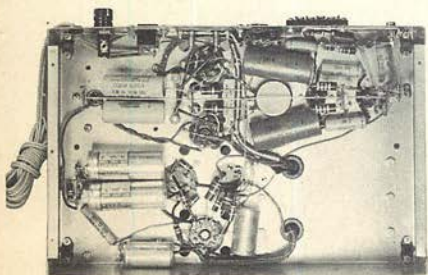
Equipment

Although physical appearance is important, and Heathkits are most attractively styled—looks, alone, do not tell the whole story where electronic equipment is concerned. It is important that the circuits and performance specifications of high fidelity equipment be considered before buying. Get all the facts—and examine them carefully.

This booklet has been prepared to give you the facts—the important particulars concerning high fidelity equipment available in kit form from the Heath Company. It provides a handy, pocket-sized reference for your use, and will answer questions pertinent to Heathkit design.

It has always been Heath Company policy to provide this information freely as a means of stimulating interest in the fine equipment we have to offer, and to remove the cloak of mystery that so often surrounds electronic equipment designs. Our objective is to produce the best possible kit-form equipment at the lowest possible cost to you. Perhaps this booklet will help you get to know Heathkits better.

THE HEATHKIT W-5M HIGH FIDELITY AMPLIFIER



SPECIFICATIONS

NOTE: There is, as yet, no general agreement for specifying amplifier performance. A cursory review of specifications may easily give a highly distorted picture of the characteristics of the amplifier. In general, it may be assumed that the most important specifications are those which are not shown.

At first glance, the specifications presented here may seem quite complex and possibly, confusing. We feel that it is necessary to provide you with complete and factual information about the Heathkit W-5M Amplifier. We urge your direct comparison of these figures against those for competitive amplifiers. It is our intention to furnish you with enough information to point up the fact that, in general, only the most optimistic technical information reaches the prospective buyer of high fidelity amplifiers.

The specifications below have been taken with the most modern and accurate test equipment available today. They are actual measurements taken on a typical amplifier, under carefully controlled conditions; not to present the most favorable advertising information, but in strict accordance with all generally accepted standard conditions. These conditions are listed at the end of this specification.

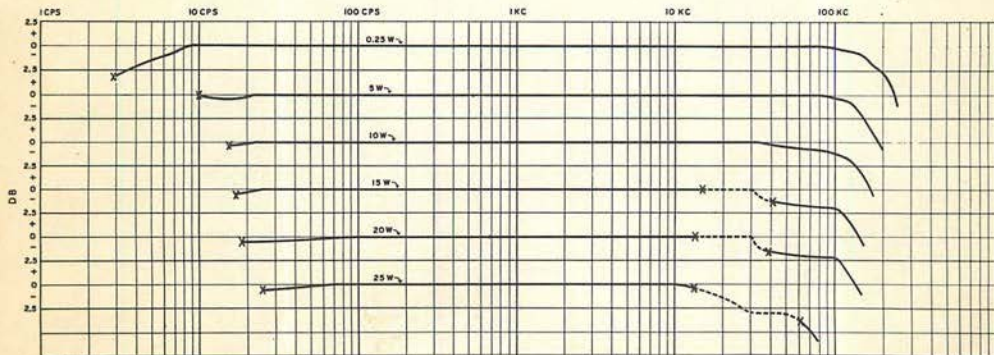
Minor variations from these specifications may be encountered in kit-assembled amplifiers. Such factors as exact lead placement, component variations and tube characteristics are possible sources of deviations. In a highly stabilized amplifier, such as the W-5M, these variables may be disregarded from a performance point of view.

POWER OUTPUT:

Rated Power..... 25 watts
 Maximum Average Power.....32.5 watts
 Peak Power..... 47.2 watts
 Power Output Related to Frequency..... See Figure 1.

Please note that on the 15, 20 and 25 watt curves, portions of the characteristic have been broken. Power measurements cannot be considered valid in this region because they were made with meters calibrated to RMS values. Waveform distortion in the broken areas was sufficient to invalidate such readings.

On the power curves, asterisks have been used to designate overload points at both low and high frequency limits.



HEATHKIT W-5M POWER RESPONSE

Figure 1

One of the outstanding features of the W-5M is the remarkable low frequency power response. Observe that the 0.25 watt curve extends smoothly to 3 cps and is only down 3 db at this point. Also, note that it is possible to obtain 20 watts of power at 20 cps without overloading. In conventional amplifiers, low frequency response at low levels has been sadly lacking. At high levels these amplifiers tend to go into overload and block on heavy bass passages. Because of the unique output transformer design featured in the W-5M, low frequency power response is greatly improved. Special attention has been given to the problem of overload recovery. (See "Overload Recovery" on Page 7.)

FREQUENCY RESPONSE:

See Figure 2 below. This curve was taken at 1 watt reference output and may be considered as the voltage response of the the amplifier.



Figure 2 HEATHKIT W-5M FREQUENCY RESPONSE (1 WATT OUTPUT)

An outstanding characteristic of the W-5M amplifier is the complete absence of the rising response at the low and high limits of the pass band which has been considered a necessary evil up to the present time. Although outside the audible range, such humps add to the instability of the amplifier and tend to create distortion in the audio range. This happens when low frequency transients, such as turntable rumble, line voltage surges or tuning thumps, drive the amplifier into low-frequency overload. In the W-5M, these transients cannot create any audible distortion and no hangover or "breathing" conditions are evident.

The curve in Figure 2, taken at 1 watt output and the 5 watt curve in Figure 1, represent average room listening levels. In this amplifier, a minimum of 500% reserve power is available to accommodate heavy bass passages and to make up for the relative inefficiency of less expensive speaker systems.

HARMONIC DISTORTION:

Figure 3 below gives five curves which relate the total harmonic distortion to power output throughout the frequency range. From these curves it becomes evident that specifying total harmonic distortion at any power level without designating the test frequency can be very misleading.

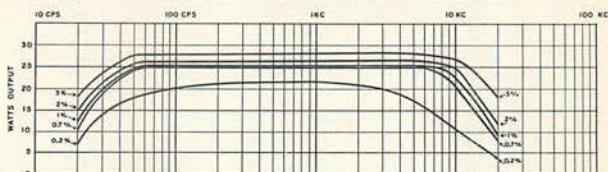


Figure 3 HEATHKIT W-5M TOTAL HARMONIC DISTORTION (DETERMINANT: DISTORTION)

Competent authorities seem to agree that a total of 2% harmonic distortion is tolerable for musical reproduction through wide-range audio equipment. Harmonic distortion below 0.7% is completely imperceptible, even to highly trained critical observers. Curves showing the output obtainable at these distortion levels throughout the frequency range have been included above.

Figure 4 indicates the distortion versus frequency curves for several power levels.

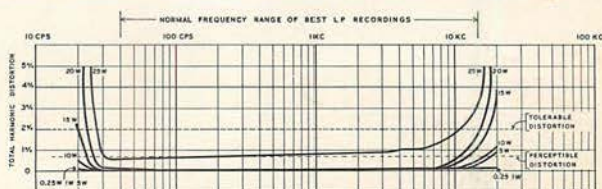


Figure 4 HEATHKIT W-5M TOTAL HARMONIC DISTORTION (DETERMINANT: POWER OUTPUT)

INTERMODULATION DISTORTION:

Intermodulation distortion curves for three separate test conditions are plotted in Figure 5. Please observe that, again, the generally accepted limits for "extremely high fidelity" amplifiers and "high fidelity amplifiers" have been added to the graph. The W-5M amplifier will supply over 20 watts of power under any one of the three test conditions before its intermodulation distortion exceeds the "extremely high fidelity" requirements.

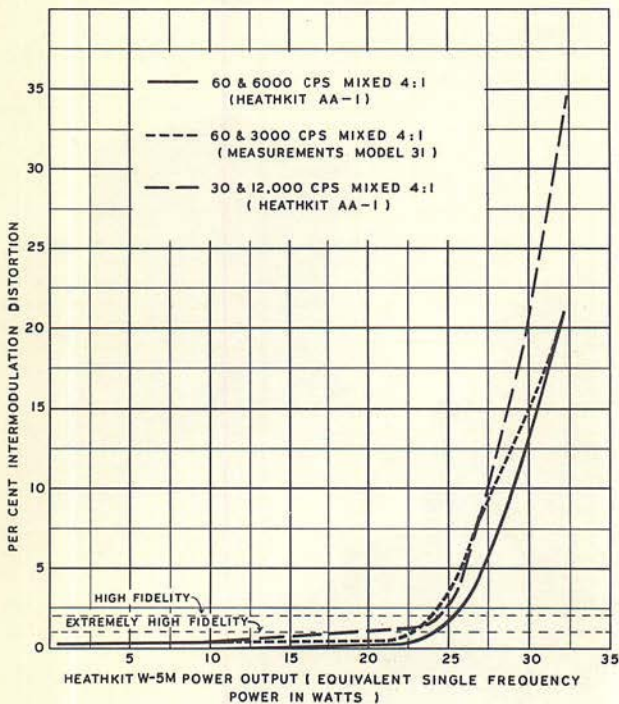


Figure 5

PHASE SHIFT:

See Figure 6 below, which is self-explanatory.

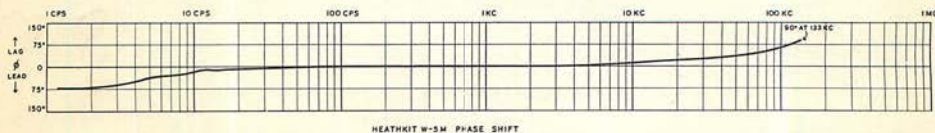
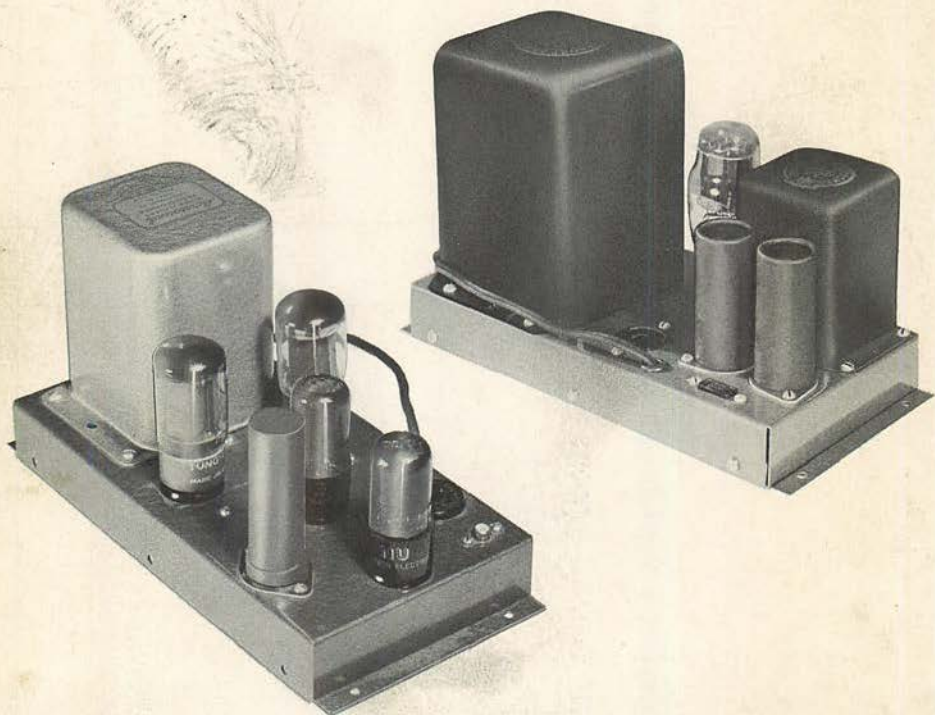


Figure 6

A phase shift of 75° occurs at 1.2 cps. It was impossible to locate the 90° leading point, since it occurs below the pass-band of the amplifier. Note also that the phase shift occurs gradually throughout the frequency range, rather than quite abruptly as is generally true of amplifiers with heavy feedback. This contributes further to the stability of the amplifier.

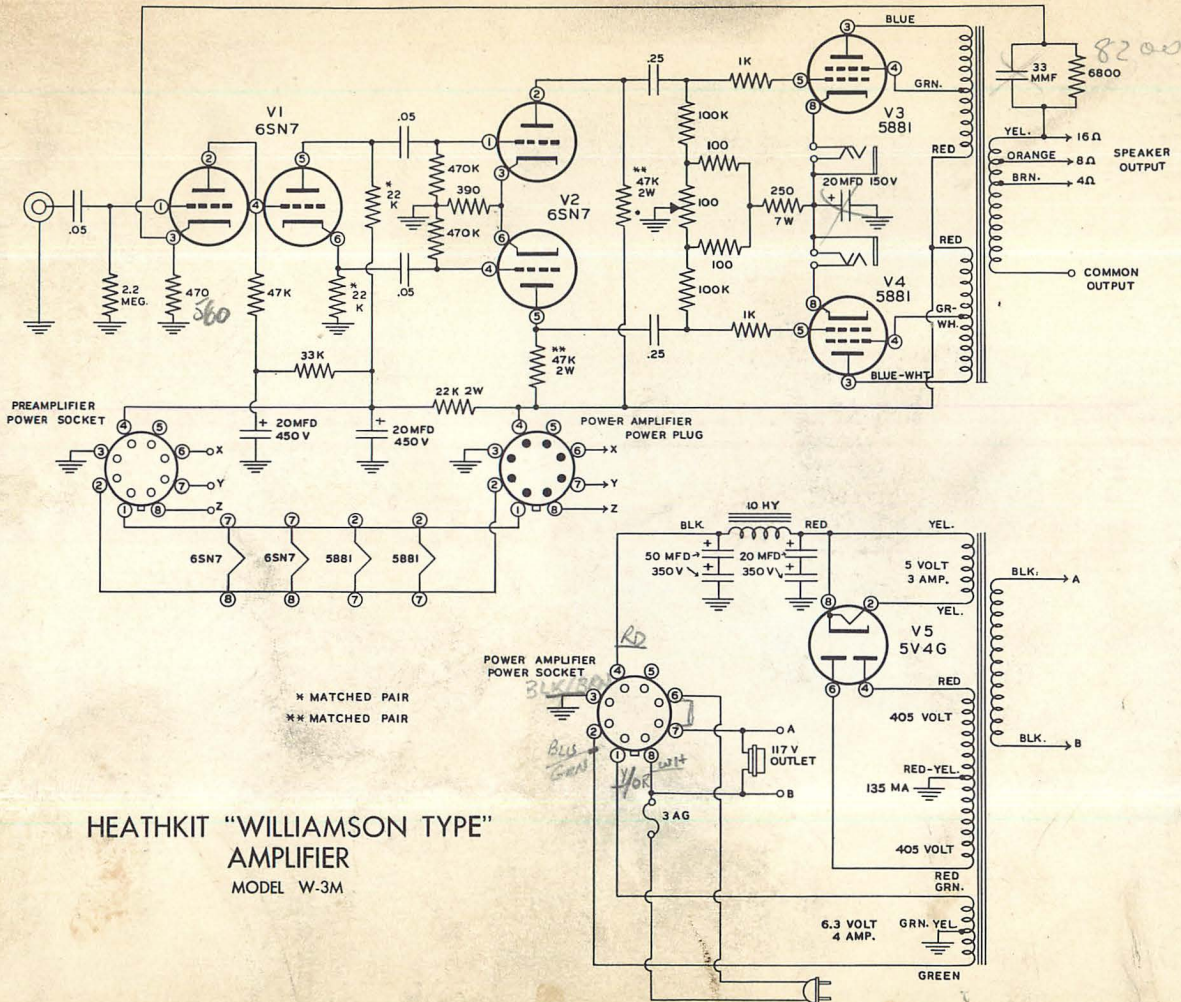
HEATHKIT "WILLIAMSON TYPE" AMPLIFIER

MODEL W-3M



TECHNICAL SPECIFICATIONS

Tube Complement.....	2 - 6SN7GT, 2 - 5881, 1 - 5V4G
Frequency Response.....	within 1 db from 10 cycles to 100 KC
Harmonic Distortion at 5 watt output.....	less than 0.5% between 20 cycles and 20 KC
IM Distortion at 5 watt equivalent output.....	0.5% using 60 and 3000 cycles
Output Impedance.....	4, 8 or 16 ohms
Input Voltage for 5 watt output.....	75 volts across 2.2 megohms
Power Requirements.....	105-125 volts 50/60 cycles 120 watts
Overall Dimensions (each unit).....	7" high x 5 1/2" wide x 11" long

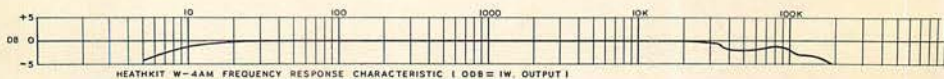


HEATHKIT WILLIAMSON-TYPE AMPLIFIER MODEL W4-AM



SPECIFICATIONS

Power Output: 20 watts at 1,000 cycles with less than 1% total harmonic distortion.
Maximum output; 27 watts. Peak power output; 36 watts.
Frequency Response: . . Curve below was taken at 1 watt output:



Harmonic Distortion: . .

	Test Frequency		
	1000 cps	20 cps	10,000 cps
At 0.25 watts:	0.06%	0.08%	0.07%
At 20 watts:	0.15%	1.4%	0.94%

Phase Shift: 30 degrees leading at 15 cps, 30 degrees lagging at 38.5 kc.
90 degrees leading at 4 cps, 90 degrees lagging at 136 kc.

ASSEMBLY AND OPERATION OF THE HEATHKIT PREAMPLIFIER

MODEL WA-P2



SPECIFICATIONS

INPUTS:

Three high-level and two low-level inputs; individual level controls for each.

High-level inputs, 1, 2 and TUNER, for 0.1 volts or higher; 0.5 megohm input impedance.

Low-level inputs, PHONO and MIC, for 0.1 volts or lower; phono input impedance normally 22 K Ω for magnetic phono pickup; microphone input impedance 2.2 megohms.

OUTPUTS:

Two: Output to main amplifier variable 0 to at least 2.5 volts RMS from any normal program source; full control of input selection, volume, phono compensation and tone balance, cathode follower output; recommended load impedance 200 K Ω or higher shunted by .007 μ fd or less; up to 100 feet of shielded microphone cable, or up to 200 feet of RG-58-AU coaxial cable, may be used between preamplifier and main amplifier with not more than 3 db loss at 10,000 cps.

Output to recorder input providing minimum of 0.25 volts RMS from any normal program source; full control of input selection, phono compensation and individual input level, but independent of volume control or tone controls; cathode follower output with same characteristics as output to main amplifier input.

GAIN:

High-level inputs:

0.05 volt input produces 0.5 volt RMS output

0.09 " " 1.0 "

0.14 " " 1.5 "

0.18 " " 2.0 "

0.23 " " 2.5 "

Low-level inputs:

1.4 millivolts input produces 0.5 volt RMS output

2.5 " " 1.0 "

3.6 " " 1.5 "

4.9 " " 2.0 "

6.2 " " 2.5 "

Measurements made at 1000 cps with LEVEL and VOLUME controls set for maximum gain.

FREQUENCY RESPONSE:

1.0 db from 25 cps to 30,000 cps

1.5 db from 15 cps to 35,000 cps

Measurements made through MIC input, tone controls set for flat response at 100, 1000 and 10,000 cps. (See Figure 2.)

HARMONIC DISTORTION:

At 2.5 volts RMS output, total measured harmonic distortion (not corrected for source distortion) is:

Input	20 cps	1000 cps	10,000 cps	20,000 cps
0.5 v at TUNER	0.63%	0.17%	0.33%	0.47%
6 mv at PHONO	1.15%	0.46%	0.54%	0.66%
15 mv at MIC	0.35%	0.26%	0.42%	0.48%
Source distortion from generator	0.74%	0.22%	0.22%	0.24%

NOTE: Where source distortion is greater than measured distortion, it is assumed that certain cancellation effects are responsible.

INTERMODULATION DISTORTION:

Measured at 60 and 7000 cps with 4:1 ratio; tone controls at flat, volume at maximum, output level controlled by adjusting LEVEL control.

Output Voltage (RMS)	MIC Input	TUNER Input
0.5	0.48%	0.2%
1.0	0.50	0.3
1.5	0.50	0.4
2.0	0.55	0.59
3.0	0.70	0.77
4.0	0.88	0.98
5.0	1.1	1.2

HUM AND NOISE:

0.5 volt at TUNER input 72 db below 2.5 volts RMS

6 mv at PHONO input 62 db below 2.5 volts RMS

15 mv at MIC input 70 db below 2.5 volts RMS

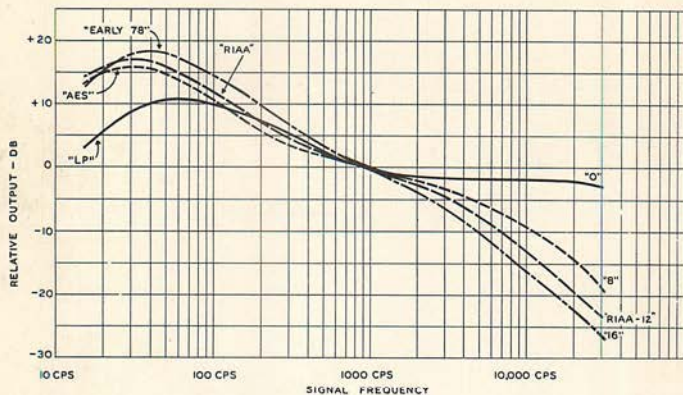
Measured with tone controls set for flat response at 100, 1000 and 10,000 cps; volume control at maximum gain; turnover control at LP; rolloff control at 0; power cord polarized

for minimum hum; hum balance control set for minimum hum in PHONO input position; LEVEL control adjusted for 2.5 volts RMS output at input voltage shown.

PHONOGRAPH:

COMPENSATION: Low-frequency compensation provided by four-position TURNOVER control. See Figure 1 for curves.

High-frequency compensation provided by four-position ROLLOFF control. See Figure 1 for curves.



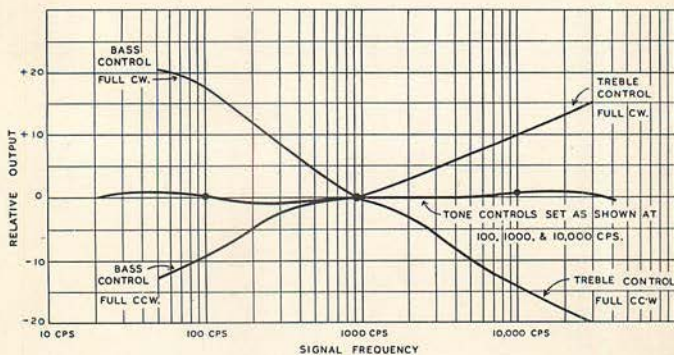
PHONOGRAPH EQUALIZER CURVES

(TURNOVER CURVES TAKEN WITH ROLLOFF SET AT 0)

(ROLLOFF CURVES TAKEN WITH TURNOVER SET AT LP)

TONE CONTROL:

Separate bass and treble tone controls. Bass control provides approximately 18 db boost and 12 db cut at 50 cps. Treble control provides approximately 15DB boost and 20 db cut at 15,000 cps. See Figure 2 for curves.

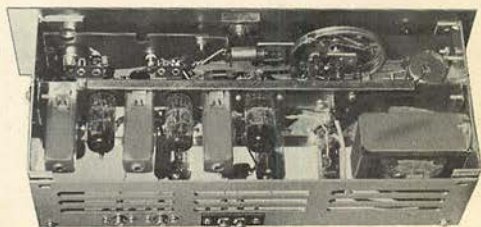
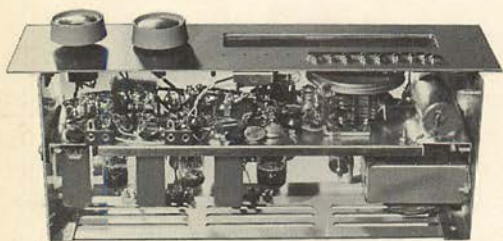
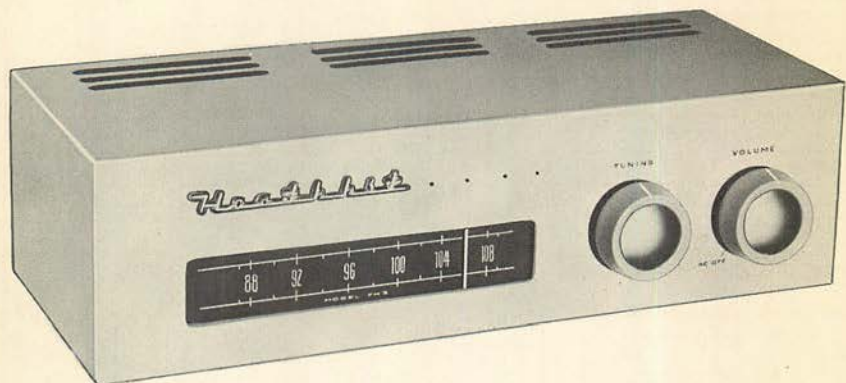


FREQUENCY RESPONSE AND TONE CONTROL CURVES

(BASS CURVES TAKEN WITH TREBLE CONTROL AT FLAT)

(TREBLE CURVES TAKEN WITH BASS CONTROL AT FLAT)

ASSEMBLY AND OPERATION OF THE HEATHKIT MODEL FM-3 FREQUENCY MODULATION TUNER



SPECIFICATIONS

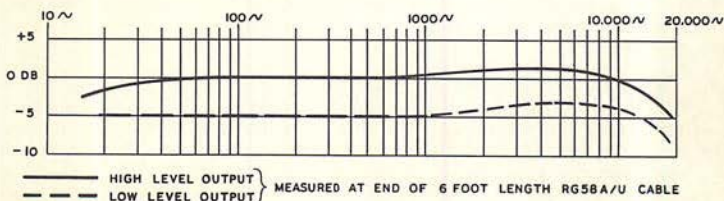
Tuning Range:..... 88-108 mc
 IF Frequency:.....10.7 mc
 Antenna Input Impedance:..... 300 Ω
 Output Impedance:
 Fixed Output..... 47 K Ω
 Variable Output.....15 K Ω
 Output Voltage: (30% modulation at 100 μ v input)
 Fixed Output.....0.12 volts
 Variable Output.....1.5 volts
 400 Cycle Distortion (Aligned):

Deviation	100 μ volts			1000 μ volts			100,000 μ volts		
	A	B	C	A	B	C	A	B	C
± 75 kc	2.5%	1.3%	1.2%	1.5%	0.3%	1.2%	2%	0.3%	1.7%
± 22.5 kc	1.2%	1.1%	0.1%	1%	0.9%	0.1%	0.8%	0.8%	0

A = total measured distortion, B = distortion indication with no modulation (source and tuner noise), C = signal distortion.

20db Quieting Sensitivity: 88 mc..... 8 μ volts 98 mc..... 10 μ volts 108 mc..... 15 μ volts	UNALIGNED	ALIGNED 5 μ volts 8 μ volts 9 μ volts
--	------------------	---

Frequency Response: (at end of 6' length of RG58A/U cable):



OVERALL CORRECTED FREQUENCY RESPONSE HEATHKIT FM-3 FM TUNER

Tube Complement:..... 1 - 6X4 rectifier
 1 - 6BQ7A cascade type RF amplifier
 1 - 6U8 oscillator-mixer
 2 - 6CB6 IF amplifier
 1 - 6AL5 ratio detector
 1 - 6C4 audio amplifier
 Power Requirements..... 105-125 volts 50-60 cycles AC 35 watts
 Dimensions Overall..... 12 9/16" long x 3 5/8" high x 5 7/8" deep
 Net Weight..... 5 lbs. 1 oz.
 Shipping Weight..... 7 lbs.

NOTE: Measurements given above were taken on representative tuners. Variations from these measurements are to be expected due to normal production deviations in components, lead placement during wiring and similar changes. The following instruments were used during tests:
 Measurements Corporation 78 FM Signal Generator, Krohn-Hite 430-A Audio Oscillator
 Heathkit HD-1 Harmonic Distortion Analyzer

CONDITIONS: 78 FM generator terminated with 150 Ω resistors between output terminals and FM-3 input terminals to properly match impedance. Line voltage, 117 volts 60 cycles AC. Measurements taken from high level output with input frequency 98 mc unless otherwise stated.

FEATURES

Most commercial high fidelity FM tuners conform to a definite circuit configuration and general performance figures are much the same for all of them. Fine performance is obtainable from these tuners, but the numerous tubes and complex circuits tend to make them prohibitively expensive. With a few exceptions, the limiter-discriminator type of tuner is almost universally used. Unfortunately, the wide use of this type circuit seems to have put an unfair stigma against other types, even though they are capable of equal or superior performance.

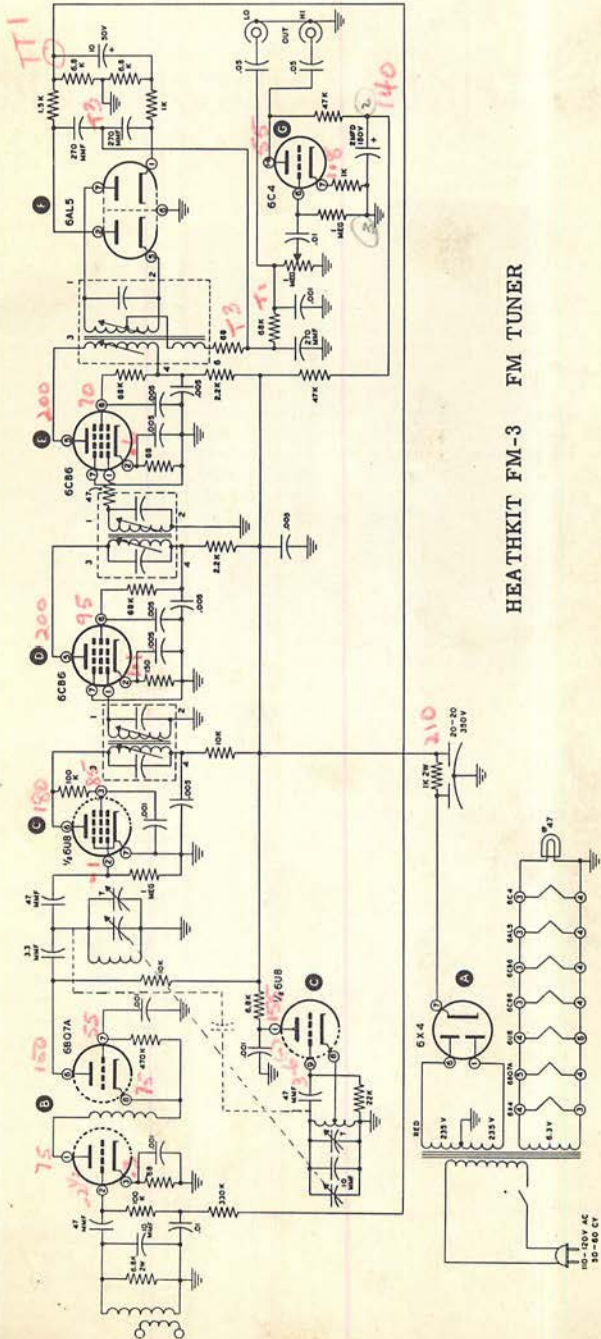
A ratio detector is used in the Heathkit FM-3 FM Tuner, for it is simple, inexpensive and easy to align. The ratio detector is capable of excellent performance and has the advantage of being self AM limiting, eliminating the need for two limiter stages. This design economy seems to have made some high fidelity enthusiasts suspicious of the circuit, without good reason for this feeling. An advantage is gained by not using limiters, since the "limiting threshold" is eliminated. Weak FM stations cannot overcome this threshold and so are heard highly distorted and with high background noise. Obviously, these stations cannot be enjoyed and the usefulness of the tuner is limited to stronger stations, although the tuner may be specified as 5 microvolts for 30 db quieting. The standard type of discriminator is sensitive to AM and if the limiters do not remove all AM from the IF carrier, severe distortion and high noise levels will result. Performance of the ratio detector on strong stations is much the same as the widely used detector circuit, but is substantially superior on weak stations which are received at a signal strength roughly equivalent to the specified sensitivity of the tuner. Of course noise levels will rise with very poor signals, but the accompanying distortion does not occur until the signal becomes too weak to be useful at all.

The only disadvantage of the ratio detector is that the audio output is dependent on signal strength to some extent. It is for this reason that a volume control is used on the FM-3 tuner. AGC voltage taken from the detector to the RF amplifier helps to even out the response to weak and strong signals so that the variations are not very noticeable except in the case of extremely weak stations.

High gain tubes are used in the IF and mixer stages of the tuner to give high sensitivity and to aid the detector in its function. A high gain, low noise cascode type RF amplifier is used for the same reason, as well as to isolate the local oscillator from the antenna. Loading and "pulling" of the oscillator by the antenna circuit is minimized in this manner and external radiation from the oscillator is substantially reduced.

An audio amplifier stage is an added advantage, since it provides adequate output to drive any amplifier system regardless of sensitivity and also can drive high impedance earphones for private listening. A fixed level output direct from the detector is available for those who prefer to control the audio system at the preamplifier only.

Sensitivity of the Heathkit FM-3 tuner is high enough that very satisfactory performance will be obtained with an indoor antenna made up of 300 Ω twin lead, if reasonable signal strength is prevalent in the area. Best "fringe" performance will be obtained with an outdoor type of antenna as discussed in the manual.



HEATHKIT AUDIO AMPLIFIER

MODEL A-9B



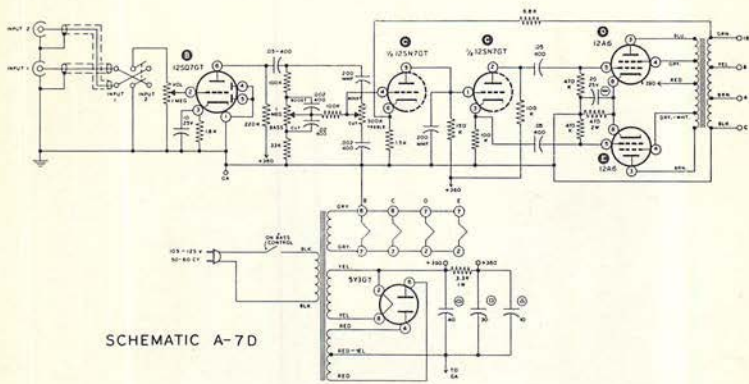
SPECIFICATIONS

Frequency Response.....	±1 db 20 to 20,000 cps
Power Output.....	20 watts
Total Harmonic Distortion.....	1% (at rated output)
Input Requirements (for 15 watts output)	
Magnetic Phono Input.....	0.007 volts
Microphone Input.....	0.01 volts
Crystal Phono Input.....	0.08 volts
Tuner Input.....	0.6 volts
Tone Controls	
Bass (at 30 cps).....	15 db boost, 15 db cut
Treble (at 15 kc).....	15 db boost, 20 db cut
Power Requirements.....	100 watts, 105-125 volts 50/60 cycle AC
Tube Complement.....	12AX7 magnetic phono preamplifier and input amplifier 12AU7 voltage amplifier and tone control amplifier 12AU7 voltage amplifier and phase splitter Two 6L6G push-pull pentode power amplifiers 5V4G Rectifier
Dimensions.....	14" x 8 7/8" x 7 3/8" high
Shipping Weight.....	23 lbs.

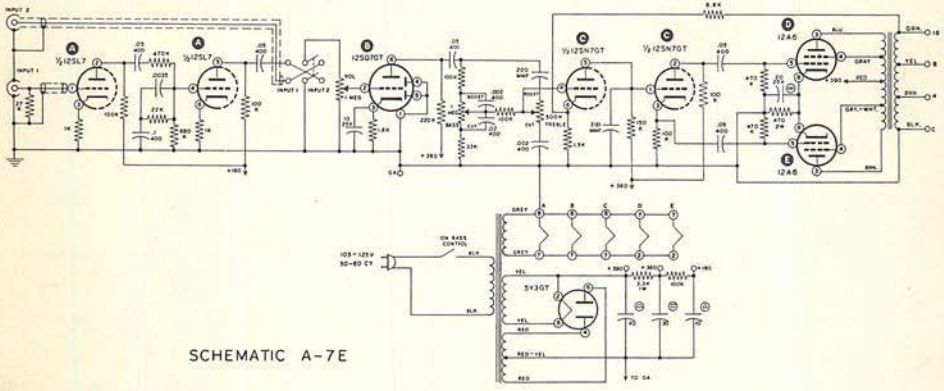
HEATHKIT AUDIO AMPLIFIER



MODELS A-7D AND A-7E



SCHEMATIC A-7D



SCHEMATIC A-7E

ASSEMBLY AND OPERATION OF THE HEATHKIT AUDIO ANALYZER MODEL AA-1



SPECIFICATIONS

Frequency Response:

AC VTVM.....	10 cycles to 100 kc ± 1 db.
Wattmeter	10 cycles to 50 kc ± 1 db.
I.M. Analyzer High Pass Filter.....	2000 cps to 12000 cps.
I.M. Analyzer Low Pass Filter	10 cps to 600 cps.

Sensitivity:

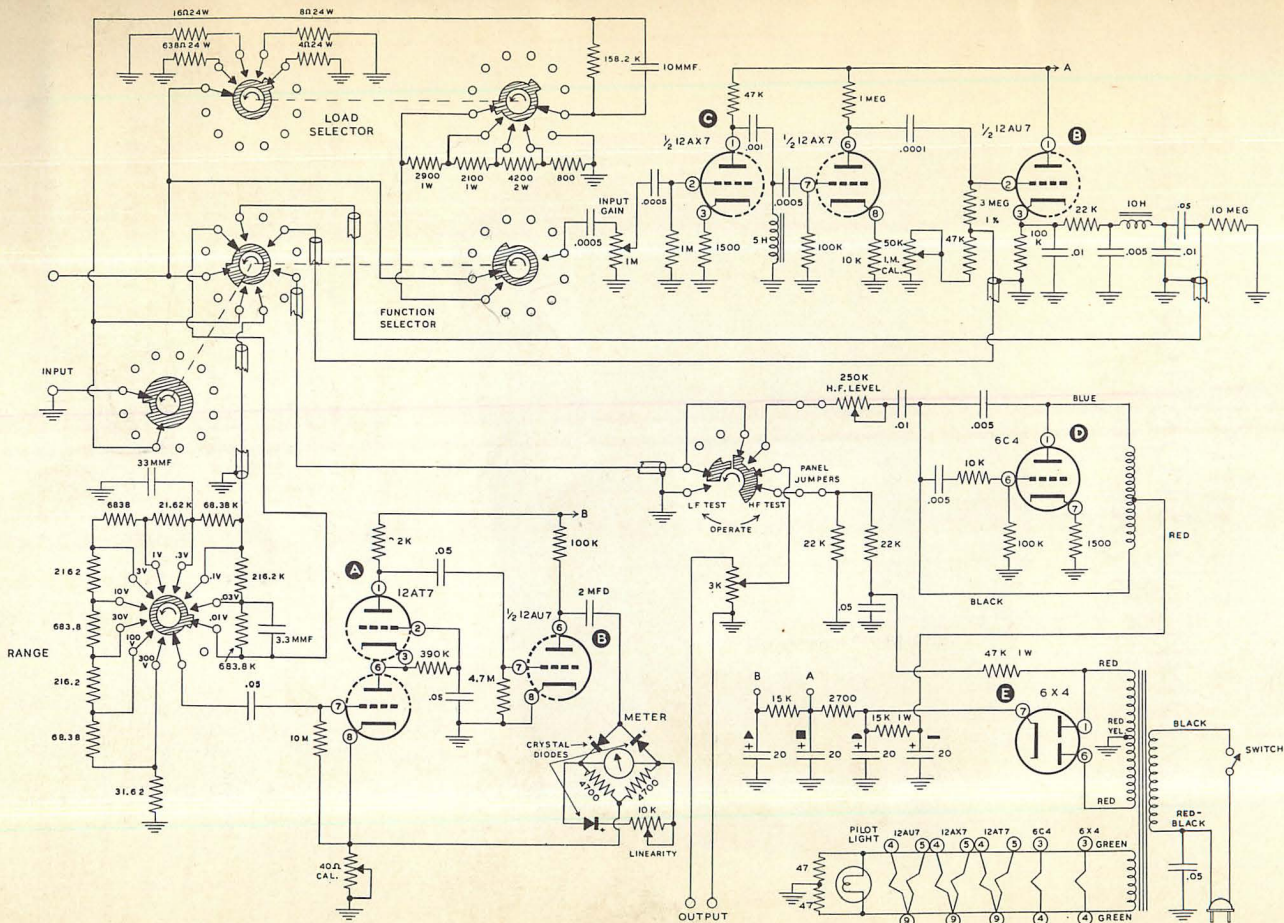
AC VTVM.....	10 millivolts full scale maximum.
Wattmeter15 milliwatts full scale maximum.
I.M. Analyzer04 volts minimum high frequency signal required or .17 volts of LF and HF energy mixed 4:1.

Range:

AC VTVM.....	.01, .03, .1, .3, 1, 3, 10, 30, 100, 300 volts RMS full scale.
DBM.....	-40, -30, -20, -10, 0, +10, +20, +30, +40, +50 reads from -65 to +52 dbm.
Wattmeter15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w, 150 w full scale. Maximum continuous power 25 watts, intermittent power to 50 watts.
I.M. Analyzer	1%, 3%, 10%, 30%, 100% full scale.

Input Impedance:

AC VTVM.....	1 megohm or 4, 8, 16 or 600 Ω , switch selected.
I.M. Analyzer	1 megohm or 4, 8, 16 or 600 Ω , switch selected.
Wattmeter	4, 8, 16 or 600 Ω internal load, 10,000 Ω across external load.



HEATHKIT AUDIO ANALYZER MODEL AA-1

HEATHKIT HARMONIC DISTORTION METER MODEL HD-1



SPECIFICATIONS

Frequency.....	20 cycles to 20,000 cycles in three ranges
Distortion.....	0-1, -3, -10, -30, -100% full scale
Voltmeter.....	0 - 1 - 3 - 10 - 30 volts full scale
Input Resistance.....	300 K Ω
Minimum Input Voltage for Distortion Measurement.....	.03 volts
Output Voltage for Monitoring.....	2.5 volts at full scale meter reading
Accuracy:	
Voltmeter.....	$\pm 5\%$ of full scale
Distortion.....	$\pm 5\%$ of full scale, $+0.1\%$
Tube Complement.....	OA2, 6X4, 5879, 12AT7, 12AX7, 12BY7
Power Requirements.....	105-125 volts 50/60 cycles, 30 watts
Dimensions.....	13" wide x 8 1/2" high x 7" deep
Net Weight.....	11 lbs.
Shipping Weight.....	13 lbs.

*The World's Finest
Electronic Equipment in Kit Form*



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