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The McIntosh compact Family



The MR 500 Digital FM Tuner complements the performance and appearance of all McIntosh products. It is specifically designed to match the industry's leading compacts — the McIntosh MC 502 Power Amplifier and the McIntosh C 504 Preamplifier. Separate, flexible McIntosh quality components that are particularly useful where space is limited.

MR 500 DIGITAL FM TUNER

The MR 500 FM Tuner is designed to perform to its specifications for many years. If you have any questions, please contact:

CUSTOMER SERVICE

McIntosh Laboratory Inc.
2 Chambers Street
Binghamton, New York 13903-9990
Phone: 607-723-3512

**Take Advantage of 3 years of
Contract Service...
Fill in the Application NOW.**

McINTOSH THREE YEAR SERVICE CONTRACT

An application for A THREE YEAR SERVICE CONTRACT is included with this manual. The terms of the contract are:

1. McIntosh will provide all parts, materials and labor needed to return the measured performance of the instrument to the original performance limits. Because battery life is dependent on conditions over which McIntosh has no control, they are not covered under the service contract, nor is any shipping cost to and from the authorized service agency or the factory.
2. Any McIntosh authorized service agency will repair McIntosh instruments at normal service rates. To receive service under the terms of the SERVICE CONTRACT, the SERVICE CONTRACT CERTIFICATE must be presented when the instrument is taken to the service agency.
3. Always have service done by a McIntosh authorized service agency. If the instrument is modified or damaged as a result of unauthorized repair, the SERVICE CONTRACT will be cancelled. Damage by improper use or mishandling is not covered by the SERVICE CONTRACT.
4. The SERVICE CONTRACT is issued to you as the original purchaser. To protect you from misrepresentation, this contract cannot be transferred to a second owner.
5. To receive the SERVICE CONTRACT, your purchase must be made from a McIntosh franchised dealer.
6. Your completely filled in application for the SERVICE CONTRACT must be post-marked within 30 days of the date of purchase of the instrument.
7. To receive the SERVICE CONTRACT, all information on the application must be filled in. The SERVICE CONTRACT will be issued when the completely filled in application is received by McIntosh Laboratory Incorporated in Binghamton, New York.
8. Units in operation outside the United States and Canada are not covered by the McIntosh Service Contract, irrespective of the place of purchase. Nor are units acquired outside the U.S.A. and Canada, the purchasers of which should consult with their dealer to ascertain what, if any, service contract or warranty may be available locally.

Installation



any position. The recommended minimum space for adequate ventilation is 17 inches (43.2 cm) wide, and 4 1/2 inches (11.4 cm) high, 15 inches (38.1 cm) deep.

To install the instrument in a McIntosh cabinet, follow the instructions that are enclosed with the cabinet. For any other type of installation follow these instructions:

1. Unpack from carton

Open the carton and remove the PANLOC brackets, hardware package, and mounting template from the carton. Remove the MR 500 from its plastic bag and place it upside down on the shipping pallet; then unscrew the four plastic feet from the bottom of the chassis.

2. Mark the cabinet panel

Place the mounting template in the position on the cabinet panel where the instrument is to be installed, and tape it in place. The broken lines that represent the outline of the rectangular cutout also represent the outside dimensions of the chassis. Make sure these lines clear shelves, partitions, or any equipment. With the template in place, first mark the six A and B holes and the four small holes that locate the corners of the cutout. Then, join the four corner markings with pencil lines, using the edge of the template as a straightedge.

3. Drill Holes

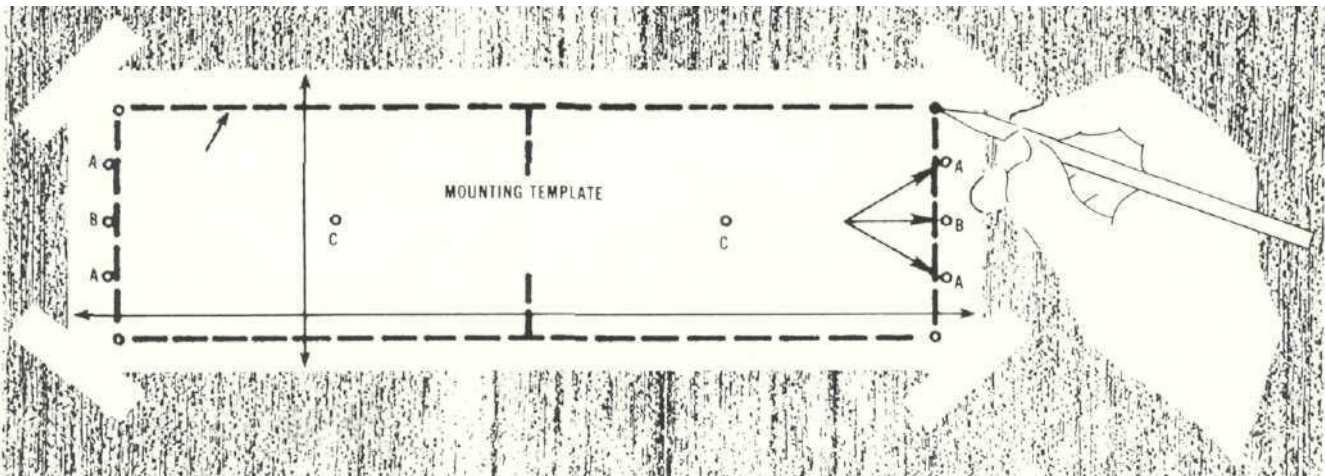
Use a drill with a 3/16 inch (5 mm) bit held perpendicular to the panel and drill the six A and B holes. Then, using a drill bit slightly larger than the tip of your saw blade, drill one hole at each of two diagonally opposite corners. The holes should barely touch the inside edge of the penciled outline. **Before taking the next step, make sure that the six A and B holes have been drilled.**

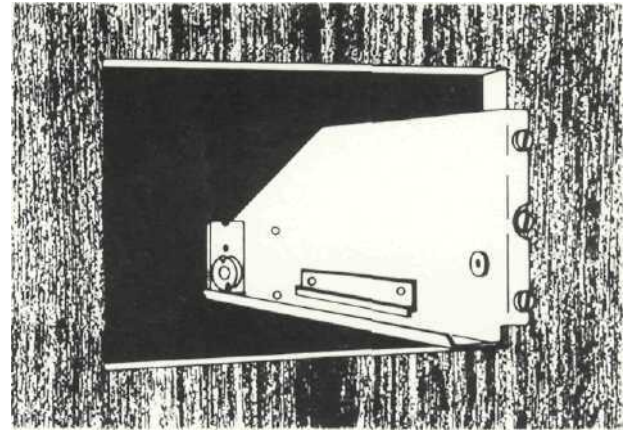
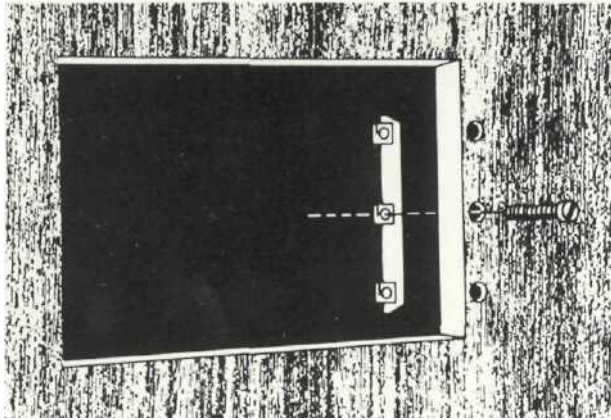
4. Saw the Panel Cutout

Saw carefully on the inside of the penciled lines. First make the two long cuts and then the two short cuts. After the rectangular opening has been cut out, use a file to square the corners and smooth any irregularities in the cut edges.

The PANLOC system of installing equipment conveniently and securely is a product of McIntosh research. By depressing the two PANLOC buttons on the front panel, the instrument can be either locked firmly in place or it can be unlocked so that the chassis can slide forward, giving you easy access to the top and rear panels.

The trouble-free life of an electronic instrument is greatly extended by providing sufficient ventilation to prevent the build-up of high internal temperatures that cause deterioration of component parts. You should allow enough clearance so that cool air can enter at the bottom of the cabinet and be vented from the top. With adequate ventilation the instrument can be mounted in





5. Install the Mounting Strips

In the hardware package you will find two mounting strips and two sets of machine screws. For panels that are less than 1/2 inch (12.7 mm) thick, use the 3/4 inch (19.1 mm) screws; for panels that are more than 1/2 inch (12.7 mm) thick, use the 1 1/4 inch (31,8 mm) screws.

Starting at the right-hand side of the panel, insert a screw of proper length into the center hole in the panel, marked B on the template. On the back of the panel, align a mounting strip with the holes in the panel and tighten the screw in the center hole until the screwhead is pulled slightly into the wood.

Repeat this procedure to attach the mounting strip to the left side of the panel.

6. Attach the PANLOC Brackets

Use two screws of the proper length in the A holes on each side, attach the PANLOC brackets to the cabinet panel; the short flange is mounted against the front (face) of the cabinet panel. The screws pass through the PANLOC bracket flange, the cabinet panel, and then through the mounting strips previously mounted.

7. Install the Instrument

Guide the AC power cord through the panel opening to the back of the cabinet. Then, slide the instrument into the opening, carefully, so that the rails on the bottom of each side of the chassis engage the tracks on the mounting brackets. Continue to slide the instrument into the cabinet until it is stopped by the adjust position latches. Press the latches inward, this permits the instrument to slide into the cabinet until its front panel is flush with the cabinet panel. Depress the PANLOC buttons at the lower left and right corners of the instrument panel to lock the unit firmly in the cabinet. Depressing the PANLOC buttons again will unlock the instrument so that it can slide to the adjust position; if you press inward on the adjust position latches then you can remove the instrument from the cabinet.

Back Panel Connections and Controls

Use of the back panel connections and controls will be described from right to left when looking at the back panel.

MANUAL AFL

Automatic Frequency Lock (AFL) is a McIntosh design which assures that the station remains ideally tuned regardless of any influences that might cause the station to drift. Because the AFL circuit does not affect the high quality performance of the MR 500, the switch should be used in the NORMAL position. There may be occasions when it would be desirable to deactivate the AFL circuit for manual tuning. With the MANUAL AFL switch in the OUT position, and when using the tuning knob, the AFL circuit is disabled. The AFL circuit is always active when the SCAN tuning and the feather touch preset station selection push buttons are used.

AUDIO OUTPUTS

Use the FIXED OUTPUT jacks on the rear panel to connect the MR 500 to a stereo control preamplifier or other equipment which has its own volume control. The position of the VOLUME control does not affect the loudness of the tuner at the FIXED OUTPUT jacks. The output level is 1 volt for 100% FM modulation.

Use the VARIABLE OUTPUT jacks to connect to equipment such as a power amplifier or a tape recorder where control of the volume is to be at the tuner. With the VOLUME control turned completely clockwise, the output at the VARIABLE OUTPUT jacks is 2.5 volts for 100% FM modulation. There is no difference in the signal quality at either of the pairs of output jacks; and, both pairs may be used simultaneously. The output impedance is very low so that long audio cables can be used without a loss of high frequencies due to cable capacity.

SCOPE

The vertical and horizontal SCOPE jacks are provided to connect to a maximum performance indicator or an oscilloscope which can then indicate FM multipath and signal strength. Connect the vertical jack to the vertical input of the indicator and the horizontal jack to the horizontal input.

REMOTE SCAN

The REMOTE SCAN jack provides an input for the cable push button assembly supplied with the MR 500. Plug the cable into the REMOTE SCAN jack to provide SCAN tuning at a convenient location remote from the tuner. If REMOTE SCAN tuning is not used, leave the jack free of any connection.

CONNECTING AN FM ANTENNA

One of three antenna systems can be used: (1) an



outdoor FM antenna, or (2) a VHF-TV antenna, or (3) the indoor dipole supplied.

An outdoor antenna is recommended for optimum performance in all areas. For best results in fringe (outlying) areas, use a highly directional FM antenna in conjunction with a rotator. If the antenna uses a 300 ohm down lead, connect it to the ANTENNA 300ohm FM push connectors.

A VHF-TV antenna designed for both FM and TV reception can be effective. Connect the down lead from the VHF-TV antenna to the ANTENNA 30012 FM push connectors.

The coaxial cable of an unbalanced 75 ohm antenna connects to the rear panel ANTENNA 75ohm FM type F coaxial connector.

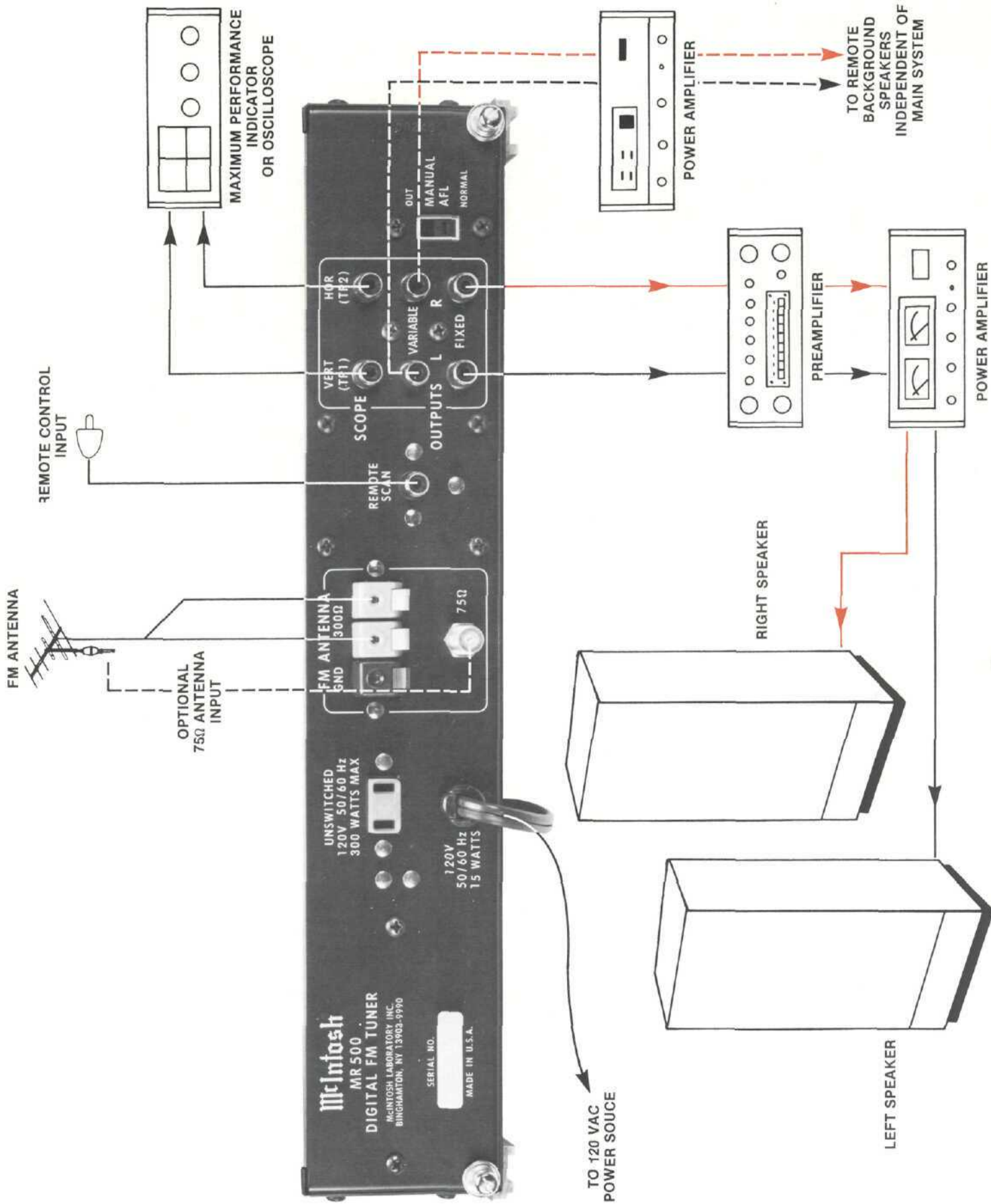
Supplied with the tuner is a flexible folded dipole antenna for use in urban or high strength signal areas. Connect it to the ANTENNA 300ohm FM push connector. The flexibility of the twin flat wire assembly permits it to be placed under a rug, tacked behind the stereo or placed in any other convenient location. In some cases, it may be necessary to "position" the antenna for best signal reception. Do this before it is permanently located. Avoid locating the antenna next to other wires or metal objects. Any indoor antenna may be ineffective in houses having metal siding or metal foil insulation.

120V AC OUTLET

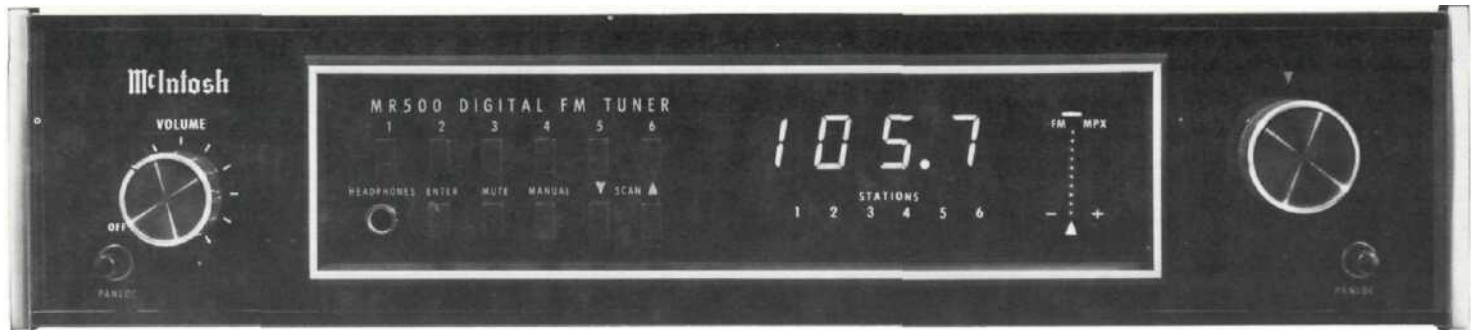
Provides a 120 volt AC power outlet with up to 300 watts available for additional equipment that has its own AC power switch. The outlet is not fused.

AC POWER CORD

Connect the AC power cord to a 120 volt, 50 to 60 Hz power line receptacle. The power used by the MR 500 is 15 watts.



Using the Front Panel Controls



On the front panel of the MR 500 there are: volume control with tuner on/off AC power switch, 6 momentary feather touch push buttons for selecting preset stations, a jack for headphone listening, 1 on/off push button for between station noise muting, 4 momentary tuning assistance feather touch push buttons, a digital frequency display, 6 preset station indicators, an all solid state tuning indicator and the manual tuning knob and indicator.

VOLUME CONTROL WITH AC POWER SWITCH

The VOLUME control has been precision tracked throughout the listening range (0 to -65 dB) for accurate stereo balance. The AC power switch is part of the VOLUME control. The output level of the VARIABLE OUTPUT jacks and the front panel HEADPHONE jack is controlled by the VOLUME control. The FIXED OUTPUT jacks are not affected by the position of the VOLUME control except when the VOLUME control is turned fully counterclockwise the AC power is turned off.

PRESET STATION SELECTING

'FEATHER TOUCH' PUSH BUTTONS

A momentary press on one of the push buttons marked 1 thru 6 will recall from the electronic memory the pre-set station assigned to that push button, the corresponding indicator under the digital frequency display will light and the station will be tuned to the exact center of the channel. AFL is then applied and precise tuning is maintained.

HEADPHONE JACK

A HEADPHONE jack is provided to drive low impedance dynamic headphones from an internal stereo power amplifier.

ENTER

The ENTER push button and one of the six momentary feather touch push buttons are used to insert into the electronic memory the desired tuned station. Stations can be selected for insertion in the electronic memory by use of either the manual tuning knob or SCAN tuning. To enter a station in the memory, tune to

the desired station with the manual tuning knob, or the SCAN tuning. Then, while pressing the ENTER push button press one of the upper row, numbered push buttons. Release both push buttons and the station tuning is recorded in the electronic memory for instantaneous recall. Because the memory is retained when the MR 500 is turned off, upon turn on it will operate in the same mode of operation and station tuning as when turned off.

THE ELECTRONIC MEMORY

CHARGING BATTERY POWER SUPPLY

A very long life, rechargeable battery power supply provides the energy for the electronic memory when the tuner is turned off. When the tuner is first connected it is wise to assume that the batteries have not been charged. The charge rate is dictated by the 'on' time of the tuner. To bring the batteries to full charge, operate the tuner for twenty four continuous hours. When fully charged, the tuner will retain the programmed instructions for more than six months with the tuner turned off. After the batteries are fully charged, using the tuner for approximately one hour per week, will maintain the batteries in a fully charged state. Battery life is dependent on usage, storage, temperature and time.

Do not attempt to remove the batteries from the MR 500. Battery replacement should only be done at McIntosh authorized service agencies.

MUTE

With the MUTE push button pressed to the IN position, weak noisy stations and between station noises are suppressed when using the manual tuning knob. Muting circuits are not active with the MUTE push button out. Muting is always active when using the preset station selectors and when SCAN tuning.

MANUAL

A momentary press of the MANUAL feather touch push button will activate the tuning knob as indicated by the lighted arrow above the knob. Rotate

the tuning knob until the frequency of the desired station shows on the digital frequency display.

A station is correctly tuned when the center arrow indicator at the bottom of the tuning indicator illuminates. On each side of the center arrow are arrows marked + and -, one of which will light as a station is approached to indicate tuning above (+) or below (-) the center of the station. When the center arrow lights, the station is center channel tuned, the FM AFL (automatic frequency lock) circuit is activated and the tuner is locked to the FM station. McIntosh AFL will give the best FM reception with lowest background noise, lowest distortion and best stereo separation.

Because of the locking action of the AFL circuit, the tuning knob can be turned, mechanically, slightly away from the frequency of the station without detuning. This makes tuning very easy but can cause the tuner to lose the station when power is turned off and on again. To prevent this, stop rotation of the tuning knob as soon as the center arrow is lighted.

A momentary press on either the SCAN or preset station push buttons deactivates the manual tuning knob and activates the tuning method selected.

SCAN

The tuner will automatically precisely tune the next station up or down the spectrum depending which SCAN push button is pressed. The arrow above the push button indicates the direction of the scan. When the remote scan cable is inserted in the rear panel receptacle, a momentary press of the push button on the end of the remote scan cable will activate the tuner scan-up circuits.

TUNING INDICATOR

Accuracy of tuning and signal strength is indicated by the 14 LED tuning indicator. At the top is a bar which, when illuminated, indicates that the tuned station is transmitting in stereo (MPX). The vertical column of 10 dots shows the relative signal strength for the received station. The greater the number of illuminated dots the greater the station's signal strength.

The three arrows at the bottom of the indicator shows above (+), below (-) or exact center channel tuning. A correctly tuned FM station will have only the center vertical pointing arrow lighted.

How the Circuits Work

TUNING SYSTEM

Today's FM electronic tuning systems can generally be classified as either a Phase Locked Loop (PLL) Synthesizer System or Voltage Synthesizer, Signal Locked Loop System.

McIntosh has selected the Voltage Synthesizer, a Signal Locked Loop (SLL) System which locks the MR 500 to the incoming signal of the FM station. With the tuner tuned to the station frequency and the correction voltage being generated by the detector "zero" crossing, all parts of the tuner, mixer, local osc., IF, etc. are inside the tuning loop and accurate tuning is assured. As long as the station transmits within the tuning range of the MR 500, regardless of frequency, the SLL system will lock on to the station and remain center channel tuned.

In contrast, in the PLL system, the local oscillator frequency is compared to a reference within the tuner, usually a crystal controlled oscillator. A comparison circuit generates a correction voltage to hold the local oscillator to an exact multiple of the reference oscillator. The frequency of the reference oscillator must be equal to the station channel spacing (200 kHz in the United States) in order to cover all the FM channels. Tuning is accomplished in discrete steps which makes it impossible to tune to frequencies between channels. In areas where FM programs are distributed by cable or non-standard frequencies, and in other parts of the world where stations may be assigned to frequencies other than those standard in the United States, proper reception is not possible. Another limit of the PLL system is that the system can generate harmonics and spurious responses in the divider chain and frequency/phase comparator. These unwanted signals will add noise interference to the received station.

The superiority of the Signal Locked Loop System made it the obvious choice for the demanding performance required of the MR 500.

On the MR 500, three modes of tuning are provided: MANUAL, SCAN and PRESET.

In the MANUAL mode a regulated temperature compensated reference voltage is fed to the tuning potentiometer. A portion of this voltage as selected by the position of the potentiometer is fed to the controller integrated circuit (IC). It is then amplified, filtered and applied to the tuning varactors. Proper tuning is always guaranteed since the output of the FM detector at zero crossing is referenced to 4.75 volts and is fed to the S curve input of the controller through a DC amplifier. If a deviation from the 4.75 volts is caused by a shift in tuning or station drift, the controller generates a correction voltage and

combines it with the voltage being fed to the tuning varactors to maintain proper tuning.

When a SCAN feather touch push button is pressed a DC ramp tuning voltage is generated, rising in voltage for SCAN up, decaying for SCAN down. The ramp continues until the zero crossing of the detector S curve is sensed at the input of the controller. The tuning voltage ramp stops and is then maintained with any necessary correction voltage added.

The tuning voltage present at the output of the controller may be put into any of the six memory push button locations at any time. Pressing the ENTER button causes an Analog to Digital conversion of the tuning voltage to take place. Then, while still holding the ENTER button, pressing one of the six numbered buttons stores the tuning information, in digital form, within the control IC memory.

A momentary press of a preset station push button will instantaneously recall the station from the digital memory. The tuning voltage retained in the electronic memory is delivered to the output of the controller. To insure proper tuning a search and fetch operation takes place. The tuning voltage is moved plus and minus its nominal value in increasing steps until the correct station zero crossing signal is received from the detector. The station frequency is captured and once again the tuning voltage is maintained with any necessary correction added. Each time a preset push button is pressed, a mute pulse suppresses any noise that may occur during the tuning process.

During the SCAN mode, an output from the controller is used to lower the tuner sensitivity to prevent weak noisy stations from being heard.

An automatically recharged long life nickel cadmium battery provides the necessary voltage to the memory to retain its instructions when AC power to the tuner is turned off. The last mode of operation used before turn off and the station frequency are retained in the memory. When the power is turned on the tuner will automatically return to the mode of operation and frequency last used.

FM TUNER

Antenna connections for 300 ohm twin lead and 75 ohm coaxial cable are provided on the rear panel. The normal input impedance of the FM-RF section is 75 ohms. A McIntosh designed and manufactured internal balun matching transformer provides a perfect match for a 300 ohm antenna. Connections for the twin lead are made with push type terminals and a type F connector is provided for the coaxial connection.

Following the antenna matching circuit is a RF tuner of exceptional performance. It uses a DMOS-FET RF amplifier, a double balanced mixer, and circuits that are tuned by a series parallel connection of four matched varactor diodes, all of which produce high spurious rejection and great sensitivity. This circuitry and the high tuning voltage (5-25V) eliminates RF intermodulation distortion caused by diode non-linearities.

The FM IF section uses 3 transistors, 3 linear phase piezoelectric filters, and one integrated circuit. They combine to provide over 120dB of gain and a selectivity greater than 65 dB. Limiting, muting, signal strength drive, and FM detection are all functions of the integrated circuit.

A phase locked loop (PLL) stereo decoder integrated circuit is the heart of the multiplex section. It has a high signal to noise ratio, low distortion, high channel separation, and high SCA rejection. The PLL MPX IC eliminates inductors to minimize drift, provides integral lamp driving capability to indicate the presence of the 19 kHz pilot, and has transient free mono/stereo switching.

Following the PLL MPX decoder is a J-FET switched filter circuit that reduces 'out of phase noise' when the MR 500 is tuned to a weak stereo station. A LC tuned notch filter is used to prevent tape recorder bias interference. The LC filter is driven from the MPX output amplifier and is terminated by the following fixed output operational amplifier. This provides the necessary filter input and output impedances for proper phase response. A low power amplifier with less than .01% harmonic distortion drives headphones output and the variable output jacks.

The MR 500 has transient free turn on/off characteristics. A light dependent resistor, whose light source is time controlled, connects the tuner outputs approximately two seconds after the power is turned on to allow all circuits to stabilize before sound can be heard.

FREQUENCY COUNTER

The frequency counter consists of two IC's. One is an Emitter Coupled Logic (ECL) buffer circuit and divide by 100 prescaler. The other is a C-MOS LSI IC that contains the reference oscillator, various dividers, latches, and LED segment drivers for the display. The LED display does not generate RF interference because it is static, not multiplexed. An adjustable IF offset is provided so that the display reads the tuned frequency accurately for the full span of IF filter tolerances.

POWER SUPPLY

The + 15, - 15, and + 5 volt supplies use IC three terminal regulators, while the +33 volt supply uses a zener diode regulator. This insures proper operation of the tuner even during periods of low AC line voltages.

Performance Limits

Performance limits are the maximum deviation from perfection permitted for a McIntosh instrument. We promise you that when you purchase a new MR 500 from a McIntosh franchised dealer, it will be capable of or can be made capable of performance at or exceeding these limits or you can return the unit and get your money back. McIntosh is the only manufacturer that makes this statement.

USABLE SENSITIVITY

13 dB_F, which is 2.5 μ V across 300ohm or 1.25 μ V across 75ohm

50 dB QUIETING SENSITIVITY

Mono - 16.8 dB_F, which is 3.8 μ V across 300ohm or 1.9 μ V across 75ohm

Stereo - 37.3 dB_F, which is 40 μ V across 300ohm or 20 μ V across 75ohm

FREQUENCY RESPONSE

Mono ± 1 dB, 20 Hz to 15 kHz.

Stereo ± 1 dB, 20 Hz to 15 kHz.

HARMONIC DISTORTION

Mono 0.08% at 100 Hz

0.08% at 1 kHz

0.1% at 10 kHz

Stereo 0.18% at 100 Hz

0.18% at 1 kHz

0.25% at 10 kHz

SPURIOUS RESPONSE

100 dB

IMAGE RESPONSE

100 dB

AM SUPPRESSION

60 dB

STEREO SEPARATION

40 dB at 100 Hz

50 dB at 1 kHz

35 dB at 10 kHz

SIGNAL TO NOISE RATIO

Mono 80 dB

Stereo 75 dB

INTERMODULATION DISTORTION

Mono 0.08%

Stereo 0.18%

ALTERNATE CHANNEL SELECTIVITY

70 dB

SCA REJECTION

60 dB

GENERAL INFORMATION

ANTENNA INPUTS

30012 balanced and 75ohm unbalanced

TUNING RANGE

88 MHz to 108 MHz

TUNING METHODS

Manual tuning.

Push buttons to select any one of six stations stored in the electronic memory.

Scan tuning up or down; scan-up can be controlled remotely.

AUDIO OUTPUT LEVELS

1V at fixed output

0 to 2.5V at variable output and headphones.

POWER REQUIREMENTS

120V, 50/60 Hz, 15W

SEMICONDUCTOR COMPLEMENT

33 Transistors

15 Integrated Circuits

8 Varactors

20 Light Emitting Diodes (LED's)

34 Diodes

MECHANICAL INFORMATION

SIZE:

16 inches wide (40.6 cm) by 3 5/8 inches high (9.2 cm) by 2 3/8 inches high (6.0 cm) by 14 1/2 inches deep (36.8 cm), including connectors. Knob clearance required is 1 1/4 inches (3.2 cm) in front of mounting panel.

FINISH:

Front panel is anodized gold and black with special gold/teal nomenclature illumination.

Chassis is black.

MOUNTING

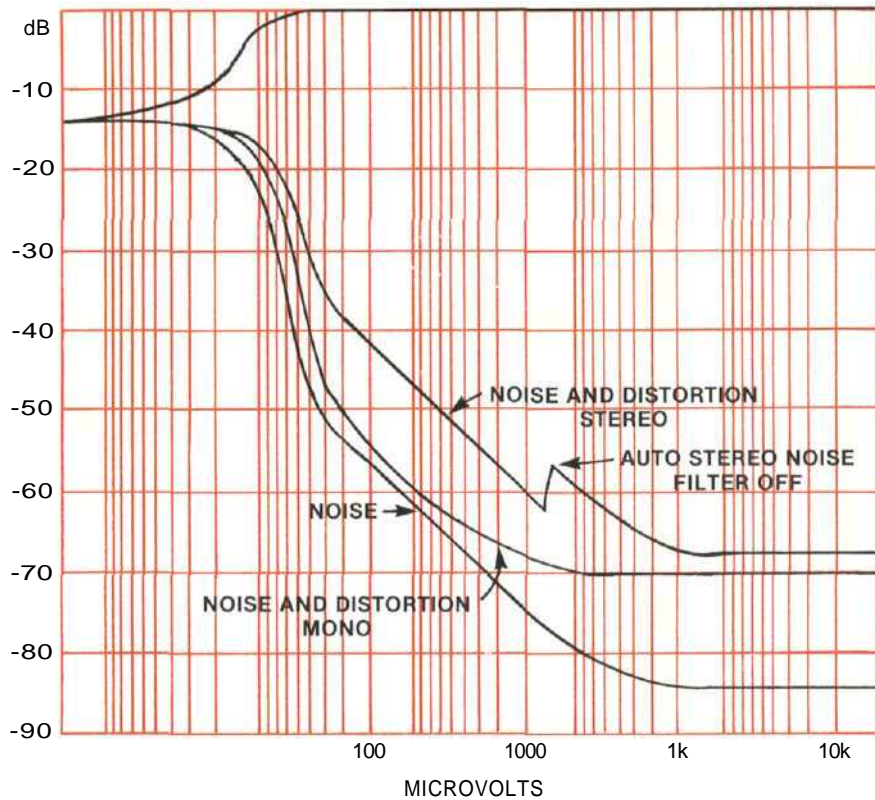
Exclusive McIntosh developed professional PANLOC

WEIGHT:

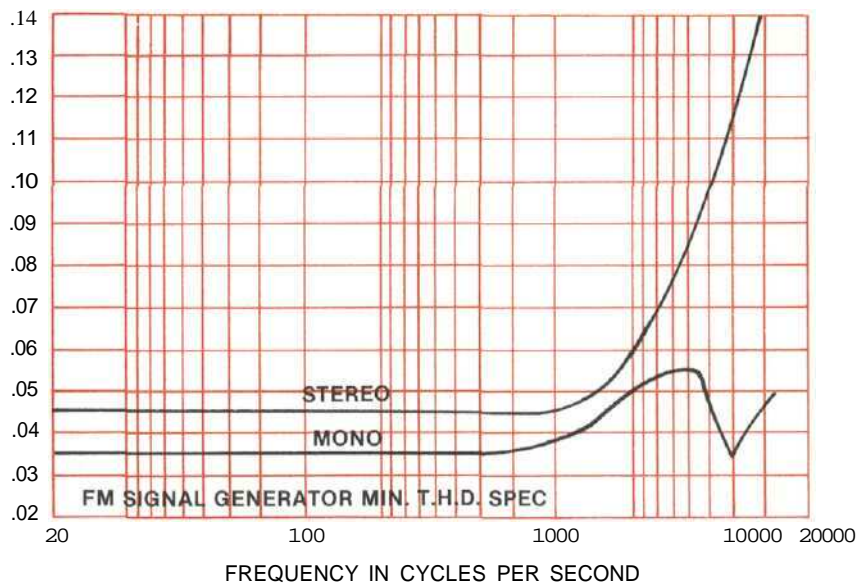
18 pounds (8.2 kg) net, 30 pounds (13.6 kg) in shipping carton.

Performance Charts

MR 500 FM SIGNAL PERFORMANCE
98 MHz, 1 kHz MOD 100%

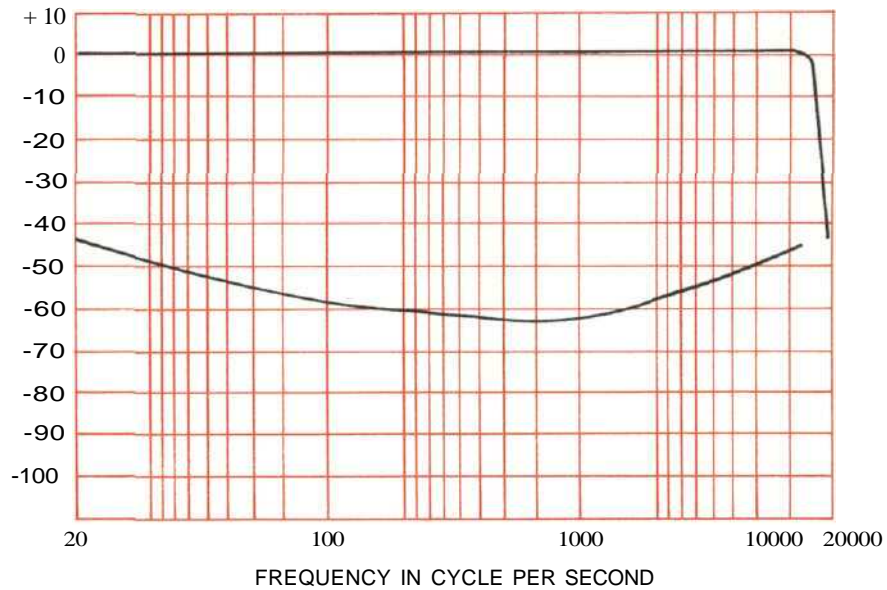


MR 500 T.H.D. @ 100% MODULATION
98 MHz



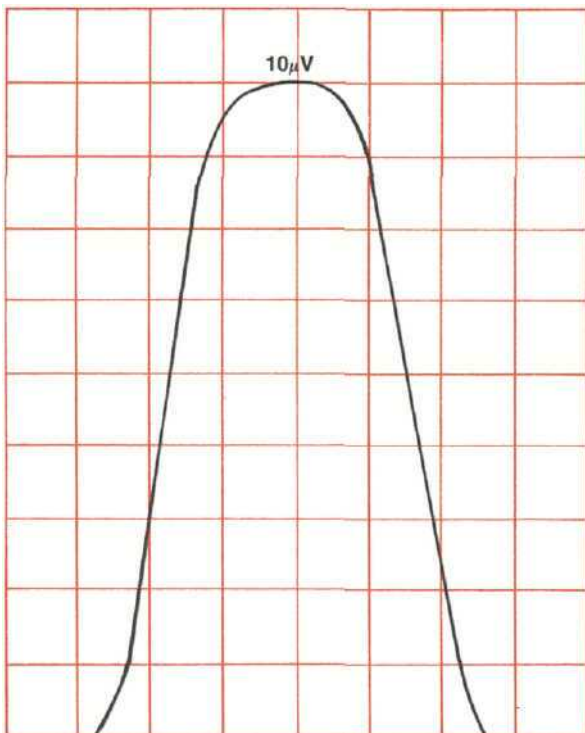
Performance Charts

MR 500 FM FREQUENCY RESPONSE
AND SEPARATION



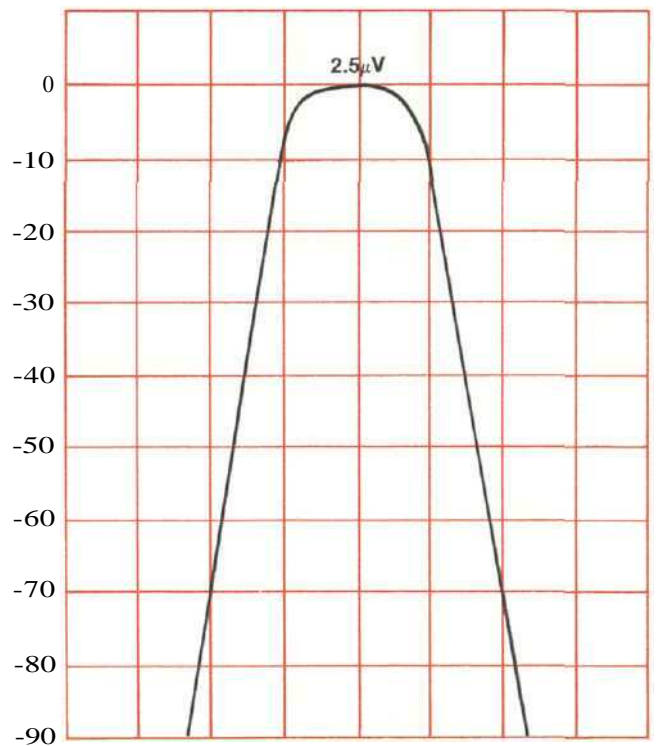
MR 500 SELECTIVITY
DEV IN kHz

-600 -400 -200 0 +200 +400 +600

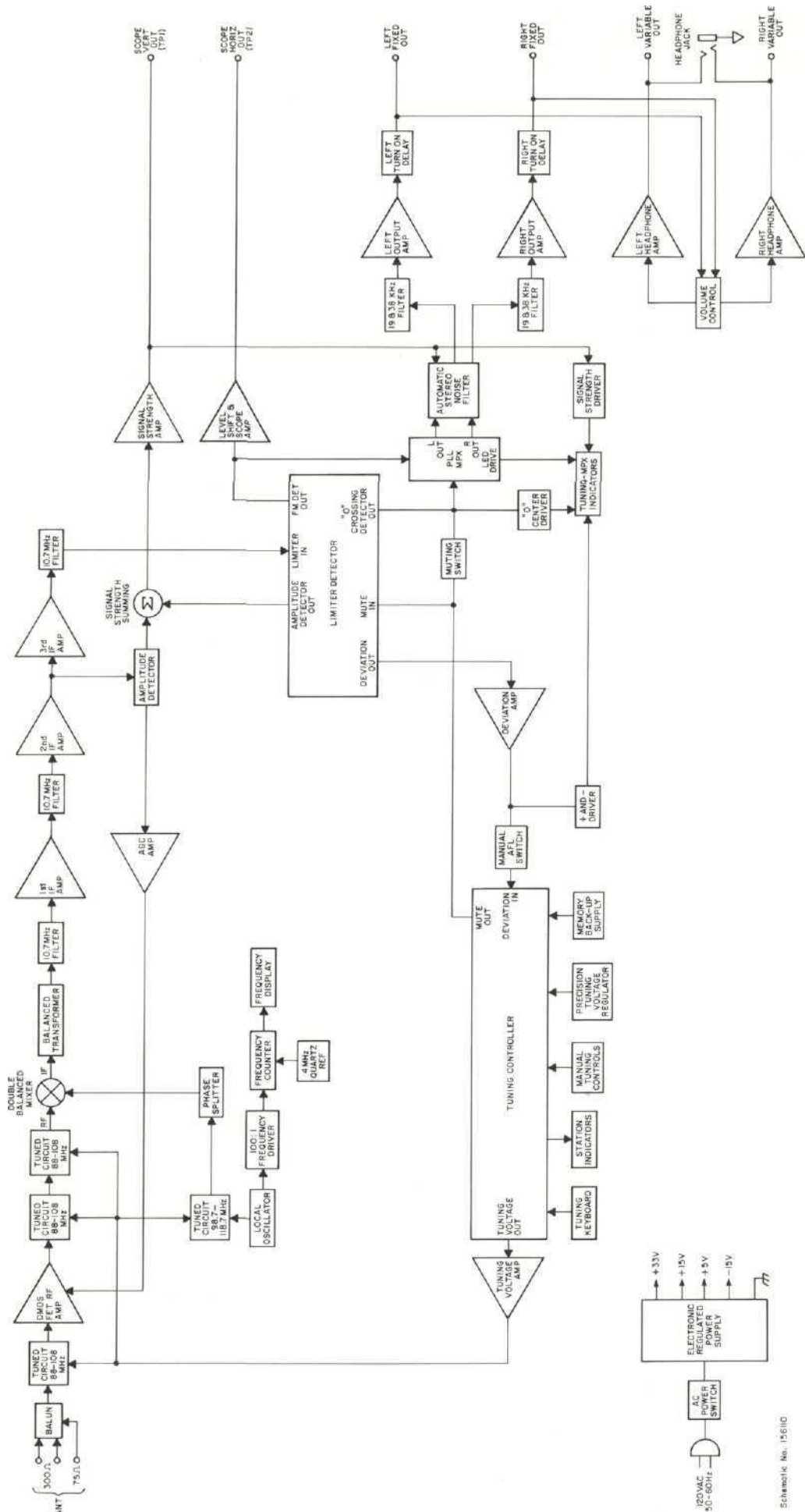


MR 500 SELECTIVITY

-600 -400 -200 0 +200 +400 +600



Block Diagram



Schematic No. 156110

VARIOUS REGULATORY AGENCIES REQUIRE THAT WE BRING THE FOLLOWING INFORMATION TO YOUR ATTENTION. PLEASE READ IT CAREFULLY.

WARNING: TO PREVENT FIRE OR SHOCK HAZARD, DO NOT EXPOSE THIS UNIT TO RAIN OR MOISTURE.

The McIntosh you have purchased is a Model MR 500. It has a serial number located on the rear panel of the chassis. Record that serial number here:

Serial Number

The model, serial number and purchase date are important to you for any future service. Record the purchase date here:

Purchase Date

Upon application, McIntosh Laboratory provides a Three-Year Service Contract. Your McIntosh authorized Service Agency can expedite repairs when you provide the Service Contract with the instrument for repair. To assist, record your Service Contract number here:

Service Contract Number

McIntosh

McINTOSH LABORATORY INC.

2 CHAMBERS ST., BINGHAMTON, N.Y. 13903-9990

607-723-3512

The continuous improvement of its products is the policy of McIntosh Laboratory Incorporated who reserve the right to improve design without notice.

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